

ECL forward for the BelleII experiment at SuperKEKB

OUTLINE:

- Introduction
- R&D on pure CsI crystals + Front End readout
- future and plans



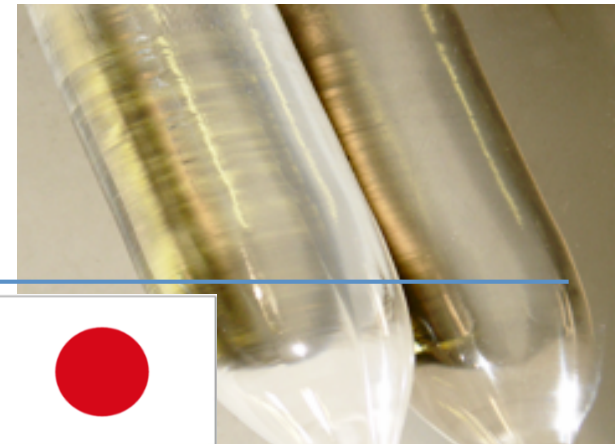
Introduction

FORWARD Calorimeter of BelleII experiment:

1150 crystals of CsI(Tl) to be replaced with pure CsI:

- same dimensions of CsI(Tl) → mechanics
- fast crystal (30 ns decay time) to avoid pile-up and occupancy
- rad-hardness good (report presented at the first JENNIFER General meeting)
- very low light yield

R&D on readout of the crystals is fundamental for the project to obtain a good energy resolution at relatively low energy with very low light output



APD (Avalanche Photodiode) as photosensor for pure CsI crystals

APD is:

- small good for the mechanics
- low gain
- S/N ratio deeply studied during R&D



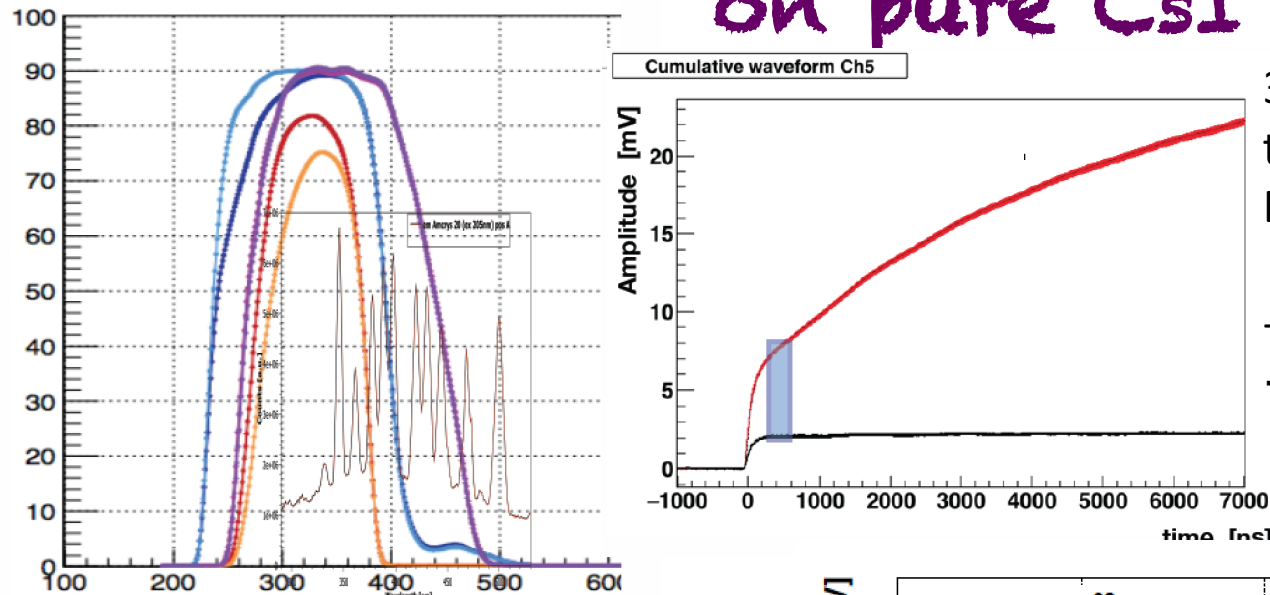
- Pure CsI:
- low light yield @310nm where the Q.E. (Quantum Efficiency) of the APD is low (APD has max Q.E. around 420nm)
 - very fast prompt emission of the light (30ns)
 - slow component of the light up to 1us



