ECL FWD Upgrade status and what's next?

C. Cecchi

- Introduction
-CsI(Tl) rad hard status
-Study of the ECL performances
- Software what we have
- Software + lab measurements, what is missing?

ECL FWD upgrade

- The ECL FWD upgrade was foreseen and presented in the TDR: from CsI(Tl) to pure CsI + photopentodes
- We suggested the readout with APD's and we proposed our R&D (SuperB heritage) to the collaboration
- The financial agreement discussed with INFN was for 20% of the ECL FWD (about 200 crystals) and about 1 – 1.5 Meuros
- At that time Canada was supposed to pay 50% of the upgrade, 30% was not assigned

ECL FWD upgrade cont'd…

June 2014 Canada didn't get funding for upgrade

1. Some physics studies were presented by the groups from Canada about performances for the ECL FWD
2. And some extrapolations from dose accumulated by crystals during BELLE experiment

→ Upgrade of the ECL FWD is apparently not necessary, CsI(Tl) calorimeter is good enough also at the dose rate of BelleII and not significant improvement seem to be obtained from the change of the technology

Physics studies summary

Using pdf from BaBar + background expected in BelleII (with safety factor 3 applied to Bkg and CsI timing resolution)→

Significance improvement of 4.5% in B→K nu nu

3.0% in B →Tau nu

Dose rate from BELLE

- Paper from Kuzmin et al. on CsI(Tl) irradiation studies: between 10 and 30% LY loss at 3.7Krad negligible impact on resolution
- From BELLE dose extrapolation:

450 rad/year expected in the fwd (steady state operation, injection could be the same)

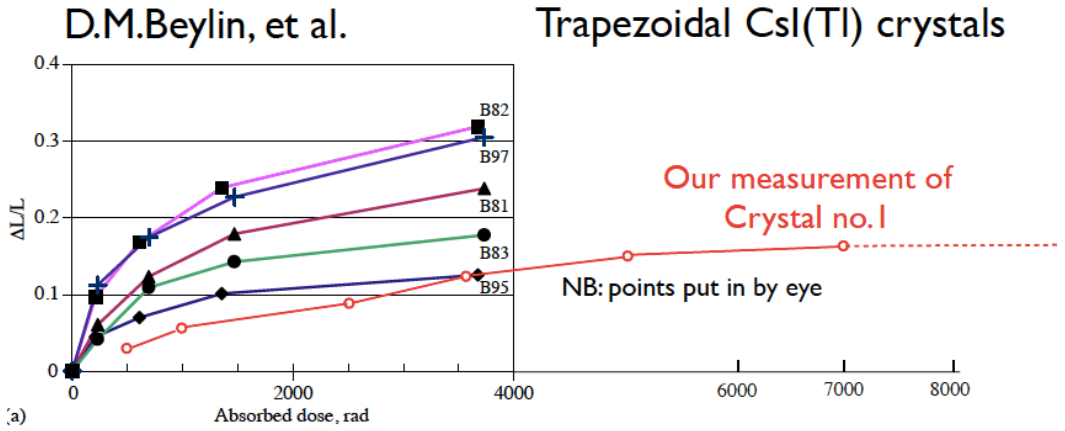
Lifetime dose quotation is 10krad (dose expected in 10 years of BelleII, changed to 3krad with the new background simulation) → we do not expect any effect

But..large spread in LY loss for

Different producers

Different theta

Phi dependence of absorbed dose has been observed



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What we have done since then…

- Continued and almost finish R&D on APD's readout of pure CsI crystals
- Irradiation campaign on CsI(Tl)

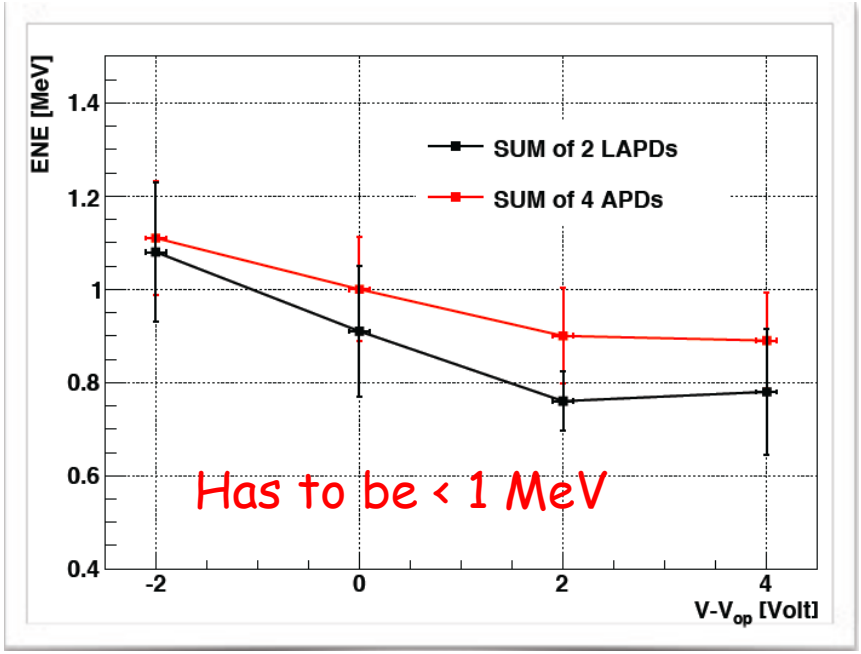
- Software study and development to create essential tools for physics performance studies

