BESIII

# Zero Degree Detector status

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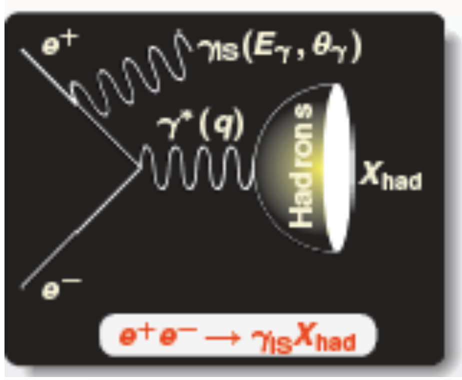
09/06/11 ISR working group meeting

# Initial State Radiation: physics motivations




◎Existing results, mainly from BABAR (ISR) show interesting and unexpected behaviors expecially at threshold for $e^+e^- \to p\bar{p}$ , $e^+e^- \to \Lambda\bar{\Lambda}$

◎Only one measurement by FENICE (energy scan) for $e^+e^- \to n\bar{n}$, now SND confirms FENICE

**Physical limits in reaching threshold of many of these channels via energy scan (stable hadrons produced at rest cannot be detected)**

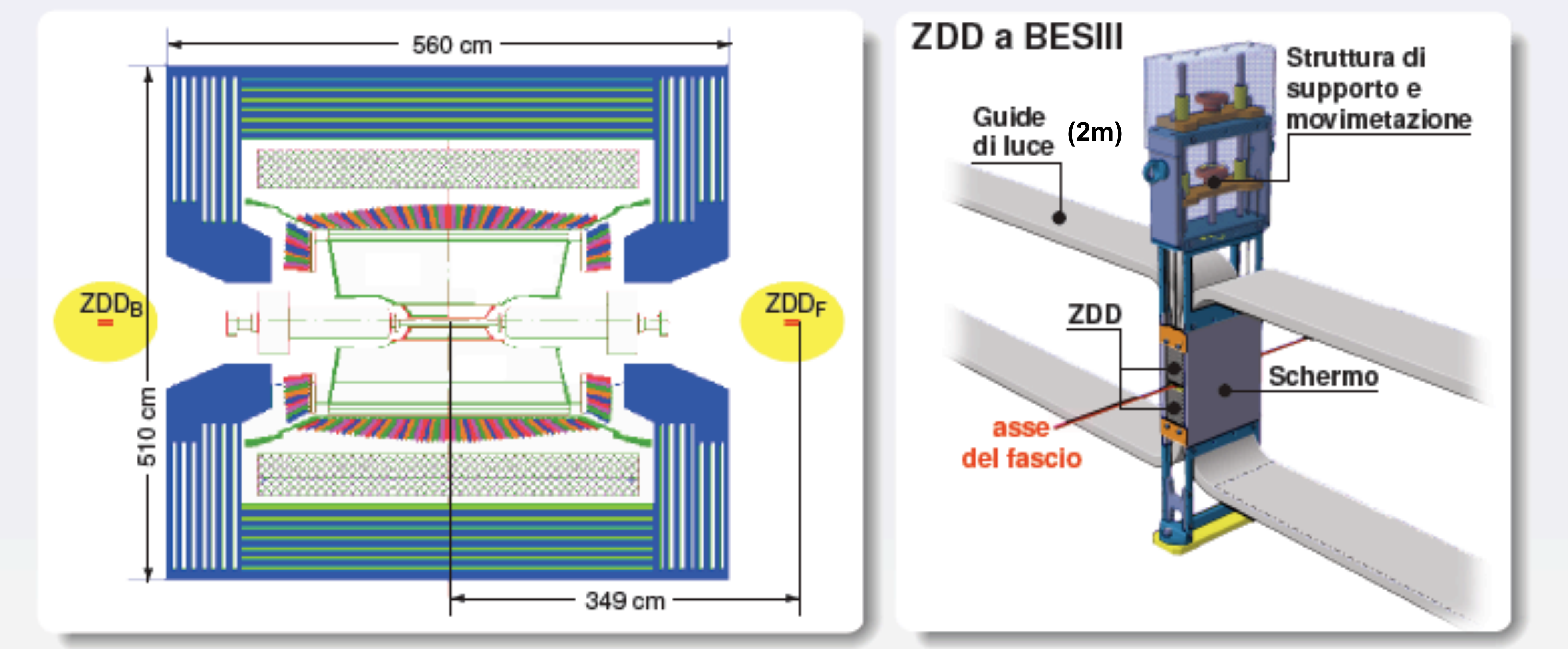
**The ISR technique provides a unique tool to access threshold regions working at higher resonances:**

- all energies ($q^2$) at the same time → better control on systematics
- detect ISR photon → full $X_{had}$ angular coverage

**A Zero Degree radiative photon tagger has just been installed at 3.5m from IP**

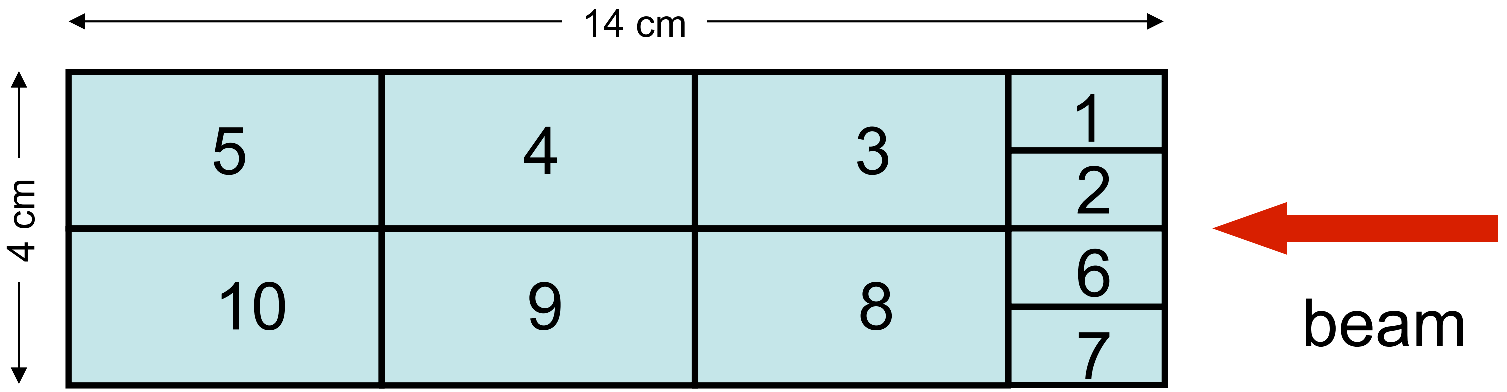
- to detect ISR photons peaked at small angle
- to suppress background from $\pi^0$ and $\gamma_{FS}$

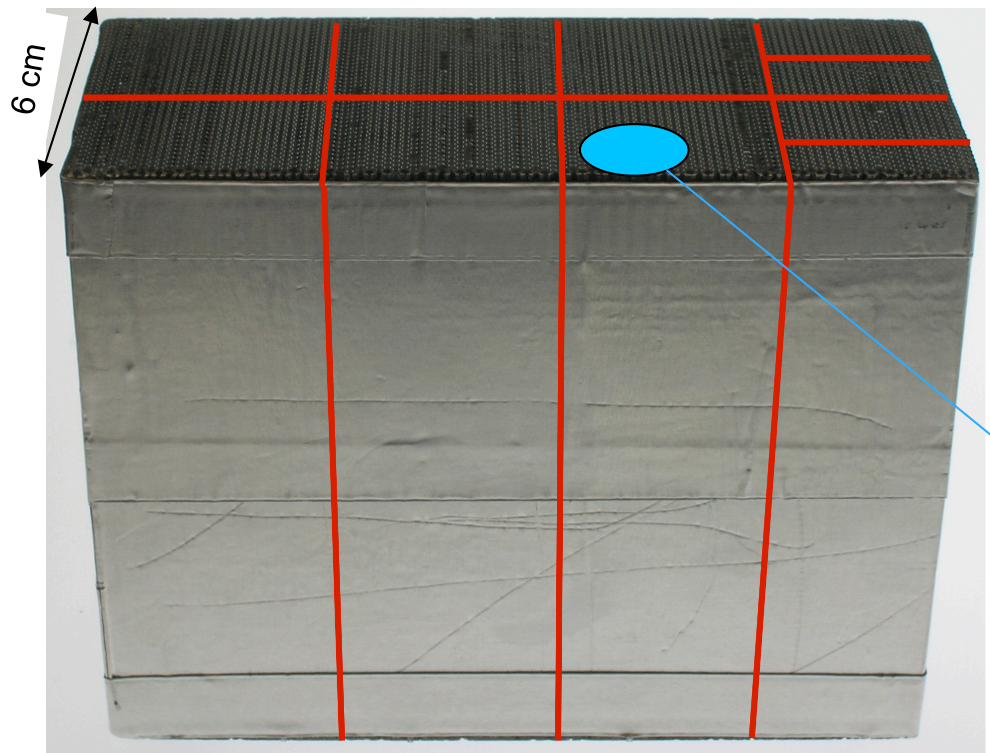
# BESIII and Zero Degree Detector



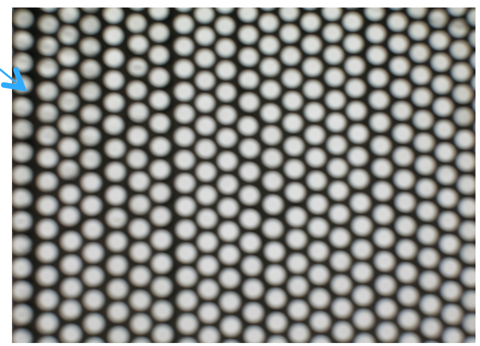

**ZDD**: **Pb/Sci.Fi Array, scintillating material 60% of total (in volume), two modules (up and down the beam) dimensions: $14x4x6cm^3$**

