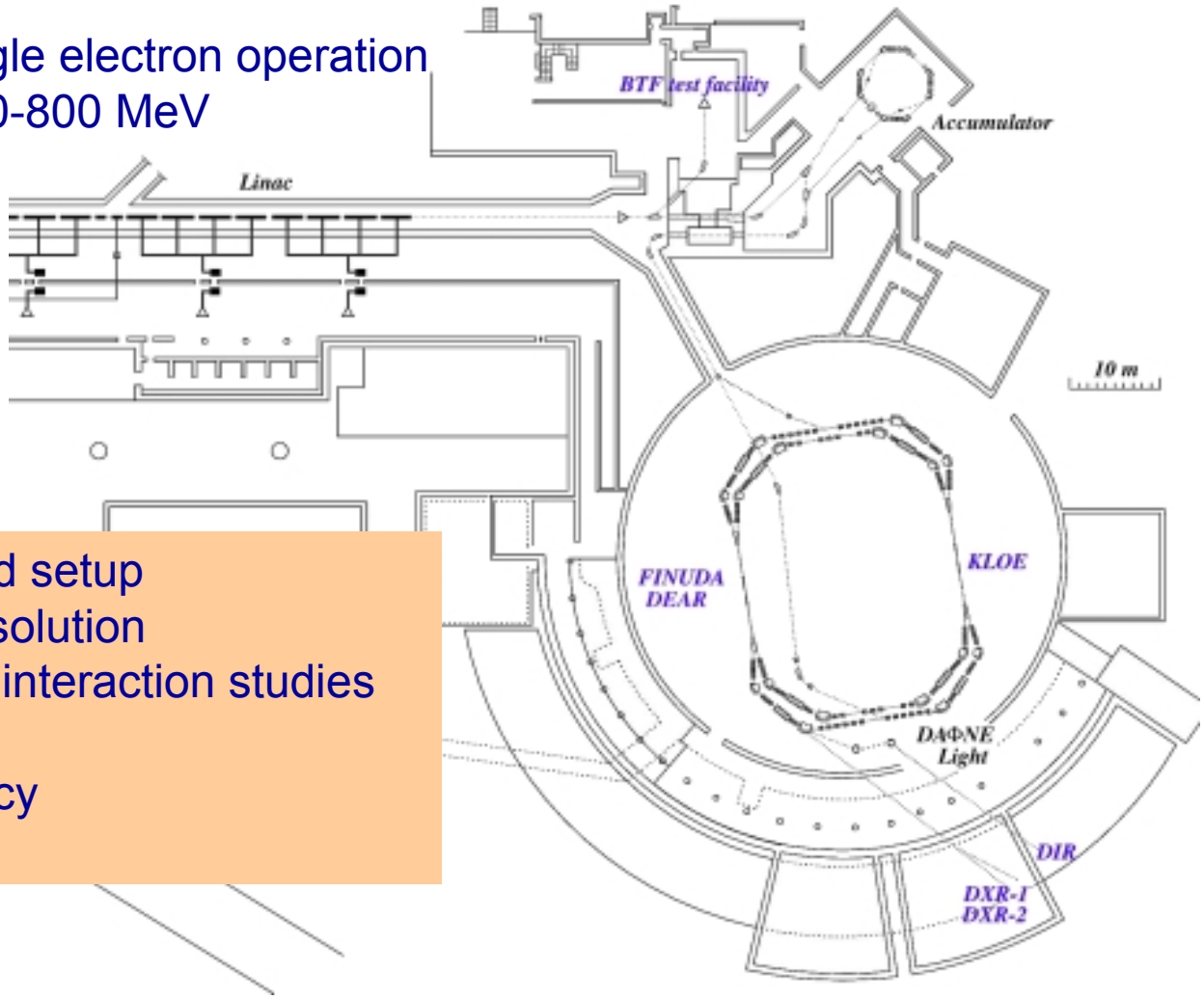
DAΦNE Beam Test Facility
Status Report

Operation and user experience

What is the DAΦNE BTF?

A e^+/e^- test-beam facility in the DAFNE collider complex, profiting of the high current LINAC…

…but mainly intended for single electron operation in a energy range between 20-800 MeV



H.E. Detector calibration and setup
low energy calorimetry & resolution
low energy electromagnetic interaction studies
high multiplicity efficiency
detectors aging and efficiency
beam diagnostics

Relevant publication

LNF Note LNF-03-003(P), PAC2003:

Commissioning of the DAFNE Beam Test Facility

NIM submitted and accepted for publication:

The DAFNE Beam Test Facility

DAFNE Technical Note BTF-1:

DAFNE Beam Test Facility Upgrade Proposal

DIPAC 2003:

Beam Instrumentation for Single Electron DAFNE Beam Test Facility

Frontier Detector for Frontier Physics:

Detectors for high multiplicity electron beam diagnostics

ECFA/DESY Workshop:

First tests of LCCAL prototype at BTF

28th ICRC:

Air Fluorescence Induced by Electrons in a Wide Energy Range

Frontier Detector for Frontier Physics:

Triple GEM detector operation for high rate particle triggering

2003 Schedule

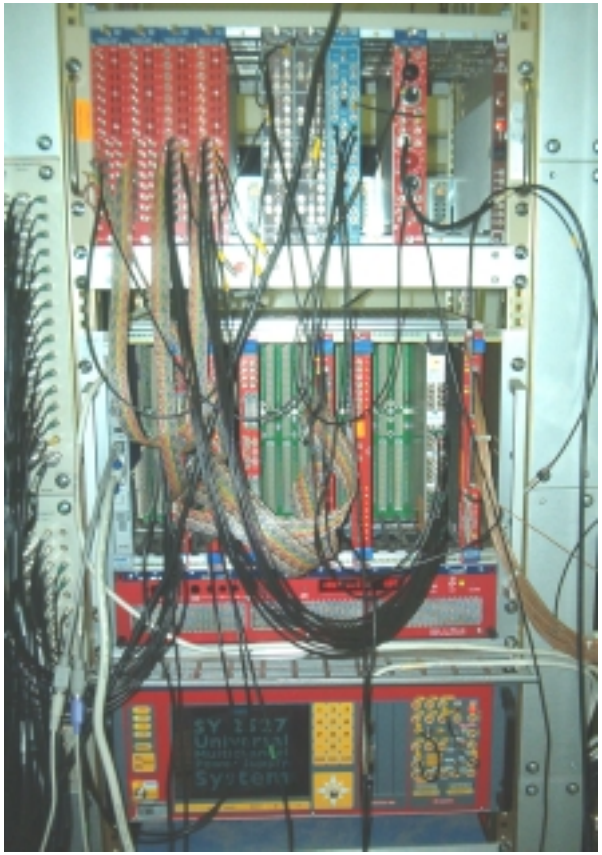
Nov - Dec 2002
Beam characterization
first user shift during DEAR runs

DAFNE weekly schedule 2003

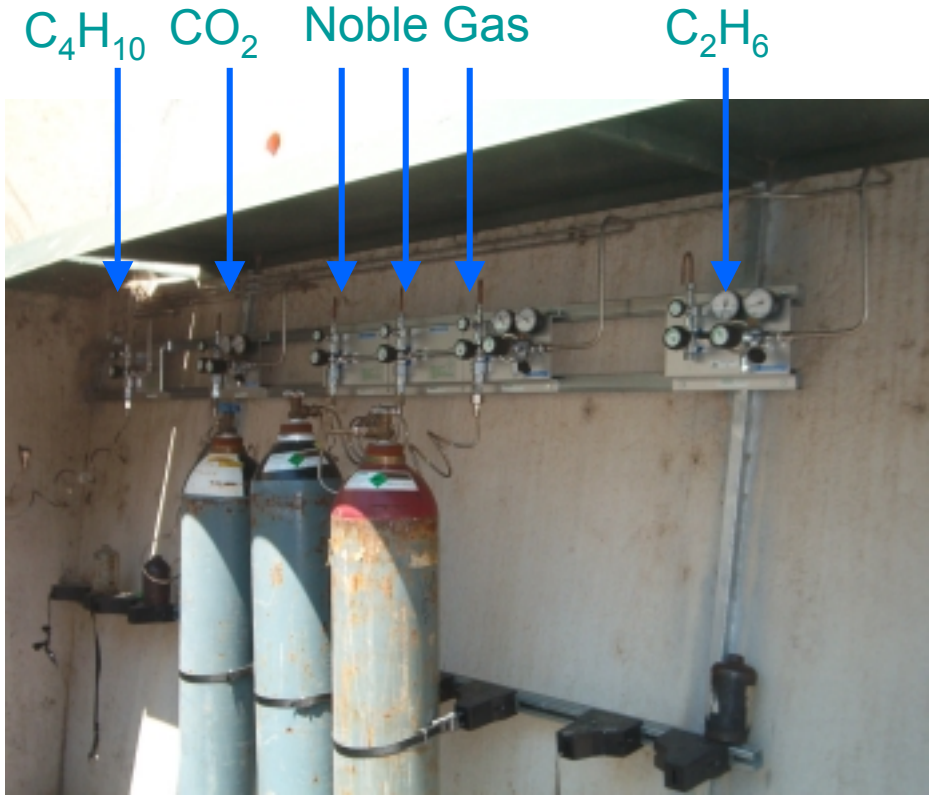
Tue Gen 01 - Sun Mar 09	SHUT DOWN
Mon Mar 10 - Sun Mar 16	LINAC System Start Up BTF restart
Mon Mar 17 - Sun Mar 23	BTF
Mon Mar 24 - Sun Mar 30	BTF
Mon Mar 31 - Sun Apr 06	BTF
Mon Mar 07 - Sun Apr 13	BTF
Mon Mar 14 - Fri Apr 18	BTF
Sat Apr 19 - Sun May 04	MAINTENANCE Easter Shutdown
Mon May 05 - Sun May 11	BTF
Mon May 12 - Sun May 18	BTF
Mon May 19 - Sun May 25	BTF
Mon May 26 - Sun Jun 01	BTF
Mon Jun 02 - Sun Jun 08	BTF
to be defined	MAINTENANCE

Run type	Period		Main User	Other Users
Test	2002-10-11	2002-10-28	BTF	
Test	2002-10-29	2002-10-30	BTF	
BTF down	2002-10-31	2002-11-04		
Parasitic	2002-11-05	2002-11-05	DIAMANTE2	BTF
BTF down	2002-11-06	2002-11-07		
Parasitic	2002-11-08	2002-11-08	AIRFLY	BTF
Maintanence	2002-11-09	2002-11-13		
Test	2002-11-14	2002-11-15	BTF	
Test	2002-11-20	2002-11-30	BTF	
Maintanence	2002-12-02	2002-12-04		
Parasitic	2002-12-09	2002-12-18	LCCAL	BTF
Parasitic	2002-12-19	2002-12-20	AIRFLY	
Dedicated	2003-03-17	2003-03-23	AIRFLY	
Dedicated	2003-03-24	2003-03-30	AGILE	LCCAL
Dedicated	2003-03-31	2003-04-06	LCCAL	AGILE
Dedicated	2003-04-07	2003-04-13	LHCb	
Dedicated	2003-04-14	2003-04-17	CAPIRE	
BTF down	2003-04-18	2003-05-04		
Dedicated	2003-05-05	2003-05-07	CAPIRE	
Dedicated	2003-05-08	2003-05-14	LHCb	
Dedicated	2003-05-15	2003-05-21	NANO	
Dedicated	2003-05-22	2003-06-01	CAPIRE	
Dedicated	2003-06-02	2003-06-08	AIRFLY	
BTF down	2003-06-09	2003-06-22		

Shutdown equipment upgrade

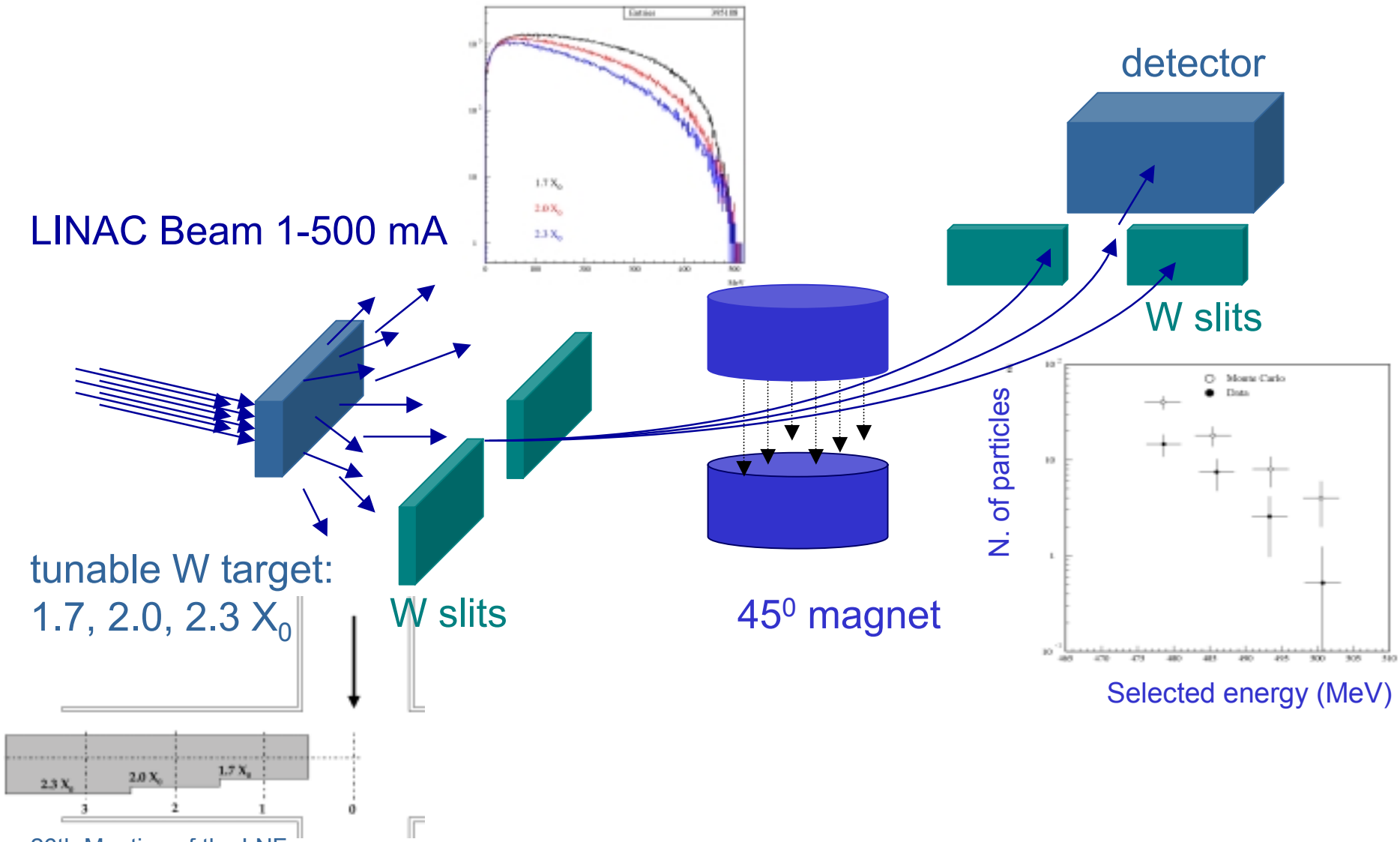


32 channel DAQ TDC/ADC→ diagnostic
NIM, VME, CAMAC Crate
CPU Devil VME controller, NIM modules
Remotely controlled trolley
Gas system