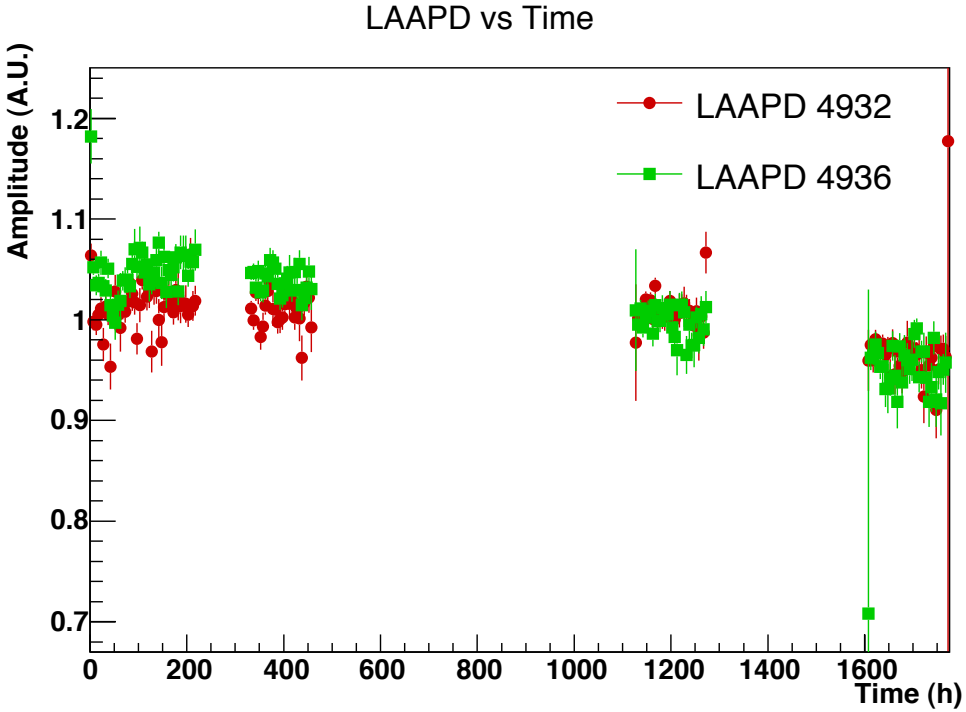
R&D on APD's

Extenisve R&D has been carried out to verify the possibility of using APD's as photodetectors for pure CsI crystals.

Pros: small dimensions (redundancy), no magnetic field dependence

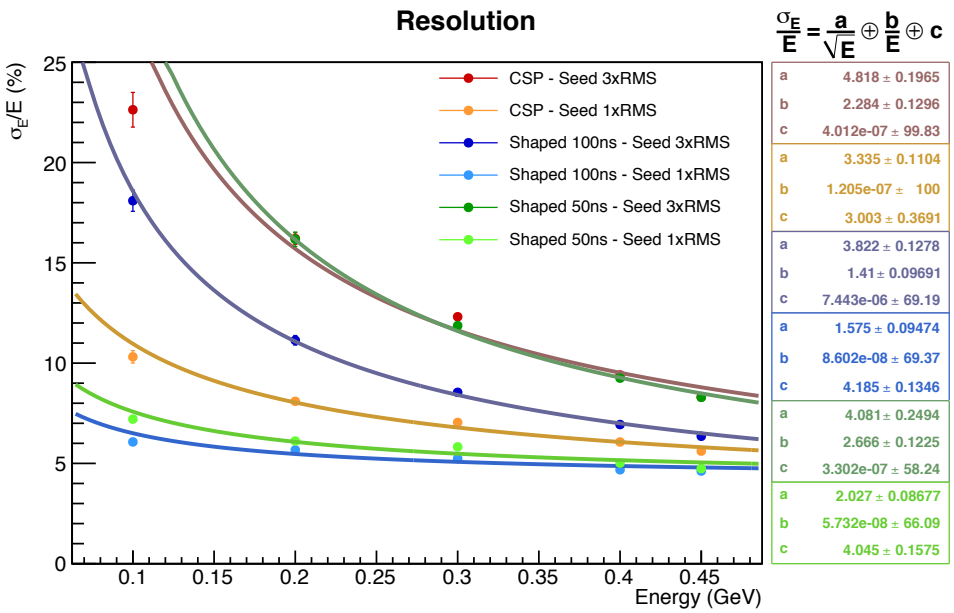
Contras: temperature dependence, stability, noise





