

# BTF @ LNF

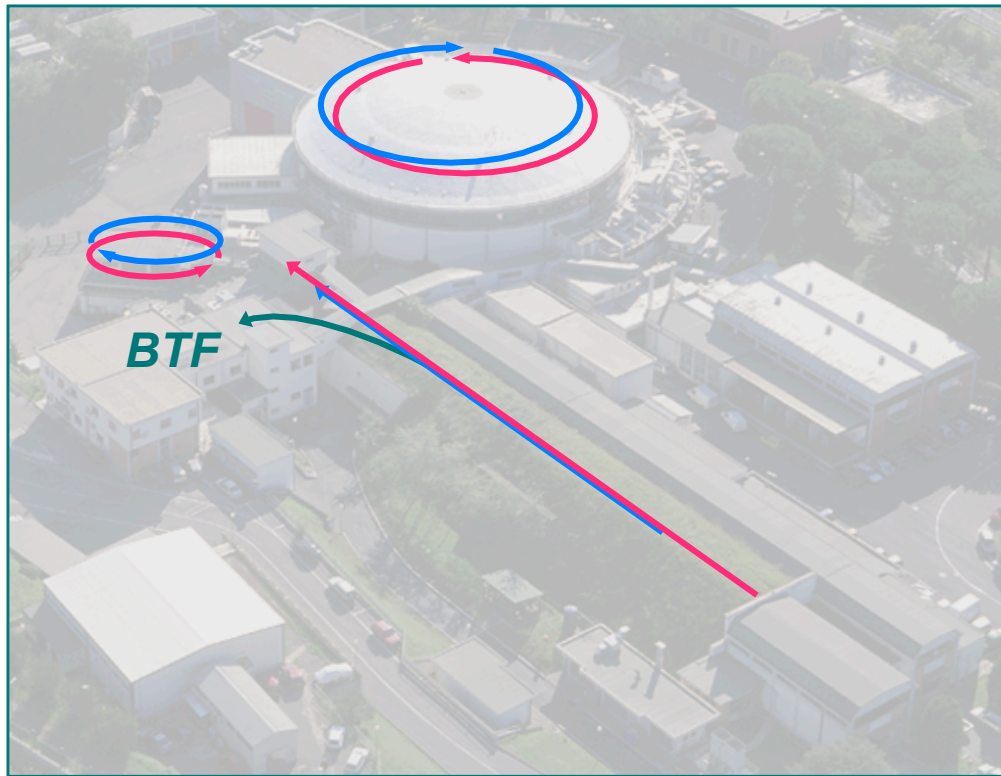
DAFNE Beam Test Facility (BTF).

From single up to  $10^{10}$  e<sup>-</sup>/e<sup>+</sup> and  $\gamma$



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

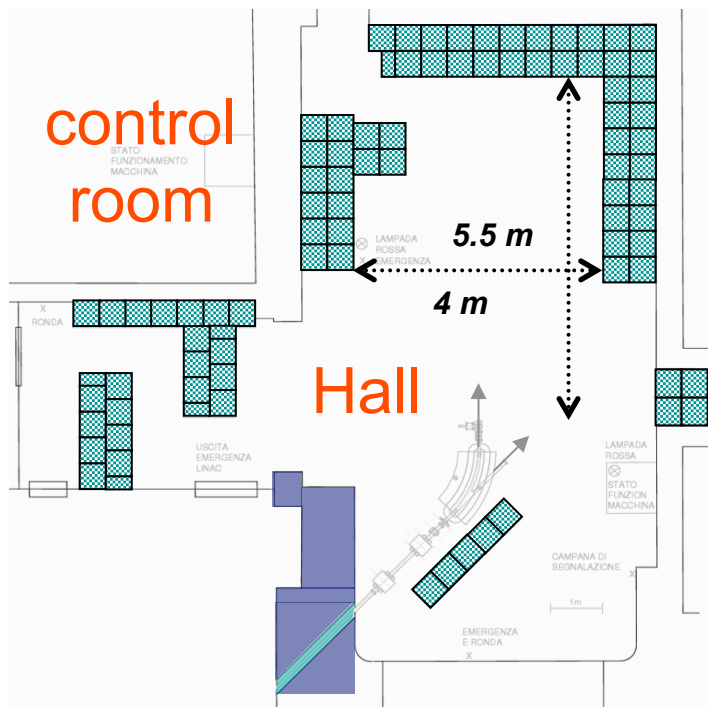
The **BTF** is a  $e^-/e^+$  **test-beam facility** in the Frascati DAΦNE collider complex

**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

BTF Hall



DHSTB02

WCM

SLTB04

SLTB03

momentum analyzer

LINAC tunnel

DHSTS01

DHSTB101

to accumulator

from Linac

DHSTP001

SLTB01

SLTB02

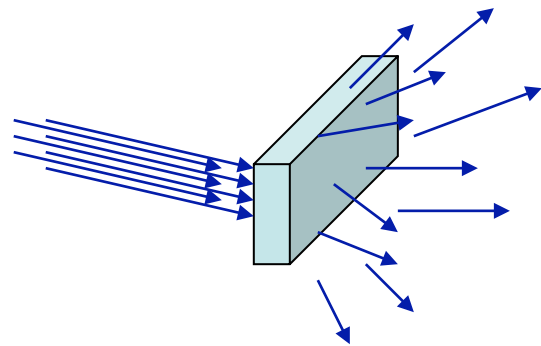
main ring

TARGET

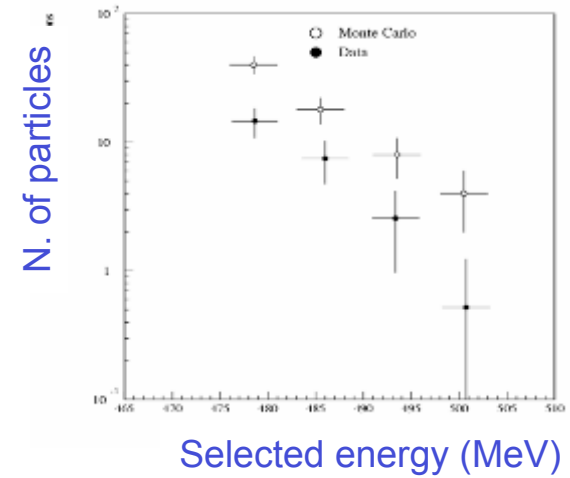
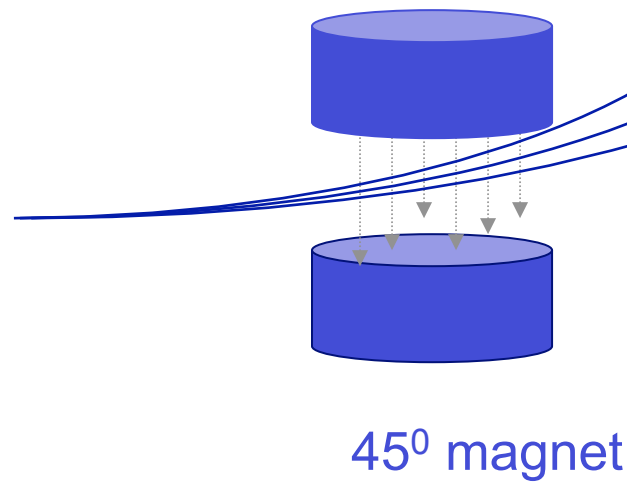
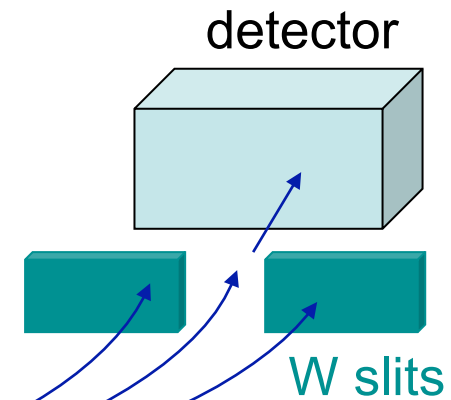
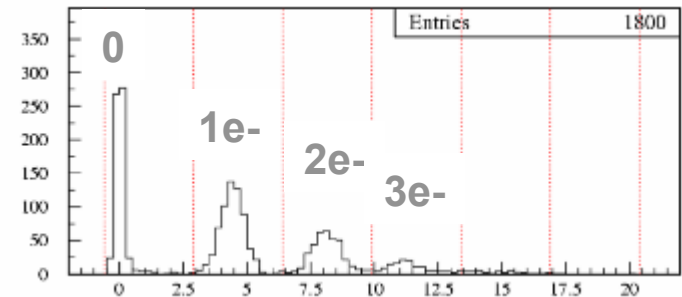
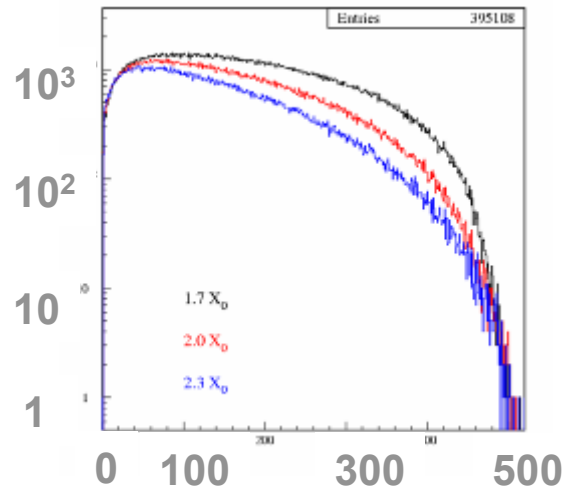
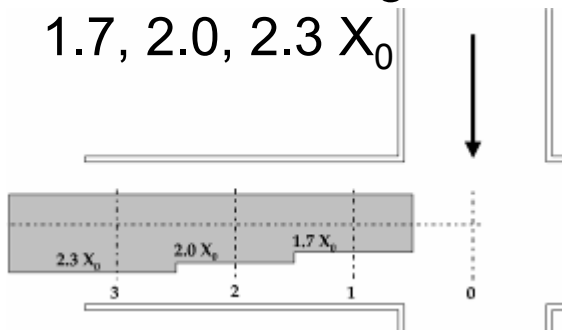
DHTB001