# ZDD segmentation (one/two module)




Each sector is sent to a PM, sectors 1&2 (6&7) are sent to the same PM



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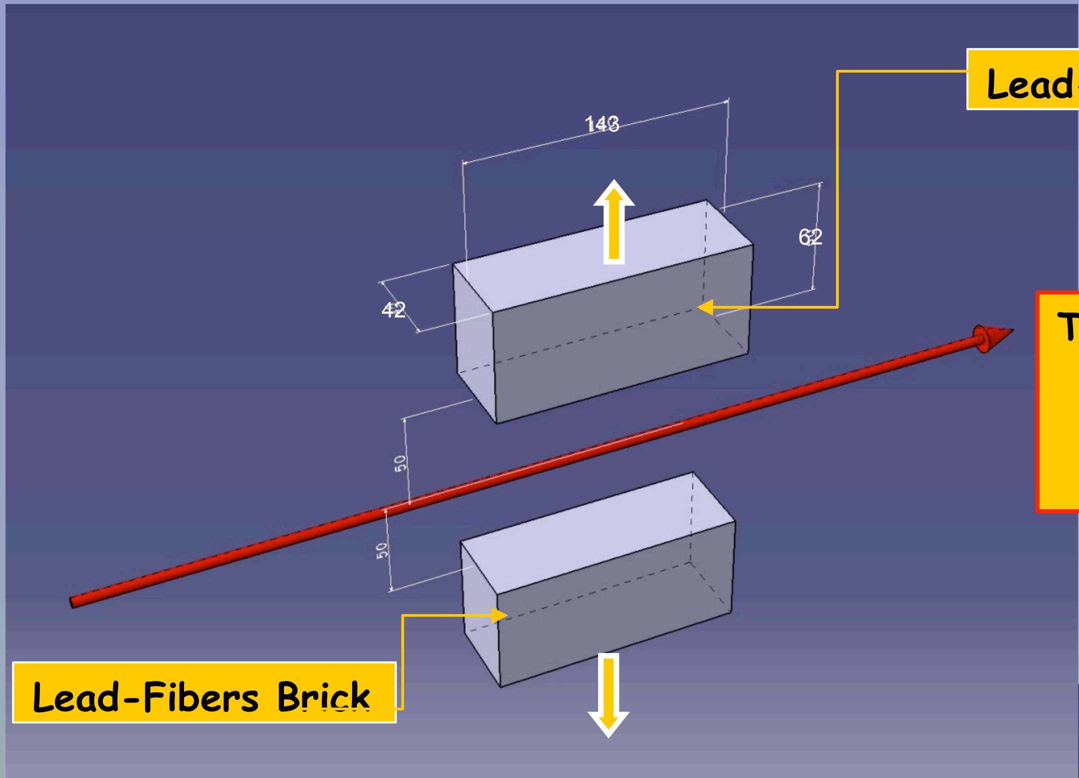
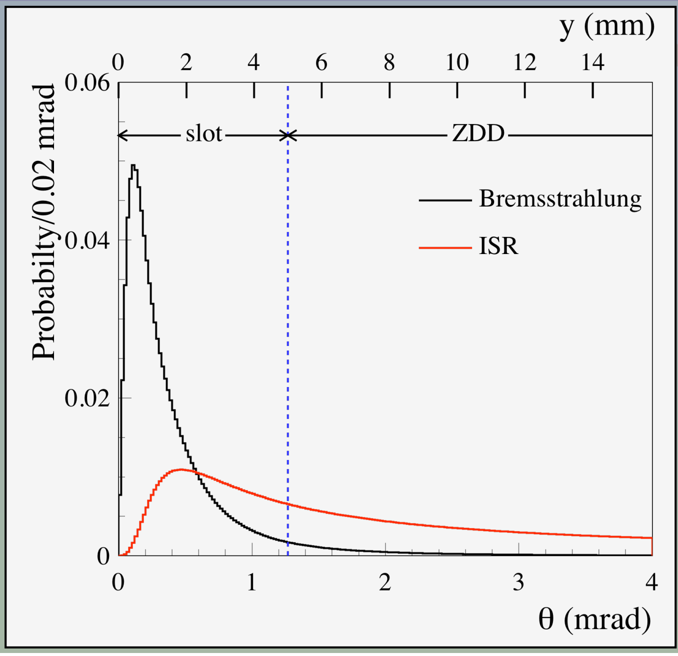
# ZDD very fast milestones

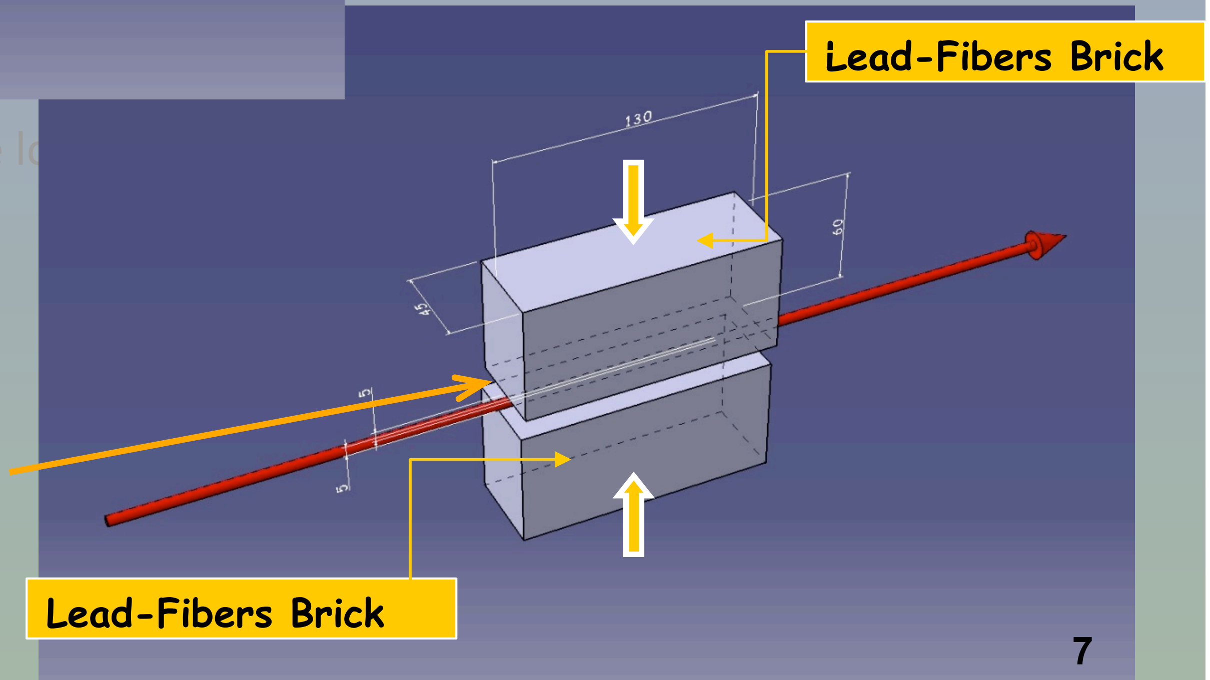
- **2009:** first ideas and studies, proposal to BESIII Collaboration
- **2010:**
  - R&D with SciFi prototype cut from P326/NA62 project in LNF
  - June summer BESIII coll meeting: approval of the SciFi proposal for ZDD, only one station leaving one Lumi monitor on the other side
  - First approval by INFN CSN1 of financial funding for 2011, but anticipated to December 2010 to allow to put orders
  - Two ZDD modules (up and down ) cut from P326 prototype
- **2011:**
  - Finishing of the two modules
  - Mechanical structure: designed and constructed
  - construction of light guide: clear fibers bundles 2m long
  - supplying of PM and electronic modules
  - Front End Electronics: project and construction at LNF
  - May-June: test with cosmic rays and e- Beam Test Facility at LNF
  - July: shipment to IHEP
  - **August: successfull installation at IHEP !**

(design by D.Orecchini)

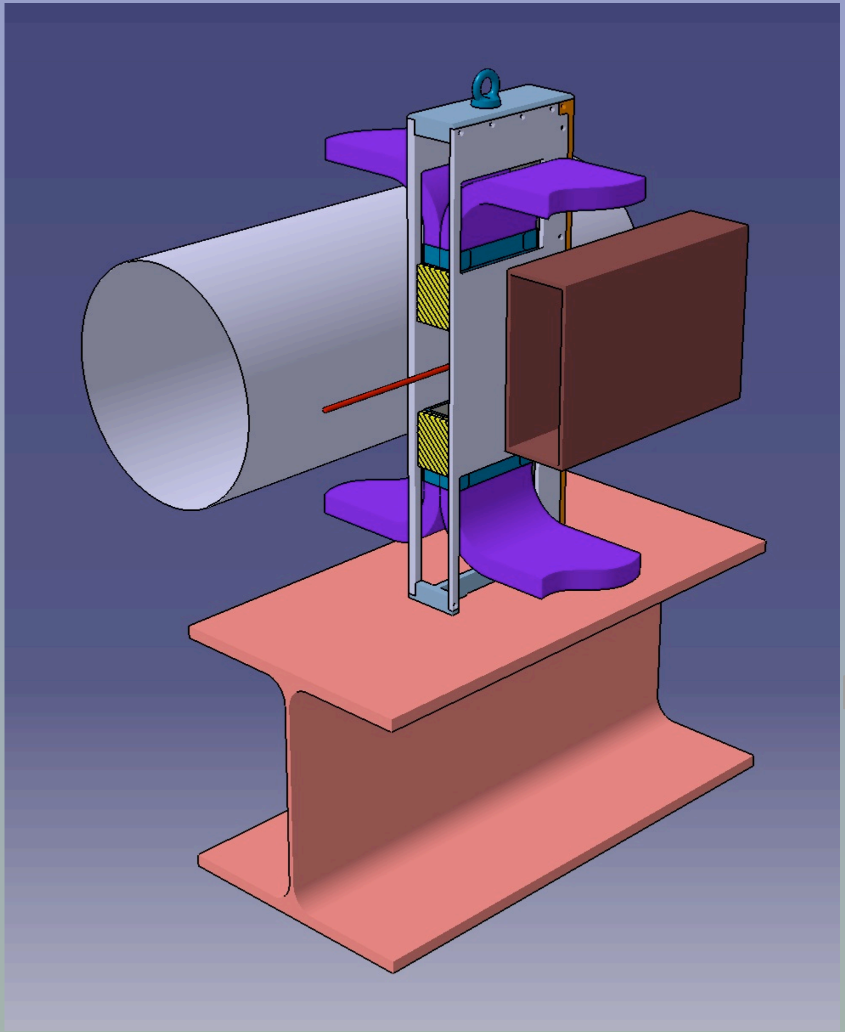


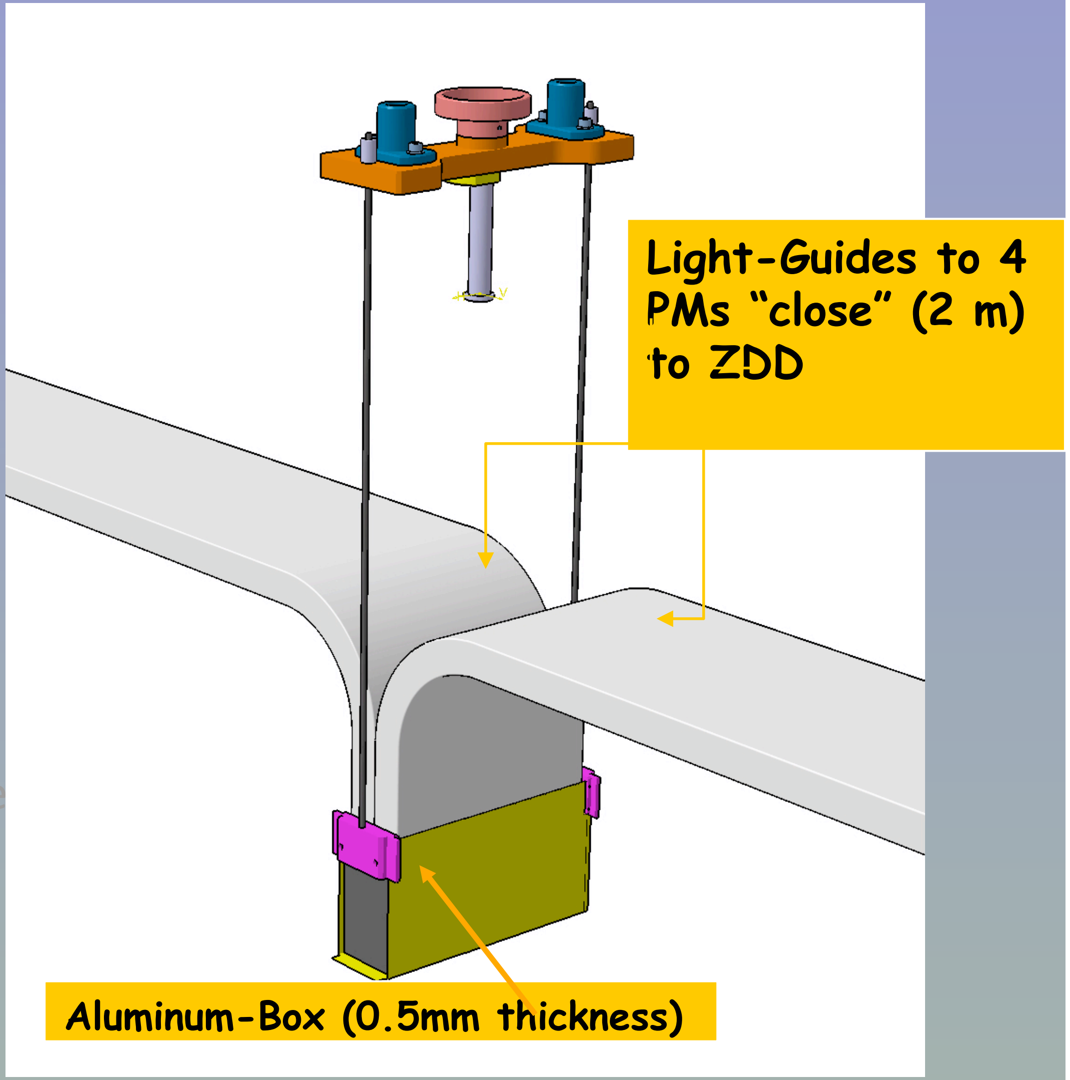

The opposite faces of the two bricks lift:
a) – Up, to 45mm from the beam;
b) – Down, to 5mm from the beam.



