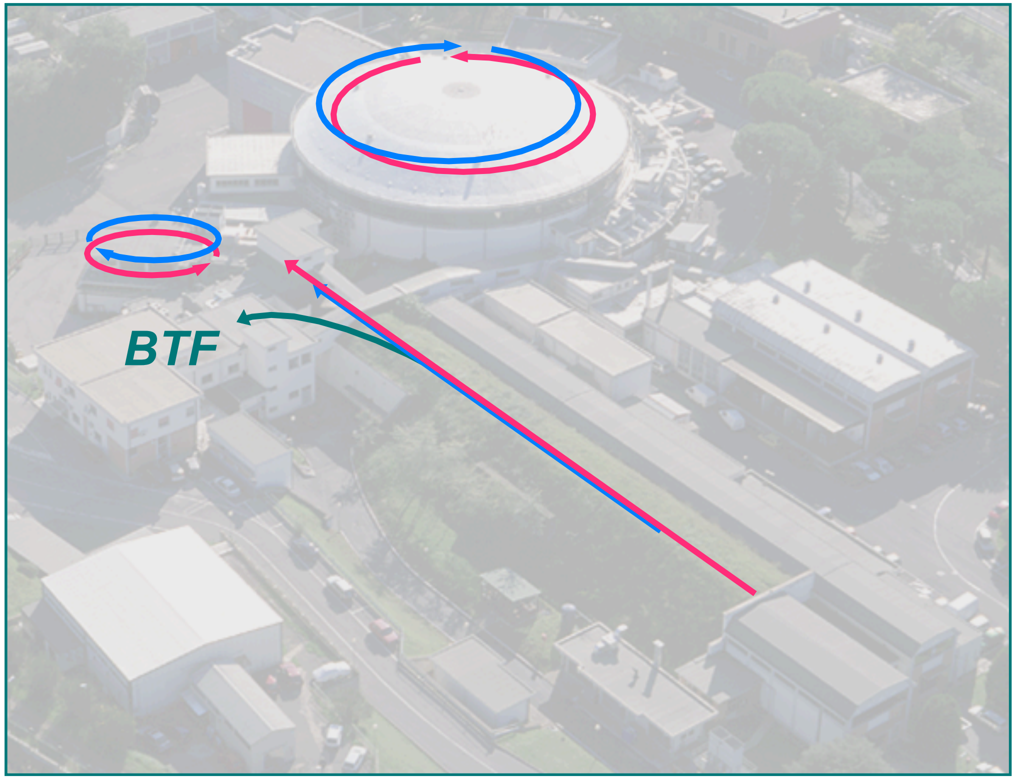
BTF @ LNF

DAFNE Beam Test Facility (BTF).

From single up to 10^{10} e^-/e^+ and γ

B. Buonomo, G. Mazzitelli, L. Quintieri, P. Valente
and many users who help us developing diagnostic and improving the facility

The DAΦNE BTF



high current Linac:

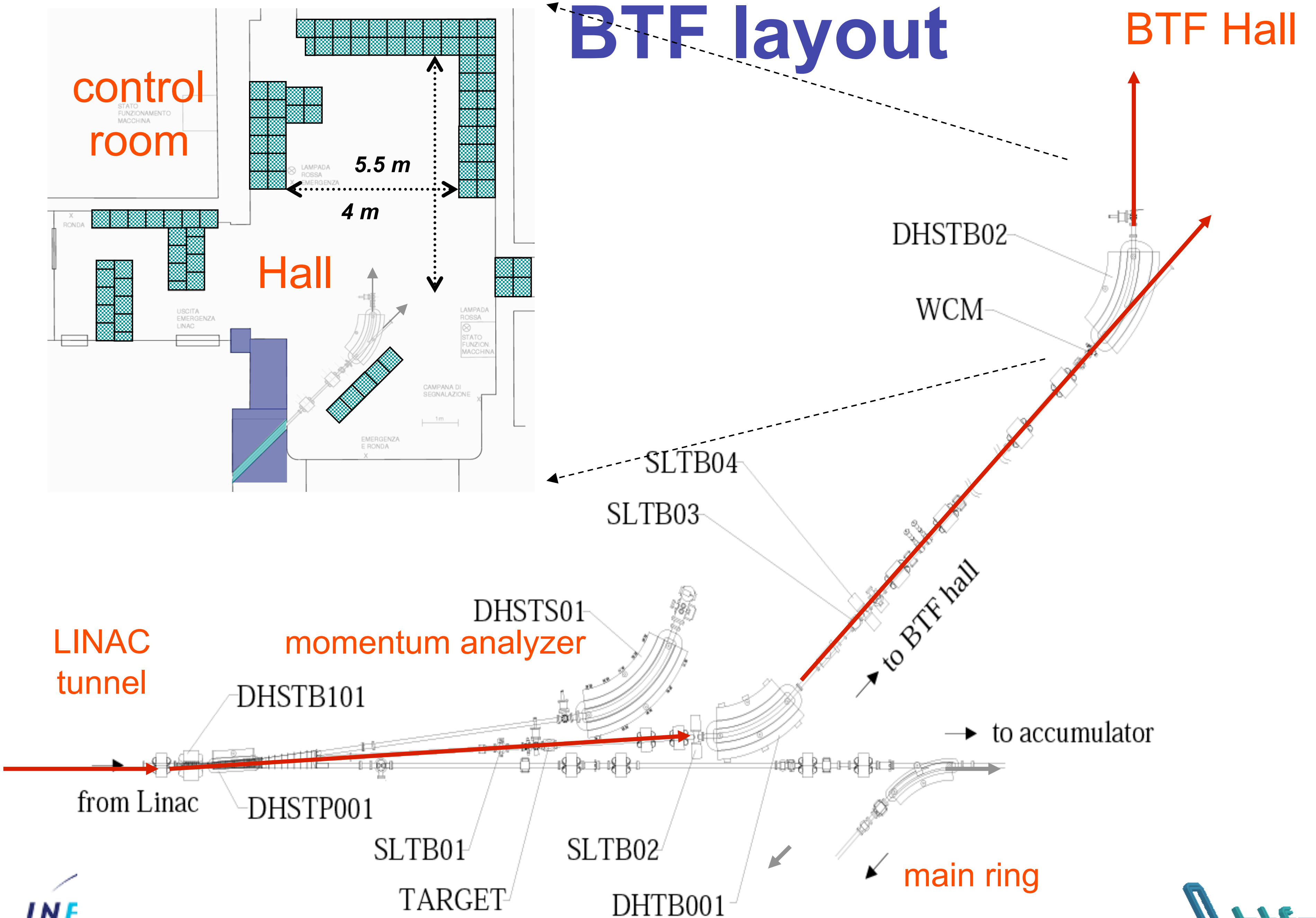
- 1 – 500 mA e^- 200 mA e^+,
- 1 - 10 ns pulses, at least 10^7 particles

The **BTF** is a e^-/e^+ **test-beam facility** in the Frascati DAΦNE collider complex

Need to attenuate the primary beam:

- **Single particle** regime is ideal for detector testing purposes
- Allows to tune the beam intensity
- Allows to tune the beam energy

BTF layout



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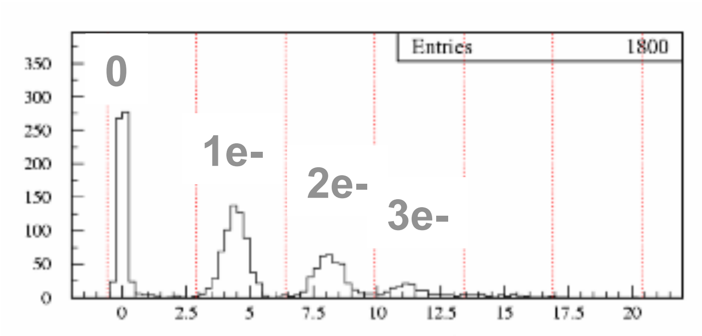
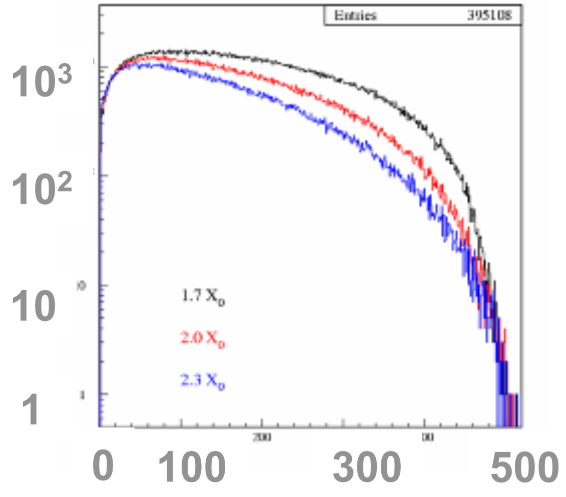
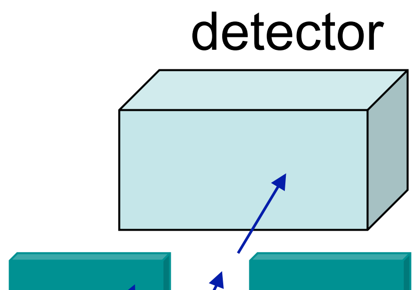
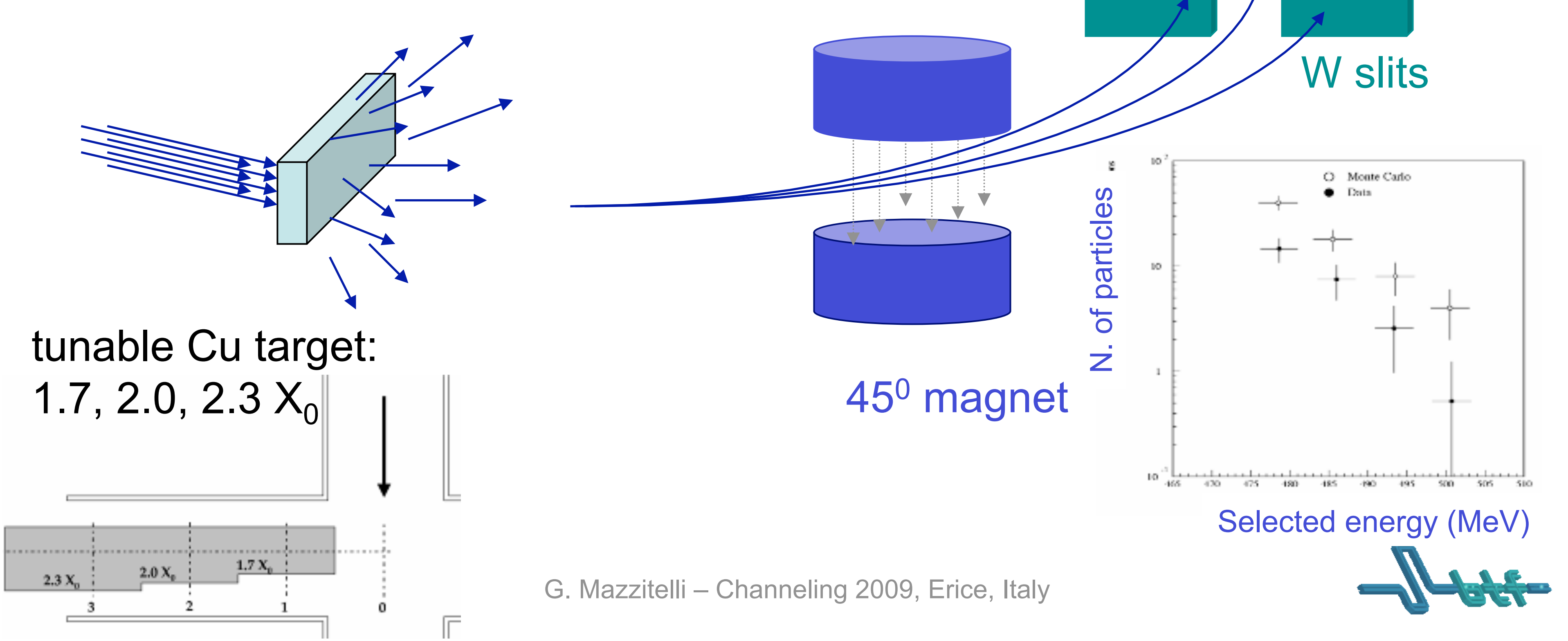
LINAC beam attenuation





