COMITATO NAZIONALE PER L'ENERGIA NUCLEARE
Laboratori Nazionali di Frascati

LNF - 63/11

Report n. 13

ACTIVITY AT THE NATIONAL LABORATORIES OF FRASCATI

July 1, 1962 - December 31, 1962

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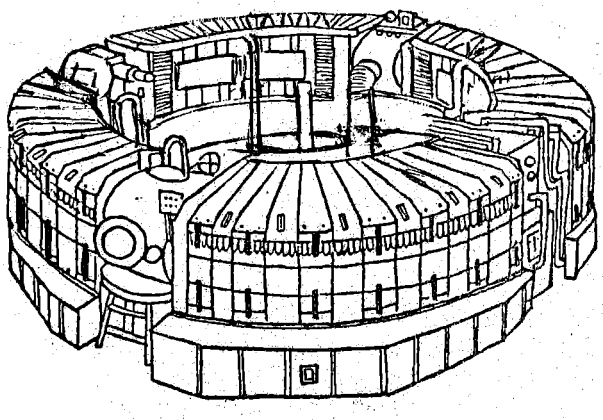
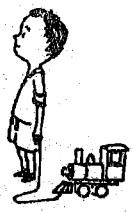
Febbraio 1963





About ten years aged

We are glad to remember to the reader that 10 years ago, exactly on February 6th 1953 the Consiglio Direttivo of Istituto Nazionale di Fisica Nucleare, decided the building of a quite large electron accelerator.

The italian 1.1 GeV electronsynchrotron, built by a staff of people headed by Prof. G. Salvini, started operating at the design energy 4 years ago, on February 9th 1959.

Looking around to the Frascati Laboratories of the Comitato Nazionale per l'Energia Nucleare, we cannot avoid to think with pleasure of the work made during these 10 years, and to look with hope and confidence to the future developments of the Laboratories, engaged in a new and original project of colliding beams machine.

With the best thanks and wishes for all people interested and working for the development of the Frascati Laboratories let us say

Evviva

Frascati, February 1963.

The Frascati Staff

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CHAPTER I - ELECTRONSYNCHROTRON.

1. OPERATION.

During the second semester of 1962 the machine runned continuously, except about ten days in August because of the holidays and eight days in October due to failures.

Table I. 1 shows the operation of the machine; on the whole, the machine was used by experimenters for 6,000 hours (4,500 hours of effective beams); the weekly average was 115 hours.

TABLE I. 1

Resume of machine hours used during 1962

	hours	% 1962	% 1961	% 1960
Experiments	6.000	69	62	63,5
Preparation of experiments	500	6	11,5	14
Machine tests and maintenance	700	8	9	7
Conditioning and putting into operation	300	3,5	4	4
Failures	900	10	6,5	8
Off-time for holidays.	300	3,5	7	3,5
Totals	8.700	100	100	100

Table I. 2 shows the hours that have been lost due to failures according to sources of failures.

During the stop in August we carried out maintenance works: overhauling of the condensers batteries, of the rotating groups, and of the heat exchangers of the magnets etc.

The eight days stop in October was needed by hardly identifiable failures. During this period were carried out an overhauling of the all correcting coils and some magnetic measurements on the electronsynchrotron magnet. The results of these measurements agree, within the experimental errors,

with the ones carried out in 1959 and 1960.

TABLE I. 2

(Hours lost due to failures)

	hours	%	hours 1961	hours 1960
Network	25	3	30	30
Magnet	65	7	50	20
Vacuum	140	15	130	160
Injector	130	14	150	250
Radiofrequency	60	7	40	120
Controls	240	27	70	60
Beam Searching	240	27	80	60
Totals	900	100	550	700

The average beam intensity at 1,000 MeV kept about 5×10^{11} quanta per minute (about 2.5×10^{11} Q/min. using an 18 mm collimator 2.50 m distant).

In the experimental room we continued the normal work for fixing and alternating the experiments. The storage ring (AdA) has been removed and set up in the linear accelerator laboratory of Orsay. Frascati ω ° experiment has gone to the "beam 3" and a rotating platform (capacity 30 tons) has been set up with an analysing magnet for the new experiment "Padova K" .

All told, during last 6 months 12 experiments worked in the experimental room. Figure I. 1 shows the data relating to December. The machine hours arrangement has not changed; the machine runs continuously with a daily 2 - hours stop.

As told in our preceding report, from the beginning of this year, the experimenters have given, for each run used, an estimate on the efficiency of the machine, taking into account especially the beam intensity and stability in connection of the requirements of the experiments.

The average efficiency of the machine throughout 1962 was about 90%, according to the experimenters. Figure I. 2 shows the efficiency (percentage) of the machine weekly averaged.

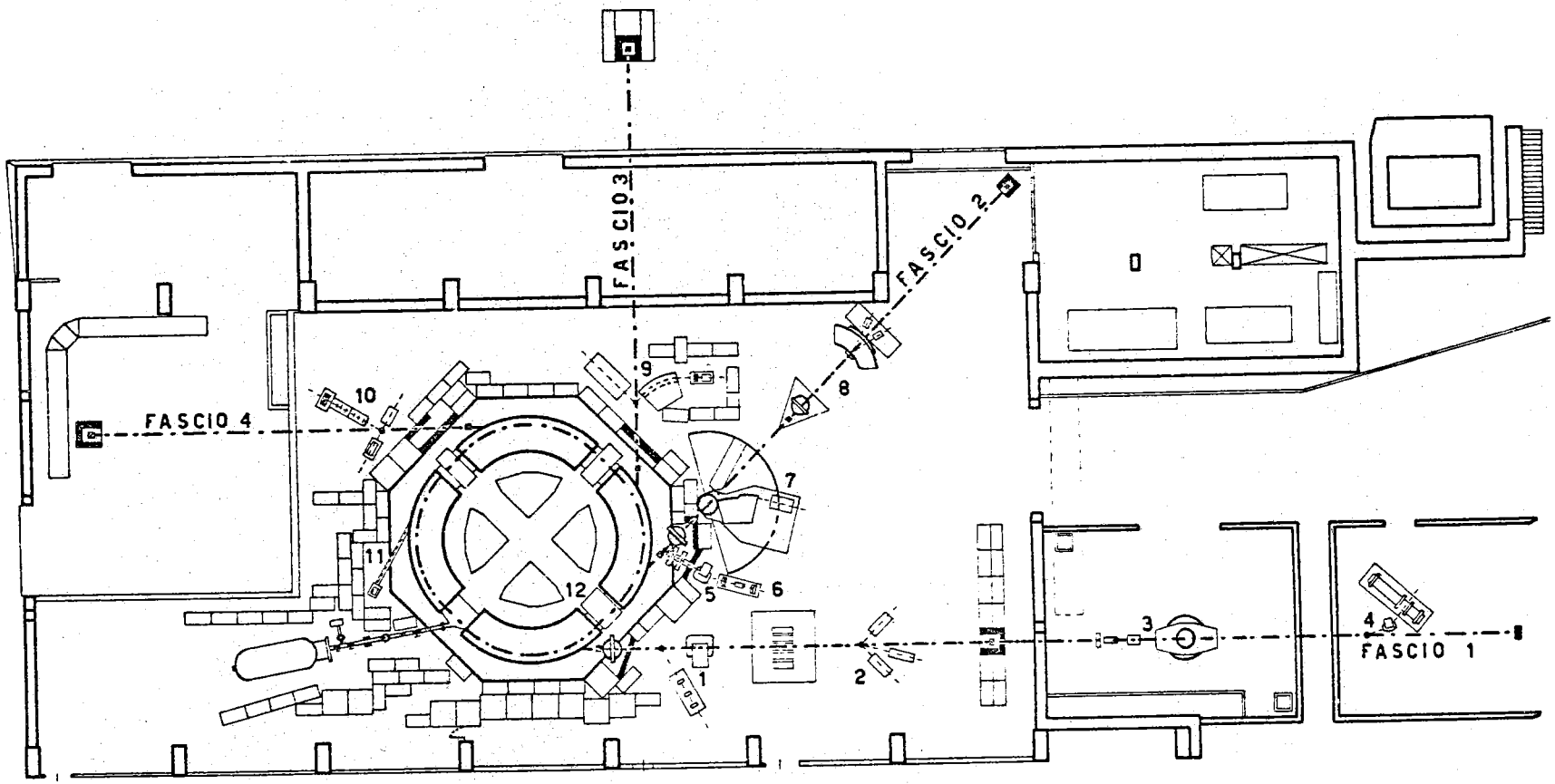

FIG. I.1 - SYNCHROTRON BUILDING. EXPERIMENT'S LAYOUT

1 – PISA – FIRENZE
2 – SANITA' π^0–ω^0
3 – GENOVA CAM. A DIFE7 – PADOVA K
4 – GENOVA CAM. A BOLLE8 – MONOCRISTALLI
5 – ROMA τ
6 – CATTURA π^-
9 – FRASCATI ω^0
10 – FRASCATI η^0
11 – SANITA' LUCE IRRAG
12 – SCATTERING e – p

