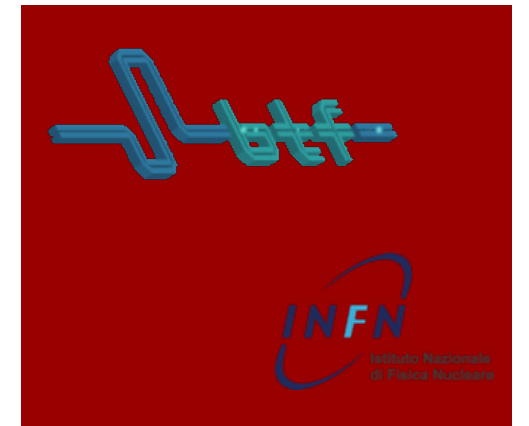




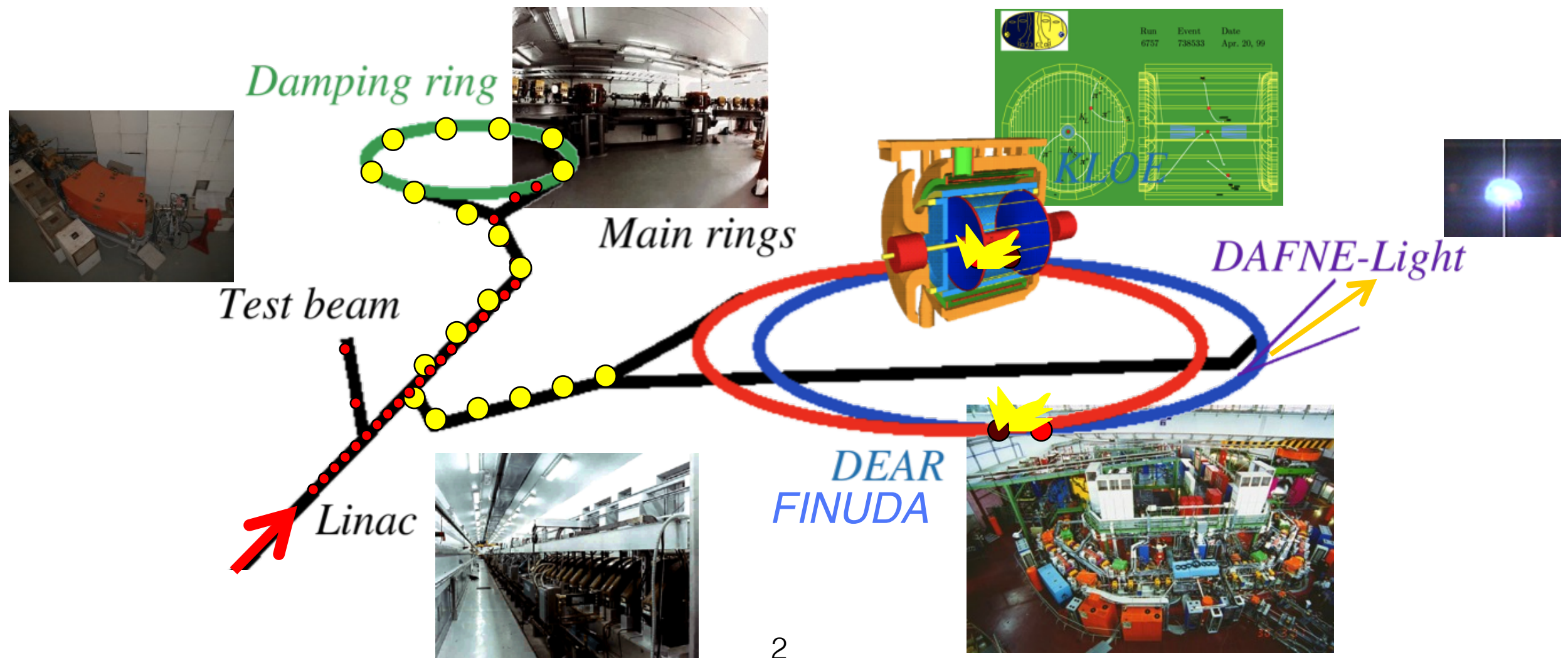
# Task 8.2.2

**Test beam infrastructure in Frascati**  
LNF, Ferrara & Perugia INFN structure  
and University of Bergen

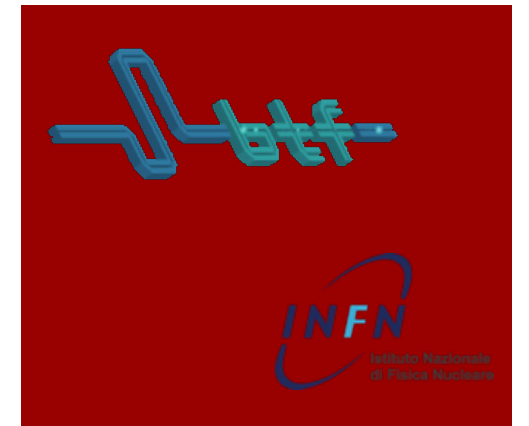
# DAFNE accelerator Complex



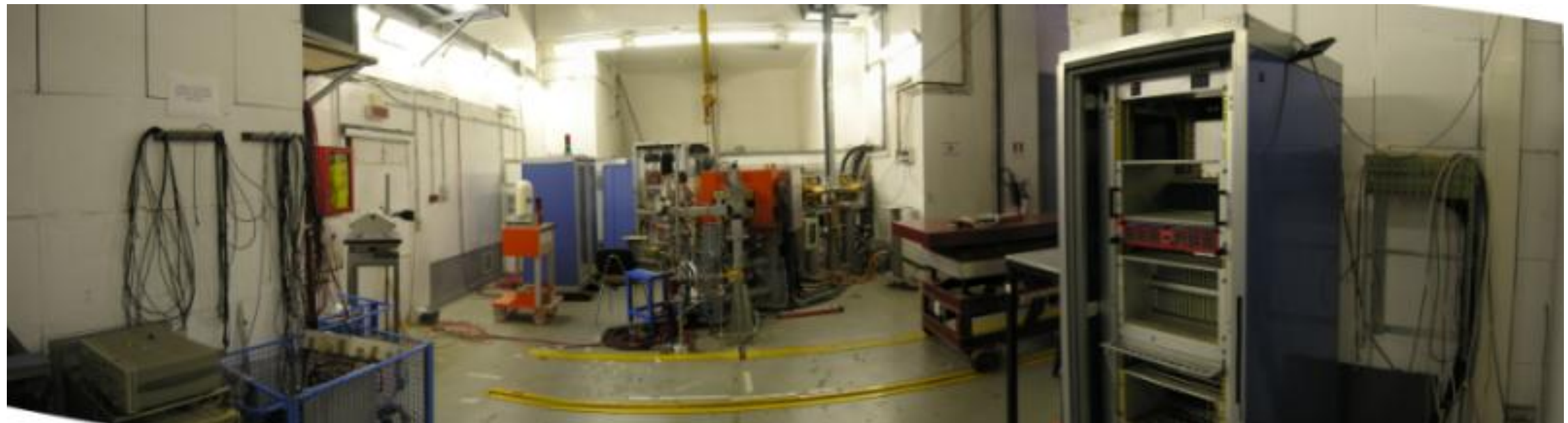
The **BTF (Beam Test Facility)** is part of the **DAFNE** accelerator complex, a particles factory devoted to the production of  $\Phi$  mesons and the study of K decay through the **HEP** and Nuclear Detectors KLOE, FINUDA and SIDDHARTA. Four **synchrotron light** beamlines are also available (Soft X, UV, Infrared, XUV).



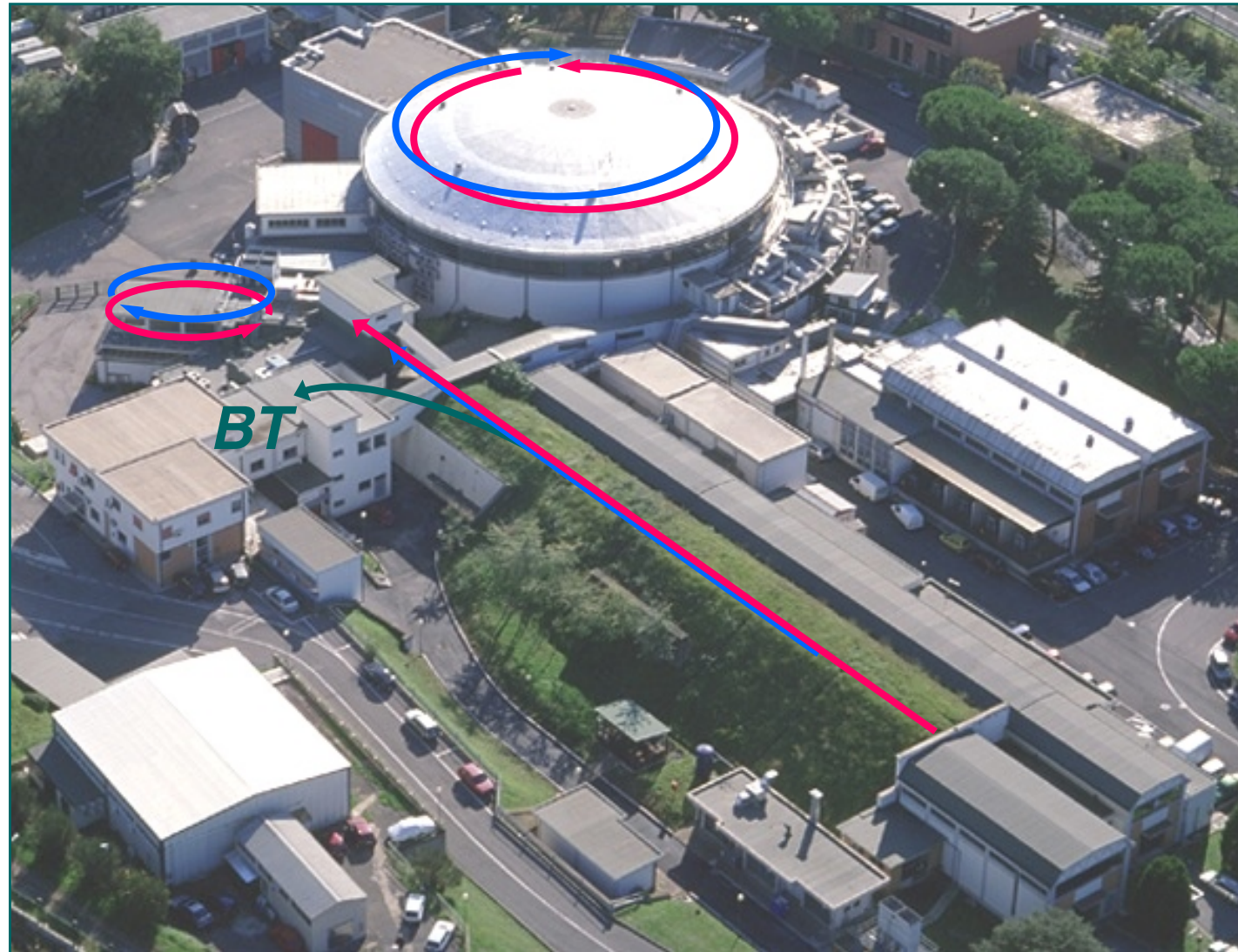
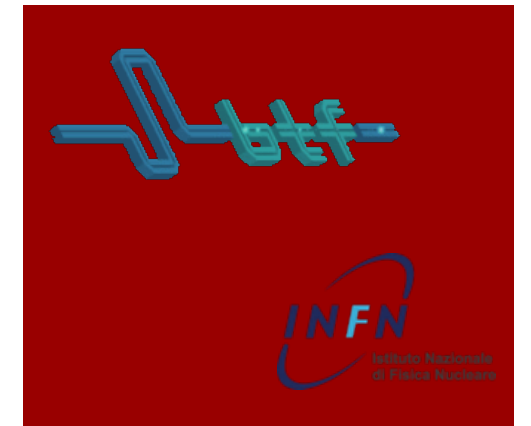
# Beam Test Facility(BTF) Infrastructure



The Frascati **Beam Test Facility** infrastructure is a beam extraction line optimized to produce **electrons, positrons, photons** and **neutrons** mainly for HEP detector **calibration** purpose. The quality of the beam, energy and intensity is also of interest for **experiments** ( $\sim 20\%$  of the users) studying the **electromagnetic interaction with matter**







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

**high current Linac:**

1 – 500 mA  $e^-$  100 mA  $e^+$ ,  
1 - 10 ns pulses, at least  $10^7$  particles