GOAL: eliminate the slow component of the light to avoid pile-up between physics events and background from machine → **use a filter to select only the fast component**
→ **use a WLS to shift the fast emitted light in the 420nm region to match the APD window**

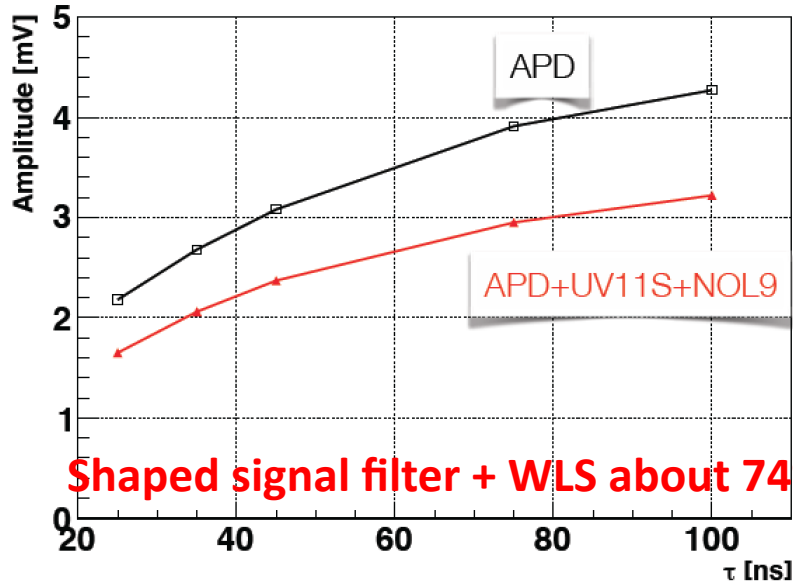


Filter + WLS (Wavelength Shifter) on pure CsI

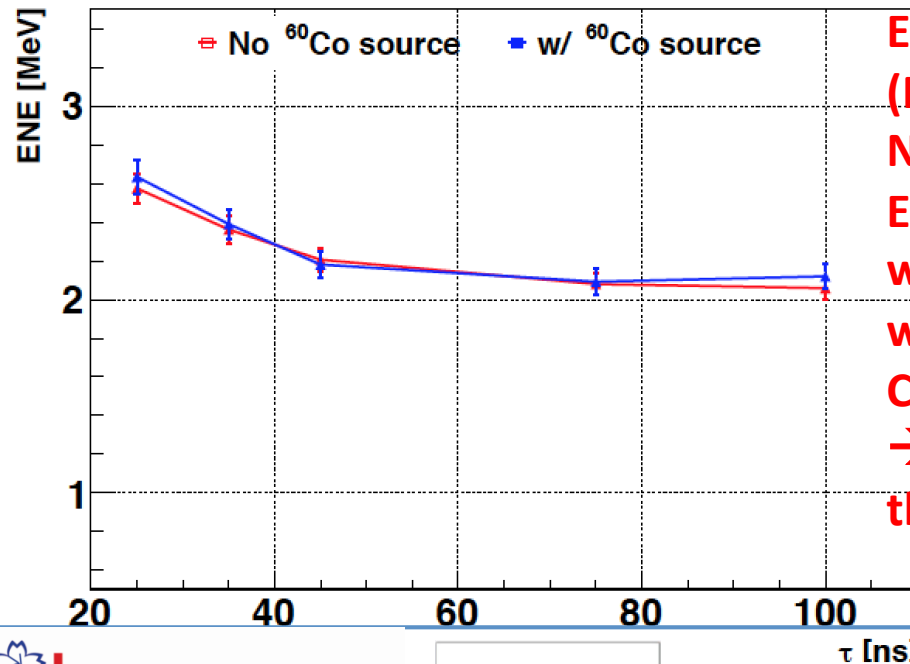


38% of the light is retained after the filter with the APD read out → ENE increase accordingly $\times 1/0.38$

