The Zero Degree Detector for BES3: status and installation plan

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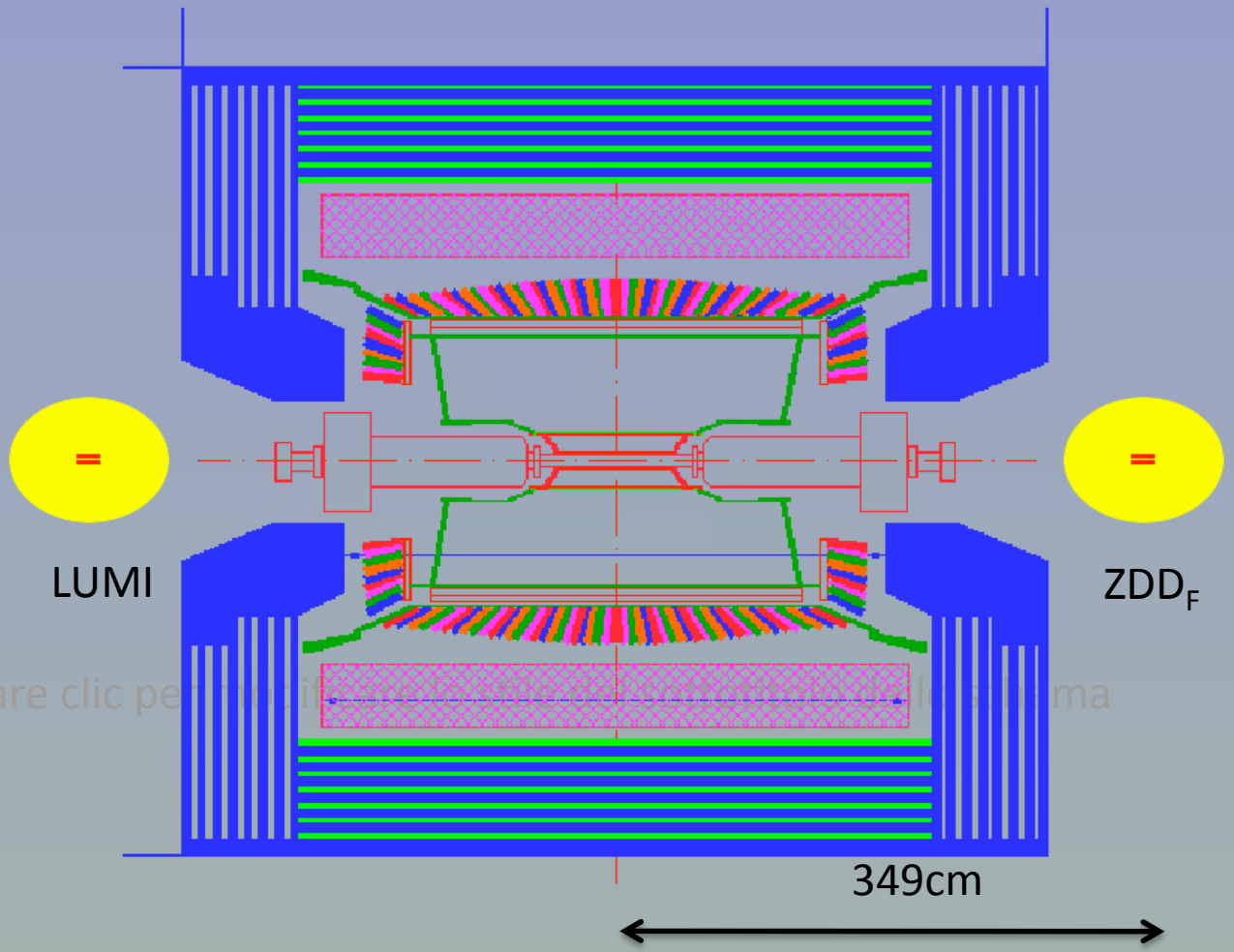
(Frascati, IHEP, Torino)

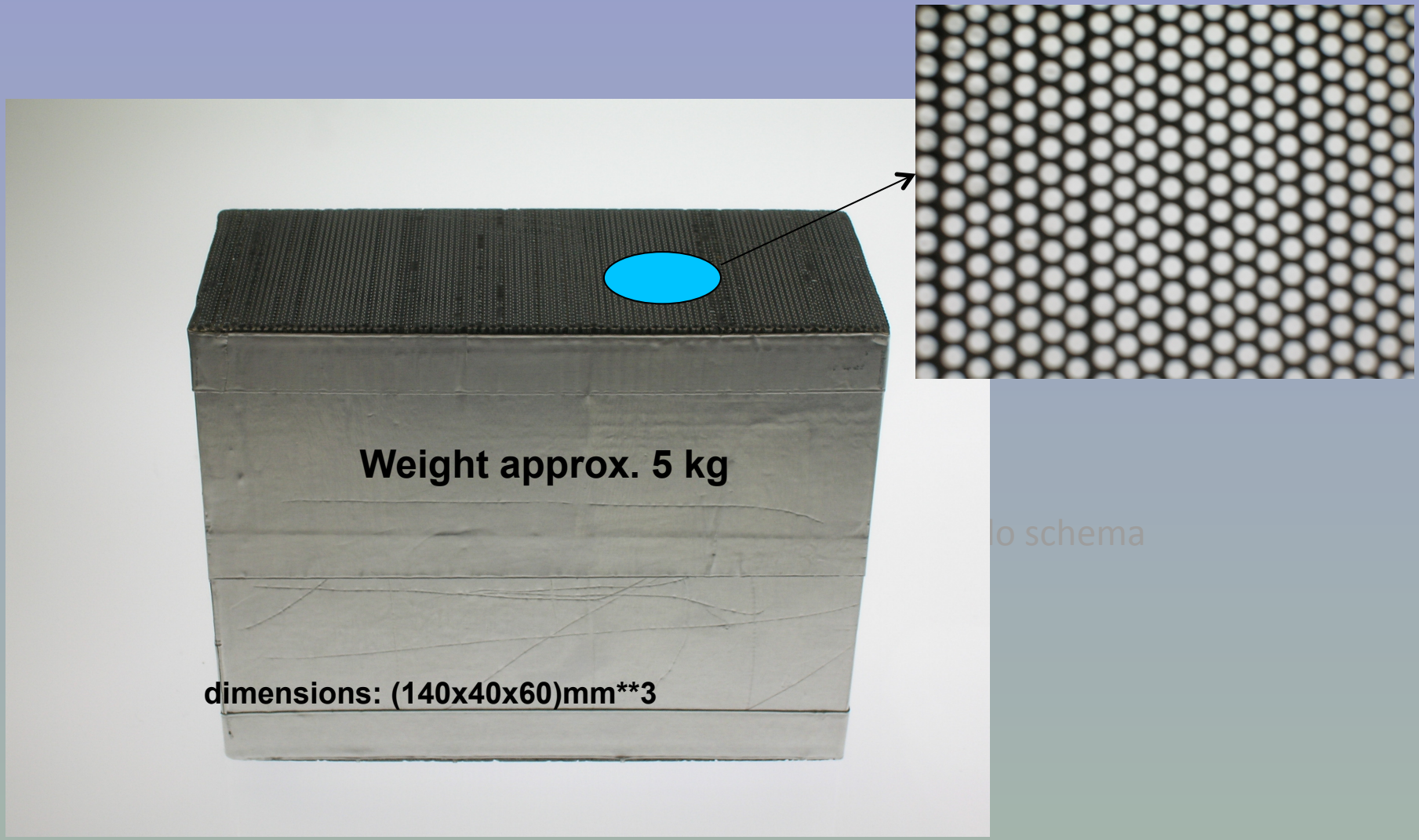
ZDD (Zero Degree Detector) @ BESIII



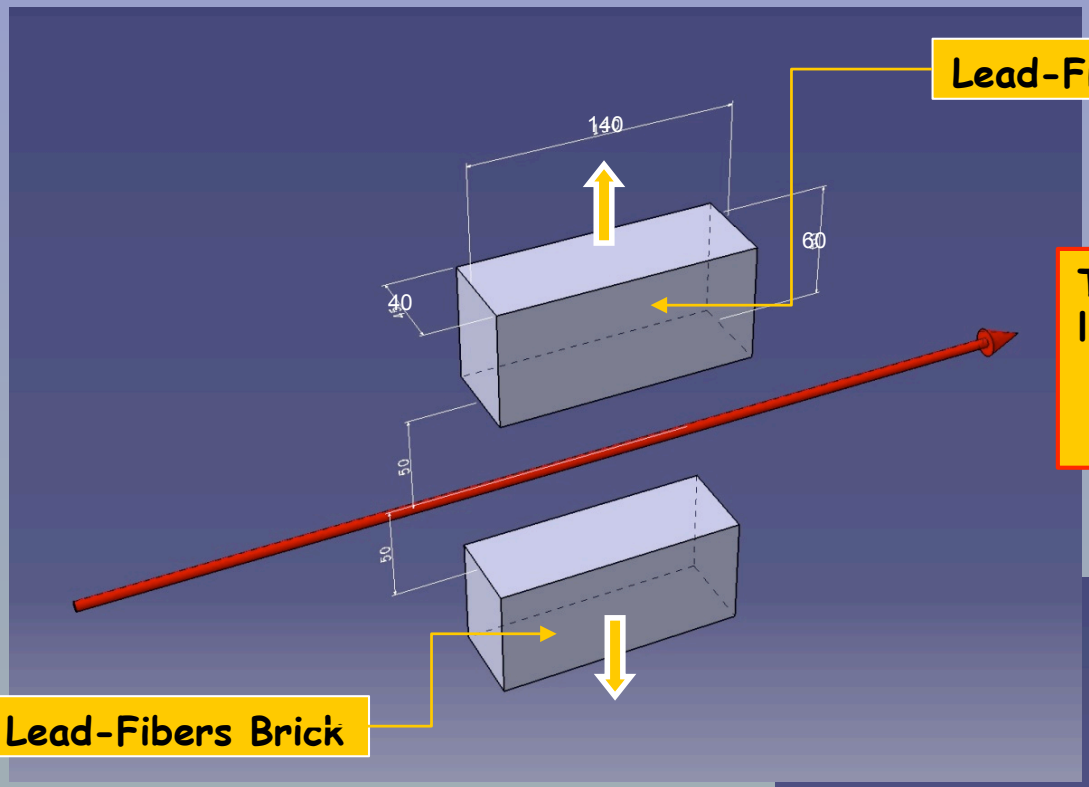
In August will replace one LUMI monitor with a mini-calorimeter ZDD based on the KLOE Pb/Scintillating fibers technique, mainly to detect ISR photons

1° ZDD module,

Pb/Sci.Fi Array, scintillating material 60% of total (in volume)



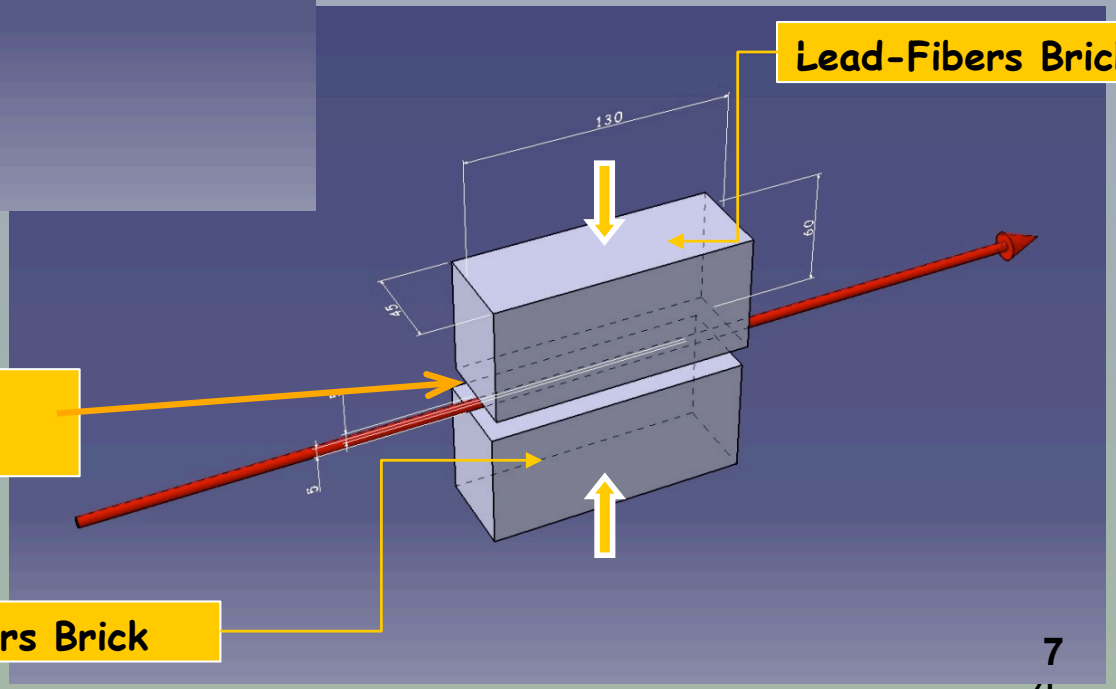
(design by D.Orecchini)