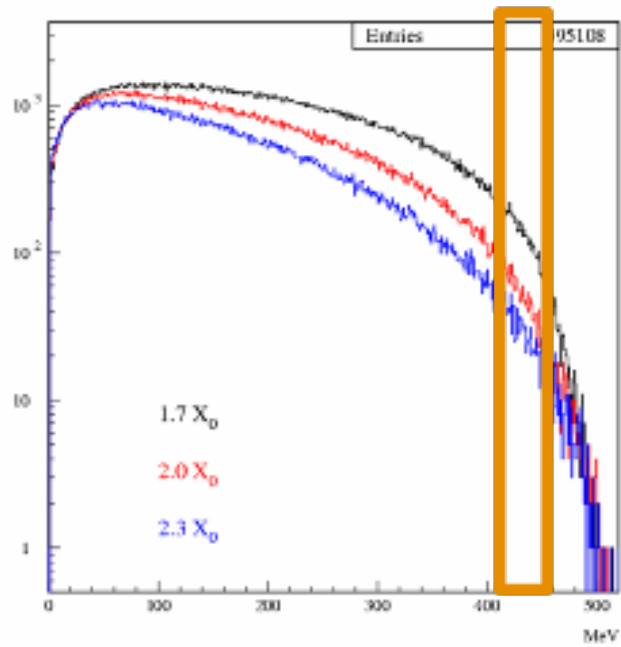
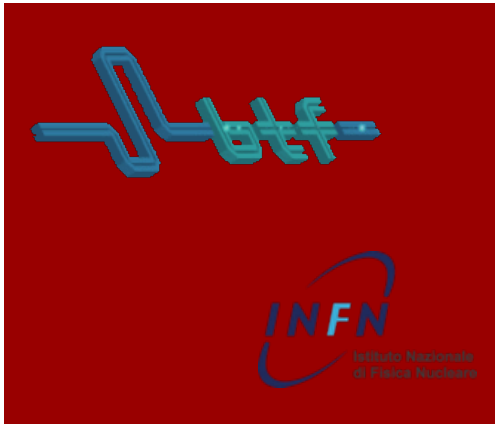
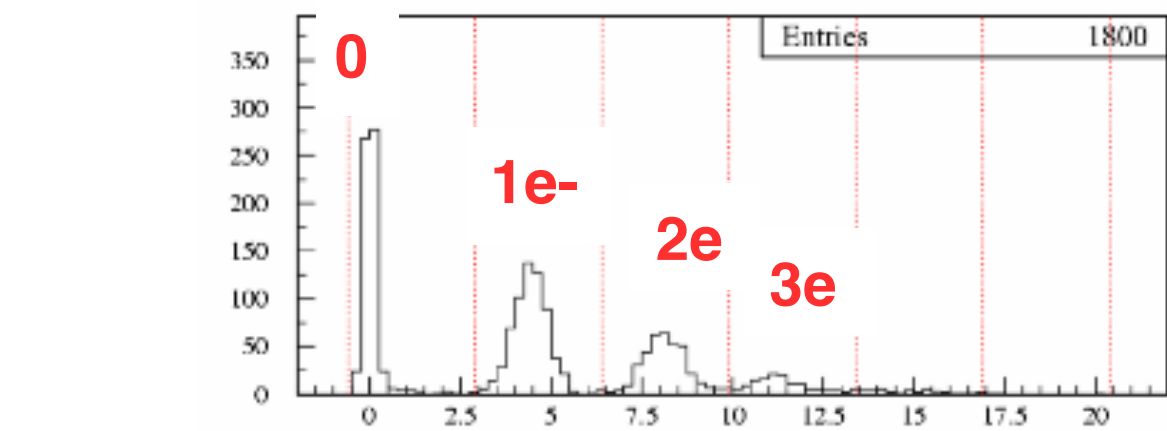
Need to attenuate the primary beam:

Single particle regime is ideal for detector testing purposes

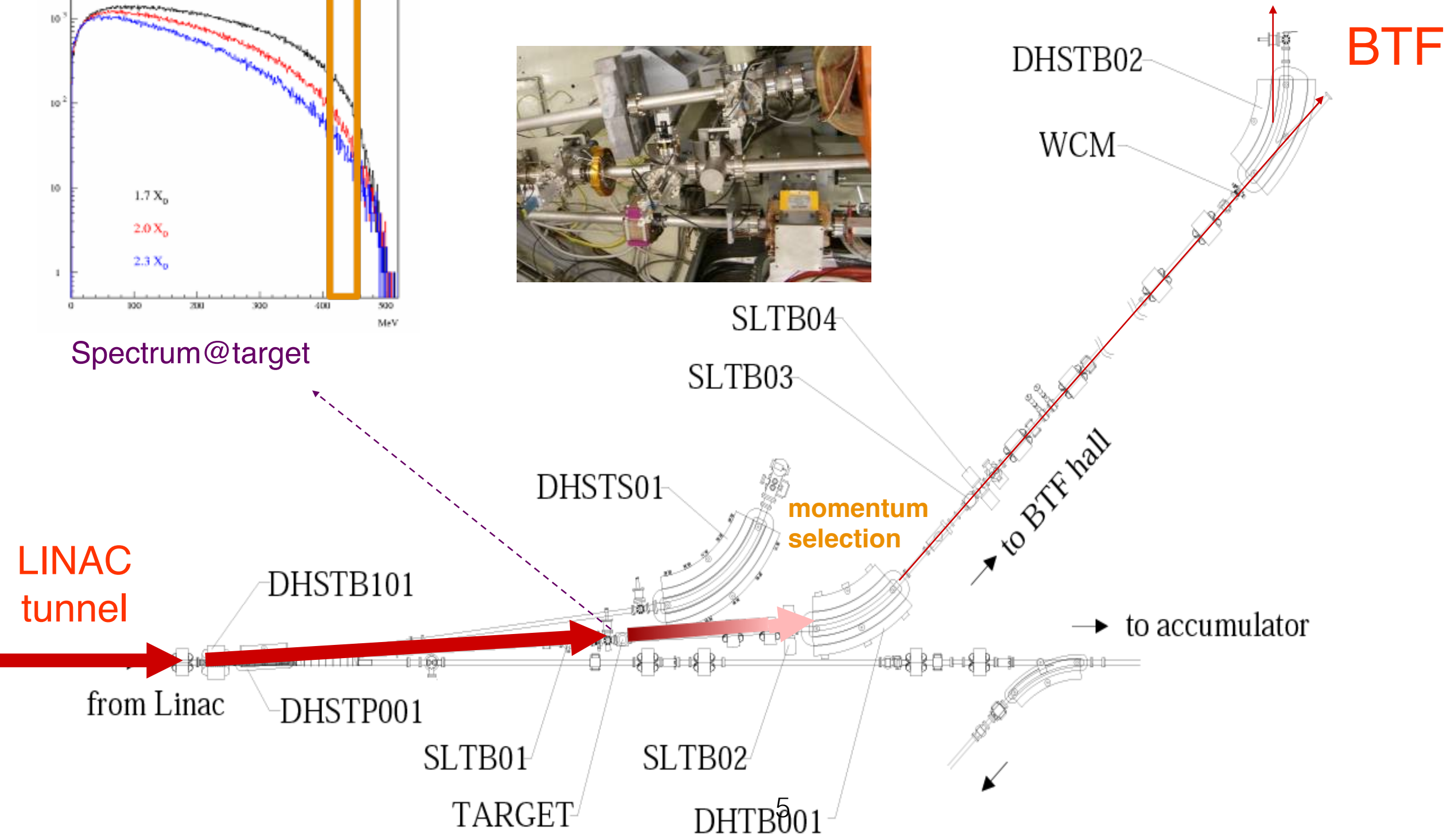
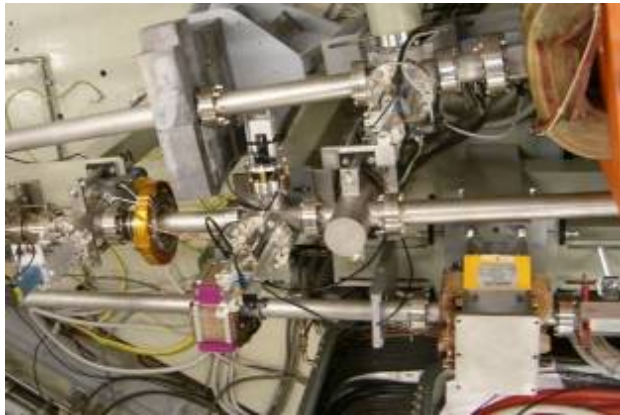
- Allows to tune the beam intensity
- Allows to tune the beam energy



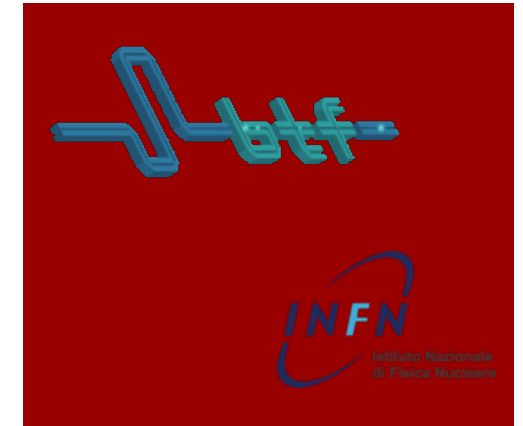
# BTF layout



Spectrum@target



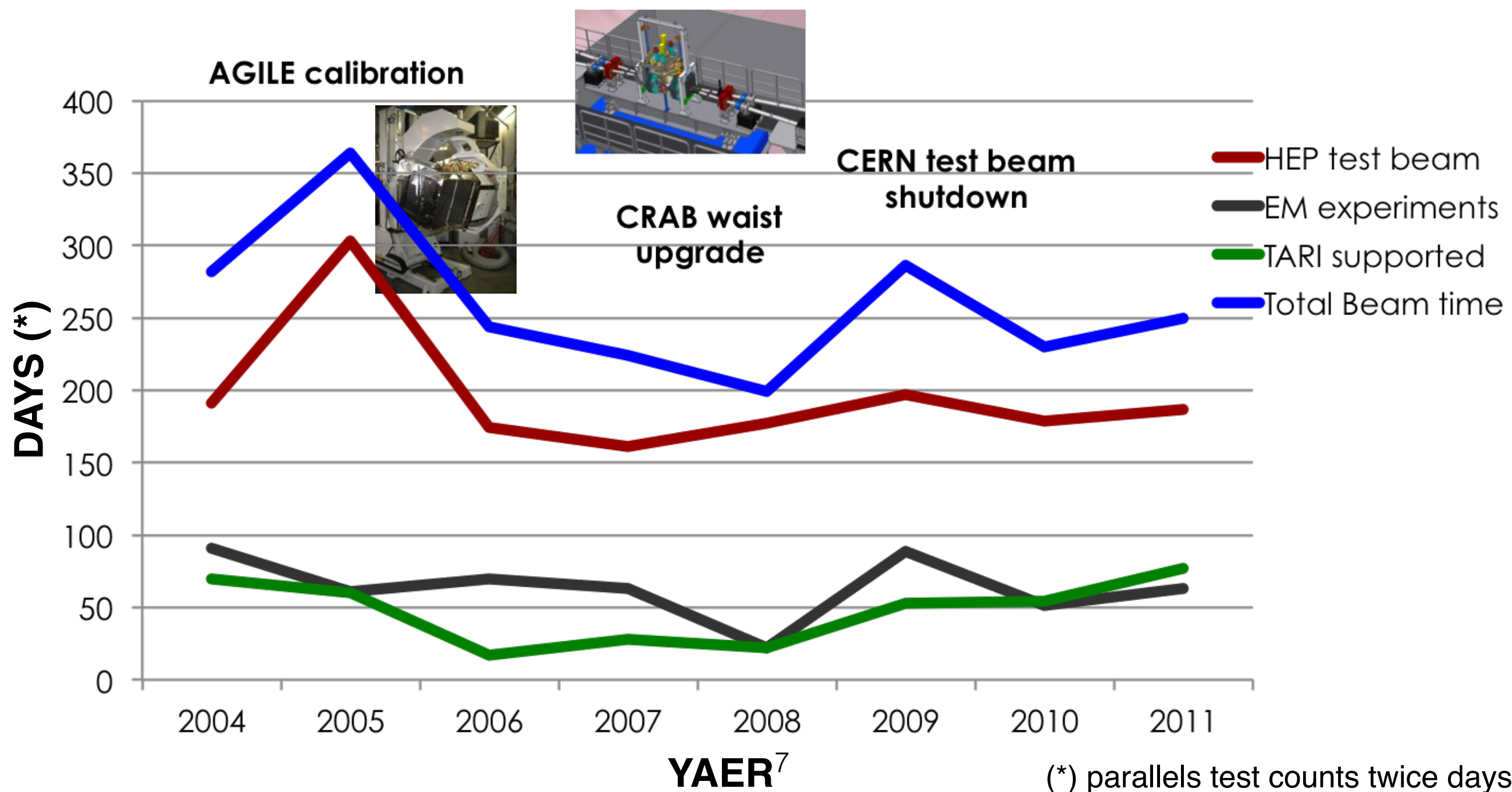
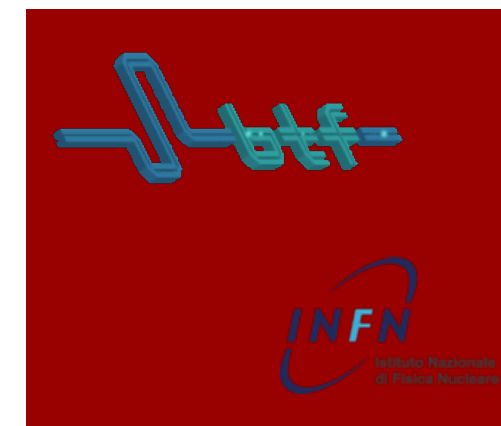
# Facility beam line summary parameters