# LINAC beam attenuation

LINAC Beam 1-500 mA



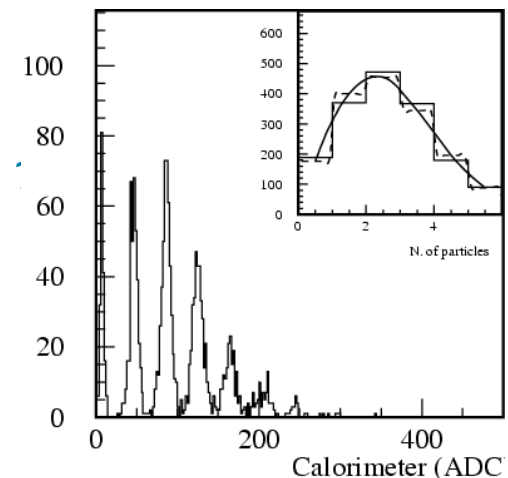
tunable Cu target:  
1.7, 2.0, 2.3  $X_0$



# 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

<b>Number</b>	(particles/pulse)	$1 \div 10^5$	
<b>Energy (MeV)</b>		25-500	25÷750
<b>Repetition rate (Hz)</b>		20-50	50
<b>Pulse Duration (ns)</b>		10	1 or 10
<b>p resolution</b>		1%	
<b>Spot size (mm)</b>		$\sigma_{x,y} \approx 2$ (single particle) up to $10 \times 10$ (high multiplicity)	
<b>Divergence (mrad)</b>		$\sigma'_{x,y} \approx 2$ (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 is in operation since 2003  
 beam is delivered 24 h/day with an efficiency of 96% but  
 when parasitizing 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%.

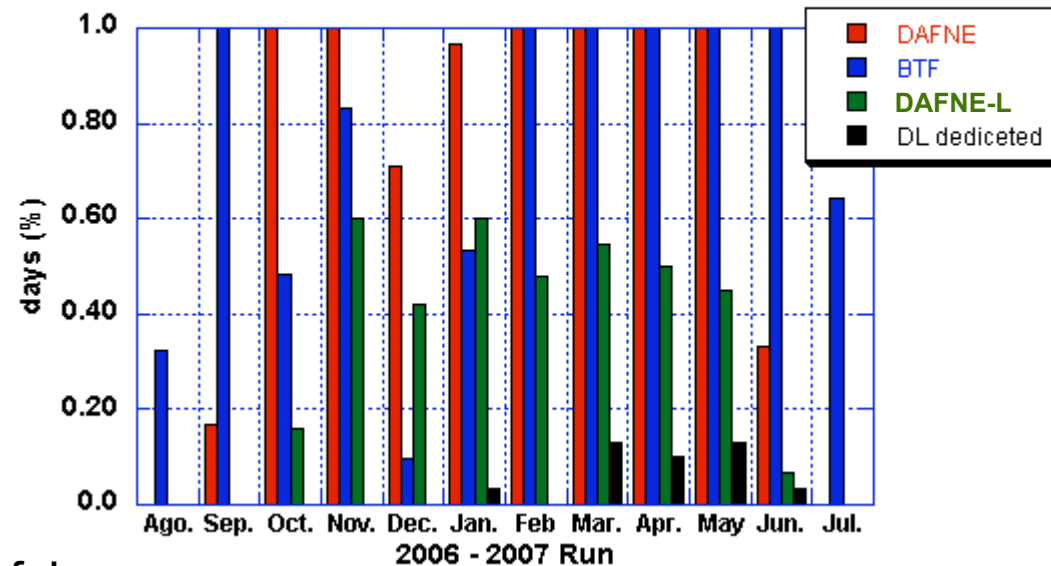


beam request in last 4 years  
 (multi users are counted twice)

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

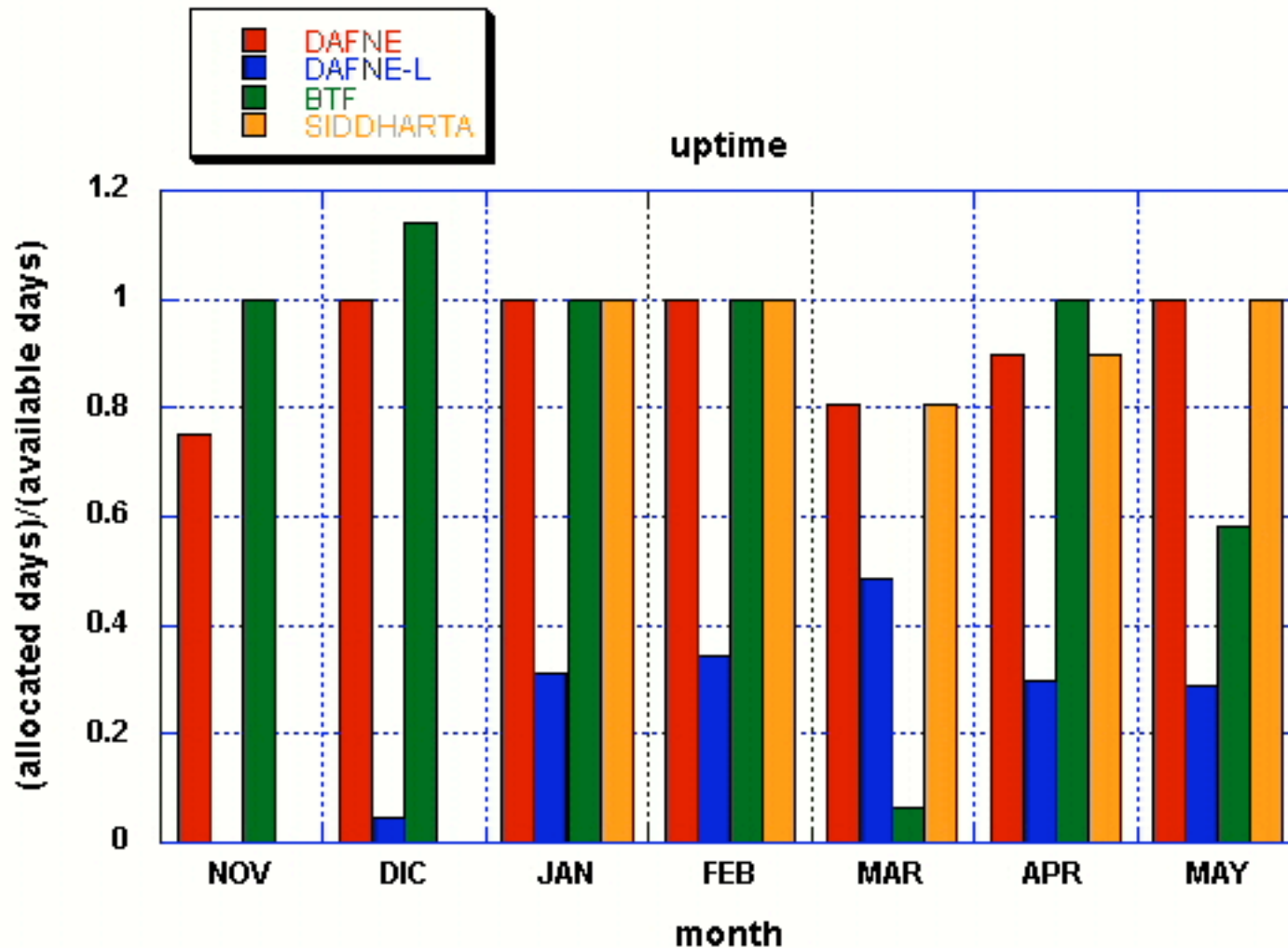
2008 - 124 days up to end of June

2006-2007 DAFNE run users requests





# Present RUN

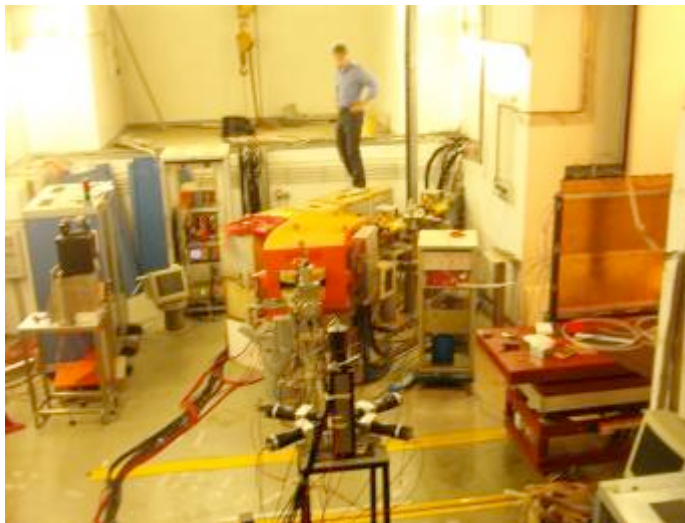


148 days allocated over 175 of operation, typical real access 80-90% of allocated time