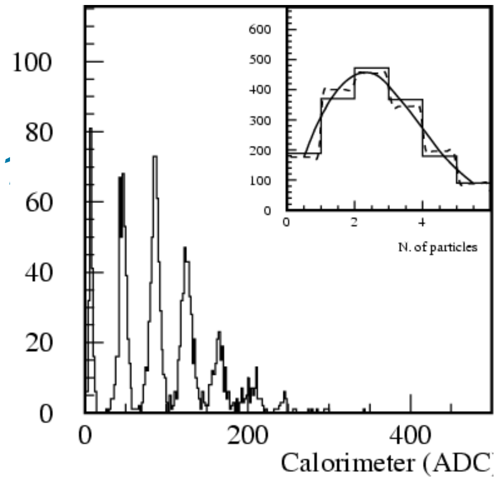


LINAC Beam 1-500 mA



BTF beam characteristic

Beam (e^- or e^+) intensity can be adjusted by means of the **energy dispersion** and **collimators**, down to **single particle** per pulses



Number *(particles/pulse)*	*1÷10^5*	
Energy *(MeV)*	*25-500*	*25÷750*
Repetition rate *(Hz)*	*20-50*	*50*
Pulse Duration *(ns)*	*10*	*1 or 10*
p resolution	*1%*	
Spot size ***(****mm****)***	$\sigma_{x,y}$ *≈ 2 (single particle) up to 10*10 (high multiplicity)*	
Divergence (mmrad)	$\sigma'_{x,y}$ *≈ 2 (single particle) up to 10 (high multiplicity)*	

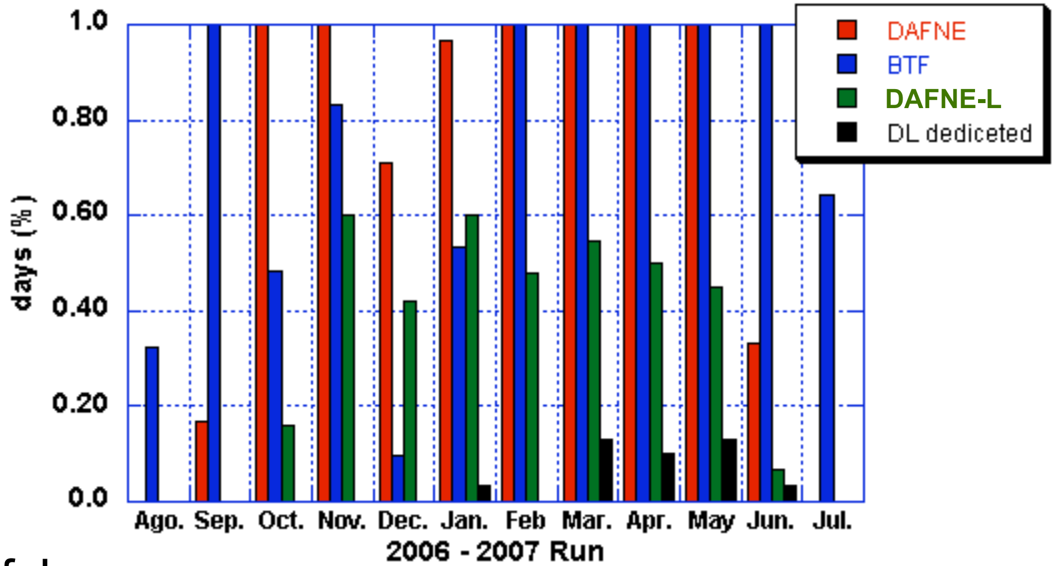
Multi-purpose facility:

- **H.E. detector calibration and setup**
- **Low energy calorimetry & resolution**
- **Low energy electromagnetic interaction studies**
- **High multiplicity efficiency**
- **Detectors aging and efficiency**
- **Beam diagnostics**

BTF Operation …

The BTF in in operation since 2003
beam is delivered 24 h/day with an efficiency of 96% but when parassiting DAFNE main operation the duty cycle was degraded ~ 45% due to continuous injection into the main ring.
In 2006 a fast pulsed power supply has been installed increasing the duty cycle up ~ 90%.

2006-2007 DAFNE run users requests

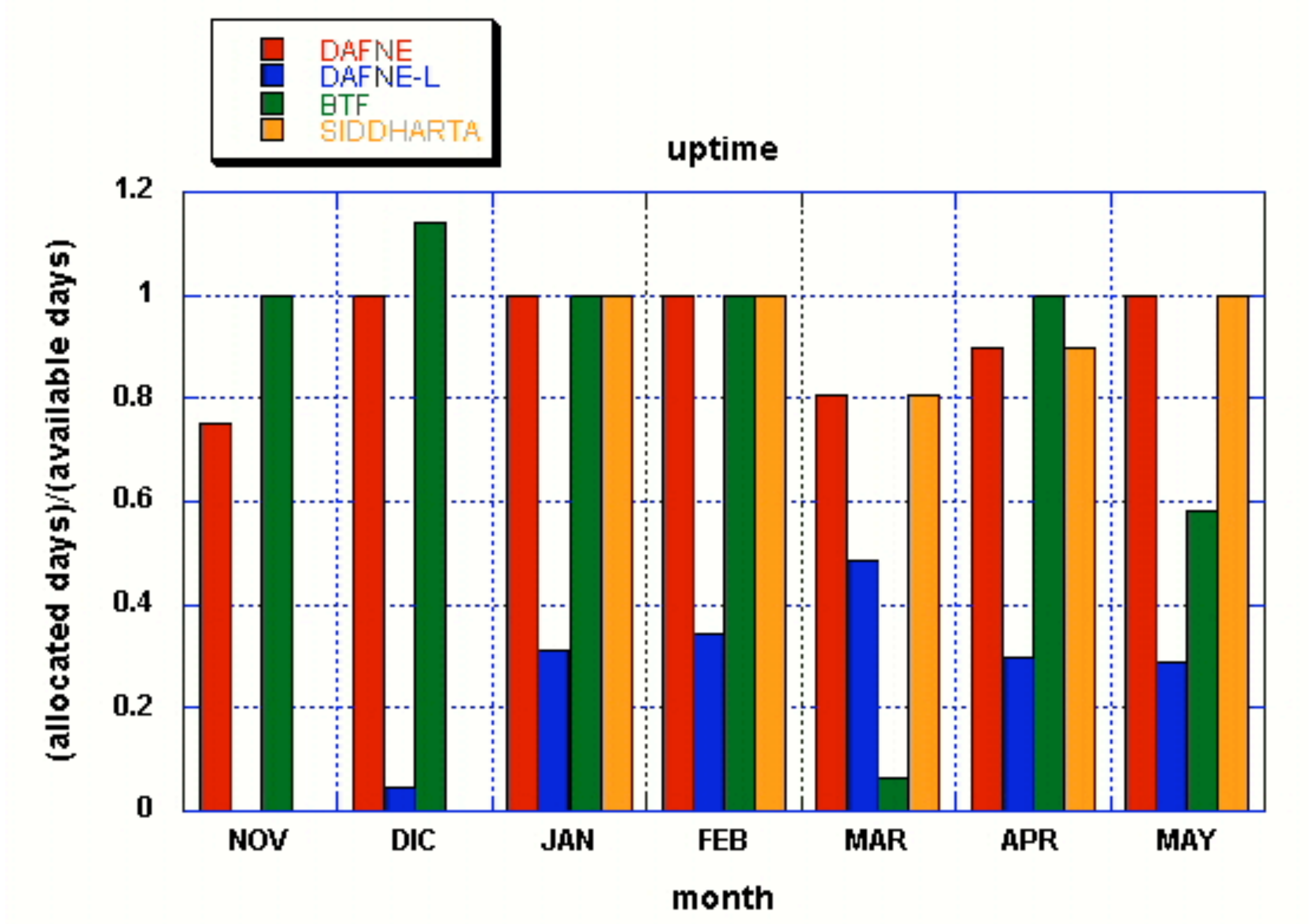


beam request in last 4 years
(multi users are counted twice)

2007 - 224 days
2006 - 244 days
2005 - 364 days
2004 - 282 days

2008 - 124 days up to end of June

Present RUN

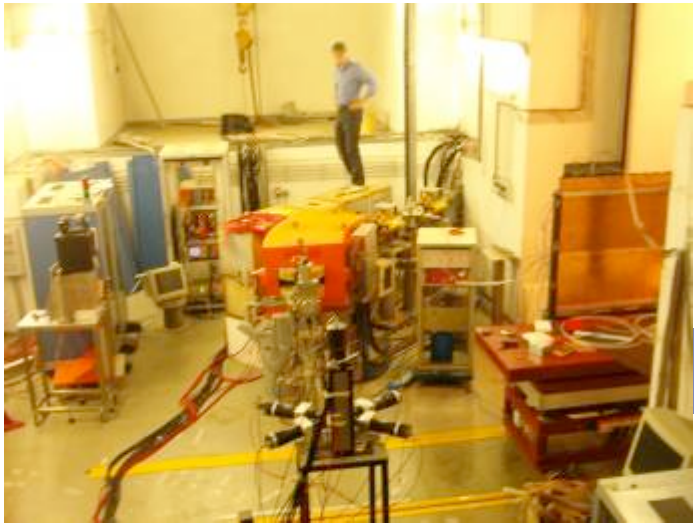


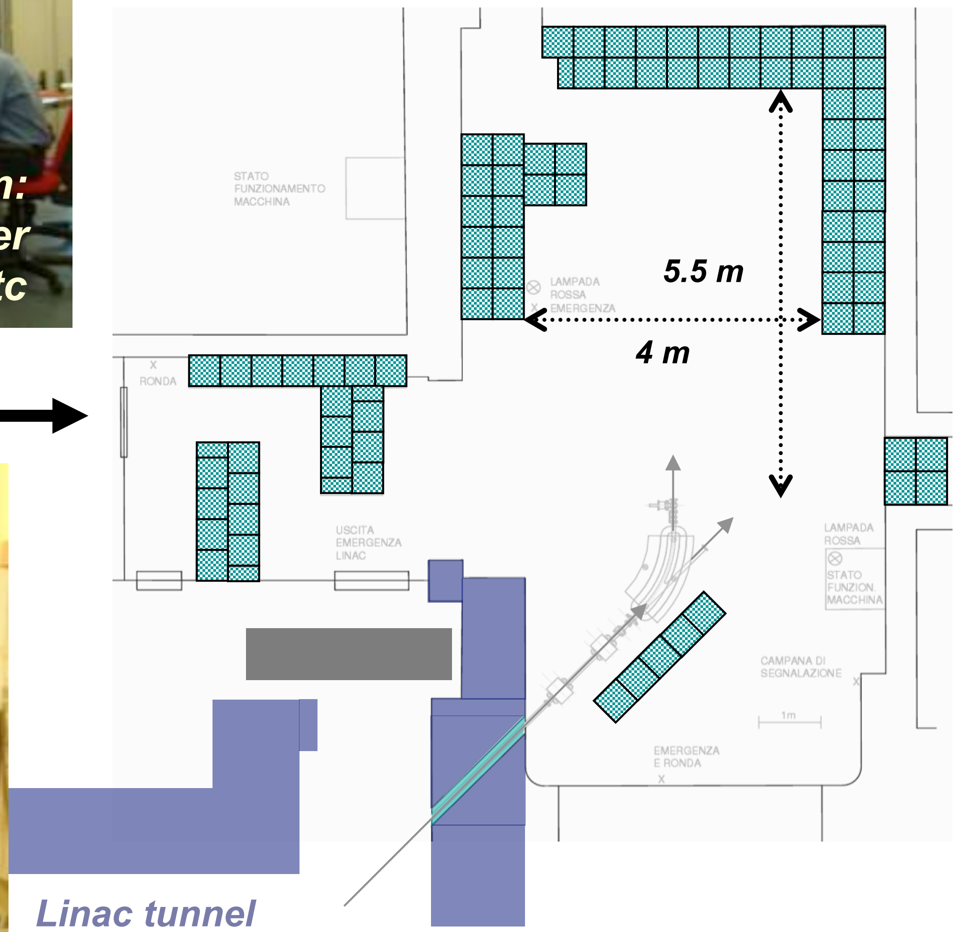
148 days allocated over 175 of operation, typical real access 80-90% of allocated time