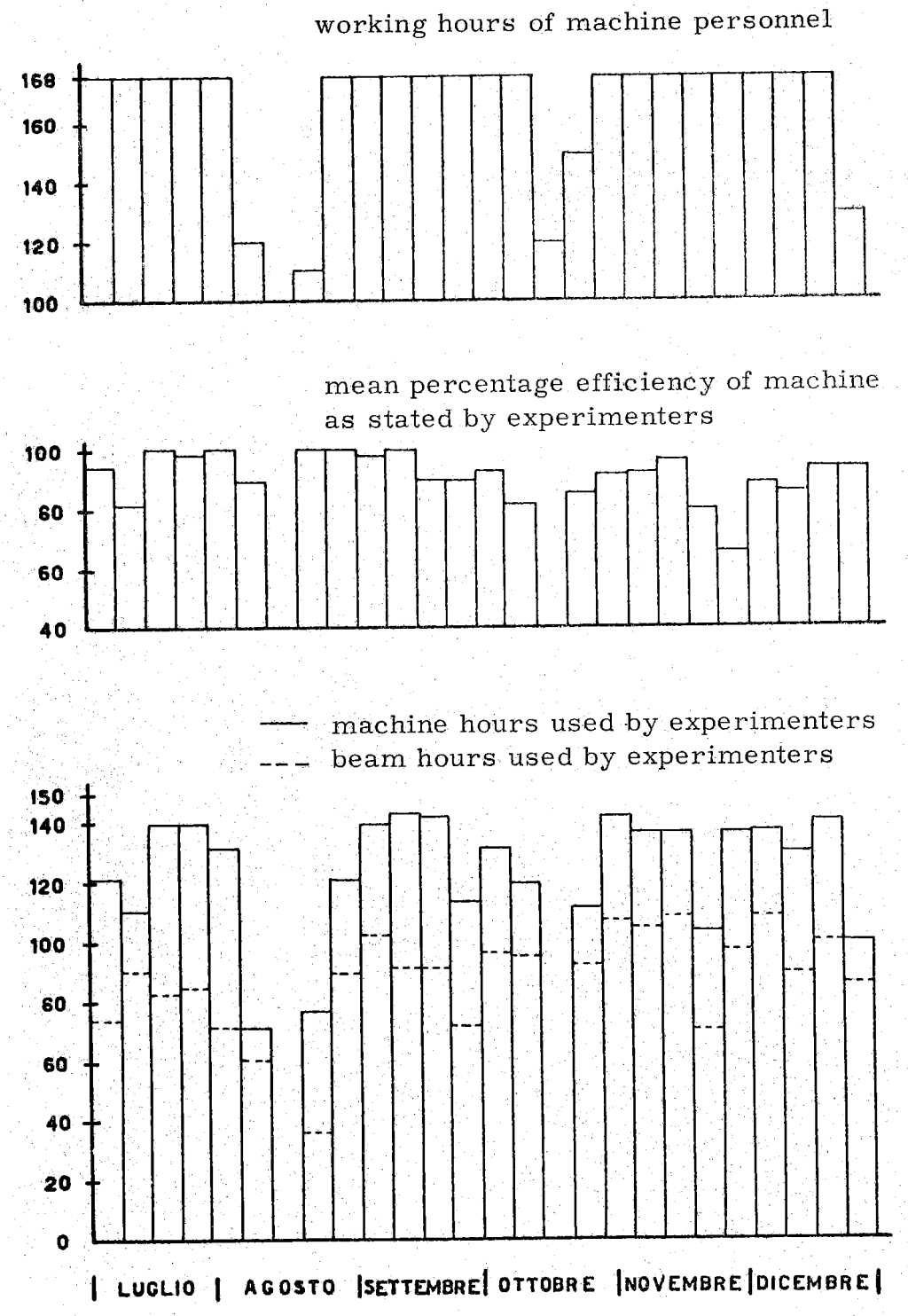

FIG. I.2 - MACHINE FUNCTIONING FROM 7.2. TO 12.30.1962.

2. LABORATORY ACTIVITY.

During the second semester of 1962 most of the laboratory activity was concentrated on works of normal maintenance and improvement of electronic equipments of the electronsynchrotron. A new voltage supply of the electrostatic deflector has been finished and put into operation whereas the old one is being repaired. A new Voltage divider of the Van der Graaff is under way. It will replace the one operating (which is defective) with an improvement of the Van der Graaff tension stability.

A new pulser for the source of the injector is being set up as well as a magnetic cylindrical lens is being made.

By next March the collimators now operating will be replaced by other collimators which will have better mechanical stability and will allow to well reproduce the movements; by the same time the internal targets will be replaced by other targets with a radial movement respect to the vacuum chamber, precise in 0,1 mm.

We continue also the test of the pulsed betatron. Many technological difficulties arise in connection to the tension and vacuum.

CHAPTER II - ACTIVITY OF THE LABORATORIES.

1. CRYOGENIC LABORATORY.

During the period August-December 1962 750 lt of hydrogen, 870 lt of helium, 15,700 lt of nitrogen and air have been liquefied.

The quantity of liquid nitrogen produced in our laboratory did not meet our requirements and 46,000 lt have been purchased from private firms.

The T. B. T. liquefier has successfully been tested. The effective production exceeded the nominal one, even not working at the highest pressure. As a matter of fact, working at about 100 atmospheres, we liquefied 68 lt/h of normal hydrogen and 38 lt/h of converted hydrogen. Furthermore, being the ortho-para conversion highly efficient, the evaporation of the containers for the hydrogen produced by means of this new liquefier, has been remarkably improved respect to the Collins liquefier.

In the "Liquefier building" the safety measures have been improved: all the electric network has been done again and the electric leads and lamps have been set into pressurized tubes and globes; moreover four new powerful fans have been installed, which allow 20 changes/hour during liquefying operation.

The new electric board, centralized for the whole liquefier's building is nearing completion.

At present in the experimental room, 5 liquid hydrogen targets are operating:

W1	Sanità π^o - ω^o	experiment	- beam 1
W4	Frascati η^o	experiment	- beam 4
HD1	Padova K	experiment	- beam 2
HD2	Pisa-Firenze	experiment	- beam 1
HD3	Frascati ω^o	experiment	- beam 3

The HD4 target is being tested and is foreseen to be set on the beam 2 for the "Monocristalli experiment" in the Electronsynchrotron experimental room by early 1963. The HD5 target has been started to be made for the Frascati η^o experiment.

In the field of foundamental research the measurements of the ion currents in rotating superfluid helium and of the ion mobilities in ^{3}He conti-

nued. Two papers on these subjects were presented at the VIII Congress on low temperature physics held in London last September[1, 2].

A magnetic susceptibility thermometer has been made for temperatures below 1° K[3], which will be used especially after putting into operation of the adiabatic demagnetization cryostat.

In the "B. T. 2" laboratory a magnet (adiabatic demagnetization) has been set up as well as the 80 KW supply ($1^{o}/_{oo}$ stabilization), which has been tested. In this laboratory preliminary tests have begun in liquid helium for the calibration of the above mentioned thermometer. The adiabatic demagnetization cryostat is nearly finished.

The "B.T. 3" laboratory in the "Sud 1" building has just begun to work. This laboratory is at disposal of internal and external experimenters who require liquid helium temperatures.

In this laboratory, not yet completely equipped, experimenters of our "Magnetic Group" carried out many experiments on superconducting magnets, to whom about 300 lt of liquid helium have been supplied.

2. "RAFELE" LABORATORY.

a) Radio-frequency Laboratory.

In our laboratory the following works have been carried out.

We made and tested a power supply for the radio-frequency (70 MHz) for the storage ring "AdA". This apparatus can supply a power of 1 KW also for long time. It is possible to modulate the voltage in the preferred manner.

A new type of power cable (made in these laboratories) between the final amplifier and the resonant cavity has been used. So we get a large flexibility of operations.

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(1) - G. Careri, W. D. McCormick and F. Scaramuzzi, "Helium ions in rotating helium", Eighth Int. Congr. on Low Temp. Phys., Londra 1962, pg. 215.

(2) - I. Modena, "Ionic mobility in liquid He^3", Eighth Int. Congr. on Low Temper. Phys., Londra 1962, pg. 156.

(3) - E. Vitale, "Progetto e costruzione di un termometro a suscettività magnetica", Tesi di Laurea, Roma 1962 (Relatore dr. I. Modena).

A 3 KW-40 MHz amplifier for the electronsynchrotron machine has been carried out and tested.

This apparatus has been made as a part of the project for an E_{max} = = 1500 MeV for our electronsynchrotron.

We theoretically studied the effect of the electron loading on the accelerating cavity from a general point of view. (Part of the results has been published(1)). In the same time we studied this problem for the particular case of linear accelerators.

The problem of pulsed deflectors is the argument of a thesis.

In Chapter IV (Adone) is reported the work made by our laboratory in connection to this machine.

b) Electronics Laboratory.

For several groups we develop the following circuits:

1) For A. d. A. group:
   a) fast coincidence resolving time 5 ns with three outputs
      1 - 50 ns, + 18 V amplitude on 125 Ω formed pulse.
      2 - 1 μs, + 18 V amplitude on 125 Ω formed pulse.
      3 - 25 ÷ 100 ms, + 8 V amplitude on 1000 Ω, variable width pulse delayed of 1 μs from coincidence.
   b) fast anticoincidence resolving time 5 ns with two outputs
      1 - 1 μs + 18 V, on 125 Ω formed pulse
      2 - 10 μs + 18 V, on 125 Ω formed pulse delayed of 1 μs from anticoincidence.
2) For experimental groups:
   a) a fast linear gate with 0,4 V pedestal, up to seven volts maximum input pulse and the gate generator of 10 + 40 ns, 3 ns rise time, cable formed width, 0,5 V minimum starting pulse.
   b) a fast non linear gate: minimum input amplitude 0,7 V+ 0,5 V for gate. Delay from start of the gate 7 ns.
   c) A pulse height digitizer from 0,2 to 5 V input and 0 + 33 output pulse. The frequency of output pulse is 1 MHz: the amplitude -18 V. The digitizer has been used in serie with a decade counters memory unit to obtain a parallel presentation for H. P. type H. O. /561B printing unit that ac-

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(1) - See LNF-62/90.

cepted the digitalization of 4 different channels. Three channels of the memory and printing unit have been used to classify the input events of the chain.

This work is the object of the report LNF-63/1.

d) We have assembled a spark-chamber films semiautomatic reading table. The films projected on a trasparent board could be read by an operator with a special purpose reading head which mechanically transfer the x, y reading to a digital voltmeter (type NLSV35) through two potenziometers actuated by wheels rotating on racks. The sensibility obtained is about 200 digit/cm. The mean square error about 4 digit on 10^4 digits.

The output of the voltmeter has been directly connected with IBM 526 punching machine. A board for introducing external refer numbers and servicing for IBM 526 have been prepared with the possibility of punching three or four decimal digit for every coordinate.

3) For technological-group:

a) A 200 V saw-tooth wave generator of 1, 2, 5 μs width on 125 Ω output

b) Amplifier with integration for the preceding generator to allow it to start with pulse width of 1 ns and 1, 5 V or 0, 5 ns width and 3 V pulse amplitude.

4) For magnets group:

A timing circuit for the discharge of a bank of condensers:

Device characteristics:

Internal clock 10 c/sec start pulse: triggering pulse 50 mV heigth positive or negative actuating directly the outputs circuits: internal clock from 0. 5 to 0. 02 c/sec continuously variable actuated automatical or by push-button starting internal logic-functions, that is:

Continuous variable delay from 2 to 5 sec, with an output for a circuit of acoustic-advisators, followed by a continuous variable delay 1 to 2 sec with output contact for actuating a camera, and by a fixed delay of 0, 5 sec the output of which allows the start of the discharge sequency.

The outputs are as follows:

Two pulse + 150 V, 3 μs width, delayed one from the other 2 + 10 ms or 10 + 100 ms continuously variable for actuation of main tyratron tubes.

The research work has only dealt with fast electronic applications.

First it has been developped a bridged tunnel diodes discriminator with very low energy absorption that can therefore be used directly on a cable without deteriorate the pulses through it. It has been the matter of the report n° 158

(5/9/62) LNF 62/73.

We have studied the problem of pulse height digitalization and realized a fully-transistorized converter that accepts input pulses from 50 mV to 0,8 V 10 + 40 ns width, corresponding to 1 + 99 digits on 4 μs time conversion (25 MHz output frequency), or to 3 + 1,25. 10^3 digits on 50 μs, or to 3 + 2,5. 10^3 digits on 100 μs. The temperature stability is 10^{-4}/°C from 20°C to 35°C and 5. 10^{-4} up to temperature of 60°C. Overall stability of the device is about 4. 10^{-4} up to 35°C.

The problem of high speed counting has been developped, first realizing a transistors five binary decade counter according to the special logic suggested by Zoltan Tarcy-Hornoch, secondly studying tunnel diode flip-flop stage.

