FINUDA

L. Benussi(Ass. Ric.), S. Bianco, M. Bertani, M.A. Caponero (Ass.),
F.L. Fabbri(Resp.), P. Gianotti, M. Giardoni, V. Lucherini (Resp.), E. Pace,
M. Pallotta, L. Passamonti(Tecn.),D. Pierluigi(Tecn. Art.15), F. Pompili(Bors.),
N. Quaiser(Bors., up to December 2001), A. Russo(Tecn. art.15), S. Tomassini(art.23)

1 Introduction

FINUDA (meaning FIsica NUcleare a DAΦNE) is an experimental set up whose aim is the study of hypernuclei formation and decay within the same apparatus. Hypernuclei are nuclei in which a bound nucleon, baryon made of only u (up) and d (down) quarks, is replaced by a hyperon, baryon made also by s(strange) quarks. The added flavour enlarges the basic nucleon-nucleon interactions also to the strange sector: the so changed level scheme of the involved nucleus gives hence information on the modification of the properties of baryon-baryon interaction due to strangeness. High resolution hypernuclear spectroscopy can also, in principle, reveals in a more clearly way a partial deconfinement of quarks in nuclear matter.

The DAΦNE e^+/e^- collider is optimized in *Luminosity* at the *c.m.* energy corresponding to the $\phi(1020)$ meson. The huge number of ϕs, produced (almost) at rest, decay with a $B.R.$ of 0.49 into back-to-back pairs of slow (127 MeV/c)charged kaons. The K^-s, stopped by a thin target, can hence produce hypernuclei, through the reaction (inside one of the target nuclei):

$$K^- + n \rightarrow \pi^- + \Lambda \tag{1}$$

The levels of the produced hypernucleus can be obtained through an accurate measurement of the momentum of the emitted (*prompt*) π^-. Since the kaons from DAΦNE have a very low and sharp momentum, they can be stopped in very thin targets, allowing unprecedented resolution (0.3%) to be reached in hypernuclear spectroscopy. Moreover, the subsequent decay of the hypernucleus, both *mesonic* (p+π^-) and $non-mesonic$ (np or nn) can be detected by FINUDA, allowing the simultaneous study of formation and decay of hypernuclei within the same apparatus, a feature never reached in previous experiments.

FINUDA is a large acceptance magnetic spectrometer based on a medium sized superconducting solenoid (2.7 m long and 2.4 m diameter), operating at a maximum field of 1.1 T. The inner of the solenoid is equipped with tracking detectors, time-of-flight scintillator barrels and vertex detectors, also embedding a system of multiple targets. The volumes between the tracking detectors are filled with He gas in order to reduce the deterioration of resolution due to multiple scattering effects. A special and complex system of thin windows bags (He bag) is used for this purpose. A sketch of FINUDA spectrometer is shown in fig.1), which also reports the name and type of the different detectors.

The FINUDA Collaboration is formed by almost 50 physicists from LNF, several INFN sections and Universities (Torino, Bari, Trieste, Pavia, Brescia) and with the participation of researchers from TRIUMF Laboratory of Vancouver, Canada.

An extensive description of the FINUDA experiment can be found in [1], [2], and [3].

2 Activity up to December 2001

As written in the conclusions of the LNF Activity Report for year 2000, at February 2001 the FINUDA experiment was in the following status: the magnet was installed in the FINUDA pit ready for cooling and subsequent energization; the TOFONE detector was already for three quarters