+ WLS some light is recovered 61% → ENE scaled accordingly $\times 1/0.6$



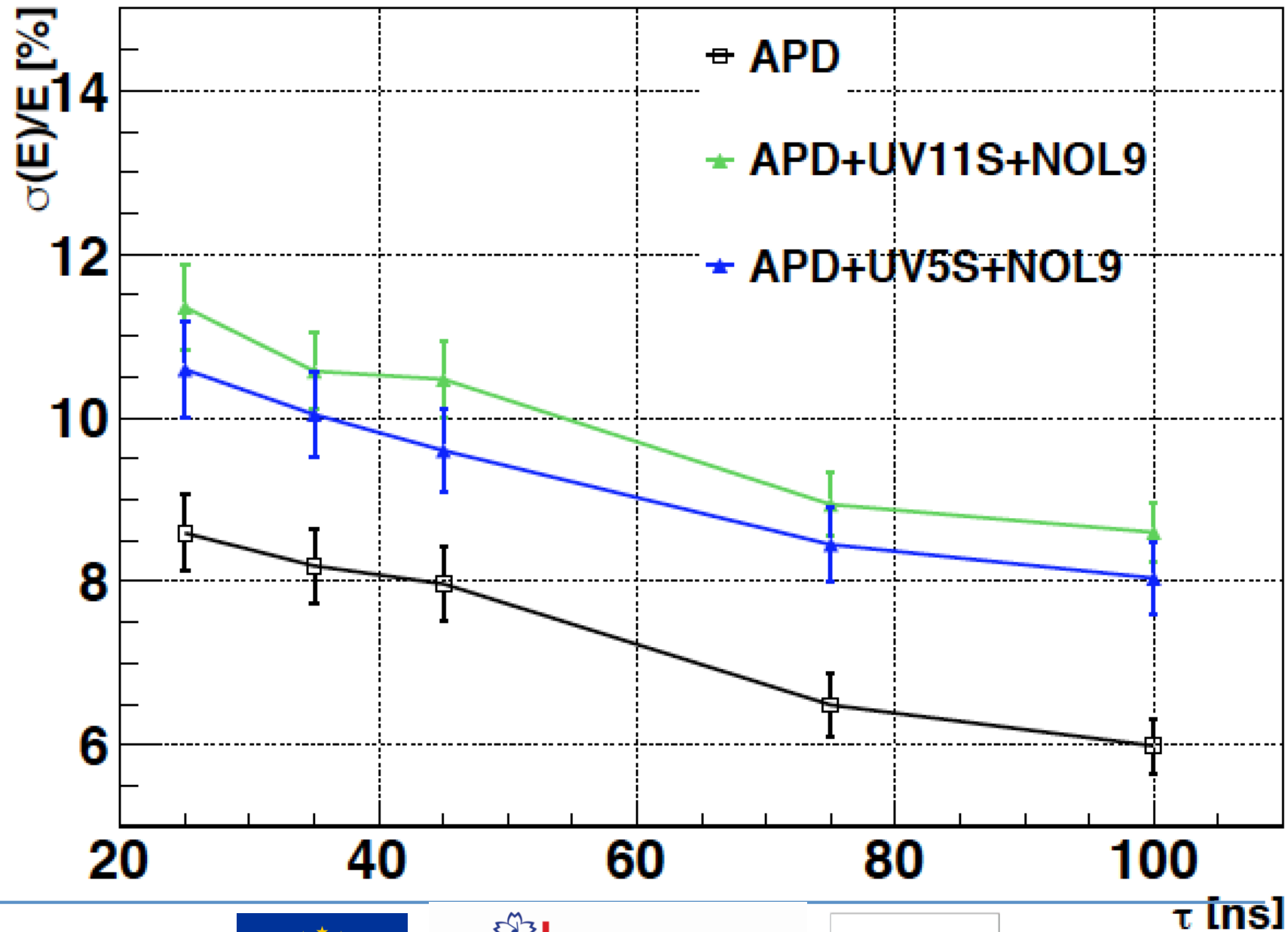
Shaped signal filter + WLS about 74%



ENE (Equivalent Noise Energy) with and without Co60 source → ENE is the same

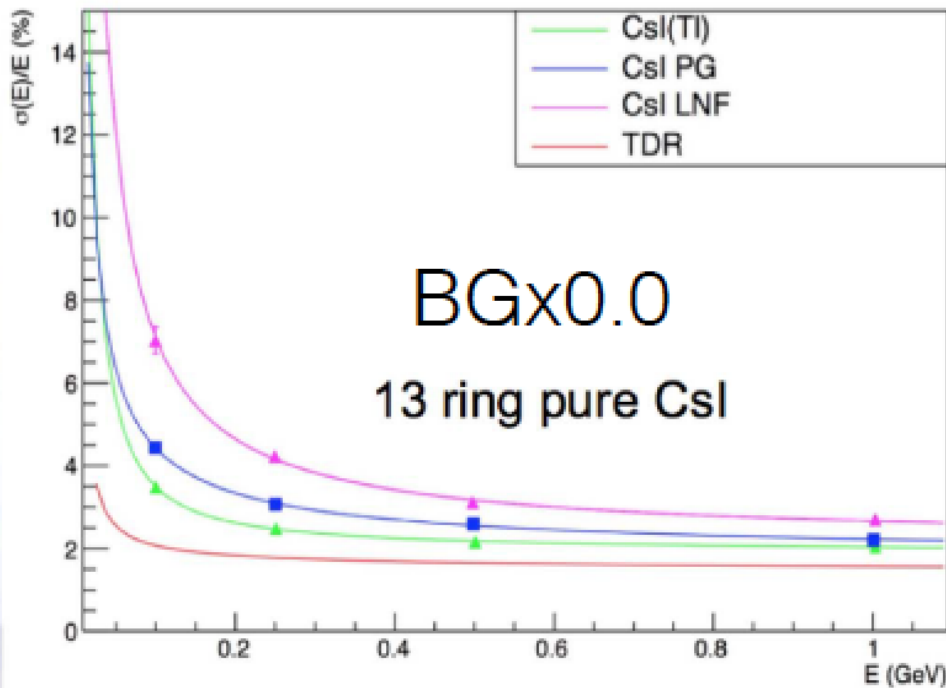


Resolution

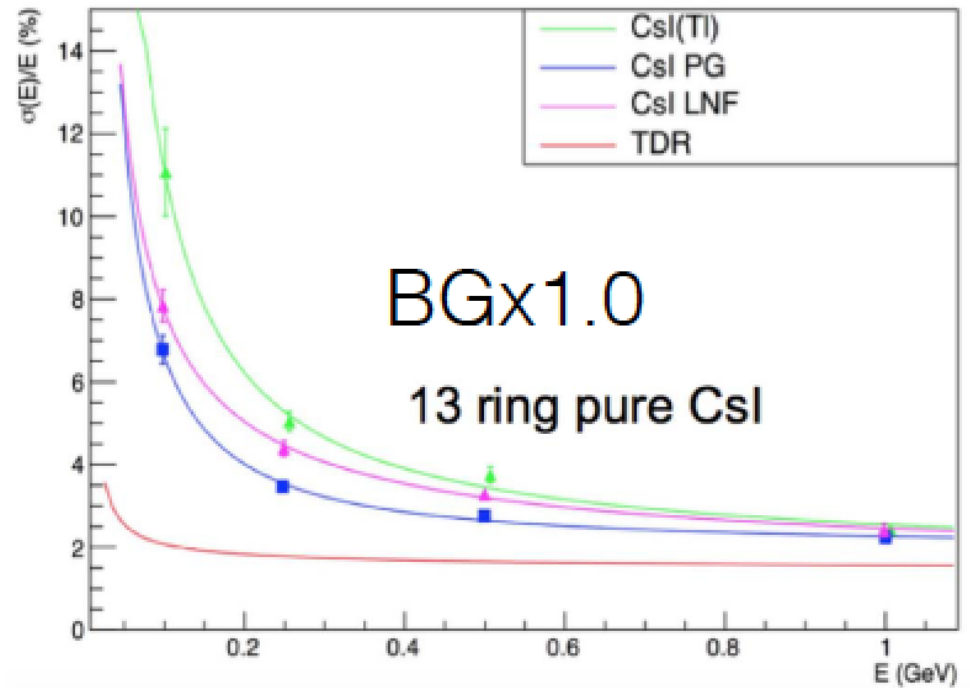


Performance studies

FWD ECL Resolution



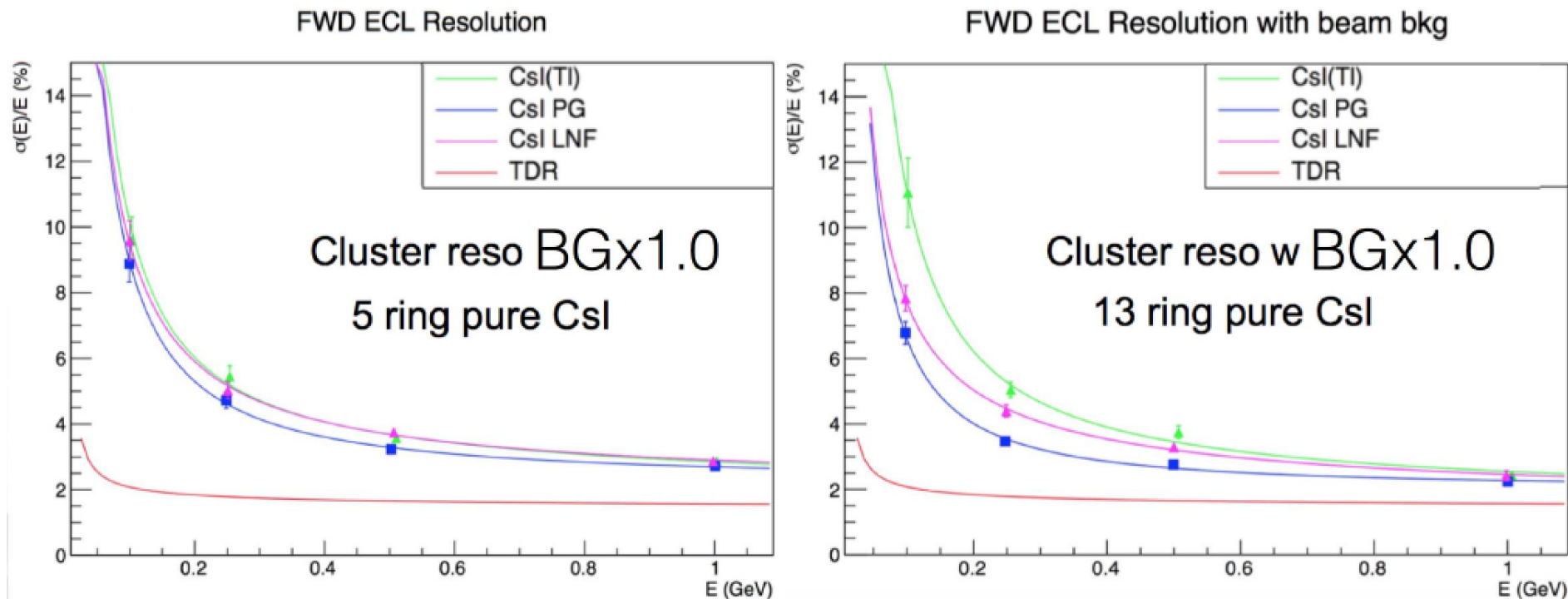
FWD ECL Resolution with beam bkg



PG: ENE 0.7 MeV and 25 ph-e/MeV
LNF: ENE 1.3 MeV and 6 ph-e/MeV



Performance studies



- Nominal background (BG =1) degrade the resolution by a factor 10%
- With BG=1 ENE + photostatistic fluctuations degrade resolution of a factor 20% each
- With current simulation → energy resolution @100 MeV about 5% (to be compared to 12% CsI(Tl))



Planning

SuperKEKB Commissioning Phases

Y. Funakoshi at June '16 B2GM

2016 Feb. ~ June

Phase 1
w/o QCS and Belle II

basic machine tuning
vacuum scrubbing
Optics tuning