We obtain a correct decoding for the decimal counter using transistors 2N709 and Q6/100 diode logic for a maximum input frequency of 148 MHz: this has been realized using a special low inductance extremely compact structure. The reproducibility of the mounting is reliable and really easy. With tunnel diode flip-flop the maximum frequency reached is 250 MHz.

The matter of fast counting will be referred on future reports.

3. ELECTRONIC SHOP.

During the second half of 1962 the Electronic Shop began work on reorganizing the supply of electronic components and of the standards used in our laboratories.

This reorganization is being made according to two programmes and namely: "Operazione EL. MA. CA. CO" (concerning the purchase of electronic components) and "Standard E. S. O. N. E." (mechanical and electric standards for the realization of electronic circuits).

1) "Operazione EL. MA. CA. CO".

This programme (Electronics: Manual of the Characteristics of the Components) intends:

a) to have a store technically adjourned;

b) to purchase components after a careful selection;

c) to avoid the superabundance of orders;

d) to predispor purchases in time;

e) to have minimum supplies;

f) to avoid having useless supplies.

For this purpose a systematic study has begun of the different items concerning the electronic components of which the greatest use is made. Untill now the following materials have been selected: resistances, condensers, coaxial connectors and semiconductors.

At the same time, a folder is issued concerning the selected items including the types and quantity of components chosen.

2) "Standard E. S. O. N. E. ".

The "Standard E. S. O. N. E. " (European Standard of Nuclear Electronics) is a very flexible modular standard fit for both value and transistor circuits.

This standard has already been officially adopted by C. E. A. (France), by Desy (West, Germany) and by EURATOM. Firstly, only a few of the rules will be adopted at Frascati relating to this standard and namely the ones concerning both mechanics and two voltage supplies (+ 24 and - 24 V).

We have just the modular plug-in units and the stabilized suppliers. The containers and the connectors are expected to be delivered in a short time by the furnishing firms.

On the same time the Electronic Service continued the normal activities of assistance to the other groups of our laboratories, including the research groups.

4. MAGNET AND MAGNETIC MEASUREMENT LABORATORY.

a) Pulse magnets.

A new frame with reduced dimensions was tested to CERN respect to the old one which allowed us to reach high fields. But this frame is not enough for the coils with which we obtain fields > 150 Kgs.

A group of Berna University (Prof. Winzler) used for its experiences on the magnetic momentum of the Σ, the coils prepared precedently with the heavier frame.

b) Condenser bank.

We have completed the 135 Kj condenser bank design and part of these is in advanced building (the connection of the ignitron, the trigger electronic, the metallic cages for condenser's arrangement and some condensers).

c) Superconductivity.

1) Tests are proceeding on the superconductor magnets realizing with two different coils, one with Nb - Zr at 33%, the other one with Nb - Zr at 75%, 37 and 38 Kgs respectively. The dimensions of the coils are reported in fig. II. 1a and II. 1b.

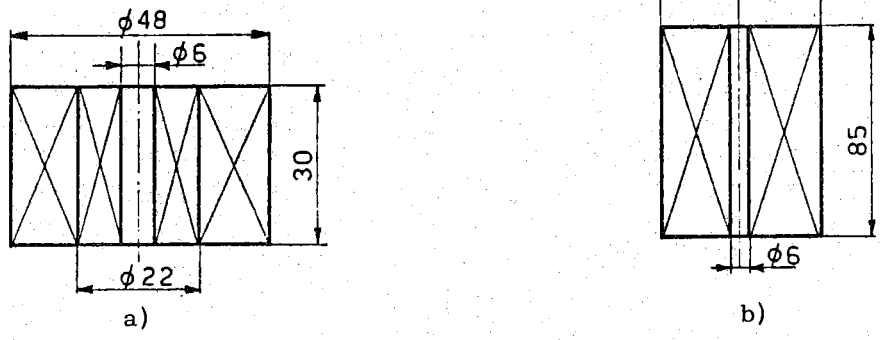

FIG. II. 1

We could not yet test bigger coils, just ready, for the delay in the delivery of the dewar. This dewar has been designed by us with an inner variable diameter still up a maximum of 250 mm.

2) Some semiquantitative tests are performed on the α radiation effect from P_o^{210} on the superconductors. We have got a ring of Pb of the thickness of 2μ by electrolytic deposition on a cylindrical source of P_o^{210} of some mc of activity (ϕ = 10 mm, h = 5 mm).

The trapped flux decays according the curve on fig. II. 2. The most probable

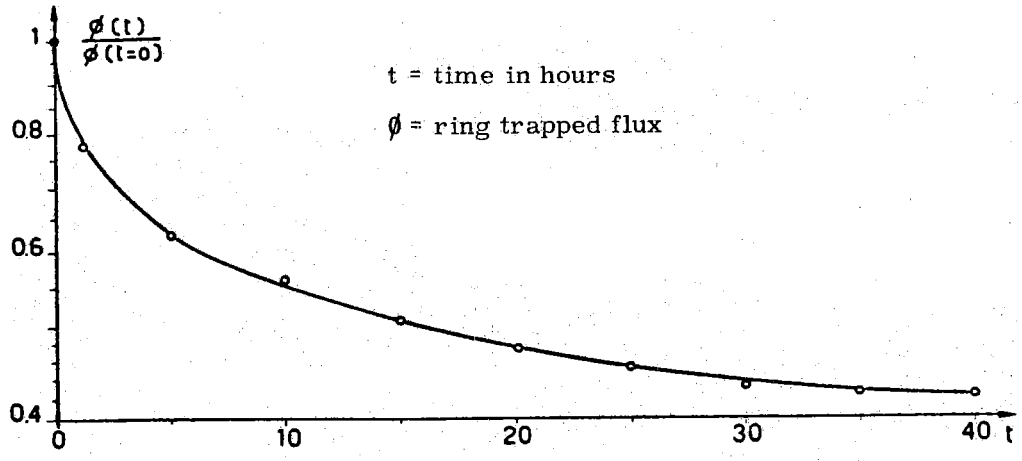

FIG. II. 2

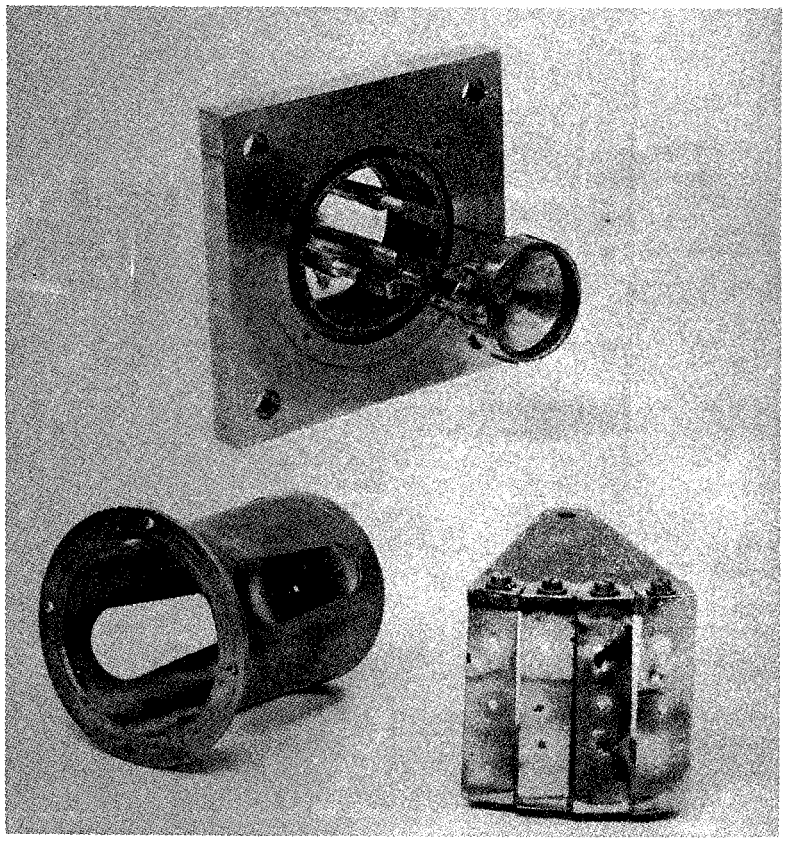

Fig. II. 3

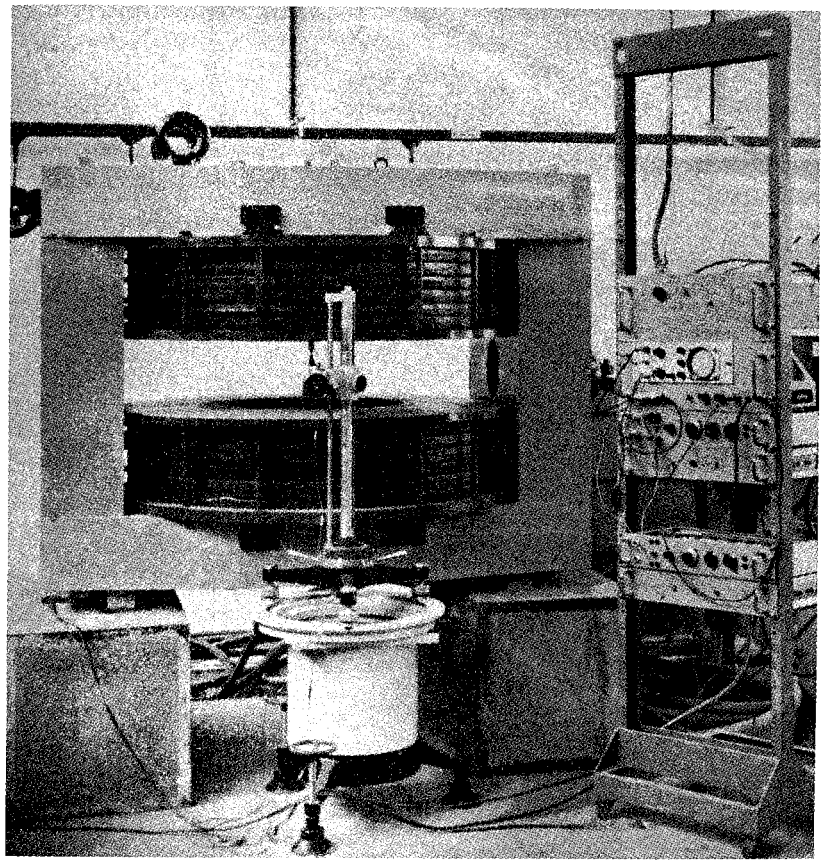

Fig. II. 4

interpretation is that the effect is due to the α particles.

We are on the point of refining the measurements to obtain more accurate informations.

d) Metallization bank under vacuum.

The construction of the metallization bank under vacuum has continued (liquid air traps, high speed (600 lt/sec) Hg diffusion pumps). We tested an electron gun to evaporate metallic Nb.

In fig. II. 3 we report some details of the electron gun.

The vacuum design was made with the collaboration of Dr. Habel.

e) Magnetic measurements and "normal" magnets.

