ECL Status, Upgrade and First Data
Belle II Italia - May 23rd 2018

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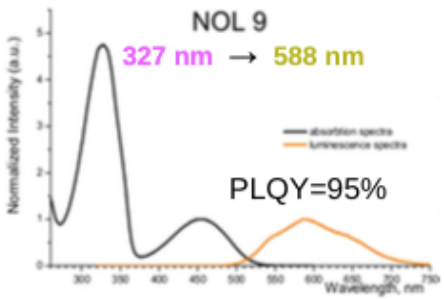
Outline

- Few words on the upgrade status
- ECL: status of the detector
- First data
- Summary and conclusions

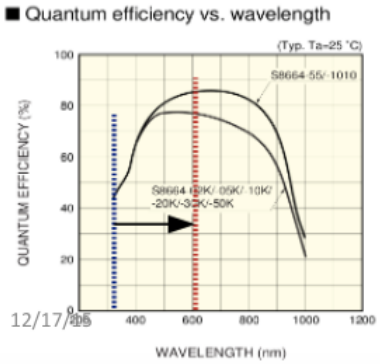
R&D on Wavelength Shifters

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

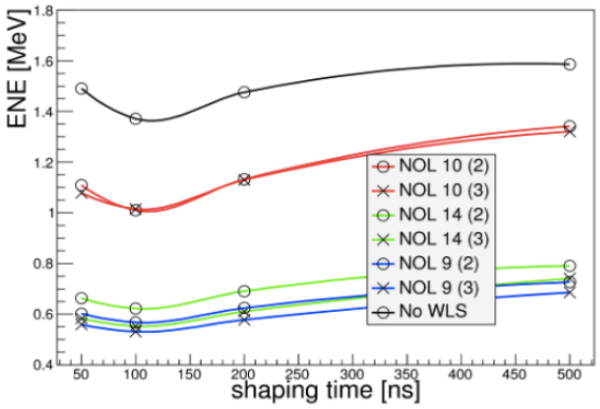
LuminoTech Co, (60x60x2 mm^3) WLS plates



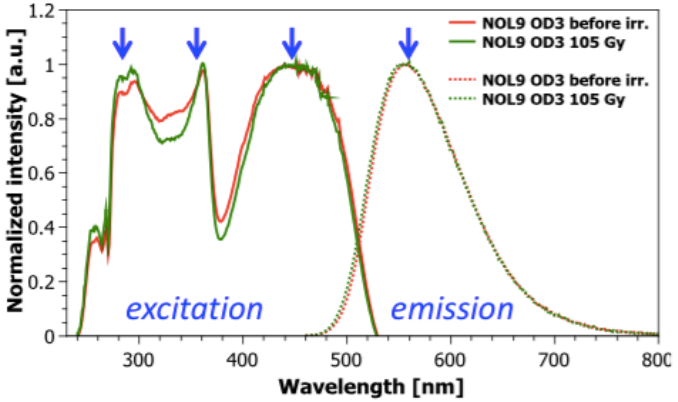
Select mainly the short time emission and cut the long tail



- Results:

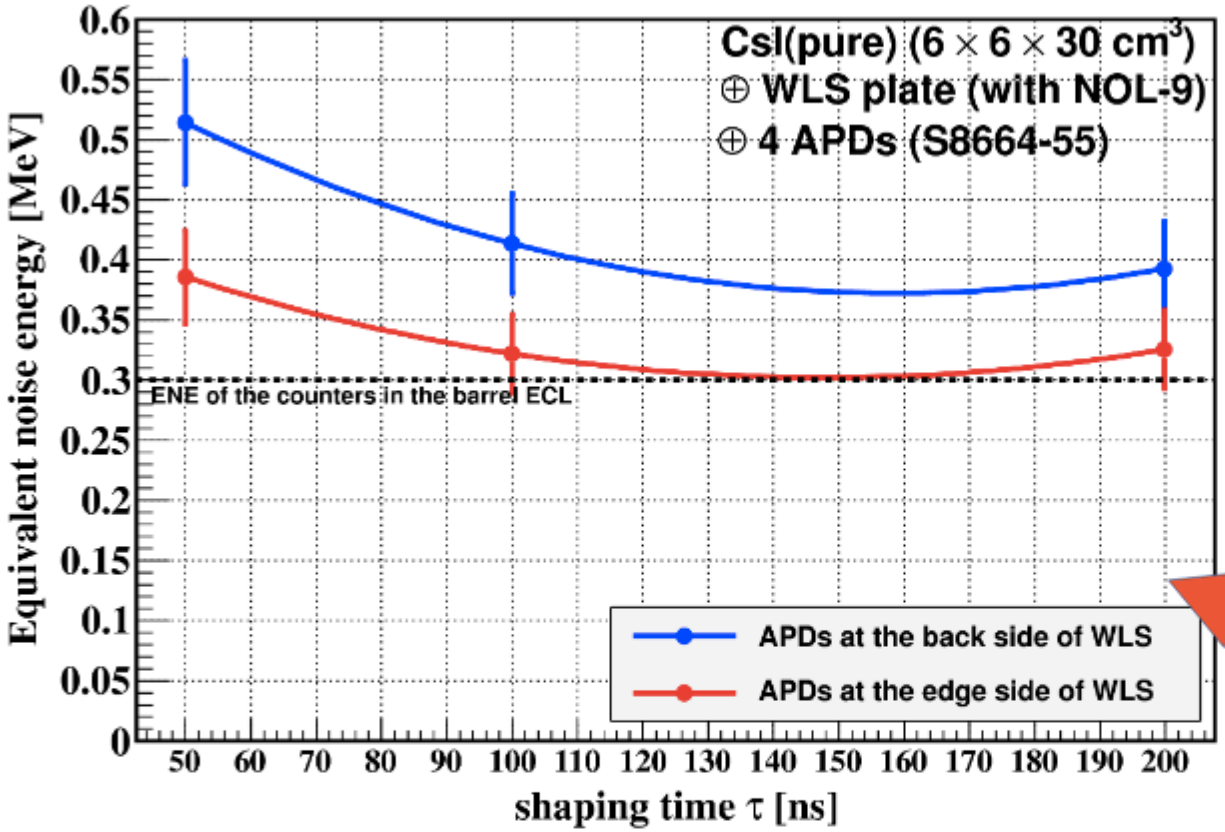


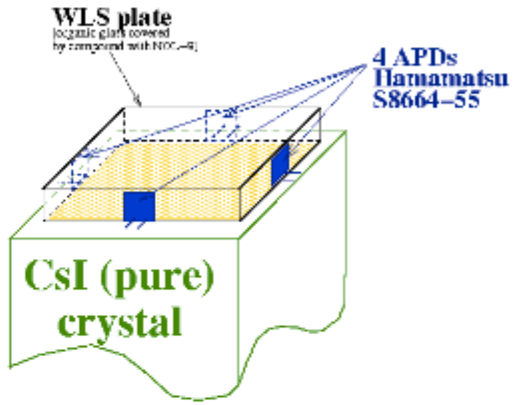
Enhancement on signal of a factor of about 3 (n.b. test performed with G=50 LAAPD)