Equipment: infrastructure

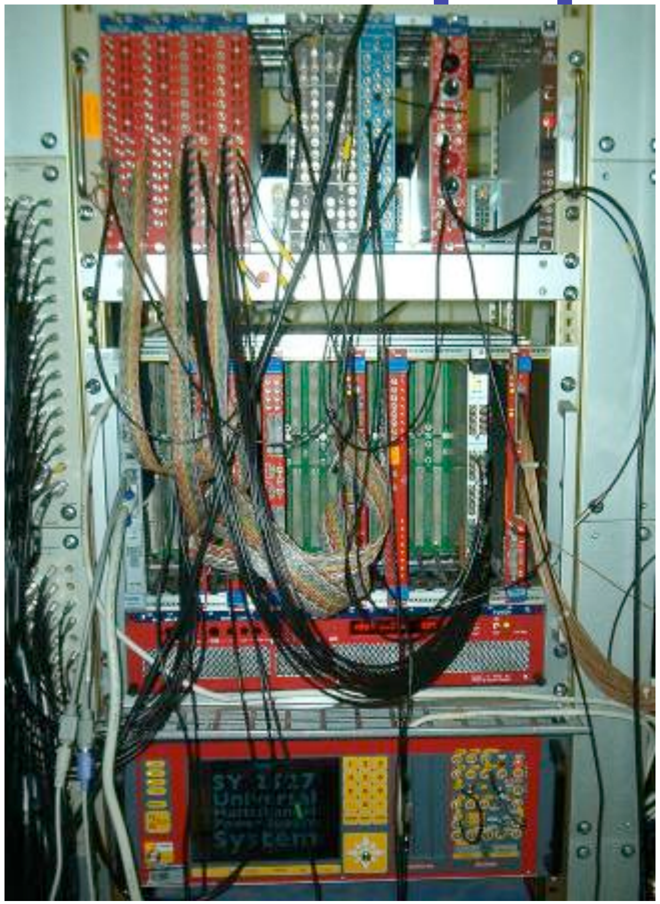
- one meeting room (WiFi)
- one guest office (LAN-WiFi)

main entrance: radioprotection wall
can be removed on demand

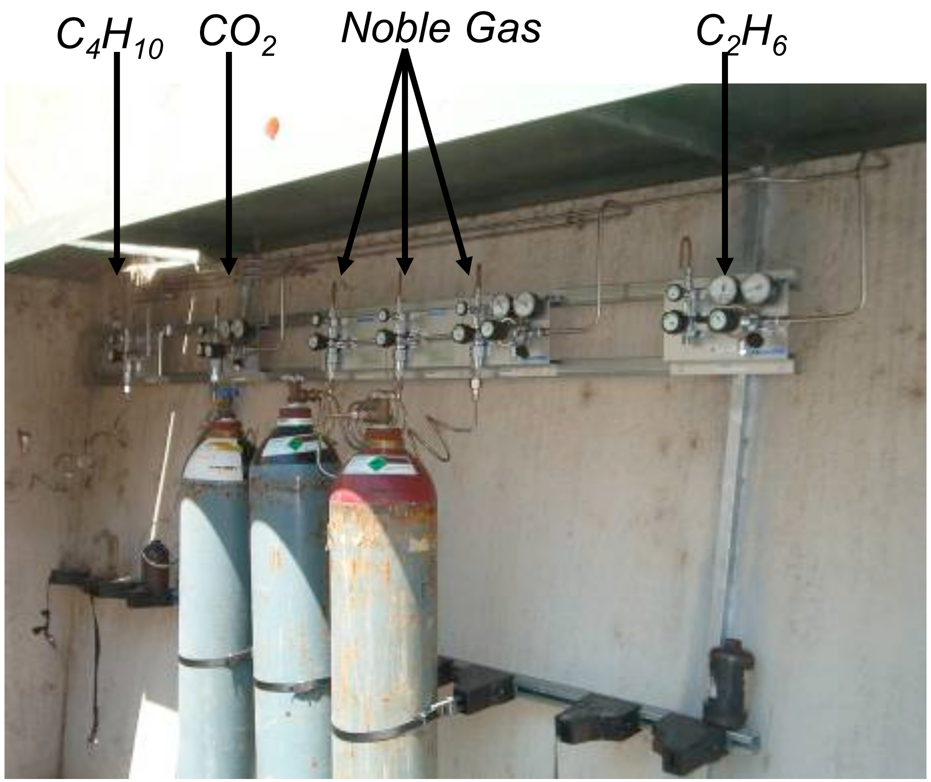




Equipment: infrastructure



- permanent **DAQ** TDC/QDC/ADC/scaler/disc. available
- NIM, VME, CAMAC Branch, VME controllers
- 'Devil'/VMIC **VME** and **CAMAC controller**, **NIM** modules
- Remotely controlled **trolley**
- **Gas** system
- **HV** system…
- crates, rack, etc.



- HV SY2527 (3/4KV neg, 3/4KV pos, 15KV pos)
- 40 ch. CAEN SY127 pos.
- **Cabling** BTF HALL-BTF CR
- **Network**: Wi-Fi, dedicated-LAN, WAN, printer

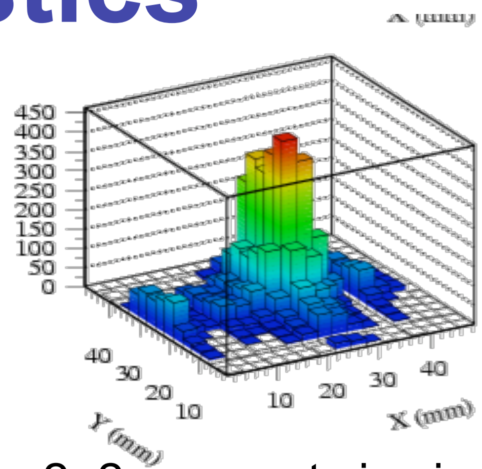
http://www.lnf.infn.it/acceleratori/btf/

Equipment: Diagnostics

low multiplicity diagnostic (1-100):

(back detector)

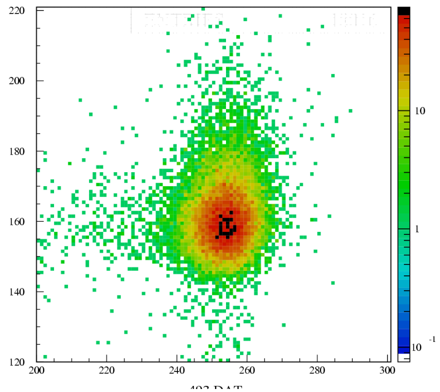
- lead glass, 5×5×35 - 10×10×35 cm
- $PbWO_4$ crystal 3*3*11 cm
- lead/scintillator fibers (KLOE type), 25×50×30 cm
- NaI high resolution 30×30 cm



2×2 mm spot size in fiber hodoscope

(front/trigger detector/not destructive/tracking)

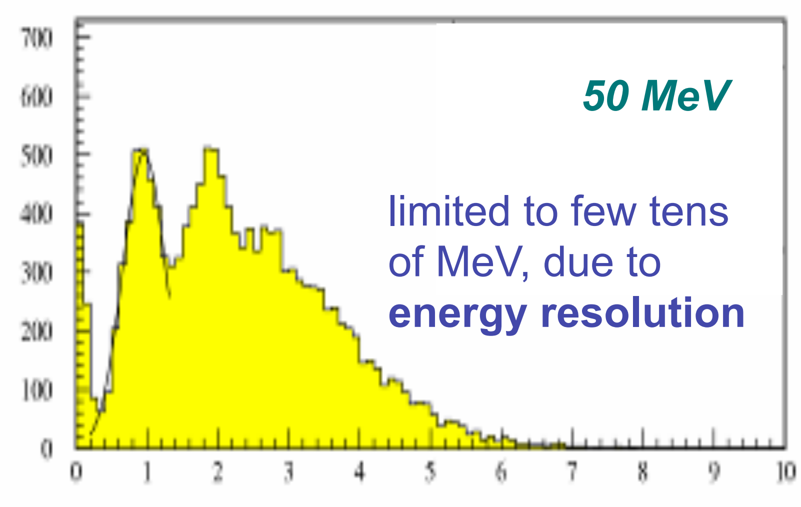
- multipurpose plastic scintillators 10x10x0.5 cm, 10x30x0.5 cm, 1x15x0,5 cm
- hodoscope; two bundle of 1 mm fiber for a total active area of 48x48 mm2
- Silicon tracker (high gain)
- 3GEM (Gas Electron Multiplier) detector

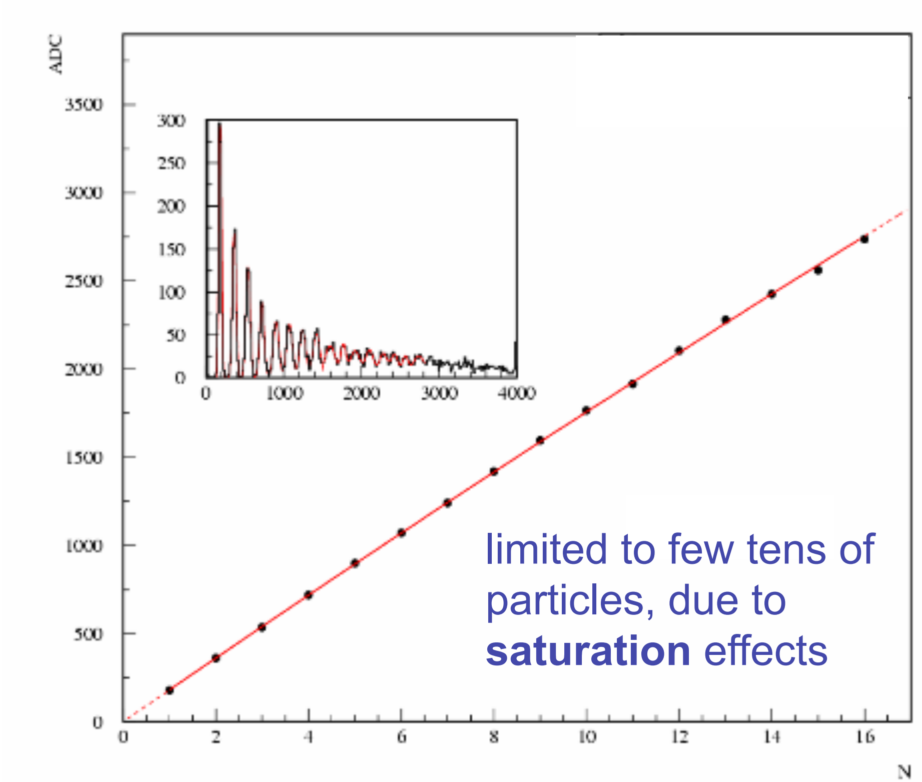


2×2 mm spot size in Silicon XY chamber

Calorimetric counting

number of produced electrons counted by total energy deposited in lead/scintillating fiber calorimeter (KLOE type):





calorimetric is OK at low intensity, not for high multiplicity beams: e.g. the AIRFLY experiment, designed to measure **absolute** fluorescence yield in air and its **energy dependence**, needs:

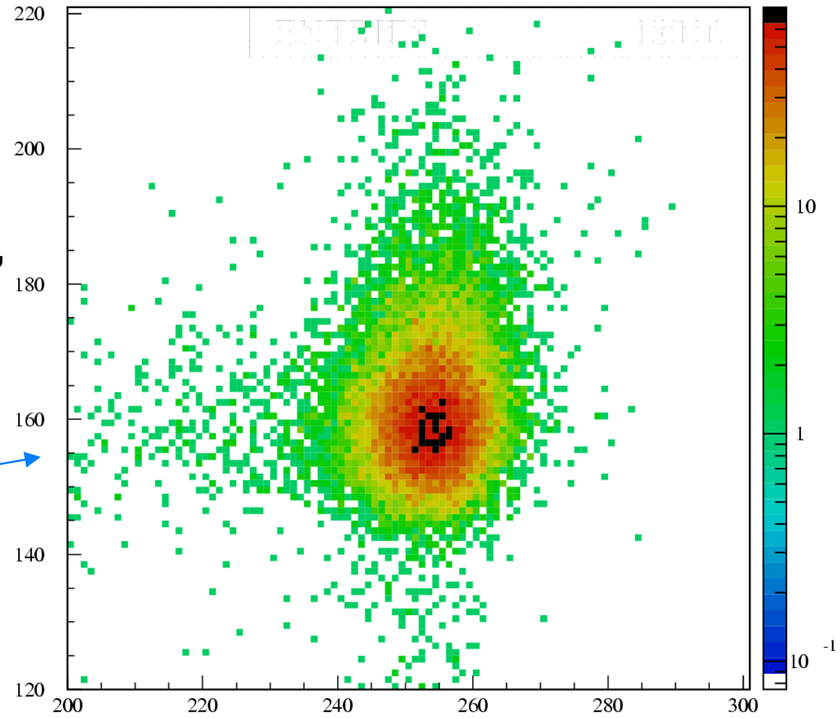
- **full energy range**
- **maximum beam intensity**

Beam profile (AGILE Si tracker)

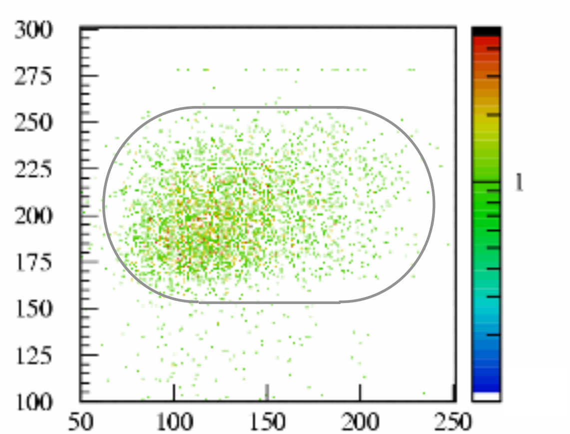
2 layers (x,y) × 384 strips, analog readout

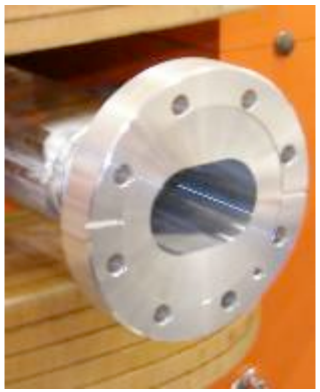
410 μm thick, single-side, AC coupled strips,
121 μm pitch, 242 μm readout pitch

Optimal focusing at 493 MeV,
measured spot size: $\sigma \approx 2 \times 2$ mm^2



Defocused





Beam spot measured with all transfer line quadrupoles off: 55×35 mm^2, limited by vacuum pipe section

Sci-fi profile detector

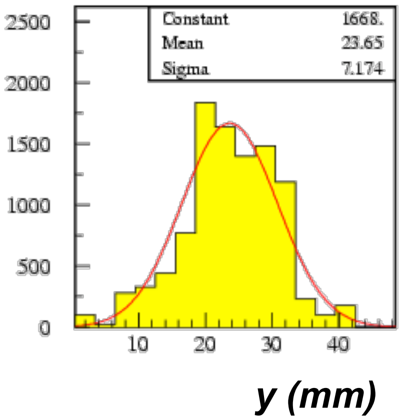
- A permanent beam position and size monitor needed, both for beam **steering** and **optimization** purposes, and for providing useful information for detector testing, complementing the beam intensity monitors
- Such a position sensitive detector should have:
  - **negligible mass**, not to spoil beam characteristics (energy, divergence, spot size)
  - **good resolution**, as compared to beam typical size (1 mm required)
  - **sensitivity** both for **single particle** (even at low energy) and at **high beam intensity**

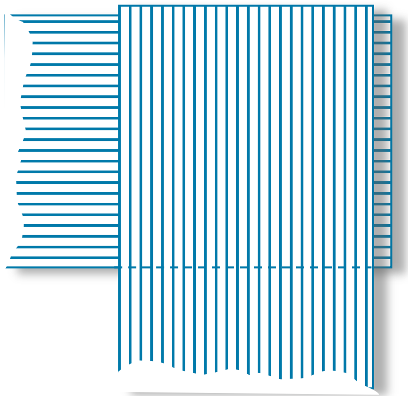
cladded scintillating fibers,
Pol.Hi.Tech type 0046, 1 mm diameter

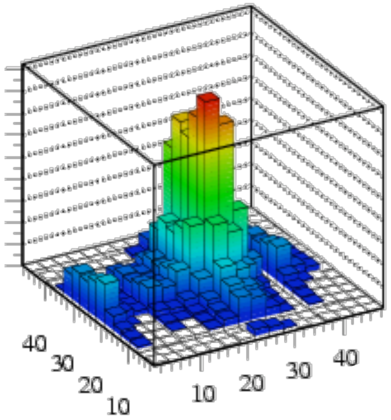
- ***4 layers of fibers glued together***
- ***staggered by ½ fiber to minimize dead zones***

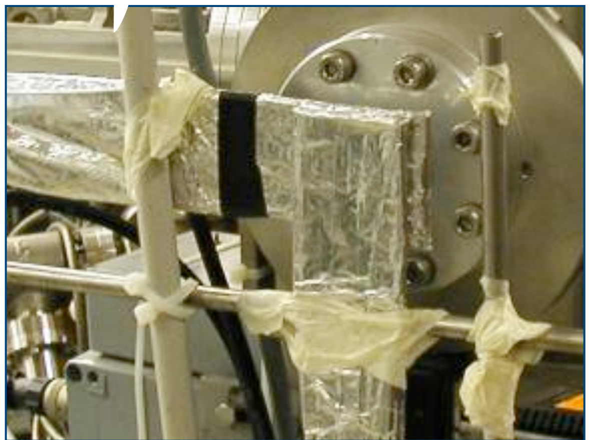
Sci-fi profile detector

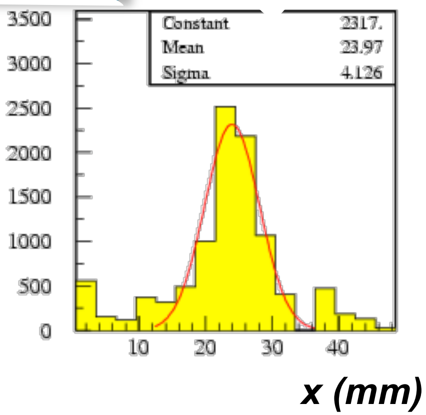
- ***Charge weighted profiles for x and y fiber bundles***



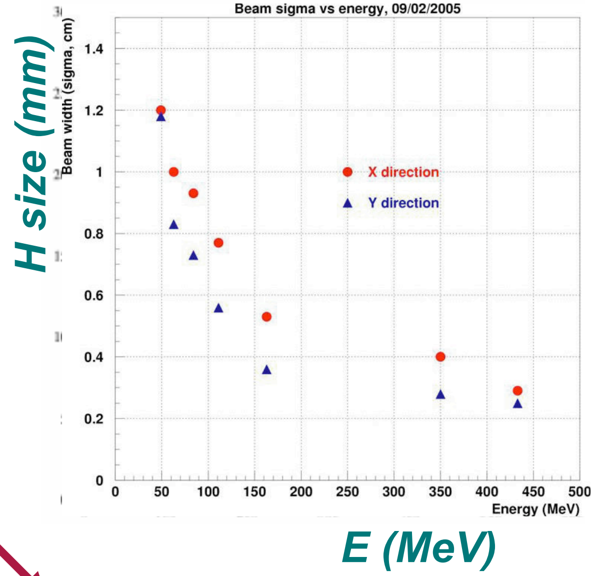


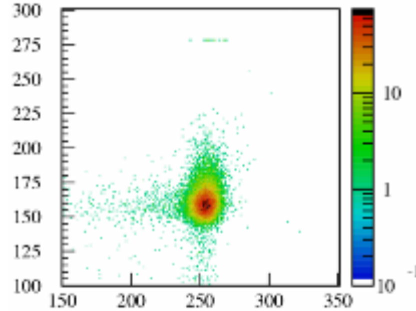






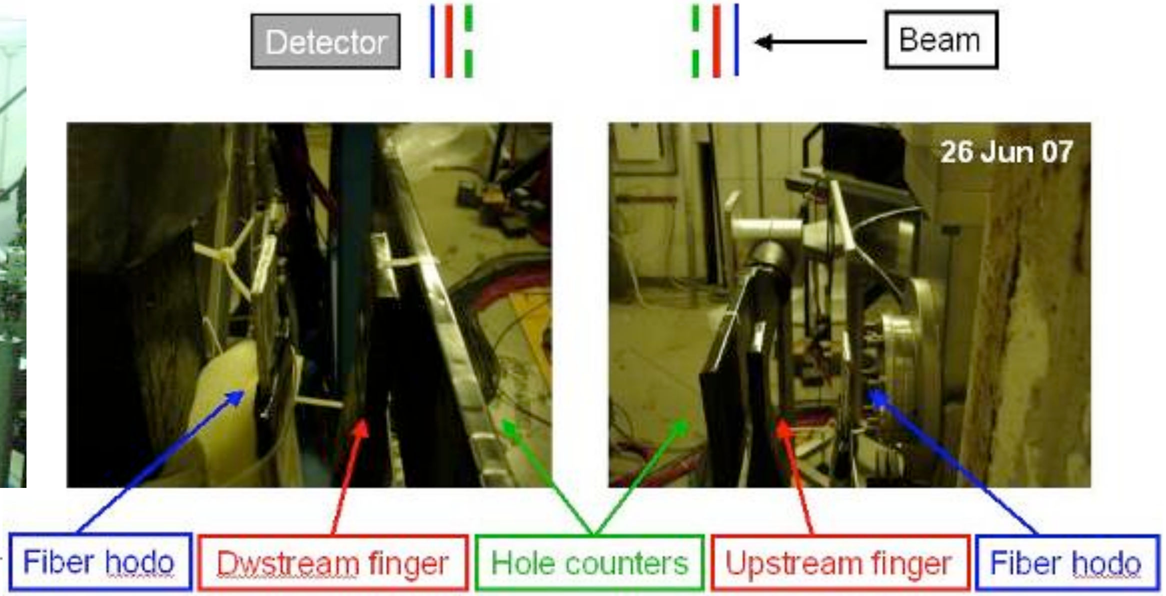
energy dependence of the beam spot size



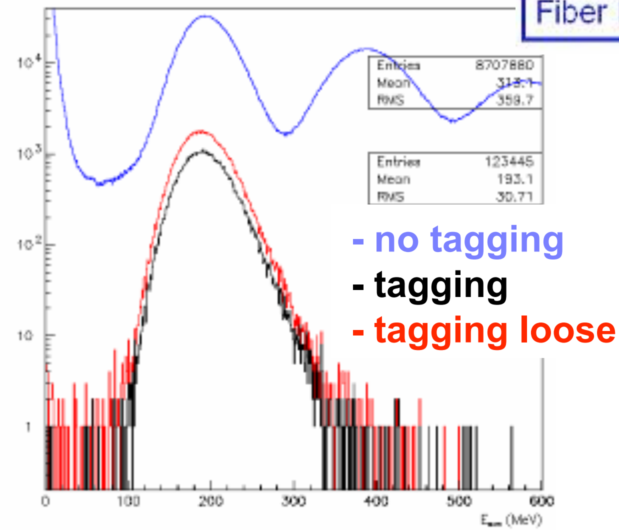


Consistent with beam image from Silicon tracker

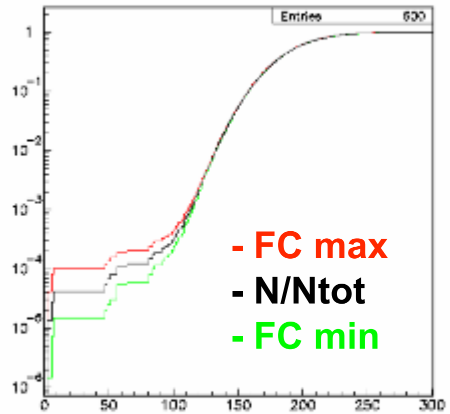
Examples of experimental setup (P326 Prototype inefficiency 200 MeV)