We are constructing NMR fluxmeters with electron-tubes while we are preparing some transistorized instruments.

We were very engaged for field measurements on superconductor and normal magnets.

We started the construction of an α-apparatus (source of P_o) for the calibration of magnetic channels.

A magnet (fig. II. 4) for diffusion chamber (INFN, Torino) has been carried out. This magnet has some rings to get an uniform magnetic field.

5. TECHNOLOGICAL LABORATORY.

During the second semester of 1962 we have been studying the possibility of improving the construction techniques of image-intensifying tubes.

Particularly we studied the problems of the leak currents on the tube walls and of the cold emission, due to the Cs let in the tube during the construction.

A technique has been developped in detail which allows to reduce noticeably this trouble, thus enabling a higher working tension.

At the same time some work has been done in order to improve the tube assembly.

At present all the glass-metal weldings are done in inert atmosphere.

A collaboration has been started with the Space Research Group of the Rome University, in order to realize an equipment for the detection of low energy charged particles, to be used for experiments on satellites.

The glass blowing shop has been completely equipped, so that we are now able to solve every problem connected with the production of glass equipments.

A new donut is being built for the electronsynchrotron.

6. COMPUTING DEPARTMENT.

The installation in August of a card-type input-output unit has permitted the statistical elaboration of experimental data. Up to now, two groups have taken advantage of this possibility. The bubble chamber group of the INFN, Rome Section, is at present elaborating events obtained at the CERN Protosynchrotron at Geneve. For the Pisa-Firenze group of the INFN have been made the programs of elaboration of the heights of the impulses in S4 and S5 counters for the determination of the forward angular distribution in the reaction $\gamma + p \rightarrow p + \pi^0$ with the dE/dx technique.

The time distribution of the calculator is shown in the table. In general, the machine is barely sufficient to satisfy the present demands of the Synchrotron Laboratories and of the INFN research groups. Analyzing the occupation time of the machine from Sept. 15, 1961 to Sept. 14, 1962, it is seen that everything happens as if the machine functioned continuously, except for Saturdays, Sundays, and during the month of August.

Table of use of the 1620 I. B. M. from July I to November 30, 1962

(Number in the table express hours)

	July	August	September	October	November	TOTALS
Experimental groups, high-energy, Electron synchrotron services, Adone, Computing Dep.	381	90	323	389. 25	377. 5	1560. 75
Laboratori Gas Ionizzati	136	85	96	22	1. 5	340. 5
INFN research groups	44	22	50	174. 25	44	334. 25
Lost time(x)	2	33	42	107. 5	213	397. 5
Free time	181	514	209	51	84	1039

(x) - Machine breakdowns, interruptions of current, installation of new supplementary units, moving of the machine, etc.

N. B. - This table has been compiled from the point of view of the machine functioning continuously.

Considerable effort continues to be devoted to didactic activity, so as to put the researchers in condition to use the calculator autonomously, at least for the most simple calculations, and this activity seems to be successful. The graph attached shows (dotted curve) the production of work executed independently by researchers of the Synchrotron Laboratories, the INFN, and the Laboratory of Ionized Gases, compared to the production of the Computing Department (full curve). (see fig. II. 5).

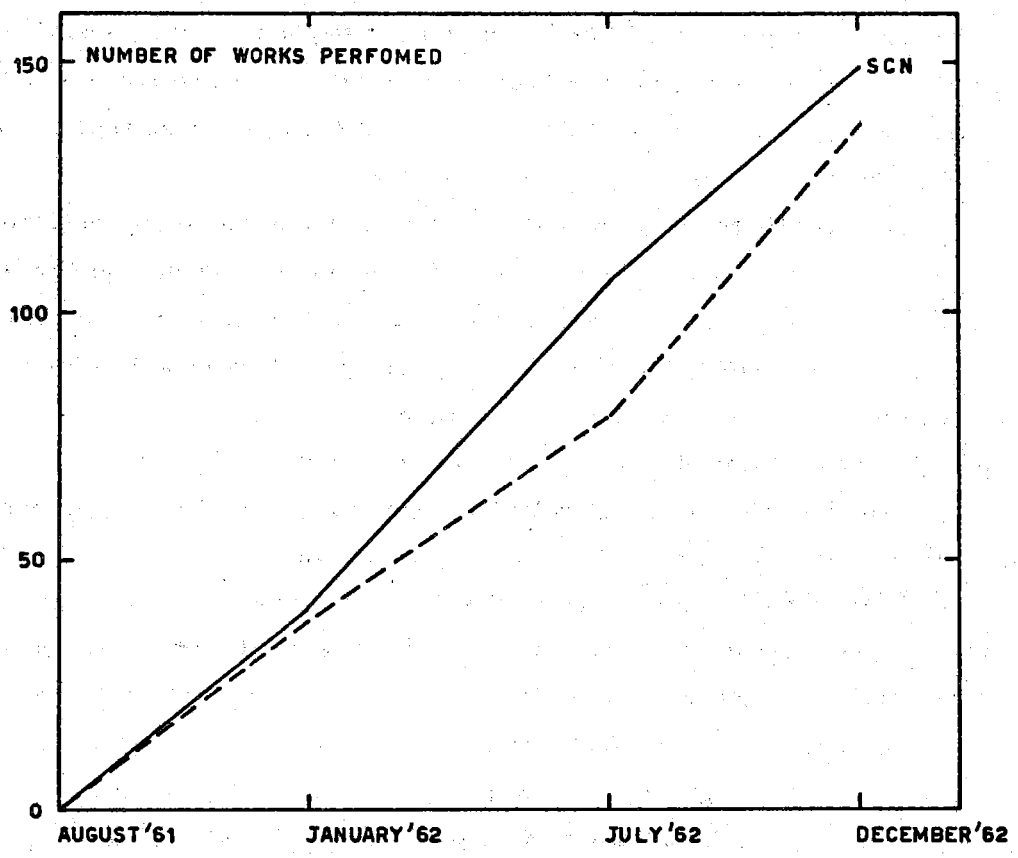

FIG. II. 5

This didactic compaign (rendered possible by the facility of the FORTRAN language) is conducted with the hope of reserving in the future the personnel of the Computing Department almost exclusively for work of difficult execution for which a specialization in mathematical, numerical, and coding techniques is necessary. Such work may not only be of use to the particular user, but also be of general use, and anyway is based on research in the fields of these techniques.

Two works have required the use of the I. B. M. 704 of the "Centro di Calcolo" of the CNEN at Bologna. One of these was for the Dosimetry Laboratory, and one for the "RAFELE" Laboratory.

7. THEORETICAL GROUP.

The Theoretical Group has continued to occupy itself with problems relative to future experiments with AdA-ADONE. In particular it has continued the calculations of the radiative corrections of electrodynamic processes at high energies.

The specific calculation which includes the contributions of hard photons in the production of pairs of μ mesons in electron-positron collisions has been concluded. In addition the contribution to electrodynamic processes of virtual state particles of strong interactions, in particular of vector mesons, has been calculated. In these calculations the recent data of the cross sections of the vector mesons has been taken into account.

In relation to the experimental activities with the electronsynchrotron the Theoretical Group has been working on the problem of production and analysis of beams of linearly and circularly polarized photons at high energies. Also the problem of photoproduction of neutral mesons in deuterium with polarized photons is being worked on. The object being to measure the $\gamma - \omega - \pi$ coupling constant. The contribution of the η_0 on the proton Compton effect and the possibility of discriminating by using polarized photons, a contribution due to an s-wave pion-pion interaction (ABC particle) is being studied.

Calculations have been made relative to the decay of η_0 mesons, in particular of the decay ratios of two γ's, to three π's, and to two π's plus γ.

The unitarity symmetry models proposed by Sakata and Gell-Mann are being used to predict the pseudoscalar and vector meson photoproduction amplitudes. In particular the high and low energy limits and contributions that violate unitarity symmetry are being studied. The same model is also being adopted to predict the scattering amplitude between pseudo-scalar mesons which will be subsequently inserted in calculations based on the peripheral model.

An investigation of the classification of the leptons has been concluded. It is based on the transformation properties of the three dimensional unitary group. This research has led to a new and original point of view for the classification and discussion of leptonic interactions.

In collaboration with the University of Cagliari, a study in the field of weak interactions has been brought to a conclusion. Based on the peripheral model it concerns the inelastic processes induced by fast neutrinos. Also in collaboration with the University of Cagliari a calculation of the photoproduction of intermediate vector mesons is being concluded.

An analysis of the experimental data relative to negative μ capture

has yielded interesting results. It has been found that this data is in desagreement with the most plausible theoretical models which seek to explain the interaction responsible for this process. A definite conclusion to this question will be obtained only after the conclusion of an accurate analysis of the molecular phenomena which precede the absorption process.

Using the elicity formalism, an investigation of the construction of the invariant scattering amplitudes for four or five particles with decay spin is under consideration.

8. HEALTH PHYSICS SERVICE.

In July-December 1962 our dosimetric service (by film badges) for the staff of the laboratories has been extended to 180 persons.

The monthly average dose has never gone up to over 100 mrem. So it was considerably below the maximum admissible.

Besides the periodical radiation controls around the electronsynchrotron (radiation maps), the most exposed points of the controlling or measuring room are always under control by tissue equivalent ionization chambers and γ ionization chambers.

Moreover the doses have been recorded in all these fixed points by the film-badges system. All these controls show us that the work, from the point of view of the protection from radiations, is very safe.

During this period particular sources of polonium have been prepared on request from some experimental groups, and the rules for the handling of these sources have been issued.

The collaboration with the biological group has continued in order to study the effect of radiations on particular embryonic rendiments culture.

During the same period a work on the tissue equivalent ionization chamber has been completed and will be printed in a very short time.

A new directional counter for fluxes measurements of fast neutron has been realized.

9. TECHNICAL OFFICE.

a) Building increase.

The doubling of the shed on the back of the workshop is being finished. It will be used as joinery workshop. The shed will be furnished with conventional

shelves and lofts; while the joinery department will be adapted to the originary plants in the first nucleus.

The enlargement of the dining-room adding a hall of about 250 mq, which can be used as recreation or meeting-room, has been carried out. Also the enlargement of the kitchen and of the connected services is being realized.

The enlargement of Gas Ionizzati laboratory is going on: the west wing (three floors) is nearly finished and for the end of February also the central laboratory and the underground will be carried out.

A shed for the joinery has been designed and work will begin, as soon as the design will be approved by CNEN.

The technical office, in collaboration with the Legal Office of CNEN, has been occupied for the acquisition of the expansion area of the Laboratories for the construction of a new machine (Adone). In the enclosed planimetry the future confines belonging to the Laboratories (the acquired area has been drawn) are shown. (see fig. II. 6).