# Equipment: infrastructure

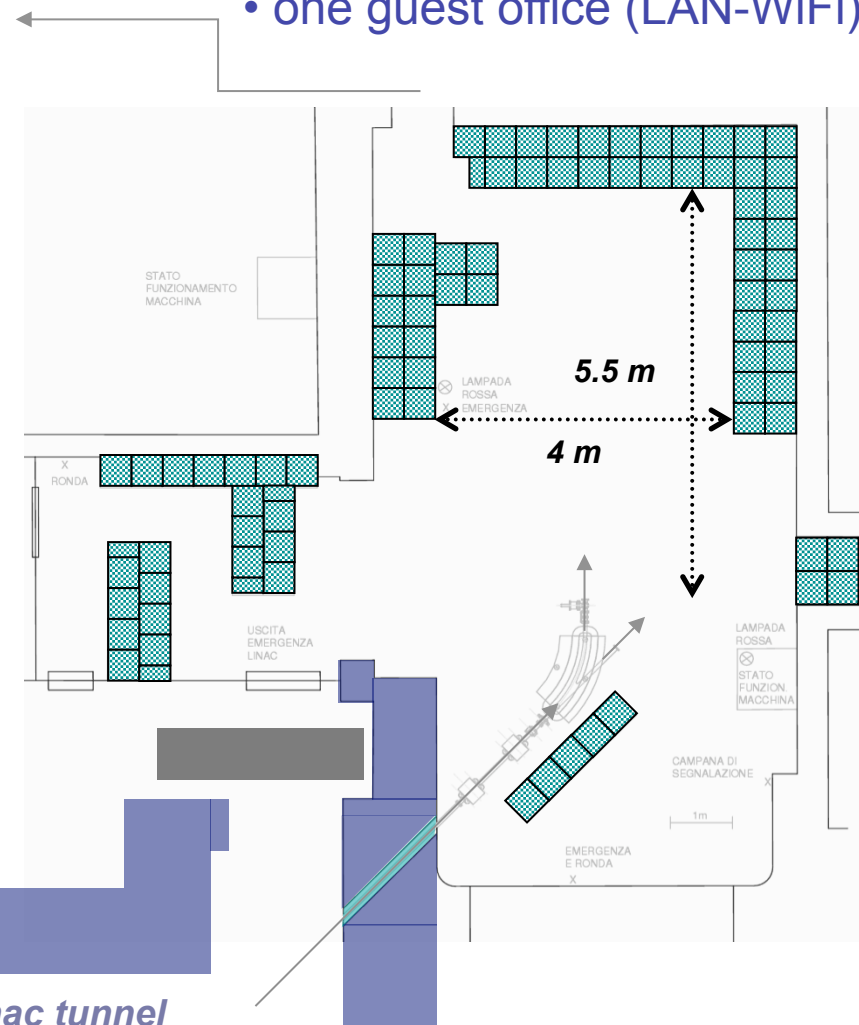


main entrance: radioprotection wall can be removed on demand



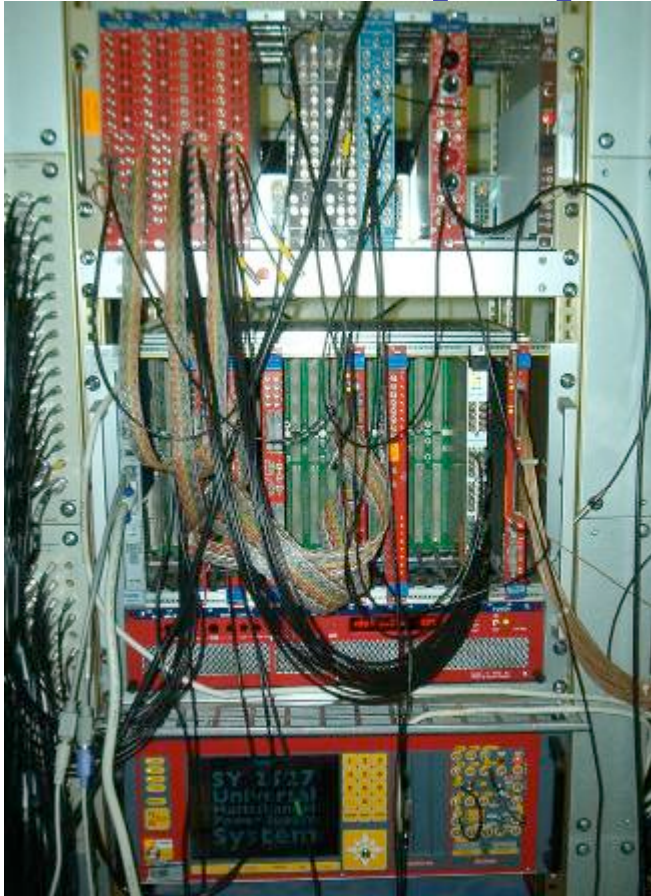
*Linac tunnel*

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





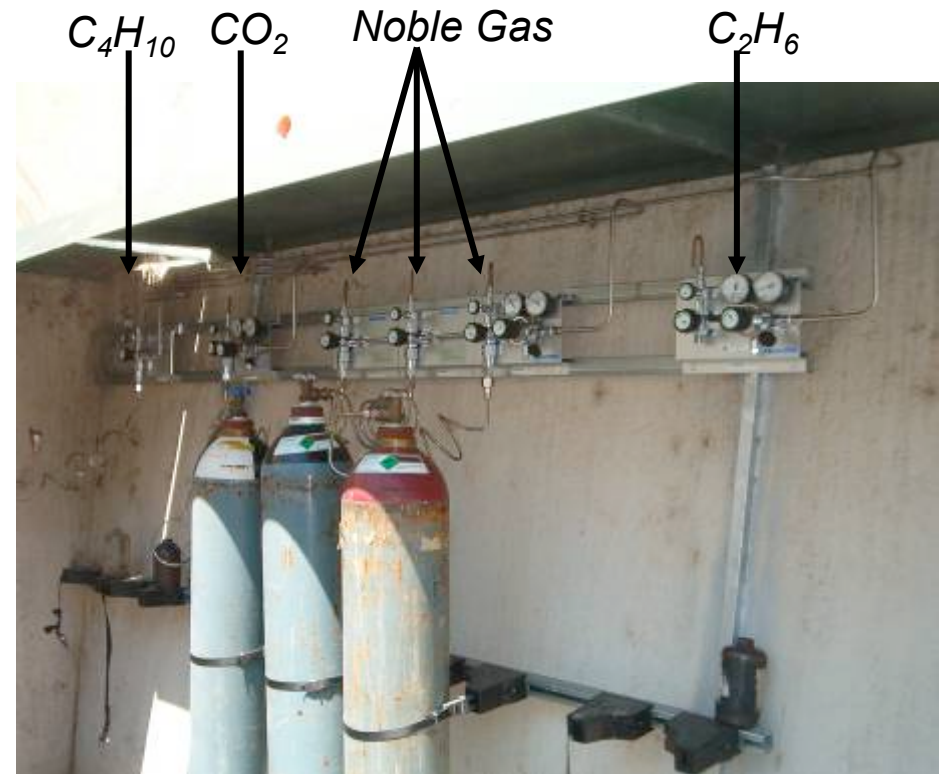
# Equipment: infrastructure



- 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

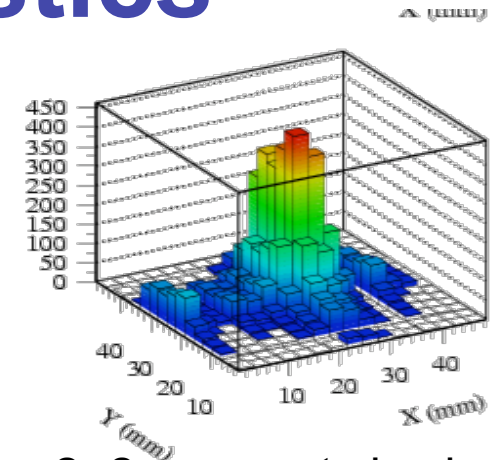
## low multiplicity diagnostic (1-100):

(back detector)

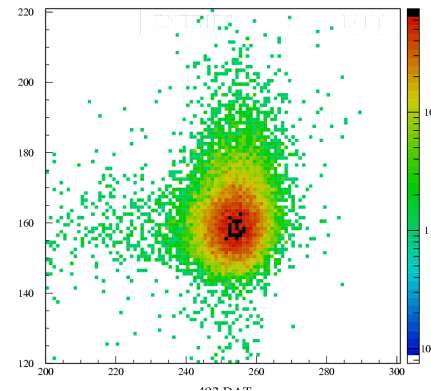
- lead glass,  $5 \times 5 \times 35$  -  $10 \times 10 \times 35$  cm
- $\text{PbWO}_4$  crystal  $3 \times 3 \times 11$  cm
- lead/scintillator fibers (KLOE type),  $25 \times 50 \times 30$  cm
- NaI high resolution  $30 \times 30$  cm

(front/trigger detector/not destructive/tracking)

- multipurpose plastic scintillators  $10 \times 10 \times 0.5$  cm,  $10 \times 30 \times 0.5$  cm,  $1 \times 15 \times 0.5$  cm
- hodoscope; two bundle of 1 mm fiber for a total active area of  $48 \times 48$  mm<sup>2</sup>
- Silicon tracker (high gain)
- 3GEM (Gas Electron Multiplier) detector