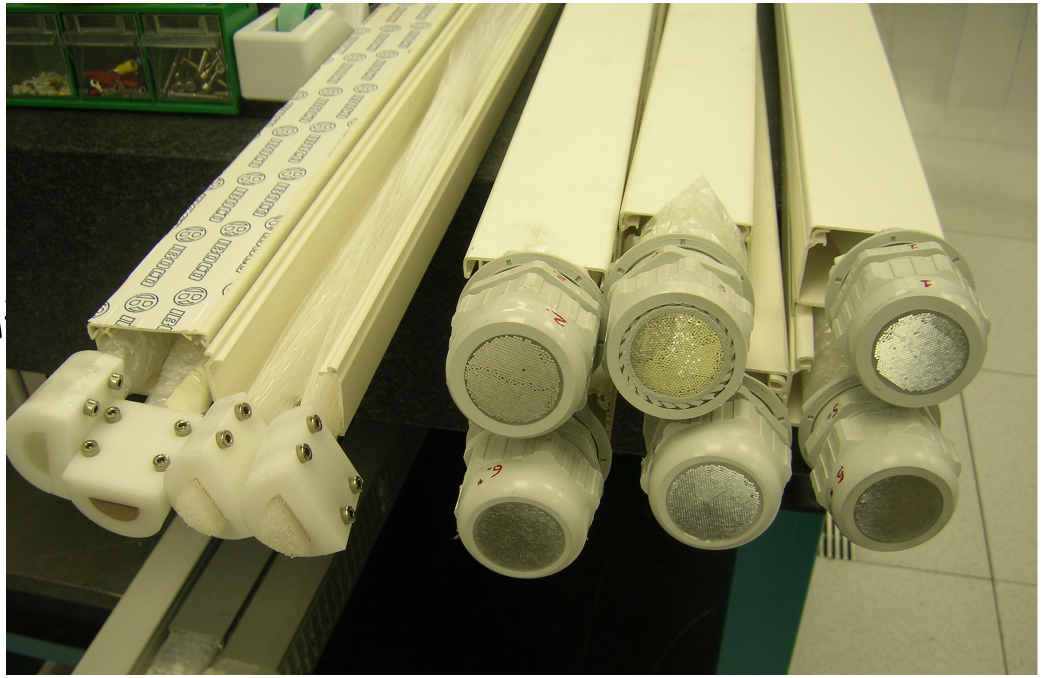
(design by D.Orecchini)



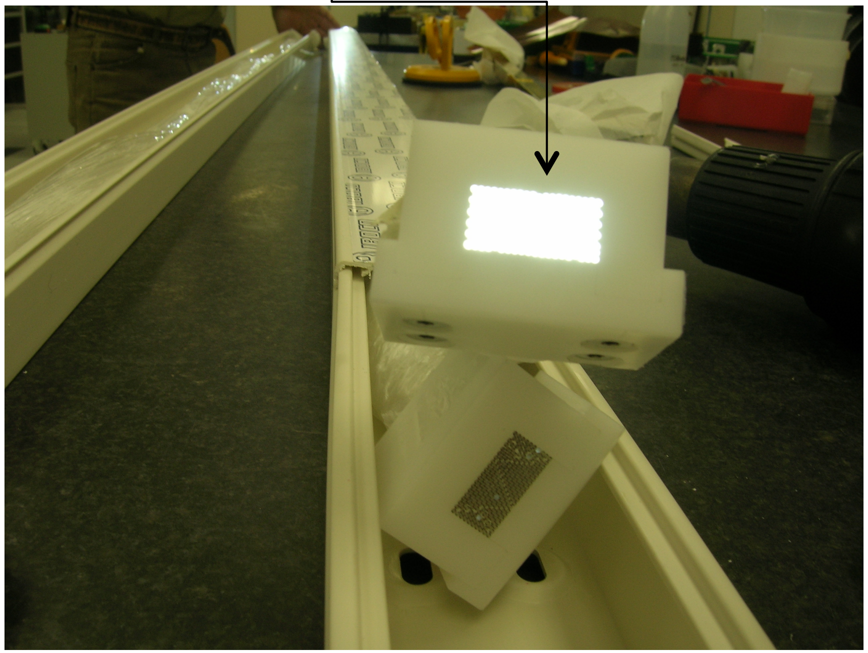


# Bundles production (clear fibers)

(SSE, resp. M.Anelli)

