WP8.2.2 Test beams infrastructure at Frascati

on behalf of INFN-LNF, INFN-Perugia, INFN-Ferrara and UiB BTF-AIDA team

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- Overview
- Status
- Summary

color code: ✓done; ✓ in progress; ✓seriously delayed; ✓on schedule

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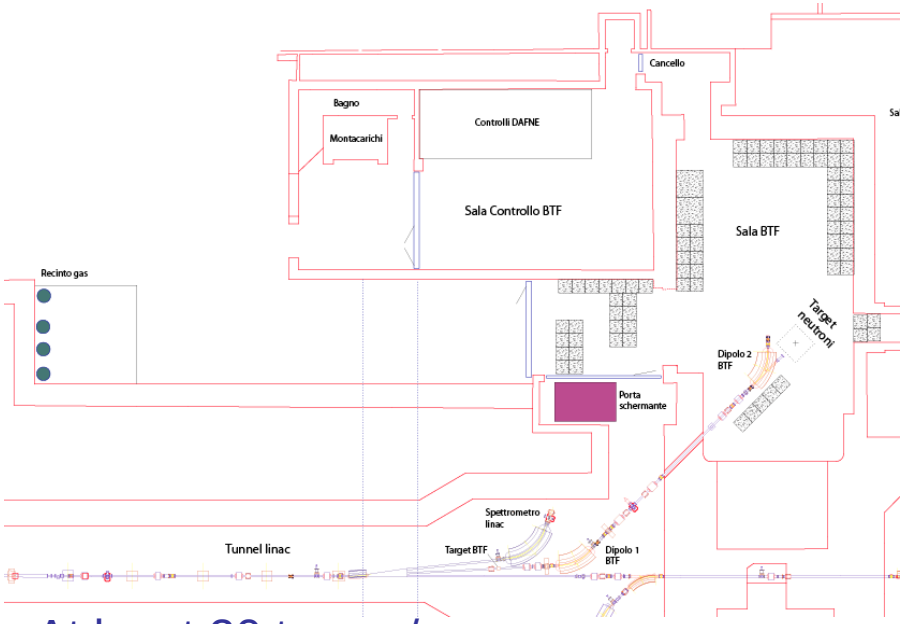
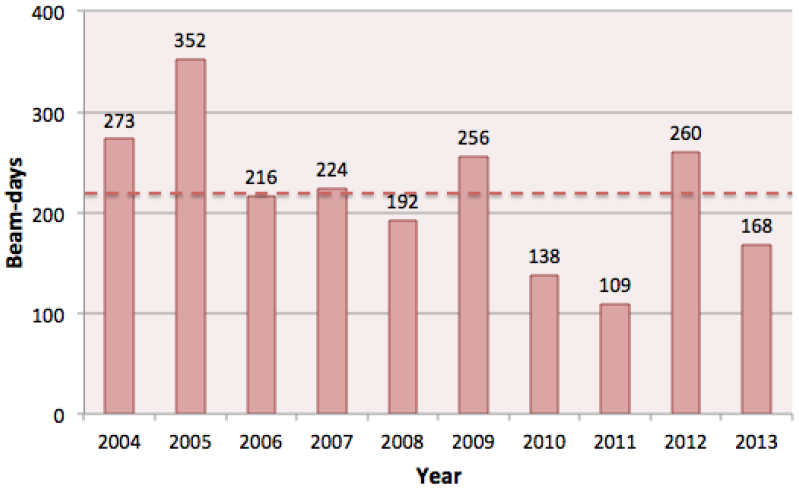
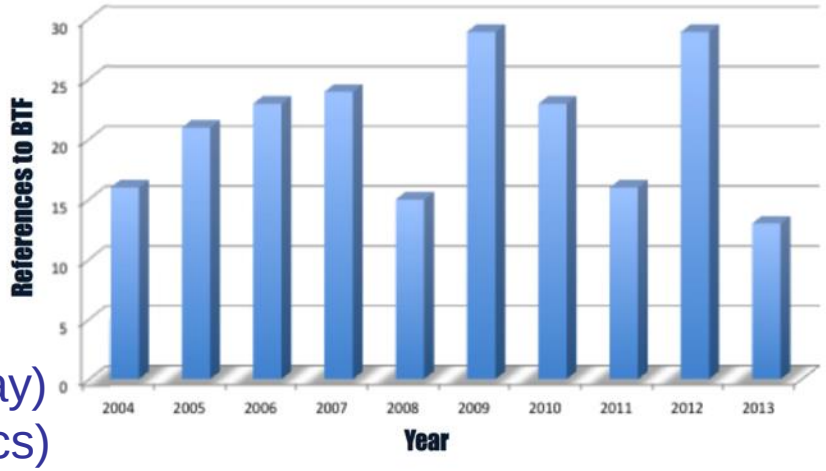
Frascati Facility (BTF)