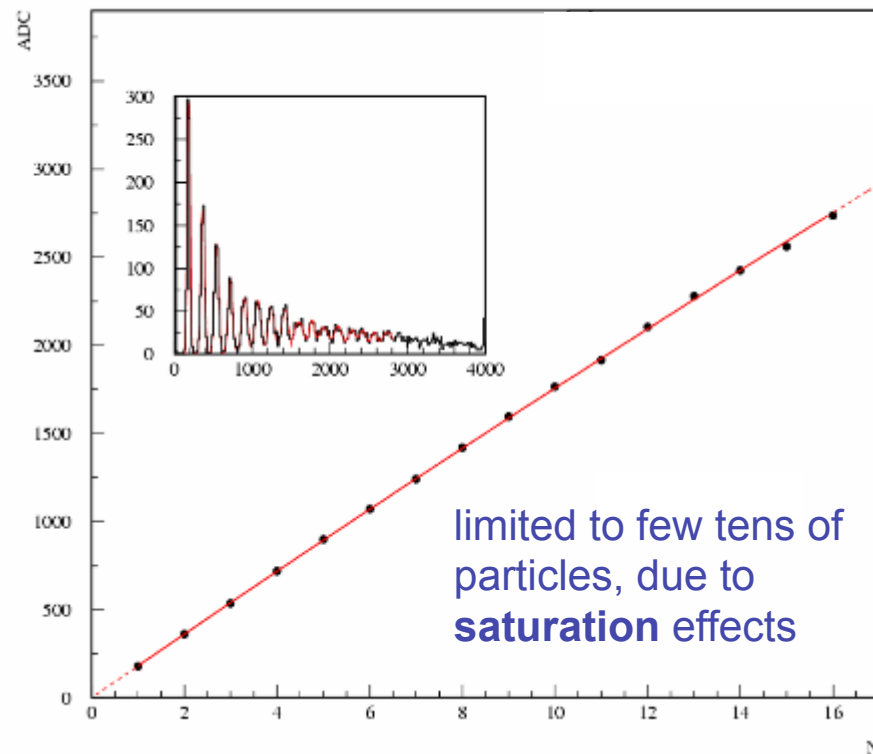
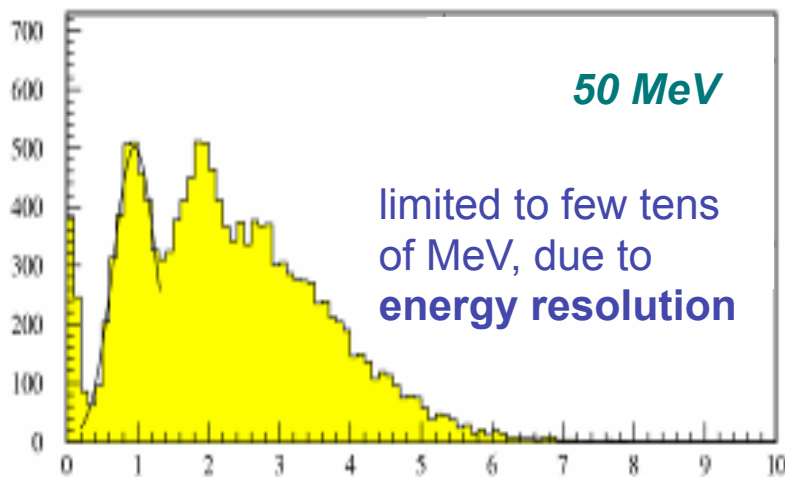
2x2 mm spot size in fiber hodoscope



2x2 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:

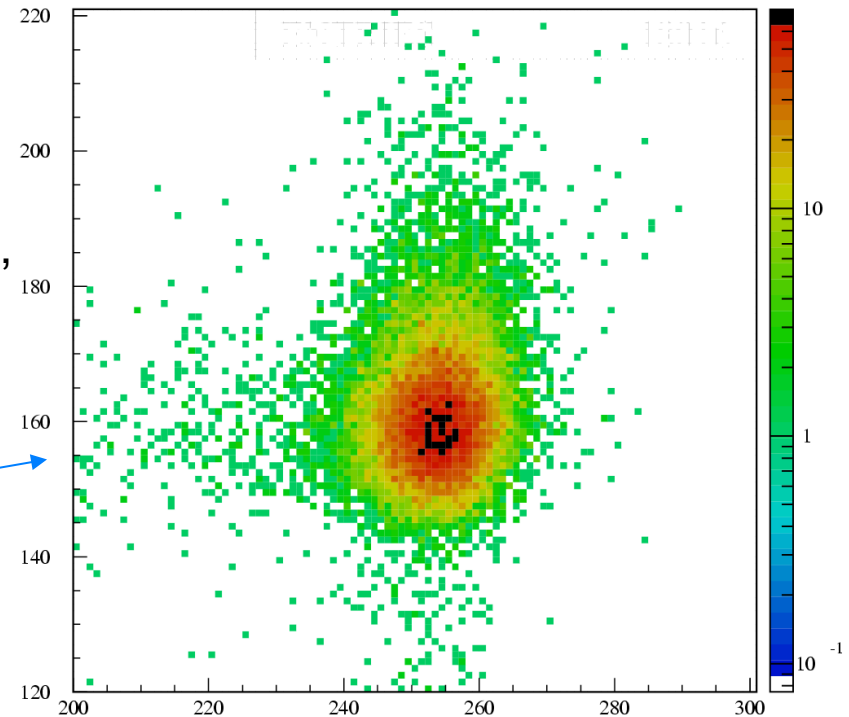
- full energy range
- maximum beam intensity

# Beam profile (AGILE Si tracker)

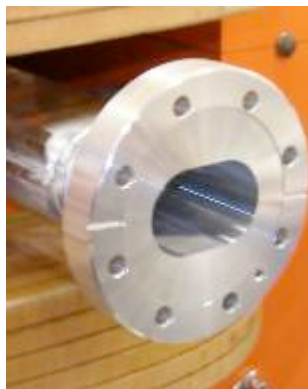
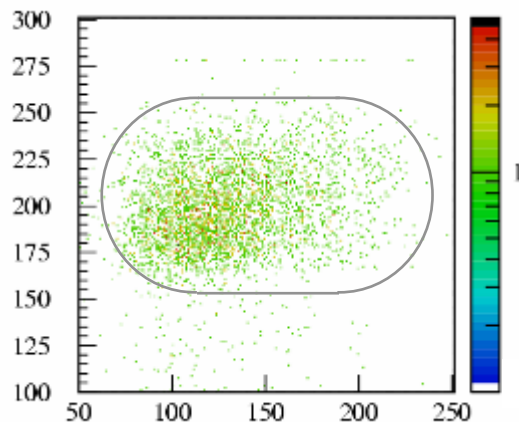
2 layers (x,y) × 384 strips, analog readout

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

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



## Defocused



*Beam spot measured with all transfer line  
quadrupoles off: 55×35 mm<sup>2</sup>, 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*

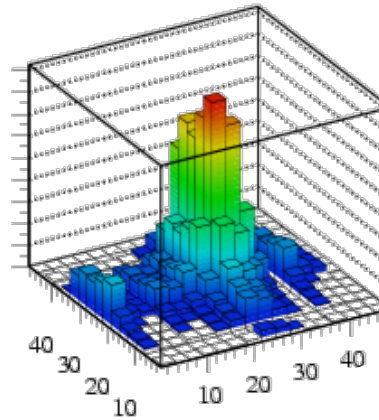
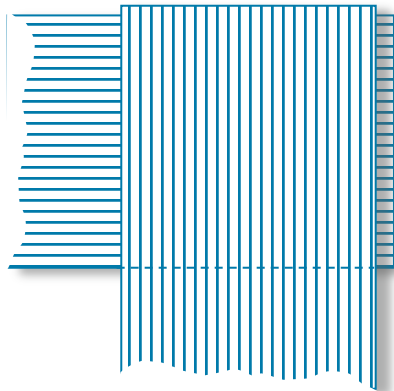
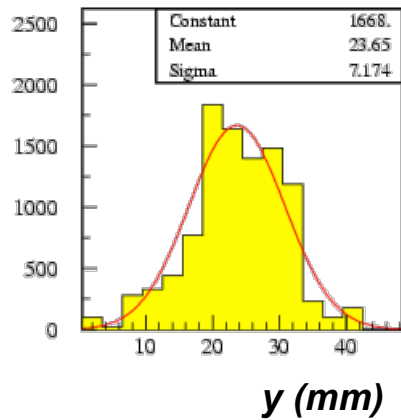


- *4 layers of fibers glued together*
- *staggered by  $\frac{1}{2}$  fiber to minimize dead zones*

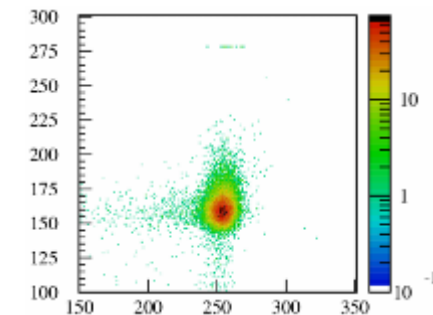
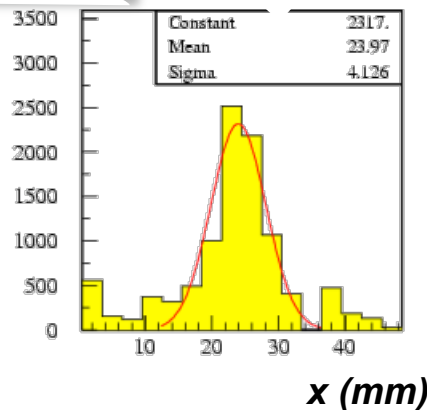
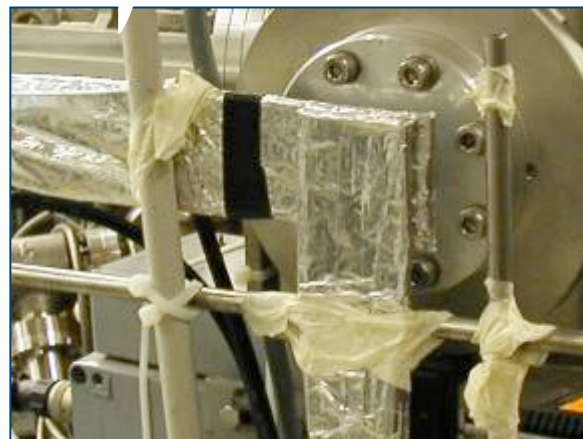
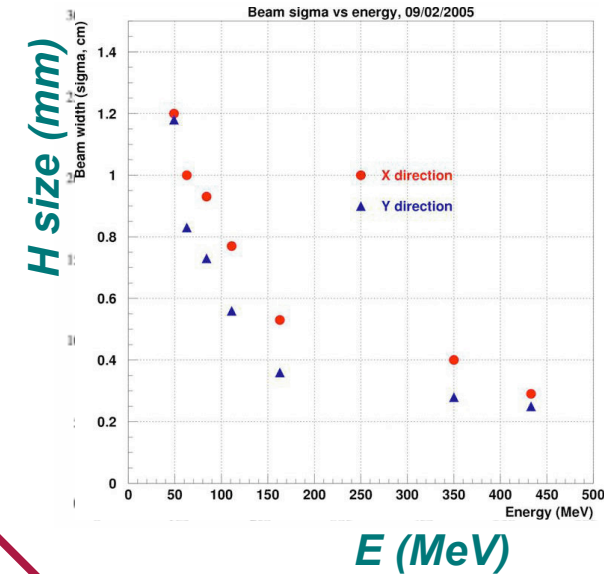