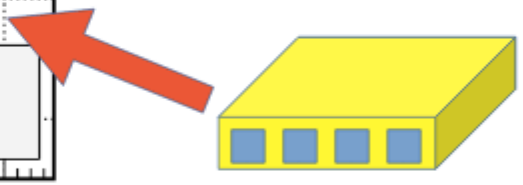


Radiation hardness tests on NOL9 WLS: no irradiation effects on excitation/emission peaks up to 105 Gy

Attaching APD's on edge side





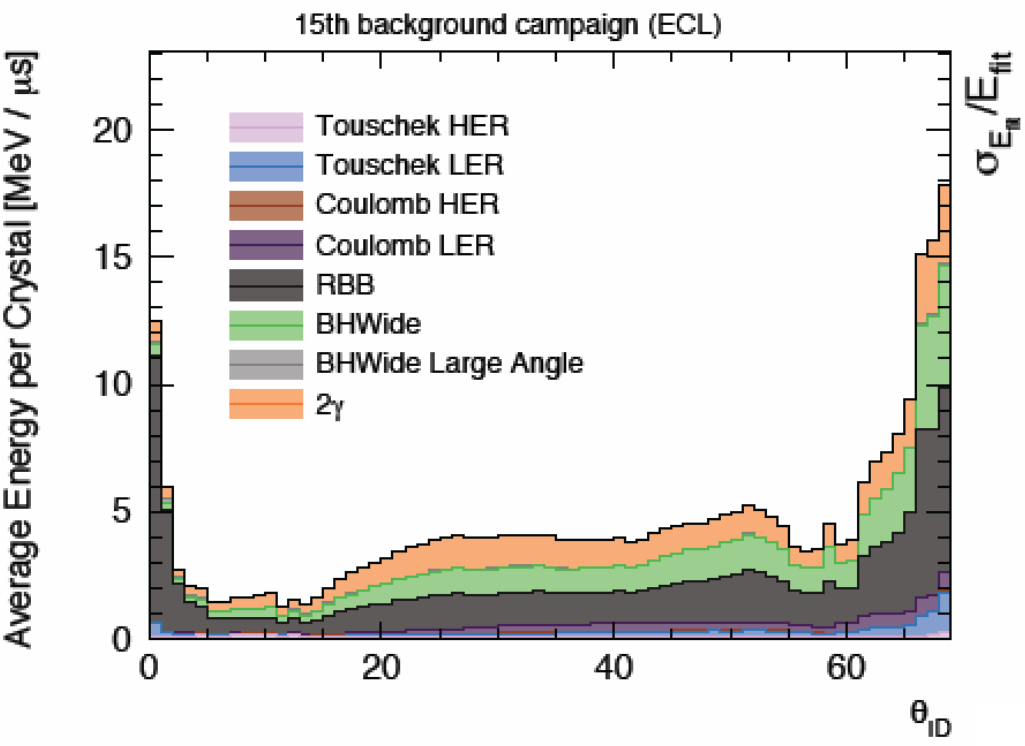


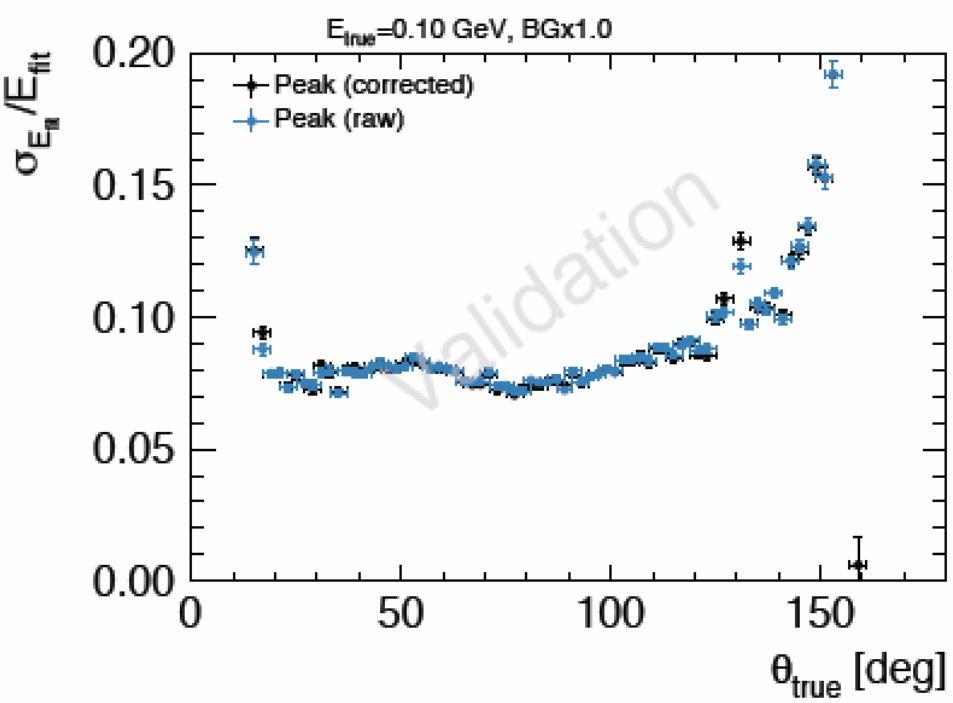
In this measurement, the APD's are attached on one side of the edge due to the limited space of our shield box.

A factor of 1.3 is earned by this configuration.