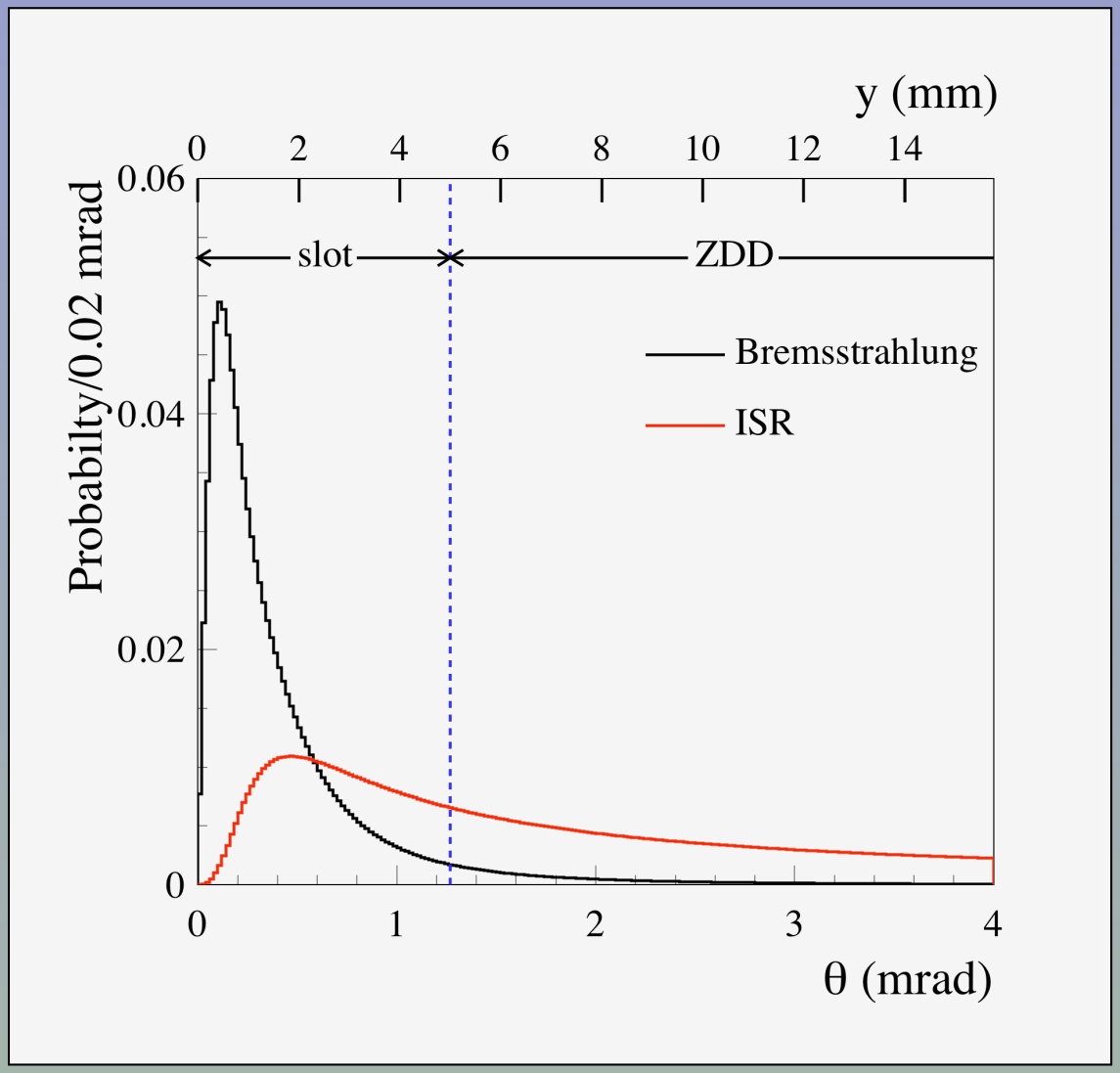
The opposite faces of the two bricks must lift:

a) – Up, to 45mm from the beam;

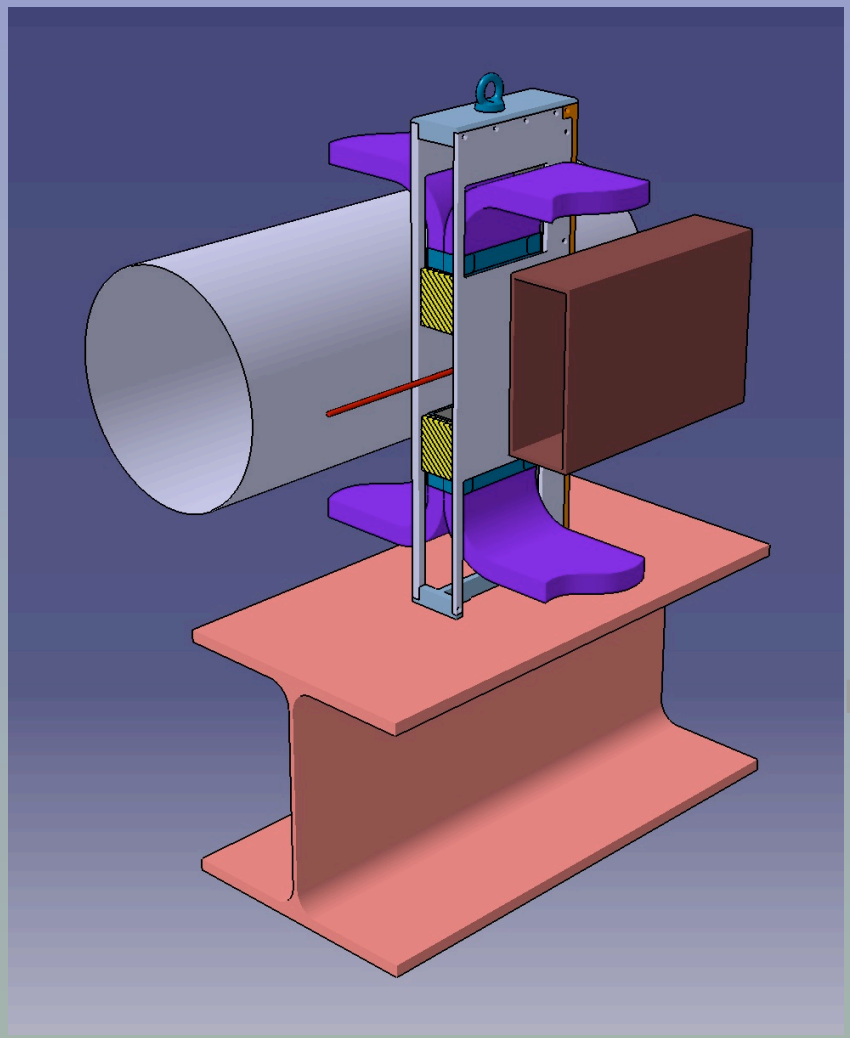
b) – Down, to 5mm from the beam.

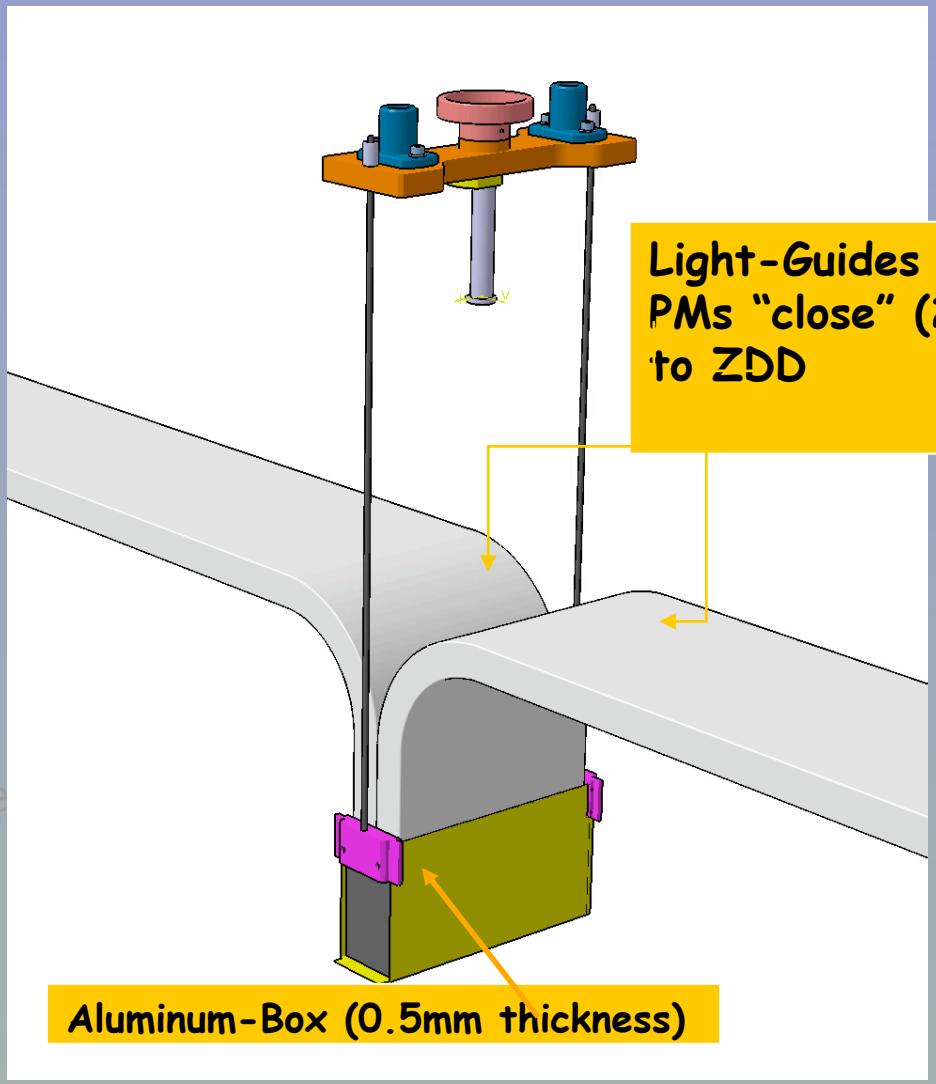


….why the hole?


y (mm)
0
2
4
6
8
10
12
14
0.06
0.04
0.02
0
Probabilty/0.02 mrad
slot
ZDD
Bremsstrahlung
ISR
0
1
2
3
4
θ (mrad)

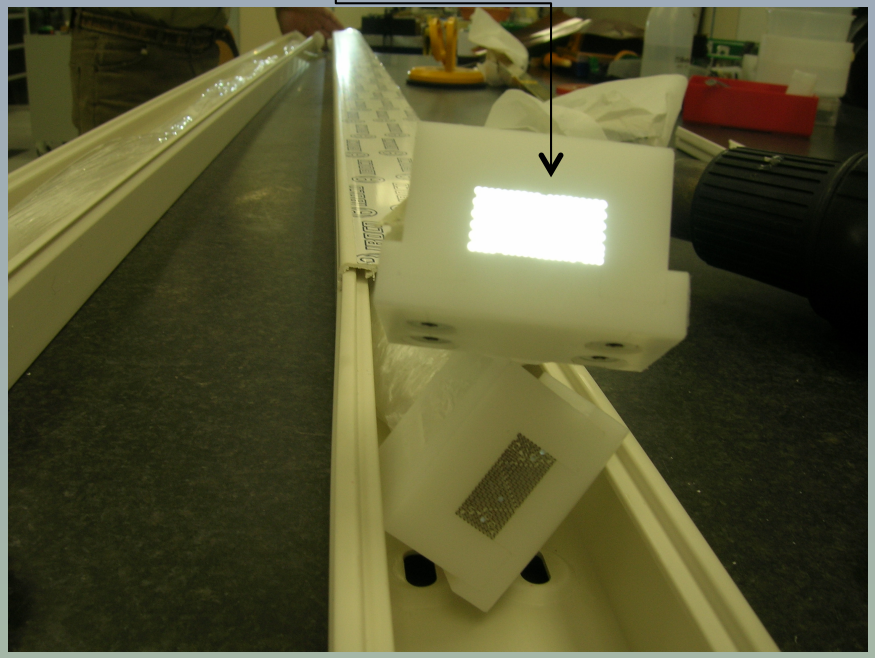
(design by D.Orecchini)

