ECL FWD studies
JENNIFER Consortium
General Meeting

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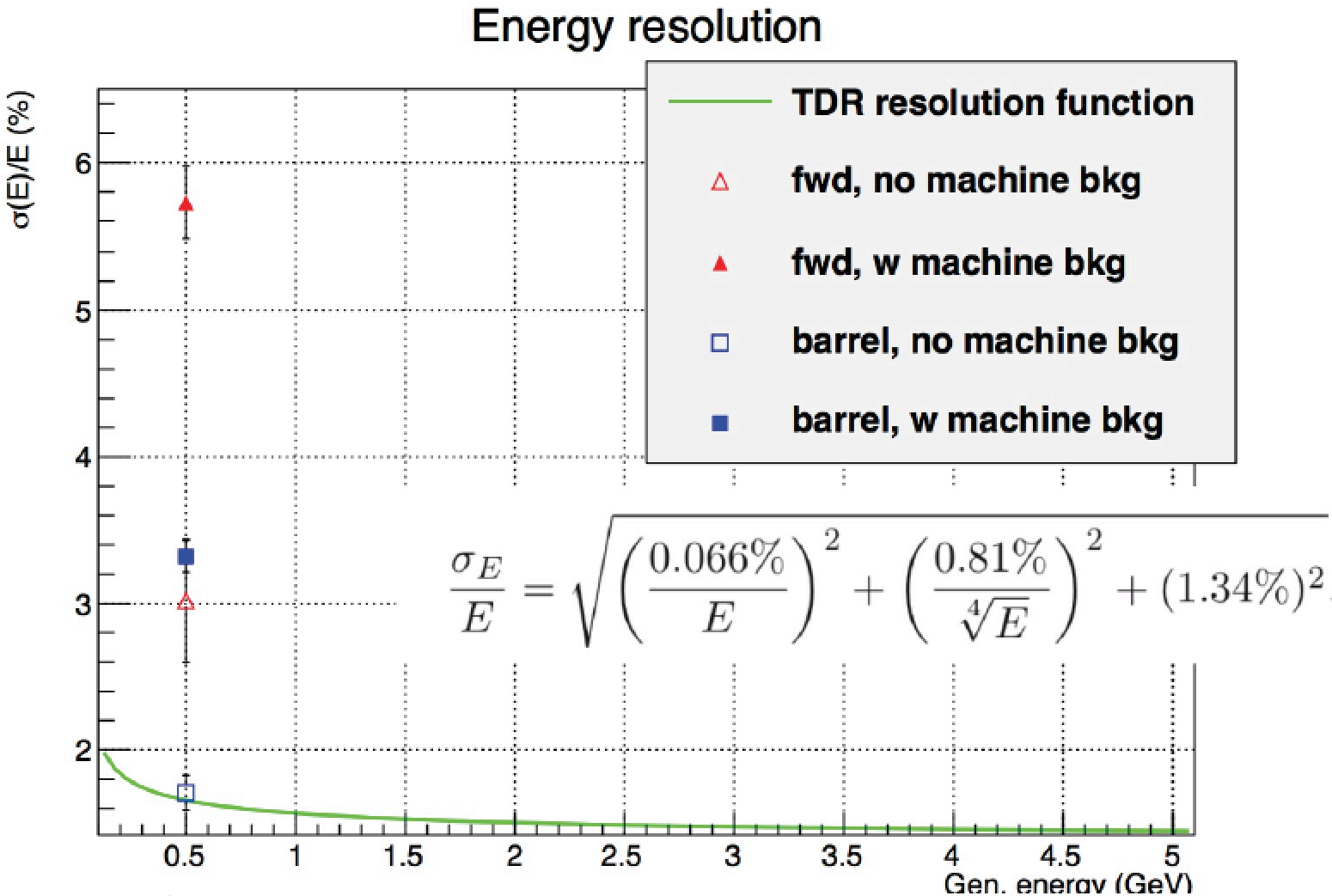
MC campaign 2015 and performance



EU grant n.644294

FWD Endcap Upgrade pure CsI

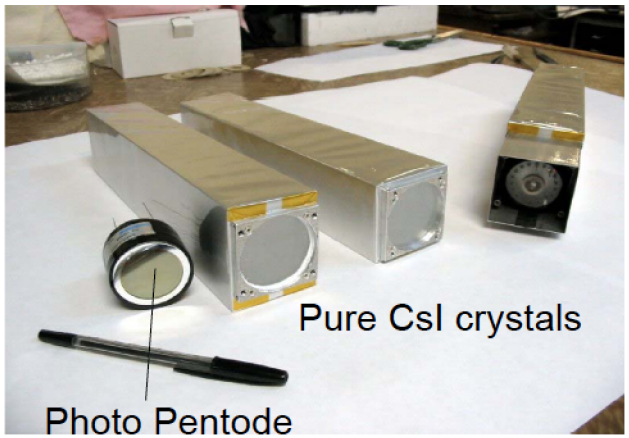
Electronics upgrade may not be sufficient for the forward endcap