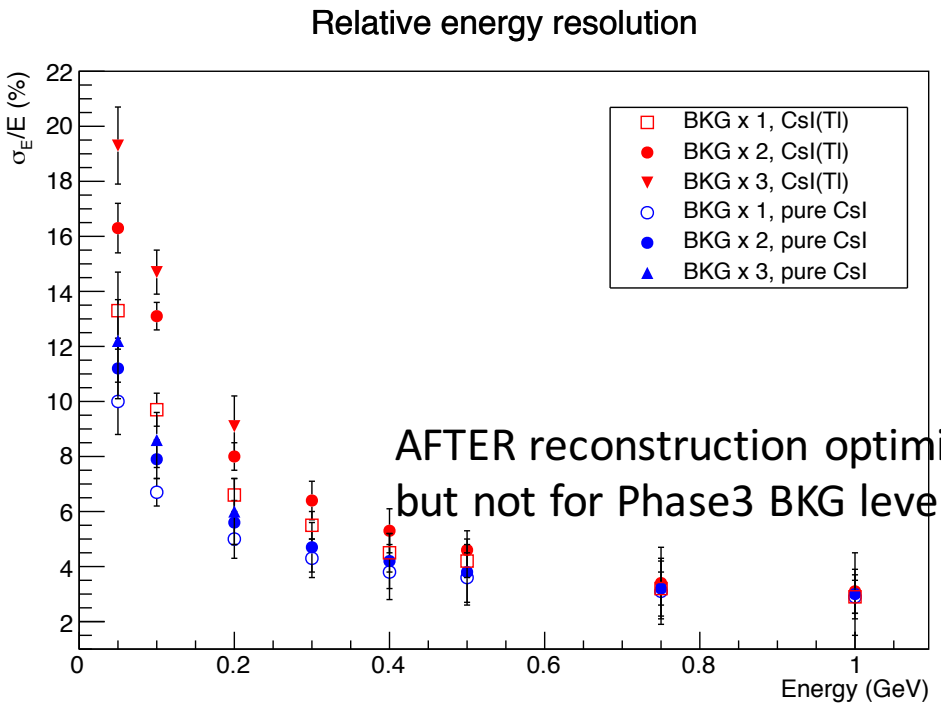
In total, in comparison with the coupling of APD's to the crystal, we earned a factor of 4.

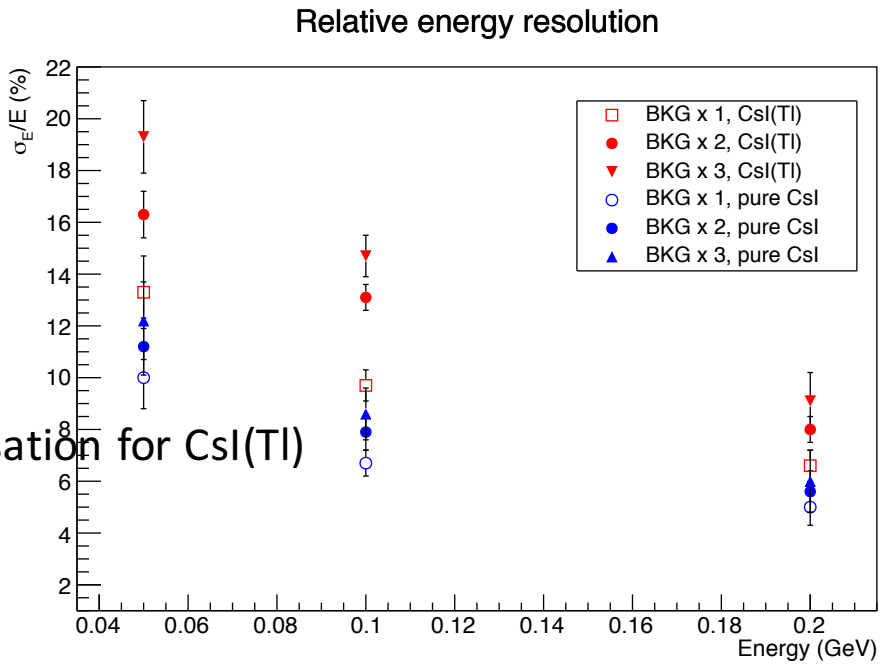
MC campaign 2017 and performance





FWD CsI(Tl) vs pure Cs(I) phase3 BKG x1, x2, x3





AFTER reconstruction optimisation for CsI(Tl)
but not for Phase3 BKG level

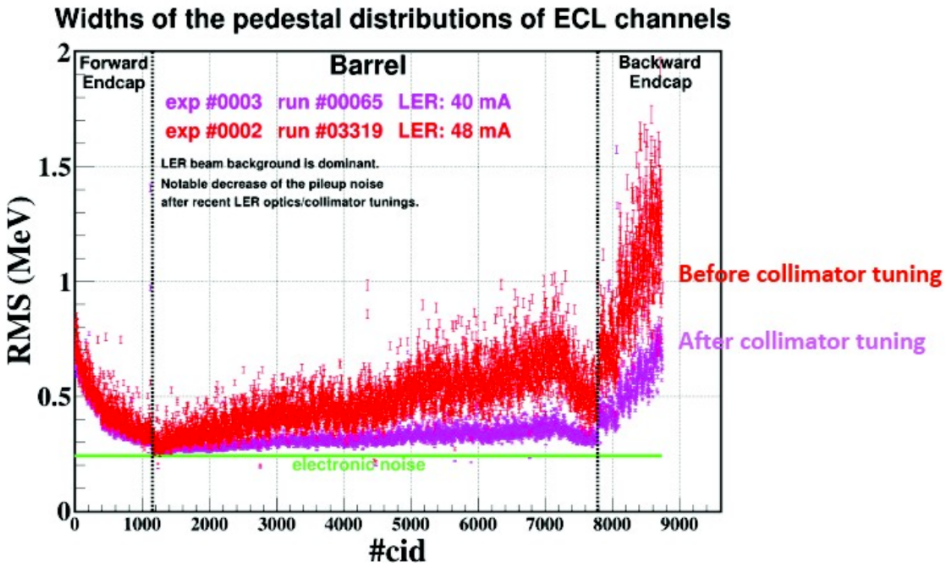
Reconstruction used for pure CsI has not been optimised

Pure CsI@100MeV (BKGx2) = 8% → which is the best reachable resolution?