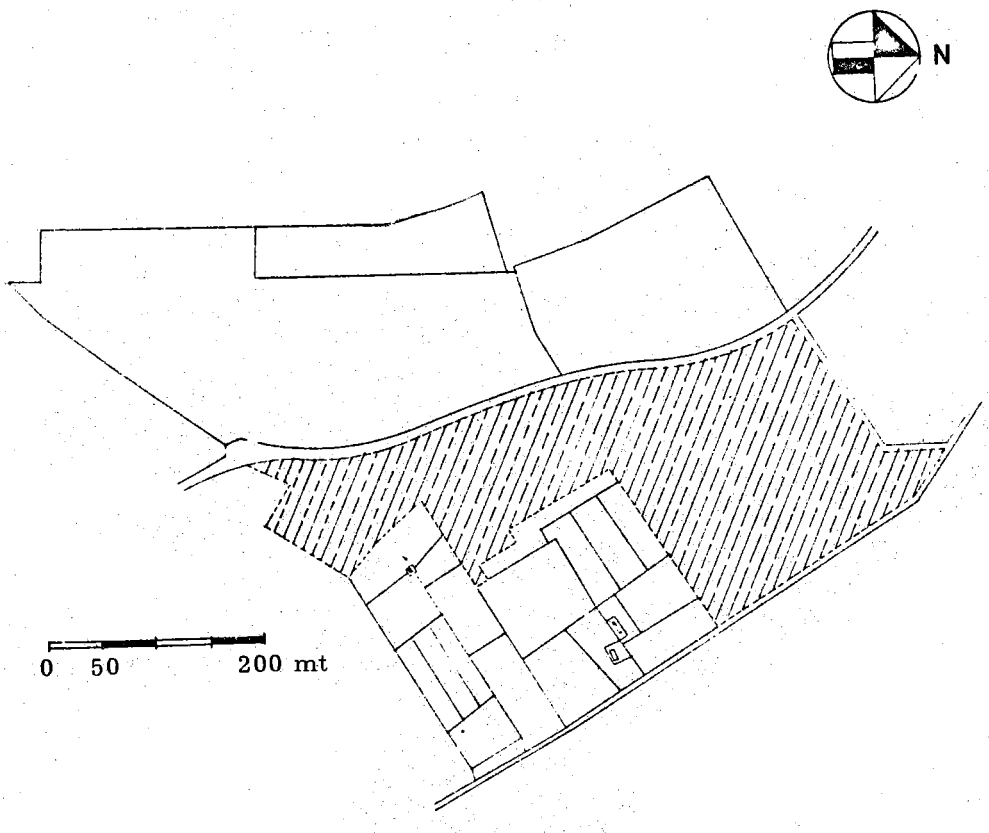

FIG. II. 6

The buildings for this storage ring and for the Linac are being designed. We are also designing a new central shop, an expansion of the mechanical workshop and of the high energy laboratories.

b) Electric plants.

In the meeting-room and in the guest-quarters all the electric plants have been carried out.

In the new shed of joinery, mentioned above, the electric plants are being performed. For the distribution of the electric power we foresee the use of armoured lines at 200 A, for a total power of 80 kW, along the walls at m 2,40 by the floor. The light installation has been studied in order to obtain an average lighting of 150 lux on the work plane (by fluorescent lamps of 250 W at 6 meters by the floor).

Our particular workshop is engaged in the completion of the various installations (already mentioned in the last bulletin) besides the normal maintenance work.

After five years of continuous work, the revision of two 20/3 kVA transformers of the central cabin has been performed. The machines are in good state of preservation.

The designing section is studying the electrification of the new area. A technical-economic analysis for the selection of the best voltage for the transport of the electric power from the new substation "CNEN-Frascati 60 kV - - 10 MVA" (to be constructed), to the secondary cabines has been performed. Of the two voltages already working (20 and 3 kV) taking into account the location for the new cabines, it results that the 3 kV distribution is more convenient for the armoured cabines and the instrumentations, while the 20 kV is more convenient for the cables of energy transport.

The final decision, in this respect, is subordinated to the conclusions of the agreement between the CNEN and the contractor firm, actually in course.

For the secondary cabin "n. 2 - Adone" (for the supply of the new accelerating machine and of the connected laboratories) a preliminary scheme of 4.000 kVA installation has been set.

c) Maintenance and general services.

Aside from the ordinary activity (external arrangements and gardening, assistance to the work groups, etc.) we have transformed a rural cottage into a second guest-quarters: seven more beds have been created and the building has been furnished of the whole necessary installations.

10. DOCUMENTATION SERVICE.

In the last September this service has been divided in two different sections: library and typographic department.

a) Library.

In 1962 the library has had an increase of about 400 volumes and 450 external reports. So it contains presently nearly 4000 volumes and 7250 reports.

Also the subscription to scientific magazines is in continuous increase.

3.000 photocopies for all other groups have been done. We requested about hundred preprints or publications to several institutes and laboratories.

b) Typographic department.

Since the beginning of September the department has begun to work also for INFN, aside from the preceding activity.

Recently the department has printed about 15 reports for INFN, encluding the 1961/62 Scientific Activity Report, and 140 internal reports of Frascati Laboratories (see list).

All the reports are normally sent to several italian and foreign Institutes.

We gave a remarkable contribution for the publication of two volumes: "Particle accelerators" by L. F. Quercia (printed by Cappelli, Roma) and "The Electronsynchrotron and Frascati Laboratories" by G. Salvini (printed by Zanichelli, Bologna).

Moreover the "Course of Electronics" by A. Odian is going to be revised and reprinted.

The equipment of our department has been improved in the last months, adding a new reproducing device (Xeros) and an Offset machine. So we can carry out several works, that were made before by external firms.

We report now the complete list of our reports (1962).

LIST OF REPORTS AND ABSTRACTS (LNF)

62/1 - A. Zichichi, S. M. Berman, N. Cabibbo and R. Gatto: "Proton-antiproton annihilation into electrons muons and vectors bosons".

62/2 - G. Pesamosca: "Un procedimento numerico per il calcolo delle traiettorie in un analizzatore magnetico".

62/3 - G. Gallinaro e G. Sacerdoti: "Misure di uniformità del campo del magnete per il Prof. Boato".

62/4 - R. Evangelisti, G. Pasotti e G. Sacerdoti: "Bobina per alti campi magnetici pulsati".

62/5 - G. Barbiellini, G. Bologna, G. Diambrini, and G. P. Murtas: "Production of a quasi-monochromatic γ- ray beam from multi-GeV electron accelerators".

62/6 - G. Garolla: "Studio di un sistema ottico con grande accettanza in energia ed in angolo".

62/7 - C. Mencuccini, R. Querzoli and G. Salvini: "The polarization of the recoil proton from the neutral photoproduction at 800 and 910 MeV".

62/8 - R. Evangelisti e G. Garolla: "Canale di e^+ e^- da 200-700 MeV ottenibile con il sincrotrone".

62/9 - "Sunto delle comunicazioni presentate al congressino di Frascati, 7, 8, 9 Febbraio 1962".

62/10 - G. Barbiellini, G. Bologna, G. Diambrini e G. P. Murtas: "Esperimenti di produzione di coppie e bremsstrahlung ad alta energia in un monocristallo".

62/11 - G. Barbiellini, G. Bologna, G. Diambrini and G. P. Murtas: "Production of a quasi-monochromatic gamma ray beam from multi-GeV electron accelerators". Phys. Rev. Lett. 8, 112 (1962). (v. 62/5)

62/12 - N. Cabibbo and E. Ferrari: "Quantum electrodynamics with dirac monopoles".

62/13 - B. Borgia e A. Rambaldi: "Programma di calcolo delle traiettorie di un magnete analizzatore a due sezioni per calcolatore IBM 650".

62/14 - C. Bernardini, U. Bizzarri, G. Corazza, G. Ghigo, R. Querzoli and B. Touschek: "Progress report on AdA (Frascati storage ring)". Nuovo Cimento 23, 202 (1962).

62/15 - N. Cabibbo and G. Da Prato: "Pion production by high energy neutrines".

62/16 - G. Sacerdoti: "The application of Lioville's theorem to the motion of charged particles in time dependent electromagnetic fields".

62/17 - M. Bassetti, R. Evangelisti e C. Pellegrini: "Determinazione dei diversi parametri di una struttura magnetica smorzata".

62/18 - G. Sacerdoti e F. Uccelli: "Alcuni studi sul quadrupolo elicoidale".

62/19 - G. Sacerdoti and L. Tau: "A double-focusing, alternate gradient; magnetic spectrometer for momenta up to 800 MeV/c".

62/20 - V. Montelatici: "Un bersaglio ad idrogeno o deuterio liquidi per le esperienze con l'elettrosincrotrone di Frascati".

62/21 - "Elenco pubblicazioni 1953-1961".

62/22 - M. G. Trigila-Cao: "Soluzione numerica delle equazioni integrali di Volterra mediante calcolatore IBM 1620".

62/23 - M. Puglisi: "Effetto del carico elettronico sulle cavità risonanti delle macchine acceleratrici orbitali".

62/24 - C. Dardini, A. Odian e R. Rizzi: "Alcuni circuiti elettronici per la sperimentazione ad alta energia".

62/25 - A. Borgia e A. Rambaldi: "Cinematiche relativistiche delle reazioni a due corpi. Programmi di calcolo per elaboratore elettronico".

62/26 - G. Sacerdoti: "Sviluppo in serie degli elementi di matrice di un sistema ottico costituito da una serie di quadrupoli disposti su uno stesso asse Z con indice di campo n(Z)".

62/27 - G. Fronterotta e A. Rambaldi: "Programma di calcolo di un best-fit".

62/28 - G. Fronterotta e A. Rambaldi: "Inversione di matrici con il metodo dell'ortogonalizzazione".

62/29 - A. Fujii: "Beta decay of hyperons via K'Particle".

62/30 - "Attività dei Laboratori Nazionali di Frascati, luglio-dicembre 1961", Notiziario n° 11.

62/31 - N. Cabibbo and E. Ferrari: "Quantum electrodynamics with dirac monopoles". Nuovo Cimento 23, 1147 (1962). (v. 62/12)

62/32 - G. Barbiellini, G. Bologna, G. Diambrini and G. P. Murtas: "Experimental evidence for a quasi-monochromatic bremsstrahlung intensity from the Frascati 1 GeV electronsynchrotron".

62/33 - A. Zichichi, S. M. Berman, N. Cabibbo and R. Gatto: "Proton-antiproton annihilation into electrons muons and vector bosons", Nuovo Cimento 24, 170 (1962).

62/34 - L. Mango: "Studio dei parametri di una struttura a funzioni separate con focheggiamento forte".

62/35 - M. Bassetti: "Calcoli numerici sugli effetti di carica spaziale in un anello di accumulazione per elettroni e positroni".

62/36 - A. Bonanni e G. Sacerdoti: "Relazione sulle prove preliminari della misura di campi magnetici pulsati mediante la rotazione di luce polarizzata (effetto faraday)".

62/37 - "Raccolta delle comunicazioni del Congressino 1962 sulla fisica e la ricerca di alta energia".

62/38 - A. C. Odian and G. Ubaldini: "Fast fourfold coincidence circuit".

62/39 - C. Pellegrini: "A calculation of radiation effects on electron oscillations in a circular accelerator". Suppl. Nuovo Cimento 22, 603 (1961).