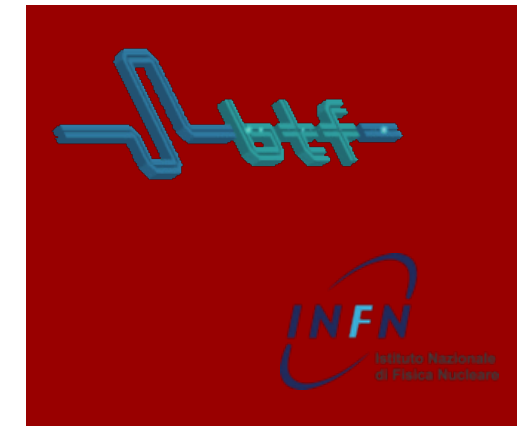
Operation mode	$e^+ / e^-$ beam	$\gamma$ beam	Neutrons beam
Energy range [MeV]	25-500 25-750(*)	100-500 100 -750 (*)	$10^{-9} \rightarrow 200$
Bunch Rate [Hz]	User triggered (*) 1 $\rightarrow$ 24 49 (*)		
Bunch length [nsec]	10 1 or 10 (*)		
Multiplicity [#/bunch]	1 $\rightarrow 10^5$ 1 $\rightarrow 10^{10}$ (*)		4 $10^5$ (@1.5m) n/s/cm <sup>2</sup>
Duty cycle [%]	~80% ~96% (*)		~40% ~96%(*)
Spot size ( $\sigma_x \cdot \sigma_y$ ) [mm]	~ 2x2 ~5.5x5.5	>20	N.D.
Divergence [mrad]	~ 1 – 1.7	>15	N.D
Energy spread	1.00%	7.00%	N.D.



# Beam Test Facility operations



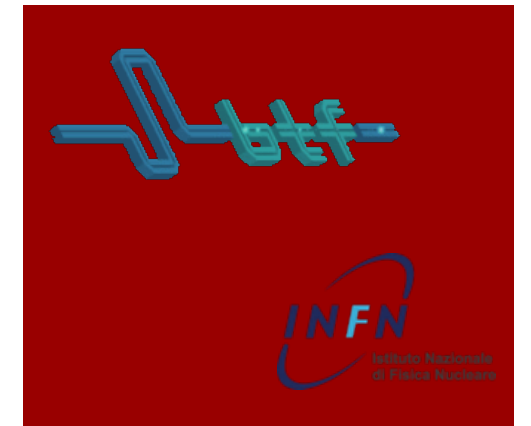
# Beam Test Facility @ Europe



The Facility is since 2004 part of the **Transnational Access to Research Infrastructures (TARI)** in the Integrating Activity of FP7 "Strongly Interacting Matter", **HadronPhysics2**

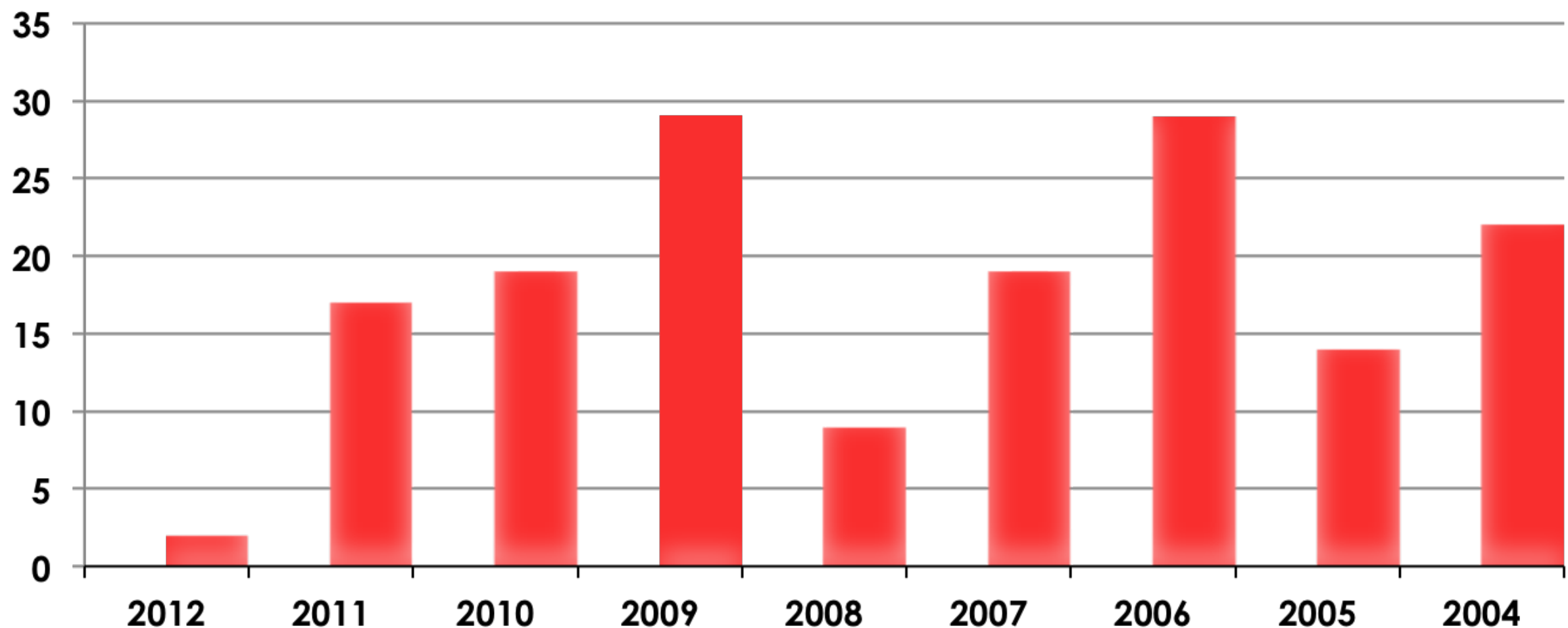
and of the **Advancing European detector development (AIDA)** for the Improvement and coordination of EU Test Beam lines



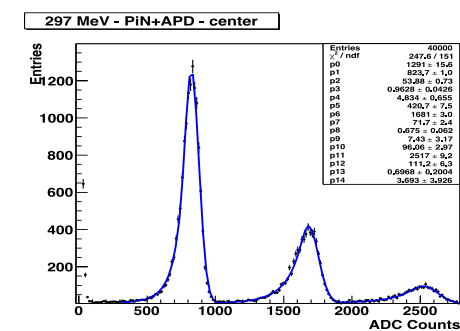
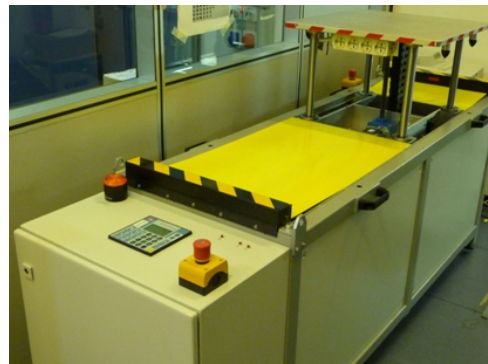
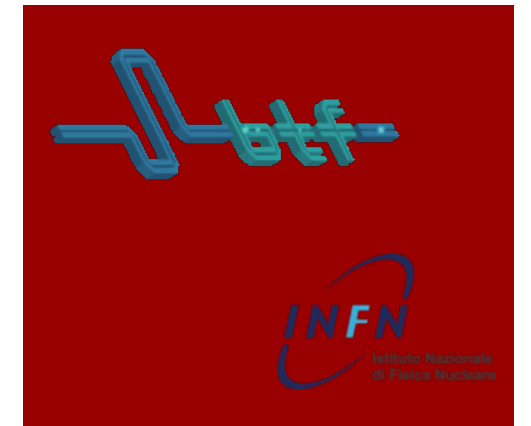


# Scientific productivity: citations

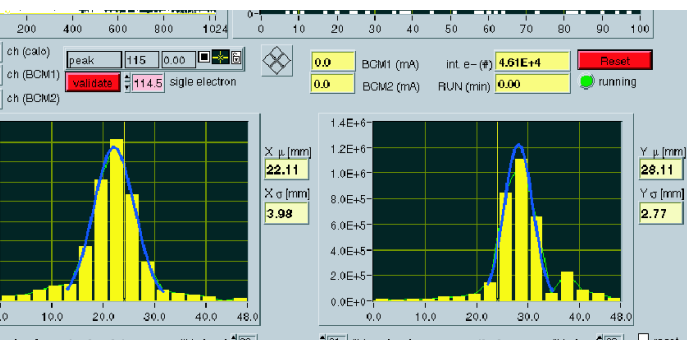
It's not easy to **track all publication**, many users do not cite the facility, someone cite in the wrong way. A simple search on *google scholar* of the keywords **BTF+INFN** show an average of **18 publications per years**.



# Conclusions @ KICK-OFF MEETING (February 2011)

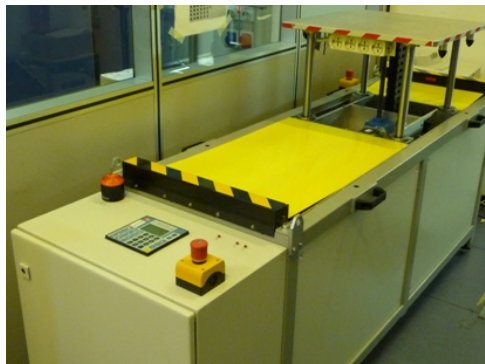
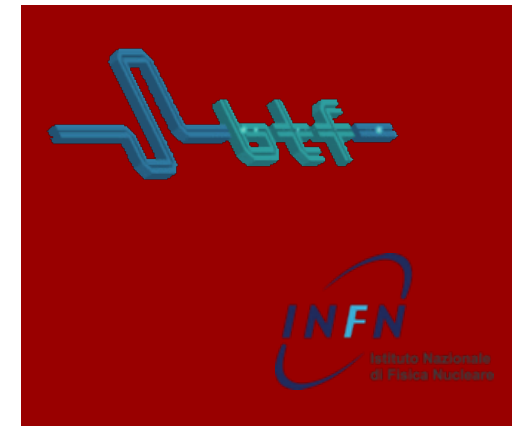


- design and put in operation a remotely controlled trolley for detector test
  - installation foreseen in march 2011**
- equip the BTF with a GEM chambers for monitoring with a resolution of about 100  $\mu\text{m}$ 
  - very good result obtained; high resolution device is under development**
- equip the BTF with LYSO calorimeter as monitor the beam energy
  - preliminary test done. More measurements, electronic tests, etc are foreseen in 2011**
- muti purpose DAQ system
  - continuously under implementation adding new board & drivers. Photon tagging & data tag and synchronization is in progress**

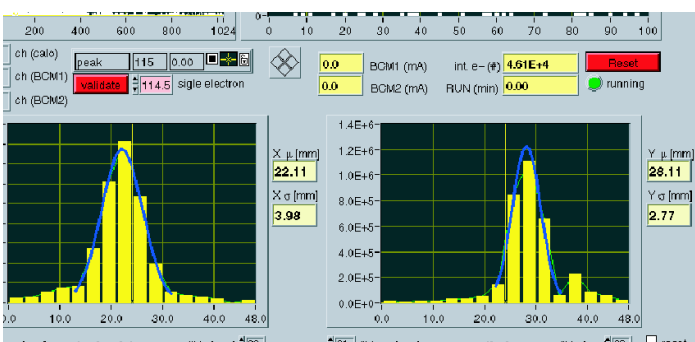
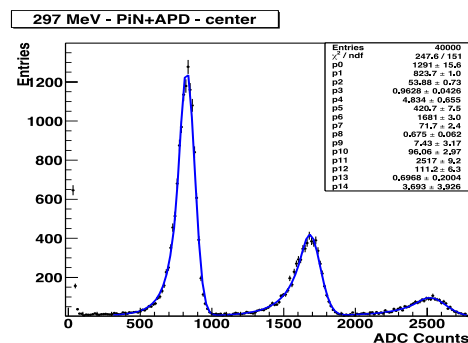