Test Beam preliminary results

- 4x4 matrix at the BTF beam line
- Electrons between 100 - 450 MeV

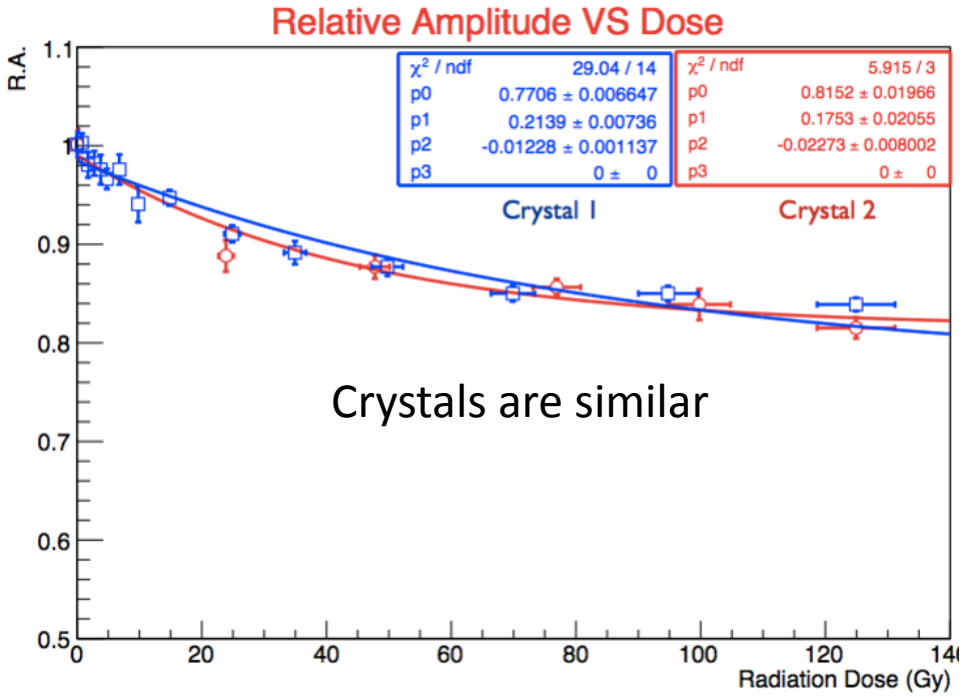


Photons bckg from primary beam on target to be studied

Scan on energy cut shows that lowering this cut improve resolution

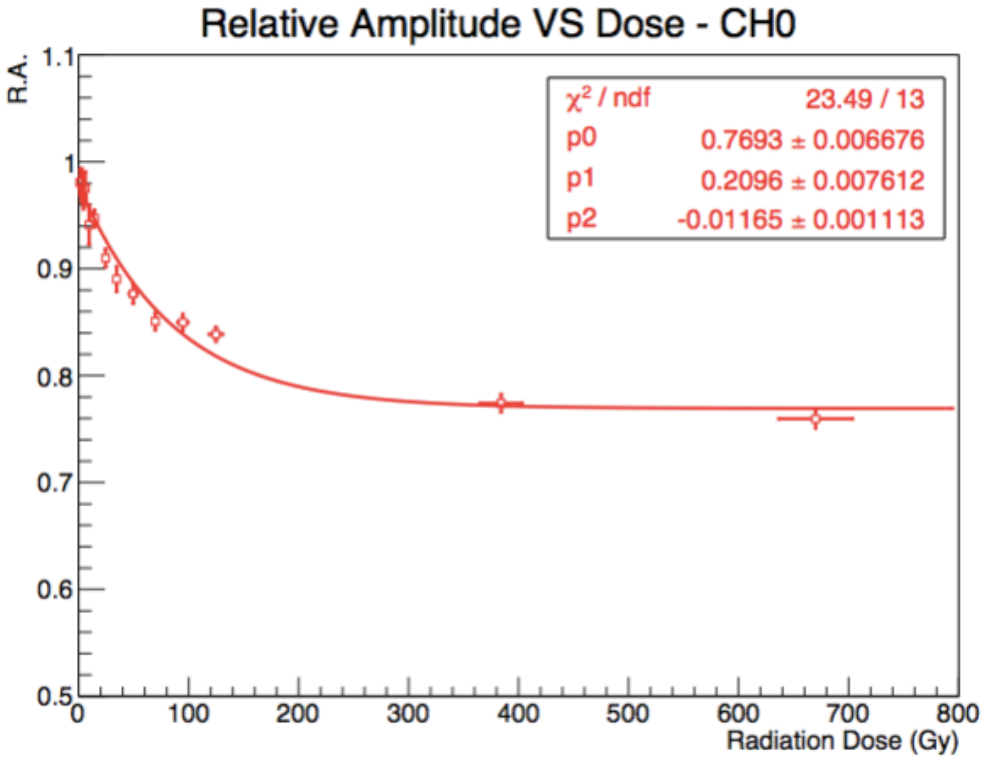
Strong dependence on energy cut
Correction for the beam energy spread not yet applied