48 ch. HV CAEN SY2527 neg.
40 ch. CAEN SY127 pos.
Cabling BTF HALL-BTF CR
Network LNF and dedicated
DAFNE Consoles and PCs available

LINAC beam attenuation



BTF (operated) parameters

e^- and e^+ $n_{average}$ = from 1 to 10^5 particles

Energy: 20–800 MeV e^-/e^+

Repetition rate: 49 Hz (+1 to energy measurement)

Pulse Duration: 1–10 ns

Single particle production (1% energy selection)

Up to 10^{11} particles/pulse (500 mA)

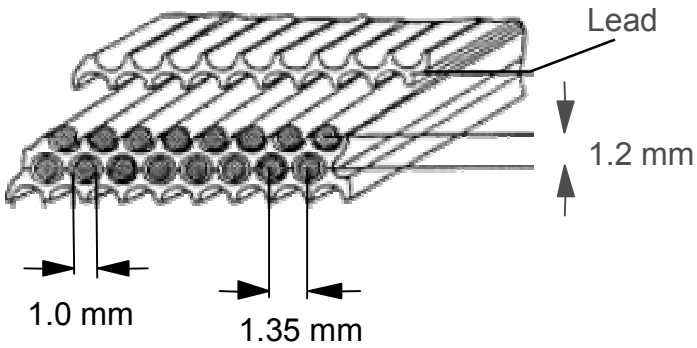
10^3 e^-/sec allowed in 2002-2003

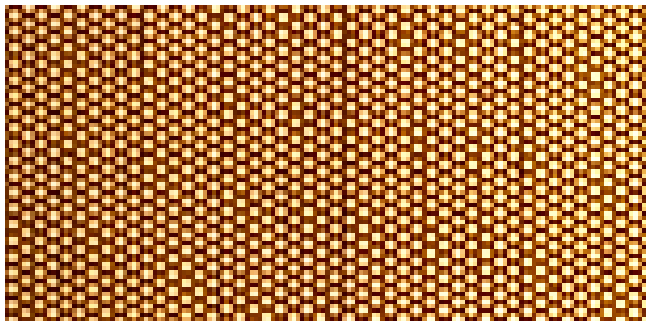
(authorizations asked for 10^{10} e^-/sec)

100 m^2 Experimental Hall

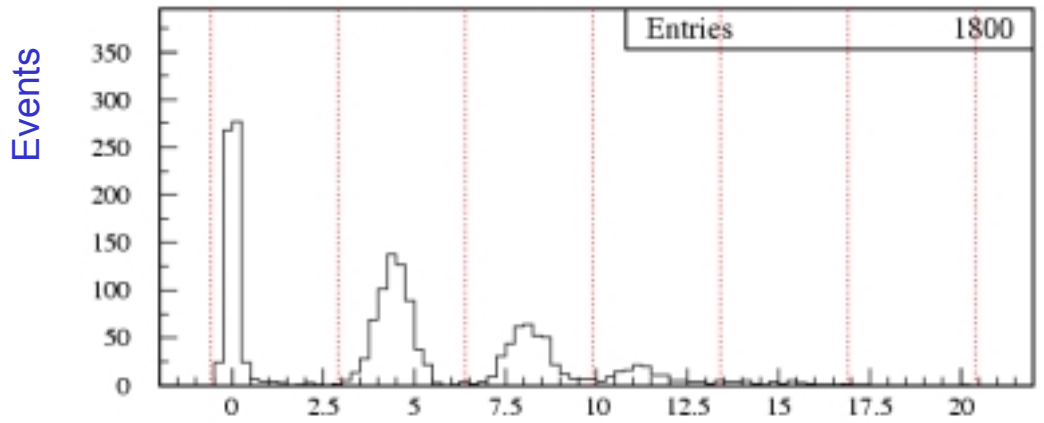
Low multiplicity diagnostics

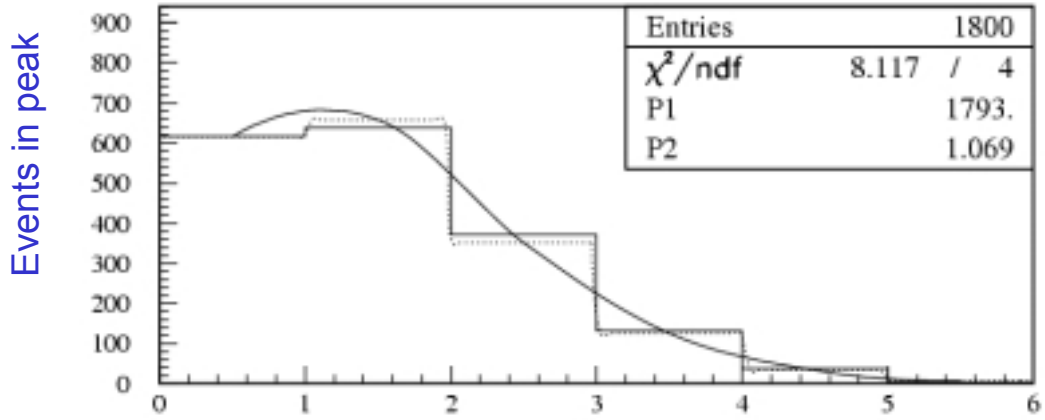
Lead/scintillating fibers calorimeters (KLOE-type) resolution 4.7%/√E(GeV)





Total energy in calorimeter proportional to number of e^-



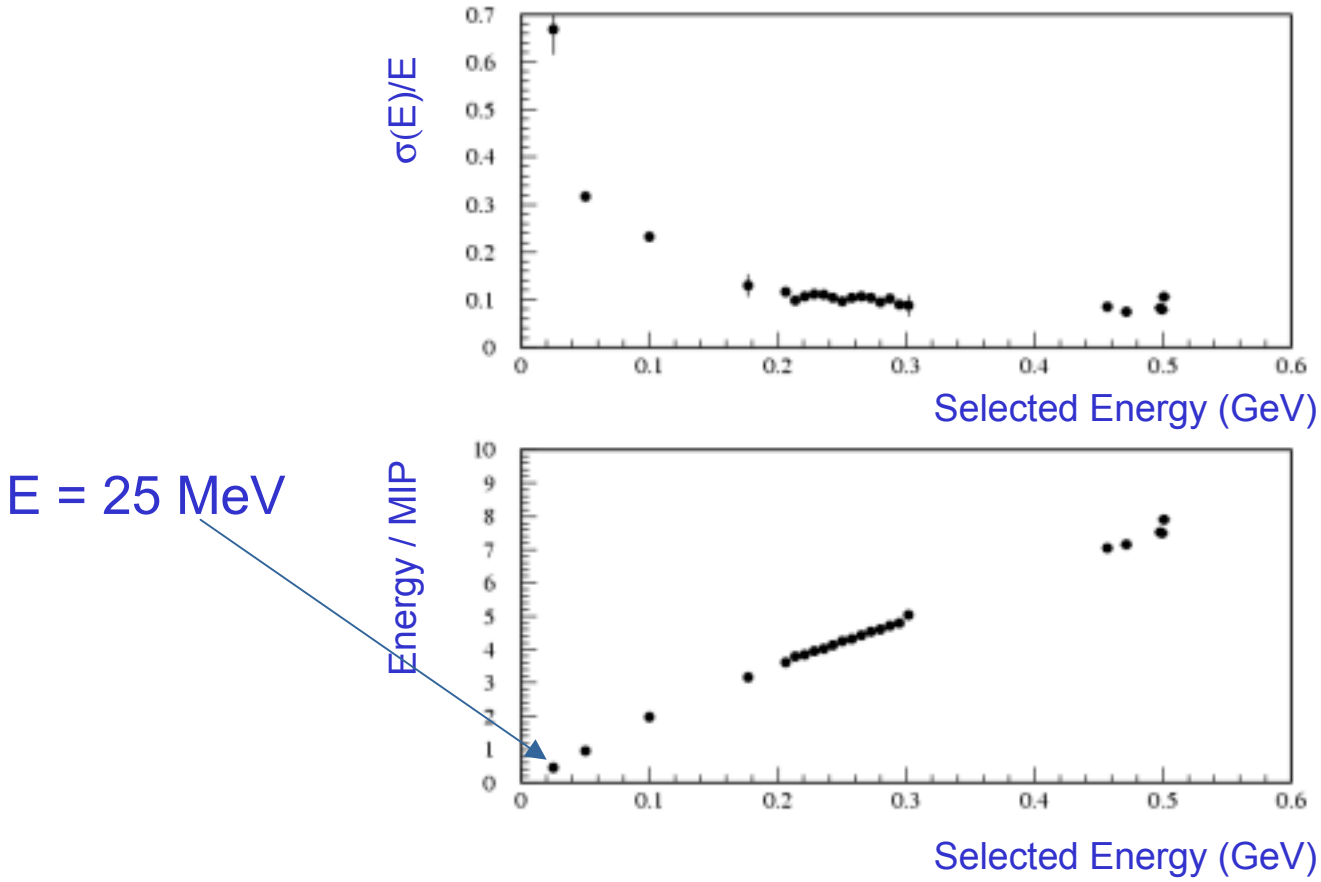


Energy range

Trying to explore all the available energy range, down to few tens of MeV…

Good linearity changing e^- selected energy

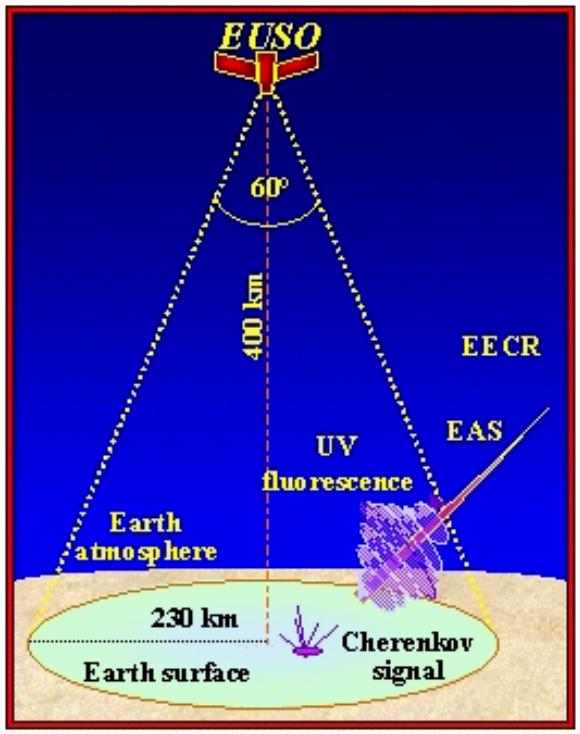
Calorimeter resolution scales as $1/\sqrt{E}$

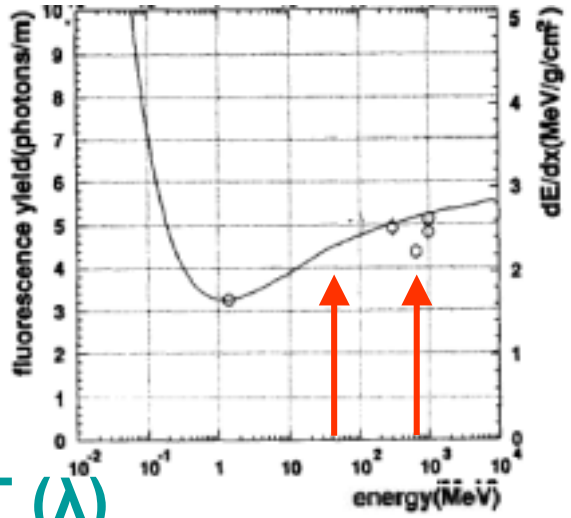


User experience: AIRFLY

Aim:

measure energy dependence of fluorescence in air/nitrogen in the energy range relevant for the core of an extensive air shower (the most probable energy of electrons in the EAS core is 80 MeV)





$$N^{p.e.} = \sum_{\lambda} N_\gamma(\lambda)\, \frac{A'}{R_i^2}\, \varepsilon(\lambda)\, T(\lambda)$$