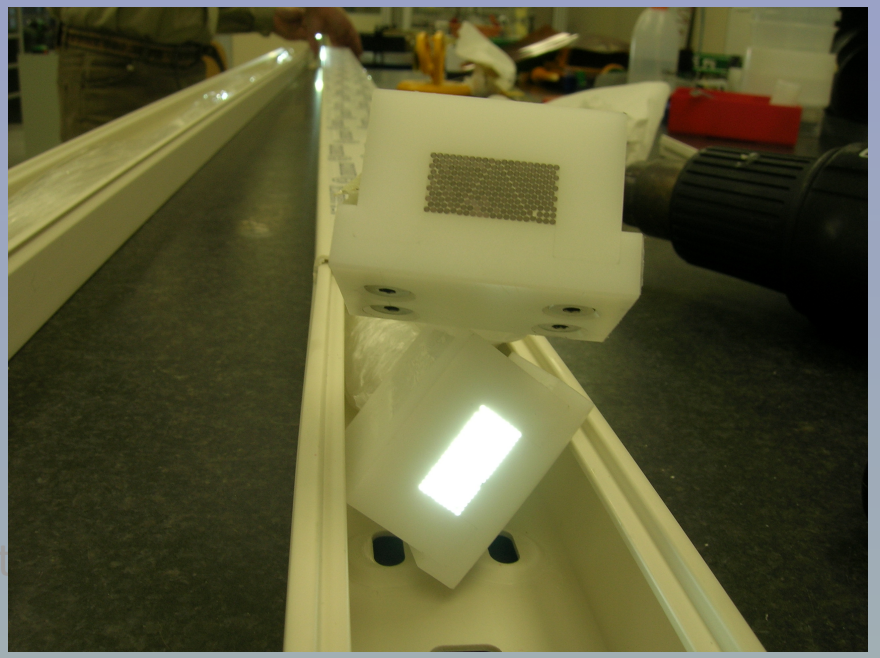




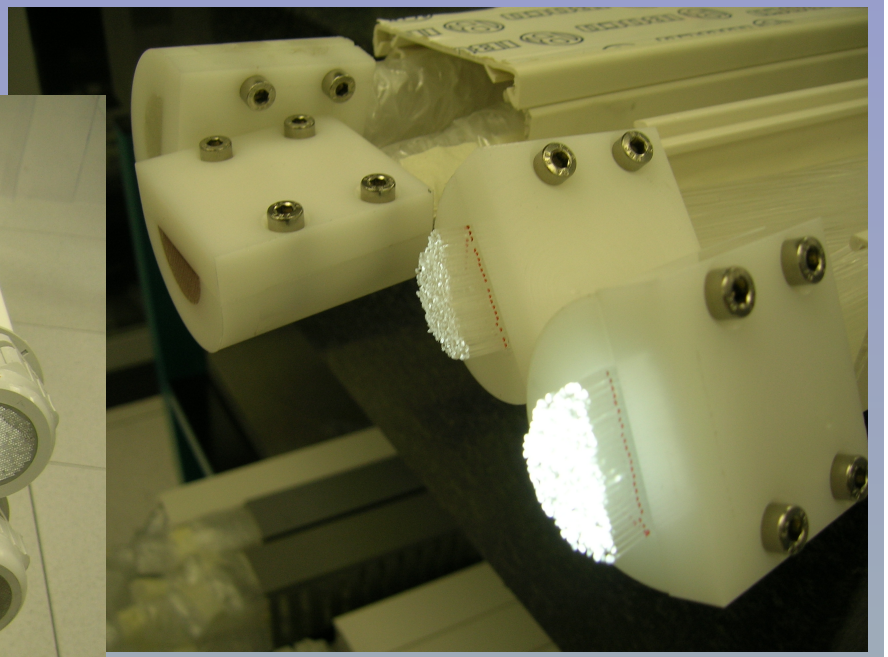
Bundles production (clear fibers): ZDD side (by M.Anelli)

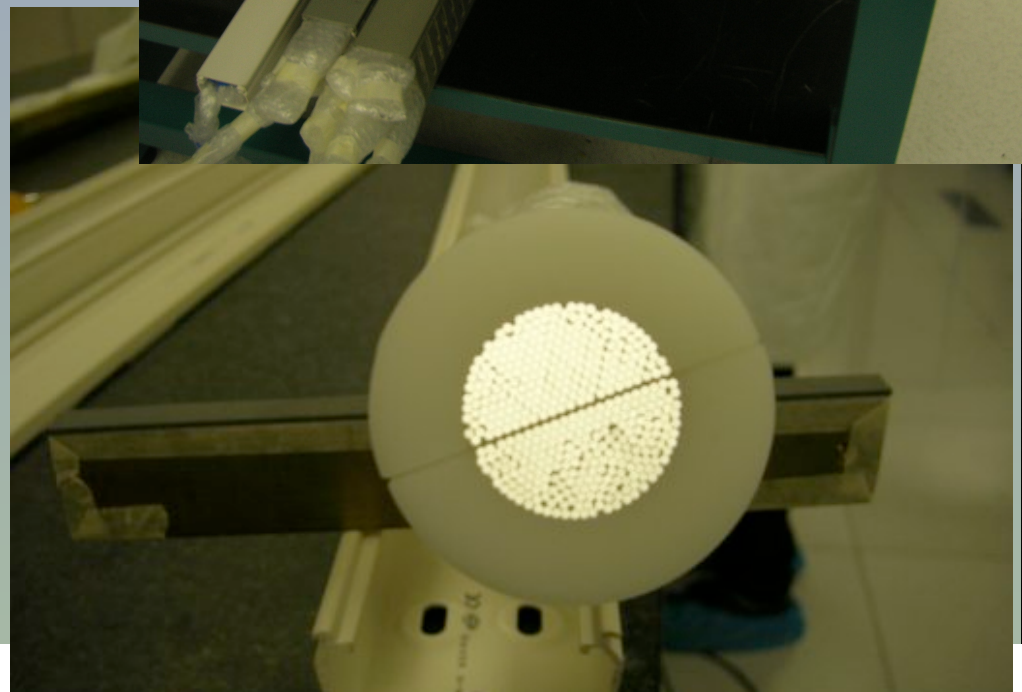
for each module:
$6x(2x4x200)cm^3$ + $4x(1x2x200)cm^3$

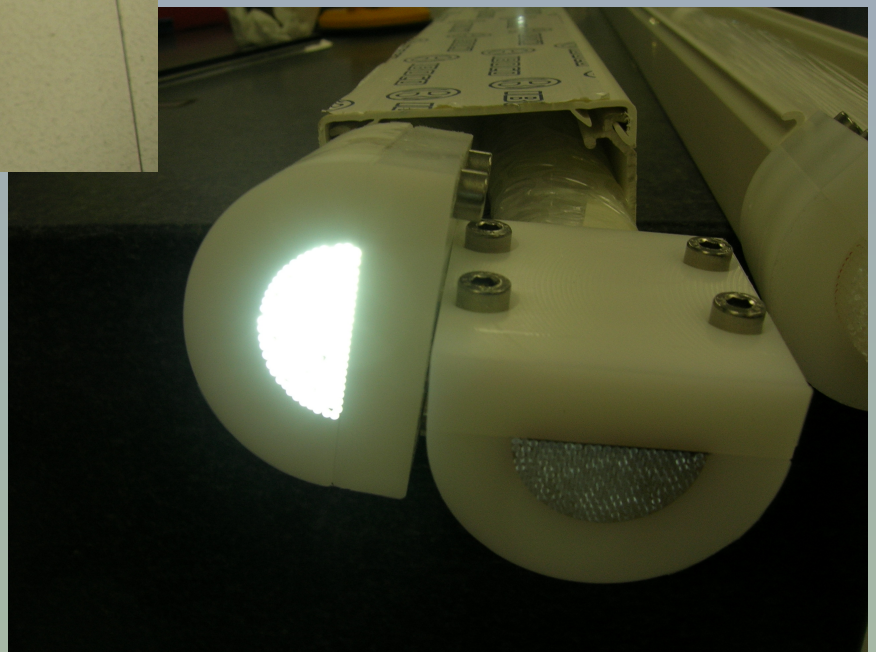




Bundles production (clear fibers): PM side (by M.Anelli)

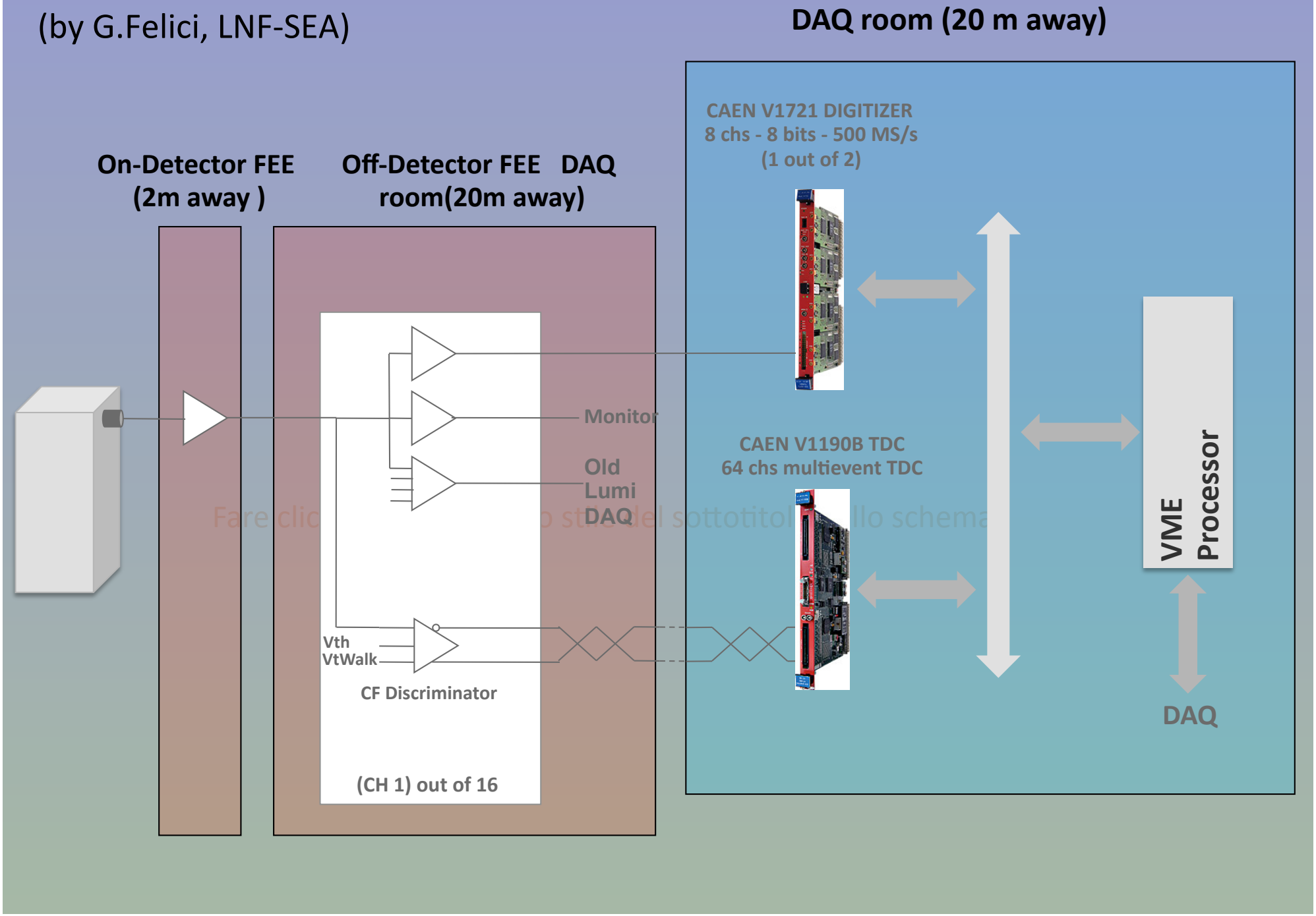






Front End Electronics

(by G.Felici, LNF-SEA)