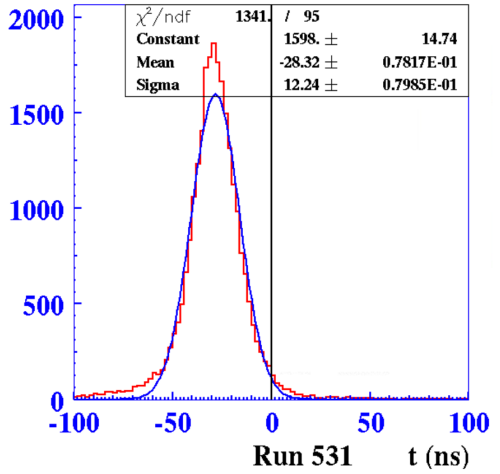
Phase2 data very important for the understanding of the background

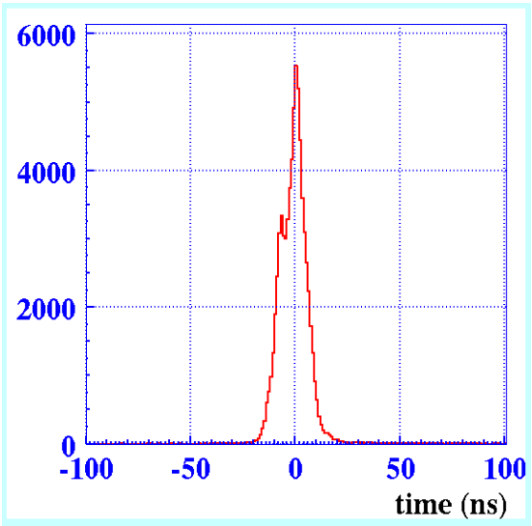
Status of ECL

- All channels works correctly
- Some of them have higher noise
- Pile-up noise induced by LER quite high
- Beam background study is ongoing



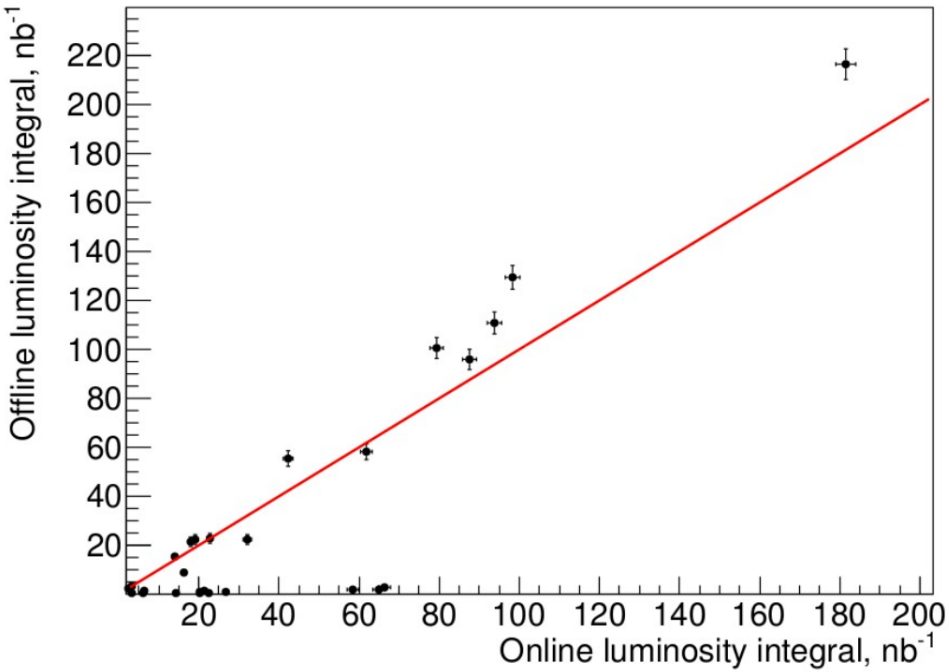
- Small time shift of about 30ns needs to be recalibrated → done





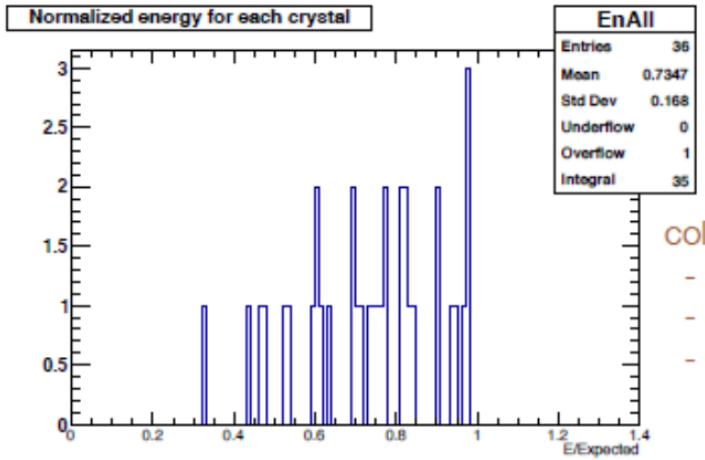
ECL Luminosity monitor measurement

- Online luminosity is measured and consistent with offline analysis

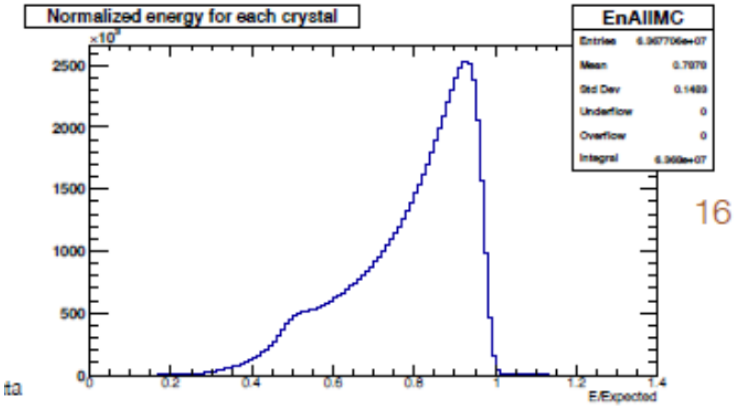


The integral online luminosity is kept on KEKCC up to run 2141, after that runs have to be recovered