Crystal	CsI(Tl)	CsI
Density (g/cm^3)	4.51	4.51
Melting Point (°CC)	621	621
Radiation Length (cm)	1.86	1.86
Molière Radius (cm)	3.57	3.57
Interaction Length (cm)	39.3	39.3
Refractive Index[a]	1.79	1.95
Hygroscopicity	Slight	Slight
Luminescence[b] (nm)	560	420
(at Peak)		310
Decay Time[b] (ns)	1220	30
		6
Light Yield[b,c]	165	3.6
		1.1
d(LY)/dT[b,d] (%/°CC)	0.4	−1.4

Because of short scintillation decay time, ~30ns, Pure CsI crystal is almost pileup free.
Photo Pentode readout is regarded as a baseline, Noise ~0.2MeV.

- same density and radiation length allow to reuse Belle mechanical structure

- much lower light yield
  - fast component of emitted light in the near-UV region
- much faster light decay time
  - but slow component is an issue for pile-up



- Use of Pure CsI requires R&D studies on:
  - photodetectors in the near-UV and wavelength shifters
  - radiation hardness of crystals, photodetectors, and wavelength shifters
  - electronics

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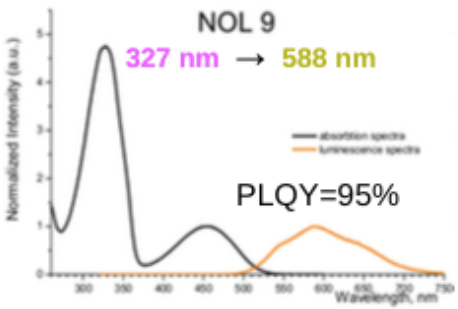
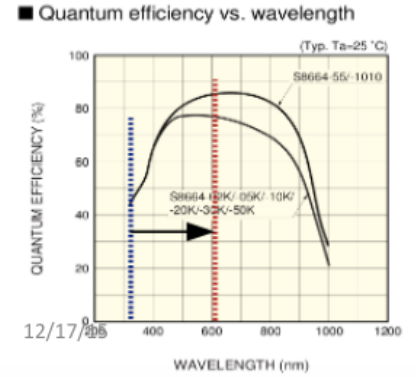
R&D on Wavelength Shifters

- Novel wavelength (WLS) plates containing nanostructured organosilicon luminophores provides essential increase in light output

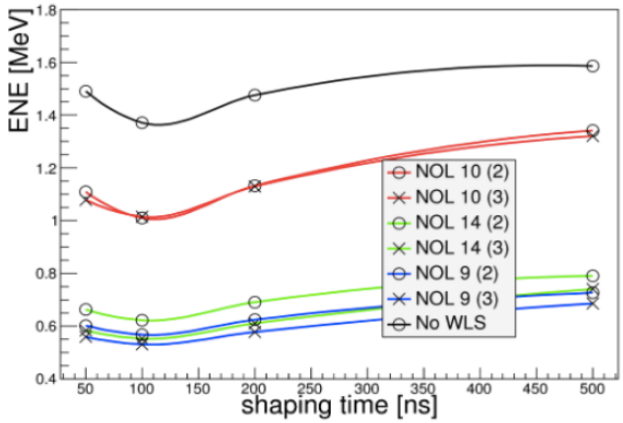
LuminoTech Co, (60x60x2 mm^3) WLS plates



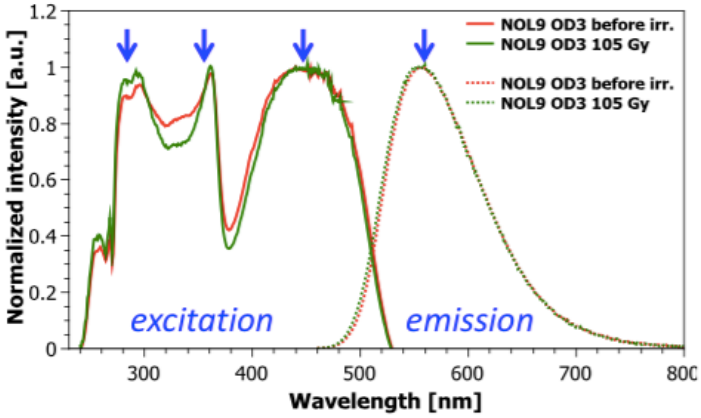
Increase in LAAPD Q.E. of a factor of 2-3



- Results:



Enhancement on signal of a factor of about 3 (n.b. test per formed with G=50 LAAPD)



Radiation hardness tests on NOL9 WLS: no irradiation effects on excitation/emission peaks up to 105 Gy