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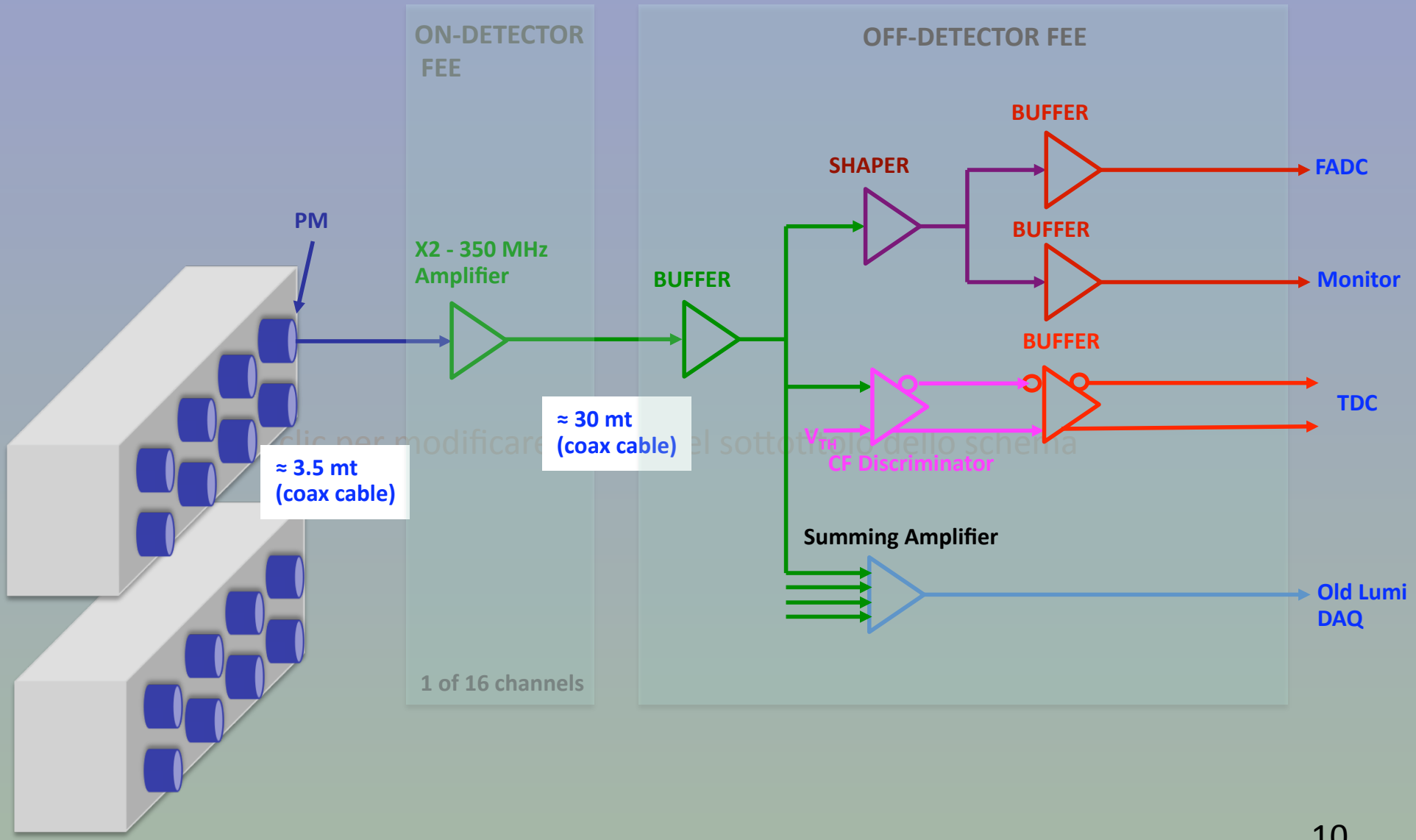


Front-End electronics

Close to the detector (~2m away) a mechanical structure will hold:

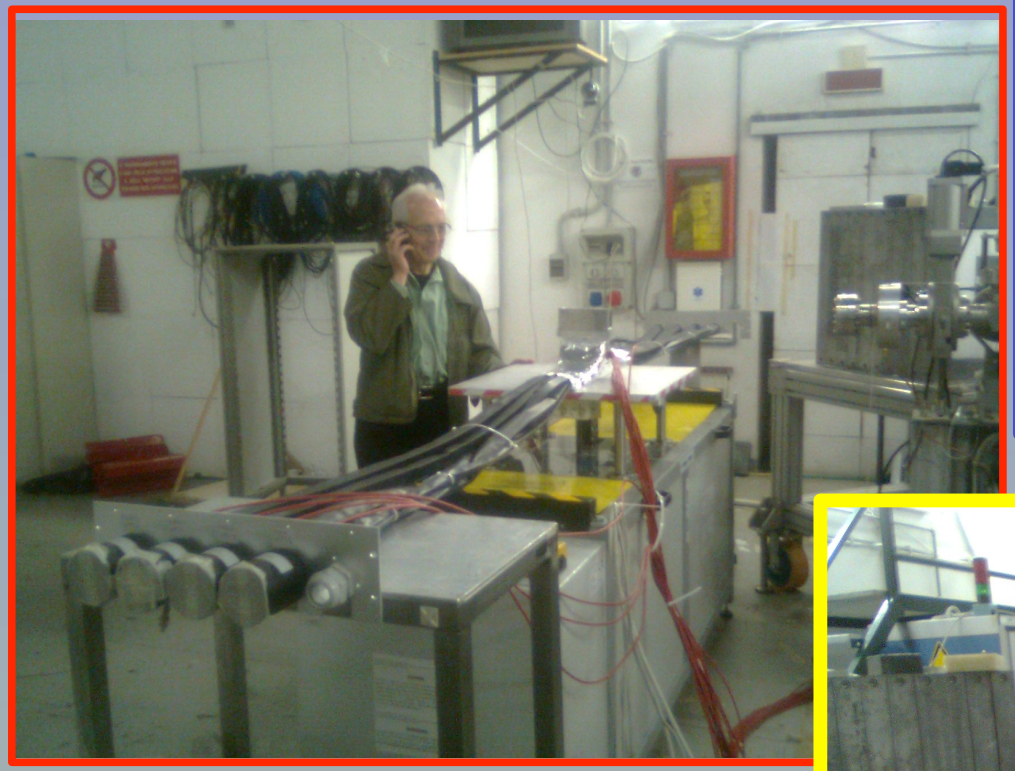
- 16 PMs (8 up, 8 dw) and fiber bundles
- cables: analog OUT (16 x 3 = 48)
- discriminators OUT (16), PM power IN (16)

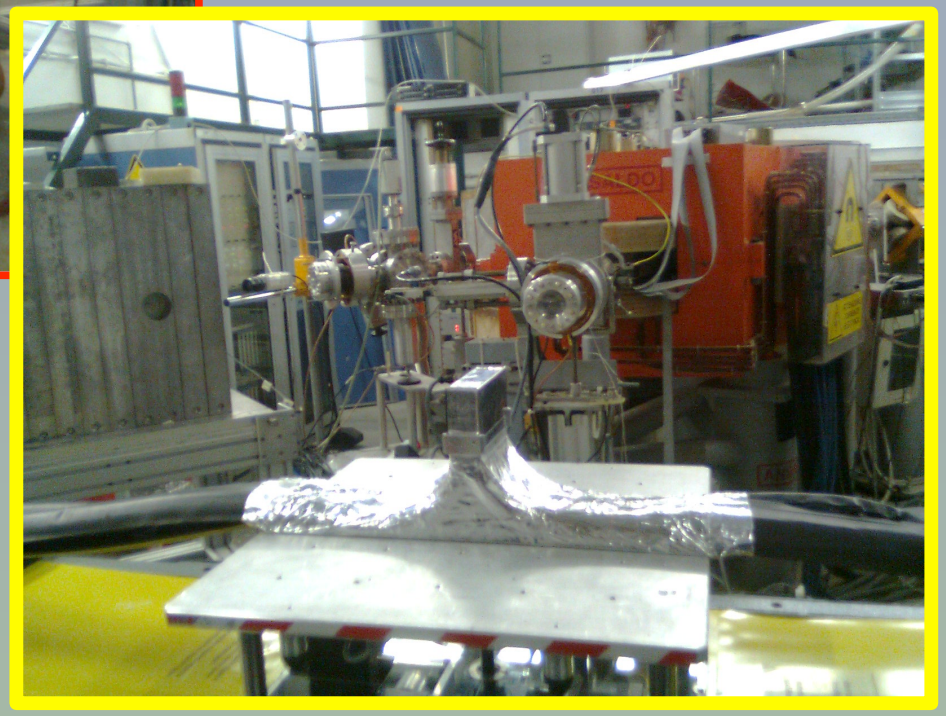
~20 kgs of electronics

May Test beam @ LNF

- May 16-22 one (out of two) modules of ZDD tested at BTF (Beam Test Facility at the DAΦNE Linac) with 450, ~300, ~200 MeV e^- bunches (N_{e^-}=1,2,3)
- final Pb-scifi ZDD first module, bundles guides, PM's, TDC, at the moment not FADC but ADC caen V792N
- Small scintillator (60x11x4) mm^3 used to trigger and select electrons impact point