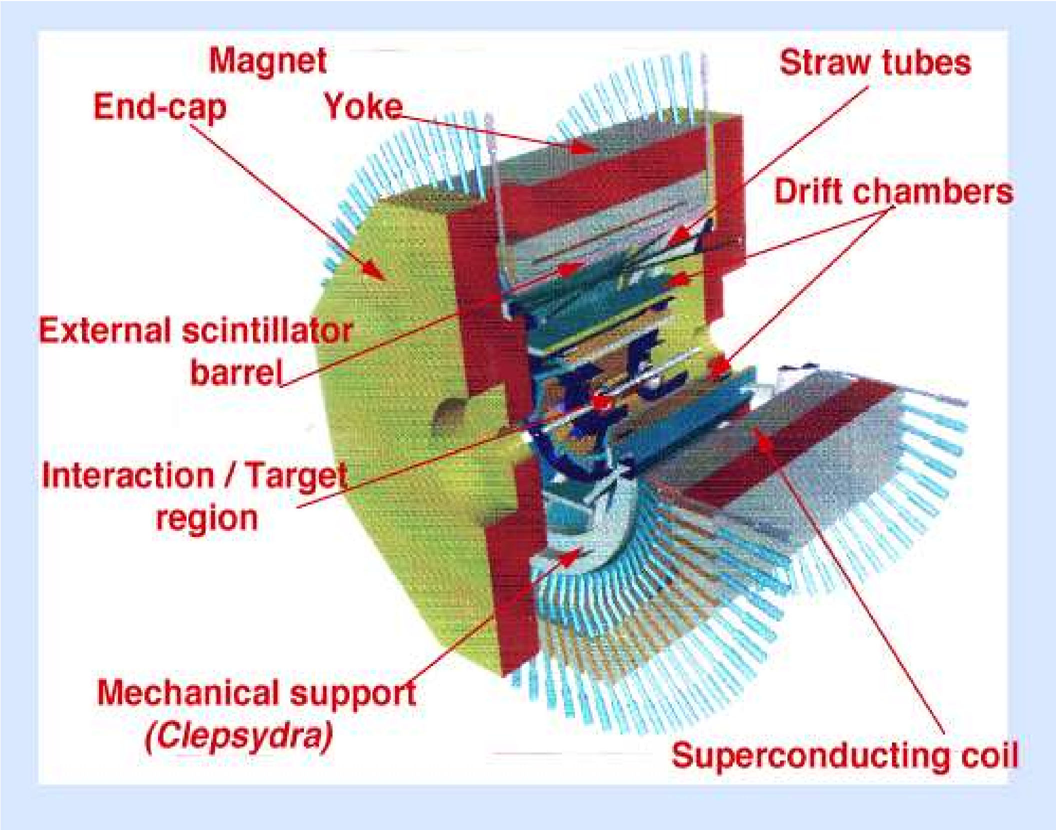

Figure 1: *Three dimensional layout of the FINUDA apparatus.*

installed inside the magnet; all other detectors, tested in several runs with cosmic rays, were standing in the ASTRA laboratory.

During the subsequent months of 2001, the activity of FINUDA can be divided in the following three main streams, according to the foreseen shut down periods of DAΦNE.

2.1 Activity from February 2001 up to May 2001

The mechanical structure called Clepsydra which supports all FINUDA detectors, TOFONE apart, and the beam pipe itself contains already installed and cabled the 2424 straw tubes which constitue the most external tracker of the experiment. During the first months of 2001, the main task of the FINUDA-LNF group was hence that to prepare the Clepsydra in ASTRA with all straws mounted and cabled in it for its journey from ASTRA to the pit in DAΦNE, foreseen during the one month DAΦNE shut down of August 2001. A trolley already existing at LNF was restored and readopted for that trip. At the end of April 2001 this task was ended, and the Clepsydra, ready for the transfer, was put on the trolley in ASTRA, fig.2.

In the meantime, the FINUDA Collaboration took advantage of two one week shut down periods of DAΦNE, in March and May 2001, to install the FEE racks, the cables on magnet to FEE racks, and to complete the TOFONE scintillators installation. At the end of May 2001, having completed ahead of schedule all the above tasks, the FINUDA Collaboration decided to use the last two days of the May week shut down to move the Clepsydra with all its straws and cables

Figure 2: *The Clepsydra with the straws inside it on the trolley in ASTRA ready for the transfer to the pit.*

from ASTRA to the pit in DAΦNE, in front of the magnet and inserted it inside (May 19, 2001), fig.3 and fig.4.

2.2 Activity from July 30th to September 2nd 2001

During the all month of August 2001, the FINUDA Collaboration was fully engaged in installation works in DAΦNE during the foreseen shut down period. In this period several tasks were accomplished.

- Clepsydra alignment inside the magnet. The precision achieved was 0.01 degrees respect to beam axis, with a 0.5 mm centering on it.
- Completing of cabling and piping from detectors to FEE racks for straw tubes, TOFONE, outer LMDCs.
- Starting of installed detectors check out and debug.
- Begining of He-bag installation (windows and piping)
- Slow control and safety system installation
- New DAQ, using PVIC, installed and debugged.

2.3 Activity during the one week October 2001 shut down

During the last shut down period foreseen for DAΦNE in 2001, FINUDA tested the crucial closure of magnet end caps with the Clepsydra inside with all the cables and piping mounted for straws, TOFONE and outer LMDCs. Moreover, installation of μ-strips FEE was started, together with

Figure 3: *The Clepsydra with the straws inside it hanged to the DAΦNE crane.*

part of the corresponding cabling. He piping was also going on in this period. Finally, the laser system for TOFONE and tofino scintillators was installed. In fig.5 it is shown the FINUDA spectrometers status at the end of the year 2001.