# Status @ 20 May 2011



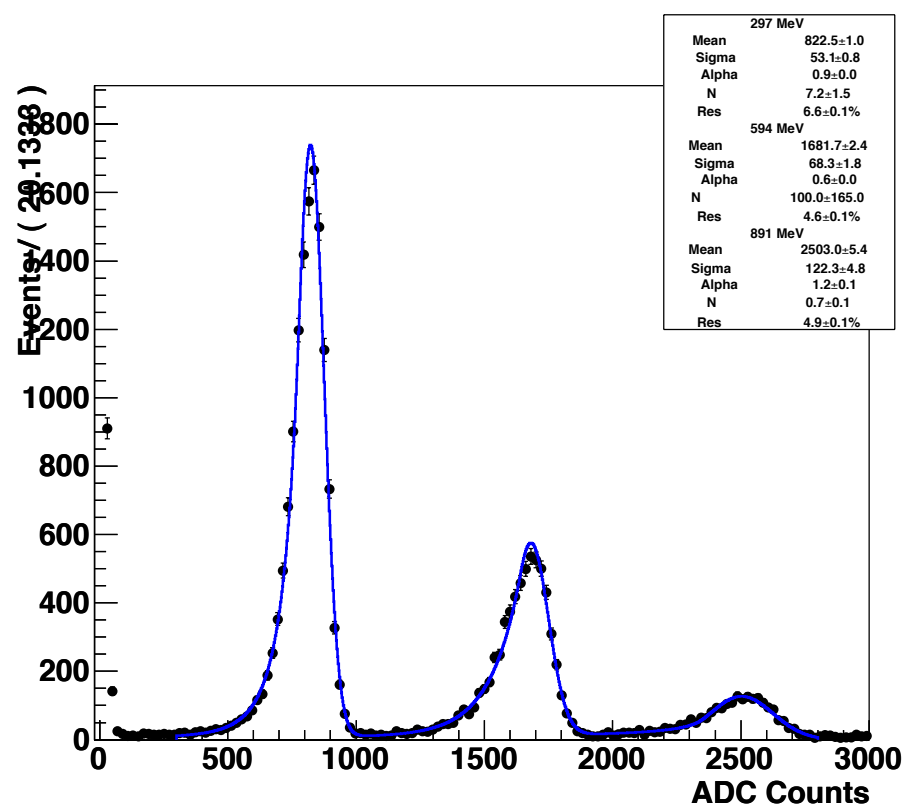
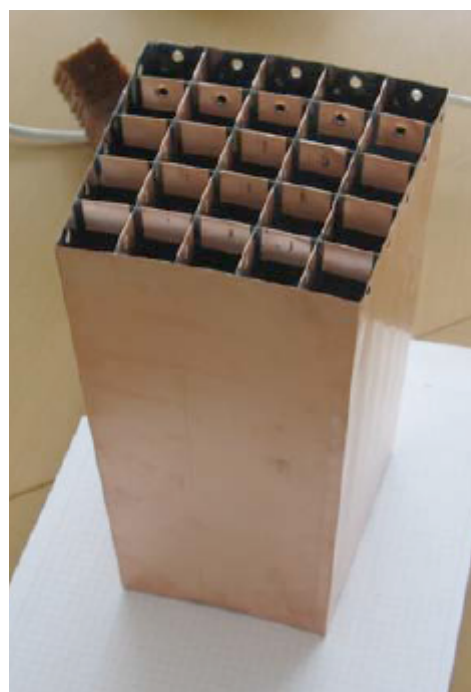
- design and put in operation a remotely controlled trolley for detector test
  - done**
- equip the BTF with a GEM chambers for monitoring with a resolution of about 100  $\mu\text{m}$ 
  - high resolution device is under development: neutron efficiency and rejection under test with new prototype**
- equip the BTF with LYSO calorimeter as monitor the beam energy
  - Second test done in May, further measurements foreseen in Sep.**
- multi purpose DAQ system
  - in progress: DAQ data ROOT interface complete and available for users.**



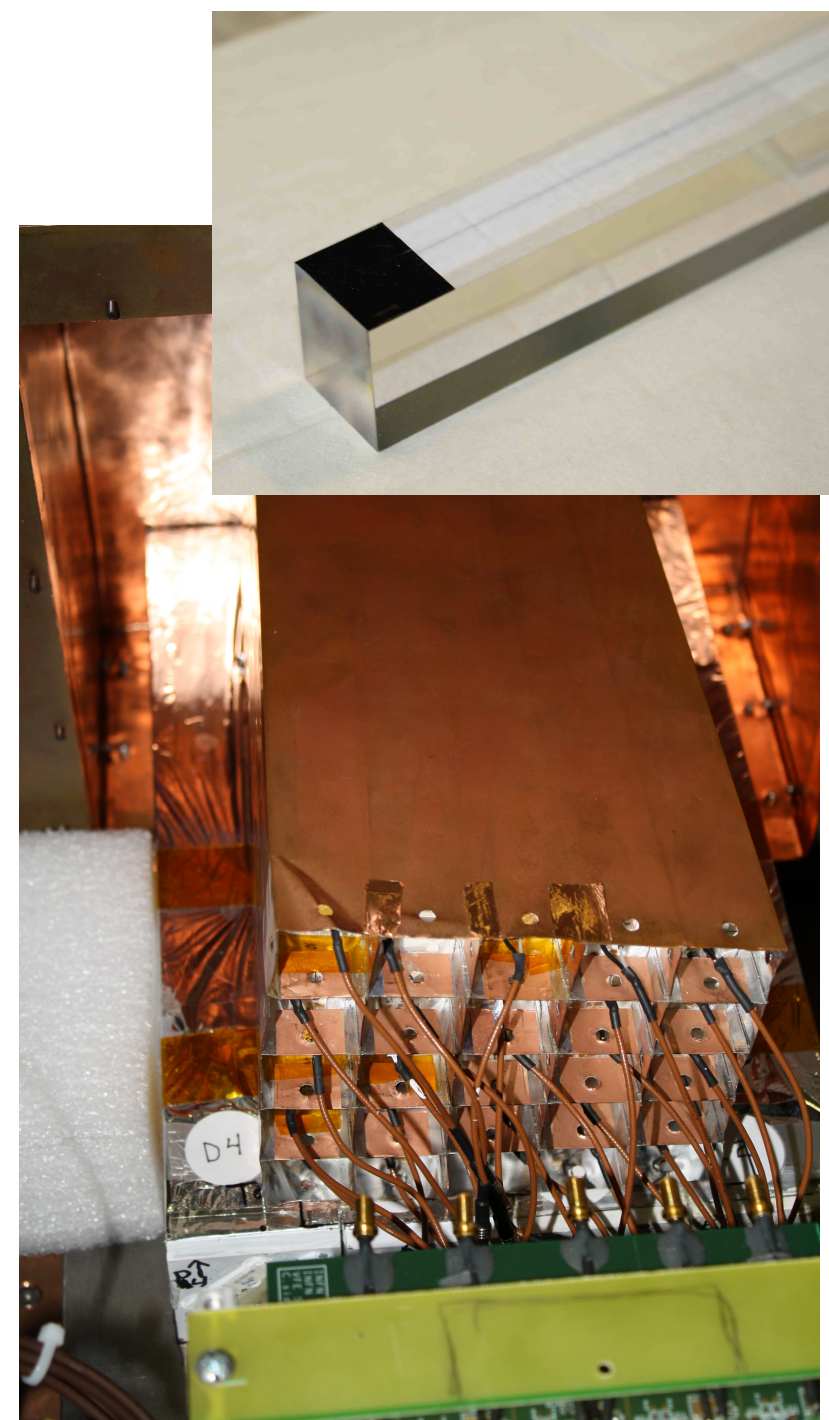
# LYSO calorimeter to study the dependence of the beam energy and resolution on the beam operating parameters

**Prototype mechanical structure has been designed and built**  
**Front-end electronics has been designed and developed**

**25 Crystals in the matrix tested at the BTF facility in 2011.**



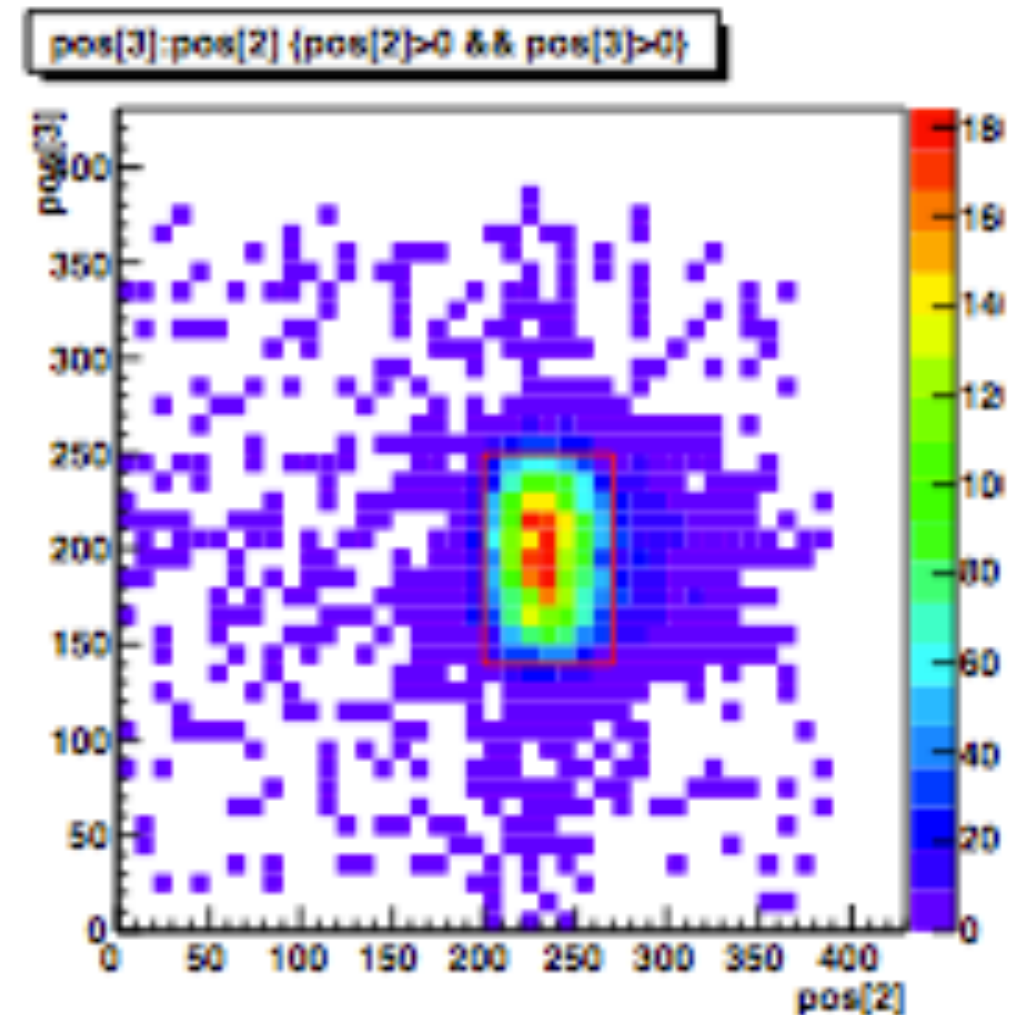
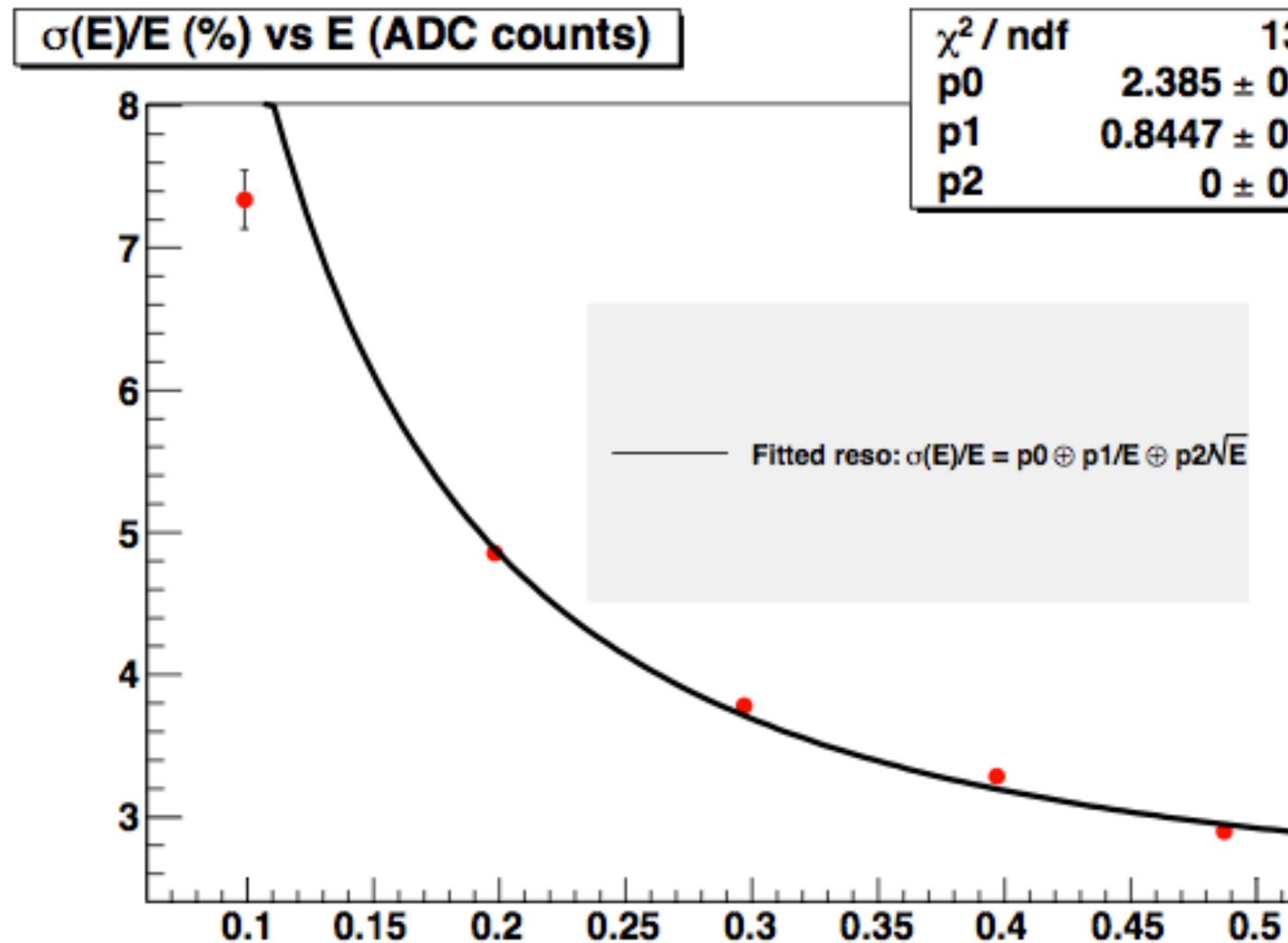
AIDA-WP8