May Test beam @ LNF

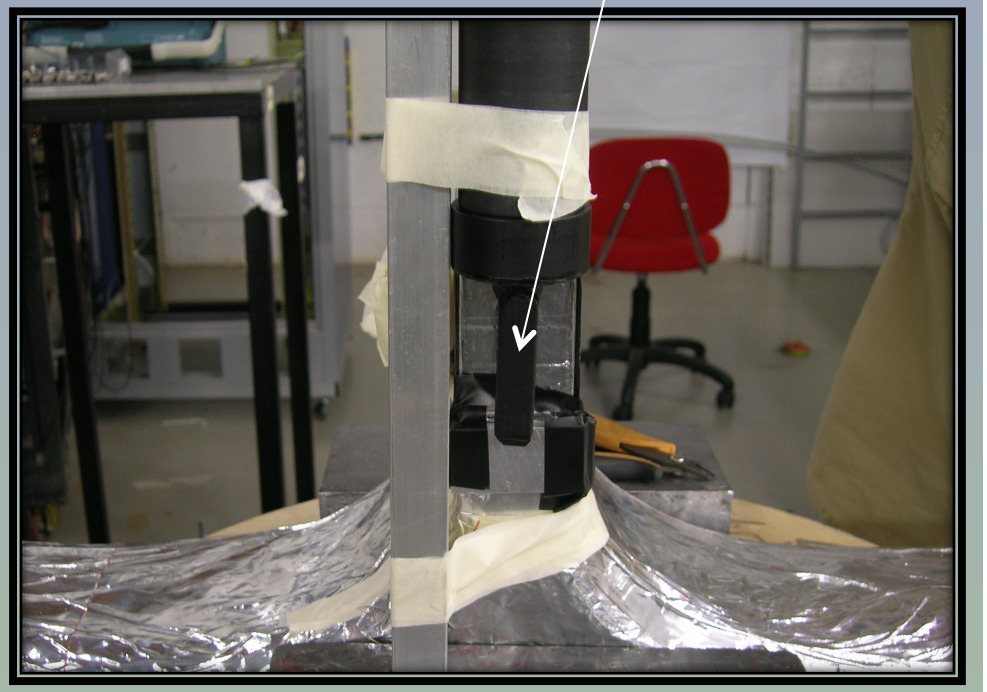




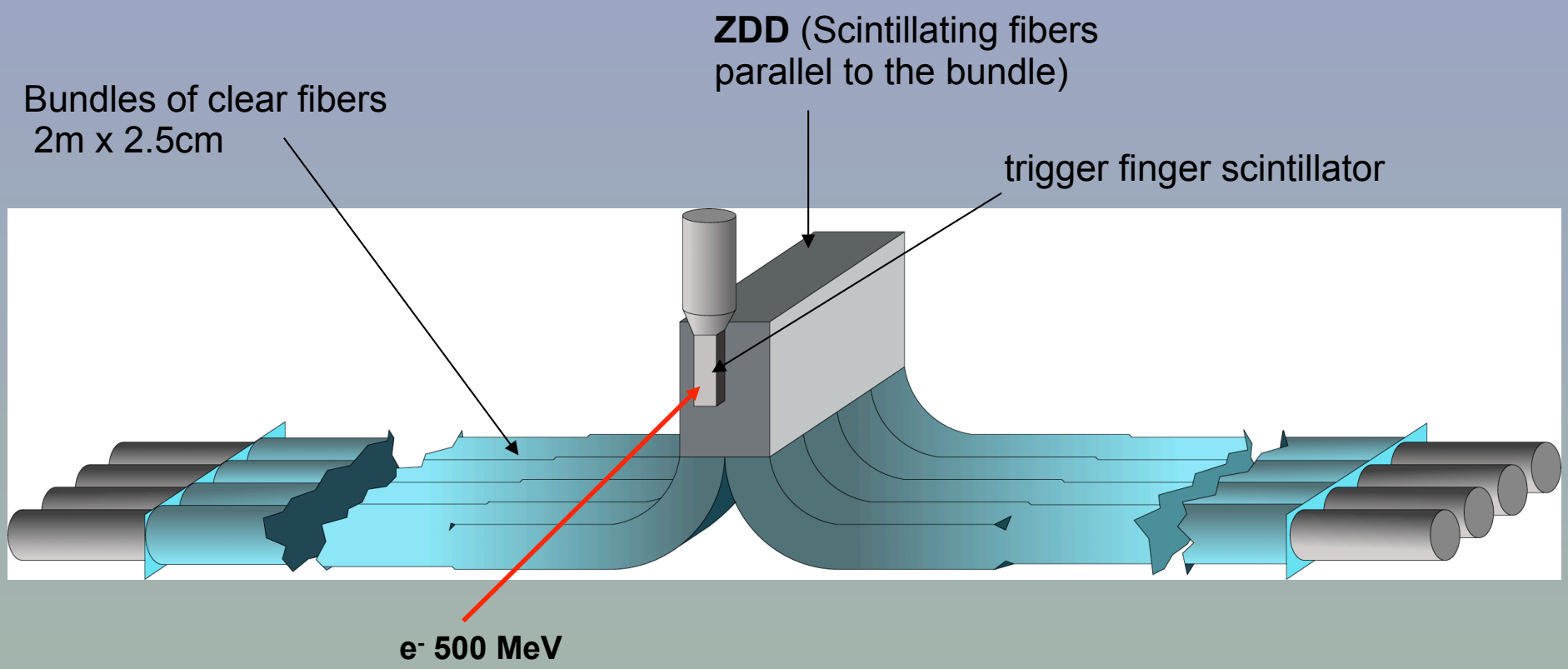
May Test beam @ LNF

Hamamatsu H10826 SEL

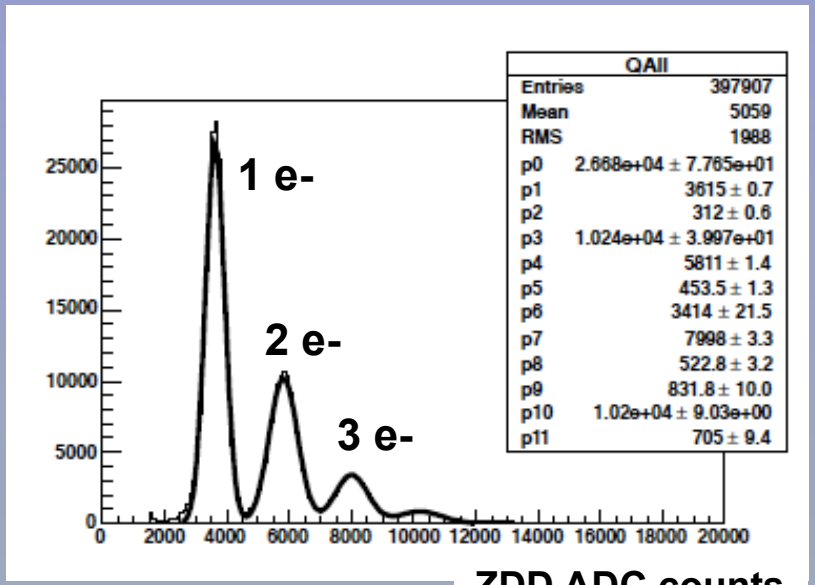
trigger finger scintillator ((60x11x4) mm^3



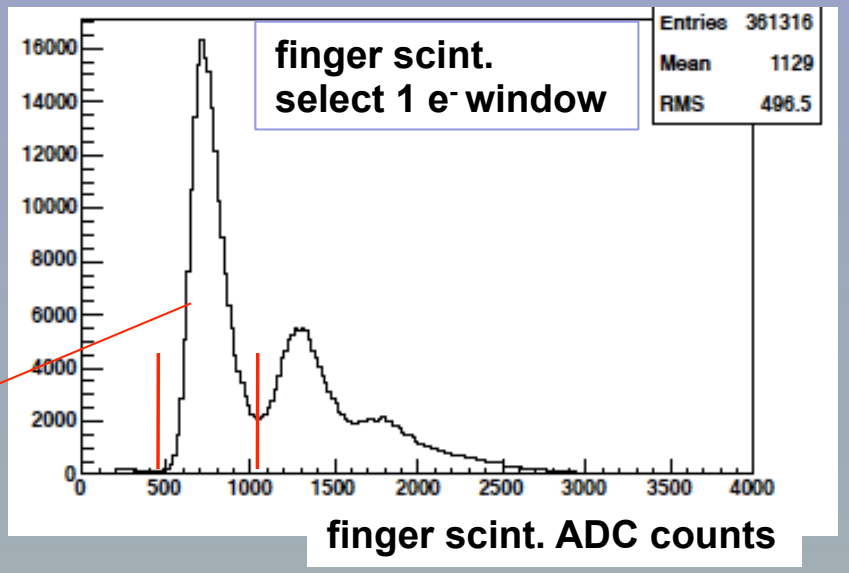
May Test beam setup



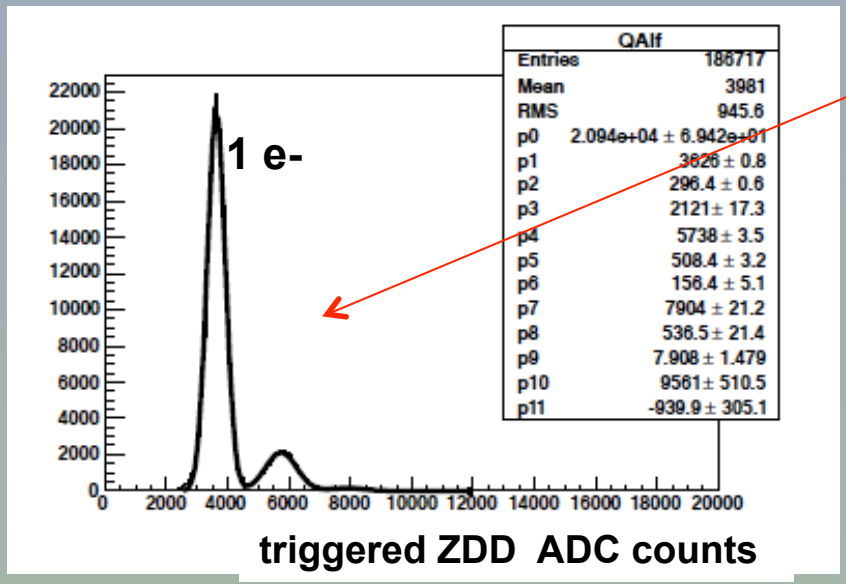
May Test beam @ LNF: preliminary results



ZDD ADC counts

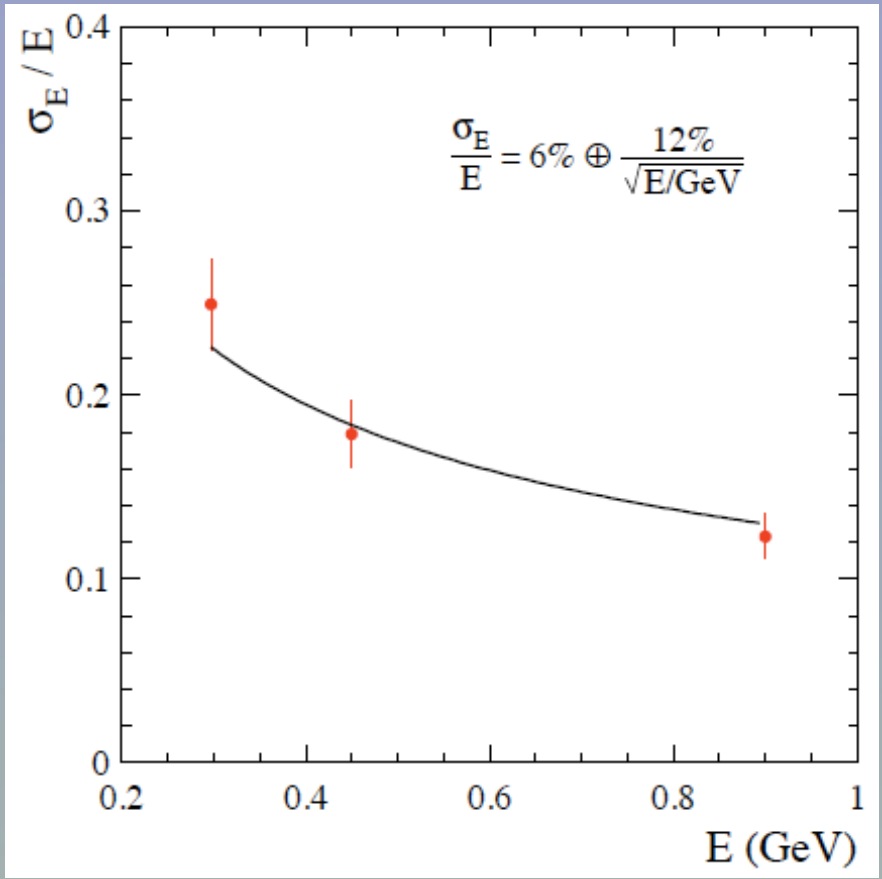


finger scint. ADC counts



triggered ZDD ADC counts

May Test beam @ LNF: preliminary energy resolution

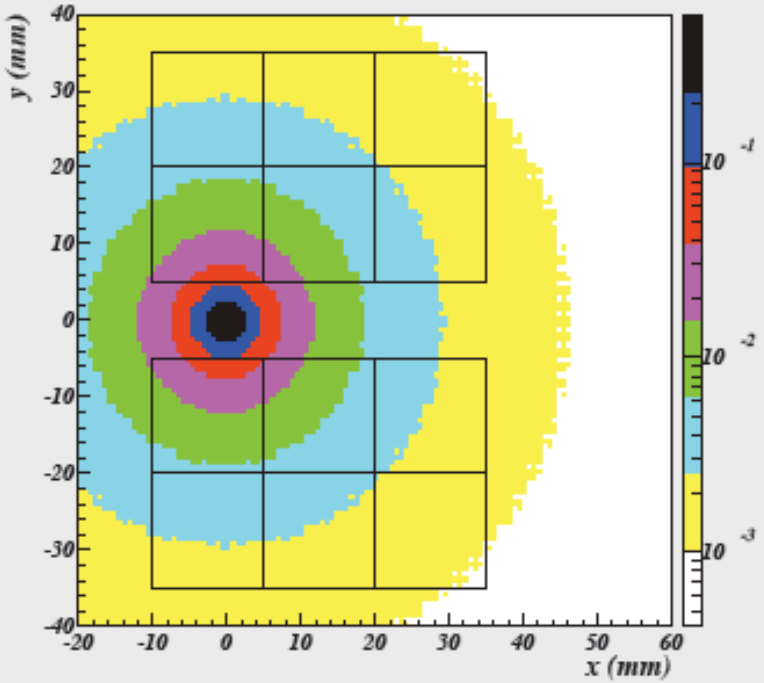


Preliminary (PM not equalised) energy resolution as expected from MC studies and KLOE results

-work in progress for energy calibration and PM equalisation
-on going: cosmic rays test
-end of June: BTF test of second ZDD module with final electronics