energy spectrum



inefficiency VS threshold



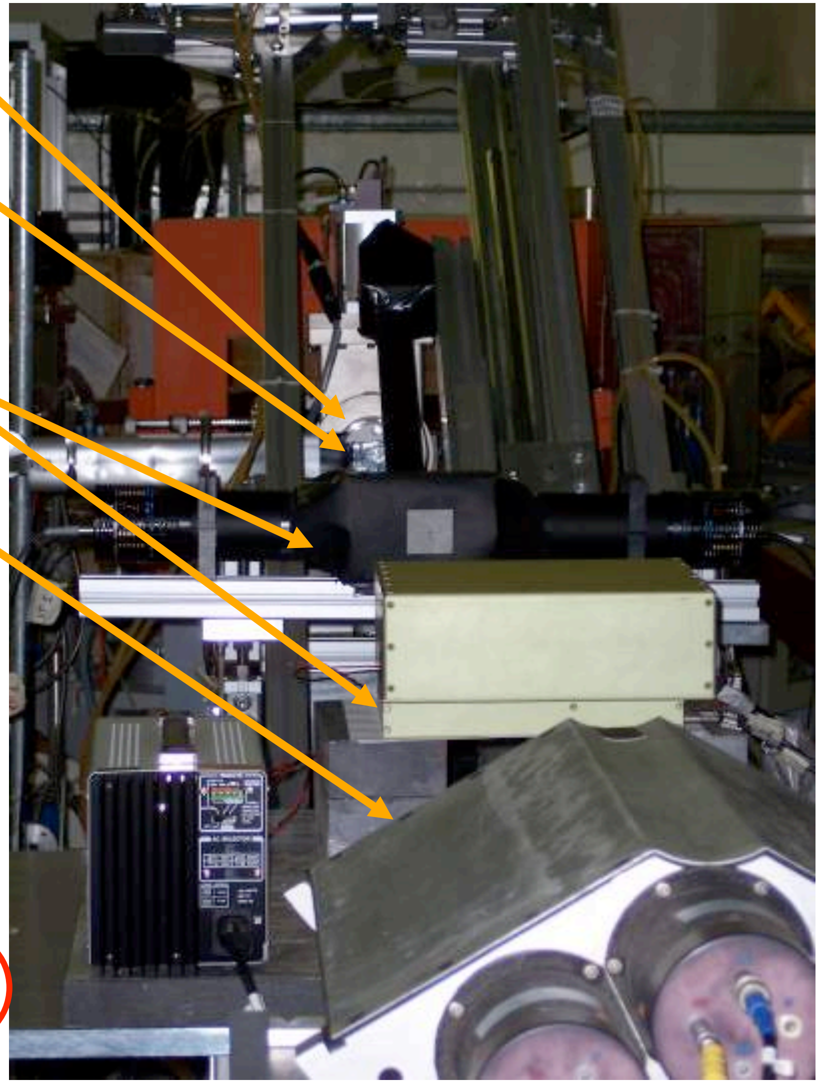
Example of experimental setup (MEG)

beam exit

sci-fi profile detector

detector
(MEG test for sci time resolution)

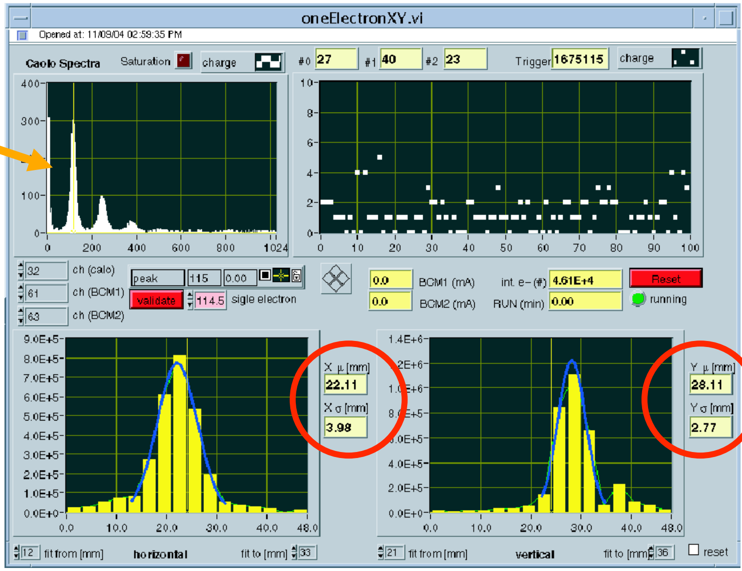
back detector (NaI calorimeter)



on line monitor

e- spectra

XY beam
sci-profile



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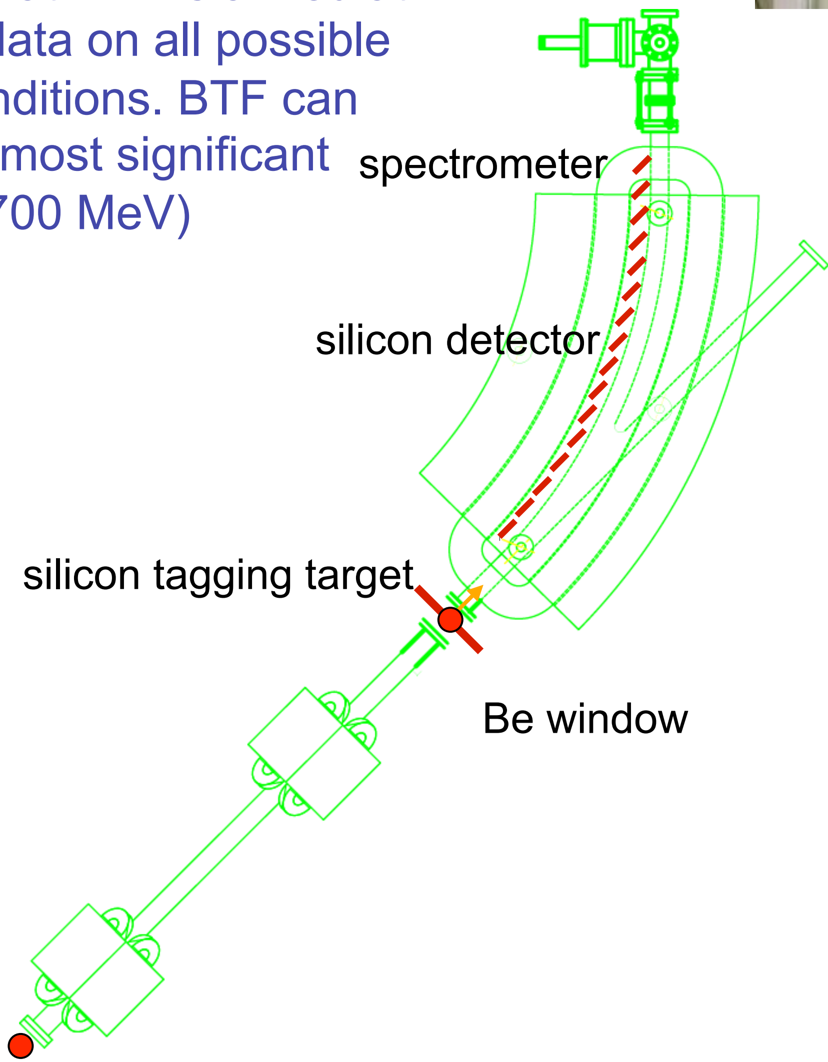
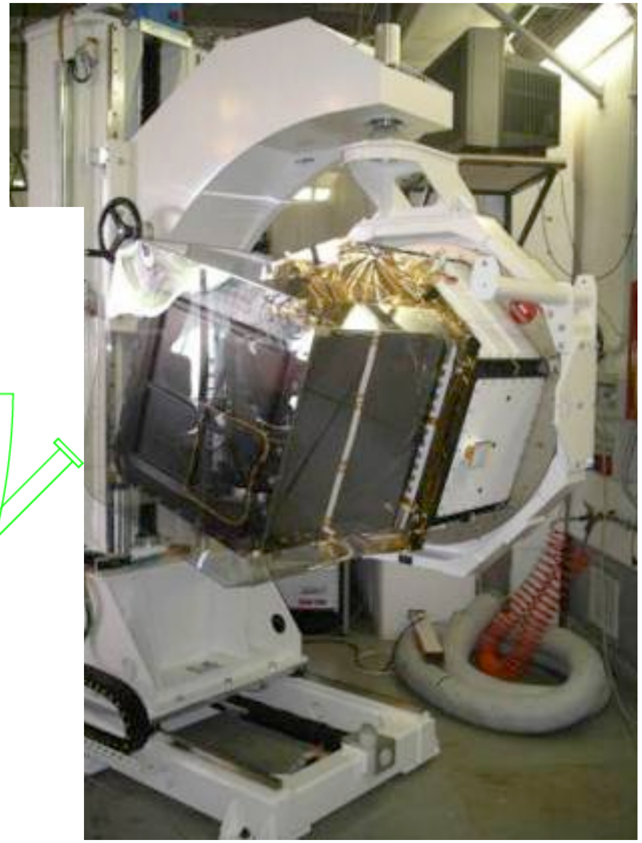
BTF photon tagged source
AGILE GRID photon calibration

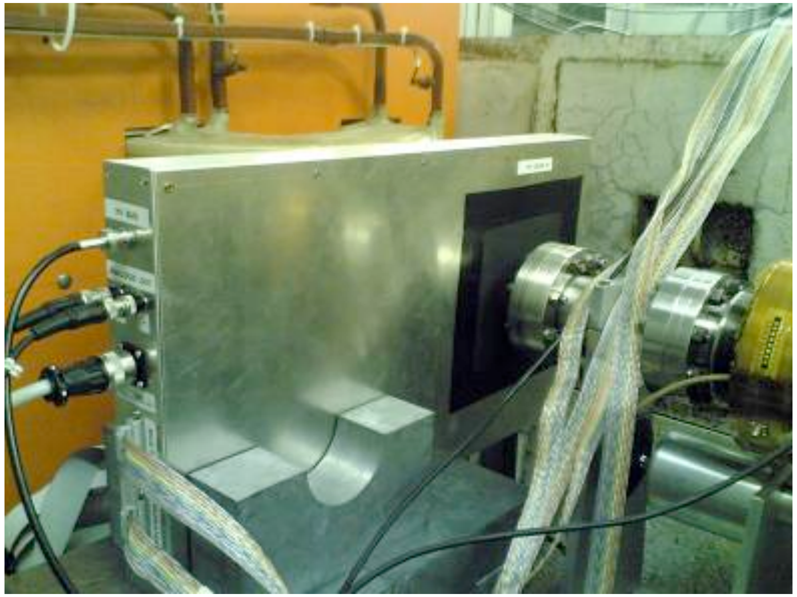
The AGILE Gamma Ray Imaging Detector calibration at BTF is aimed at obtaining detailed data on all possible geometries and conditions. BTF can provide data in the most significant energy region (20-700 MeV)