62/40 - M. A. Locci: "Risoluzione numerica di equazioni di poisson mediante calcolatore IBM 1620 (metodi alle differenze, iterativo, di Monte Carlo)".

62/41 - R. Breschi, M. Ladu e E. Rotondi: "Spettro di energia di neutroni diffusi intorno al sincrotrone di Frascati". Minerva Nucleare 6, 18 (1962).

62/42 - F. Uccelli: "Calcolo delle matrici di transfert di un quadrupolo con modello trapezoidale".

62/43 - M. G. Trigila-Cao: "Soluzione numerica di equazioni integro differenziali del 1° ordine del tipo di Volterra, mediante calcolatore IBM 1620".

62/44 - A. Fujii: "A doublet symmetry shared by strong and weak interactions". Physics Letters 1, 91 (1962).

62/45 - A. Fujii: "Pionic decay of hyperons in the pole approximation", Physics Letters 1, 75 (1962).

62/46 - A. Fujii: "Kaon production by high energy neutrinos".

62/47 - G. Careri, W. D. McCormick and F. Scaramuzzi: "Ions in rotating liquid helium II", Physics Lett. 1, 61 (1962).

62/48 - G. Barbiellini, G. Bologna, G. Diambrini and G. P. Murtas: "Experimental evidence for a quasi-monochromatic bremsstrahlung intensity from the Frascati 1 GeV electronsynchrotron", Phys. Rev. Lett. 8, 454 (1962). (v. 62/32)

62/49 - G. Barbiellini: "Polarizzazione del fascio gamma prodotto per bremsstrahlung di elettroni di alta energia in cristalli".

62/50* - C. Mencuccini, R. Querzoli and G. Salvini: "Polarization of the recoil proton from the neutral photoproduction at 800 and 910 MeV", Phys. Rev. 126, 1181 (1962). (v. 62/7)

62/51 - I. F. Quercia: "Relazione sul viaggio in U. S. A. - Maggio 1962".

62/52 - R. Habel e T. Letardi: "Convertitore di immagine monostadio a focalizzazione magnetica".

62/53 - M. L. Corazza, M. Ladu, M. Pelliccioni e E. Rotondi: "Sulla risposta delle camere di ionizzazione per γ in flussi pulsati di alta intensità".

62/54 - C. Bernardini: "The Z-distribution of an electron beam in a storage ring".

62/55 - G. Moneti and V. Montelatici: "A liquid deuterium target refrigerated by liquid hydrogen", Nuclear Instrument & Methods 15, 207 (1962).

62/56 - G. Bologna: "Calcoli di sezioni d'urto per bremsstrahlung in cristalli".

62/57 - G. V. Silvestrini: "Adair argument and ϕ^{o} spin".

62/58 - G. De Feo, G. Pasotti e G. Sacerdoti: "Risultati preliminari di bobine superconduttrici".

62/59 - R. Querzoli e G. V. Silvestrini: "Studio cinematico del processo $\gamma+p\rightarrow p+2\pi^{o}$".

62/60 - M. Ladu, A. Palma, M. Pelliccioni e E. Rotondi: "Misure con camere di ionizzazione in materiale equivalente al tessuto umano".

62/61 - M. Conte and E. Ganssauge: "Some calculations concerning the measurement of the polarization of μ - mesons, using møller scattering in the magnetized iron plates of a spark chamber".

62/62 - C. Mencuccini, R. Querzoli, G. Salvini and G. V. Silvestrini: "A first evidence of a radiative decay mode of the intermediate pion resonance (M ~ 550 MeV)".

62/63 - A. Alberigi, M. de Pretis, G. Marini, A. Odian, G. Stoppini e L. Tau: "Photoproduction of muon pairs in carbon".

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62/67 - R. Balzano, G. Sacerdoti e G. Pasotti: "Teoria lineare delle macchine acceleratrici".

62/68 - N. Cabibbo, G. Da Prato, G. De Franceschi and U. Mosco: "New method for producing and analysing linearly polarized gamma ray beams".

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62/70 - N. Cabibbo, G. Da Prato, G. De Franceschi and U. Mosco: "Absorption of gamma rays in crystals and the production and analysis of linearly polarized gamma rays".

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62/77 - F. Amman and D. Ritson: "Design of electron - positron colliding-beam rings", 1961 international conference on high energy accelerators proceedings (Brookhaven Nat. Laboratory, 1961), pag. 262.

62/78 - F. Amman and D. Ritson: "Space-charge effects in electron-electron and positron-electron colliding or crossing beam rings", 1961 international conference on high energy accelerators proceedings (Brookhaven Nat. Laboratory, 1961), pag. 471.

62/79 - G. Sacerdoti and L. Tau: "A double focusing, alternate-gradient, magnetic spec trometer for momenta up to 800 MeV/C", Nucl. Instr. and Methods 16, 139 (1962).

62/80 - R. Evangelisti, G. Pasotti and G. Sacerdoti: "A pulsed magnet for high magne tic fields", Nucl. Instr. and Methods 16, 189 (1962).

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62/82 - A. Massarotti e M. Puglisi: "Studio di un discriminatore di fase per l'accordo dei risuonatori a cavità impiegati nelle macchine acceleratrici", CNEN-RT/EL (62) 14.

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62/85 - P. de Feo and G. Sacerdoti: "Decay of trapped-flux in a superconducting ring subjected to an irradiation of α particles from a P_o^{210} source".

62/86 - A. Fujii: "Radiative decay of the η-particle", Progress of Theoret. Physics 27, 1274 (1962).

62/87 - G. Barbiellini, G. Bologna, G. Diambrini and G. P. Murtas: "Measurement of the polarization of the Frascati 1 - GeV electronsynchrotron ray beam from a diamonf crystal radiator".

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62/93 - G. Barbiellini, G. Bologna, G. Diambrini and G. P. Murtas: "Measurement of the polarization of the Frascati 1 GeV electron synchrotron γ-ray beam from a diamond crystal radiator", Phys. Rev. Letters 9, 396 (1962). (v. 62/87).

62/94 - R. Gatto: "Consequences of higher symmetry for elèctromagnetic and for weak transition".

62/95 - C. Pellegrini: "Effetti di piccole rotazioni del piano mediano di un sincrotrone sulle orbite delle particelle".

62/96 - C. Pellegrini: "Non linear effects on the damping constants of electron oscillations in a synchrotron".

62/97 - R. Gatto: "The two neutrinos".

62/98 - R. Gatto: "Classification of lepton currents".

62/99 - H. Shimodaira: "On the decay of the η meson".

62/100 - N. Cabibbo, G. Da Prato, G. De Franceschi and U. Mosco: "Circular polarization of high-energy gamma rays by birefrangence in crystals", Phys. Rev. Letters 9, 435 (1962). (v. 62/84).

62/101 - R. Querzoli and V. Silvestrini: "On the quantum number of the η particle".

62/102 - V. Montelatici: "Alcuni metodi per la polarizzazione magnetica dei nuclei".

62/103 - R. Gatto: "Possibilità sperimentali con fasci incrociati di elettroni e positroni", Ric. Sci. 32(1), 161 (1962).

62/104 - "Meeting of the european accelerator study group. December 1962. Summary of reports".

62/105 - C. Pellegrini: "Spinning test particles in the tetrad formulation of the theory of gravitation".

62/106 - A. L. Bartoli and F. Scaramuzzi: "Completely space charge limited currents in superfluid helium: a method for the measurement of the ionic mobilities in the vicinity of the lambda-point".

62/107 - G. Barbiellini, G. Bologna, G. Diambrini and G. P. Murtas: "A crystal method for the measurement of the photon linear polarization in the multi GeV region".

62/108 - G. Sette: "Integrali nello spazio delle fasi per sistemi di due e tre particelle".

62/109 - A. Fujii: "Muon capture in hydrogen".

62/110 - F. Amman, M. Bassetti, M. Bernardini, G. Corazza, A. Massarotti, C. Pellegrini, M. Placidi, M. Puglisi e F. Tazzioli: "Gli anelli di accumulazione per elettroni e positroni ad alta energia in progetto presso i Laboratori Nazionali di Frascati", Ric. Sci. 32(I), 197 (1962).

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62/114 - G. Barbiellini, G. Bologna, G. Diambrini and G. P. Murtas: "Angle distribution of thin crystal bremsstrahlung".

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62/119 - F. Amman, G. Ghigo, G. Sacerdoti, G. Salvini e R. Toschi: "L'Elettrosincrotrone: il progetto e la realizzazione del magnete", Suppl. Nuovo Cimento 24, 97 (1962).

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62/125 - F. Amman, G. Sacerdoti e R. Toschi: "L'Elettrosincrotrone: impianti di alimentazione del magnete", Suppl. Nuovo Cimento 24, 203 (1962).

62/126 - F. Amman, G. Ghigo e G. Sanna: "L'Elettrosincrotrone: gli avvolgimenti di correzione", Suppl. Nuovo Cimento 24, 209 (1962).

62/127 - G. Corazza, R. Habel e S. Sircana: "L'Elettrosincrotrone: impianto di vuoto", Suppl. Nuovo Cimento 24, 217 (1962).

62/128 - A. Alberigi-Quaranta, M. Puglisi e I. F. Quercia: "L'Elettrosincrotrone: introduzione e discussione del progetto del sistema a radiofrequenza", Suppl. Nuovo Cimento 24, 234 (1962).

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62/135 - A. Alberigi-Quaranta, C. Infante e I. F. Quercia: "L'Elettrosincrotrone: il sincronizzatore principale", Suppl. Nuovo Cimento 24, 321 (1962).

62/136 - M. Ageno e altri: "L'Elettrosincrotrone: la ricerca del fascio", Suppl. Nuovo Cimento 24, 334 (1962).

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62/139 - G. Scaccia-Scarafoni: "I Laboratori di Frascati: il complesso edilizio", Suppl. Nuovo Cimento 24, 360 (1962).

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CHAPTER III - EXPERIMENTS UNDER WAY WITH THE ELECTRONSYNCHRO TRON.

We now give a brief summary of the experiments under way at the Electronsynchrotron (written by the authors). The order is that of presentation by the groups. We did not receive the reports on the following experiences: "Roma τ " - "Frascati ω^o" - "Sanità π^o" - "Sanità π^- capture" and "Sanità Synchrotron light".

1. PHOTOPRODUCTION OF η -MESONS IN HYDROGEN.

C. Bacci(x), C. Mencuccini, G. Penso(x), R. Querzoli, G. Salvini(x), V. Silvestrini and A. Wattenberg(o).

Further work has been done on the lines of the experiment started at the beginning of 1962 to study the photoproduction of η particles.

The description of the experimental set-up as well as our preliminary results have been reported on the Report n. 12 of this Laboratory. In the second half of 1962 we have begun a measurement whose main aims are the following:

a) Measurement of the cross section of the process

$$\gamma + p \rightarrow \eta + p \qquad (1)$$

as a function of the primary γ-ray beam energy.

b) Measurement of the branching ratio

$$\frac{\eta \rightarrow \gamma + \gamma}{\eta \rightarrow \text{other neutrals}}$$

For this purpose in the proton telescope a spark chamber has been included, thus allowing a fine measurement of the angle and energy of the recoil protons.