ECL reconstructed energy

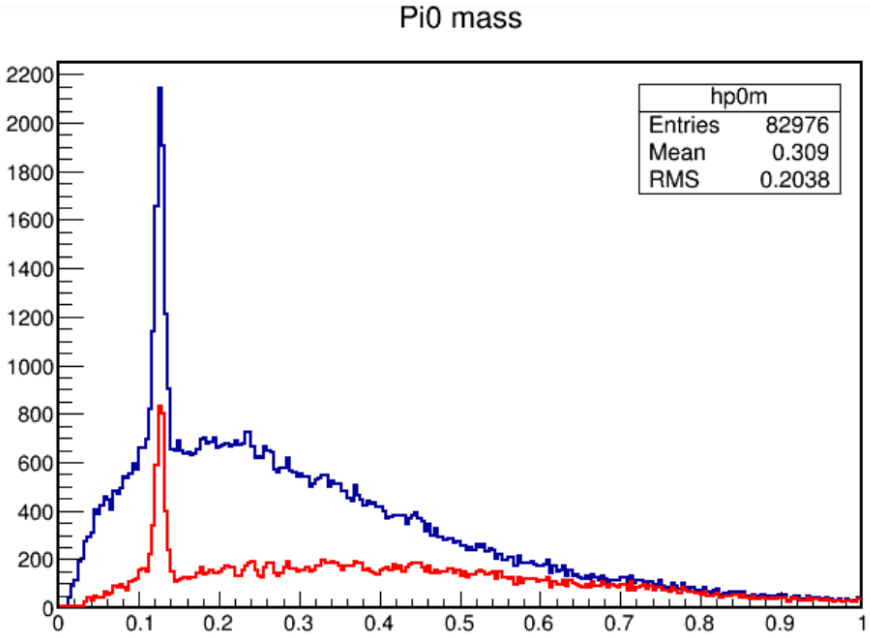


colliding beam data
- 28 entries run 120
- 8 entries run 114
- 0 in others



16 fb^{-1} MC sample

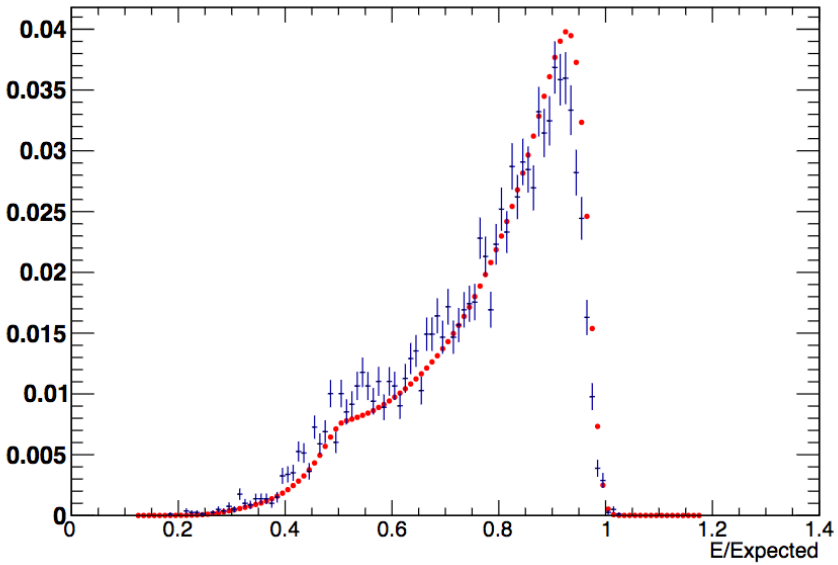
- ECL shows reasonable performance looking at data in offline analysis
- Pi zero have been observed



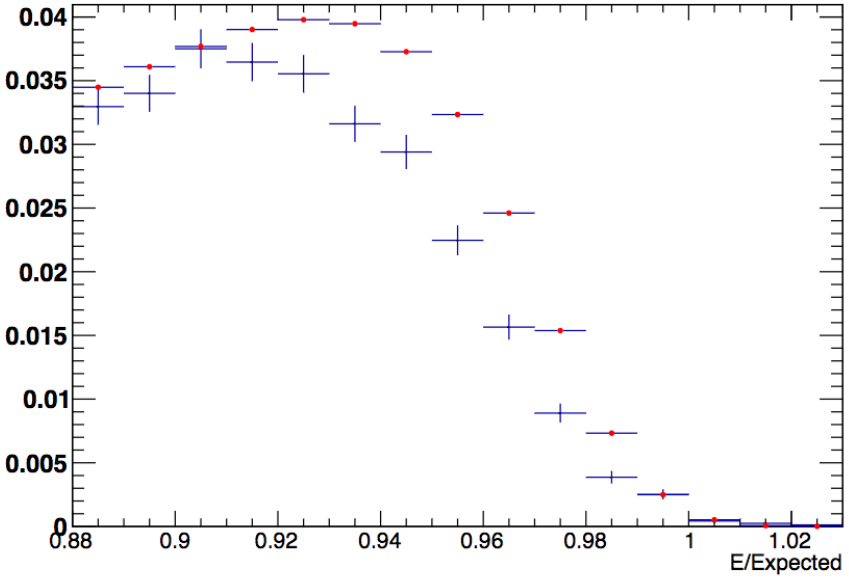
Energy calibration

- Calibration of individual crystals looks reasonable close.
- Calibration uses the ratio of observed to MC predicted energy in single crystals.
- Summing over all crystals, the average calibration appears to be ~1% low.