# Sci-fi profile detector

- Charge weighted profiles for x and y fiber bundles

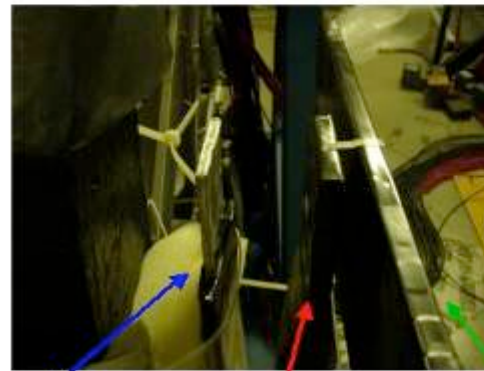


*energy dependence of the beam spot size*

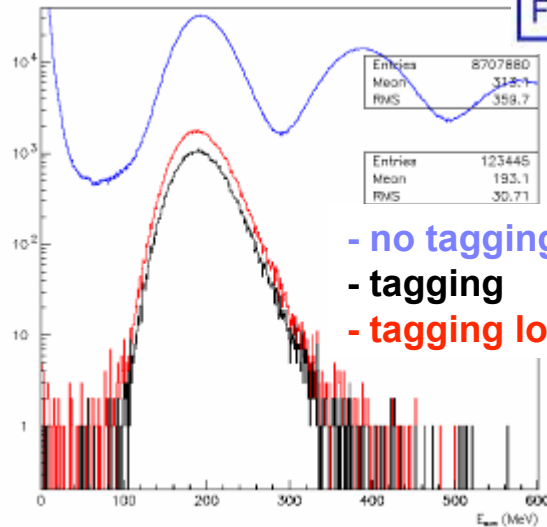


**Consistent with beam image from Silicon tracker**

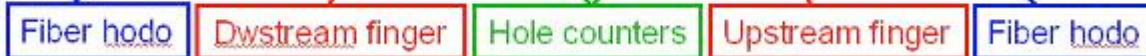
# Examples of experimental setup (P326 Prototype inefficiency 200 MeV)



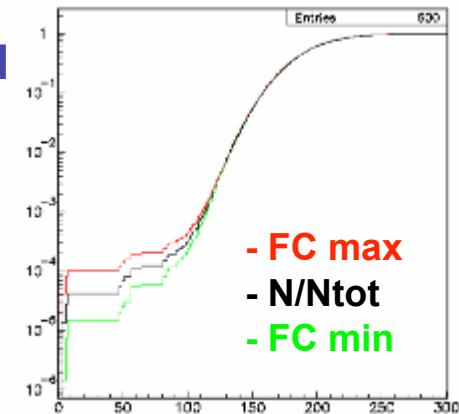
energy spectrum



- no tagging
- tagging
- tagging loose



inefficiency VS threshold



# Example of experimental setup (MEG)

beam exit

sci-fi profile detector

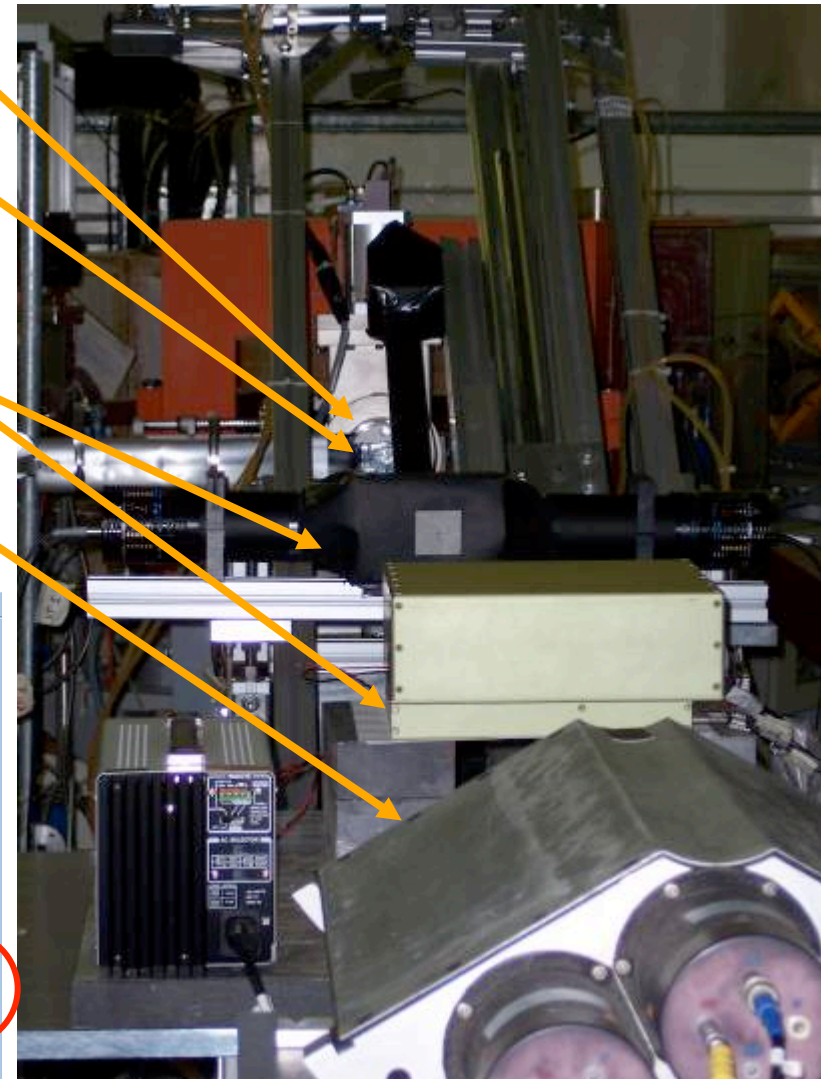
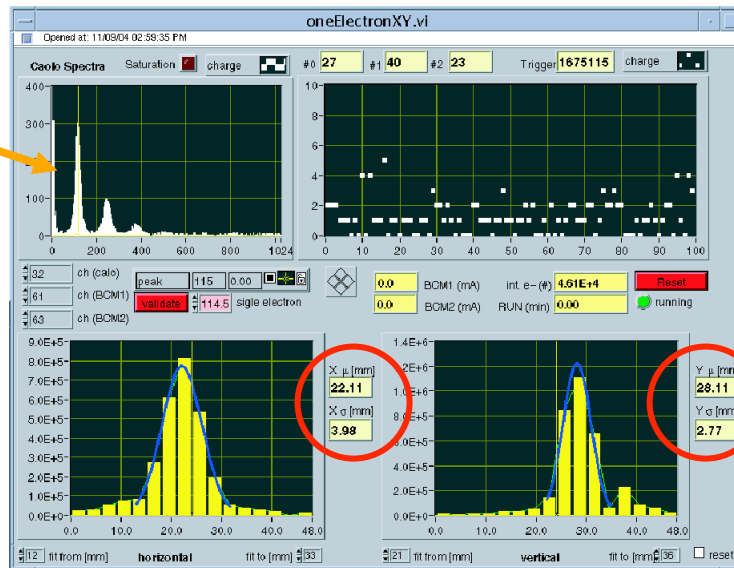
detector  
(MEG test for sci time resolution)

back detector (NaI calorimeter)