Emitted Photons — Geometry — Detector — Atmosphere

Common systematics

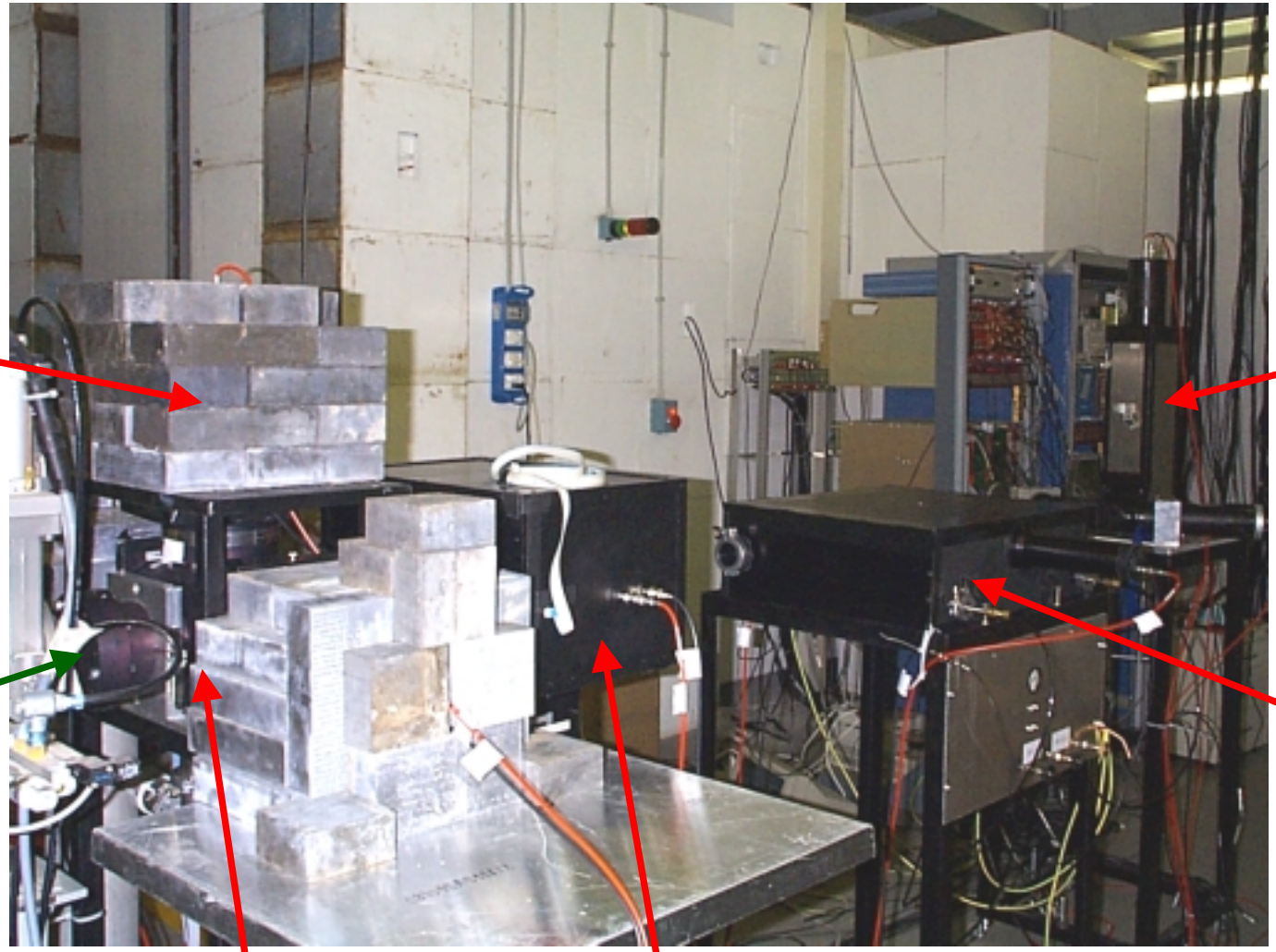
Requests:

Multiplicity between a few electrons and 10^4-10^5

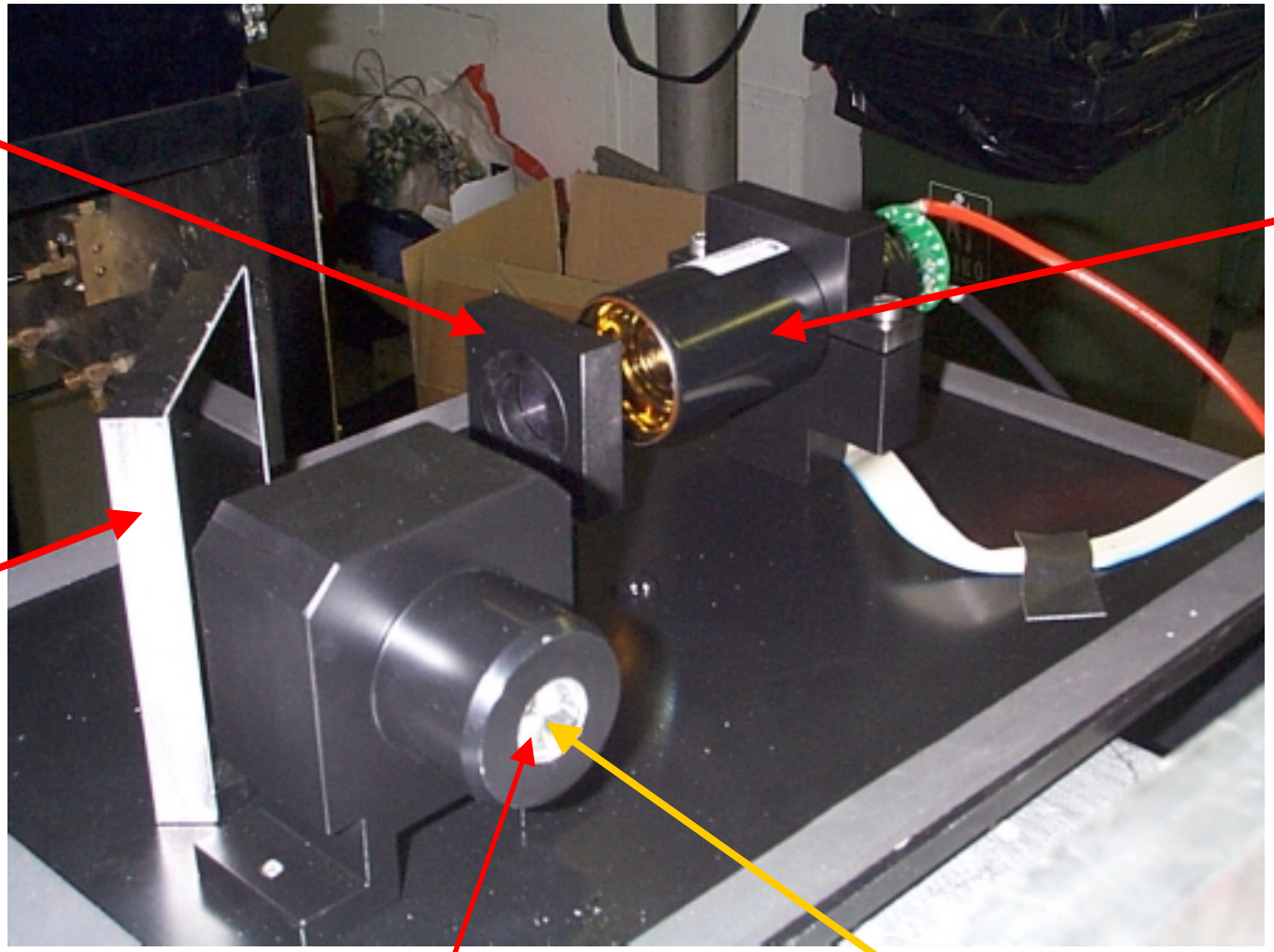
Energy in the range 50 – 800 MeV

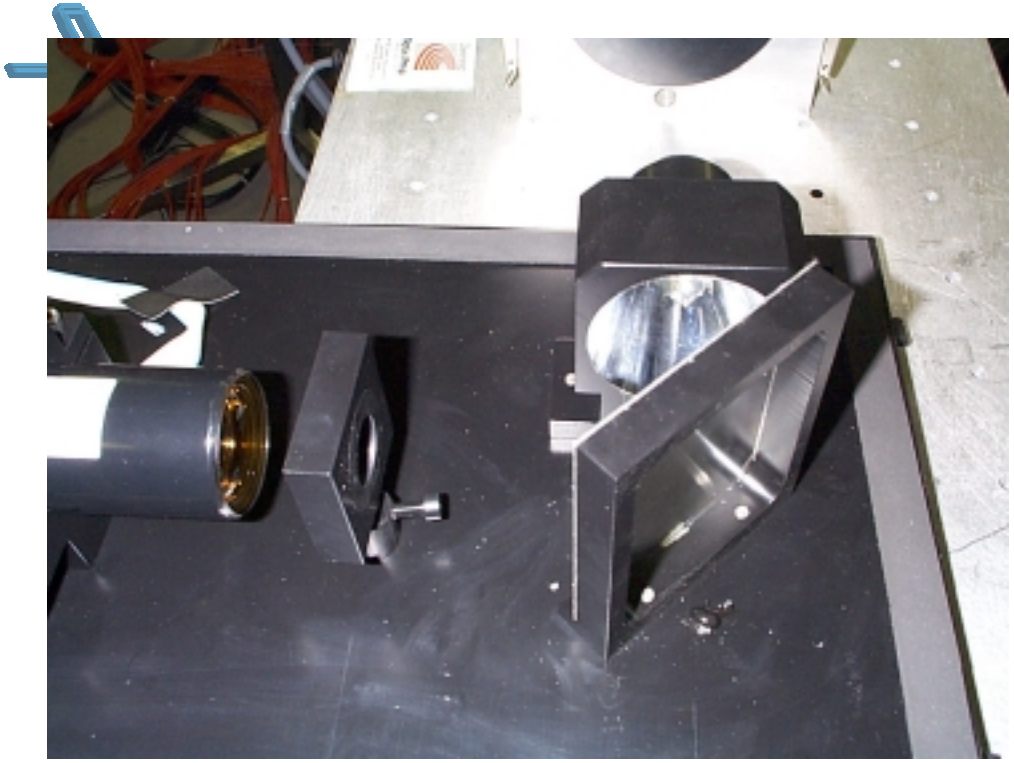
- Electron energy
- p and T, gas
- and λ dependence

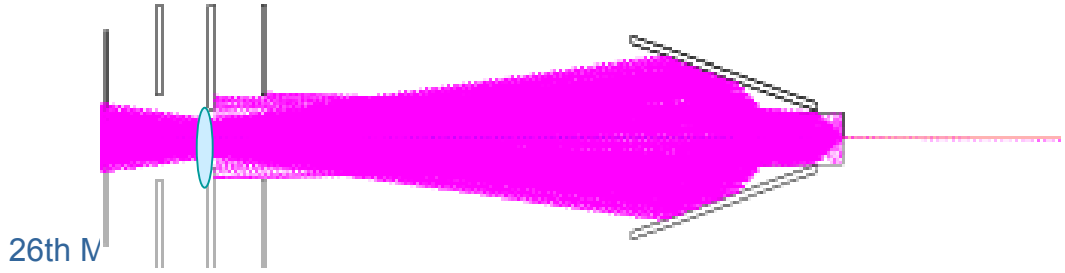
AIR FLuorecence Yeld Setup



The Cerenkov beam monitor







The Cerenkov beam monitor

The Cerenkov light is extracted from the plexiglass radiator by appropriate shaping of the end part without optical connection to the PMT.
Calibrated attenuating filters allow the measurement of the beam intensity over several order of magnitudes.
Inter-calibration with the calorimeter

Measurements at the first test beam

Understanding and optimization of beam associated background. Improved shielding along the BTF line and around PMTs.

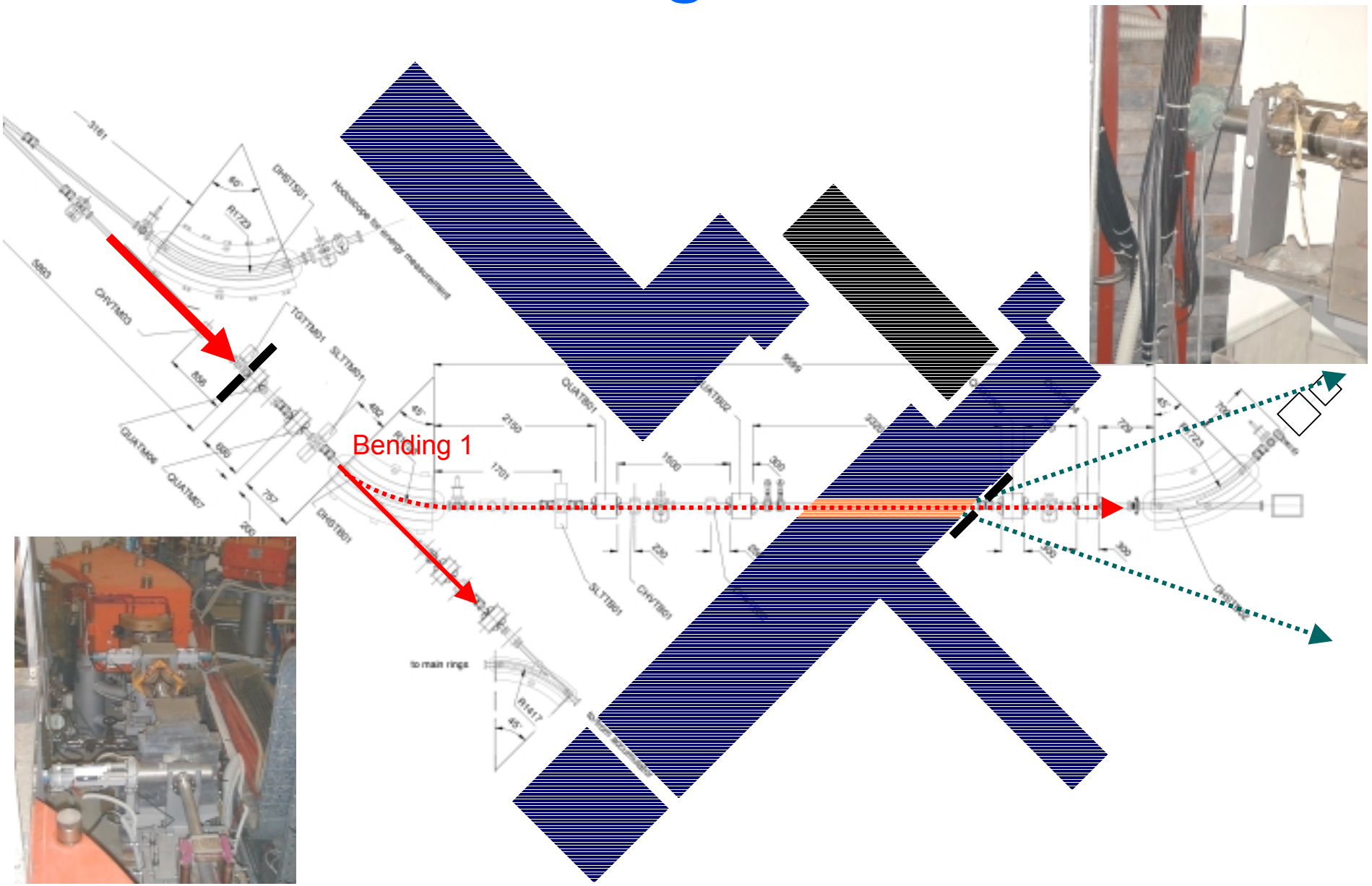
Successful BTF commissioning of 1 ns bunch for fluorescence lifetime measurement

Operation of fluorescence chamber with nitrogen and dry air. Remote control of gas and pressure. First measurements with interference filters. First energy scan.