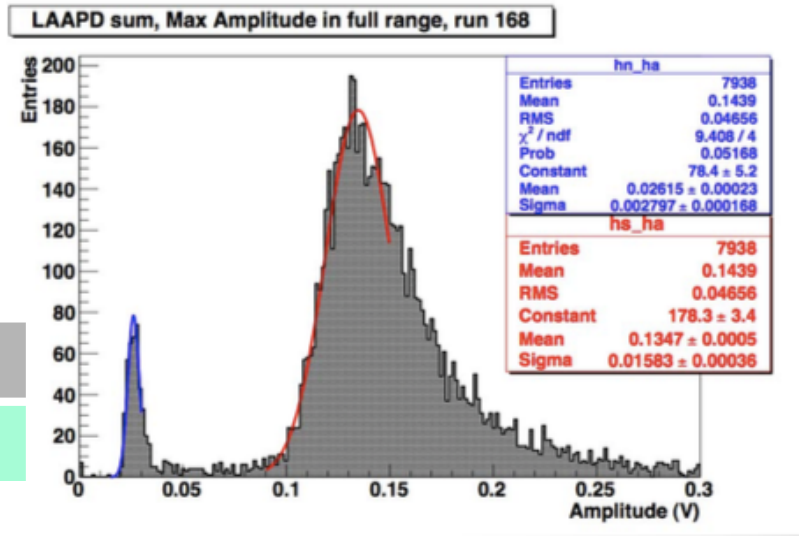
U grant n.(

R&D on LAAPD

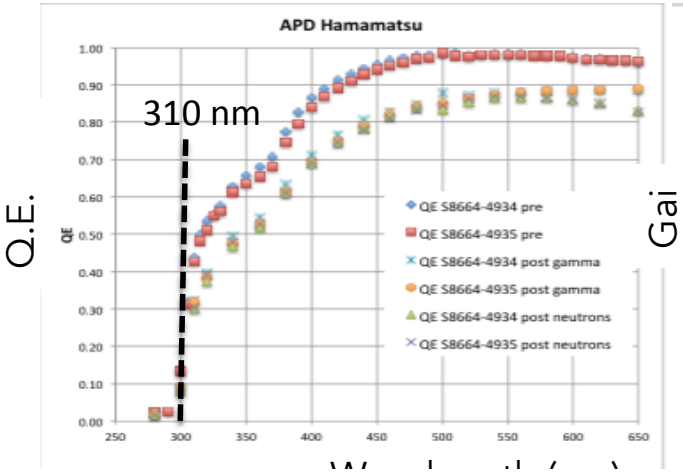
Extensive R&D has been done on Pure CsI + LAAPD

They meet the experiment requirement (ENE O(1MeV))

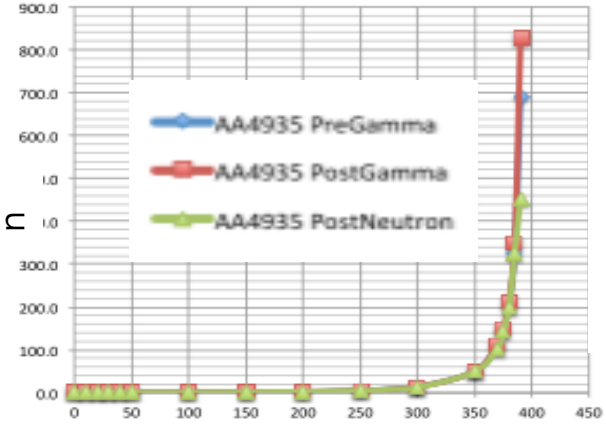
σ[mV]	Signal [mV]	S/N	ENE[MeV]
2.80±0.17	108.6±0.6	38.8±2.4	0.77±0.05



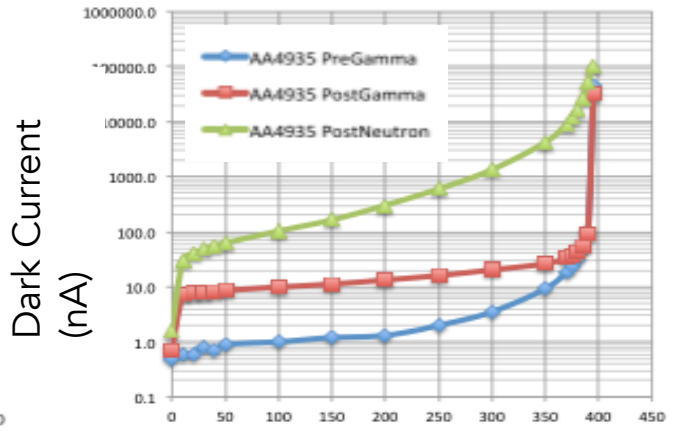
- Study effect of ionizing and non-ionizing radiation:
  - gamma: 250 Gy = 10 y data taking x ~10 safety factor
  - Neutron fluence: 10^{12} n/cm^2 = 10 y data taking x 5 safety factor