BKG study

~2017 Autumn (~ 5month)

Phase 2
w/QCS and Belle II
w/o Vertex detector

DR commissioning
BKG study
Luminosity tuning
Target luminosity:
 $1 \times 10^{34} \text{ cm}^{-2} \text{ s}^{-1}$

~2018 Autumn

Phase 3
w/ full Belle II

Physics Run
Luminosity tuning



Planning

Due to the delay of the SuperKEKB operations (about one year) the decision on the FWD EMC upgrade has also been delayed

- a task force has been settled (C. Cecchi co-chair) to finish the R&D and take the final decision

JENNIFER DELIVERABLES:

- FWD ECL TDR 10 months (Feb. 2016) → R&D report March 2017, 24 months
- Commissioning report FWD ECL (48 months) → TDR when Background studies will be available as they are crucial



Summary of secondments for ECL

370 days until September 1st (about 1 year)

Secondments planning: by August 2016 19 secondments (1 month each) should have started → 19 months

14 secondments (people) have started

8 should finish the 1st month

5 have to finish the 2nd month

1 is in the 3rd month

TOTAL 21 secondments (1 month each) have started



Conclusions

- R&D is going on and is approaching the final steps
- Filter + WLS on pure CsI give good results → ECL FWD detector is not affected by presence of BKG a slightly loss of signal is observed (74% of the light is retained after shaping)
- CsI(Tl) + APD shows good level of noise → to be tested at more stable values of APD Gain
- Performance studies are ongoing → pure CsI is better in presence of BKG than CsI(Tl) with the present level of BKG and with the actual clustering → clustering is a key ingredient for these studies and to understand how CsI(Tl) can be improved
- Besides the delay non directly coming from the ECL group the ECL FWD Task Force will decide on the upgrade max in 1 year from now and there is still a slot of opportunity for the installation and commissioning of the detector which will have sensible impact on the physics results.