- At least 20 teams/year
- Average of 8 days/team
- Average of 220 beam-days/year
- 30% of foreigner users

- Typically, two calls/year (November and May)
- TNA funding in FP6 and FP7 (HadronPhysics) average funding: 150 man-days and 15-20 travels/year
- About 40% of beam requests rejection in 2013

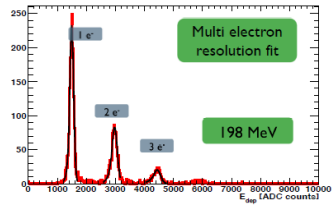
BTF users

- **Test of detectors or beam diagnostics**
  - Any kind of detector: calorimeter,s scintillators, fibers, drift chambers, micro-pattern gas detectors (GEM, MSGC), RPC, diamond, silicon pixels, silicon micro-strips, fluorescence detectors, Cerenkov, RICH, …
  - HEP, nuclear and astro-particle communities mainly
    - 25% large or very large collaborations, e.g. sub-detector groups from ATLAS, CMS, ALICE, LHCb, …
    - > 50% from intermediate-size collaborations, e.g. NA62, KLOE, MEG, UA9, AGILE, Auger, JLAB, …
    - Remaining fraction smaller groups for detector/readout/diagnostics dedicated R&D programs
- **Real experiments using the electron or positron beam**
  - Thermo-acoustic expansion of materials due to ionizing particles (RAP)
  - Absolute air and Nitrogen fluorescence yield (AIRFLY)
  - Microwave emission from e.m. showers (AMY)
  - Electron and positron channeling, parametric radiation

Task 8.2.2- Frascati

- Upgrade of the Beam Test Facility:
  - equip the BTF with a **remote trolley**
  - equip the BTF with a **GEM** tracking chambers (res<100 μm)
  - use the **LYSO** calorimeter to measure the beam energy spread
  - improve multi purpose **DAQ**

Operation mode	e^+ / e^- beam	γ beam	Neutrons beam
Energy range [MeV]	25-500 25-750(*)	100-500 100 -750 (*)	10^{-9} → 200
Bunch Rate [Hz]	User triggered (*) 1 → 24 49 (*)		
Bunch length [nsec]	10 3 or 10 (*)		
Multiplicity [#/bunch]	1 → 10^5 1 → 10^{10} (*)		4*10^5 (@1.5m) [n/cm²/sec]
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.



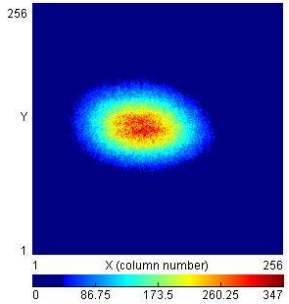
The Frascati **Beam Test Facility** infrastructure is a beam extraction line optimized to produce **electrons, positrons, photons and neutrons** mainly for HEP detector **calibration** purpose. The quality of the beam, energy and intensity is also of interest for **experiments** (~ 20% of the users)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

Remote Trolley & DAQ

disposable area	600x600 mm
min height	915 mm
max height	1250 mm
horiz. excursion	1000 mm
max load	200 Kg
accuracy	< 1 mm^2

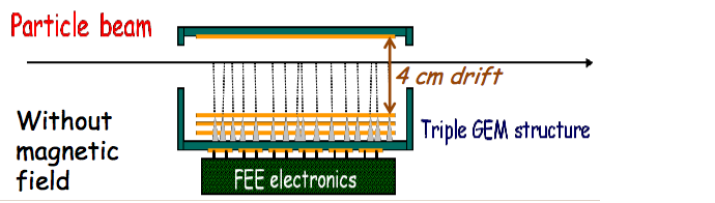
AIDA-NOTE-2012-003

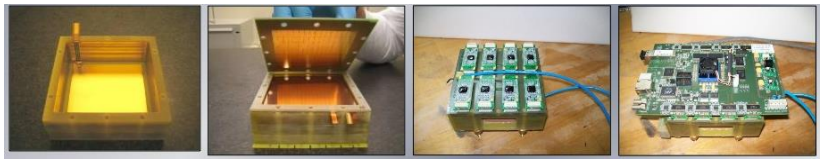
- ✓ Up to now, the DAQ system is fully operative with a standalone software now working at 25Hz bunch rate in !CHAOS MEMCACHED live data storage
- ✓ A MEDIPIX detector (Timepix) has been tested to increase transverse beam detection quality and qualify the BTF calorimeters over a wide range of multiplicity.
- ✓ Preliminary study for the porting of the BTF DAQ and the main subsystem of the BTF device in !CHAOS environments has been started.