Normalized energy from γγ, summed over all crystals, overlaid with MC prediction

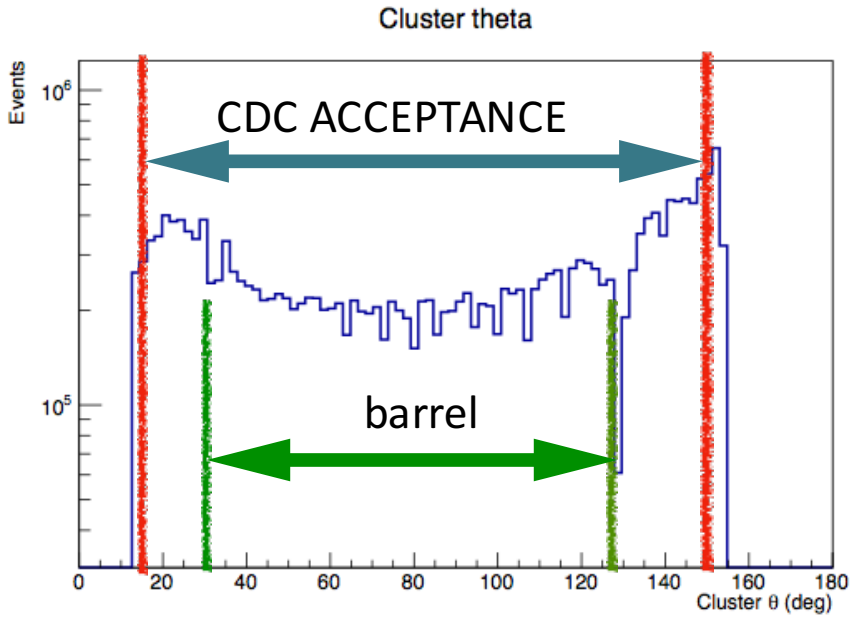


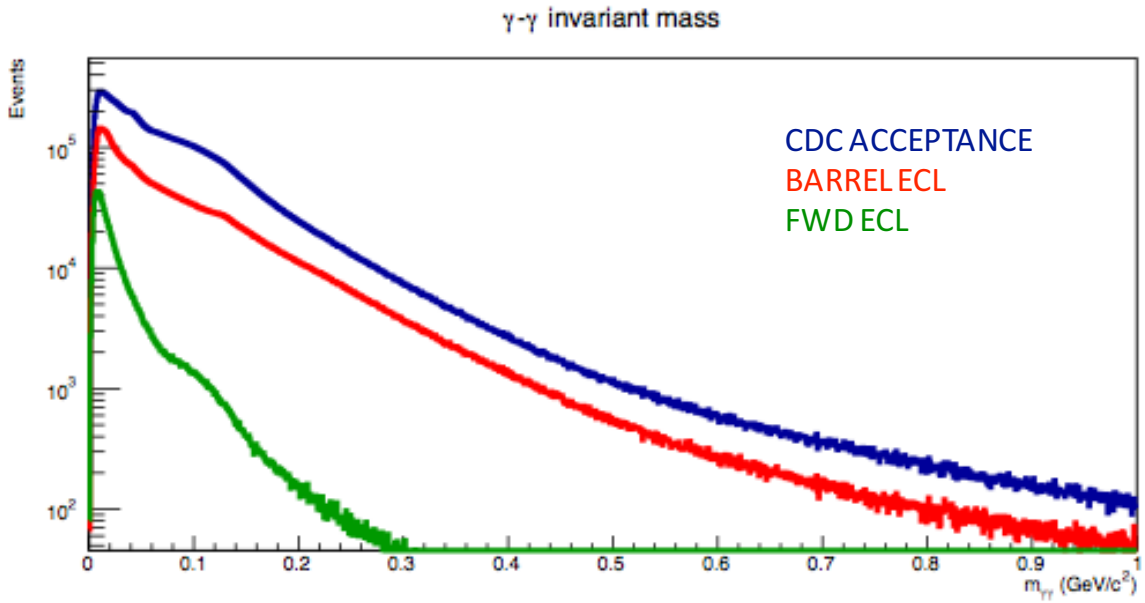
zoom



- γγ skim is useful for this calibration.
- 1–2 fb-1 sample will give ~1% calibration for >95% of crystals. Requires loosening timing cut by 5× given the current poor timing calibration.
- Effective luminosity of muon pair sample, which we also use for calibration, is half that of the γγ sample. Not clear that we have a two-track trigger, which we need for this sample.

$\gamma\gamma$-invariant mass prima dei tagli





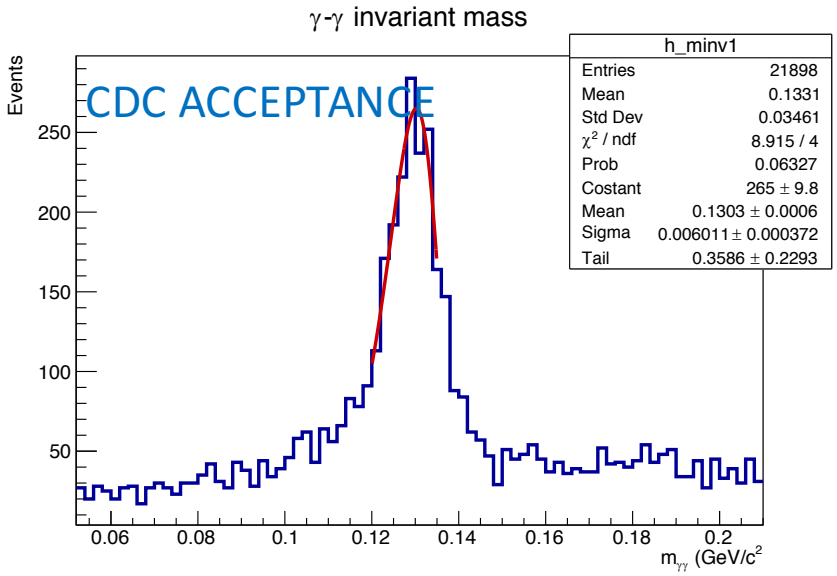
Selezione

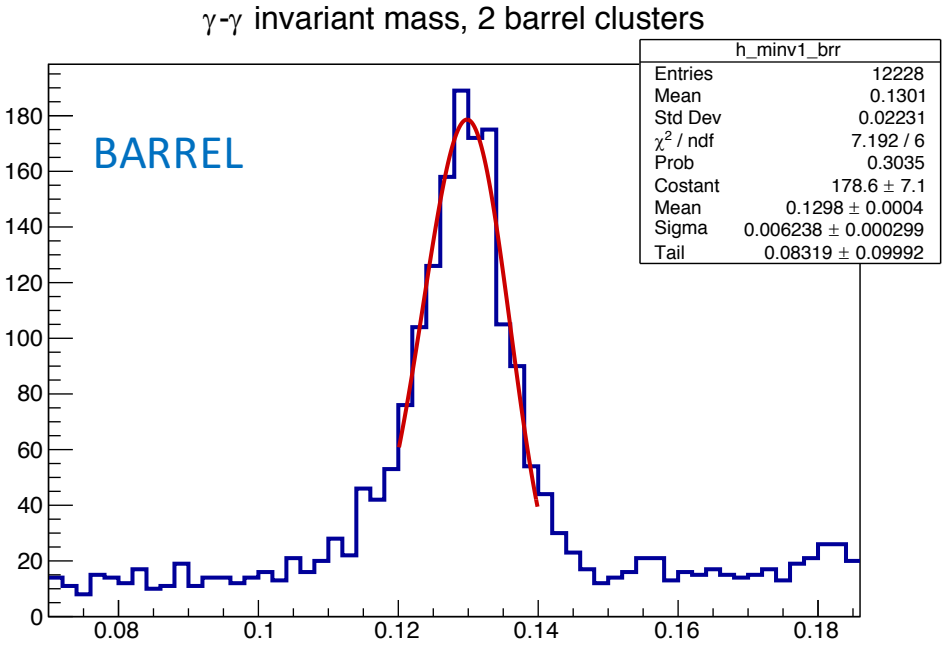
- almeno 2 clusters
- almeno 3 GoodTracks (abs(dz)<5.0 cm and abs(dr)<2.0 cm and pt>0.15 MeV/c)
- > 1.5 Hit nel calorimetro
- E_cluster>300 MeV
- E9/E21 > 0.9
- theta_gamma in CDC acceptance [17°,150°]
- barrel (fwd) pi0: 2 clusters con theta in [32.2°,128.7°] ([18,31.4])