# Energy resolution fit – Silicon Selection

## Silicon Selection Effects



- no selection : **3.0 +/- 0.02 %**
- loose selection : **2.9 +/- 0.03 % ; x = [200,270] , y = [140,250] 1.6x2.3 cm**
- tight selection : **2.7 +/- 0.02 %; x = [220,250] , y = [160,220] 0.7x1.4 cm**
- very tight selection : **2.6 +/- 0.003 %; x = [220,240] , y = [180,220] 0.5x0.9 cm**

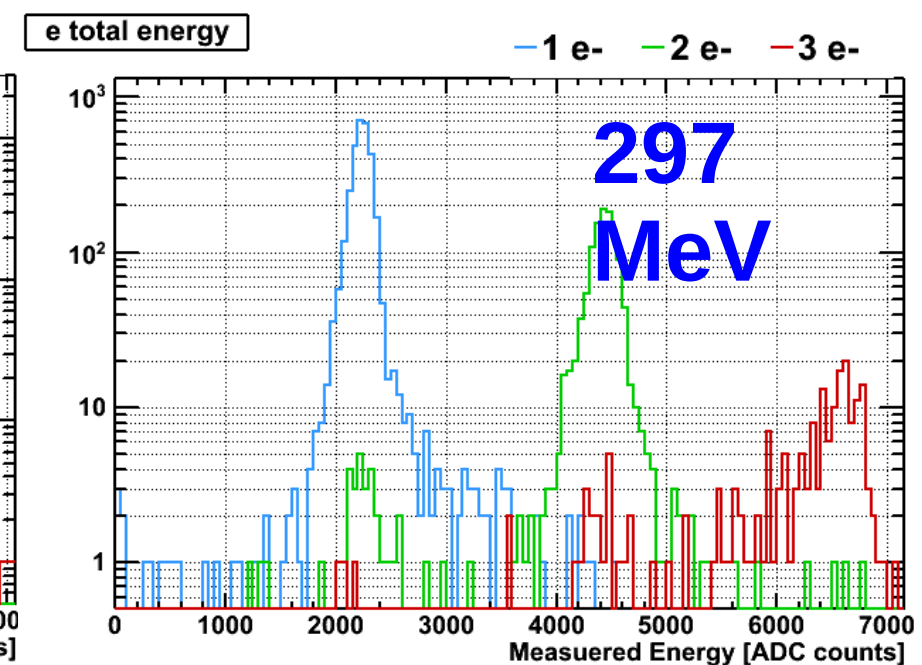
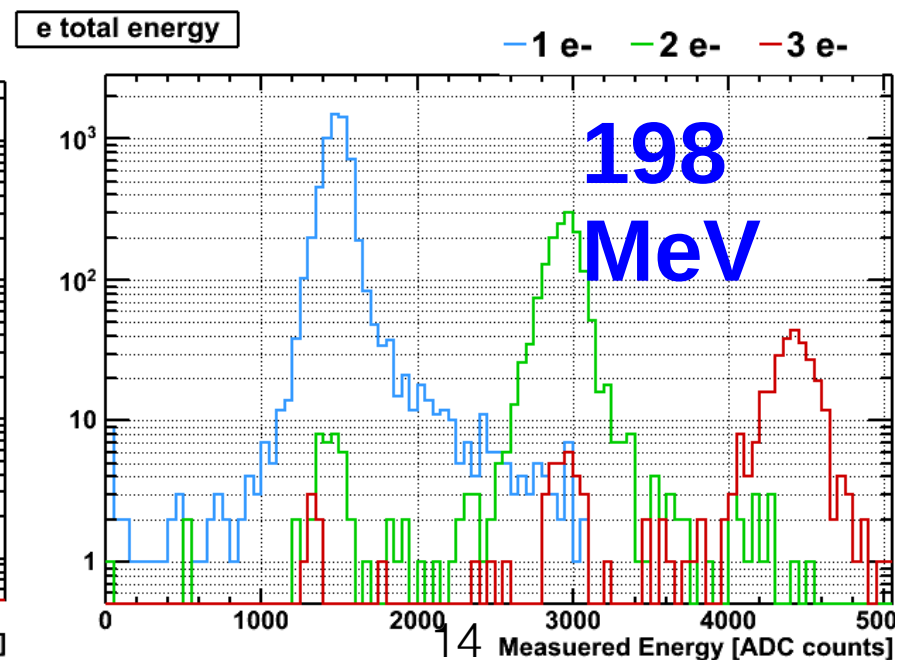
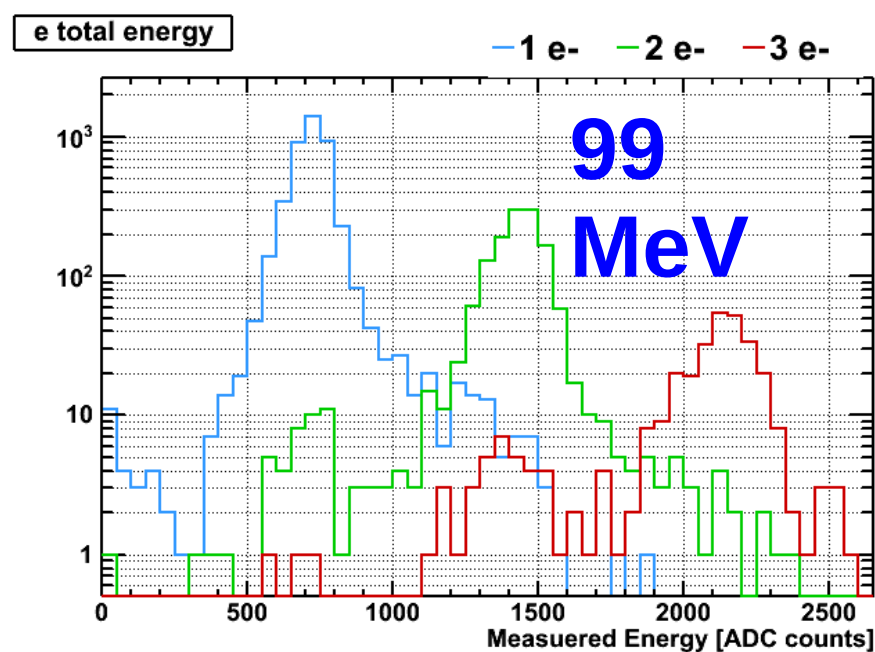
**Another Test Beam is ongoing this week with optimized LY uniformization (roughening of the crystal surface)**

AIDA-WP8

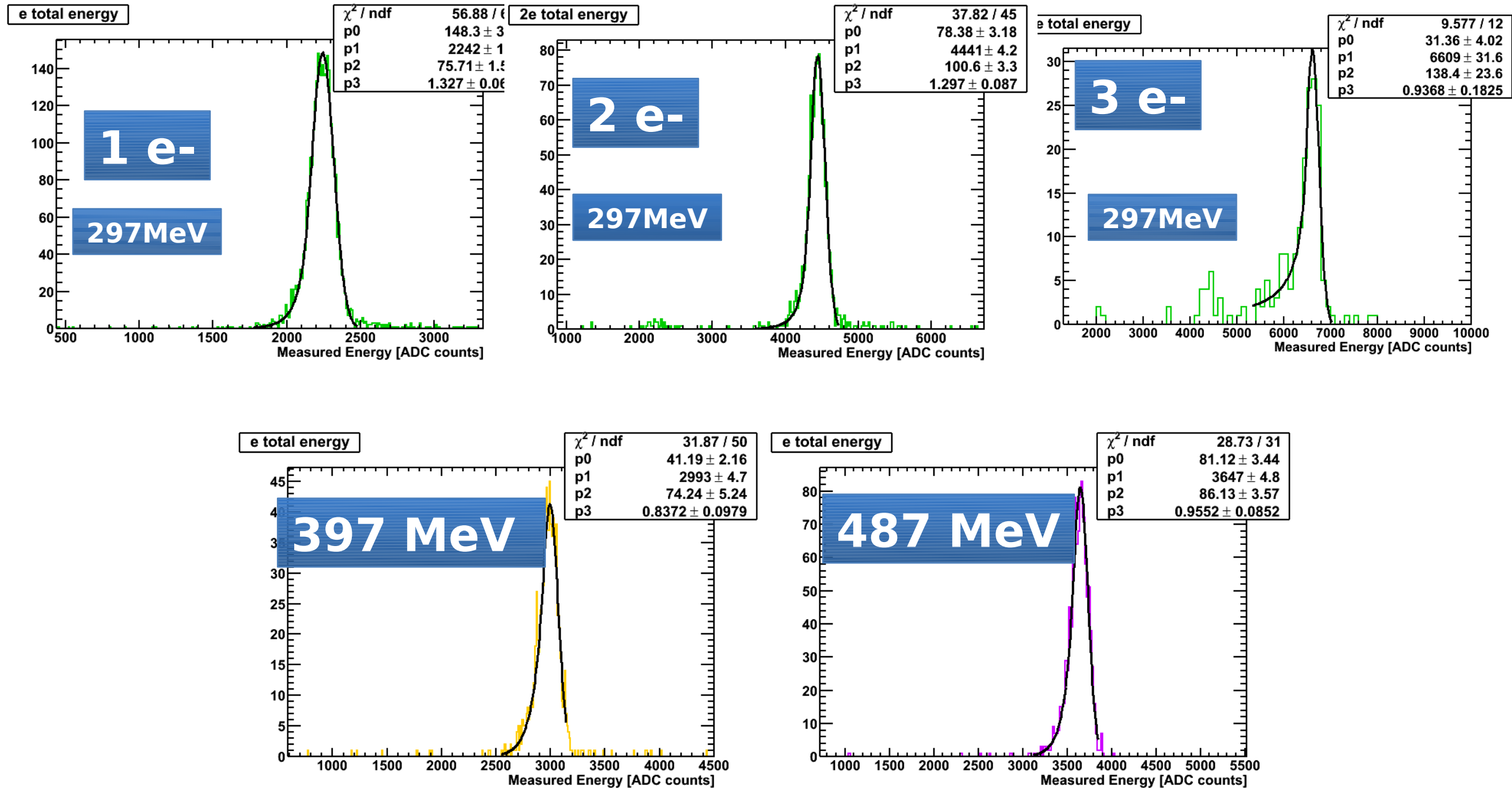
2

# LOW MULTIPLICITY ANALYSIS

$E_{\text{meas}}^{\text{Beam}}$	99	198	297	397	487	594	891
99	99x1	99x2	99x3				
198		198x1		198x2		198x3	
297			297x1			297x2	297x3
397				397x1			
487					487x1		