Quantum efficiency:
- Decrease after irradiation with γ at 250 Gy

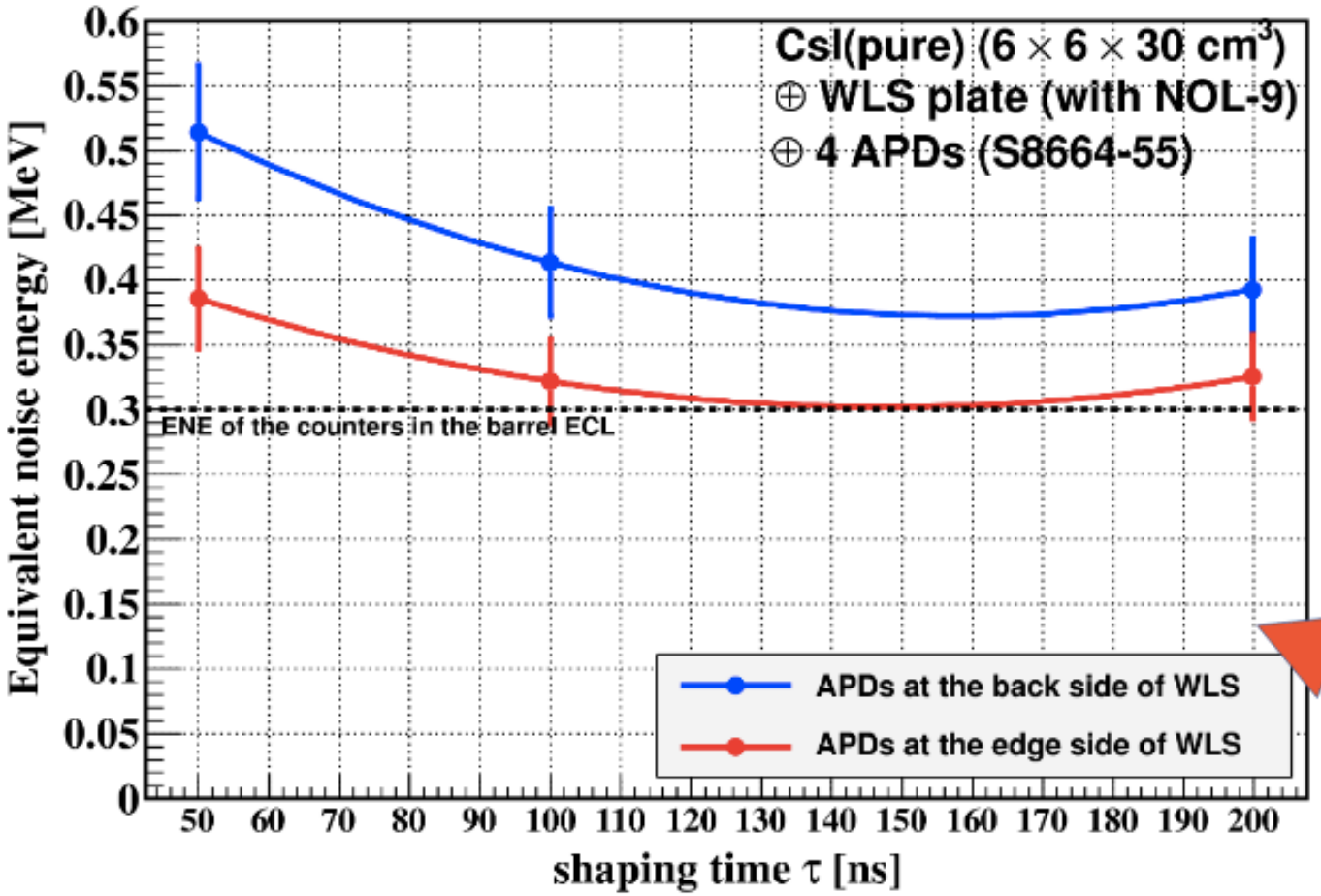


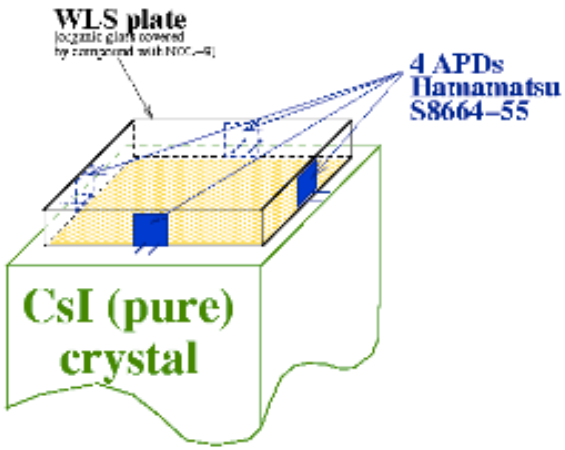
Gain:
- almost stable

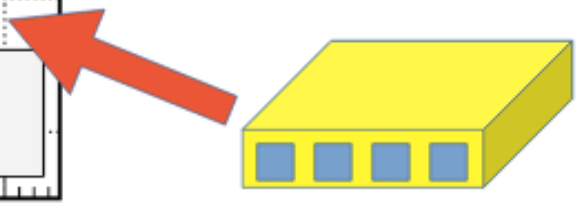


Dark current
- 2 orders of magnitude increase after neutrons + gamma

Attaching APD's on edge side







In this measurement, the APD's are attached on one side of the edge due to the limited space of our shield box.

A factor of 1.3 is earned by this configuration.