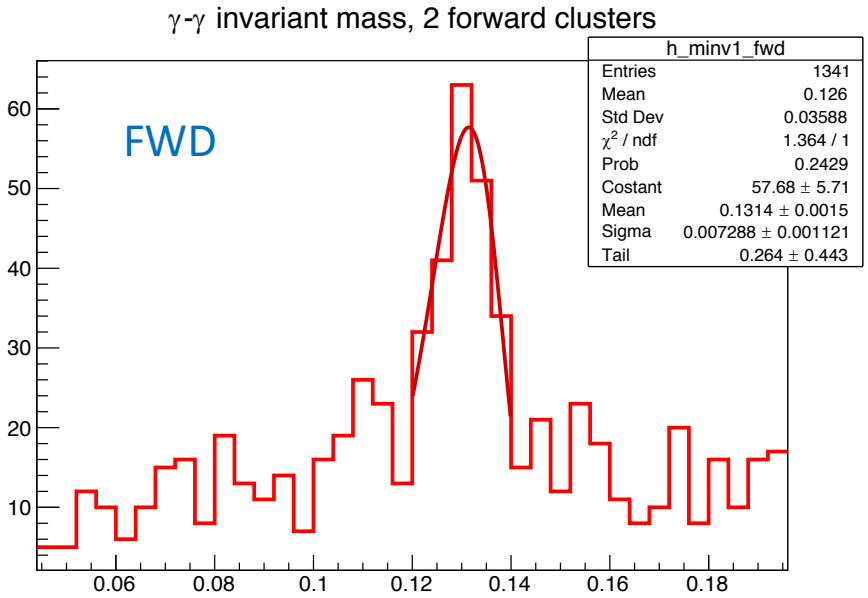
Table 8
Geometrical parameters of ECL

Item	θ coverage	θ seg.	ϕ seg.	No. of crystals
Forward end-cap	12.4–31.4°	13	48–144	1152
Barrel	32.2–128.7°	46	144	6624
Backward end-cap	130.7–155.1°	10	64–144	960

$\gamma\gamma$-invariant mass dopo i tagli (II)



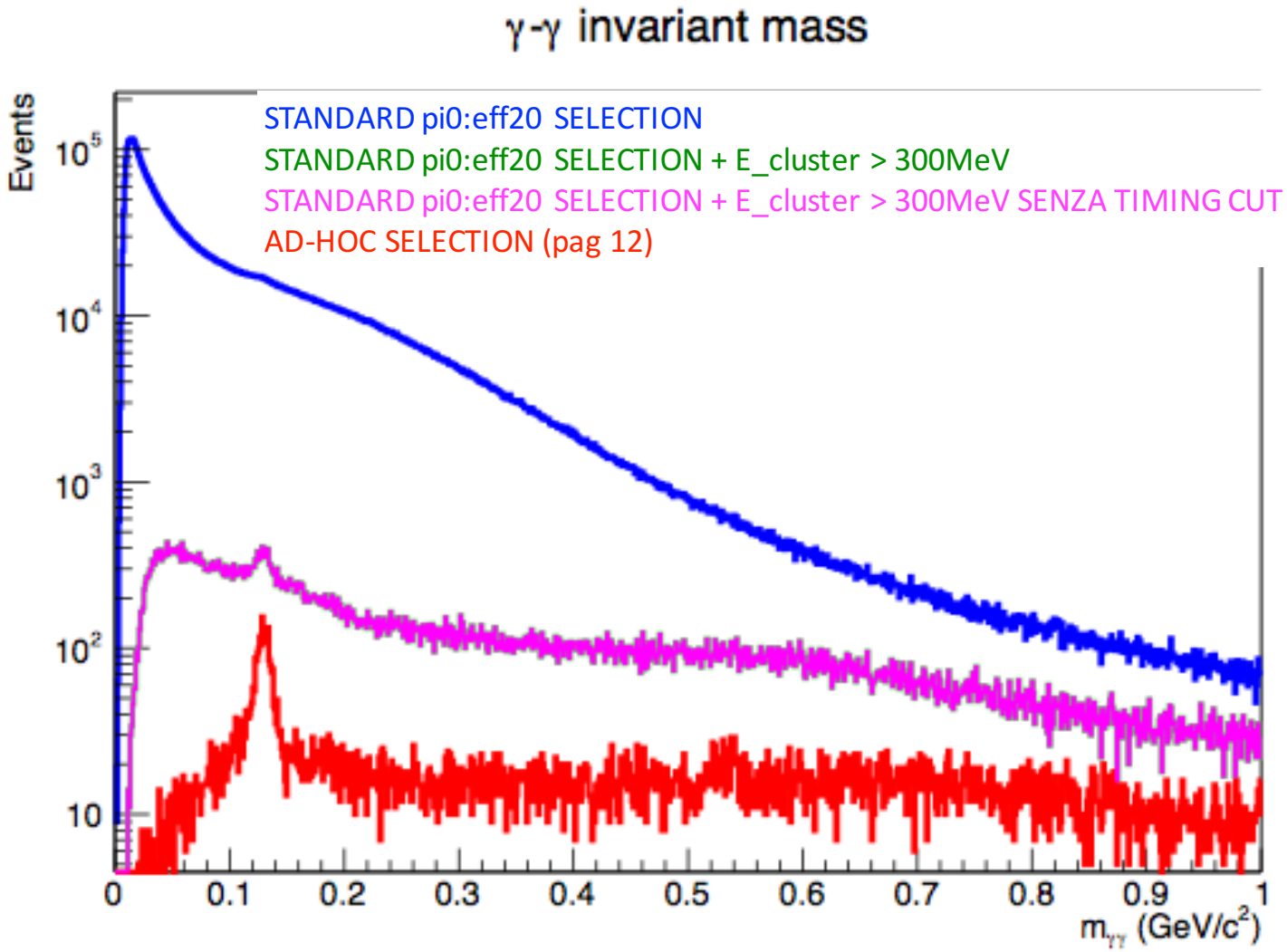




Confronto tra selezioni (I)