Successful test of elliptical mirror concept (factor 10 higher light collection)

Inter-calibration of calorimeter and Cerenkov beam monitor.

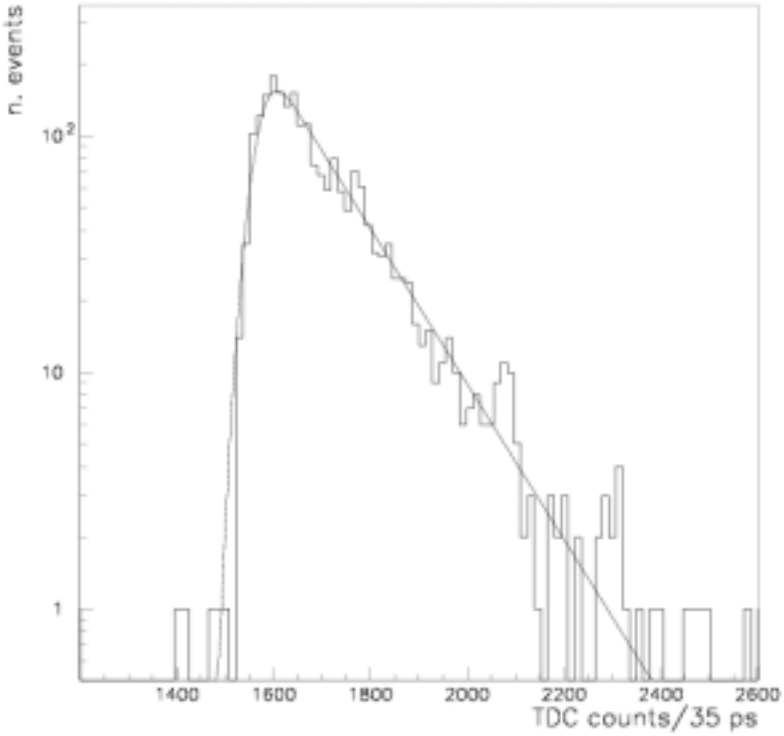
Background reduction



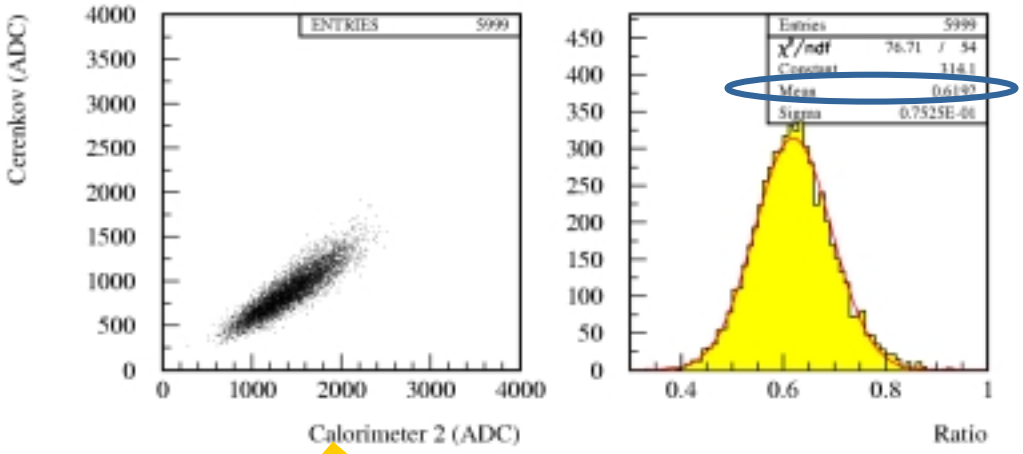
AIRFLY: first measurements

Calorimeter – Cerenkov calibration

Fluorescence Lifetime ≈5 ns at 340 mbar N_2

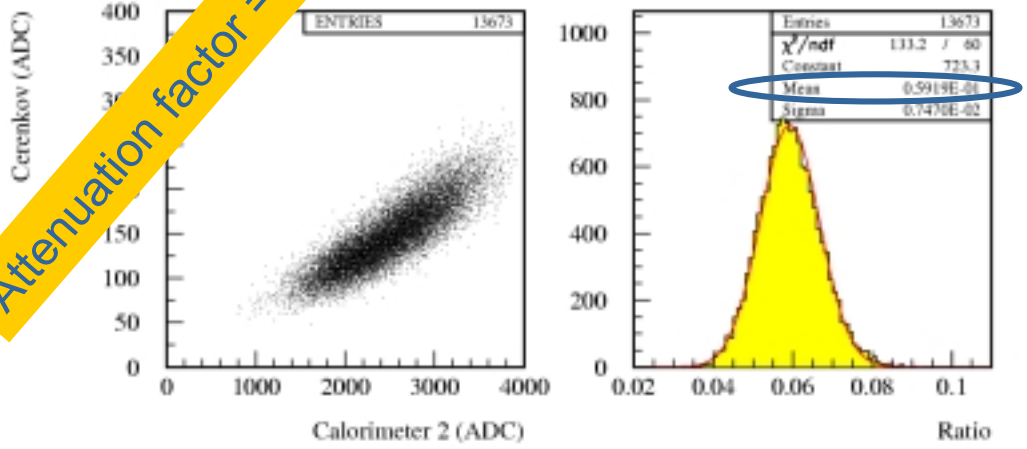


No filter



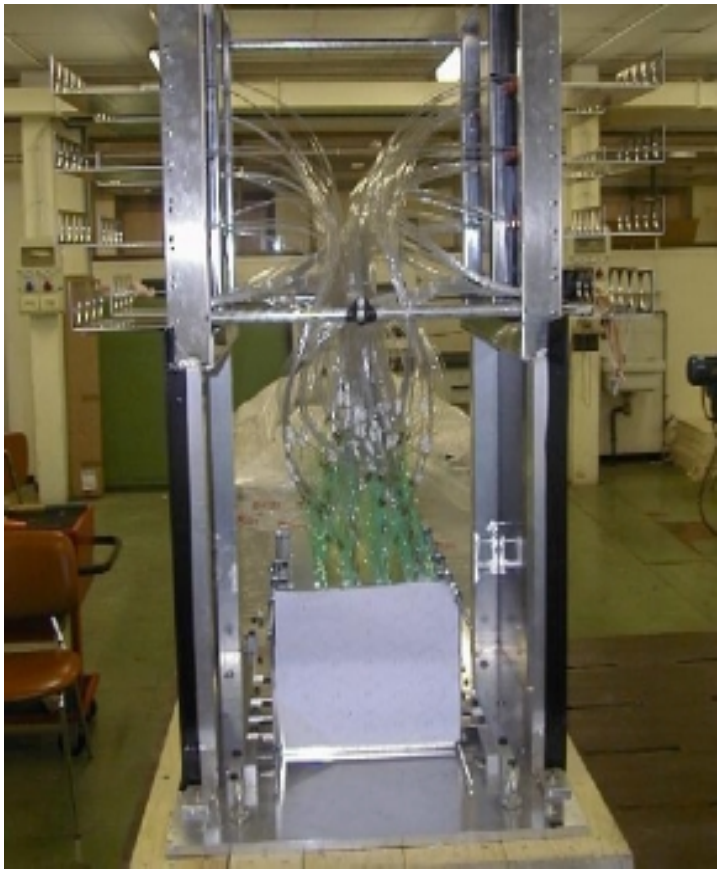
Attenuation factor = 0.096

:10 optical filter

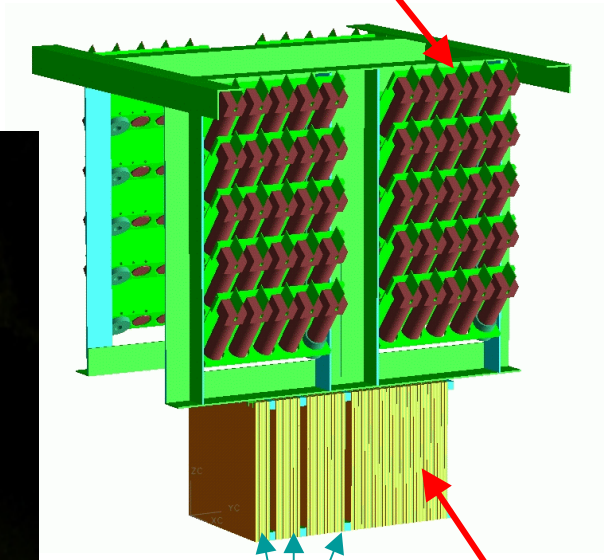


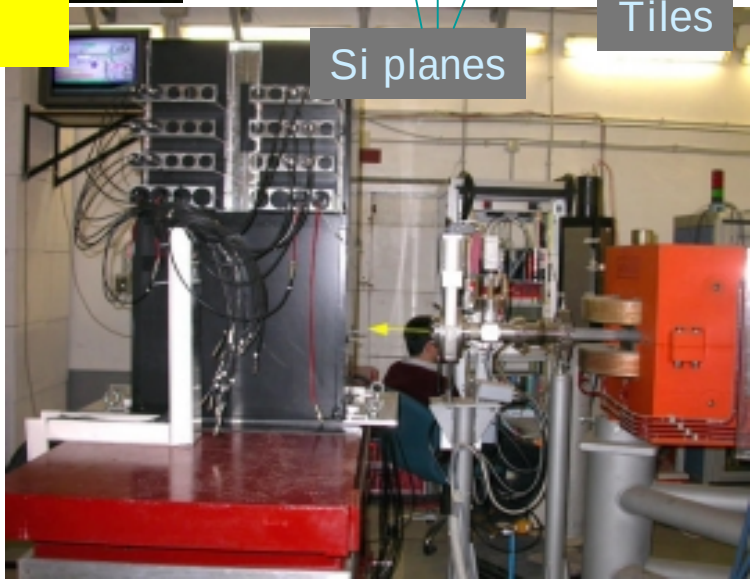
User experience: LCCAL
(hybrid EM calorimeter)