In total, in comparison with the coupling of APD's to the crystal, we earned a factor of 4.

New software reconstruction

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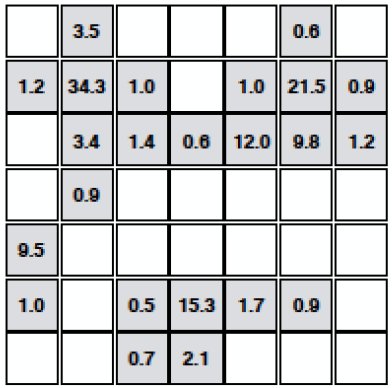
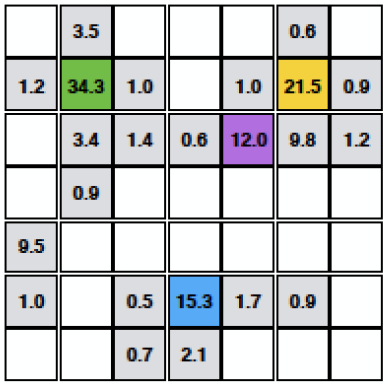
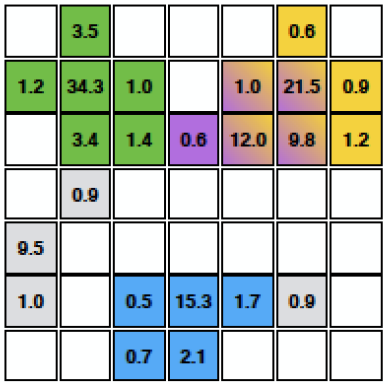
New ECL reconstruction: connected regions finder



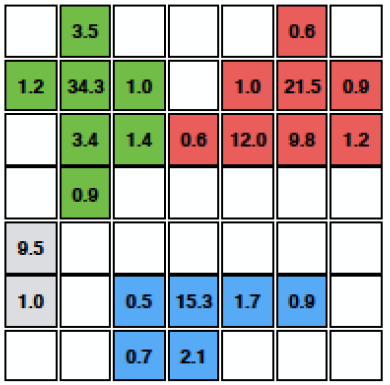
Use only digits with E>0.5MeV.



Digits with E>10MeV are seeds.



Neighbours are grouped with the seed.

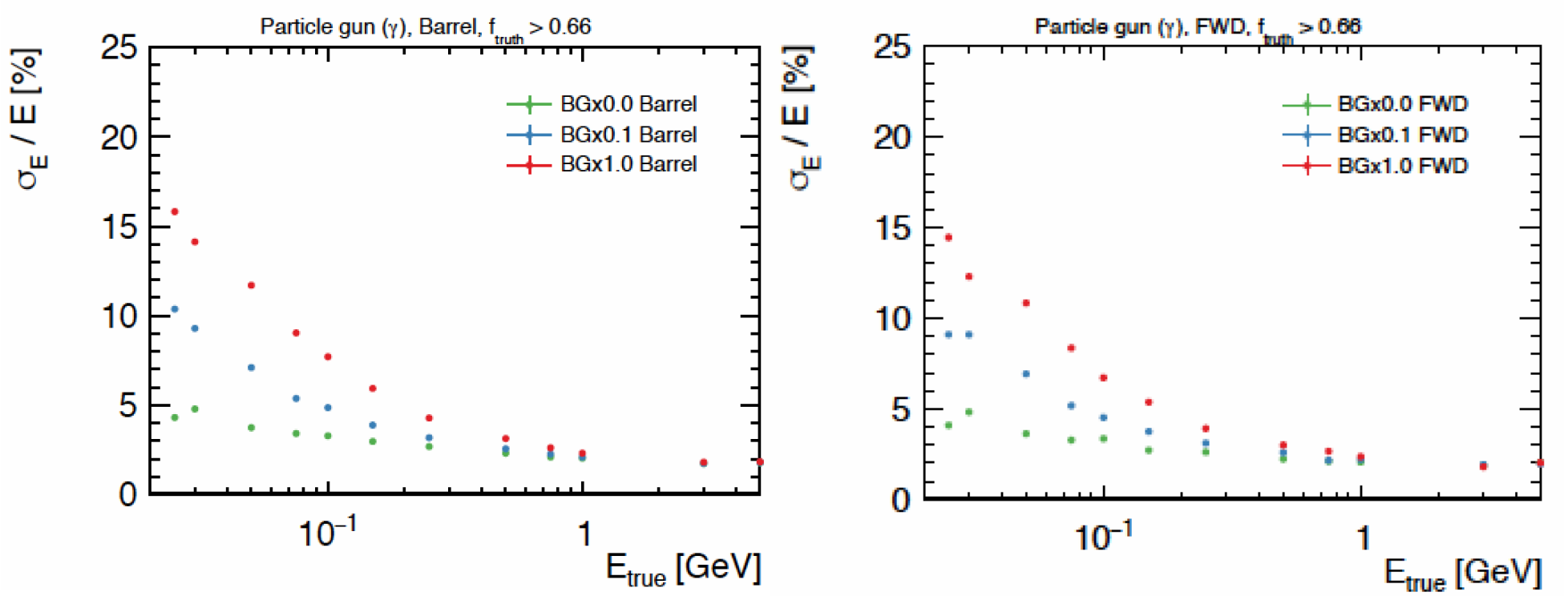


Overlapping CRs are merged.