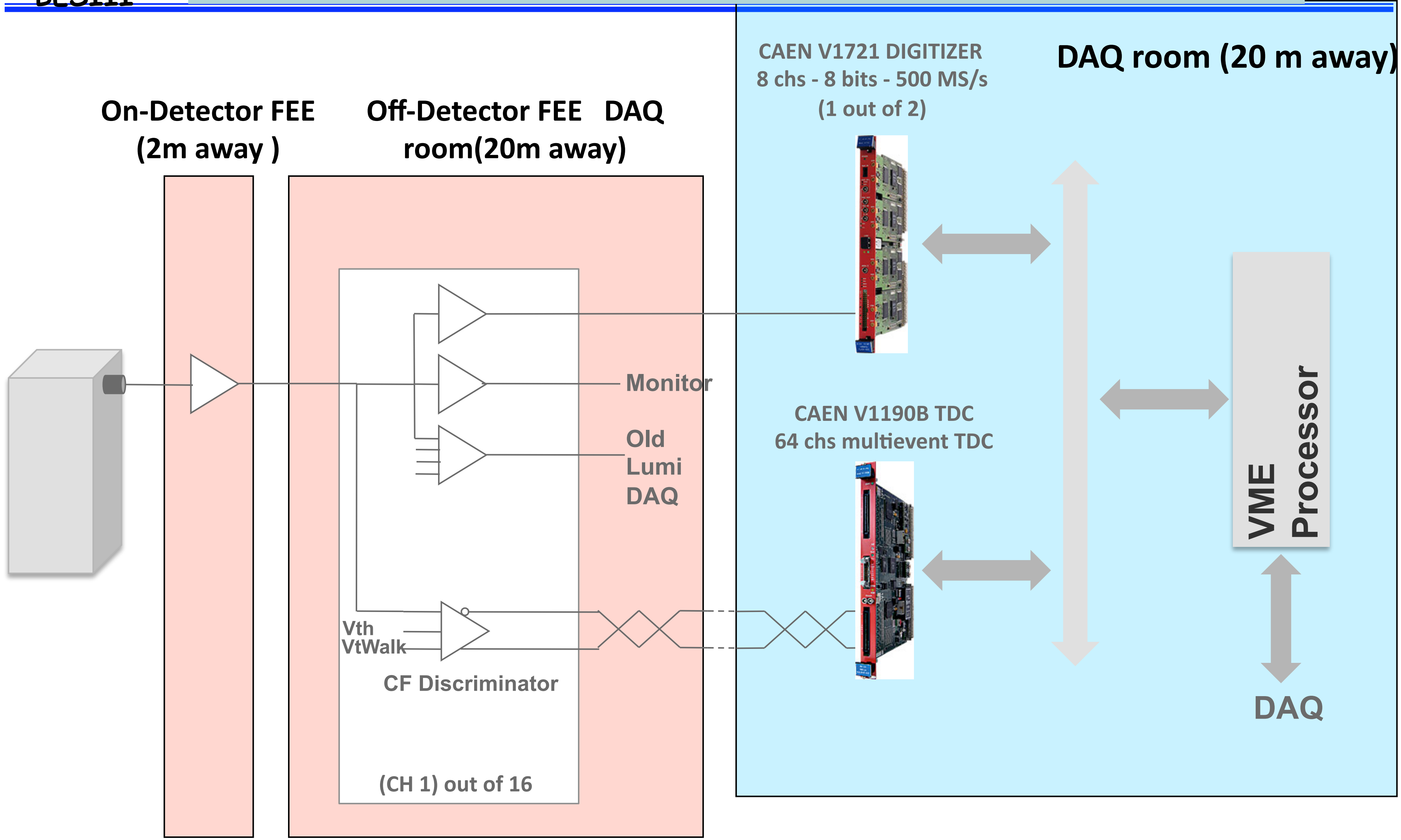


for each module:
6x(2x4x200)cm$^3$ + 4x(1x2x200)cm$^3$
8PM



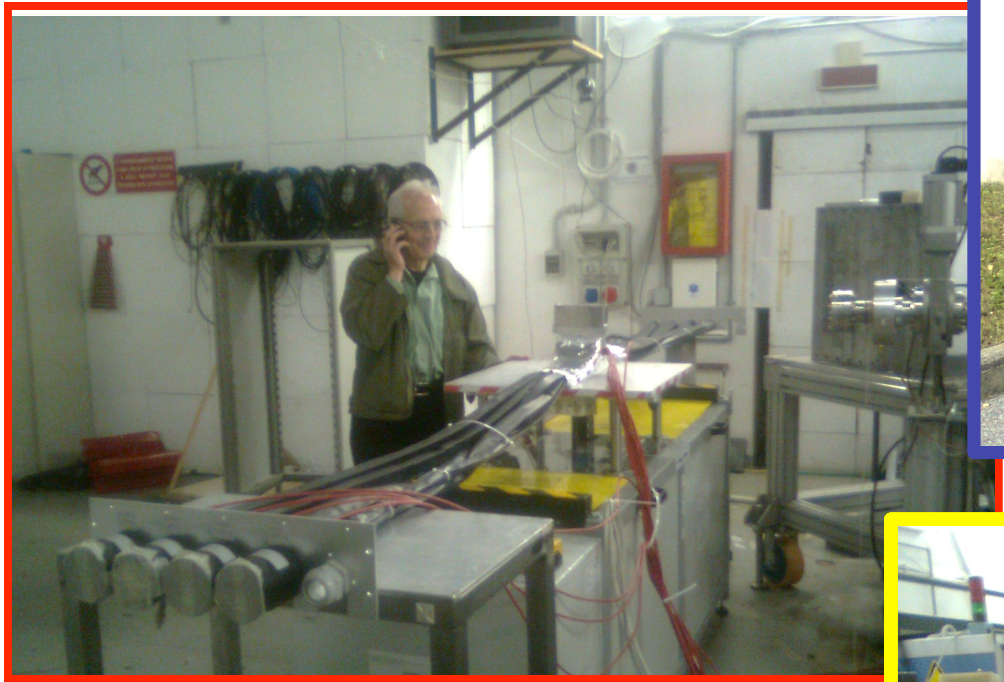
# Front End Electronics

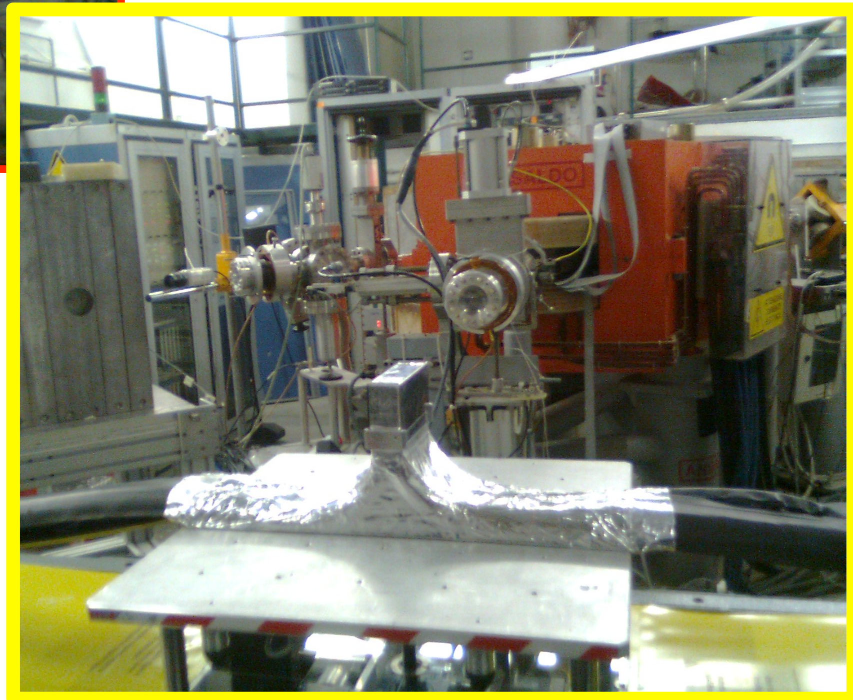
(by G.Felici, LNF-SEA)



# BTF test beam

(may 16-22 2011)



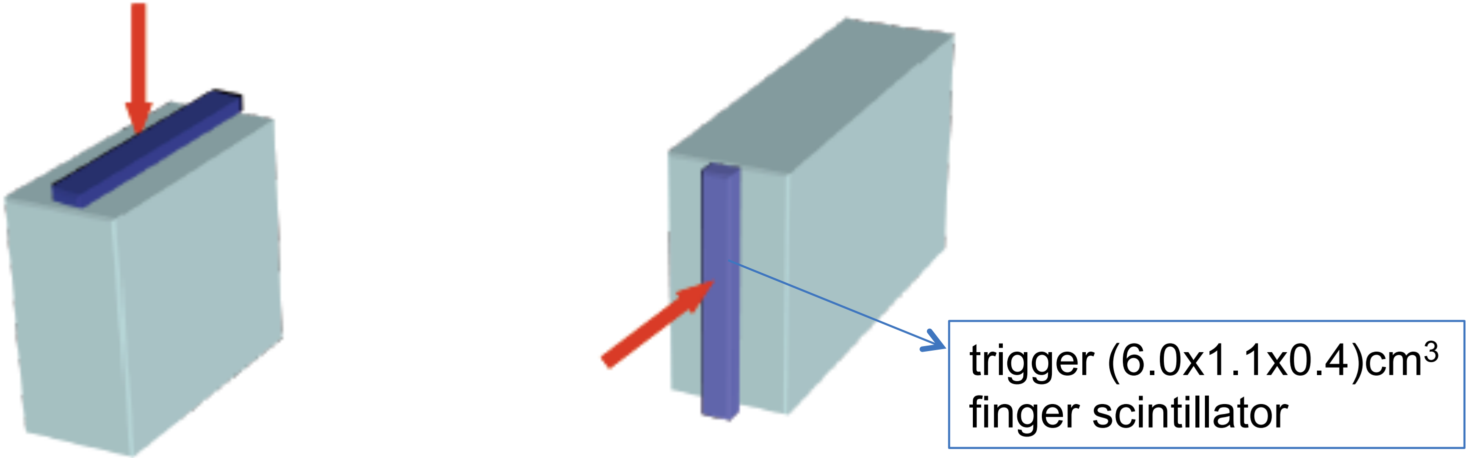


One (out of two) ZDD module tested at BTF
with 450, ~300, ~200 MeV $e^-$ bunches ($N_{e-}$=1,2,3)

Final Pb-scifi ZDD module, bundles guides,
PM's, TDC, at the moment not FADC but ADC
caen V V792N

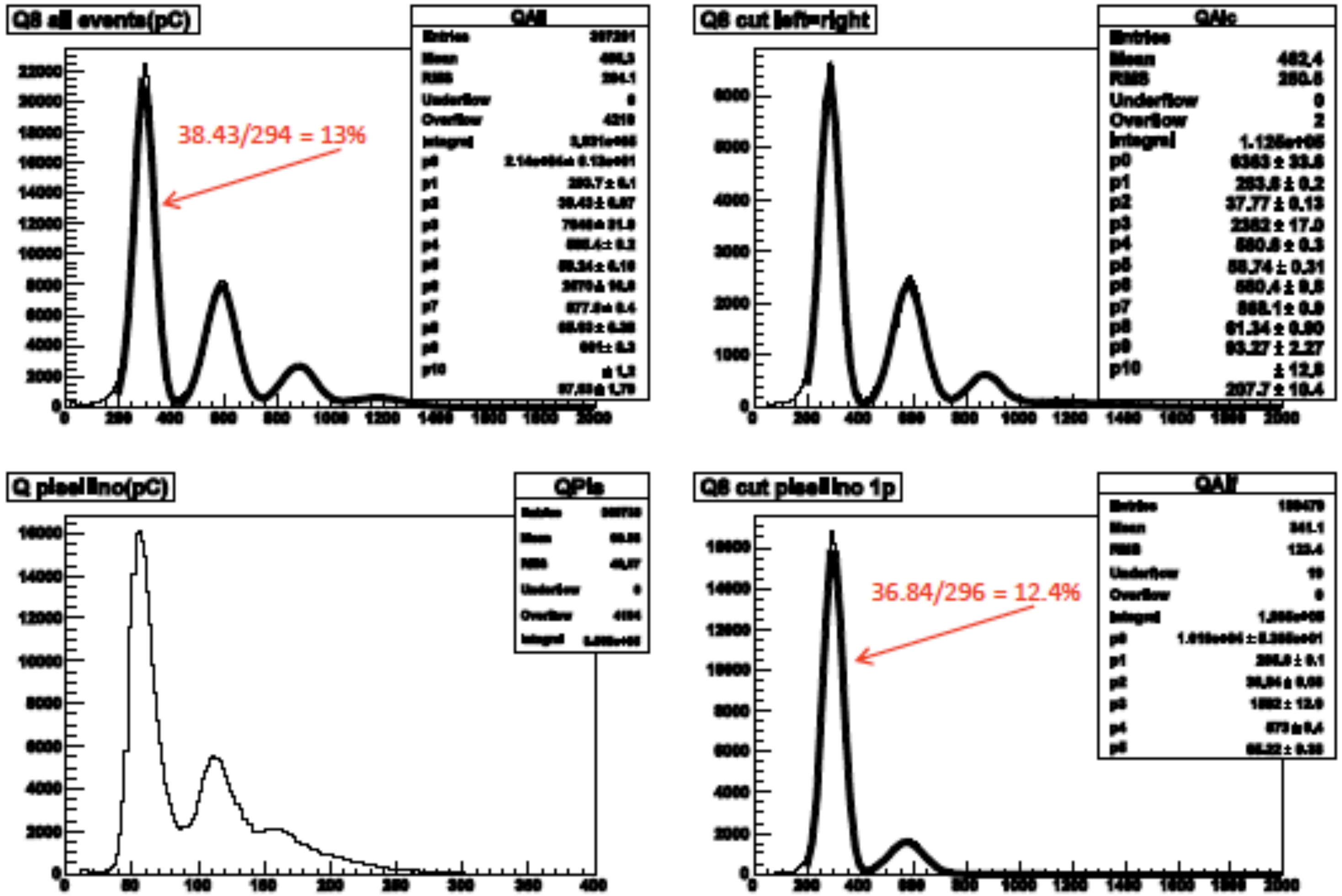
Small scintillator (60x11x4) $mm^3$ used to trigger
and select electrons impact point

# Cosmic rays and Beam Test Facility

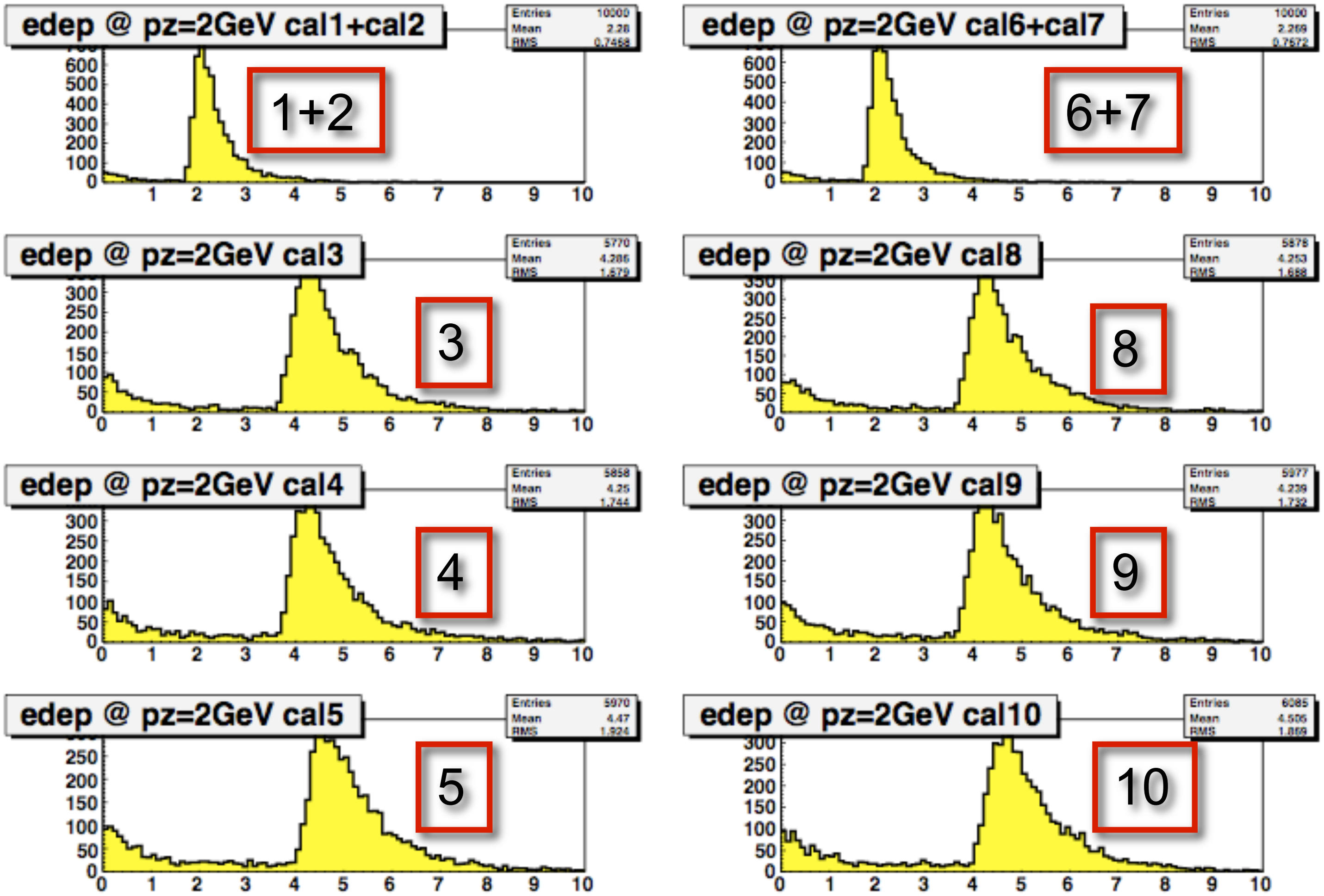


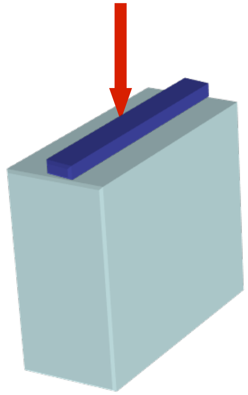

- From cosmic ray data set compute a set of correction factors for PM equalisation
- Read back the BTF data applying individual factors to the 8 channels
- Recompute the the sums of left, right collected charge