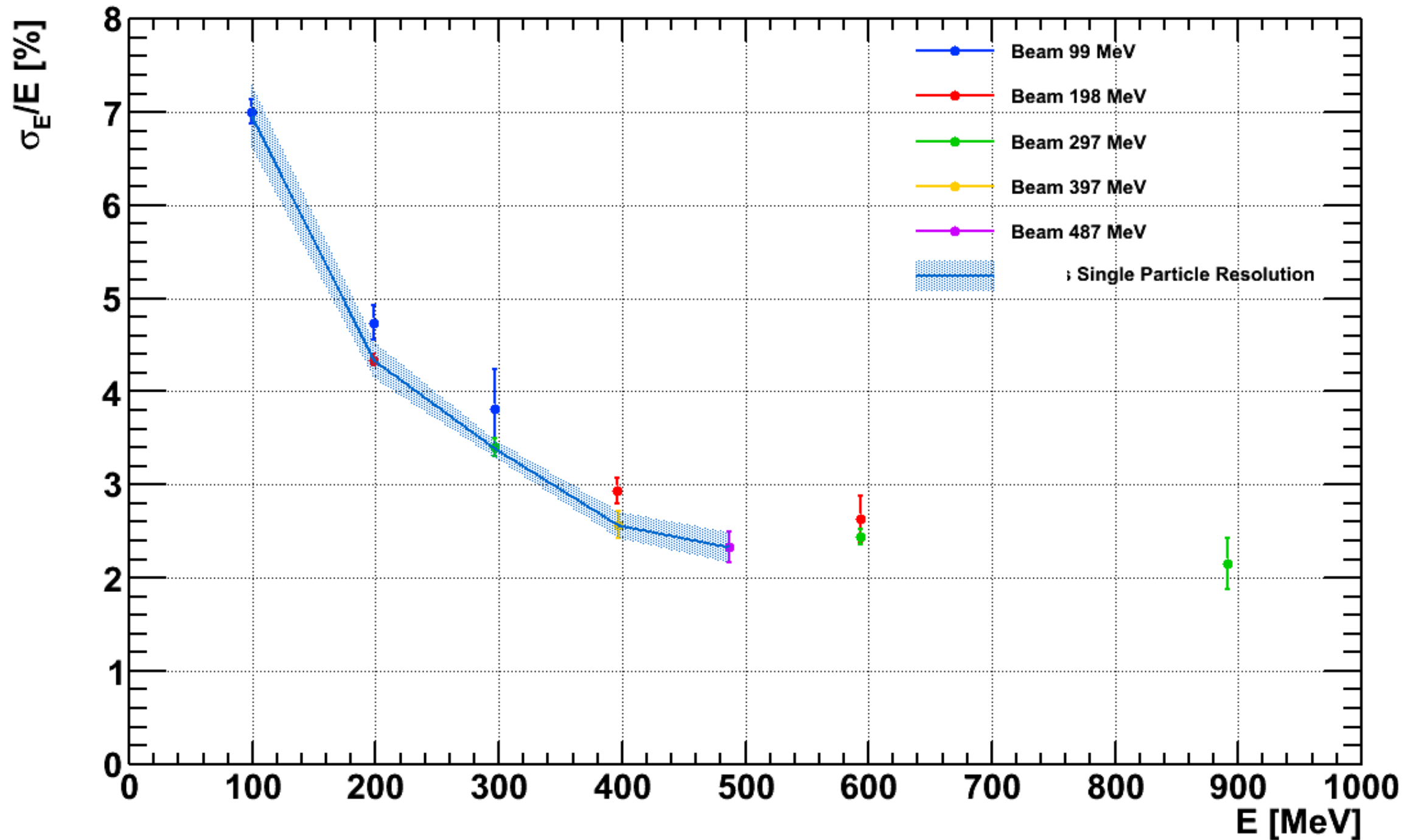


# TYPICAL ENERGY FIT

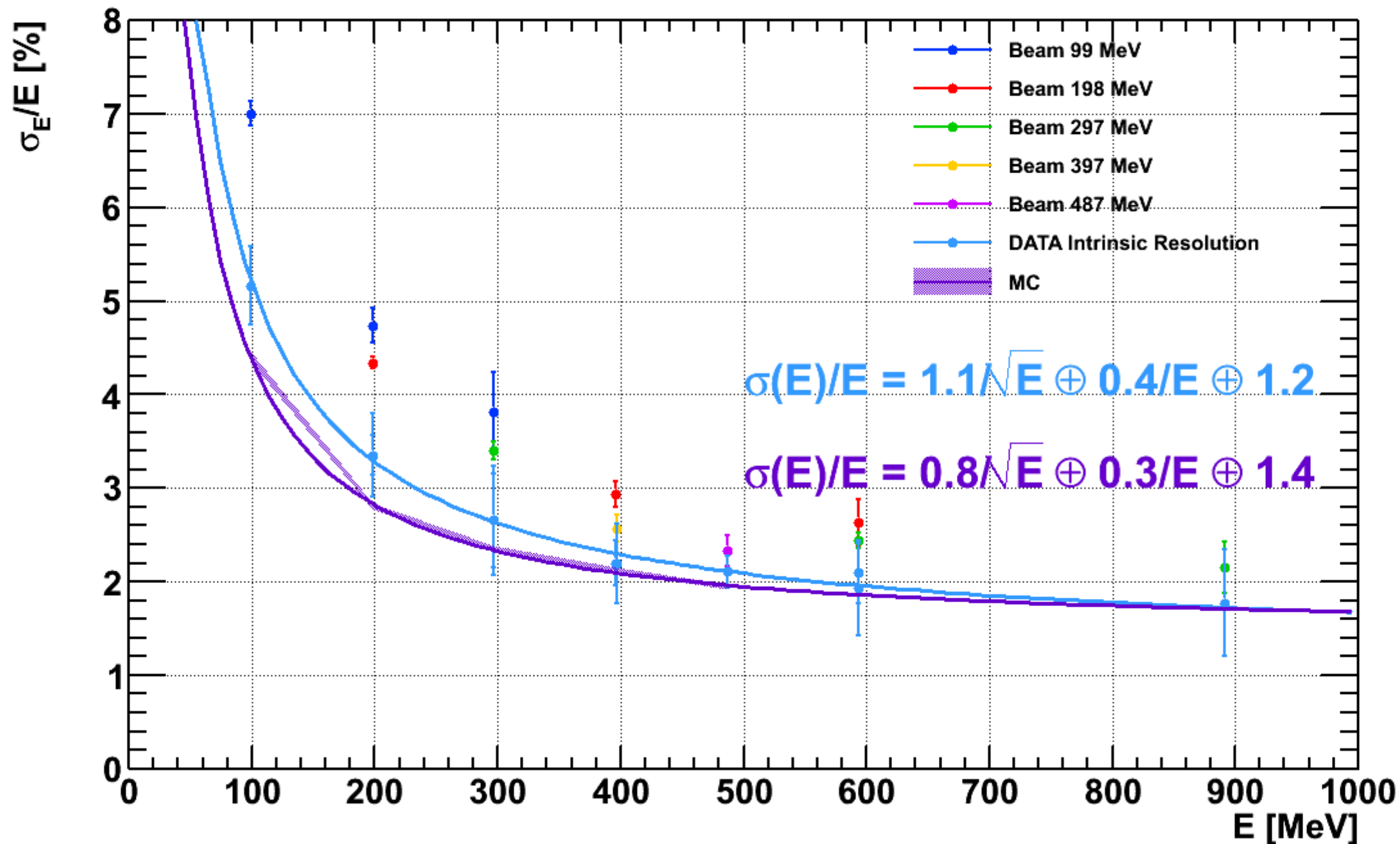




# Multi Particle Resolution vs Energy

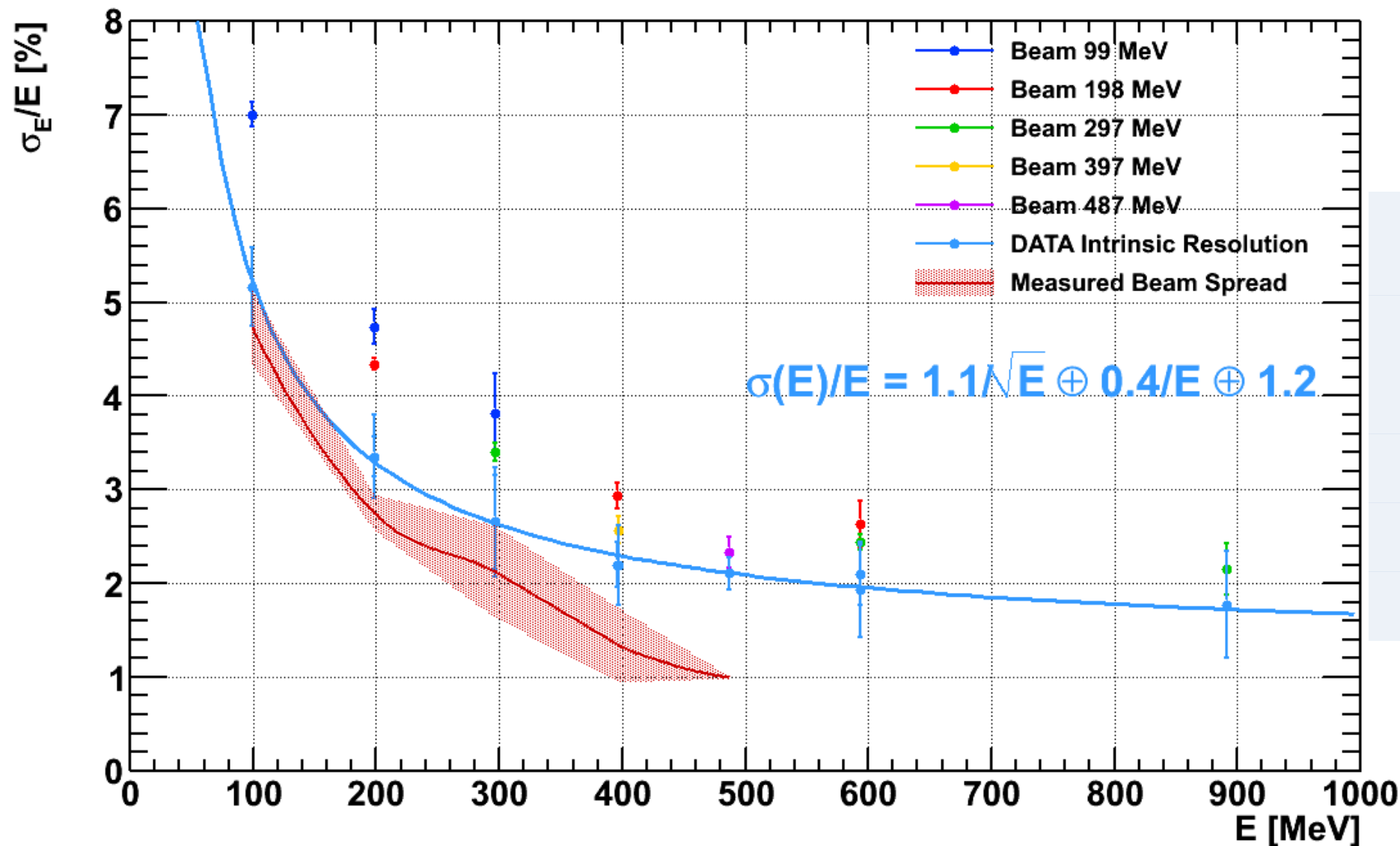


# Exp. Data vs MC comparison



- Subtracted DATA-MC agreement within errors, MC resolution is systematically better than DATA
- MC with proper beam spread under production