on line monitor

e- spectra

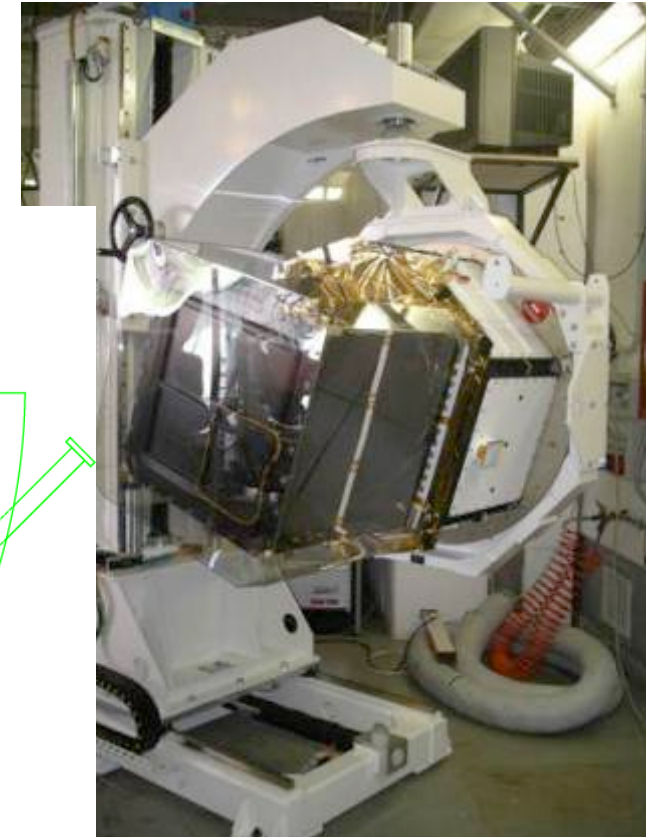
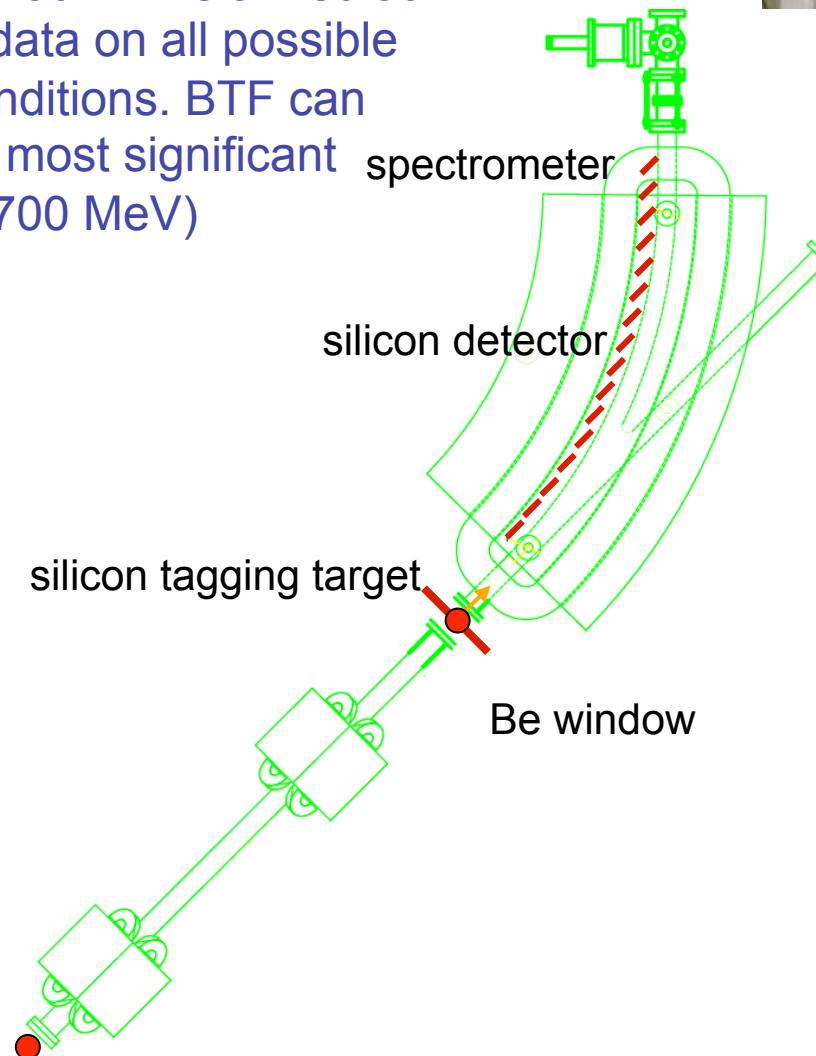
XY beam  
sci-profile





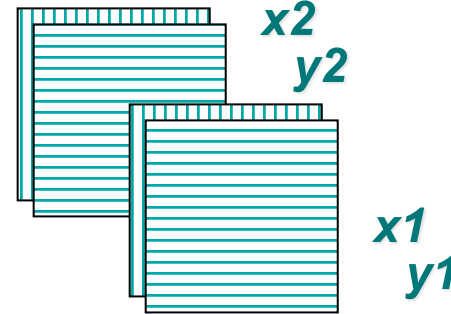
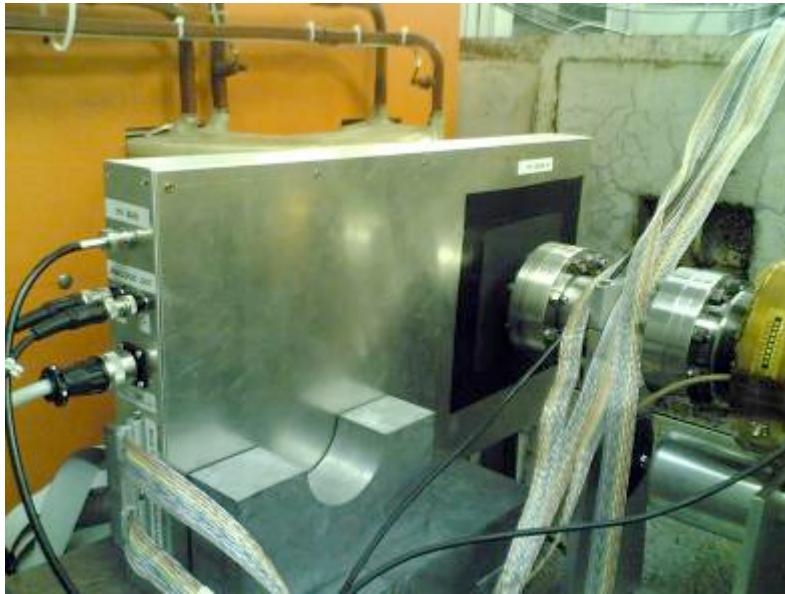
# BTF photon tagged source AGILE GRID photon calibration

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)



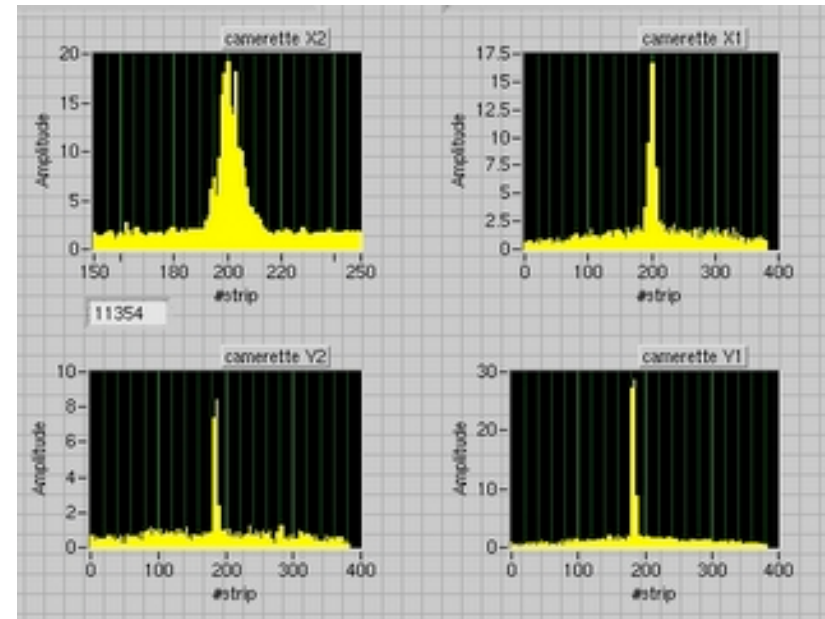
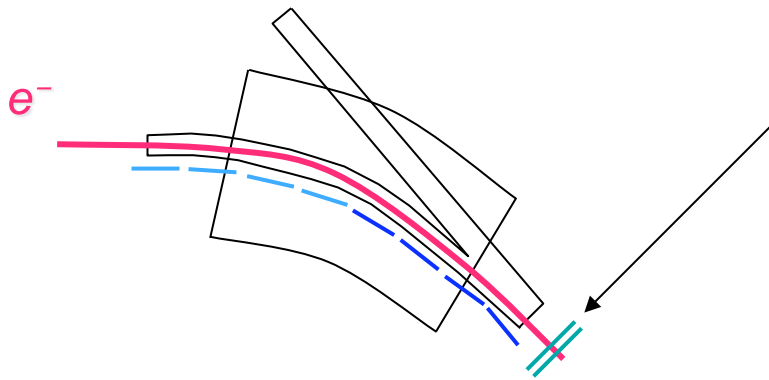
**AGILE  
GRID**

# $\gamma$ tagging @ BTF



position and direction of the in-coming electrons

*Nominal B field*





# $\gamma$ tagging @ BTF

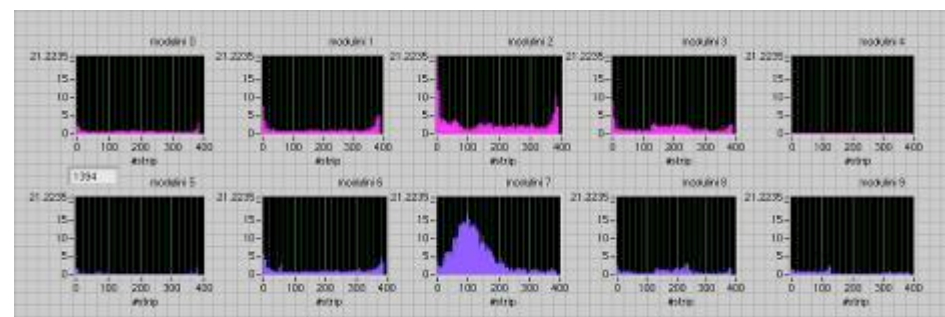
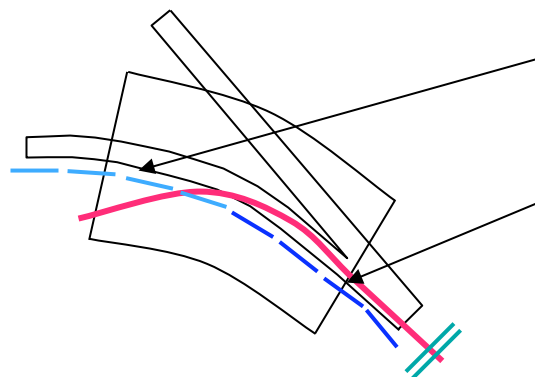


position and  
momentum of the  
out-coming electrons

*Nota bene*

*Online plots, analysis in progress*

Increase  $B$  field



# 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 ( $3 \times 10^6$  particles) BCM
  - high sensitivity fluorescence flags – cromox, Be, yag:ce