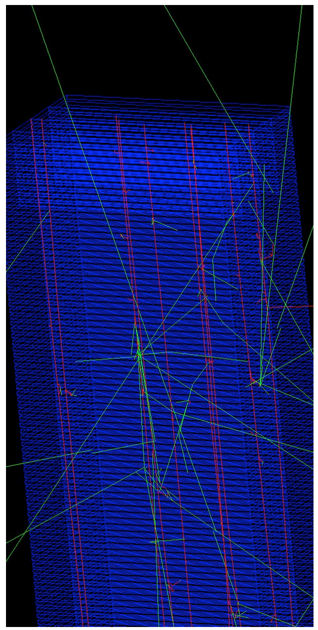
# Run 4, 450 MeV, corrected data



# Geant MC: Cosmic rays (1)

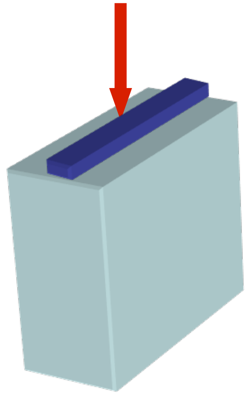


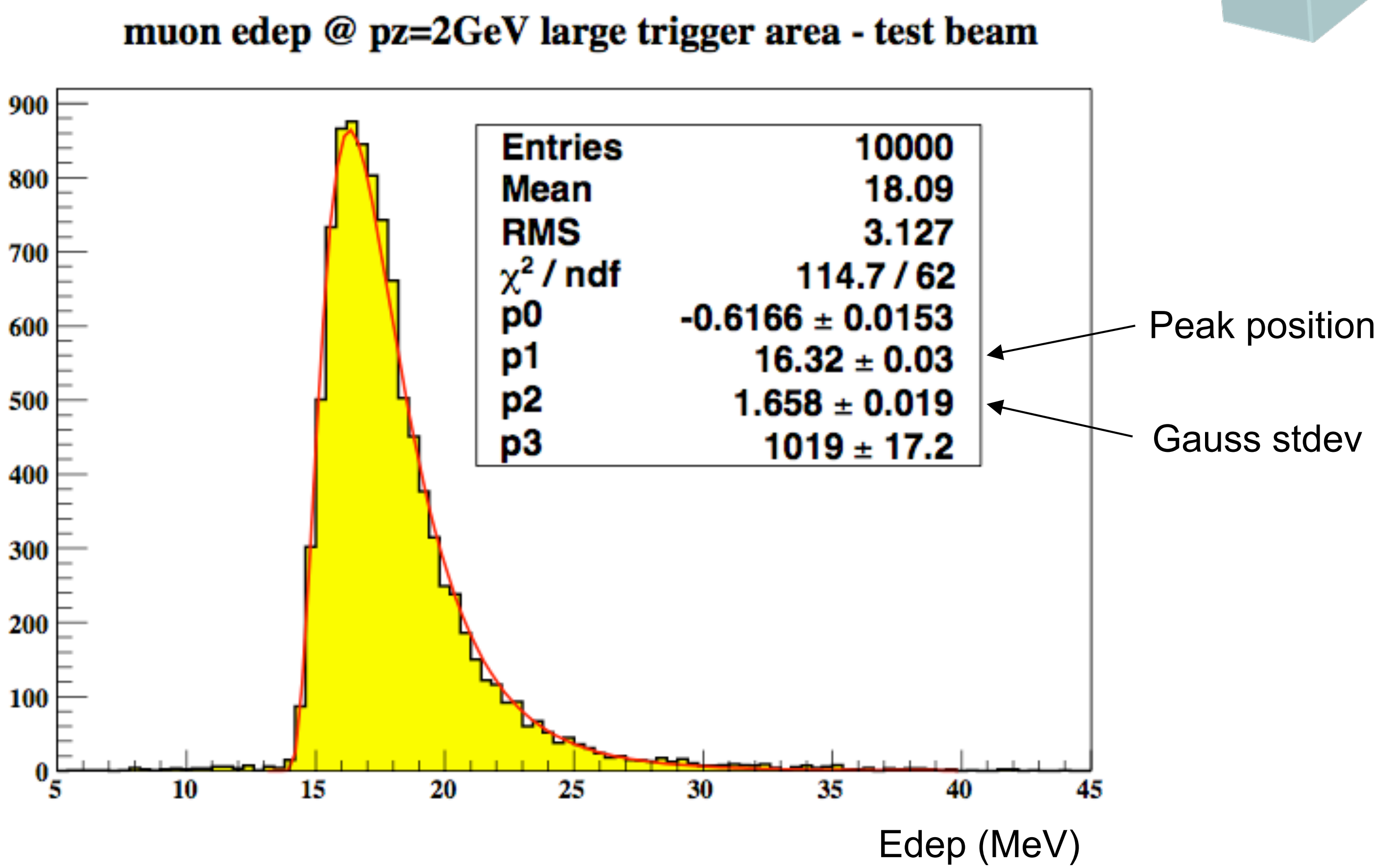





The histograms represent the deposited energy by the muons into the 8 RO sectors (slide 2). The peak position is in agreement with the prediction for a mip traversing the material. The initial part of the distributions is due to the energy loss by the delta rays produced by the muon when it pass through the neighbour sector of the same layer.

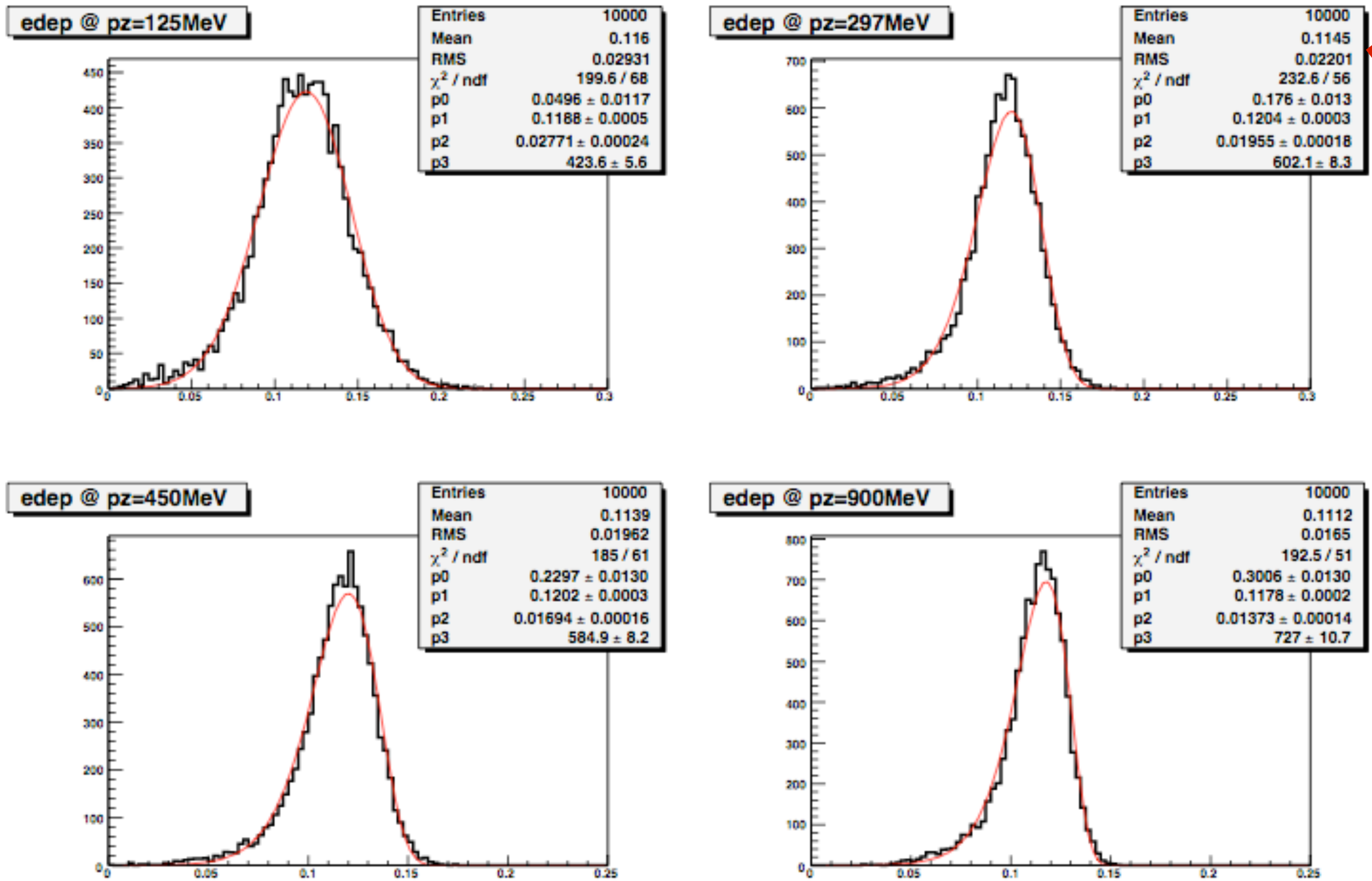
# Geant MC: Cosmic rays (2)

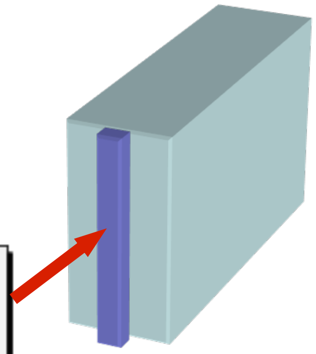





The histogram represents the total deposited energy by the muons (sum over all 8 sectors). The MC data are fitted with the standard log gaussian distribution.