Neighbours of digits with E>1.5MeV are added as well (continued)

→ Then within each CR find a LOCAL MAXIMA (LM)

Energy reconstruction



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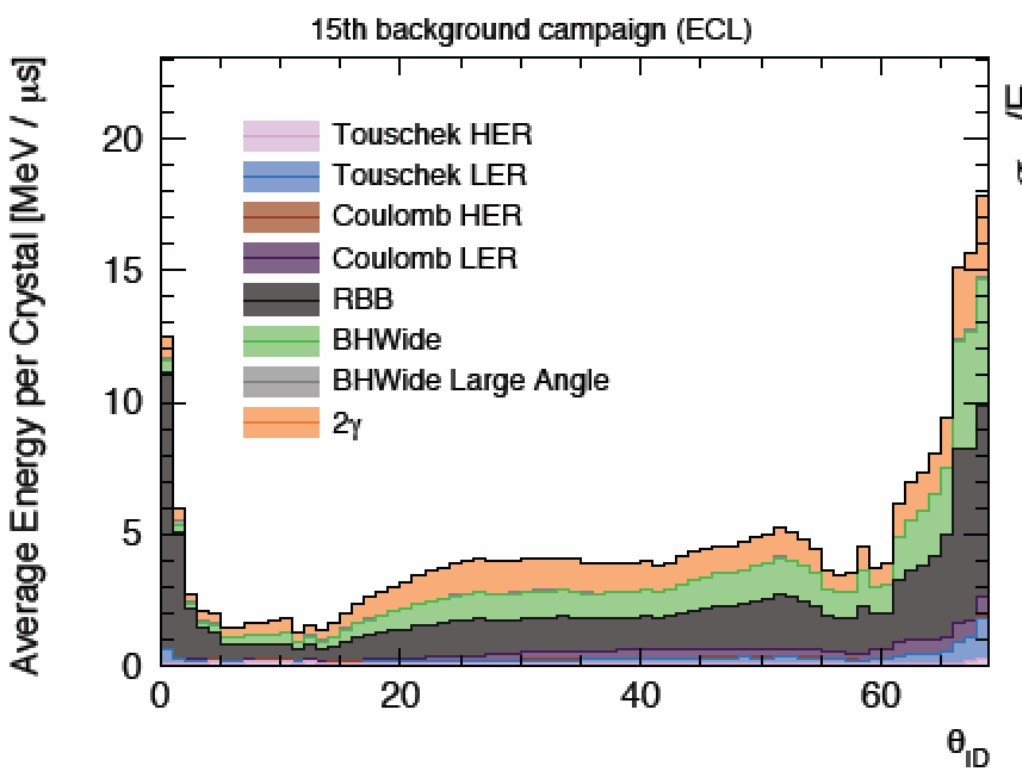
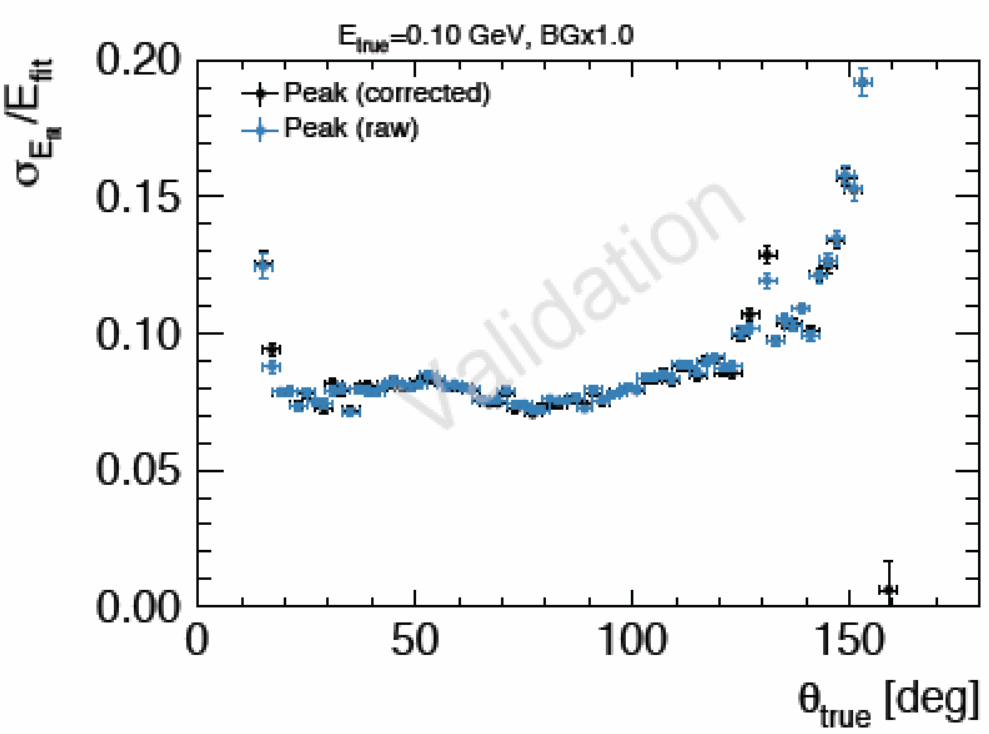
MC campaign 2017 and performance