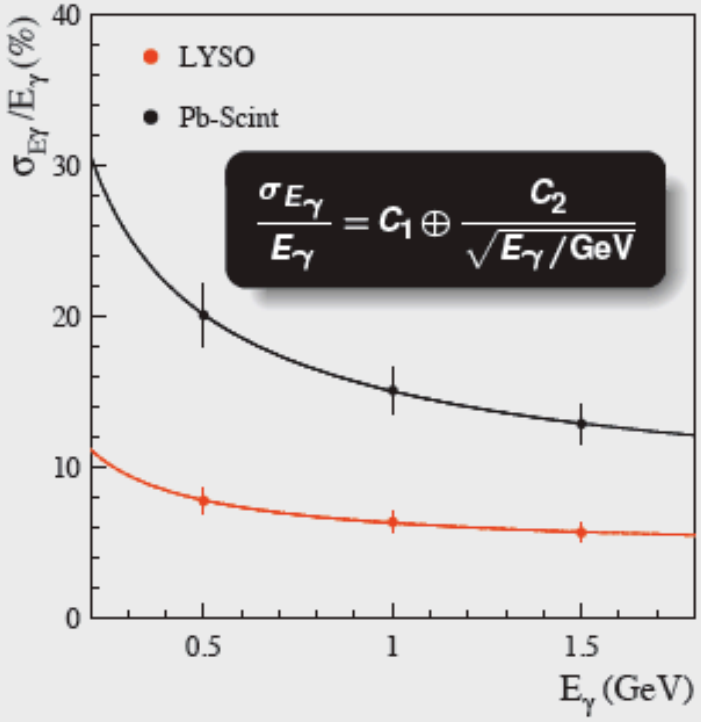
Energy resolution, the ISR case

ISR angular distribution on ZDD



E_γ (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 %

DAQ problem: data size

- FADC should be configured with long windows and triggered via L1
  - CAEN software for now forces complete readout of all memory:
    7 μs => 3500 bytes * 16 channels * 4 kHz = 200 MBytes/s
  - Much more than all the rest of BESIII together
  - Asked to CAEN to rearrange memory more efficiently (initial parts first for all channels) or to implement random memory readout

- In the first phase of next run, we plan to read FADCs via optical cables
- These will connect to a separate PC with a card made by CAEN. This card can read 4 cables.
- In principle, each optical cable path is rated around 100 MB/s
- This could be just enough to run with long windows

Status and Time schedule

- 1 complete module (ZDD+Bundles+PM) ready and tested @ LNF
- Second module being assembled, ready next week
  - will be tested in June

- Light guides bundles per both modules ready:
  - 12x(2x4x200)cm^3 + 8x(1x2x200)

- Holding Tower in preparation, will be ready by June

- FEE electronics: test modules ready, being tested with cosmic rays, production will start by mid of June to be completed by July.

- Shipping: beginning of August, 2011
- Installation at BEPCII:
  - From August 22nd to September 4th, 2011
- Commissioning at BEPCII:
  - at the start of data taking (October/November ?)
  - separate DAQ to be sent to BESIII data flow

谢谢！

Fare clic per modificare lo stile del sottotitolo dello schema

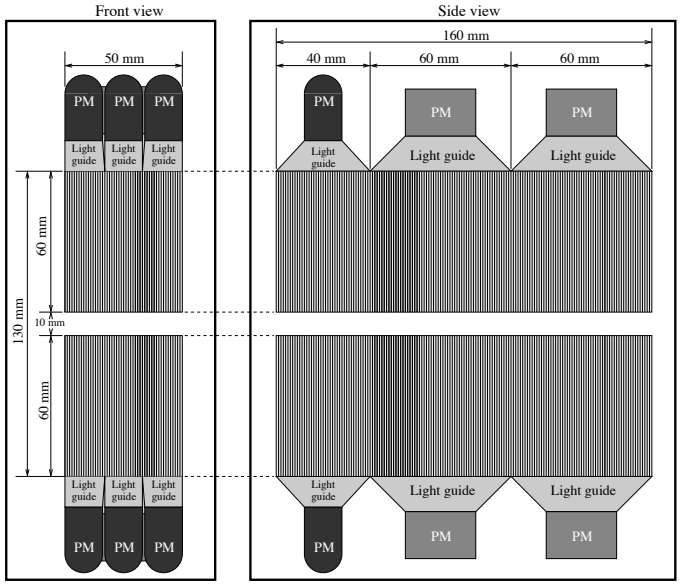
SPARE slides

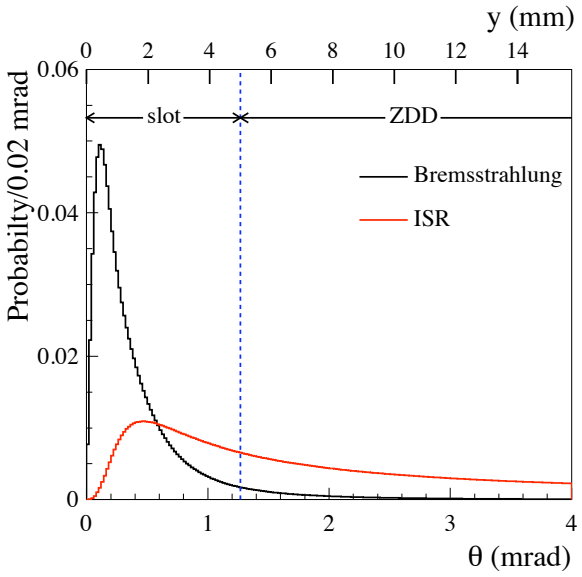
Fare clic per modificare lo stile del sottotitolo dello schema

Pb-Scifi design a` la Kloe

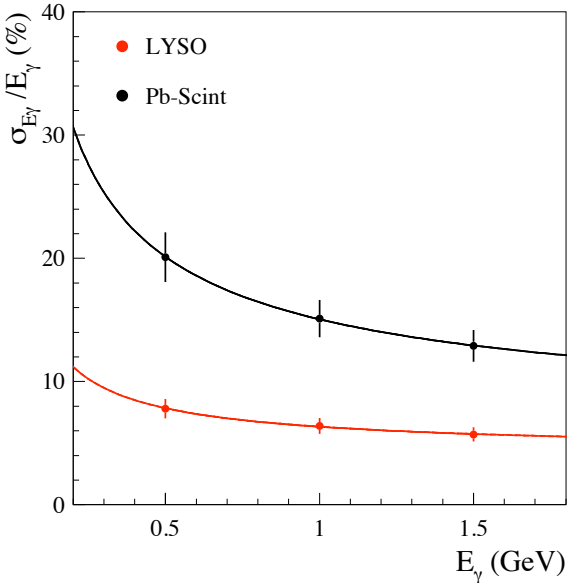
(INFN CSN1 meeting July 2010):

- Kloe prototype module zero available for cutting (thanks to Kloe collab.)
- mechanical vertical movement to vary the opening





- $E_{beam} = 1.89$ GeV
- $E_{\gamma}^{min} = 50$ MeV
- $\sigma_{Bre}(4\pi) = 353$ mb
- $\sigma_{Bre}(ZDD) = 10$ mb
- $\mathcal{L} = 8 \times 10^{32}$ cm^{-2} s^{-1}



$$\frac{\sigma_{E_\gamma}}{E_\gamma} = C_1 \oplus \frac{C_2}{\sqrt{E_\gamma / \text{GeV}}}$$

	LYSO	Pb-Scint
C_1	4.3%	6.9 %
C_2	4.6%	13.4 %
τ(ns)	40	2.5

- ISR in ZDD 13.7% of total solid angle
- Bremsstrahlung in ZDD 2.8% of total solid angle
- Bremsstrahlung rate in a single ZDD element (upper or lower):

800 kHz at $\mathcal{L} = 3 \times 10^{32}$ cm^{-2} s^{-1}
2.1 MHz at $\mathcal{L} = 8 \times 10^{32}$ cm^{-2} s^{-1}

2011 run test with Pb-Scifi with better timing resolution dealing with high rates.

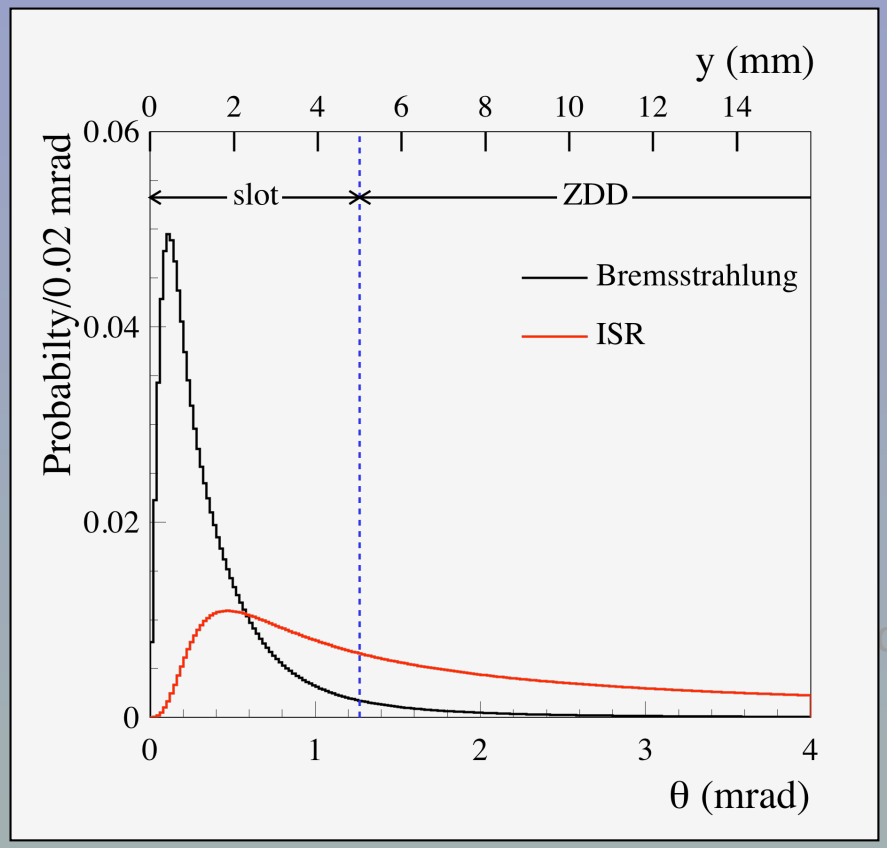
Physical properties of materials

Material	LYSO	Pb-Scint (**Kloe prototype**)
Density (g/cm^3)	7.4	5.3
Radiation Length (cm)	1.1	1.6
Molière Radius (cm)	1.9	2.9
Decay Constant (ns)	40-44	2.4
Peak Emission (nm)	428	460
Radiation Hardness (rad)	$\sim 10^8$	$\sim 10^6$

- $\sigma_{Bre}(ZDD/4) = 2.6$ mb
- $T = 1.5 \times 10^7$ s
- $\overline{\mathcal{L}} = 1.5 \times 10^{32}\ cm^{-2}s^{-1}$
- $E_{c.m.} = 3.77$ GeV

$$\Rightarrow \quad \frac{\text{dose absorbed}}{\text{year}} = \begin{cases} 0.4\ \frac{\text{Mrad}}{\text{year}} & \text{LYSO} \\ 1\ \frac{\text{Mrad}}{\text{year}} & \text{Scint} \end{cases}$$