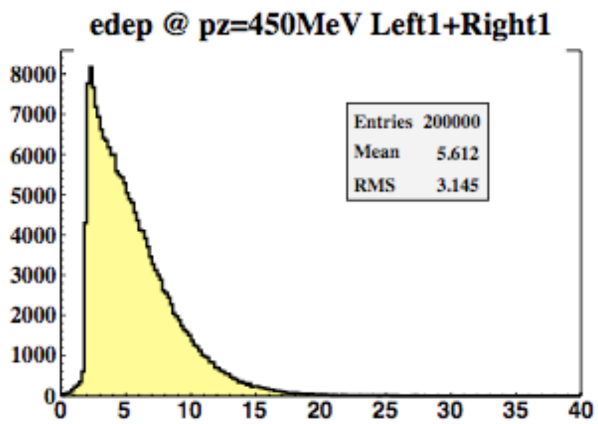
# BTF Geant

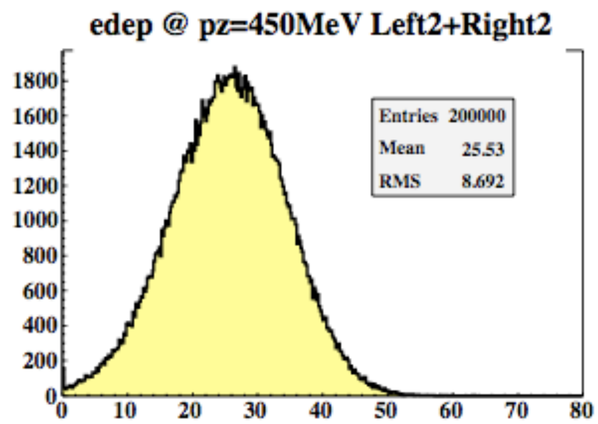


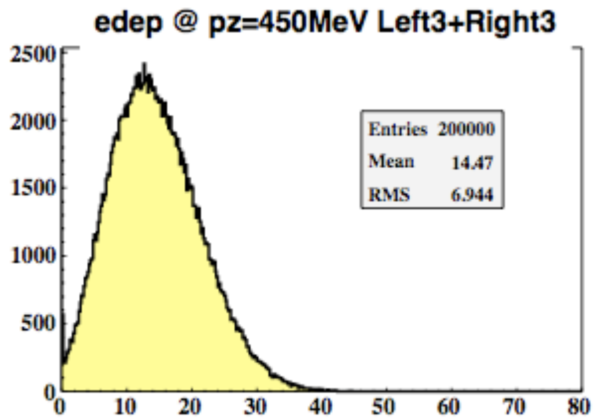



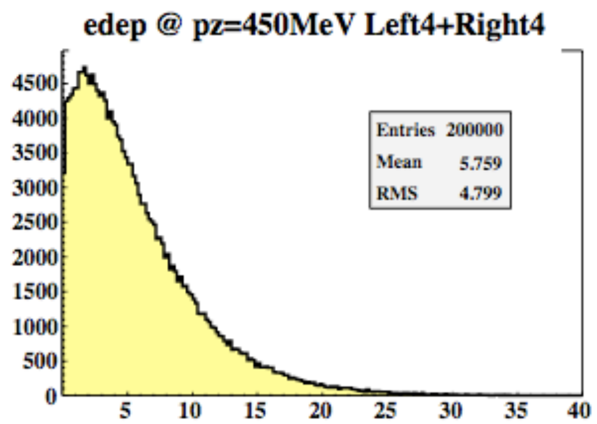
The 4 histograms represent the total deposited energy (sum over all 10 sectors) by the beam electrons, normalized to the beam energy, for the 4 analyzed energy. The data are fitted with the standard log gaussian distribution.

# BTF Geant @ 450MeV



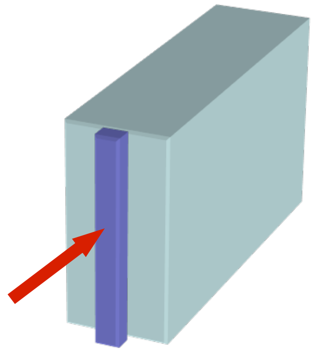



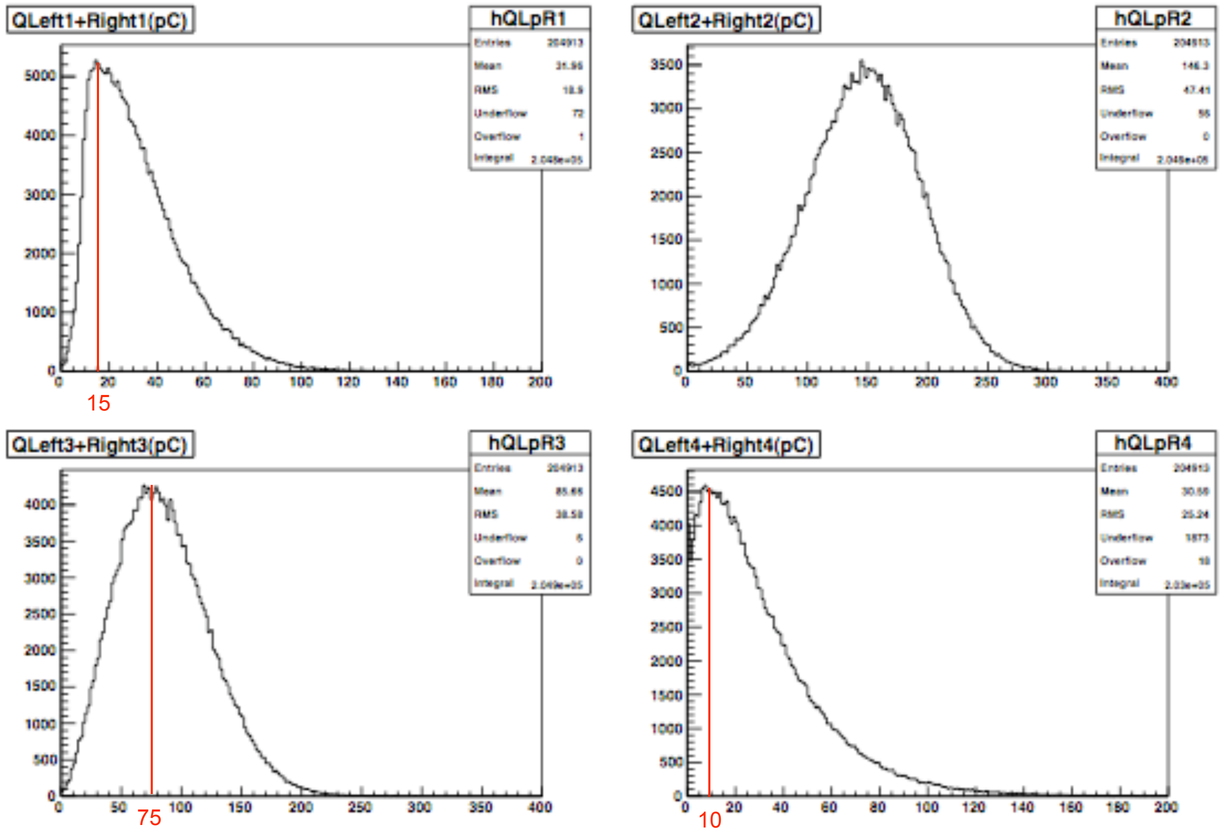




The 4 histograms represent the deposited energy per layer (e.g. 3+8 sectors) at the beam energy 450MeV

# BTF TB data @ 450MeV





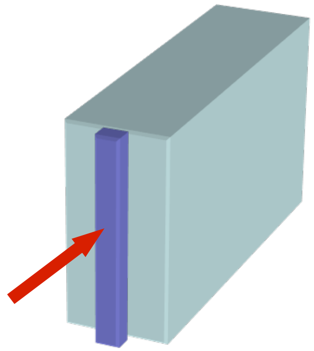

The 4 histograms represent the deposited energy per layer (e.g. 3+8 sectors) measured during the test beam (run 4) with 450MeV beam energy.

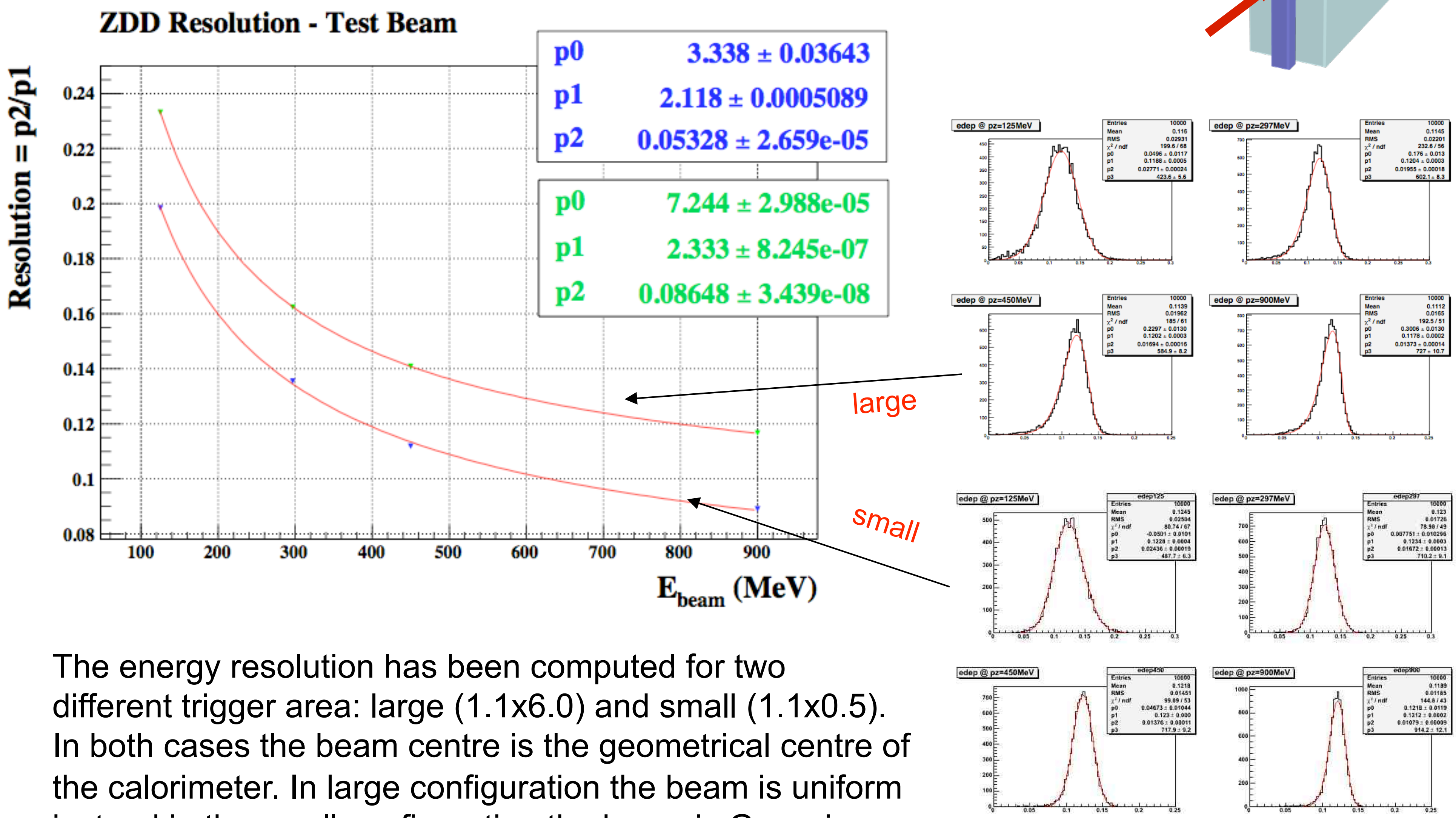
# Comparison data-MC @ 450MeV

The shape of the distributions data and MC are very similar. The initial part of the MC distribution of the layer1 is steeper then the data one. This is still under study.
The ratio between the peak position of the data distribution and the MC distribution gives the scale factor and equalization factor. The <R> is in agreement with the formula <n_pe/MeV> * G * $1.6 \cdot 10^{-19}$ when <n_pe/MeV> = 5 and G = $5 \cdot 10^{6}$ .