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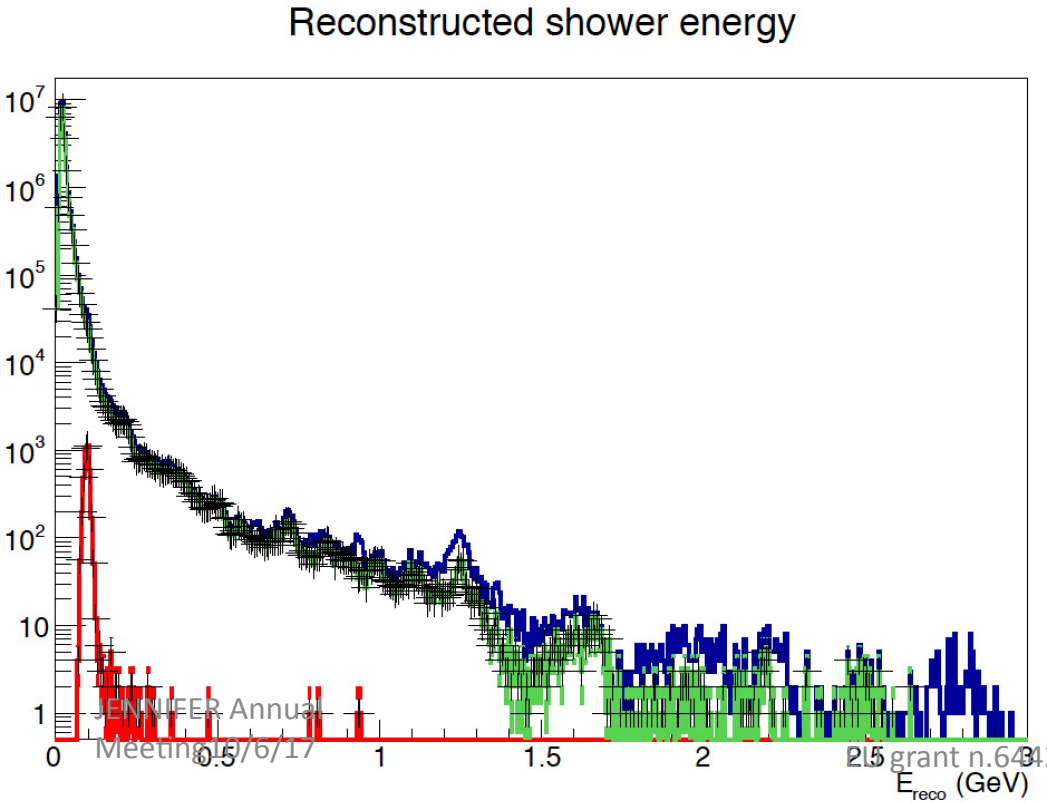
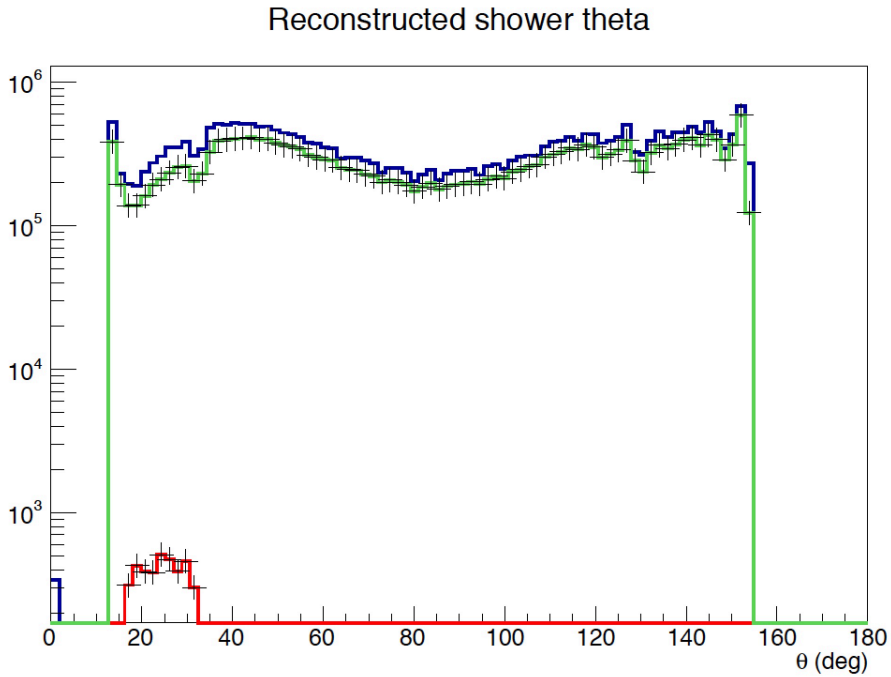
Analysis of last MC campaign

120k photons 100 MeV generated in the FWD

-Best candidate photon →
- lowest timing +
- E1/Egen > 0.7
- E1/E9 > 0.8





Selection is extremely pure, but very low effciency!!!