# Btf Beam Energy Spread



Energy [MeV]	Spread [%]
99	4.7
198	2.8
297	2.1
397	1.3
487	1.0

But this method needs further measurement to be validate:

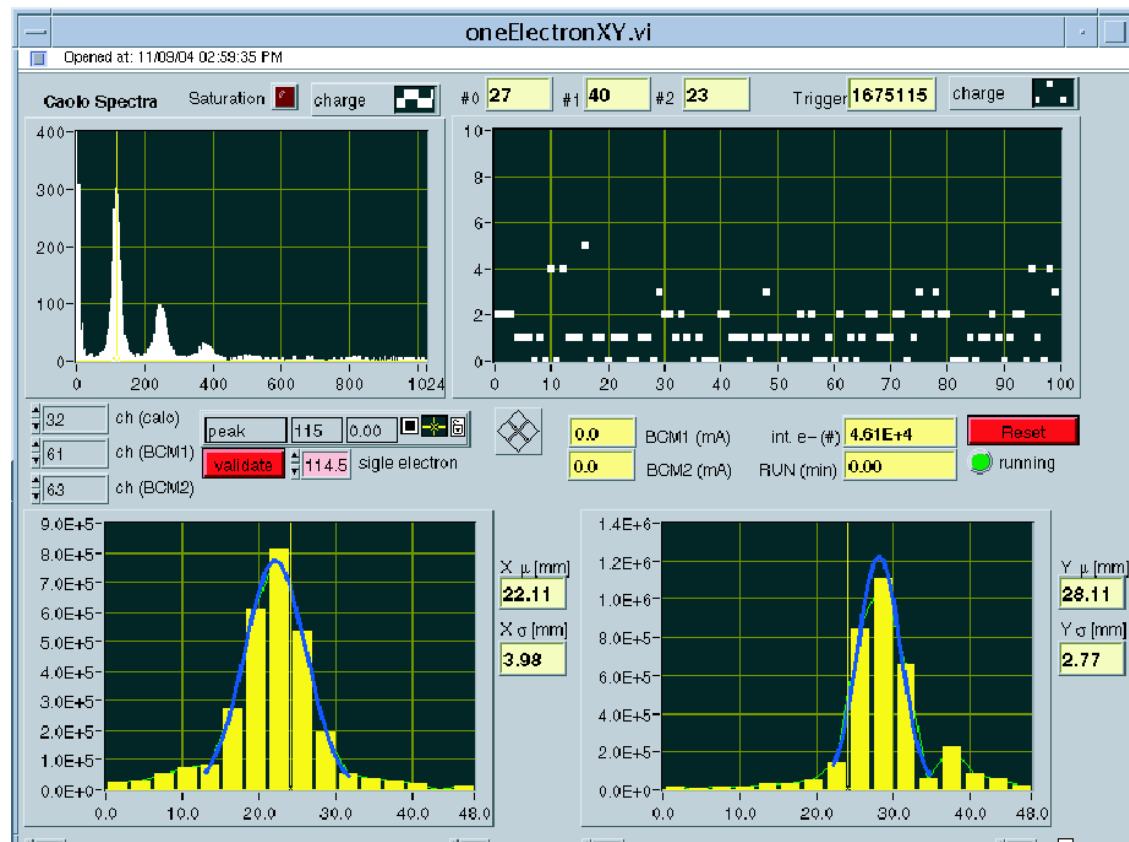
- energy loss due to beam divergence - calorimeter/cells border effects
- energy loss in the Silicon Tracker
- statistics



# LYSO calorimeter

- During 2011/2012 the measure of energy beam quality has been setup and we **understand** how to proceed
- A **cross calibration** of the calorimeter is foreseen for October 2012 at the Mainz photon beam.
- In the mean time the UIB is setting up a **crystal calorimeter** in order to measure the component in 100keV range
- A **simulation** of the full calorimeter matrix is in progress. Is expected to be completed in 2013
- In the second half of 2013 the final measurements is expected to complete the milestone.

# DAQ & full simulation



The BTF DAQ is developed in labVIEW and partially integrated in DAFNE control system

The purpose of the task is to **integrate** all the **device** available for users, beam **diagnostics** and DAFNE **controls** in a common DAQ system able to **acquire** most of the users equipment and/or **share** machine data for experiments

A full **simulation**, **optics** layout etc, are continuously upgrading in order to take in to account the beam line development

# DAQ and software development

- GEAN4/GEANT4 BEAM LINE of the full BTF extraction line.
- Development and optimization of the DAQ for:
  - GEM tracker
  - Neutrons detectors
  - Silicon tracking chamber (photon tagging)
- Refurbishing of the BTF DAQ System in !CHAOS framework

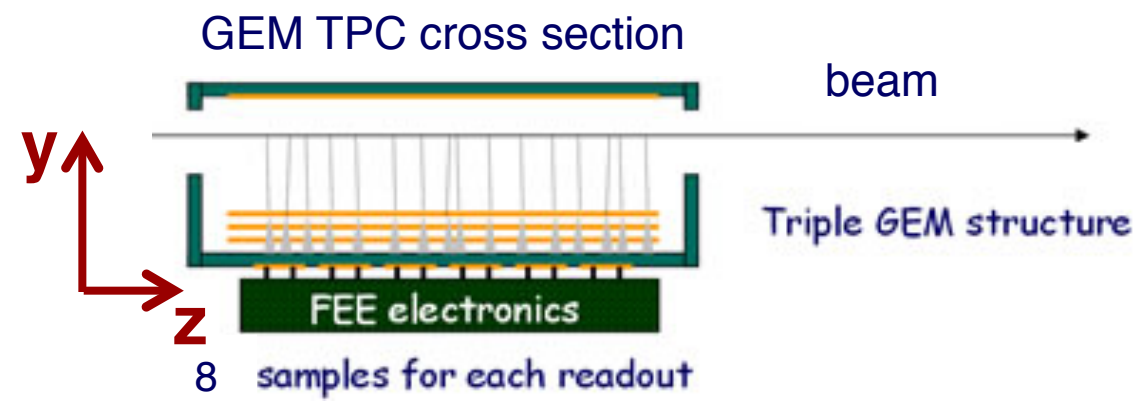


# !CHAOS

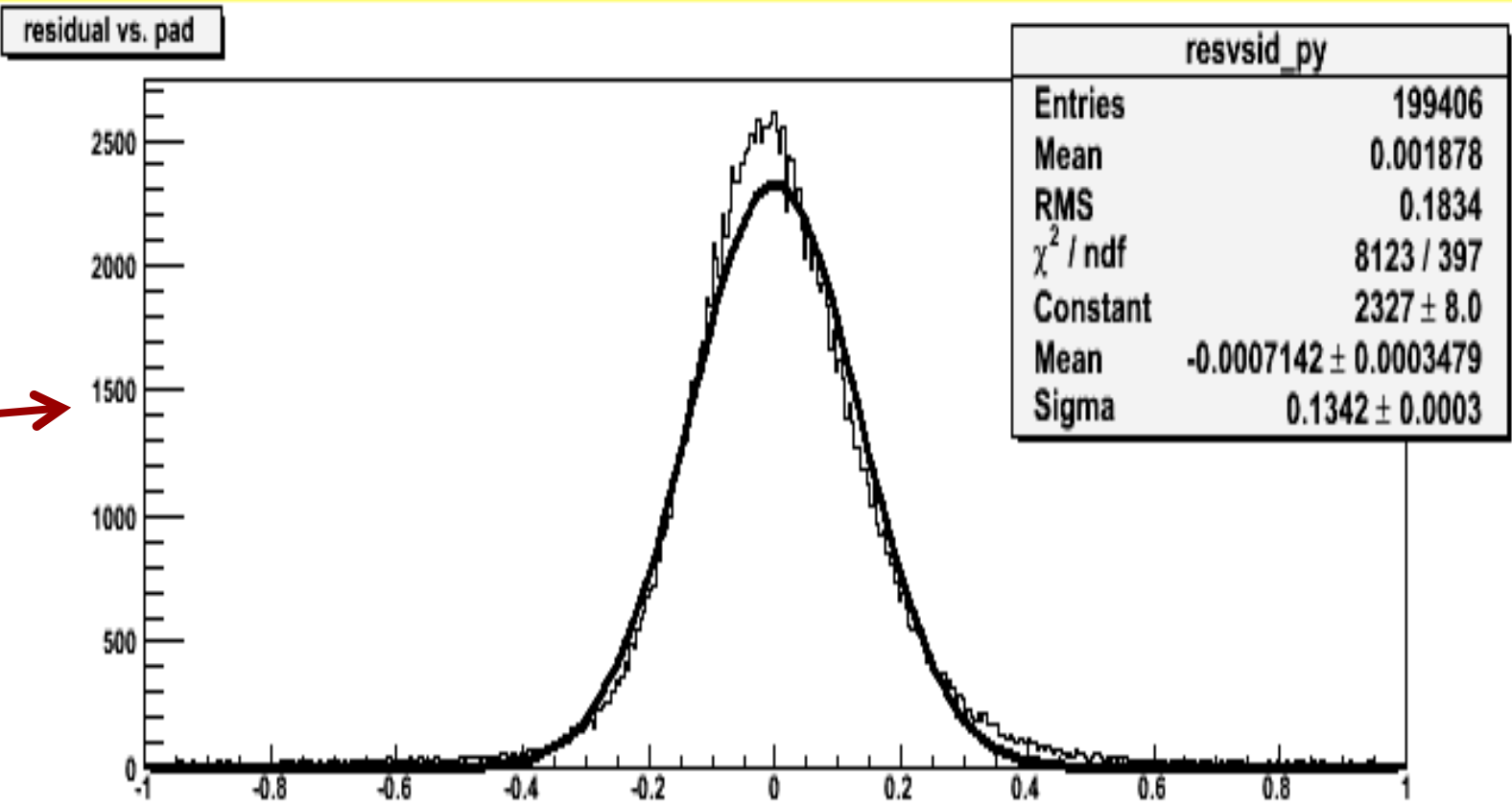
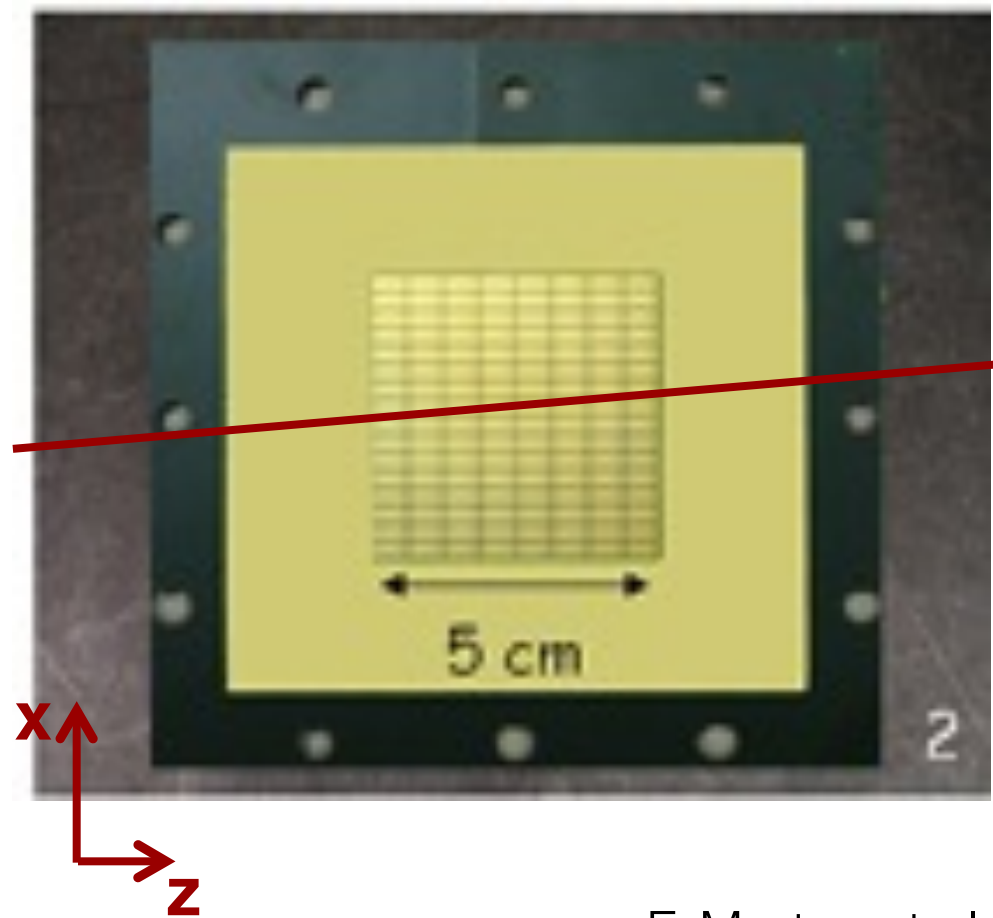
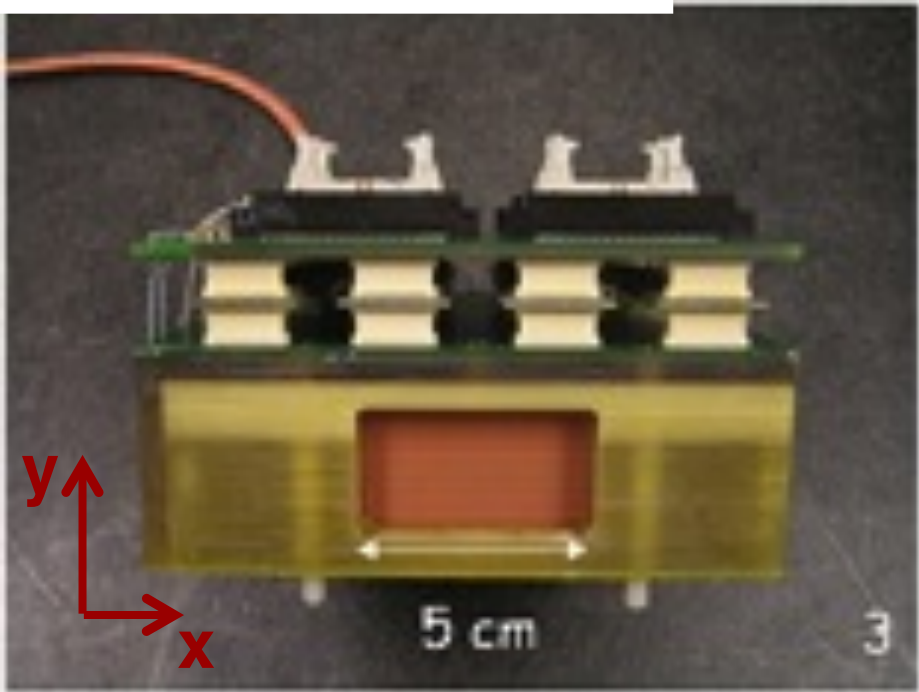
## ***a new SidC topology with the following futures:***