| Layer | Peak (pC) | Peak MC (MeV) | R (pC/MeV) |
|---|---|---|---|
| 1 | 15 | 2.2 | 6.8 |
| 2 | 146.3 | 25.5 | 5.54 |
| 3 | 75 | 12.7 | 5.91 |
| 4 | 10 | 1.8 | 5.56 |

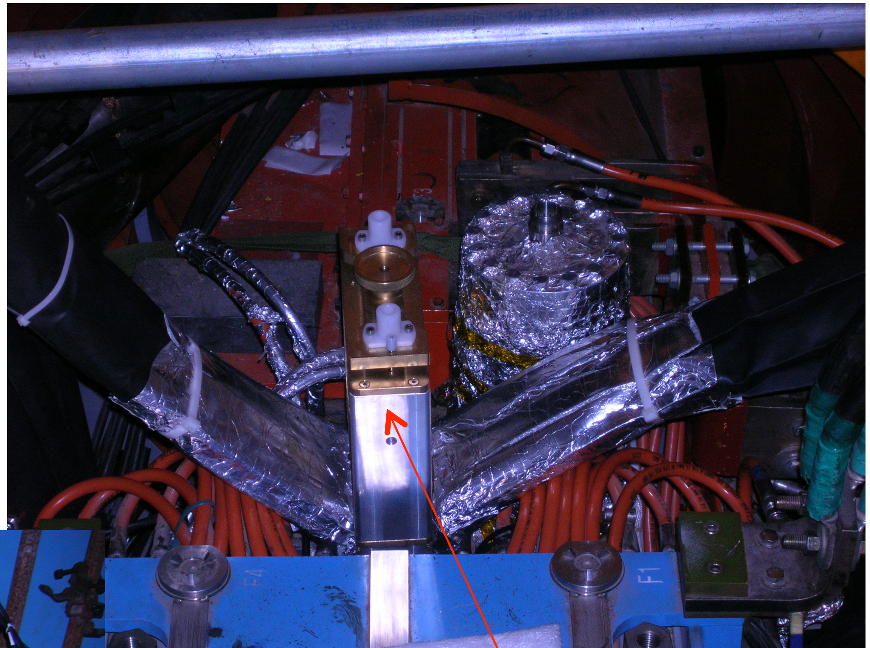
# BTF Geant

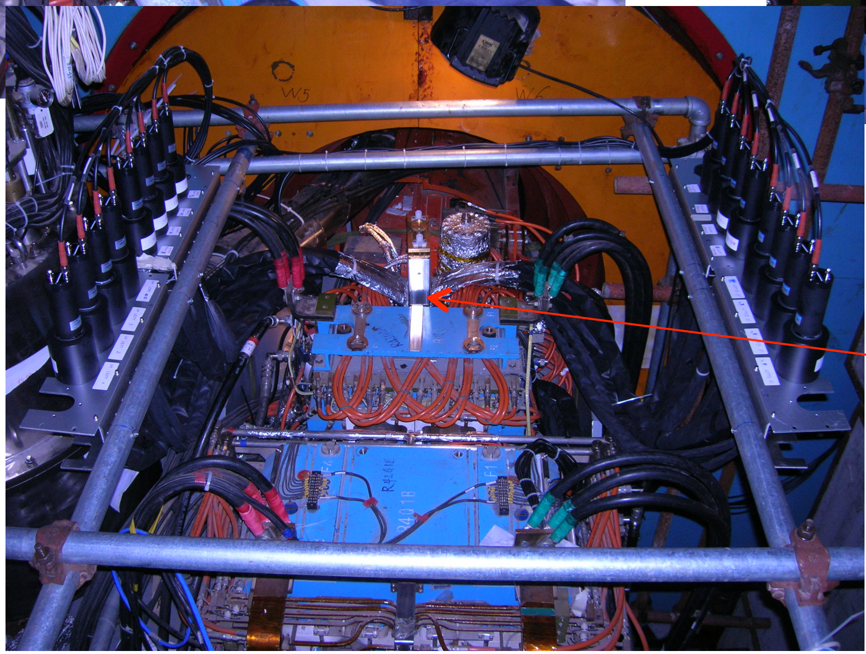





The energy resolution has been computed for two different trigger area: large (1.1x6.0) and small (1.1x0.5). In both cases the beam centre is the geometrical centre of the calorimeter. In large configuration the beam is uniform instead in the small configuration the beam is Gaussian.

# August Installation at BEPCII





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# August Installation at BEPCII

*In 10 days at IHEP the ZDD station has been mounted successfully in the very crowded area of BEPCII !*

•Mechanical structure is in place
•Bundles light guides are connected with all the PM in the patch panel and cabled
•Custom FEE is also in place
•It has been turned on and checked all the signals in and out of the FEE box

*On September 2nd: ZDD is on place and working*

•next step: setup a cosmic ray test in loco

# spares

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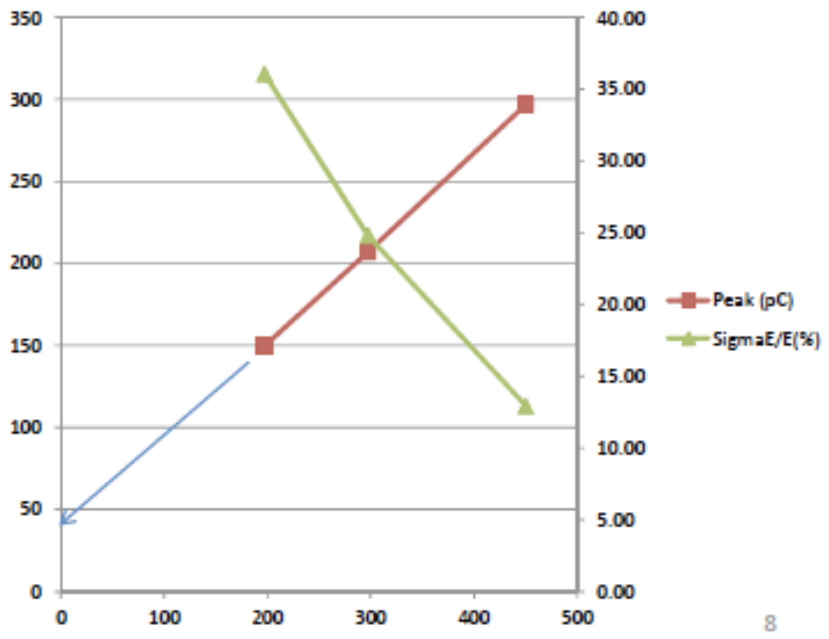
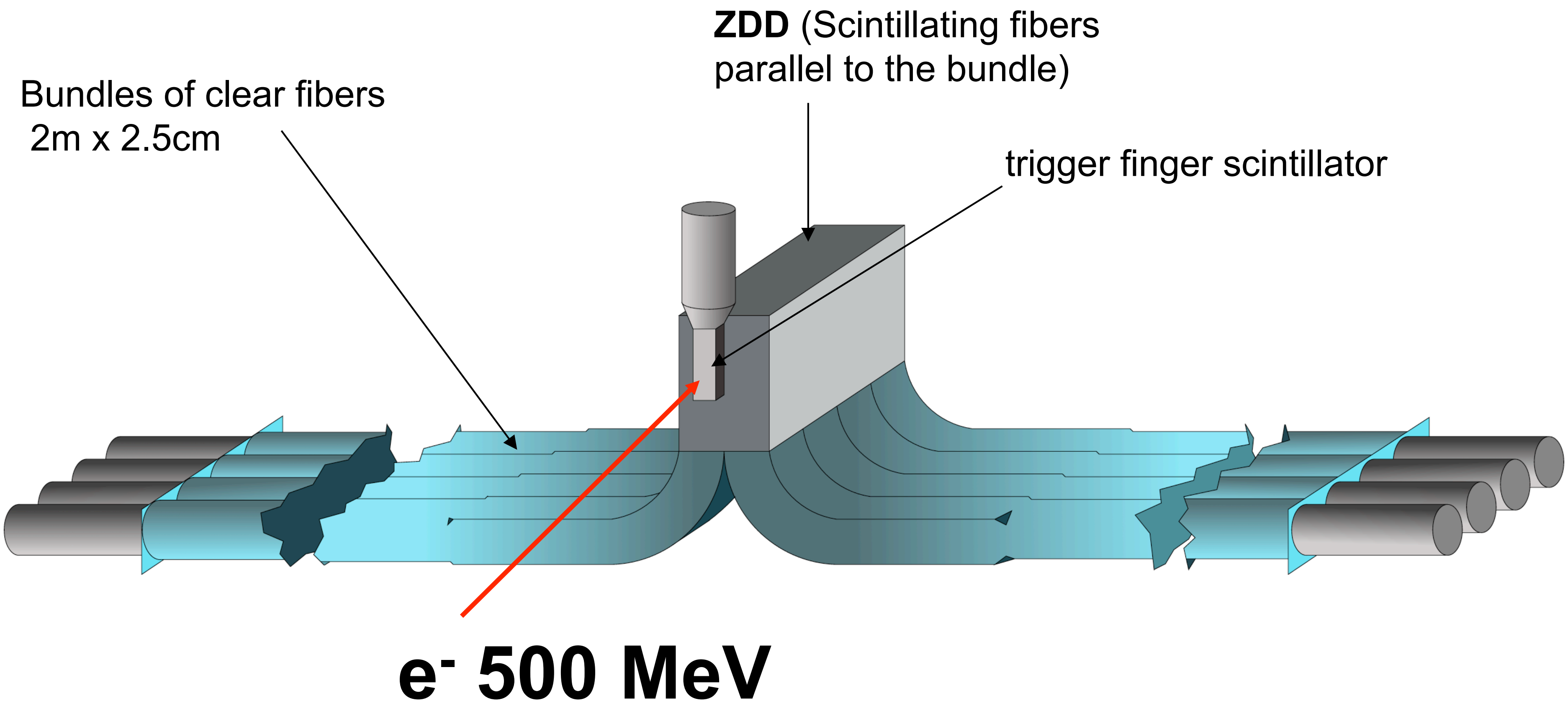
# BTF data

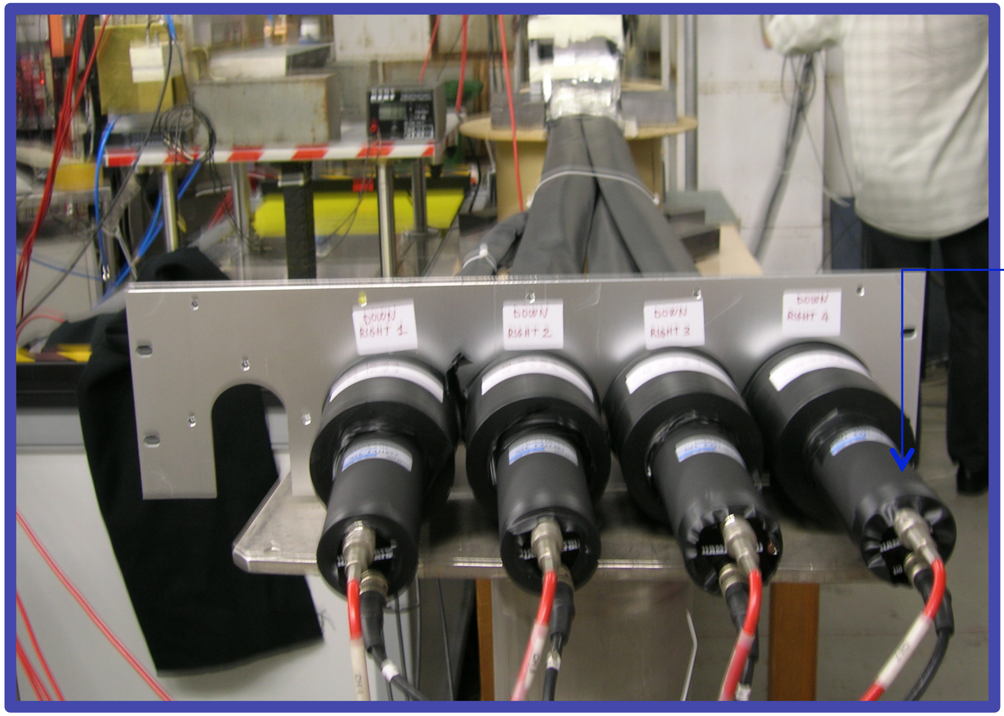



| Energy | Peak (pC) | SigmaE/E(%) |
|---|---|---|
| 197 | 150 | 36.08 |
| 297 | 207 | 24.84 |
| 450 | 297 | 12.94 |