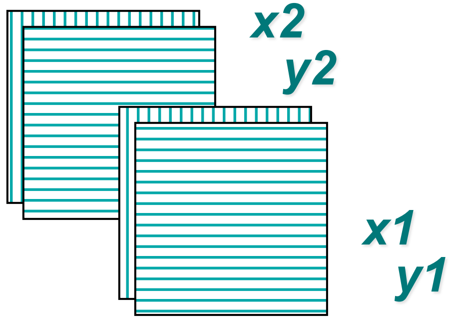




AGILE GRID

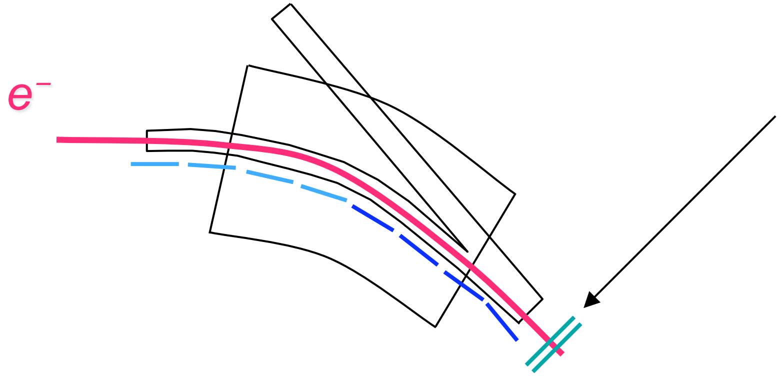
γ tagging @ BTF

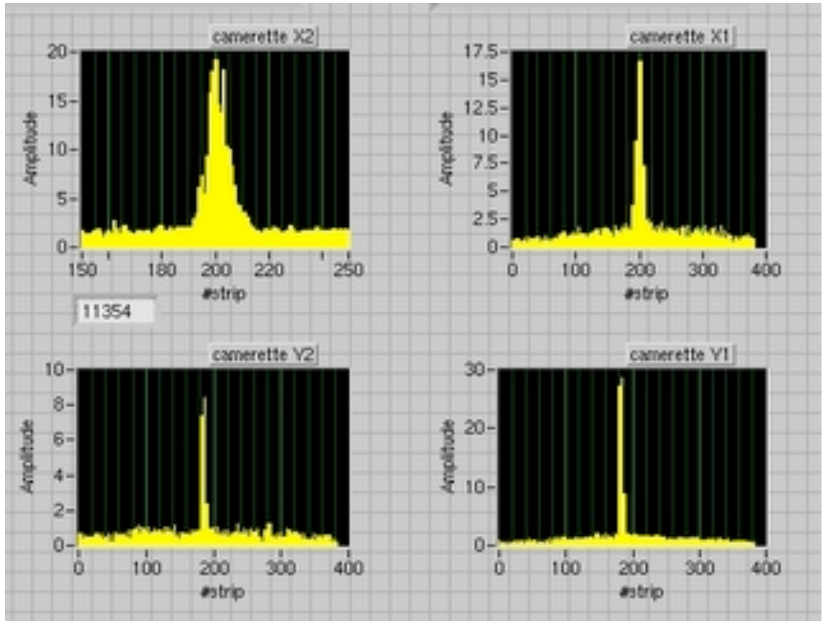




position and **direction** of the in-coming electrons

Nominal B field

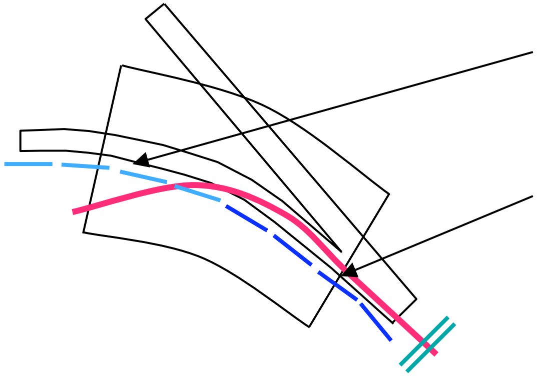




γ tagging @ BTF

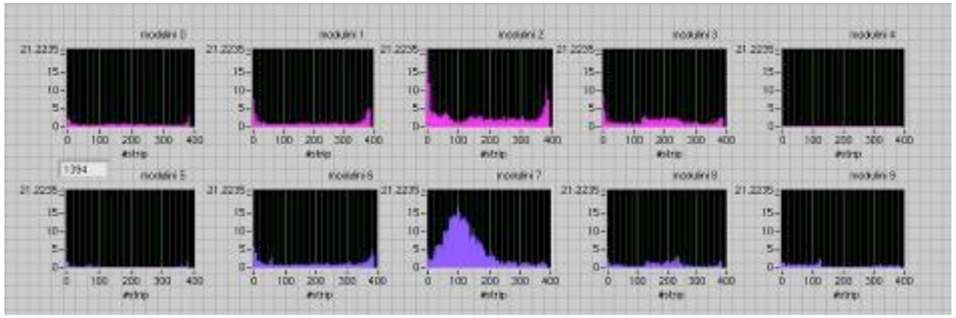
position and **momentum** of the out-coming electrons

Increase B field



Nota bene

Online plots, analysis in progress



Equipment: Diagnostics (con't)

- medium multiplicity diagnostic ($100-10^8$):

(front detector/not destructive)

- Cerenkov light emission
- Silicon Beam Chamber (low and tunable gain)
- Triple GEM TPC (under development)

- high multiplicity diagnostic (10^7-10^{10}):

(front detector)

- low noise (3×10^6 particles) BCM
- high sensitivity fluorescence flags – cromox, Be, yag:ce

Cerenkov beam monitor

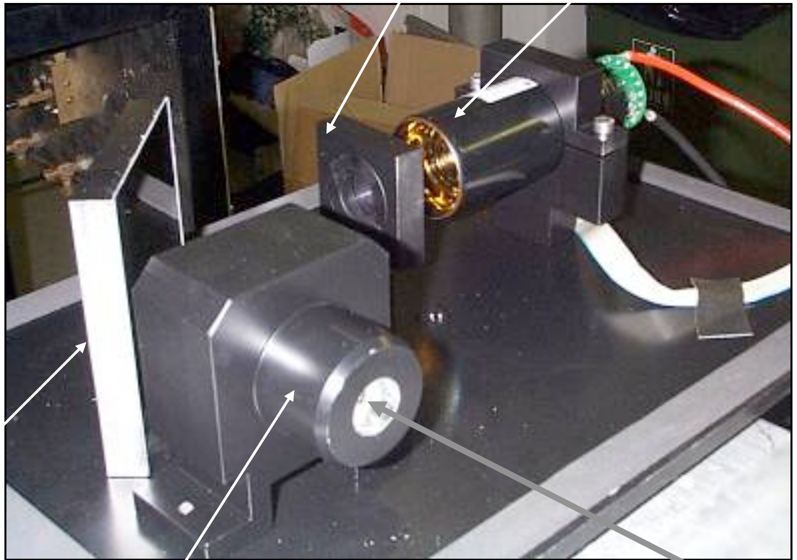
detector, designed and built, in collaboration with the AIRFLY group, based on **Cerenkov light emission**

- **Cross-calibrated** with calorimetric measurement at low particle multiplicity
- Used to monitor beam intensity at higher intensity up $10^4 \div 10^5$ particles, **in the full energy range**

dynamical range can be further extended:

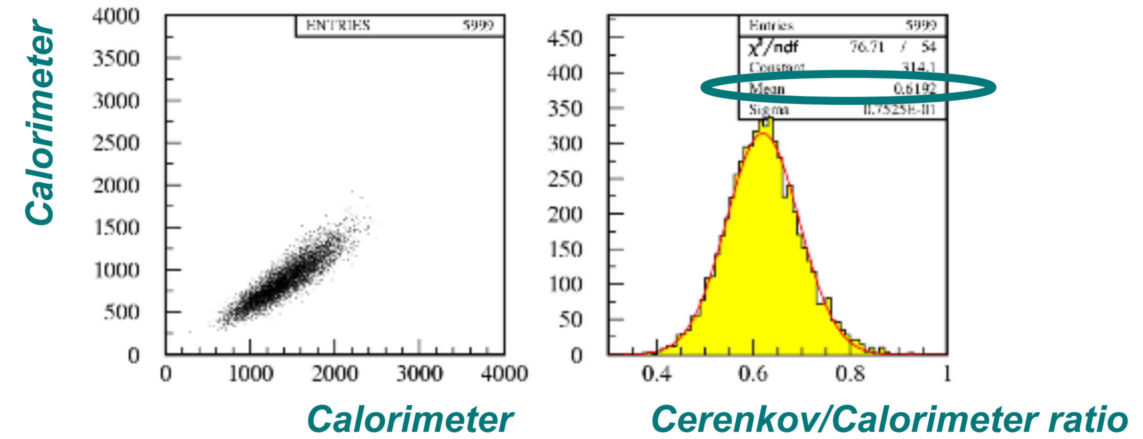
- calibrated optical filter in front of the PMT
- use air as Cerenkov radiator