2.4 Other activities during 2001

While during the time of machine shut down, the FINUDA Collaboration activity was mainly devoted to operations in the pit, only in those periods accessible, during all other periods of the year other activities proceeded. One of the them was the installation in counting room of the racks of the electronics, the terminals and PCs for slow controls, DAQ, and safety. Another was the delicate work of selection and building of the complex system of multi targets of the experiment. Both very pure and rare material targets (as Li^6) were prepared, or their construction carefully studied. Finally a continuous refining of the software tools for the simulation of detector response and physical processes was carried out.

3 Conclusions

At the end of 2001, FINUDA has achieved on schedule all the tasks previously established for this year, having the full detectors (included cabling, piping and electronic) of the outer region of the spectrometer installed and under debugging. Moreover, the slow control system, the safety system, the new DAQ, and the installations in counting rooms were almost totally ended.

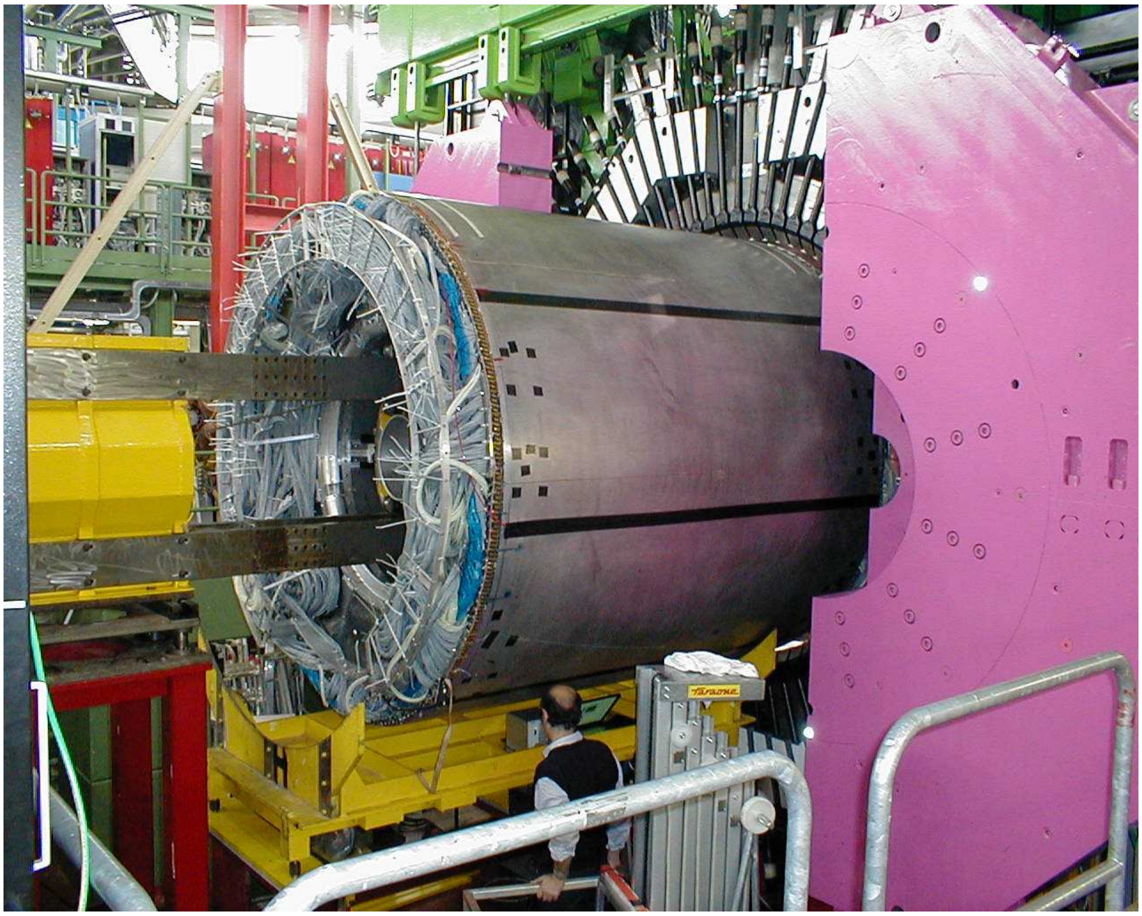

Figure 4: *The Clepsydra being inserted inside the FINUDA solenoid.*

Figure 5: *The FINUDA spectrometer with the straw tubes and external drift chambers mounted together with their electronics. The outer part of the He-bag is also visible.*

References

1. P. Gianotti *et al*, The FINUDA experiment at DAΦNE, in: Proc. HYP2000 VII International Conference on Hypernuclear and Strange Particle Physics (Torino, October 23-27, 2000).

2. A.Zia *et al*, Nucl. Instr. and Meth. **A461**, 60 (2001).

3. L.Benussi *et al*, Nucl. Instr. and Meth. **A461**, 98 (2001).