# BTF Test beam setup

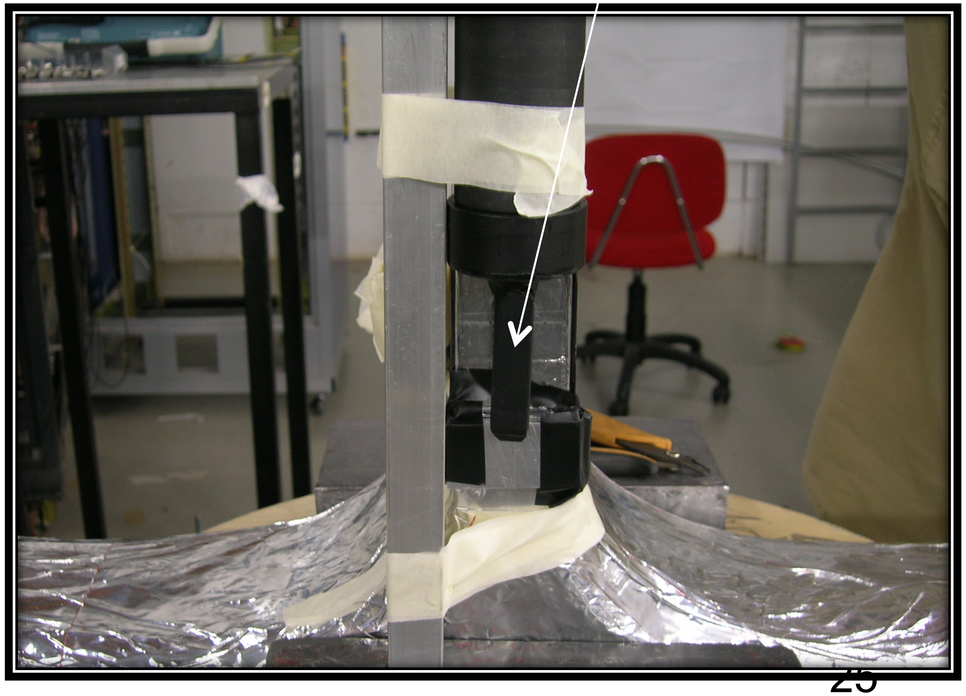


# BTF test beam



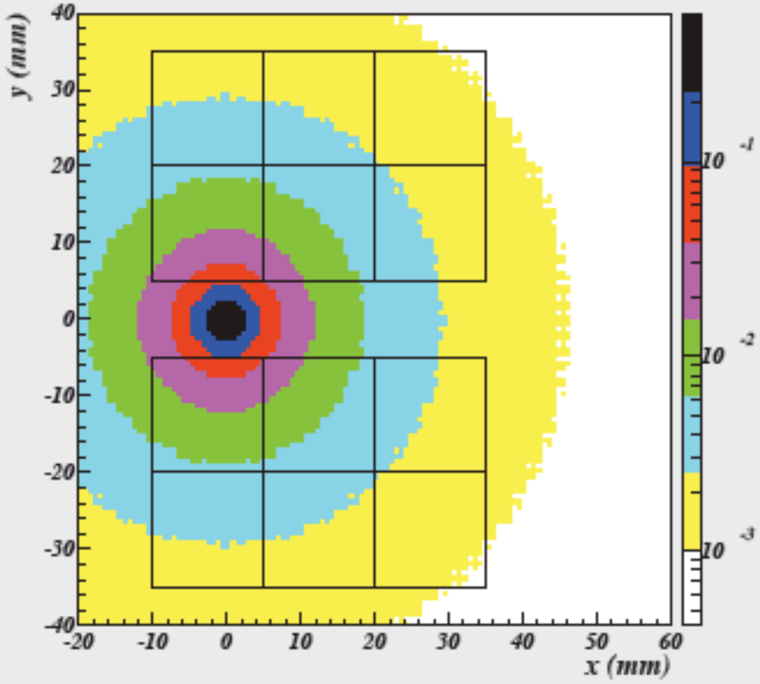

Hamamatsu H10826 SEL

trigger finger scintillator
((60x11x4) mm$^3$



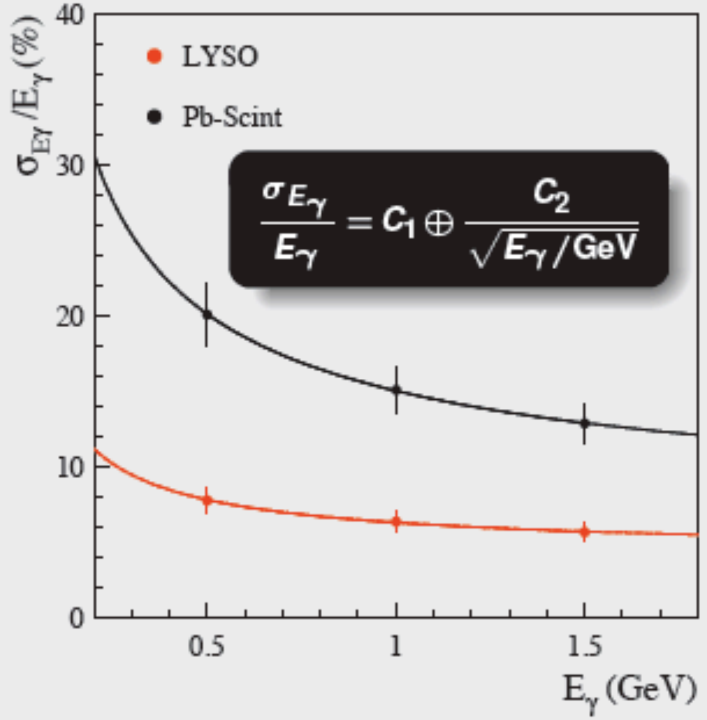
# Energy resolution, the ISR case

## ISR angular distribution on ZDD




| $E_\gamma$ (GeV) | LYSO $\sigma_{E_\gamma}/E_\gamma$ | Pb-Scint $\sigma_{E_\gamma}/E_\gamma$ |
|---|---|---|
| 1.5 | 5.7% | 12.9 % |
| 1.0 | 6.4% | 15.1 % |
| 0.5 | 7.8% | 20.1 % |

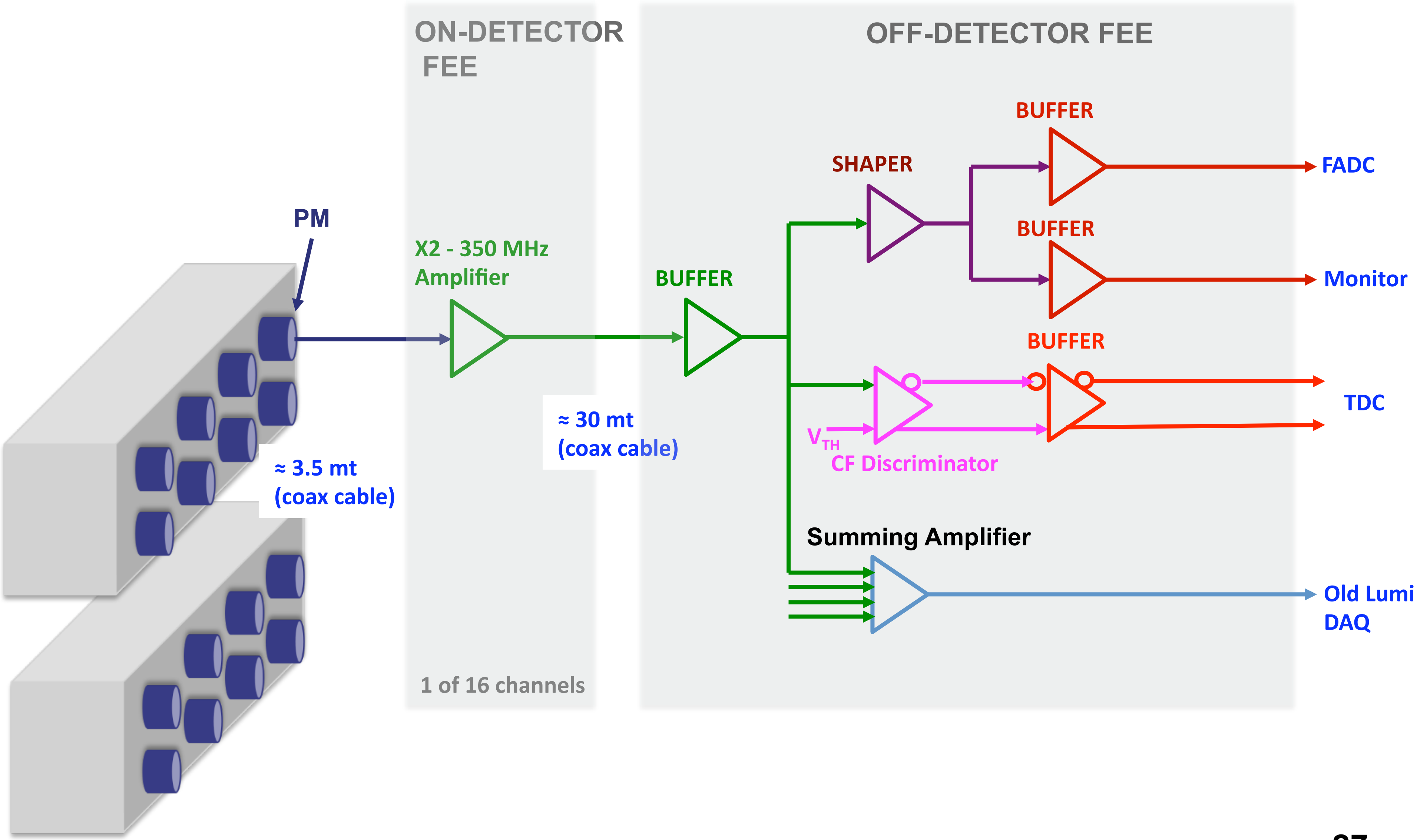
## Energy resolution for ISR




| | LYSO | Pb-Scint |
|---|---|---|
| $C_1$ | 4.3% | 6.9 % |
| $C_2$ | 4.6% | 13.4 % |

# Front End Electronics

(by G.Felici, LNF-SEA)



# Front-End electronics

- Close to the detector (~2m away) a mechanical structure holds:
  - 16 PMs (8 up, 8 dw) and fiber bundles
  - cables: analog OUT (16 x 3 = 48)
  - discriminators OUT (16), PM power IN (16)
- ~20 kgs of electronics