detector tested up to 10^{10} particles with a cross calibration with BCM



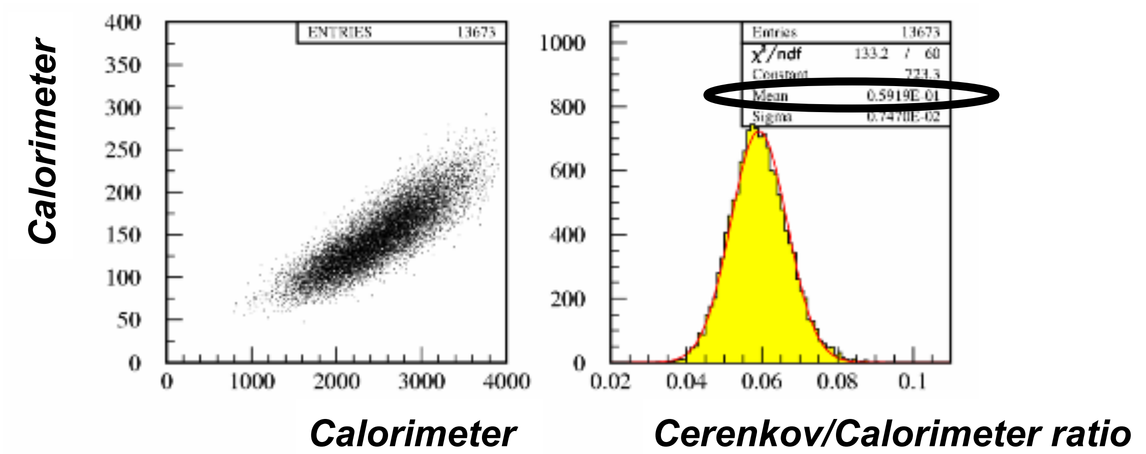
Cerenkov beam monitor

No optical filter



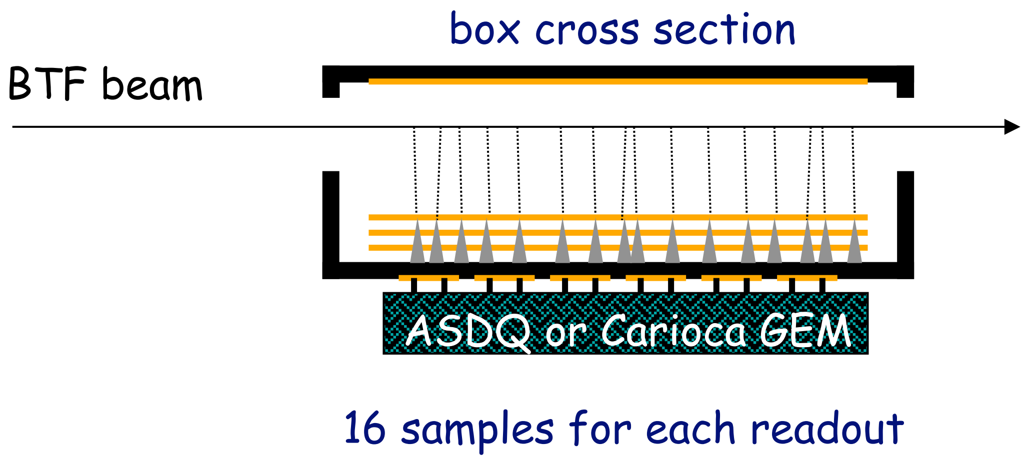
:10 optical filter

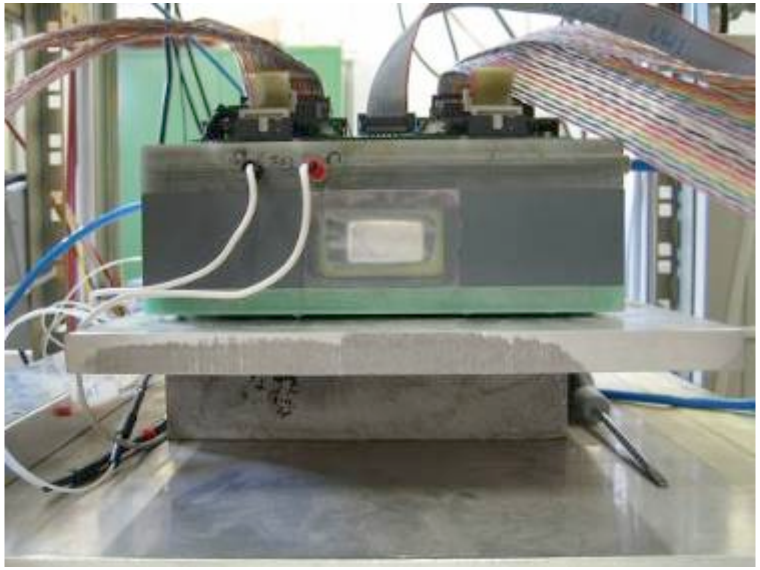
(measured attenuation = 0.096)



Compact-Triple Projection GEM

It's essentially a small TPC with a 3-4 cm drift
Also high current beam can be monitored in position (TDC) and dE/dX (ADC)

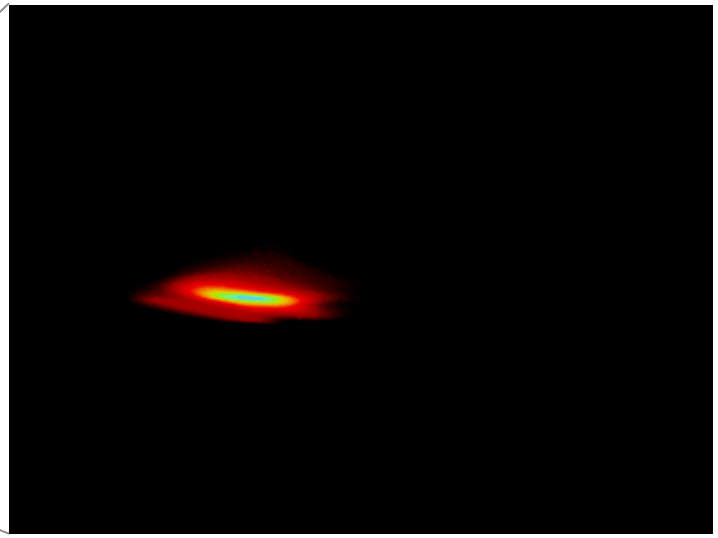




The detector will be realized with standard 10x10 cm^2 GEMs inside a G10 box; the readout will be realized with
- ASDQ (first phase) at CERN for test beam
- then Carioca Cards (second phase) at BTF

Possible DE/Dx measurements (LVDS width proportional to signal charge)

Beam profile
(FLAG fluorescence target)

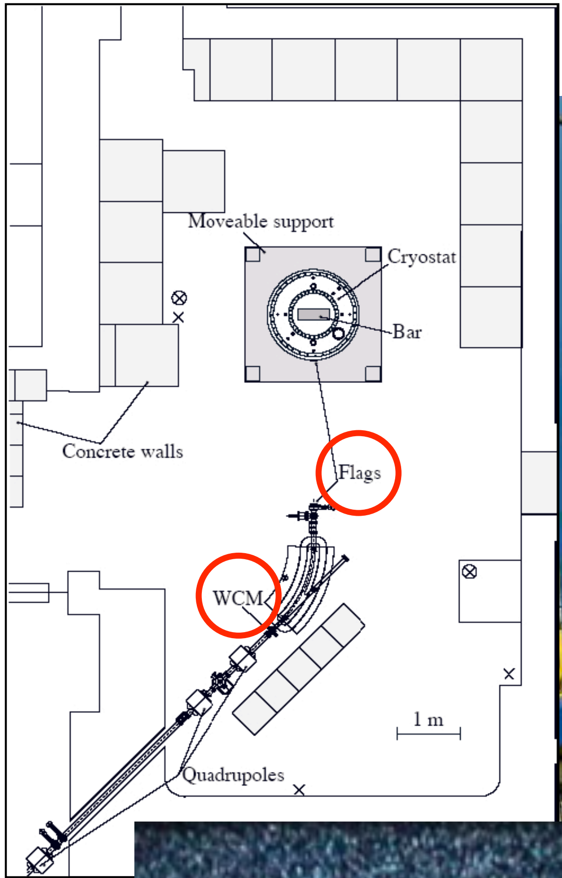


Very low current beam image on 1 Inc yag:ce

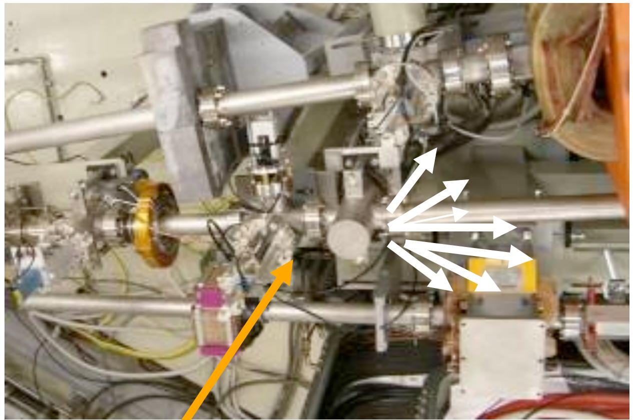
Flag = metallic high fluorescence plate viewed by a camera

Different fluorescence targets(Be, cromox, yag:ce) for very low current beam diagnostics