Tiles surrounded by holder structure for PM

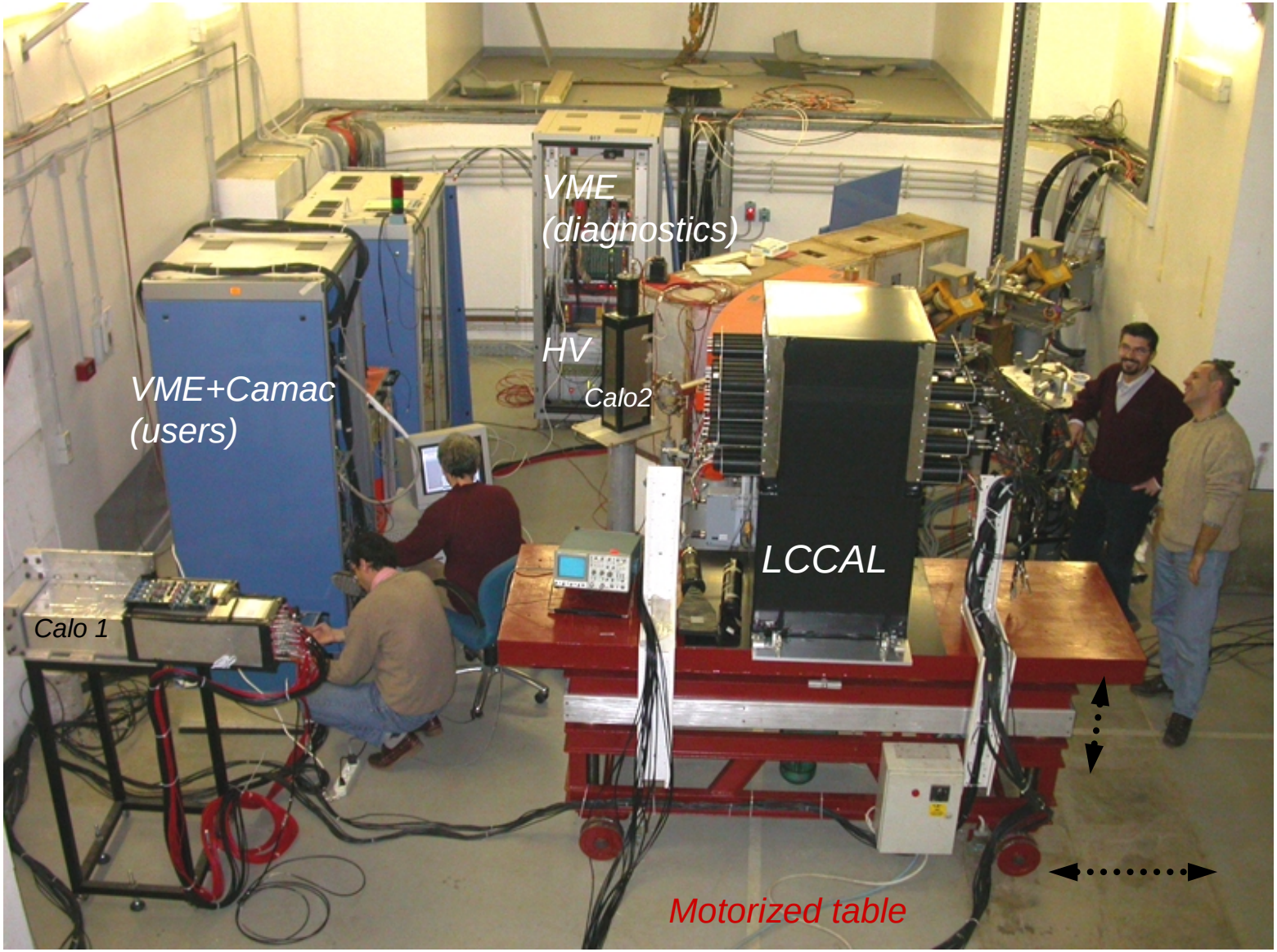


Fibers inside collector
In front of PMs



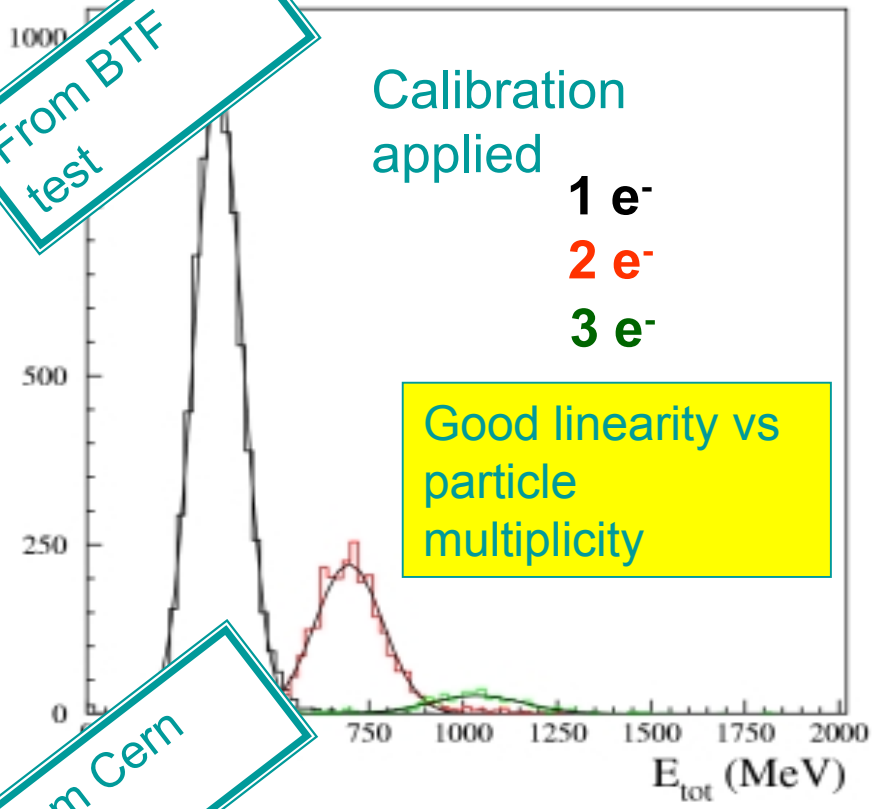


LCCAL Setup


VME
(diagnostics)
HV
Calo2
VME+Camac
(users)
LCCAL
Calo 1
Motorized table

LCCAL: energy resolution/linearity

From BTF test



Calibration applied

1 e⁻

2 e⁻

3 e⁻

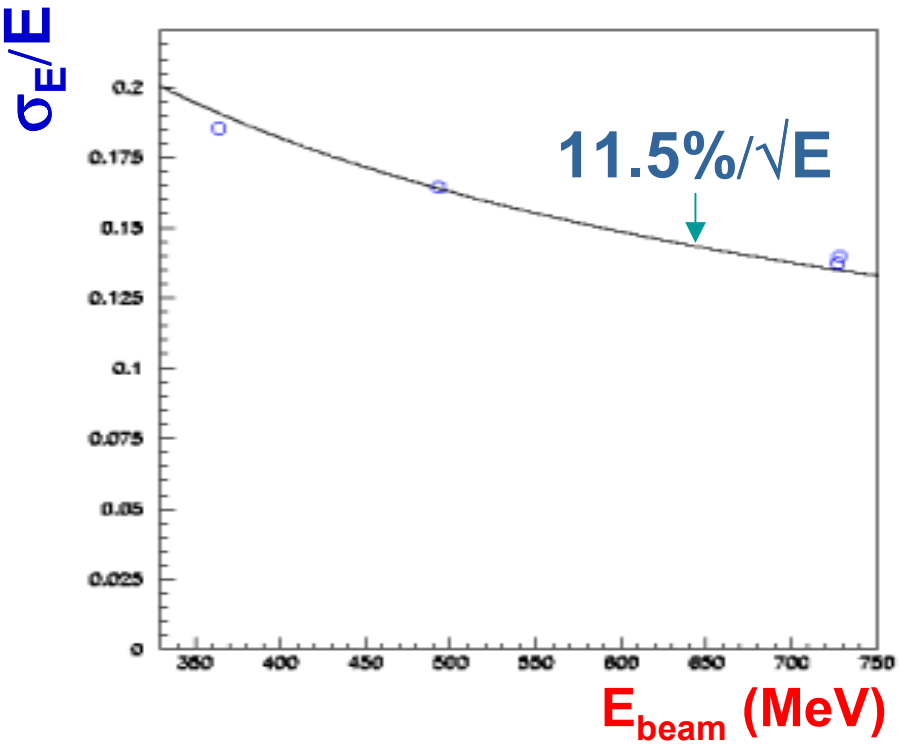
Good linearity vs particle multiplicity

From Cern TB

N_{phe}>5.1 /layer →**Cal(45 layers) ~ 250 MeV/Mip ~ 800Npe/GeV**

Light uniformity better than 20%

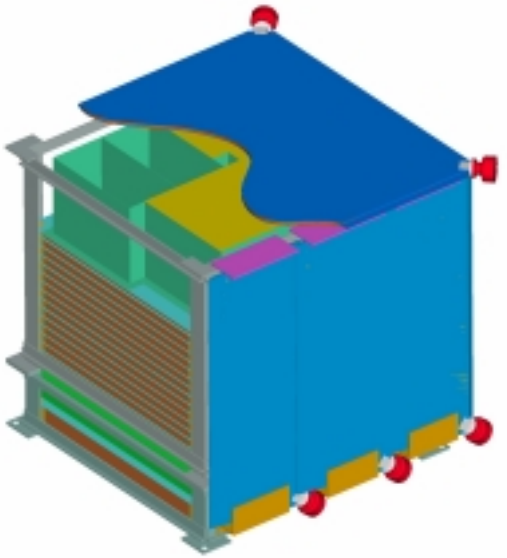
OK also @ BTF (E ~500 MeV)



1. Photoelectron stat. Negligible
2. Sampling term 11.5% as in MC
3. Uniformity of light collection still at a level < 10% using all layers. Effect on resolution to be evaluated at next Cern TB (Aug 2003)

User experience: AGILE

AGILE Silicon Tracker: 14 planes, with two Si-layers per plane providing the X and Y coordinates. 9.5 x 9.5 cm2, microstrip pitch equal to 121 μm, and thickness 410 μm. 384 readout channels (readout pitch equal to 242 μm)