# Cerenkov beam monitor

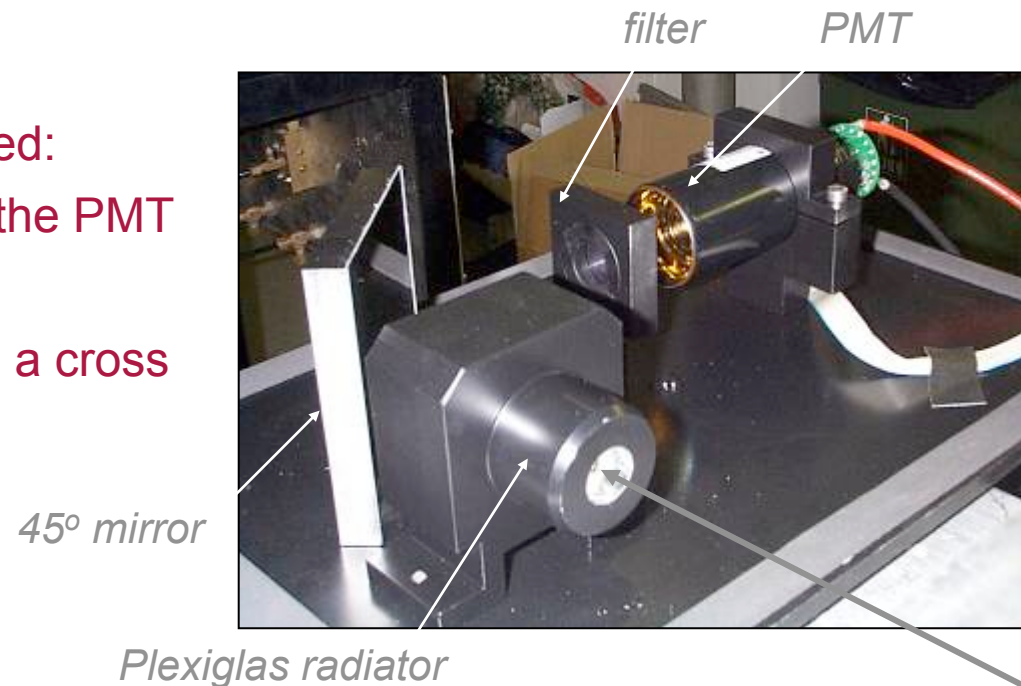
detector, designed and built, in collaboration with the AIRFLY group, based on **Cerenkov light emission**

- **Cross-calibrated** with calorimetric measurement at low particle multiplicity
- Used to monitor beam intensity at higher intensity up to  $10^4 \div 10^5$  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

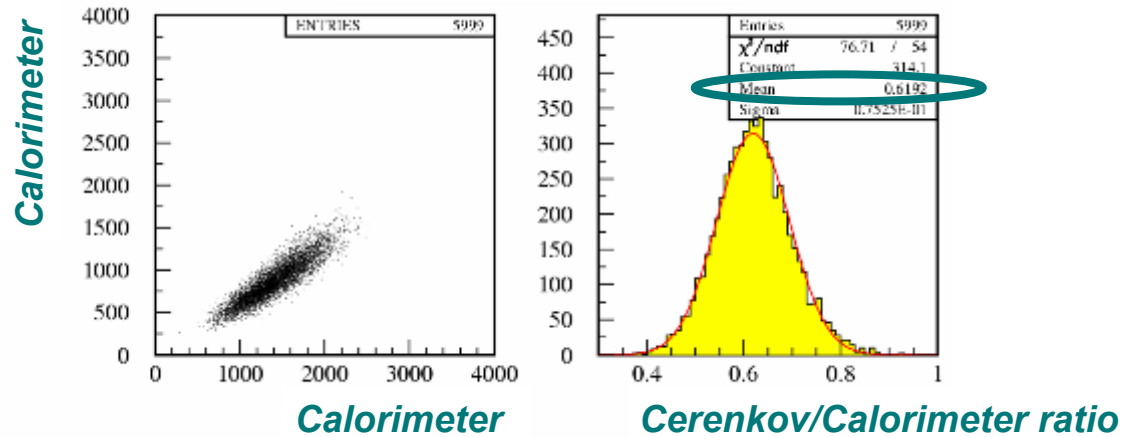
detector tested up to  $10^{10}$  particles with a cross calibration with BCM



# Cerenkov beam monitor

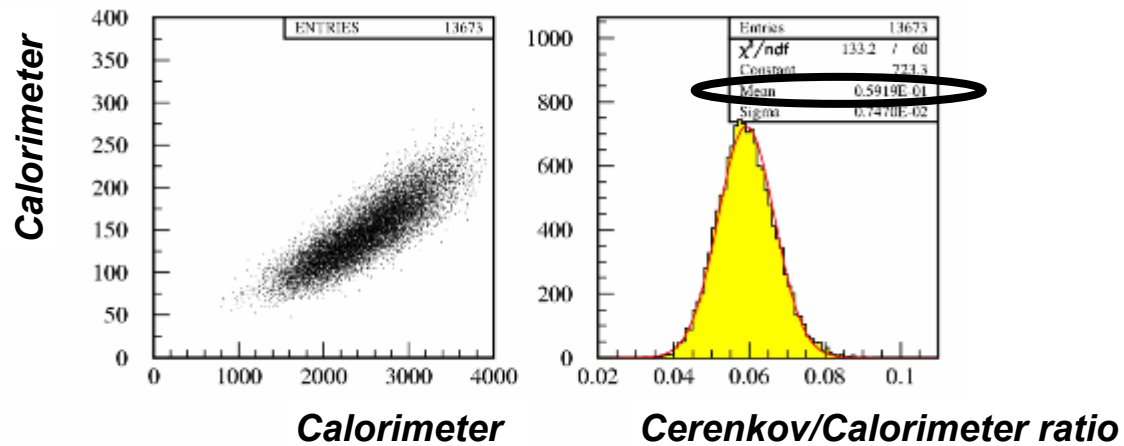
Calorimeter/Cerenkov calibration

*No optical filter*



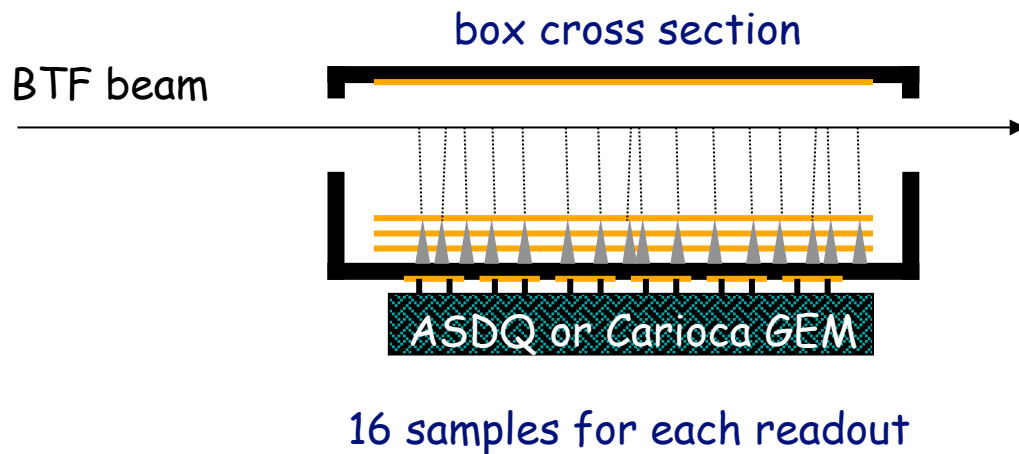
**:10 optical filter**

(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)



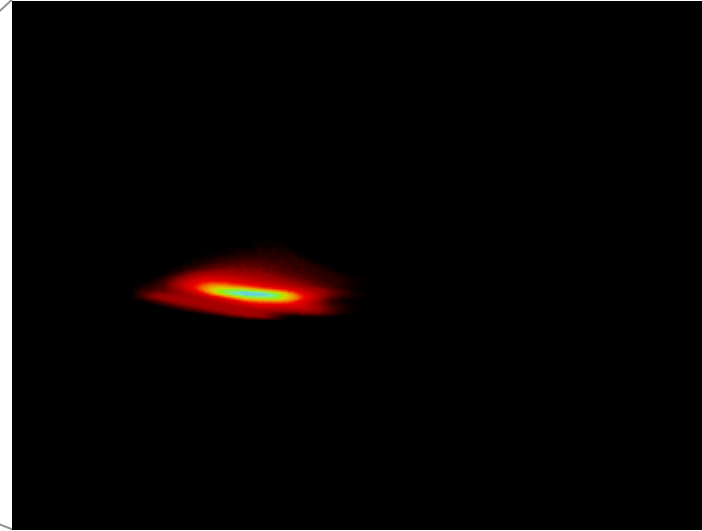
The detector will be realized with standard  $10 \times 10 \text{ cm}^2$  GEMs  
inside a G10 box; the readout will be realized with

- 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)