- Selezione lista standard pi0:eff20
  - E_cluster>75 MeV (vs 300 MeV nella sel precedente)
- E9/E21 > 0.7 || E_cluster>100 MeV
- theta_gamma in CDC acceptance [17°,150°]
- timing_cluster<0.1*timing_error_cluster || E_cluster>100 MeV

Confronto tra selezioni (II)



Conclusions

- R&D on pure CsI is quite in the finishing line and requirements on equivalent noise energy and signal to noise have been fulfilled
- Best option for APD readout is 4-small APD's on the edge of the WLS
- Test beam at Novosibirsk end 2018 of a matrix of pure CsI
- Study of background level in phase2 is crucial

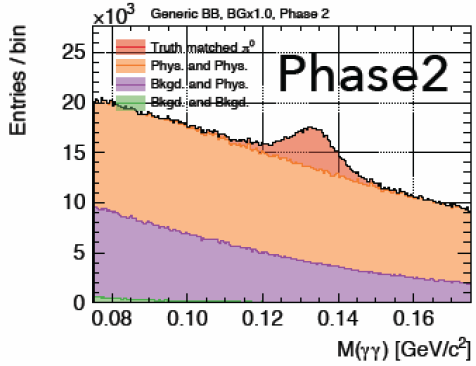
- ECL is working: all channels are good and functional
- Timing needs calibration
- Calibration with physics events needs to be implemented with more statistics

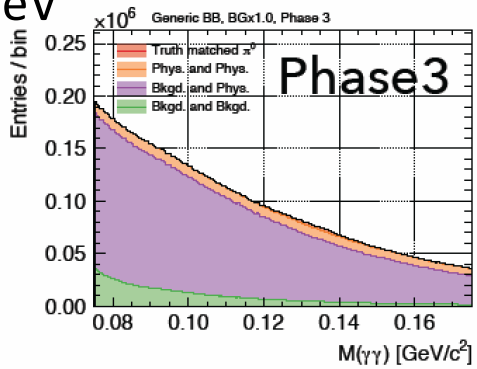
- First data → pi zero peak observed with a "special" selection.
- pi zero official list cannot be used yet because of the timing calibration problem
- Peak is not calibrated a small shift of about 2-3% is observed

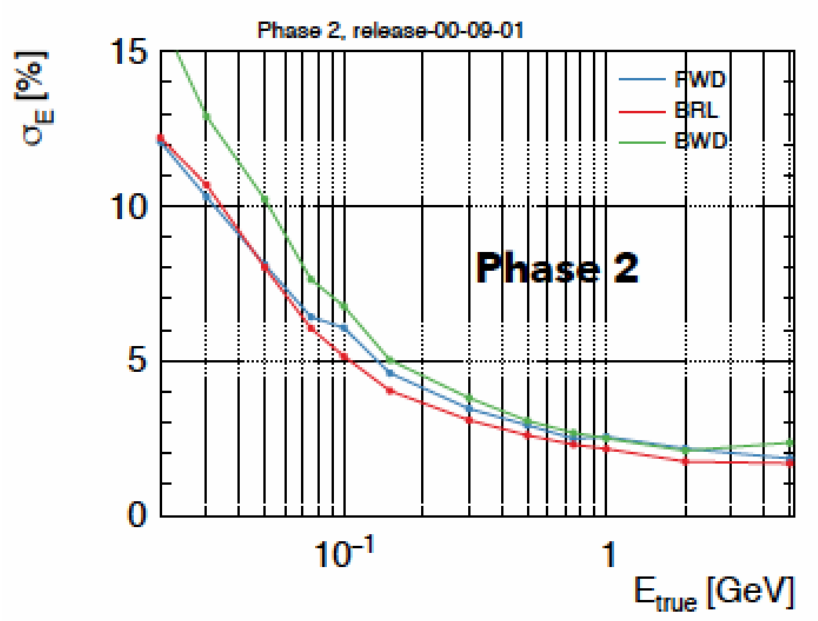
BACKUP SLIDES

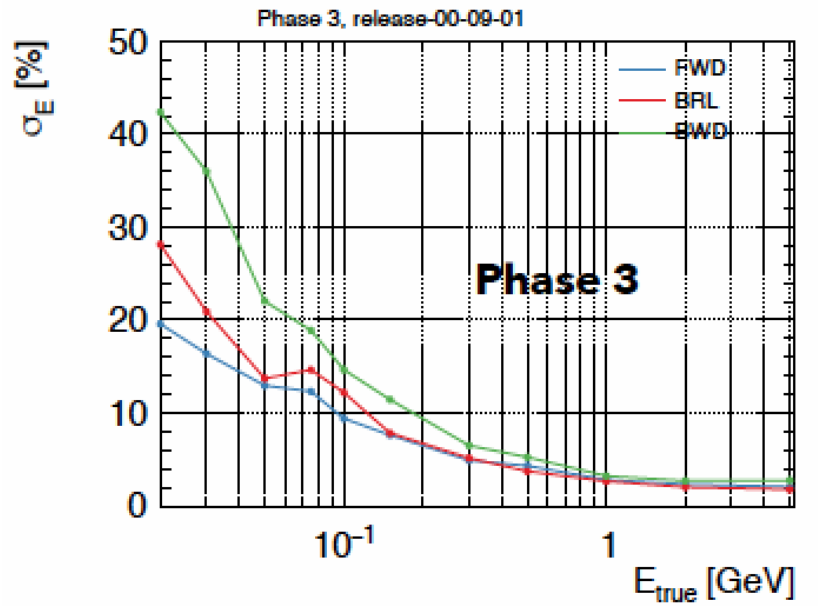
Effect of pile-up increasing

- Optimization of the reconstruction for phase2 and phase3 needed once BKG better known
- Efficiency → has to be as highest as possible including low energy photons in presence of high beam background









Π⁰ reconstruction
All photons with E>20 MeV

B→K*νν

- Significance and shape variables not change observed from no BKG to BKG1

1 ab^{-1} equivalent statistics

	"BGx0"	"BGx1"
N_{bkg}	6415 ± 80	3678 ± 61
ε (10^{-4})	10.3 ± 0.3	5.38 ± 0.23
$N_{sig}/\sqrt{N_{bkg}}$	0.16	0.15
UL (10^{-4})	2.6	3.8