Accidental coincidences on ZDD due to eeγ

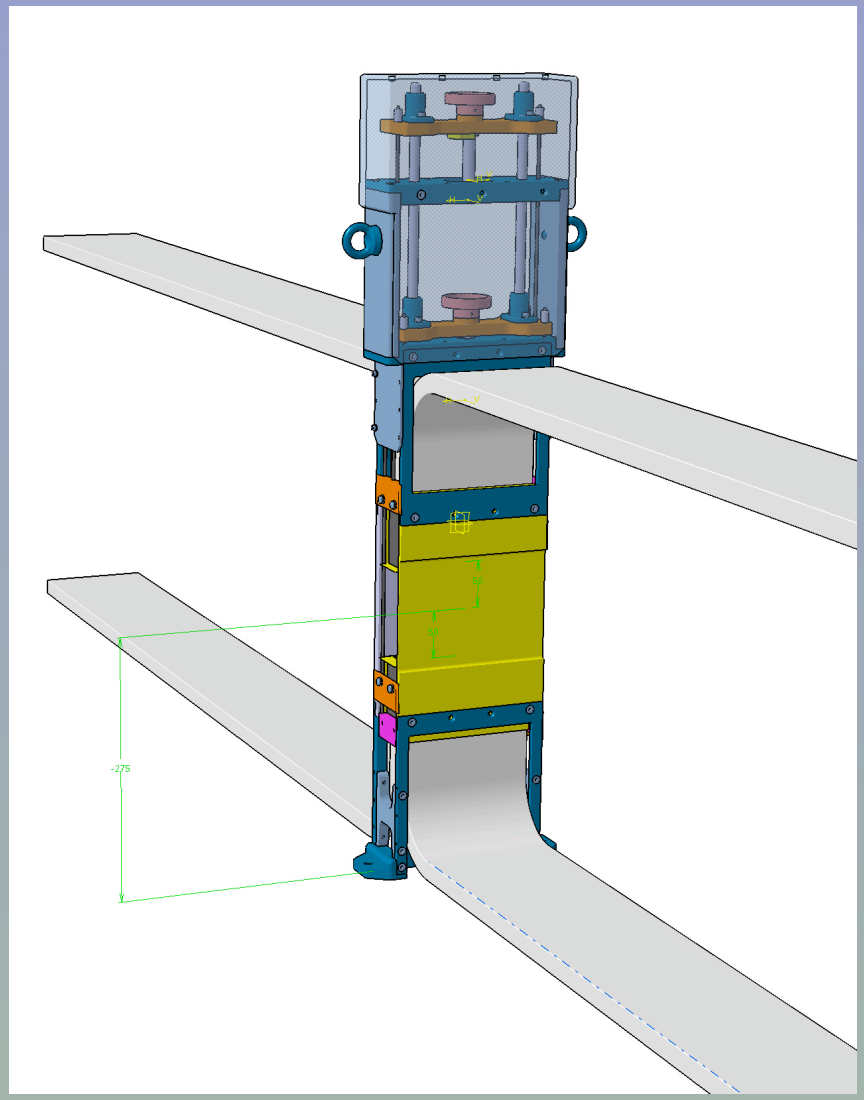


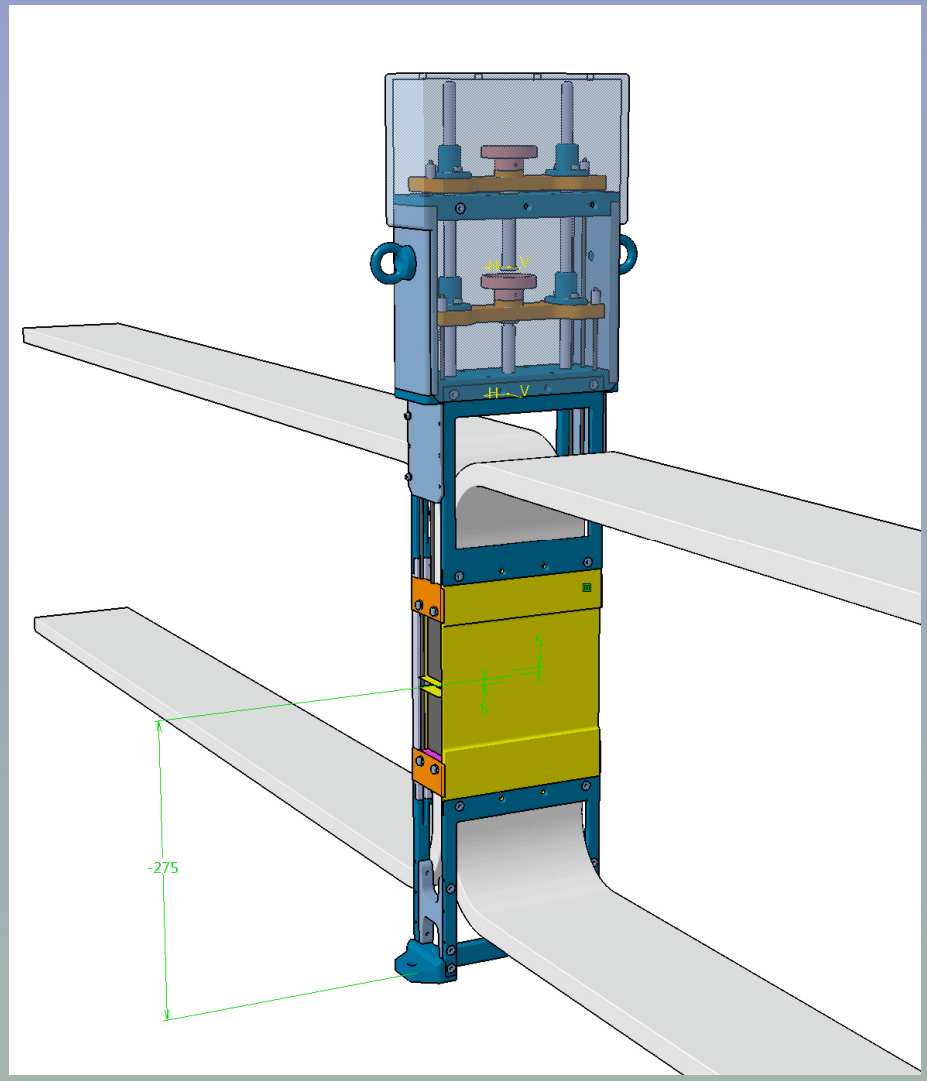
On ZDD standalone eeγ rate is too much higher than ISR rate:
-look for ISR candidates events in BESIII
-than look for a γ in coincidence in ZDD
-for these events the probability P of a γ from eeγ to fake an ISR event or overlap it :

del sottotitolo dello schema

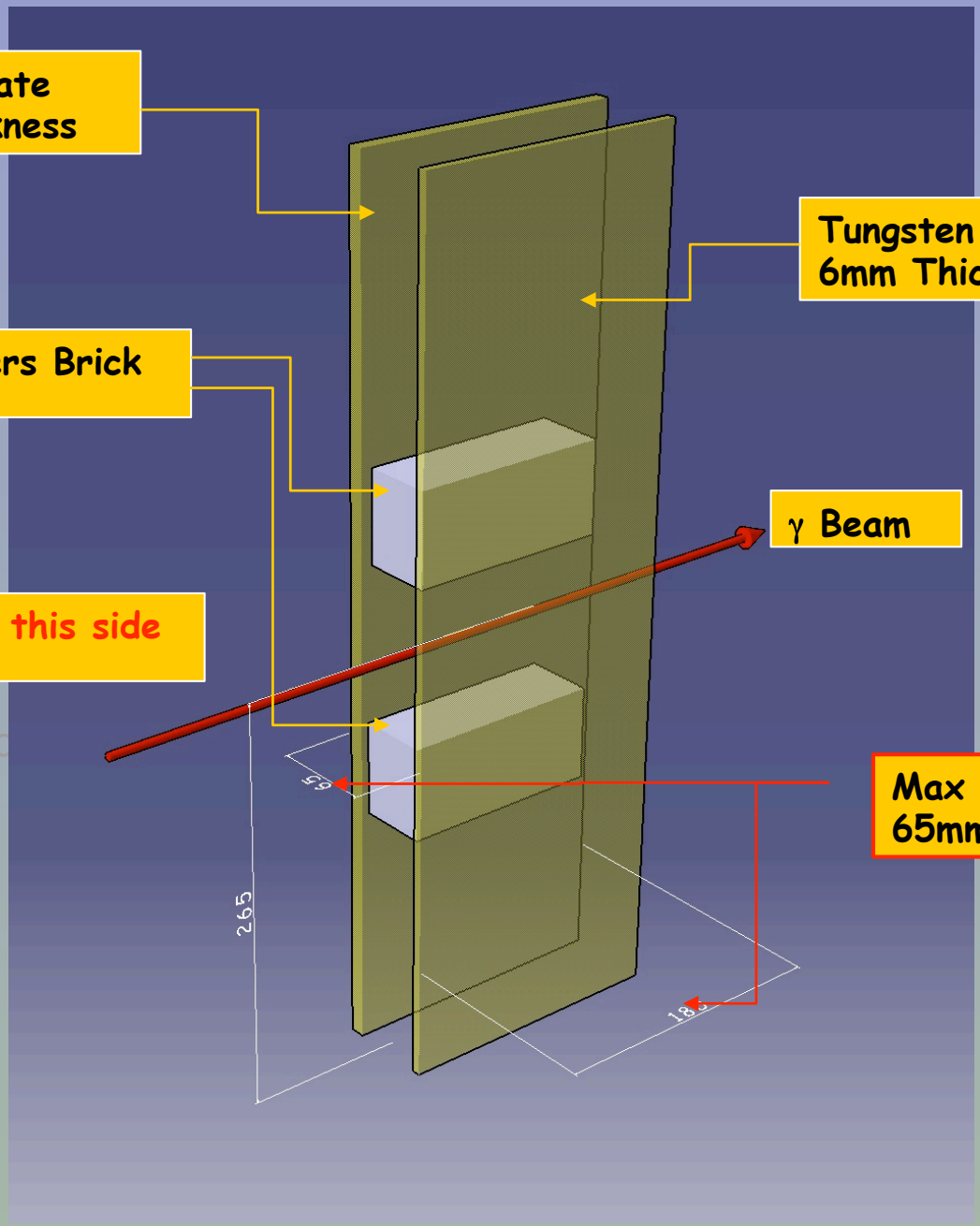
P=σ ε L Δt ~ 2% → 25% in the 100ns time window of ZDD signal

σ(E>100MeV)=170mb
ε=3%
L=5E32cm-2s-1
Δt = 8ns bunch spacing

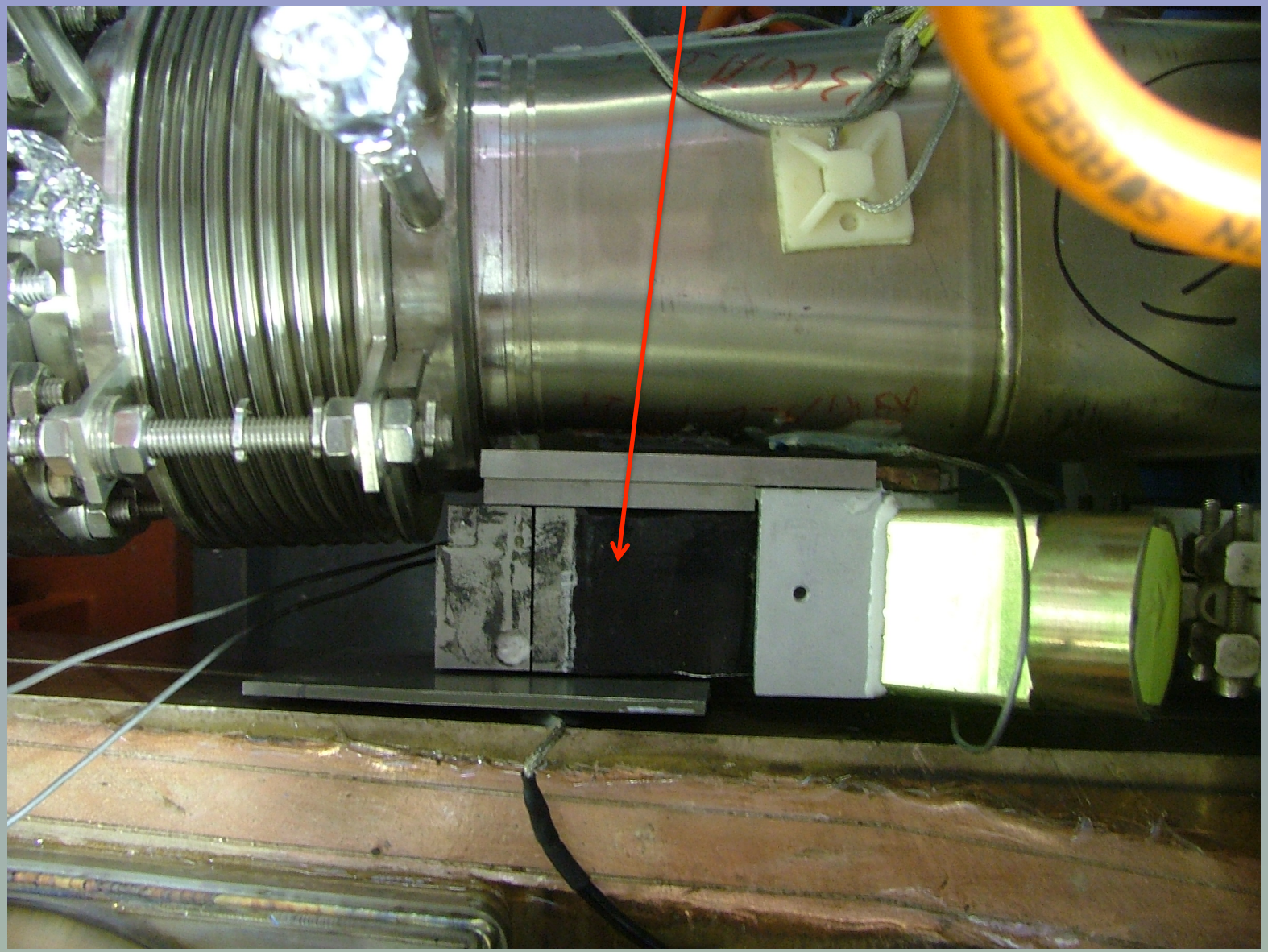

-275


-275

(design by D.Orecchini)