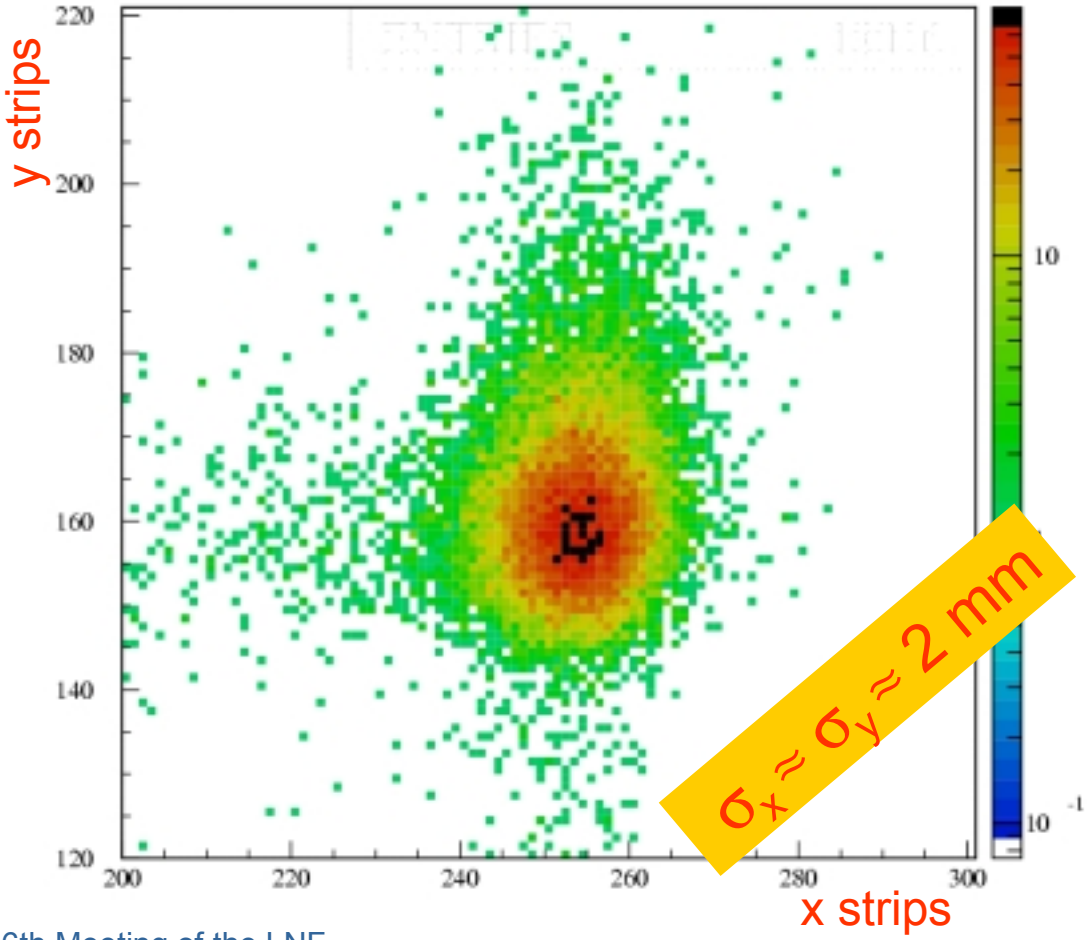


Astro-rivelatore Gamma a Immagini LEggero

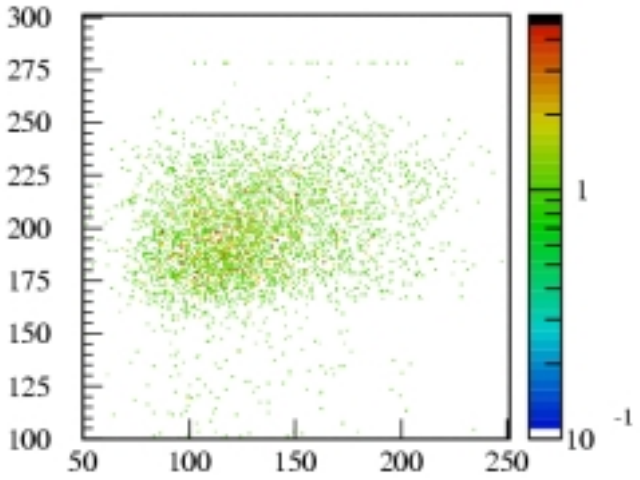
Beam spot measurement

410 μm thick, single-side, AC coupled strips, 121 μm pitch, 242 μm readout pitch

2 layers (x and y) × 384 strips, analog readout



Defocussed beam



User experience: LHCb

The **L**arge **H**adron **C**ollider **b**eauty experiment

Electron Beam @ 500 MeV

49 Hz single electron with ~1 ns resolution time

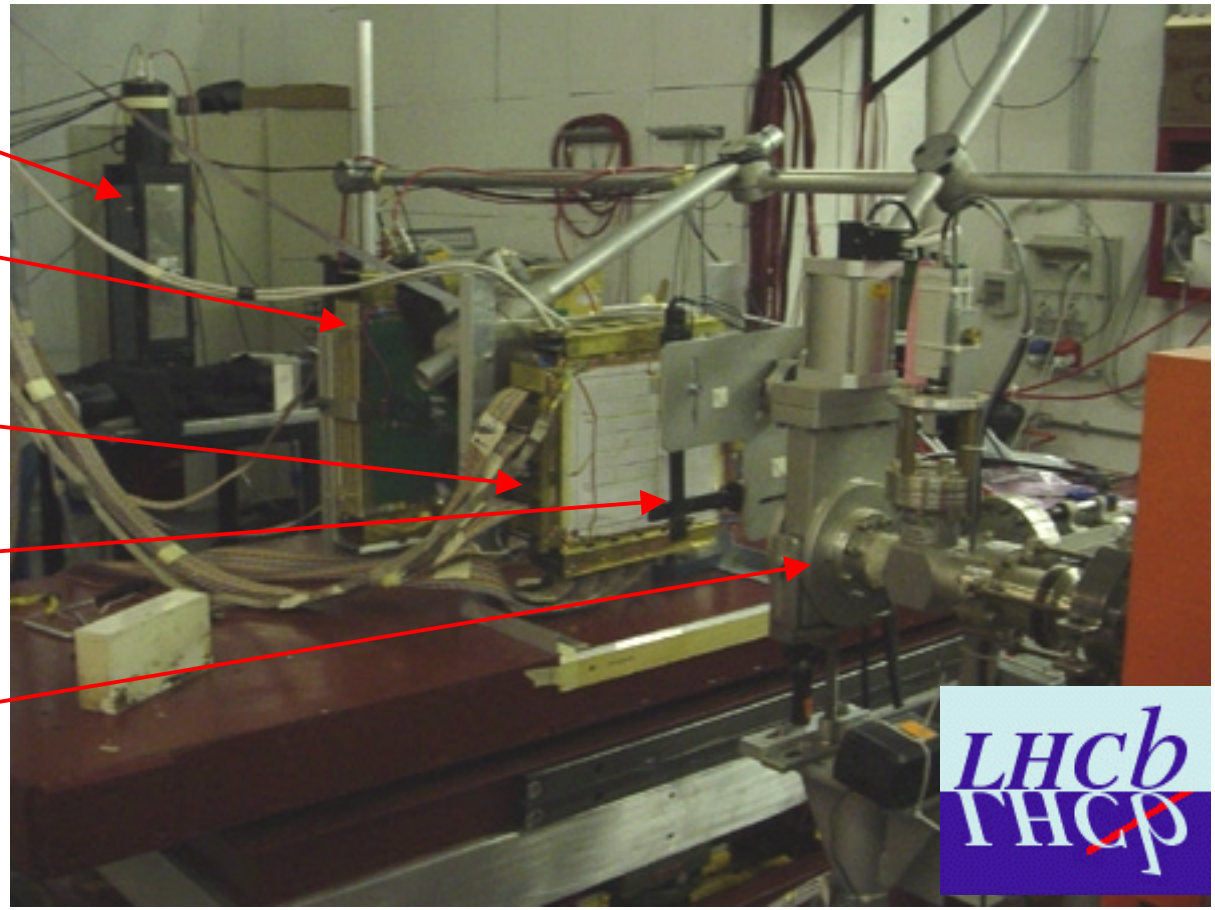
Calorimeter

MWPC P#6

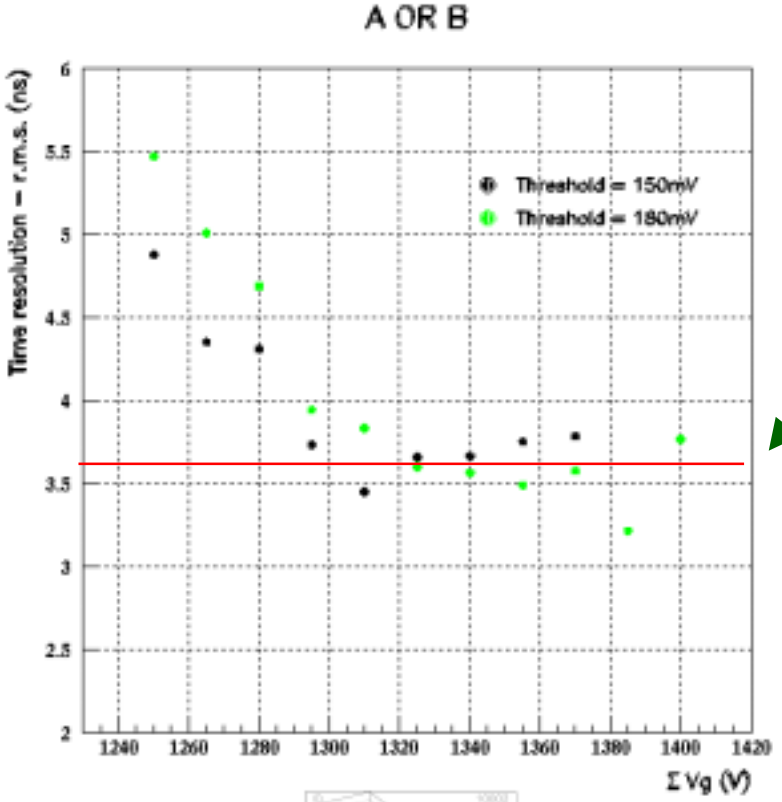
GEM Module 0

Fingers

Beam pipe

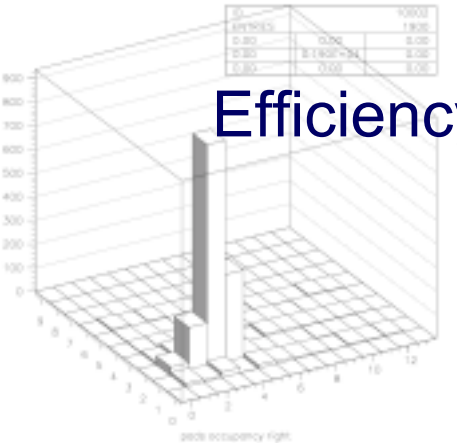


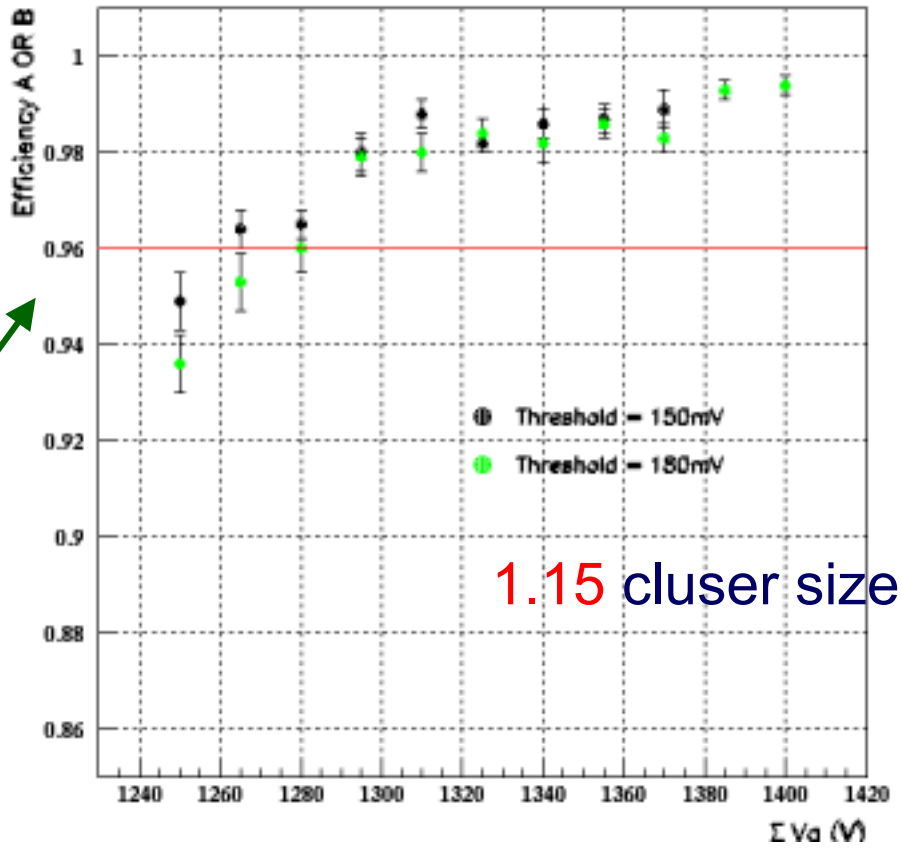
Time resolution and Efficiency



3.6 ns (RMS)

Efficiency in 20 ns





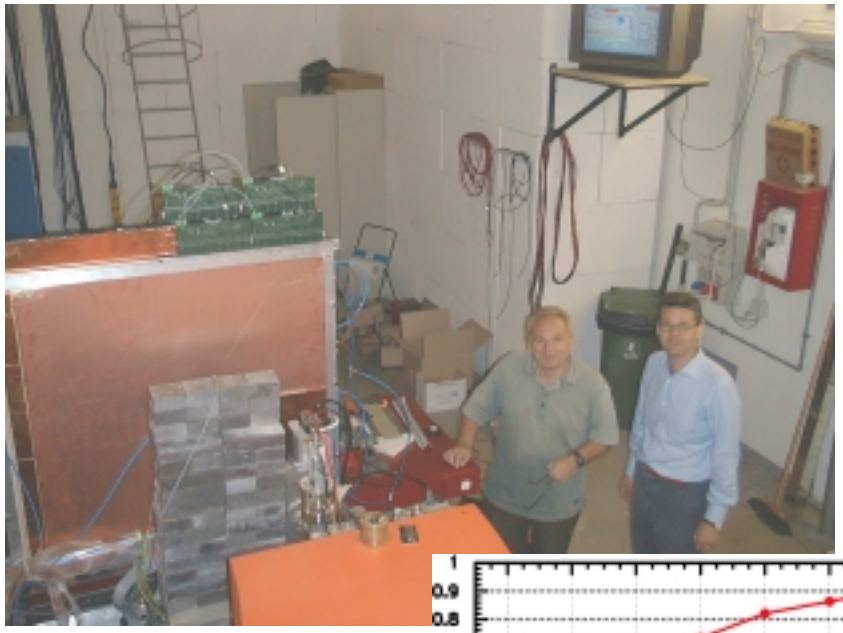
1.15 cluser size

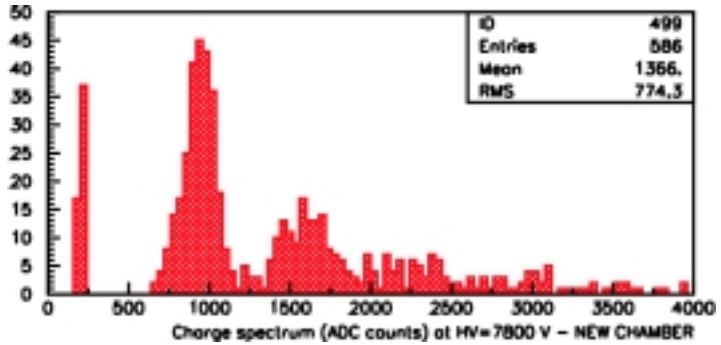
User experience: CAPIRE

Camere a Piani Resistivi design, test and industrialization of Resistive Plate Chambers for high energy physics

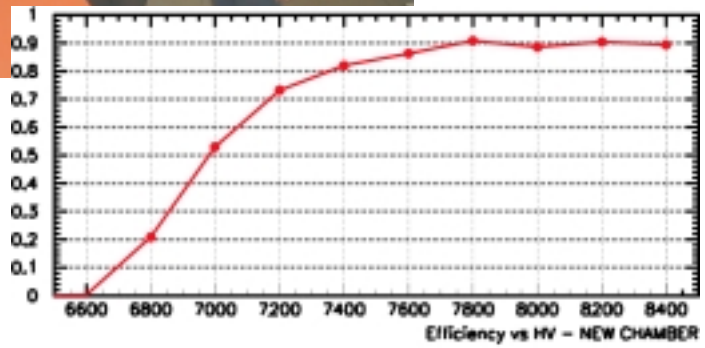
Glass Restive Plate Chamber efficiency in wide range of multiplicity and repetition rate (up to 10 Hz/cm^2) as a function of gas mixture and position (i.e. near spacers and edges)