CsI(Tl) Rad Hard



Crystals are similar

LY decrease of about 20%
We do not have a simulation to see the effect on resolution but we do not expect this to be enough to have the upgrade.



For the next future planning to finish irradiation campaign see Alessia's talk

Irradiation studies in Canadd

Study CsI(Tl) rad hard up to 50krad

LY and resolution uniformity with:

Cs-137 (662 KeV)

Bi-207 (569, 1064 KeV and 1.7 MeV)

Cosmic rays (40 MeV)

Timing resolution with CR

Crystal transmittance

Studies of ECL performance

- Possible configurations
  1. CsI(Tl) + PiN (actual ECL= BELLE)
  2. CsI(Tl) + APD (never studied in lab)
  3. Pure CsI + APD
  4. Pure CsI + photopentode

Study of the resolution at different energies

- Photons-electrons in ECL sigma(E)/E vs E
- Π^0, reconstruction + Δm
- Physics benchmark channels

What we could do….

- Change of the resolution vs S/N (o ENE)
  → to be implemented in the Digitizer
  1. Equivalent to the study of different photodetectors and then different shaping times
  2. Answer to one of the possible question: could be useful/enough/resolutive to replace PiN with ADP using CsI(Tl)?
  3. This is a very important question if CsI(Tl) is good w.r.t. rad hard

What we could do……

Study of the timing window to distinguish S e B

As of today:

$|t_0 - t_{TRIG}| < 5000$ ns/E(MeV)

(In this cut heritage of BELLE? Has it been studied for BelleII?)

TDR ref: reduction of the background for a factor of 7 with an efficiency of 93% (E> 20 MeV)

How it changes for the different configurations? In case of APD+CsI(Tl) or APD/photopentodes + pure CsI S/N is better→ how it changes the rejections factor?

Strictly related to the clustering algorithm (should we study it in detail for BelleII?)

Details of the configurations

CsI(Tl) + PiN → 500ns shaping - 700 KeV ENE

CsI(Tl) + APD → ??? To be done

Pure CsI + photopentode → 30ns shaping – 100 KeV ENE

Pure CsI + APD → 50ns-100ns shaping – 1 MeV ENE

What is missing?

- Irradiation of the BELLE PiN (we have 2 pcs) start in January
- Study S/N for CsI(Tl) + APD in lab

1 CsI(Tl) new crystal is available

(The two studies are partially correlated)

- Study of the clustering

What is missing?

Digitizer:

How to implement the different configurations is not straightforward

The information on the signal shape is implemented trough matrices produced with SPICE; is it possible to reproduce the same for all the options?

How we can put the information in the Digitizer?

It can be envisageable re-write a new Digitizer which takes directly the values of ENE and shaping in a more simple way (at least for this purpose)?

More on software development

We have just taken some responsibilities in different tasks in the software effort:

ECLCluster and MCParticle matching (Benjamin)

Timing reconstruction to select ECLClusters (Elisa + Erika)

Software: see more on Benjamin talk

Conclusions

- Many steps before to have the good instruments for the studies of the performances (detector and physics)
- But the effort is proceeding
- Timescale to have the tools available could be of the order of 2-3 months
- Timescale of the choice YES/NO upgrade? (with the new BelleII schedule)
- ECL BPAC scheduled for the next B2GM collaboration meeting in February