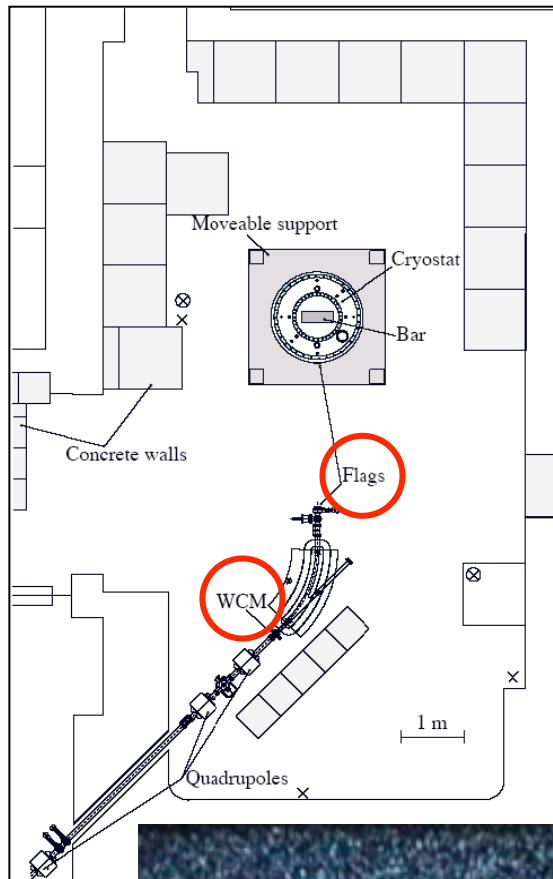


*Very low current beam image on 1 Inc yag:ce*

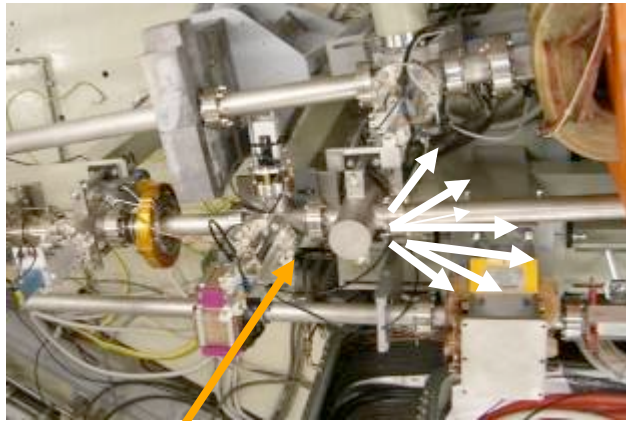
Flag = metallic high fluorescence plate viewed by a camera

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

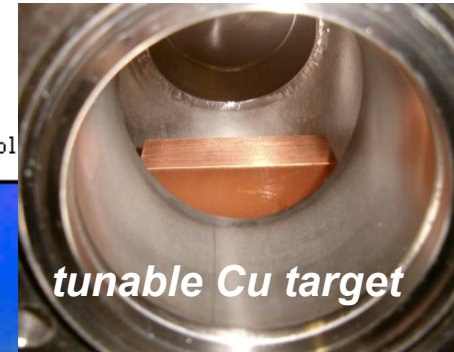
# RAP experiment @ BTF



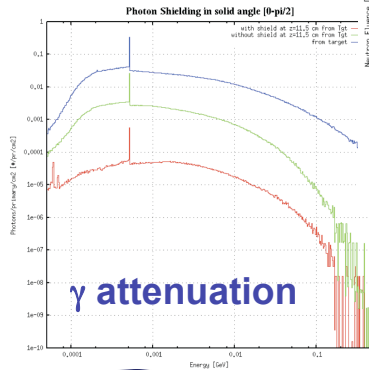
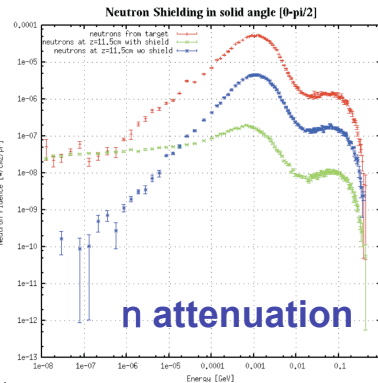
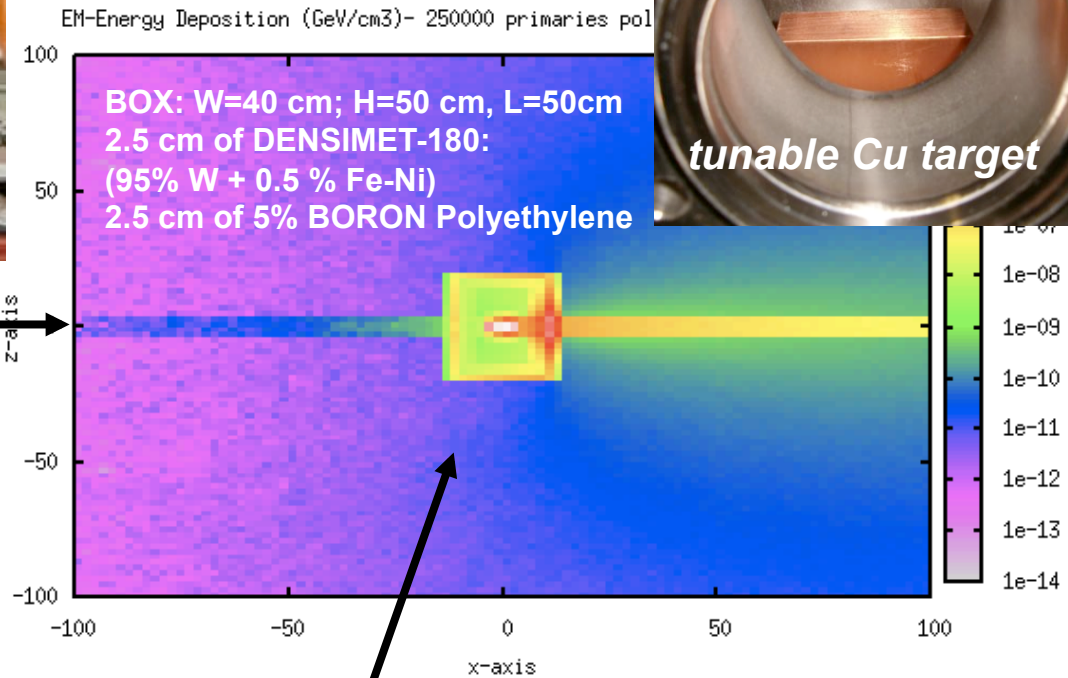
# Background attenuation



High current LINAC beam



tunable Cu target



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

Energy Range	25-750 MeV e <sup>+</sup> /e <sup>-</sup>
Max. Repetition Rate	50 Hz
Pulse Duration	1-10 ns
Particles/Pulse	1 to 10 <sup>10</sup> particles

Request: MySQL on mysqlsrv1.lnf.infn.it:306 as valsrv1 - Mozilla Firefox

Request: MySQL on mysqlsrv1.lnf.infn.it:306 as valsrv1 - Mozilla Firefox

# Access BTF @ LNF

**Access Documentation for the DAFNE Beam Test facility**

- ♦ **Step 1:** The group leader has to provide via e-mail at last two working days before the date of arrival the complete list of the participants (LNF personnel must be included).
- ♦ **Step 2:** All participants have to provide or check the hospitality documentation. For a new submission the application form (Italian version) must be sent via fax to the "Ufficio Utenti Esterni" (+39 06 9403 2226/2630) of the date of arrival.
- ♦ **Step 3:** Participants who have submitted a new application can check the status of their application. For any problems please contact the "Ufficio Utenti Esterni" (e-mail, tel: +39 06 94032227/2508)
- ♦ **Step 4:** Participants should apply, upon arrival, for a badge at building 16, 2nd floor, room 5 (Mon-Thu 14.30-15.30, Fri 10-12)

♦ Modulo per l'accesso ai LNF per le operazioni presso la BTF, Application Form to access LNF  
♦ Annex 1: Informazioni per la sicurezza e il lavoro presso la BTF, Security rules for BTF access  
♦ Annex 2: Scheda di Destinazione Lavorativa  
♦ Annex 3: Norme Interne di Protezione delle Radiazioni Ionizzanti nella Fase di Esercizio del Complesso DAFNE  
♦ Annex 4: Transfer line layout, Experimental Hall layout  
♦ Annex 5: Piano di emergenza interno dei Laboratori Nazionali di Frascati, Safety Matters Laboratori Nazionali di Frascati  
♦ Annex 6: Norme per l'utilizzo dei gas compressi ai LNF

**Check the status of your access documentation**  
People who have the correct access documentation are registered in the LNF database. Check your status, and check if you have the access rights for experiments:

- ♦ List of people who have access under BTF group
- ♦ Search your last name in the LNF database    
(people belonging to different LNF groups can not appear in the BTF group)

**Related links**

- ♦ Ufficio Utenti Esterni LNF Web Page
- ♦ Unita' Funzionale Medicina del Lavoro LNF Web Page

- [btf@lnf.infn.it](mailto:btf@lnf.infn.it) for scientific and technical question.
- [btfsupport@lnf.infn.it](mailto: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 screenshot shows a web browser window displaying the website for the DAFNE Beam-Test Facility. The page features the INFN logo, a stylized 'btf' logo, and the title 'The DAFNE Beam-Test Facility'. A table lists technical specifications: Energy Range (25-900 MeV e<sup>-</sup>), Max. Repetition Rate (25-550 MeV e<sup>-</sup>), Max. Repetition Rate (50 Hz), Pulse Duration (1-10 ns), Current/pulse (1 to 10<sup>10</sup> particles), and Allowed Current (10<sup>9</sup> particles/second). Below the table, there are sections for 'Documentation', 'BTF Commissioning', and 'Users Committee', each with a list of links. A teal banner with the URL 'http://www.inf.infn.it/acceleratori/btf/' is overlaid diagonally across the right side of the screenshot.

Energy Range	25-900 MeV e <sup>-</sup>
Max. Repetition Rate	25-550 MeV e <sup>-</sup>
Max. Repetition Rate	50 Hz
Pulse Duration	1-10 ns
Current/pulse	1 to 10 <sup>10</sup> particles
Allowed Current	10 <sup>9</sup> particles/second

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

*...and will be involved in the **EU 7<sup>th</sup>** Framework Program*

Thanks for your attention