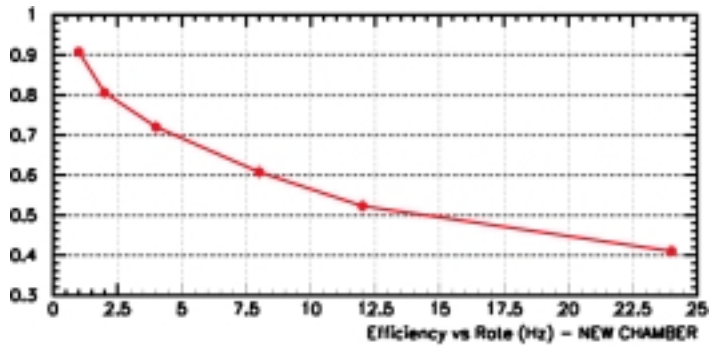
CAPIRE large glass chamber efficiency



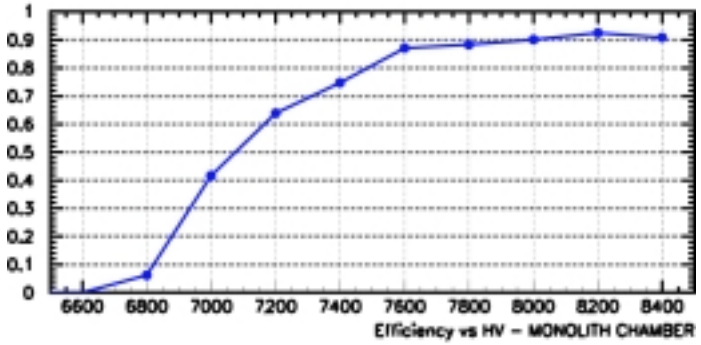


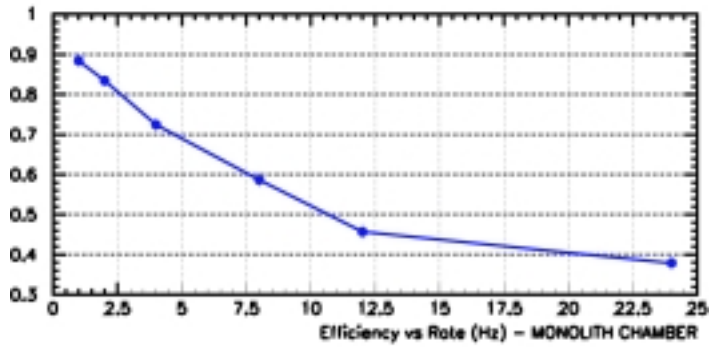
new large glass chamber





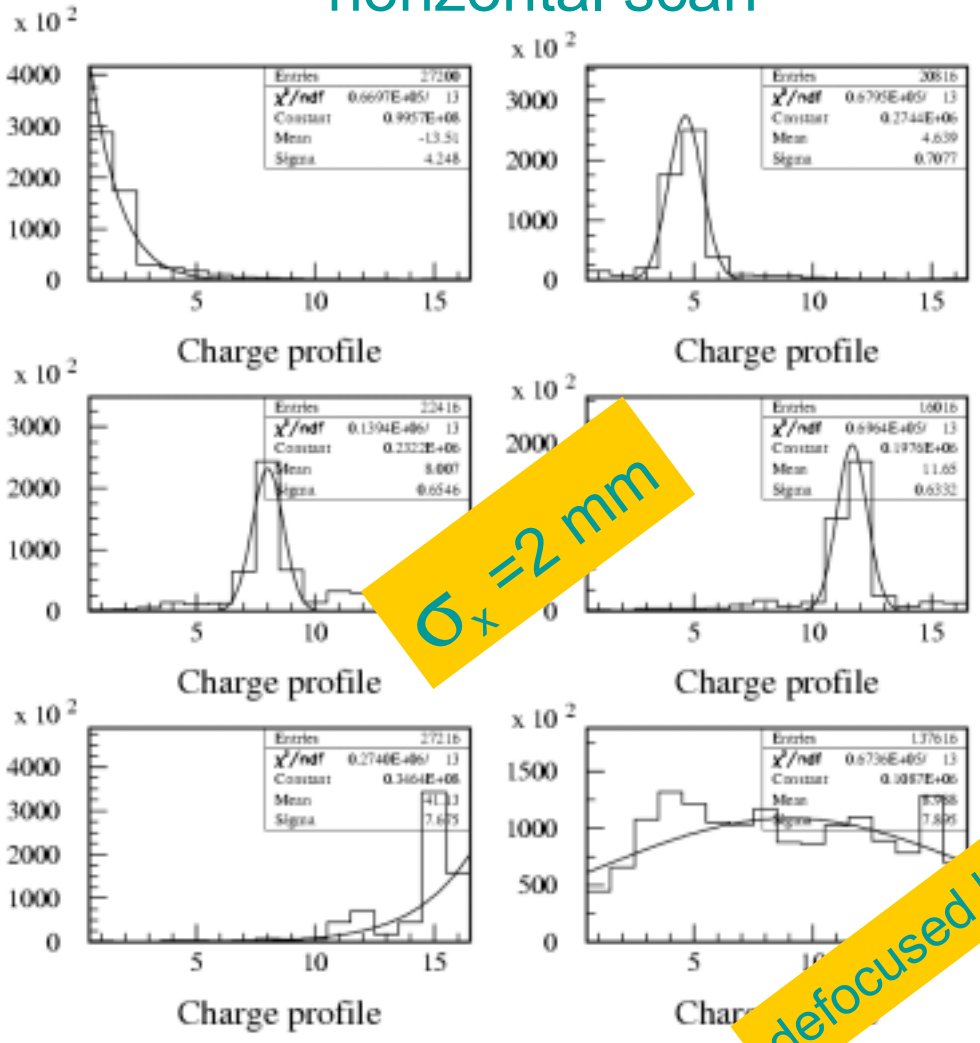
old small chamber

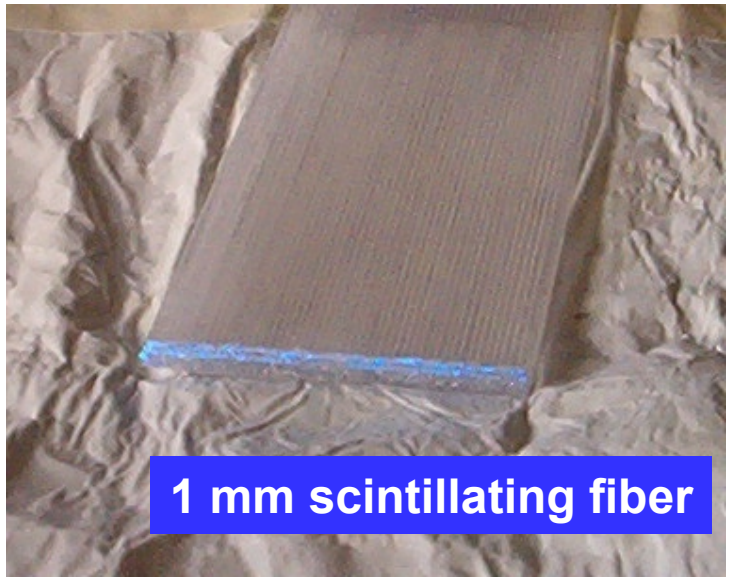




Beam spot size
(scintillating fiber beam profiler prototype)

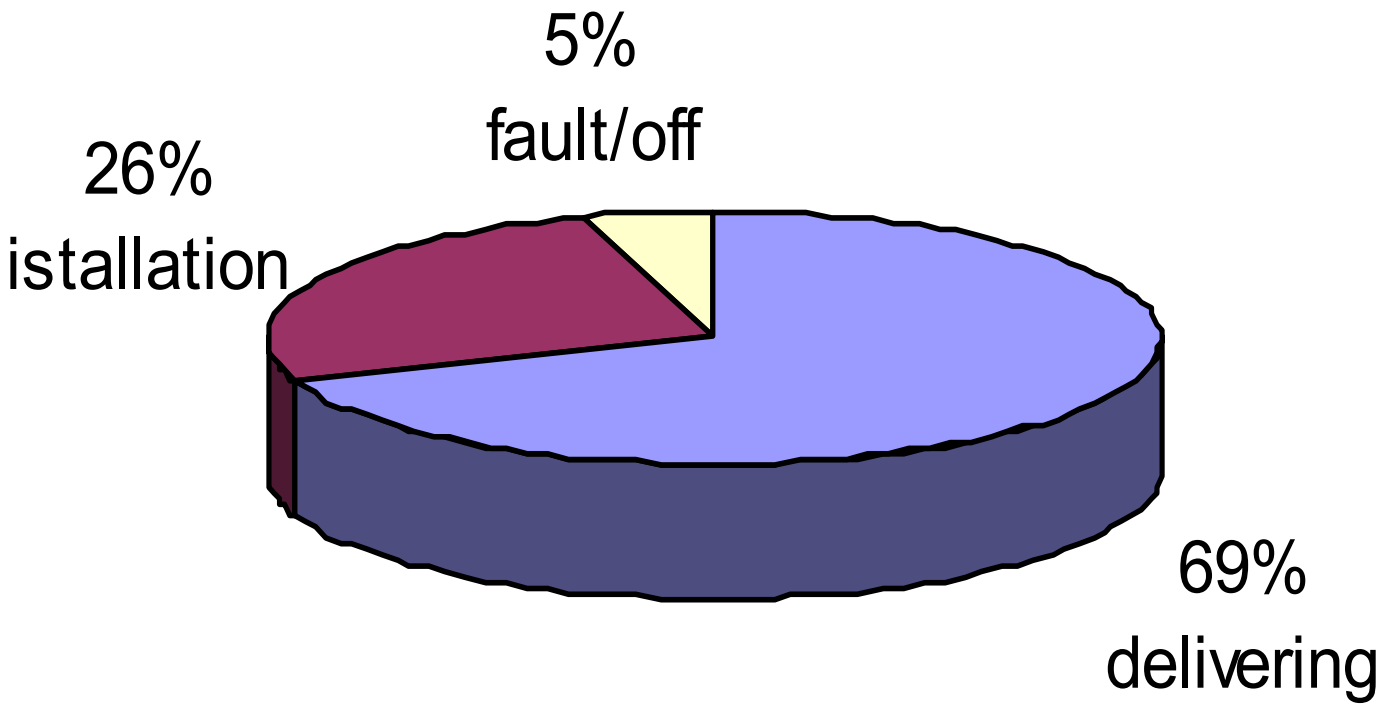
horizontal scan



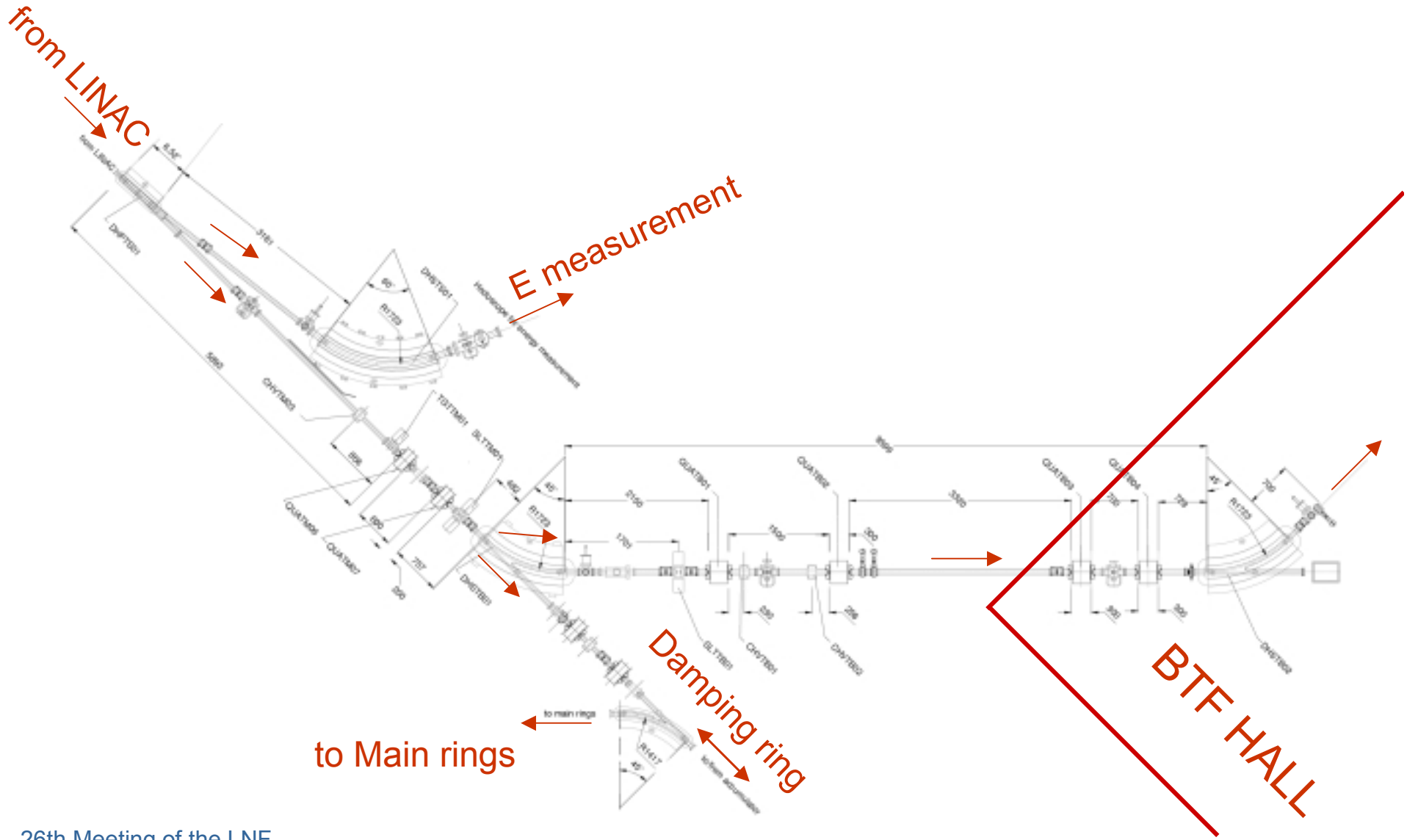


17 Mar-15 Apr Operation (~1000 h)

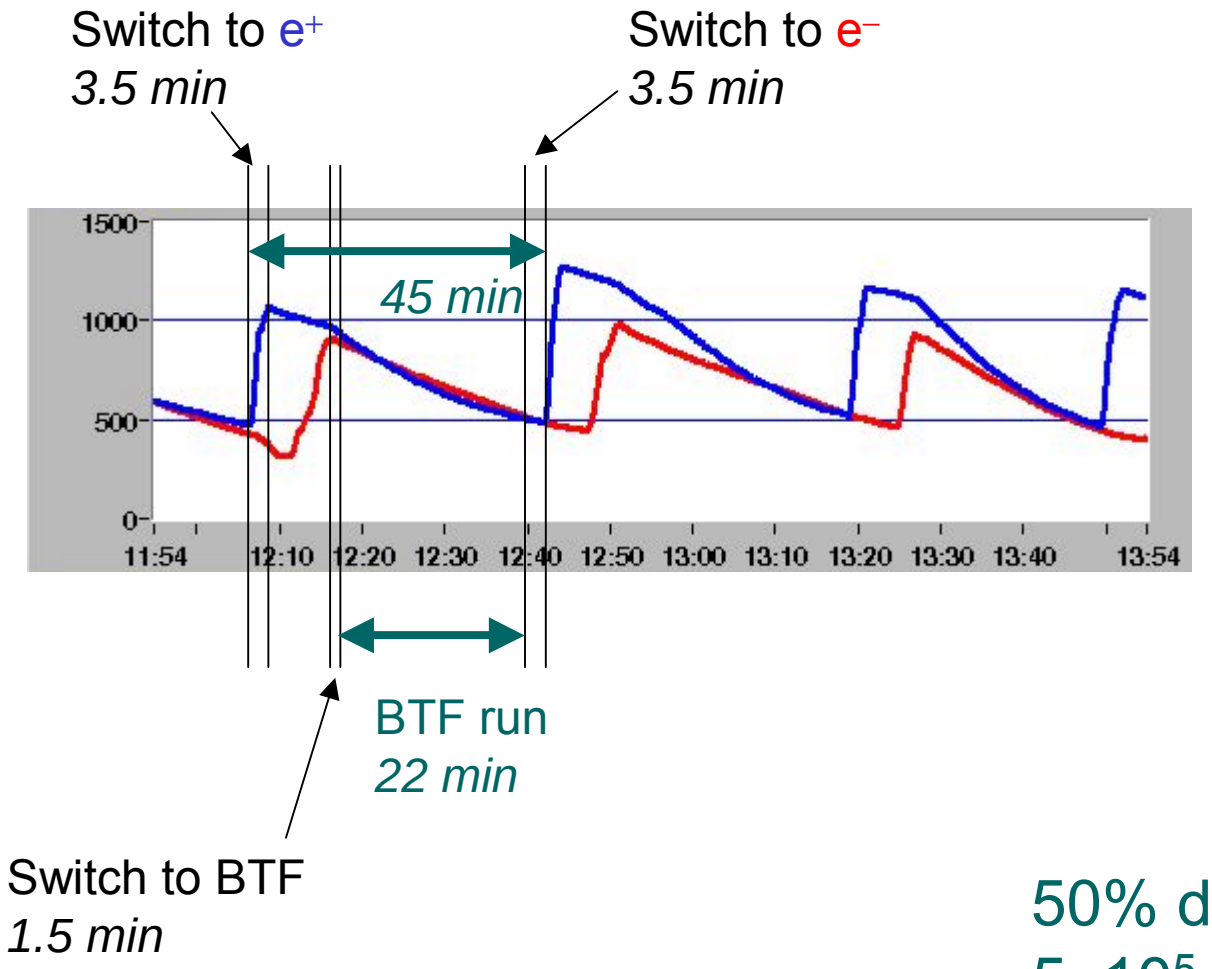
All the programs as been successfully operated (only TARI29 does not present at the scheduled shift)