Plotting the spectrum of the protons as a function of their energy, a two-body process like (1) will show up by the presence of a step whose position depends on the maximum energy of the bremsstrahlung spectrum and on the mass of the particle in this way it is possible to determine the mass of the ob-

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served particle with a precision of about ± 10 MeV.

Depending on the energy of the γ-ray detected in coincidence with the proton in the total absorption lead-glass cerenkov counter, the step is due to the process:

$$\gamma + p \rightarrow \eta + p$$
$$\hookrightarrow \gamma + \gamma$$

or

$$\gamma + p \rightarrow \eta + p$$
$$\hookrightarrow 3\pi^0$$

we get in this way a simultaneous measurement of the cross section and of the branching ratio.

2. STORAGE RING. AdA.

C. Bernardini, U. Bizzarri, G. Corazza, G. Di Giugno, G. Ghigo, R. Querzoli and B. Touschek(x).

By the end of 1961 the results obtained with the Frascati storage ring could be summarized thus:

1) Electrons and positrons can be stored and kept with a mean life of about 40 hours at a vacuum of $5.\ 10^{-10}$ mm.
2) Using frequency modulation it was possible to improve the acceptance rate from about 0.4 $secs^{-1}$ to about 8 $secs^{-1}$.
3) The radial extension of the beam was photographed and found in good agreement with theory.

The work of 1962 was directed towards an increase in the speed of accumulation with the hope of being able to observe some electron positron interactions.

AdA was moved from the machine hall (15 m from the electronsynchrotron target) into the actual electronsynchrotron room to a distance of about 3.6 m from the electronsynchrotron. To this end it was necessary to change the mounting, the tower being replaced by a spit which allowed for the rotation of AdA around a horizontal axis perpendicular to the beam. The rate of acceptance (about 50 electrons or positrons per second) proved disappointing and it was decided to transfer the storage ring to the laboratories of the Paris Science faculty in Orsay. Collaboration with the Orsay staff (P. Marin, F. Lacoste) was started in March and AdA complete with spin and doughnut was installed at the 500

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MeV station of the Orsay Linac by mid July.

Though the acceptance rate in the 0.6 μA beam was satisfactory (up to about 5000 electrons or positrons/second) the storage ring seemed in many ways erratic Particles were lost, while turning the ring and by changing the magnetic field. In November it was found that a possible cause of this strange behaviour were deposits of dust (visible through the windows for the observation of electron-synchrotron radiation).

It was therefore decided to change the mounting again and to adoperate a system of rotation plus translation, which would not disturb these dust deposits. The new arrangement was tried out at the end of december. Coincidences observed with an arrangement of two Cerenkov counters are compatible with beam beam annihilation (there are three such events) but much better statistics will be required to obtain significant results. Work on the improvement of the counter equipment as well as for the observation of μ-mesons by means of spark chambers is proceeding.

3. ELASTIC ELECTRON-PROTON SCATTERING AT LOW MOMENTUM TRANSFER.

B. Borgia(x), E. Ganssauge(o), R. R. Wilson(+)

Since the first preliminary measurements reported in the last issue (n. 12) we worked in order to get a good resolution of the elastic peak of the protons and to reduce the background.

We used targets of different dimensions, collimators and absorbers. Finally we decided to take carbon and CH_2 targets of 1 mm and 2 mm diameter respectively. In order to estimate the effect of multiple scattering of the protons in the counter we used two different counters of the dimensions 20 x 15 x 2 mm and 20 x 15 x 3 mm respectively. A collimator in front of the counter was shown to increase the background and thus it was taken away.

We measured at momentum transfers on 1,5; 2; 2,5 and 3 f^{-2} and at electron energies of 800 and 1000 MeV.

Now we are evaluating the data, but because of the background it is still not quite clear if our results will be of the precision as high as we hoped at the

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beginning.

4. MEASUREMENTS ON ANGULAR DISTRIBUTION OF K^+ AND Λ^o POLARIZATION $\gamma + p \rightarrow K^+ + \Lambda^o$.

B. Borgia(x), M. Grilli, P. Joos(o), L. Mezzetti(+), M. Nigro(+), E. Schiavuta(+), F. Villa(x).

As previously reported(1), our program of measurements are on angular distribution of K^+ (from $\gamma + p \rightarrow K^+ + \Lambda^o$) and the Λ^o polarization.

We now want to report on the work done by our group during the period July to December 1962.

In the last August we have mounted the apparatus for K^+ detection at Electronsynchrotron and we began the trials.

After the first measurements and reduction of the background, we carried out all the normal adjustments on counter telescope for K^+.

A special care was dedicated to the three Cerenkov counters C_1 C_2 and C_D(1). As in our condition the ratio π/K is ~ 750, we need a good veto for π which is done by $C_1 + C_2$. We were able to reduce this ratio, by aid also of the criterium of the delay for the $K^{\pm}$ decay, to $\leq 1/10$.

Clearly, the efficiency of C_D is very important as this counter detect the decay secondaries of K^+. Working on the light collection (we use, finally, a MgO reflector we get, for π (400 MeV/c) that traverse all the counter (15 cm), a resolution $\Delta V/V \sim \pm 30\%$.

In the next future we will try to make a measurement of efficiency of C_D, using the decay $\pi \rightarrow \mu \rightarrow e$ for π^+ which will be stopped in C_D.

Finally we get a situation in which the K mesons are about 10% of the events that trigger the scope.

In the last October we put also the Λ^o telescope in the final position.

We have met large difficulties on working with this telescope, because, due to the small angle between the counter telescope and the γ beam, we get a large electromagnetic background. We are able by working on collima-

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(1) - Raccolta delle Comunicazioni del Congressino di Frascati sulla fisica e la ricerca di alta energia - Laboratori Nazionali di Frascati, Report LNF/62-37, pg. 72. (In this report we specified our program and we described the apparatus).

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tion and shielding to reduce, the background not coming from the H_2 target to 30% of the total counting rate.

At present it seems, from the results of last runs, that is possible to clearly separate the protons of Λ^o from the background by time-correlating (resolving time $\pm$ 3 ns) the scintillator counters, adding also a pulse analysis of these counters. All this analysis (time correlation, pulse analysis) is done by showing the Λ^o counters on the scope, triggered by $K^{\pm}$ master pulse.

We will begin our program of measurements on the next February.

5. π^o PHOTOPRODUCTION IN THE COULOMB FIELD OF NUCLEUS.

G. Bellettini(x), C. Bemporad(x), P. L. Braccini(x), and L. Foà(+).

In this experiment we had to overcome troublesome difficulties coming both from Cerenkov counters instability both from the high rate of background events. Some useful checks have been introduced in order to obtain a better stability of counters amplifications. The background counting rate has been sufficiently lowered by a more refined shielding.

The two γ rays energy (K_1 and K_2) are measured by pulse height analysis. We plot in a diagram K_1 against K_2 (fig. III. 1). The hyperbolas show

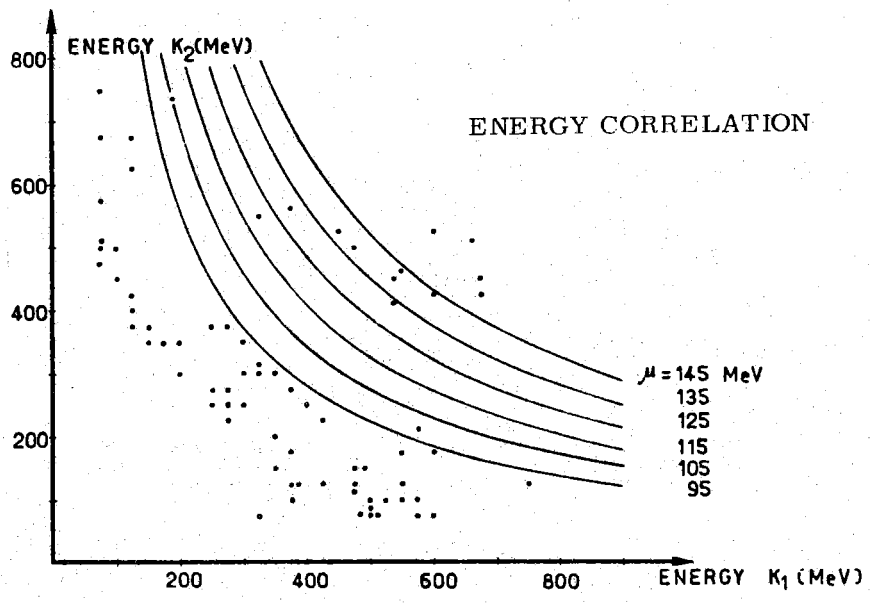

FIG. III. 1

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the energy correlation between the γ rays coming from the decay of a mass μ particle.

Usually "pions" are well separated from background events.

At this moment we are determining a first angular distribution.

6. FORWARD PHOTOPRODUCTION OF π^0 MESONS USING THE dE/dx TECHNIQUE.

E. H. Bellamy(+), G. Bellettini(x), C. Bemporad(x), P. L. Braccini(x) and L. Foà(o)

In parasating the "Primakoff" experiment, we determined the differential cross section at c. m. s. $\theta_{\pi^0} = 40^\circ$ (corresponding to $65,5^\circ$ proton laboratory angle).

The empty target background is quite high, about one half of the full target counting rate. We analyzed 1/3 of the data at our disposal obtaining the cross section drawn in fig. III. 2 (purely statistical errors).

We are now measuring the cross section at different c. m. s.

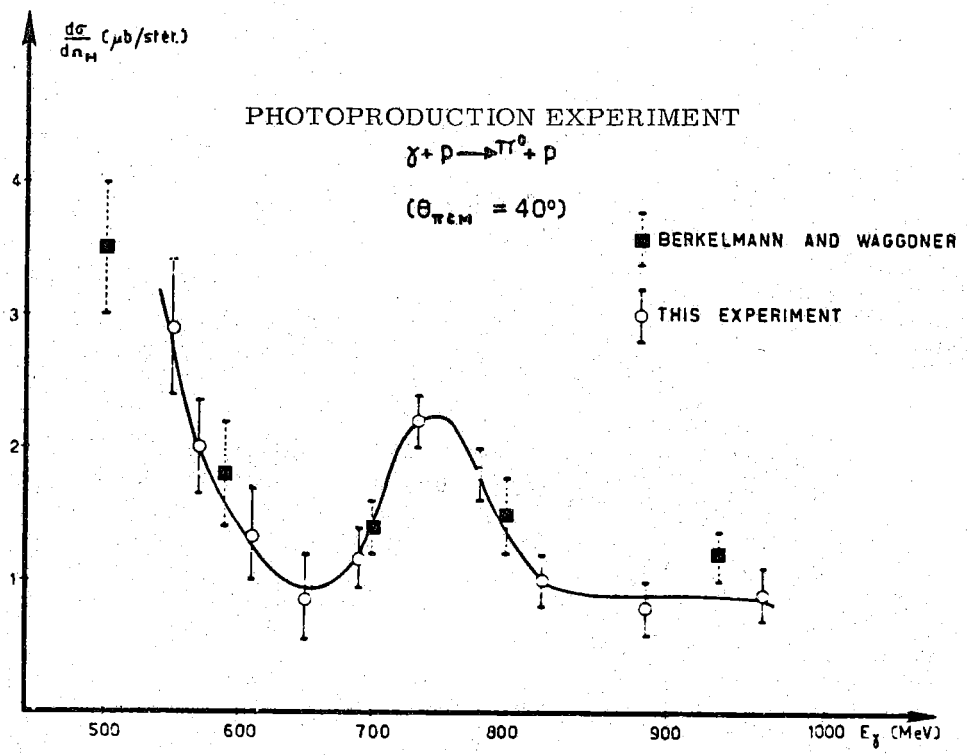

FIG. III. 2

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7. CLOUD DIFFUSION AND BUBBLE CHAMBERS GROUP.