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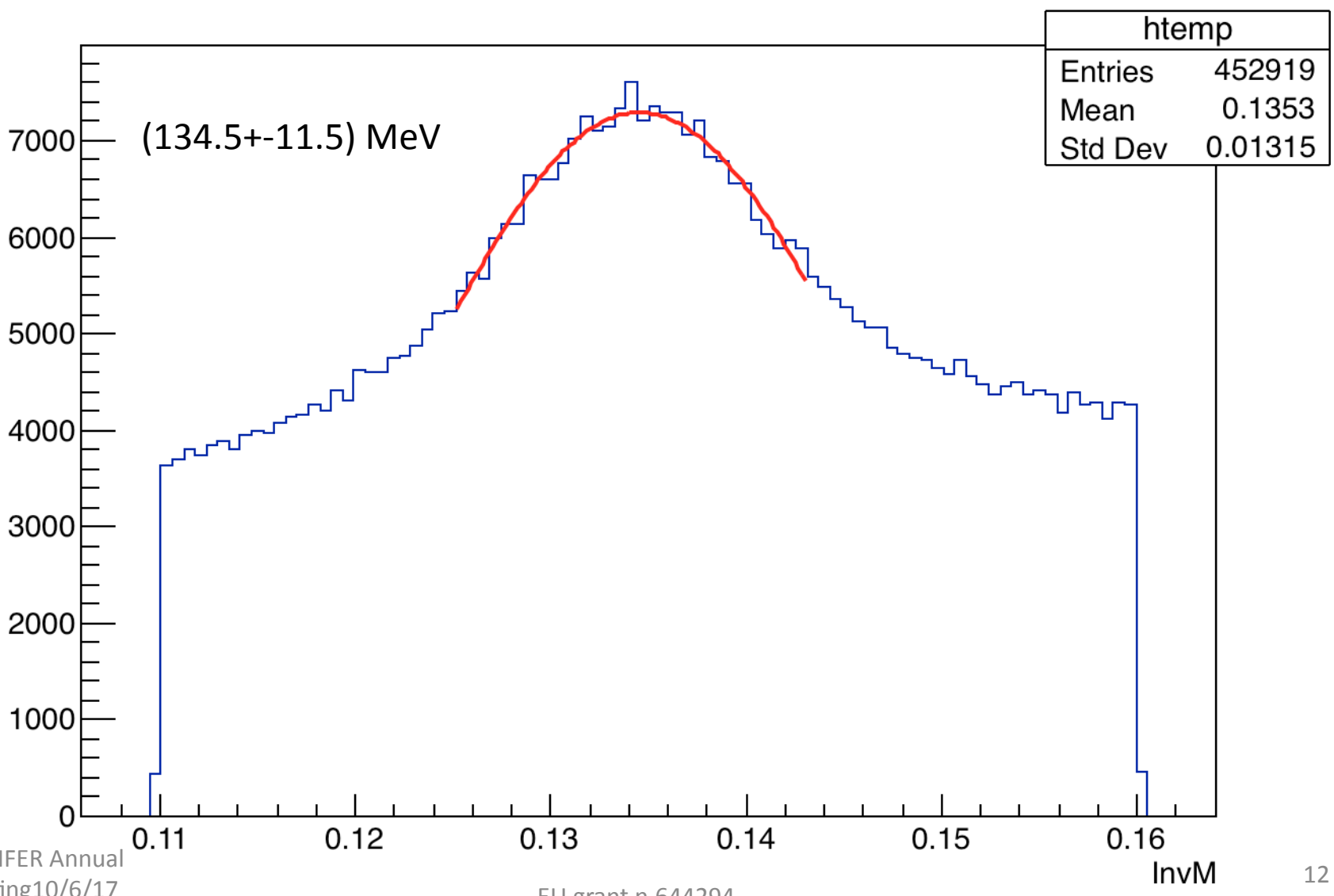
Last MC campaign: pi zero mass



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Conclusions and deliverables

- R&D studies are essentially concluded

- The “unknown” and crucial quantity is the background

- Even if resolution of 8% should not be an issue, the efficiency of the selection is a problem because the reconstruction of the signal is completely masked by the background → pile-up!!!

→

- Repeat analysis with pure CsI in the simulation (FWD)

- Measurements of phase2 background is crucial to understand on the real need of the upgraded FWD

-**DELIVERABLES**

- FW ECL R&D report: submitted and approved 2017
- FWD-ECL TDR: to be discussed at the end of phase 2

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