BTF layout


from LINAC
E measurement
Damping ring
to Main rings
BTF HALL

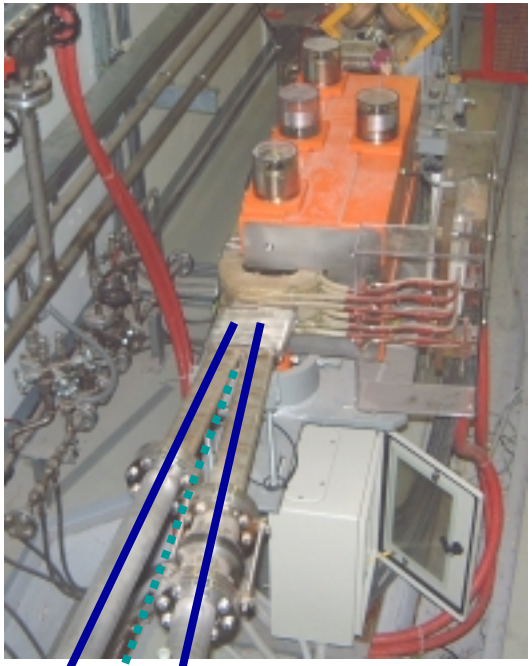
‘Parasitic’ operation



50% duty cycle

5×10^5 single e^-/day

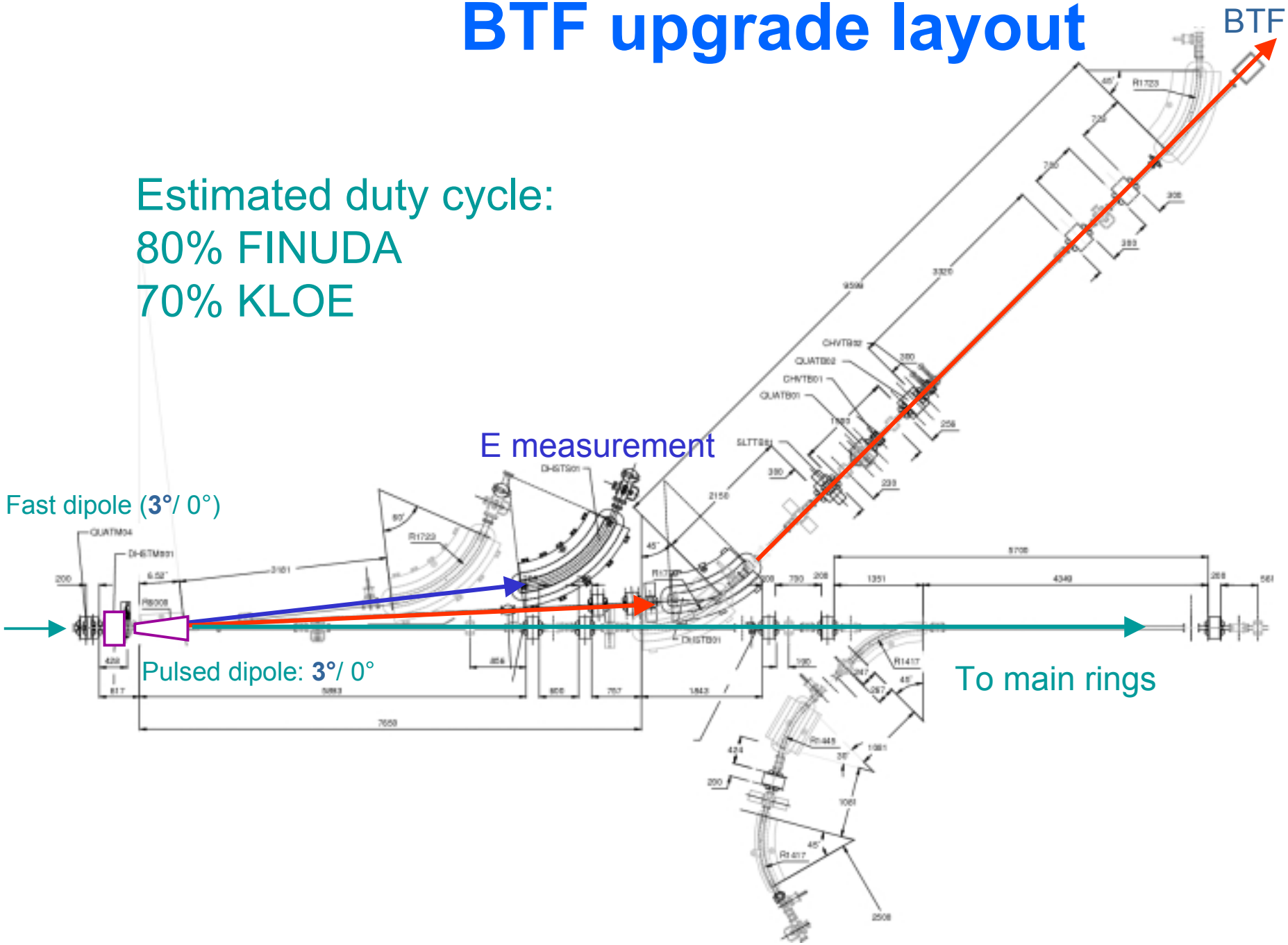
BTF Upgrade



An independent line is now being designed in order to operate the BTF in a true parasitic mode…

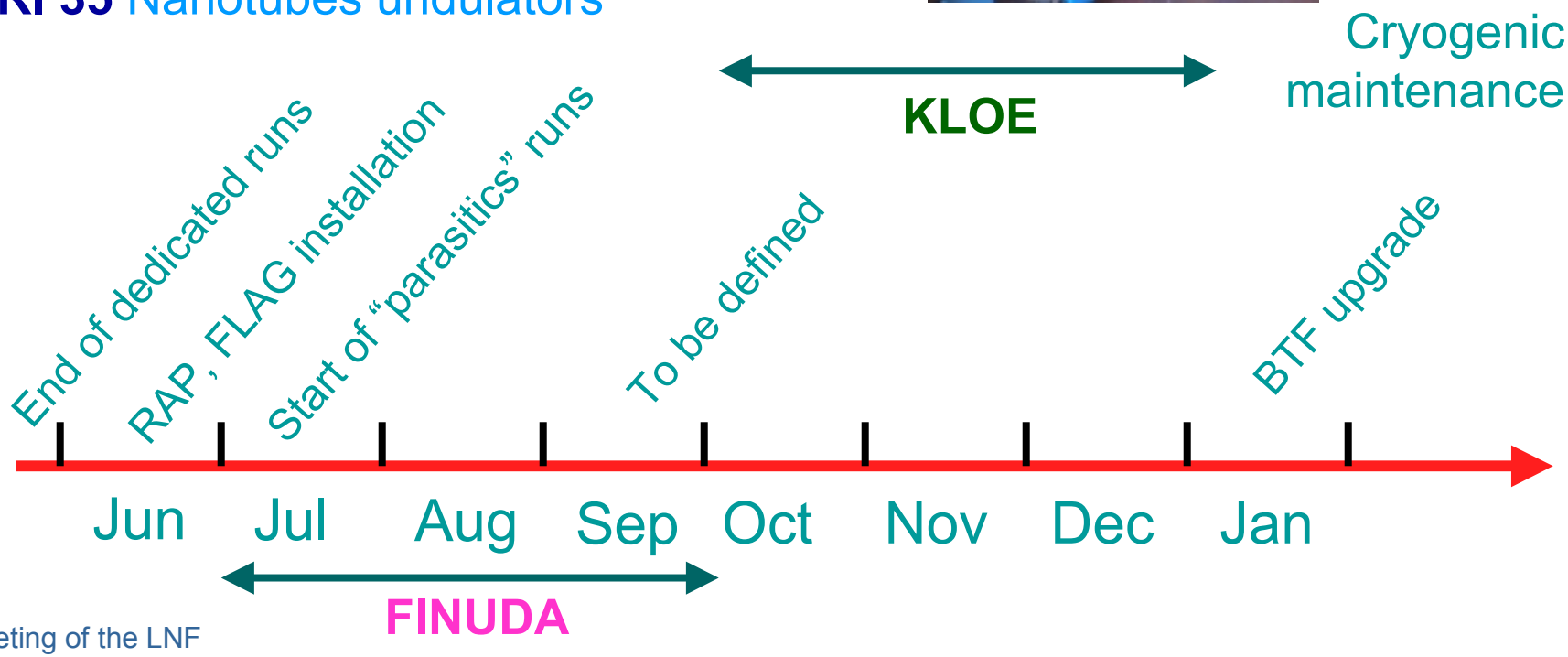
The allowed dose (10^3 particle/sec) will be increased up to 10^{10} (for neutron, photon production, beam diagnostics device test, detector aging, etc.)

BTF upgrade layout



2003 Schedule after 8th June shutdown

RAP Rivelazione Acustica di Particelle
FLAG fluorescence flag study
AIRFLY (TARI 29)(3th run)
CaPiRe (3th run) RPC
DEAR II Silicon Drift detector test
PAMELA Full Flight Model test
TARI 23 Nanotubes bending
TARI 35 Nanotubes undulators



Summary

The DAΦNE Beam Test Facility start successfully operation with experiments

2 month of parasitic and more then 2 month of dedicated operation (12 equivalent weeks and 8 different users) in a wide range of multiplicity and energy has shown that the BTF can provide particles in a wide range of energy and multiplicity (with very good repeatability)

First users experience was very positive

With the future upgrade (planned Jan. 2004) the facility will be even more useful…

…but more work is needed for further beam characterization!

Air/N chamber for High multiplicity, scintillating fiber detector for beam profiling, NaI and/or BGO calorimeters for energy resolution measurements are under developing and implementation…

We would like to thank sincerely all the technicians of the* Divisione Acceleratori *for their fundamental work,

the members of the BTF commission,

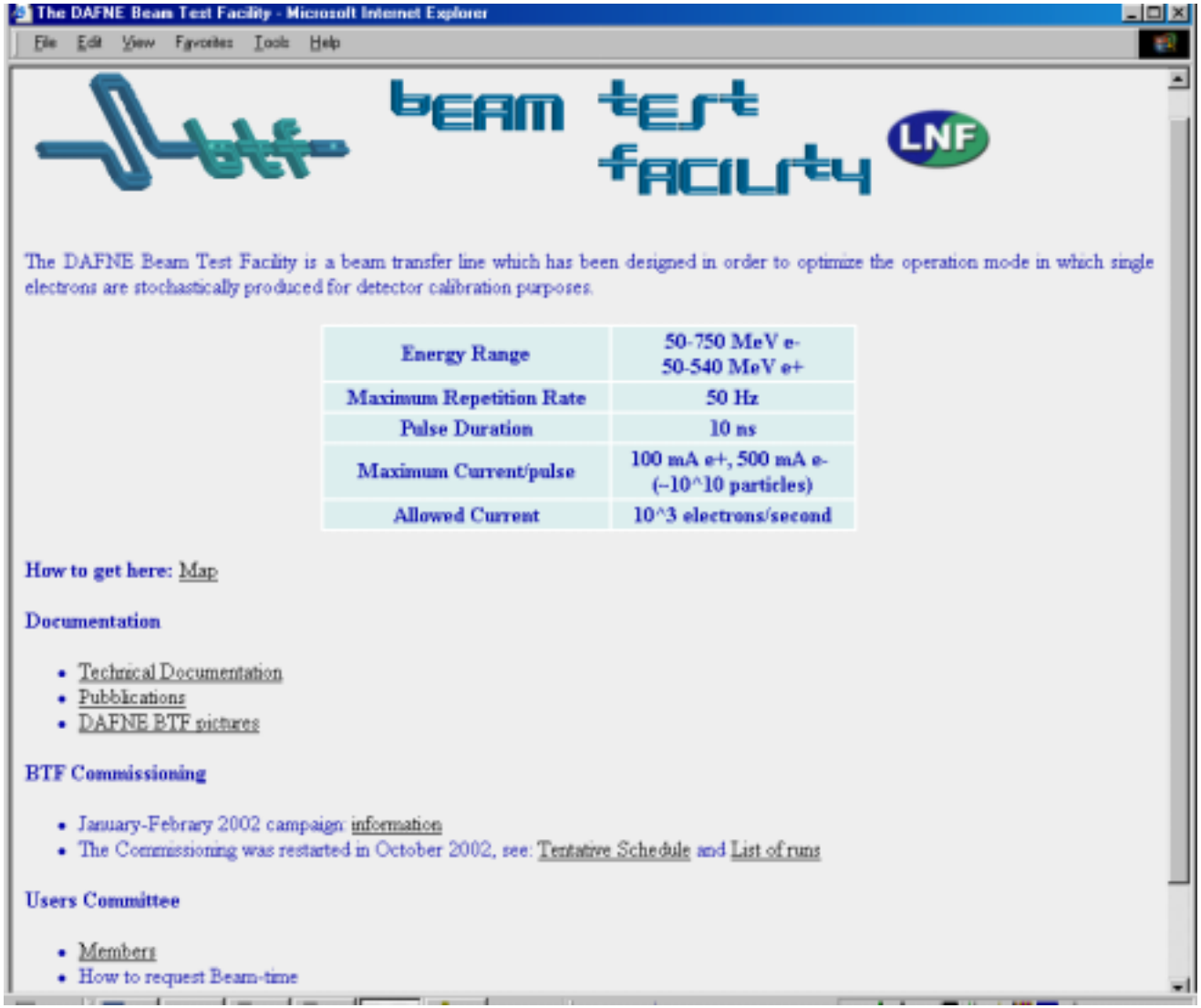
the first experimental groups,

and the collaboration of many LNF colleagues

The BTF staff: G. Mazzitelli & P. Valente

More details…

http://www.lnf.infn.it/acceleratori/btf/



Access to the facility

The LNF Director formed a 'Users Commission':

- P. Gianotti
- G. Mazzitelli (responsible)
- S. Miscetti
- M. Preger (chairperson)
- P. Valente

P. Possanza, secretariat

All requests should be addressed to the commission and/or the facility responsible

A Web form will be available soon

The BTF is one of the LNF TARI facilities (European Union program)