P. E. Argan(x), G. Bendiscioli(+), V. Bisi(o), M. I. Ferrero(o), A. Piazzoli(+) and G. Piragino(o)

With the aim of increasing the statistics in the study of the reactions of π photoproduction in He^4 nucleus (till now made on 15,000 photos) other 25,000 photos in cloud diffusion chamber have been made.

This is the first part of an experimental program of 50,000 photos.

In this way we hope to test the existence of H^4 state more clearly(1) and to ascribe to this state its quantum numbers.

The second aim of this experiment is the study of the reactions

$$He^4(\gamma, 2\pi^+)4N \quad \text{and} \quad He^4(\gamma, 2\pi^-)4P.$$

The cross sections of these reactions are small but probably connected to the He^4 nuclear structure.

The 20 lt bubble chamber is actually on trial for the revelation of the same reactions with a liquid He^4 target.

8. MEASUREMENT AND UTILIZATION OF THE POLARIZED γ-RAY BEAM FROM A DIAMOND RADIATOR.

G. Barbiellini, G. Bologna, J. De Wire(¤), G. Diambrini, G. P. Murtas and G. Sette

As far as the measurement of the γ-ray beam polarization is concerned, we concluded an experiment (see Report n. 12), the results of which have been already published(2).

We made also a proposal for the measurement of the linear polariza

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(1) - P. E. Argan, G. Bendiscioli, A. Piazzoli, V. Bisi, M. I. Ferrero and G. Piragino: Phys. Rev. Letters 9, 405 (1962).

(¤) - On leave from the Cornell University, Ithaca.

(2) - G. Barbiellini, G. Bologna, G. Diambrini and G. P. Murtas: Phys. Rev. Letters 9, 396 (1962).

tion of photons in the many - GeV region, by means of a crystal analyzer[3].

As a further theoretical activity we carried out the calculation of the differential cross section, in order to obtain the angle distribution of thin crystal bremsstrahlung[4].

Symultaneously with these works we prepared the experimental apparatus designed for the study of the reaction.

$$\gamma + p \longrightarrow \pi^0 + p$$

from polarized γ-rays.

An extensive account on the considerations involved in single photoproduction of π^0 mesons in hydrogen from polarized γ-rays may be found in an Internal Report of the Frascati Laboratories[5]. The experimental apparatus is completely conventional. The π^0 decay photons are detected by means of an integral Cerenkov counter; the recoil proton is detected by means of a range detector telescope.

Our first aim is to make a check of the existence of polarized photons in our bremsstrahlung beam from a crystal radiator. This is done by comparing the numbers of π^0 mesons produced from photons polarized at right angles. The nominal energy of the photons, selected by means of the kinematical conditions, is 320 MeV. The π^0 mesons are detected at 90° in the center of mass system. The laboratory conditions are the following. The proton is detected at $40^\circ \pm 1^\circ 30'$; its kinetic energy is 57 ± 12 MeV. The π^0 is detected at 72°.

Measurements are in progress.

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(3) - G. Barbiellini, G. Bologna, G. Diambrini and G. P. Murtas - LNF-62/107 (to be published).

(4) - G. Barbiellini, G. Bologna, G. Diambrini and G. P. Murtas - LNF-62/114

(5) - J. De Wire - LNF-61/39

CAPTER IV - ADONE

STUDY GROUP FOR AN ELECTRON AND POSITRON STORAGE RING (Adone).

F. Amman, R. Andreani, M. Bassetti, M. Bernardini, A. Cattoni, V. Chimenti, G. F. Corazza, E. Ferlenghi, L. Mango, A. Massarotti, C. Pellegrini, M. Placidi, M. Puglisi, G. Renzler, F. Tazzioli.

During the second semester of 1962 the design of the 750 MeV storage ring has been carried out. At the same time, the preliminary design of the 1500 MeV storage ring has begun.

Studies of the various parts of the machine and contacts with the firms for the supply of the main components have proceeded. Particularly, dealings for the purchase of the linear accelerator have been carried on.

Within the first six to eight months of 1963 we think to be able to go on with the orders of the linear accelerator, of the magnet, of the power supplies, and of the building contract.

The linear accelerator and the ring buildings together with the new site arrangement are being designed by the Technical Office.

a) Theoretical Group.

Many problems (some of them were mentioned in the last bulletin) have been satisfactorily studied.

The problem of the thermal diffusion (for a given geometrical configuration) inherent to the cooling of the e^- - e^+ conversion target in the linear accelerator has been studied.

Also some marginal calculations inherent to the Linac design have been performed. We carried out the calculations of the magnet alignment tolerances. The study of the coupling effects between vertical and horizontal betatron oscillation has been examined thoroughly; further the effect of the deformations of the quadrupole profile on the field behaviour has been studied.

The calculation of radiation effects has been carried out with the non-linear approximation, taking into account the quadrupole contribution that is not negligible for the relatively high values of the gradients. But we have seen that the corrective terms of the damping constants are negligible at all.

Resonant stopband widths around the betatron frequencies of the value 1/3, due to the derivatives of the magnetic field of the order ≥ 2 have been calculated.

At last we faced the problem of the electrons-positrons conversion with the Montecarlo method. Presently we dispose of digital computer programs concerning: conversion yield, angular and space distributions, collision losses in the converter versus inpinging electrons energy and versus target thickness.

The program has already given preliminary results on the IBM 1620 computer of the laboratories. Soon it will be transferred on the IBM 7090 computer at Ispra.

b) The magnet.

Considering the alignment tolerances required by the storage ring, the tolerances due to mechanical errors and those due to positioning have been defined for the bending magnets and the quadrupoles; we have detailed the definitive design, except for the azimuthal dimensions and pole profile, depending on informations that we shall have from magnetic measurements performed on models.

To stay easily within the limits established by the theory of the machine we have choosen a mechanical machining method of the magnets and of the quadrupoles such to assure a good geometrical homogeneity of the gap.

We have also designed the alignment system: it allows to repeat reliably relative measurements on the different octants and provides for a high accuracy in the angle and length measurements.

The mechanical solution and the adopted alignment system will allow to keep the relative misalignments between the single components of the storage ring within $\pm$ 0,1 mm.

Preliminary bids have been requested to several firms interested in the magnet and quadrupole construction.

We studied the ring power supply; we use separated generators for the bending magnets, focusing and defocusing quadrupoles, while the single components of each group is connected in series.

An 1:2 scale-model magnet and 1:1 scale-model quadrupole construction has been carried out.

We have also completed the equipment for the magnetic measurements to be performed on these models, the delivery of the rectifier stabilized at 0,1% for their power supply is imminent.

c) Vacuum system and donut.

The vacuum system design for the 750 MeV ring has been improved in particular for the part that concerns the beam transport from the Linac to the ring. The design includes the instrumentation and controls, for the ring operation.

Some experiments on the behaviour of the vitilan gaskets in ultrahigh vacuum conditions and on the efficiency of the hydrogen treatment on the degassing

materials have been performed in laboratory. Moreover the getters pumps have been treated with Argon flushing; it prooved to be useful to increase the aspiration speed to the low pressures.

The installation for the vacuum gauges calibration and for the measurements of the pumping speed of the pumps is being carried out.

A vacuum system similar in size and shape to an octant of the storage ring is being built; so, in a short time, we can control the design calculations. We are installing also a cryogenic pump.

d) RF and deflector.

A 10 MHz resonant cavity has been designed and is being built.

This cavity resonator is the 1:1 scale-model of the final cavities for the 1,5 GeV ring and therefore it must work at 80 kV.

A RF amplifier system has been built up to the 3.5 kW level; the power amplifier (35 kW is under construction).

At the same time we are studying, theoretically and experimentally, the best coupling system between the power amplifier and the cavity.

The second scale-model (1:1) of the pulsed inflector has been built. So we could perform tests at relatively high voltages ($\sim$ 10 kV) and field measurements that, together with the measurements in the electrolytic tank have been used to determine the final electrodes profiles.

The behaviour and matching of the delay line, constituting the inflector, with sine waves at 20-30 MHz, has been checked.

The third 1:1 scale-model of the inflector is being built. This model has electrically the structure that we actually think definitive.

e) Injection optics.

To avoid a chromatic problem in the vertical plane that is more critical for the ring acceptance, the possibility to have in different planes the Linac and the ring has been discarded.

We now look at a solution solving separately for the several parts of the system between the Linac and the ring the problem of the achromatism in the radial plane. The matching of the Linac emittance to the ring acceptance is also obtained separately.

We have chosen a separated function system to make the setting up easier.

Following this way some possible beam transport systems are being calculated to the first order; in the future we shall try to optimize the actual solutions.

f) Injector.

At the end of August 1962 four offers have been presented for the supply of the Linac for electrons and positrons which will be installed in the Frascati Laboratories by the CNR; the Linac will be also used as injector for Adone.

The linear accelerator consists of a first section at a relatively low energy (60 + 90 MeV) and high current; this section can accelerate an electron beam with a peak power of about 30 MW which hits a converter about one radiation length thick, a small part of the positrons produced is accelerated in the second section to an energy of about 350 MeV; the expected peak positron currents are of the order of 200 + 300 μA with a duty-cycle of about $5 + 7 \times 10^{-4}$.

To accelerate electrons, the converter is taken off and at the end of the Linac a peak current of 50 + 100 mA is available, at an energy of about 380 MeV, always with duty-cycle of about $5 + 7 \times 10^{-4}$.

In the use of the Linac as injector, the repetition rate will be very low: about two pulses per second for the 750 MeV ring and one pulse in two seconds for the 1500 MeV ring; the high duty-cycle will be used for the direct experimentation with the linear accelerator.

For the same use we foresee the availability of very short pulses (about 3 + 5 nsec).

The electron-positron conversion has been studied particularly; as we said in the last bulletin, efficiency measurements of conversion till 30 MeV for the primaries were performed in collaboration with a group of Saclay. Recently at Orsay have been published some new results on the conversion of electrons from 55 to 220 MeV.

The data now available allowed us to improve the Linac performances for the positrons production.