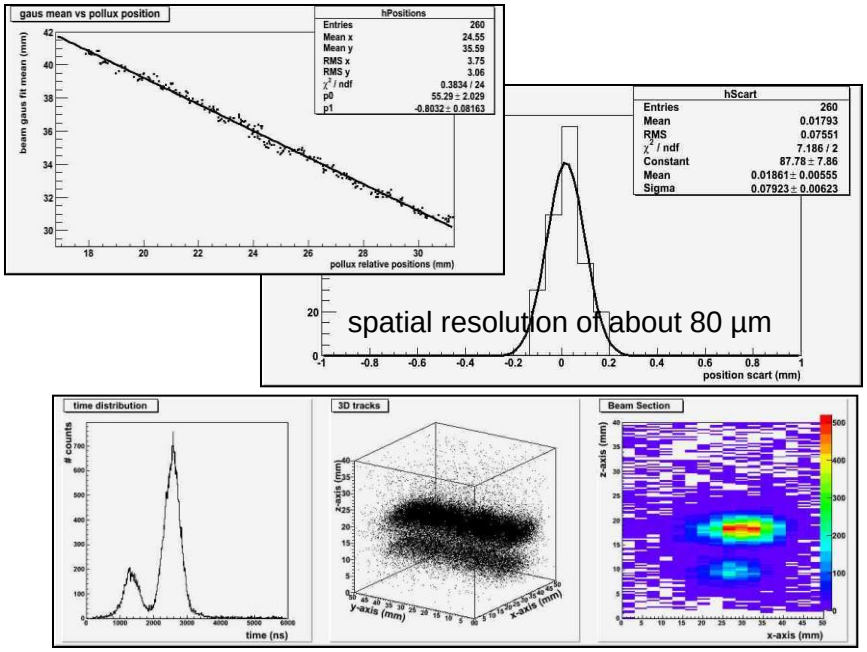


TPC GEM tracker

✓ The prototype of the TPC GEM tracker has been replaced by a fully operative system completed of all service elements (gas system, electronics, etc).







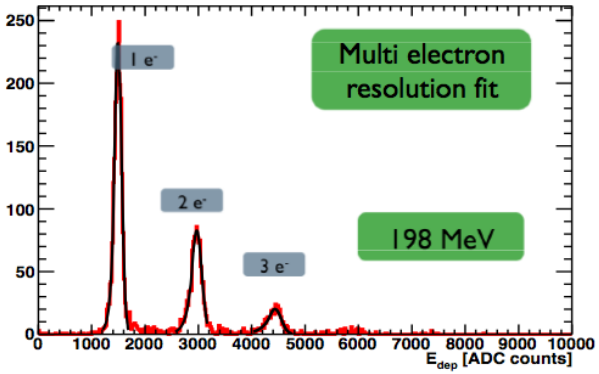
Measurement @BTF of positron beam splitting through a crystal

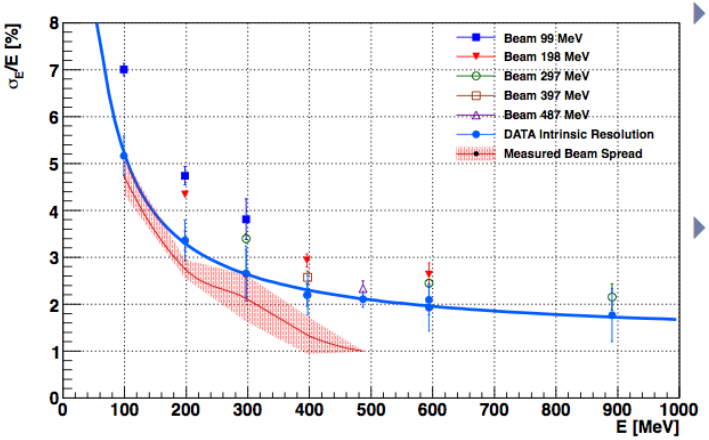
➡ Al the functionality of the GEM system (CANBUS via KVASER in HVGEM) runs temporary on virtualized environment and we are still developing of CANBUS over Ethernet software.