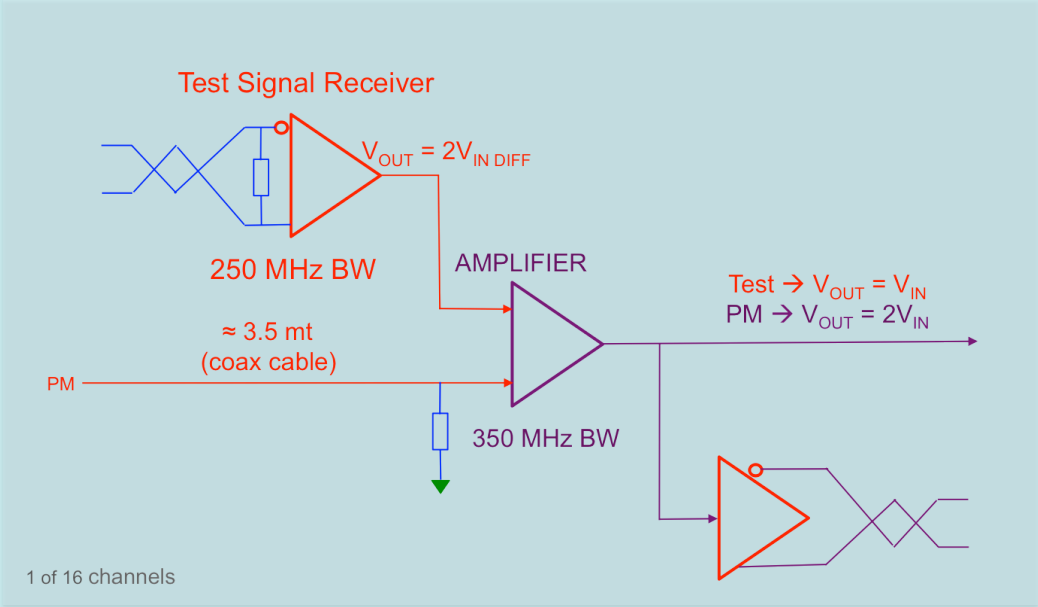


Present BESIII Lumi detector

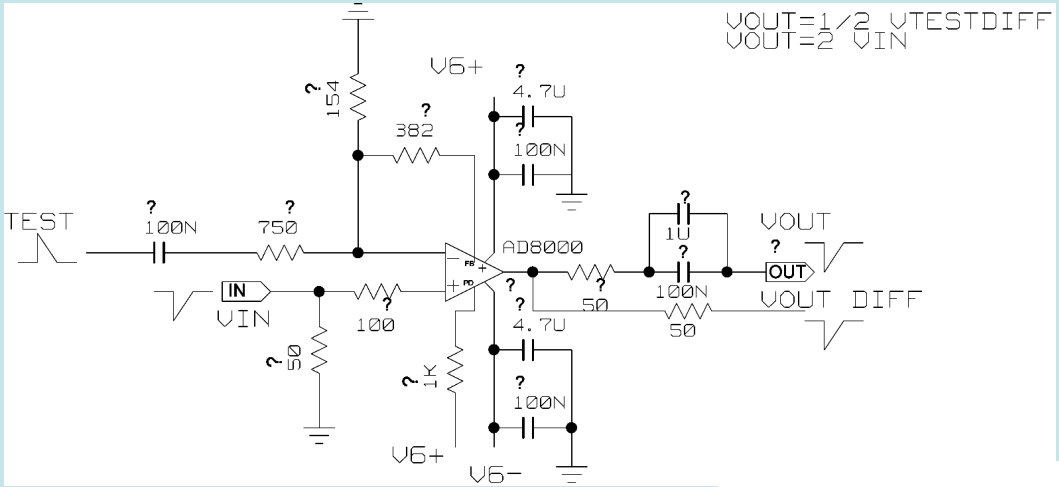


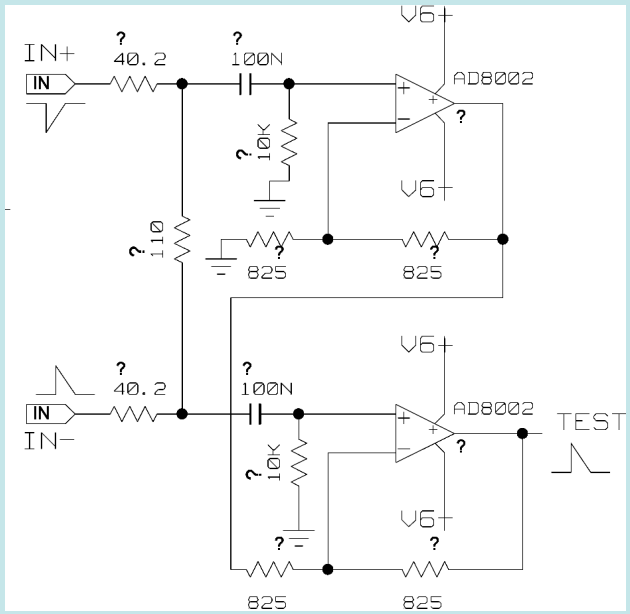
On-Detector FEE – Block Diagram & Requirements

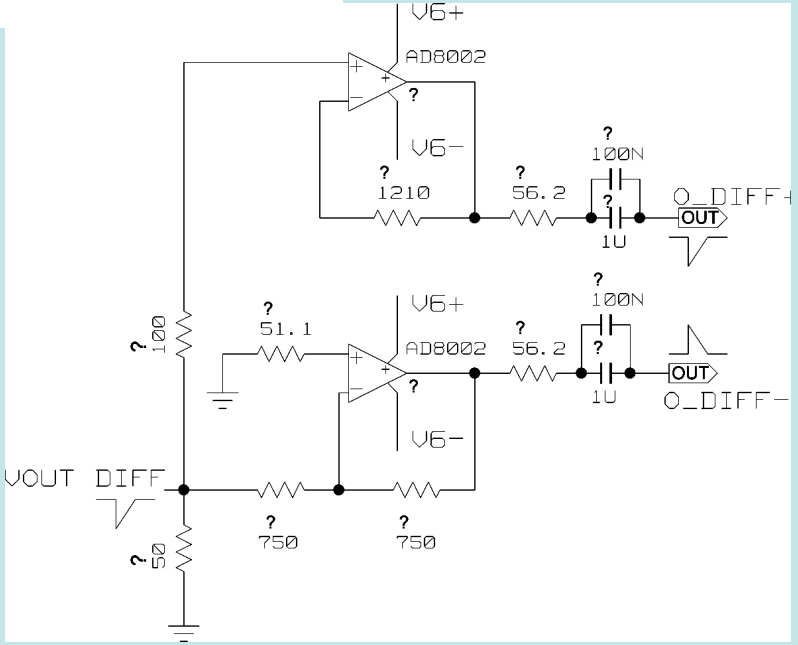
- 16 input signals from PM (40mV – 400 mV range - 1.5 ns rise time - negative polarity)
- ≈ 3 mt coax cable input connections - ≈ 30 mt coax cable output connections



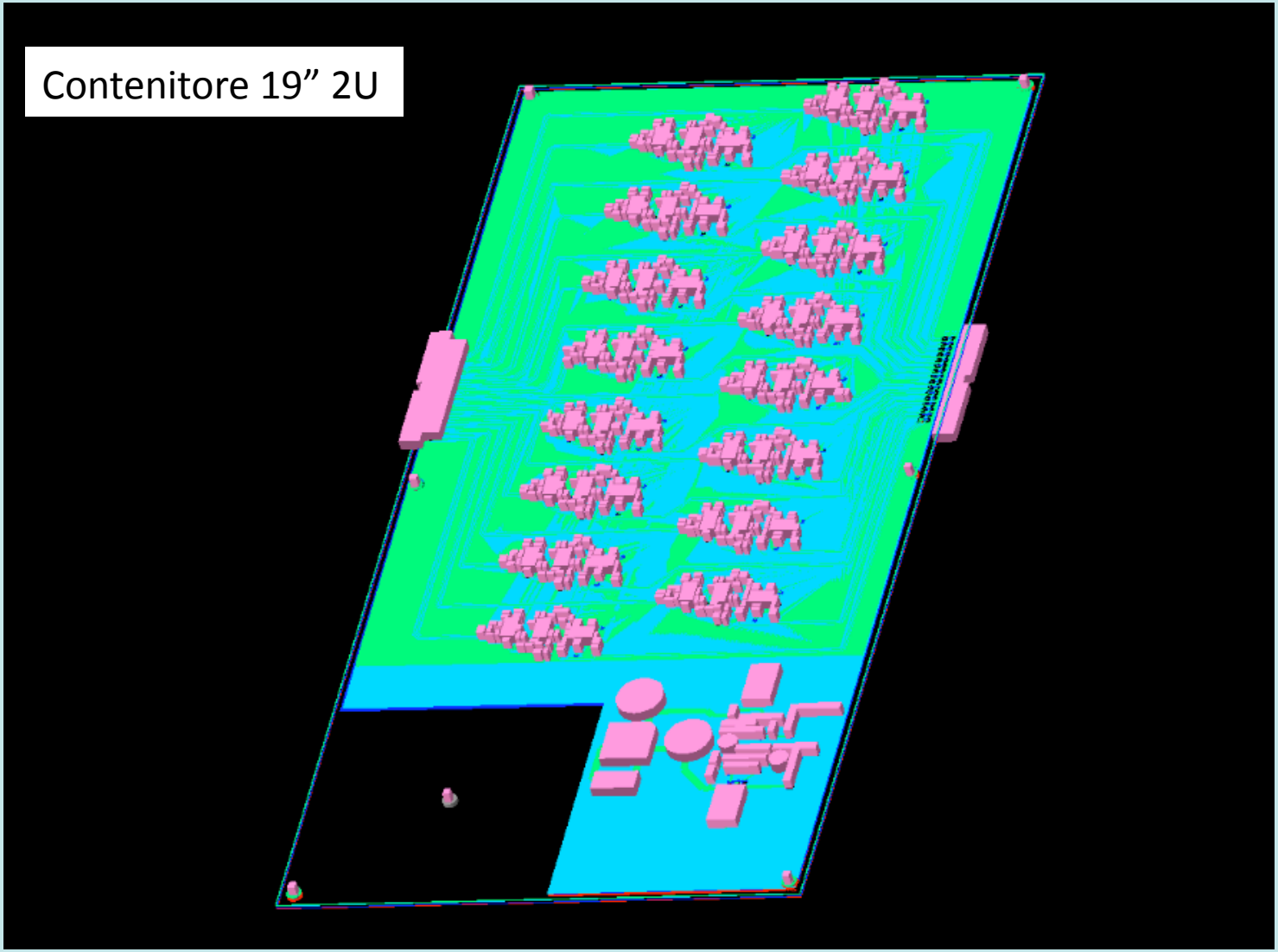
On-Detector FEE - Schematics







On-Detector FEE - Master



Off-Detector FEE - Block Diagram & Requiremnts

- 4 chs modularity
- Input signal : 80mV - 800 mV range - 1.5 ns rise time - negative polarity - 50 Ω
- Output signals :
  - Analog shaped output (≈ 125 MHz BW) for fast digitizer (FADC)
  - Analog output for monitor propose (≥ 250 MHz BW)
  - Analog sum output for Old Lumi (≥ 250 MHz BW)
  - Digital output for TDC