- **redundancy** of all its parts; intrinsic **scalability**; **no point of failure**; hardware (device to be controlled) **hot-integration** and **auto configuration**
- integration in the SidC structure (library) of **triggered DAQ** operation mode
- based on a **distributed object caching** for real-time data access (Live Database)
- based on **no relational** database-oriented archiving data (History Database)
- abstraction of the structural components of the control to **reduce dependence on the particular HW and SW**, allowing for an extreme adaptability
- compatibility with **commercial standard** and custom components and any **future developments**

# GEM-TPC Tracker



GEM TPC prototype



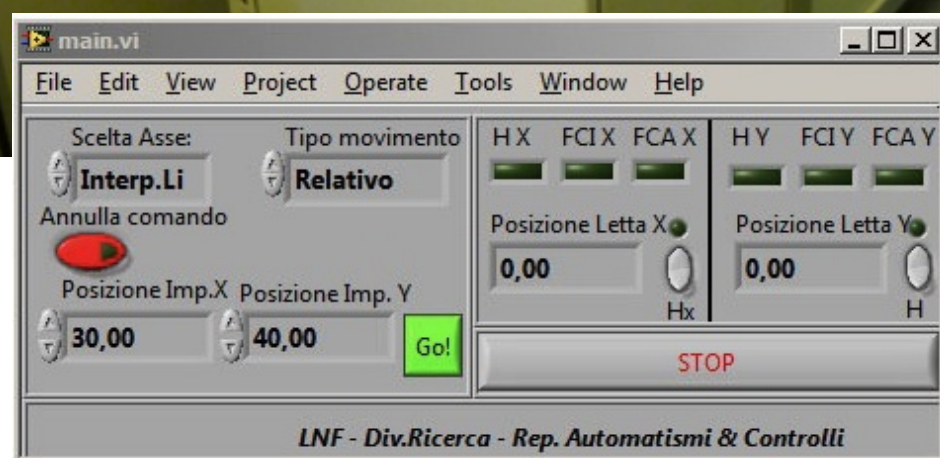
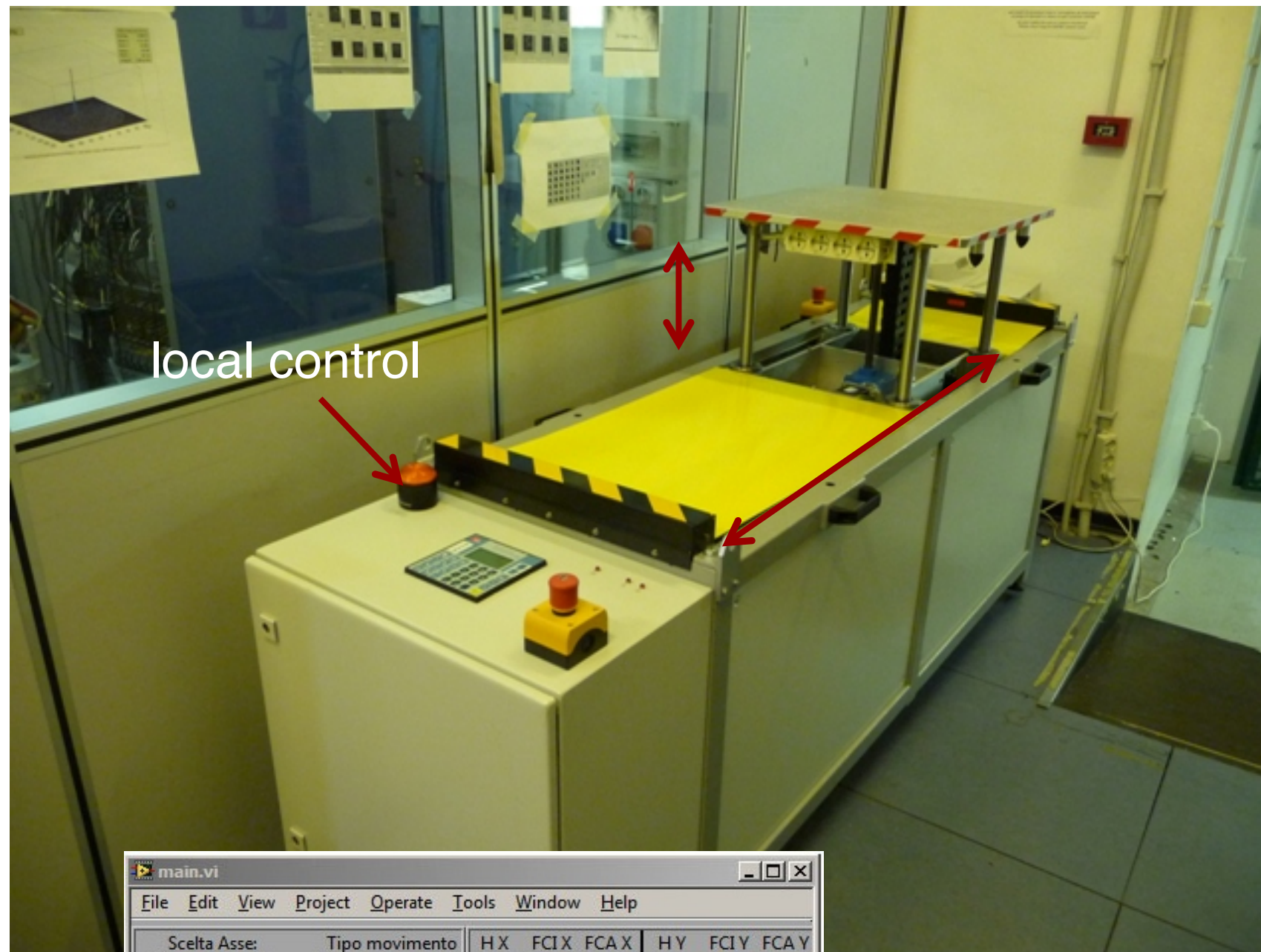
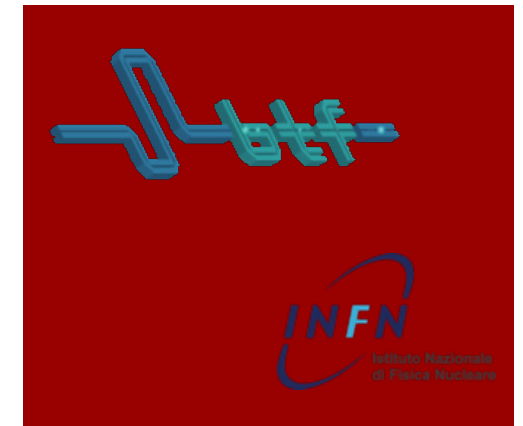
Y resolution  $\sim 50 \mu\text{m}$  (limited by drift time)  
X resolution  $\sim 1 \text{ mm}$  (limited by pad pitch)

# Activity report for a TPC GEM tracker

- A prototype for a 3D track system has been developed in Frascati Laboratory. It consists of a **compact TPC with 4 cm drift**, and a **triple GEM** structure as readout system.
- The tracker system has been tested at BTF in various condition of particles multiplicity, from single up to thousand electrons per bunch, and at CNAO with continuous **proton** beams. A resolution of **80 microns** for a single particle has been **checked correlating data of a medipix** telescope.
- A test beam has been done on November at CERN using a **Lead Ion beam**.
- Final system of TPC GEM **readout** with a data acquisition card based on FPGA and powered with the **HVGEM** module will be ready in April. The test of two profile chamber prototypes is **foreseen for the end** of the 2012



# Remote trolley



LNF-DR - Reparto Automatismi e Controlli:  
Ubaldo Denni, M. Antonietta Frani,  
Giuseppe Papalino



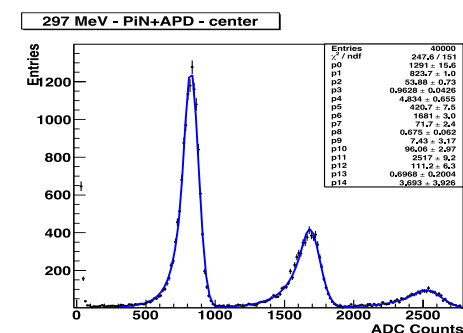
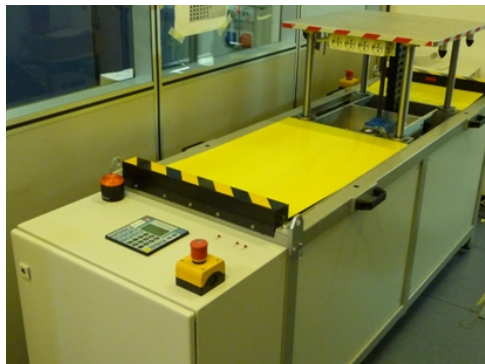
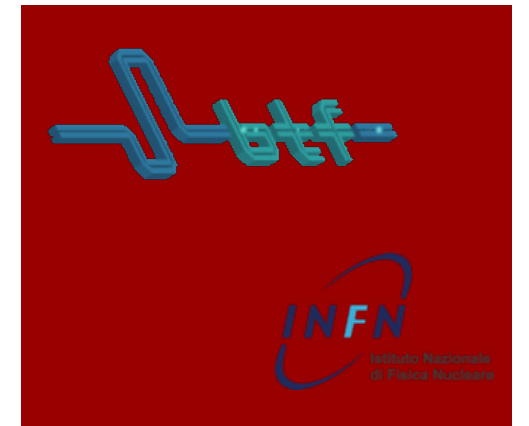
# Remote trolley

Trolley parameters	
disposable area	600x600 mm
min height	915 mm
max height	1250 mm
horiz. excursion	1000 mm
max load	200 Kg
accuracy	< 1 mm2



KLOE inner tracker (GEM foil cylindric)  
test beam on the BTF remote controlled  
trolley

# Task 8.2.2 milestone status @ 28 Mar 2012



- remote trolley
  - **done**
- equip the BTF with a **GEM** chambers for monitoring with a resolution of about 100  $\mu\text{m}$ 
  - **in progress:** HVGEM module will be ready in April. The test of two profile chamber prototypes is foreseen for the end of the 2012
- equip the BTF with **LYSO** calorimeter as monitor the beam energy
  - **in progress:** new measurement started on the 25/3. A cross calibration of LYSO is foreseen at Mainz in October.
- multi purpose **DAQ** system
  - **in progress:** we are working on the integration on new diagnostics and the porting under !CHAOS freimwork