➡ Some preliminary test to study the relation among HVGEM currents and particle multiplicity has been started to obtain an independent beam current monitor over a wide range.

LYSO Calorimeter

✓ **Analysis** of the data collected during the test beam has been performed. A reasonable **agreement between data and Monte Carlo** has been obtained.





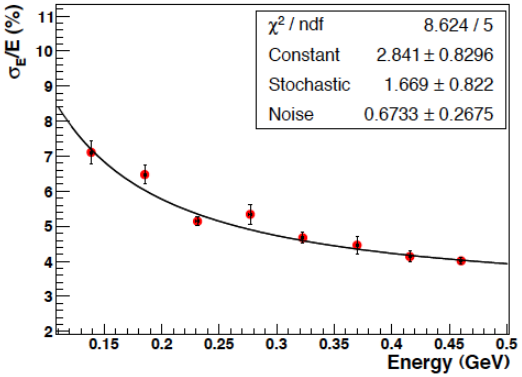
- Beam spread at 500MeV fixed at 1%
  - Only one point at this energy, BS can't be extracted
- Measured beam spread:
  - 4.8% at 100MeV
  - 2.7% at 200MeV
  - 2.1% at 300MeV
  - 1.4% at 400MeV

- LYSO matrix resolution

$$\frac{\sigma_E}{E} = \frac{1.1\%}{\sqrt{\mathrm{E(GeV}}} \oplus \frac{0.4\%}{\mathrm{E(GeV)}} \oplus 1.2\%$$

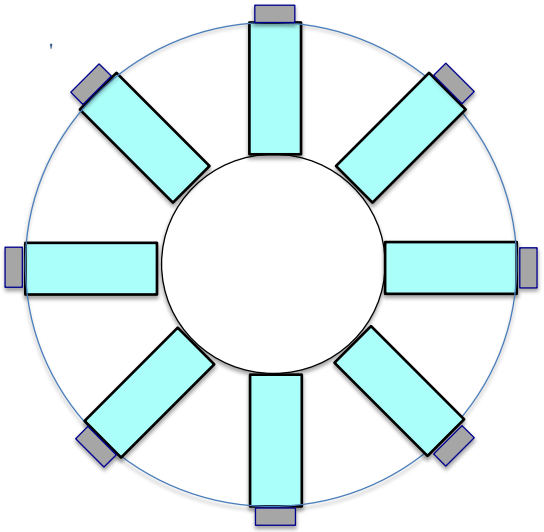
✓ 9 LYSO crystals have been readout with 36 (4 per crystal) and tested at the BTF line with energy range from from 100 up to 500 MeV

✓ also in this configuration, with a **constant term of about 2%**



Beam Radiation Monitor

- The goal is to build a beam radiation monitor for DaΦne at Frascati
- The detector consists of an array of 8 LYSO crystals arranged in a ring around the beam pipe to record beam radiation photons in the 100 keV energy range
- Each crystal (dimensions of 0.5 cm x 0.5 cm x 4 cm) is wrapped in Tyvec paper and is read out with a SiPM from KTEK with an active area of 0.3 cm x 0.3 cm
- The mechanical support structure requires visit to Frascati to inspect beam area, as many cables are tied to the beam pipe
- SiPMs, LYSO crystals, reflector and sources (^{133}Ba, ^{57}Co, ^{22}Na, ^{137}Cs) are in Bergen
- We have performed first readout of LYSO crystal with SiPM yesterday due to late arrival of LYSO crystals and leaving postdoc
- Replacement for Eric starts early April (lost 6-7 weeks)