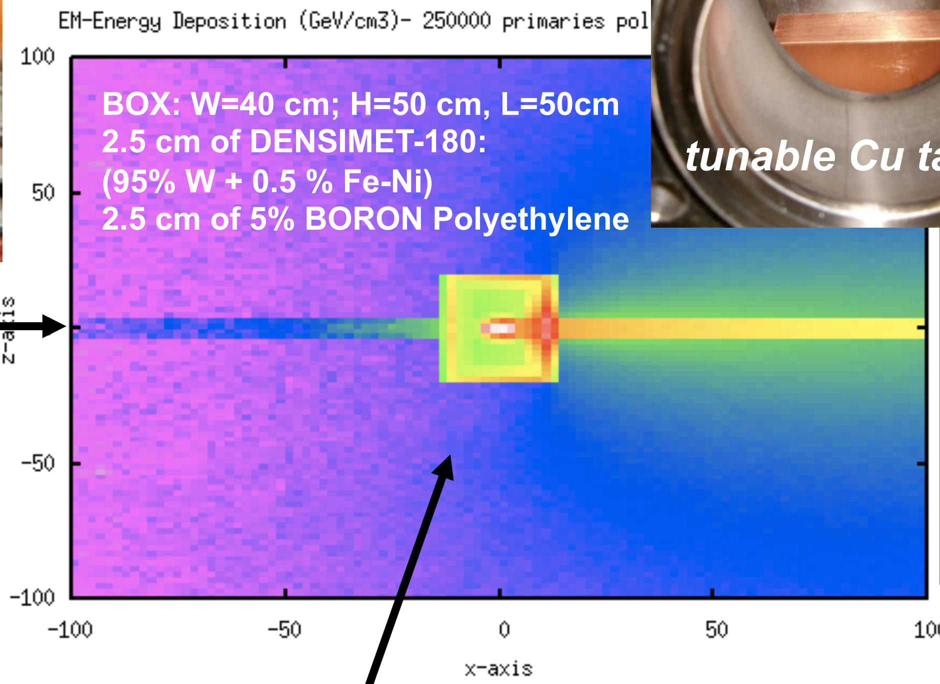
RAP experiment @ BTF

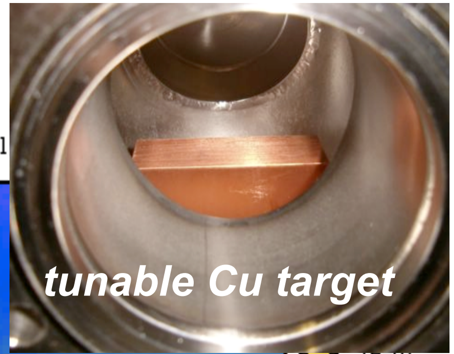


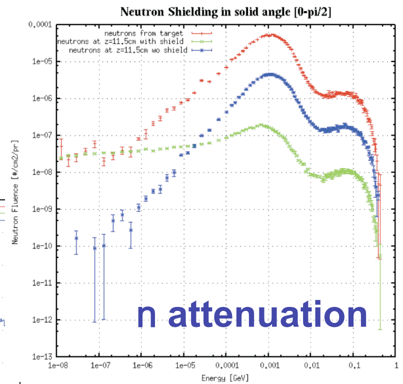
Background attenuation

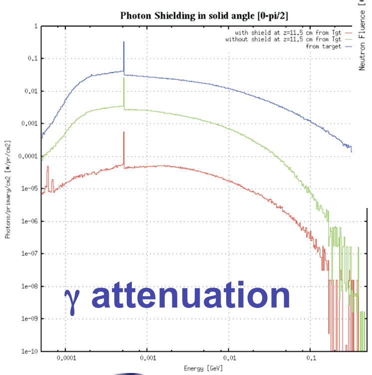


High current LINAC beam





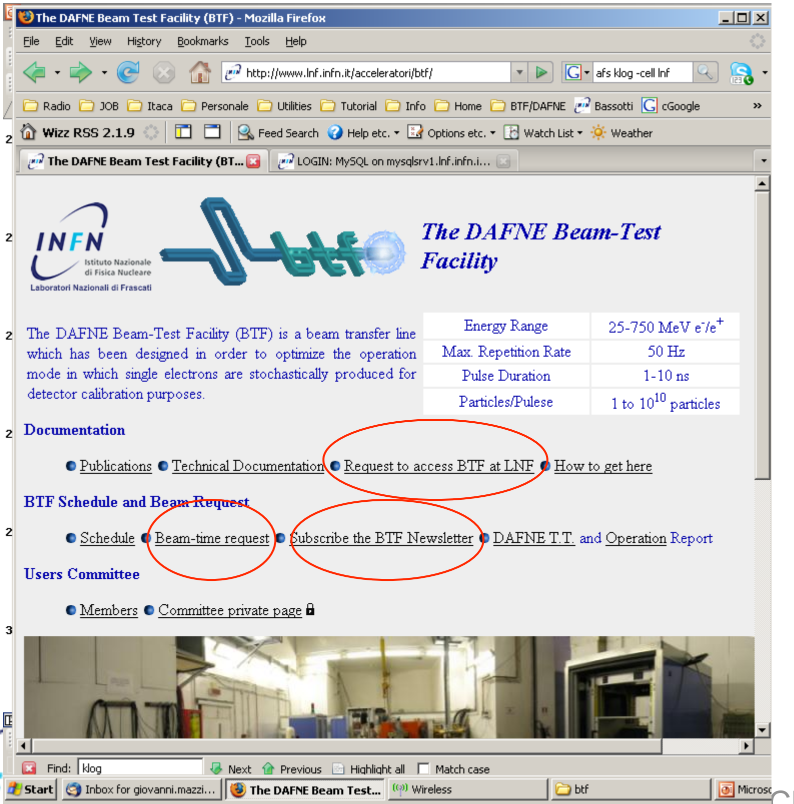


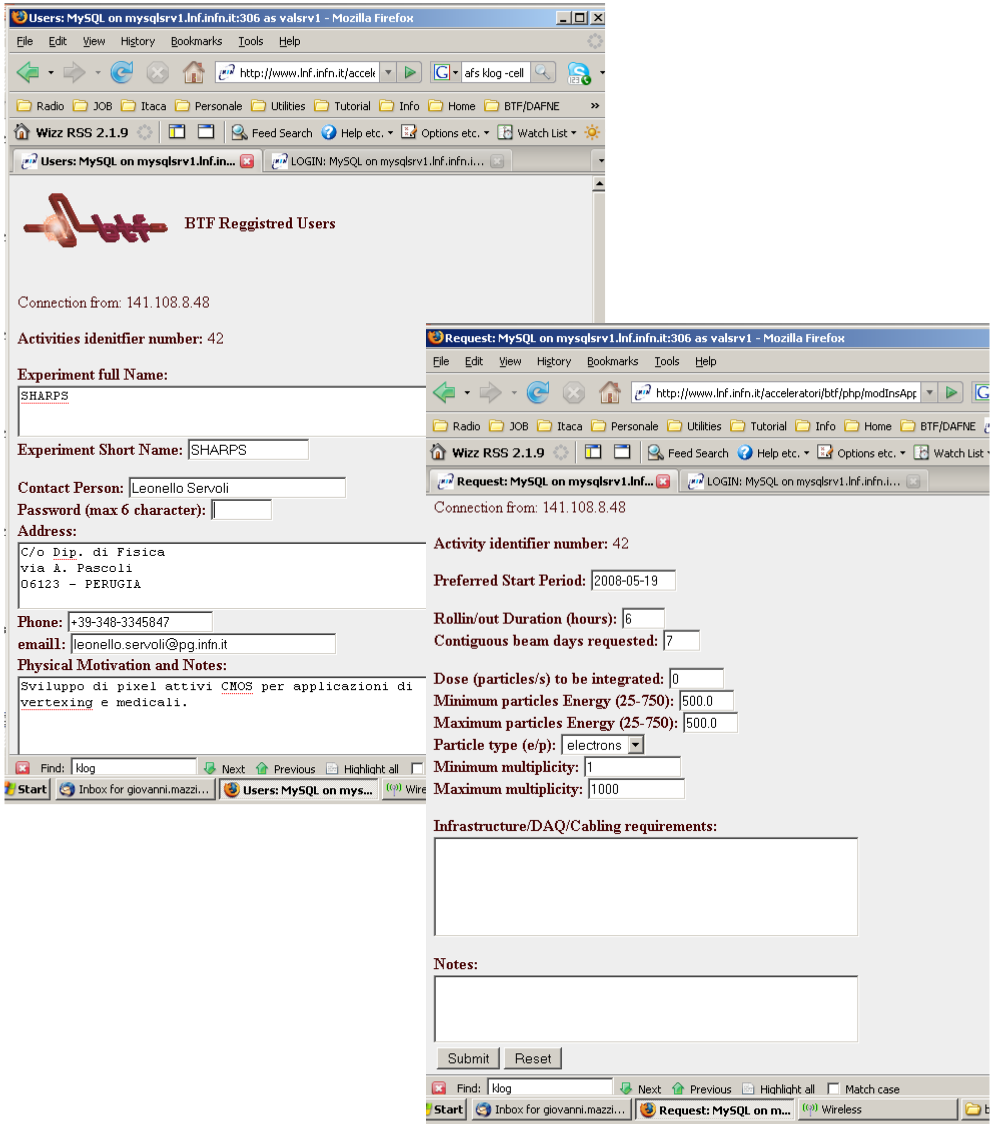


A tungsten box is going to be installed in order to shield the high divergent beam coming from the Cu degrader target – an attenuation of ~ 100 is expected by simulation (FLUKA)

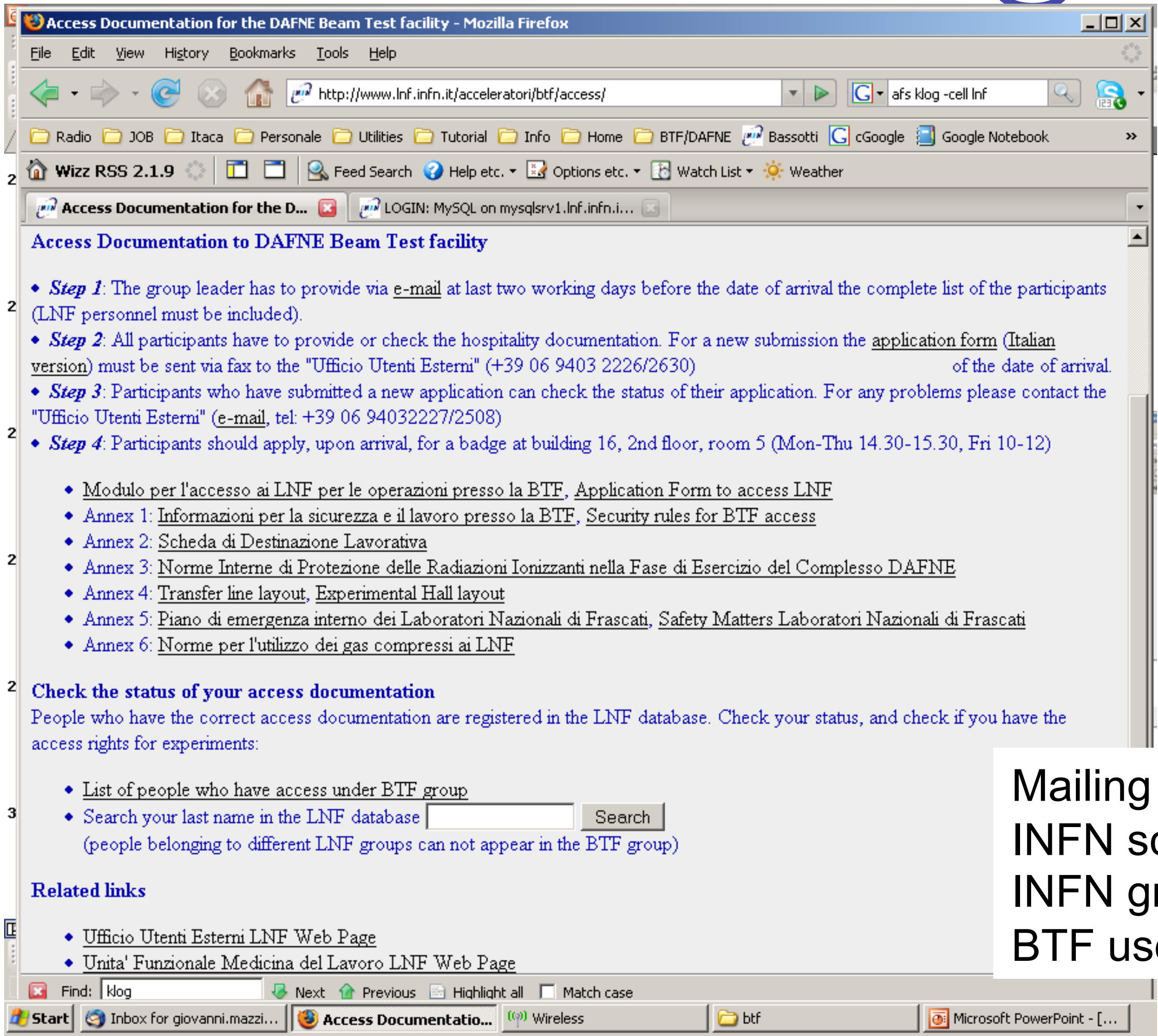
Application form to access BTF

Pasquale Di Nezza - INFN, LNF
Flavio Gatti - INFN, Genova
Clara Matteuzzi (Chairperson) - INFN, Milano
Giovanni Mazzitelli (Responsible) - INFN, LNF
Antonio Passeri - INFN, Roma III
Paolo Valente - INFN, Roma I
Beam Test Facility Secretariat: Annette Donkerlo





Access BTF @ LNF

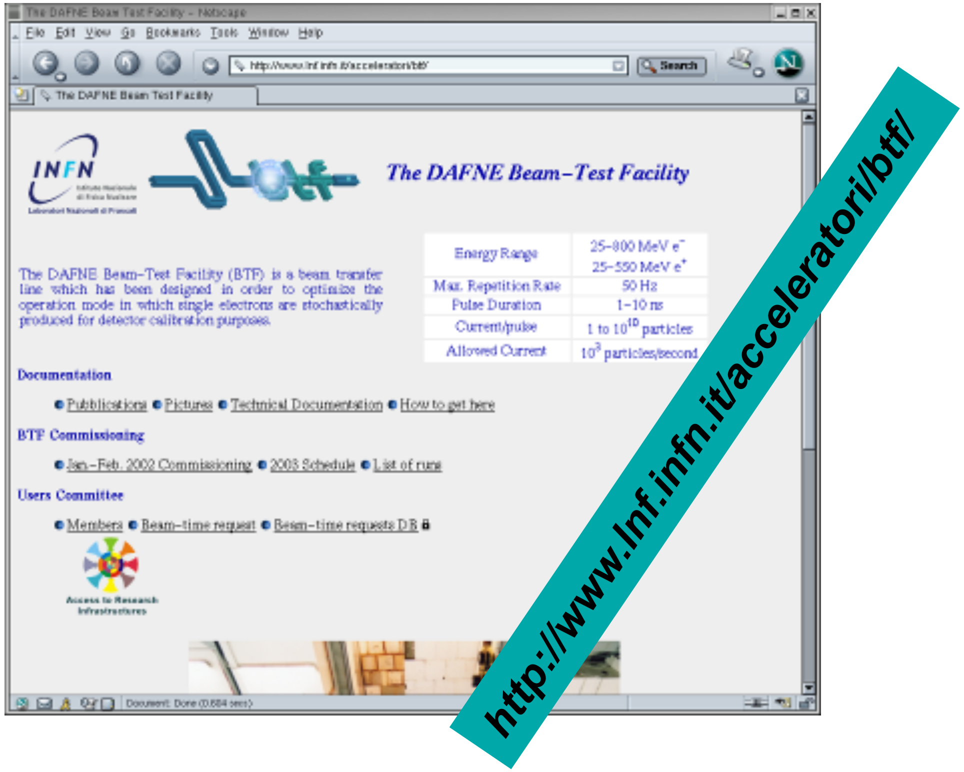


- btf@lnf.infn.it for scientific and technical question.
- btfsupport@lnf.infn.it for administration problem.

Mailing list
INFN scientific CN coordinators
INFN group responsible
BTF users

General information

*technical documentation for **users** and **operators** is available on the web as well as beam request, shift archive, schedule, documentation, virtual logbook, etc*



*The BTF was widely used as a TARI facility in the **EU** 6th Framework Program*

*…and will be involved in the **EU** 7th Framework Program*

Thanks for your attention