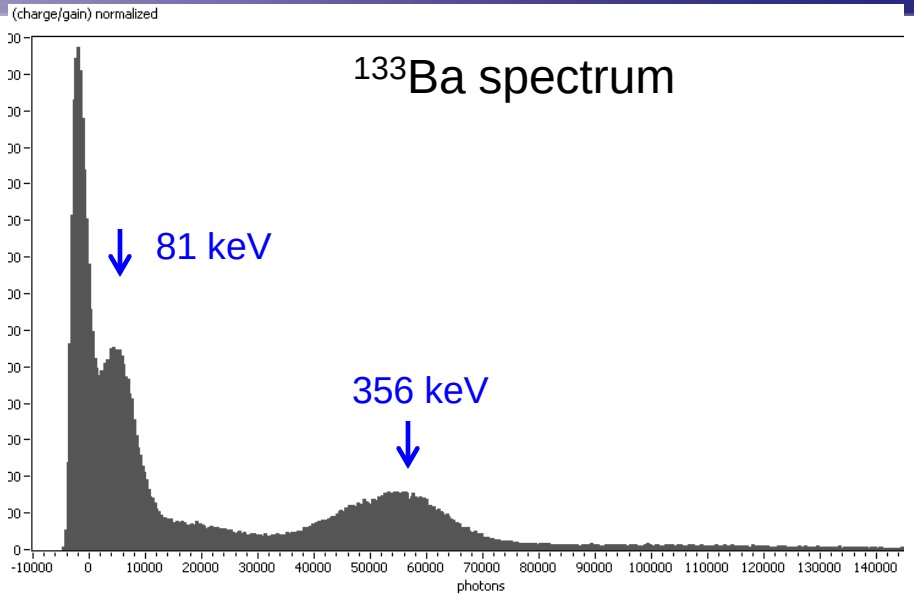


G. Eigen Aida meeting, 26/03/2014

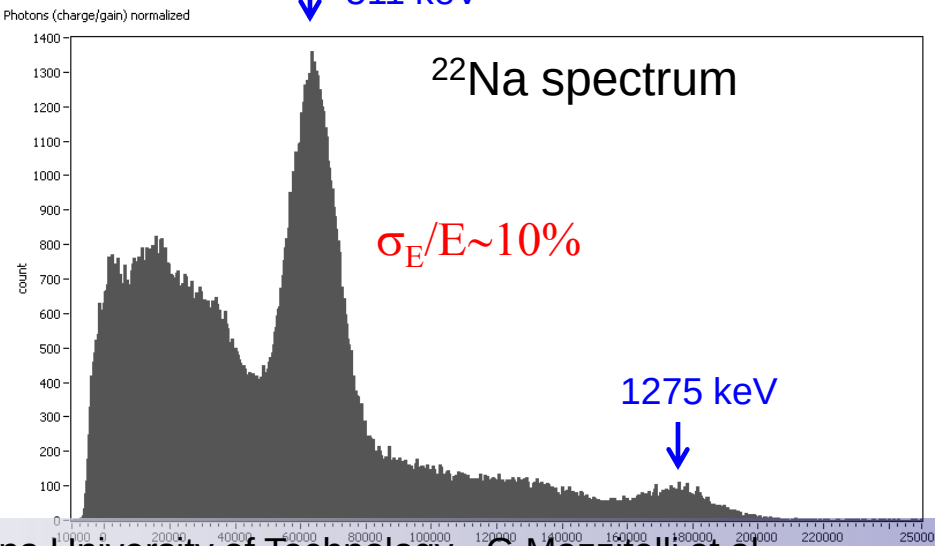
AIDA Readout of LYSO Crystal

- Wrap LYSO crystal in Tyvec
- Cover front face with silver mirror
- Attach SiPM to backside via optical grease
- Use KETEK MP20 V4-W8 SiPM instead of 12-W1 TR planned for the project
- Amplify and invert SiPM signal
- Trigger on negative edge
- Record signal with 14 bit ADC that is read out by Labview
- Measure spectra of sources

G. Eigen Aida meeting, 26/03/2014



511 keV



Next Steps

- Analyze source spectra to determine resolution
  - Understand why purchased KETEK SiPMs behave worse than tested samples
- Perform R&D on the LYSO crystal readout to optimize light collection (adapt preamp to SiPM, optimize diffuse reflector, place mirror on uncovered back face, modify trigger, select best SiPM)- April
- Equip all 8 crystals with SiPMs and test performance- April/May
- Design mechanical support structure after visit to Frascati- May
- Construction of mechanical support structure at UiB- June
- Install detector at DaΦne and test it with beam- fall
- Write report

G. Eigen Aida meeting, 26/03/2014

Task 8.2.2 - Conclusion

- Status and future work
  - ✓ **remote trolley** done (see AIDA-NOTE-2012-003)
  - ✓ **GEM tracker** with a resolution less the 100 μm **is completed:** the prototype of the TPC GEM tracker has been replaced by a fully operative system completed of all service elements
  - ✓ **LYSO** calorimeter beam energy spread measurements **is completed**: LYSO resolution data normalized by energy beam spread are fitting optimally the Monte Carlo data; UV optimized SiPM has been tested showing a reduction of SNR reproducing a ~2% of energy resolution for the beam line as previously measured.
  - ➡ multi purpose **DAQ system is in progress:** neutron detectors, environmental detectors, and beam diagnostic detectors has been implemented; GEM tracker system in under integration in the BTF controls.
- Status of Milestones & Deliverables
  - ✓ D8.8 [m48] "All equipment ready" is on schedule