BelleII Italia meeting
Conclusioni e prospettive sessione ECL

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Considerazioni su quanto visto nella sessione

- Abbiamo indicazioni, ma credo non conclusioni CHIARE e DEFINITIVE
- Alcune informazioni sono mancanti
- Fare un grande sforzo nei prossimi mesi per portare avanti
  - Full sim CsI puro
  - WLS e filtri

To increase the light output

The light collection coefficient strongly depends on the quality of APD coupling to crystal and reflectivity of the wrapping material.

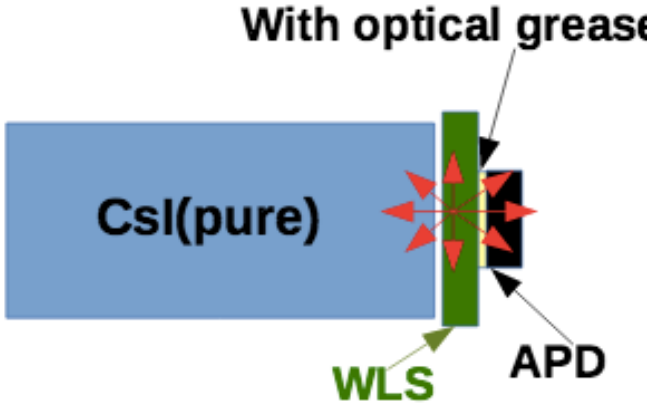
1, Three types of optical grease were tested, OKEN-6262A, BC-630 and TSF451-50M. However, we didn't find anything better than OKEN-6262A.

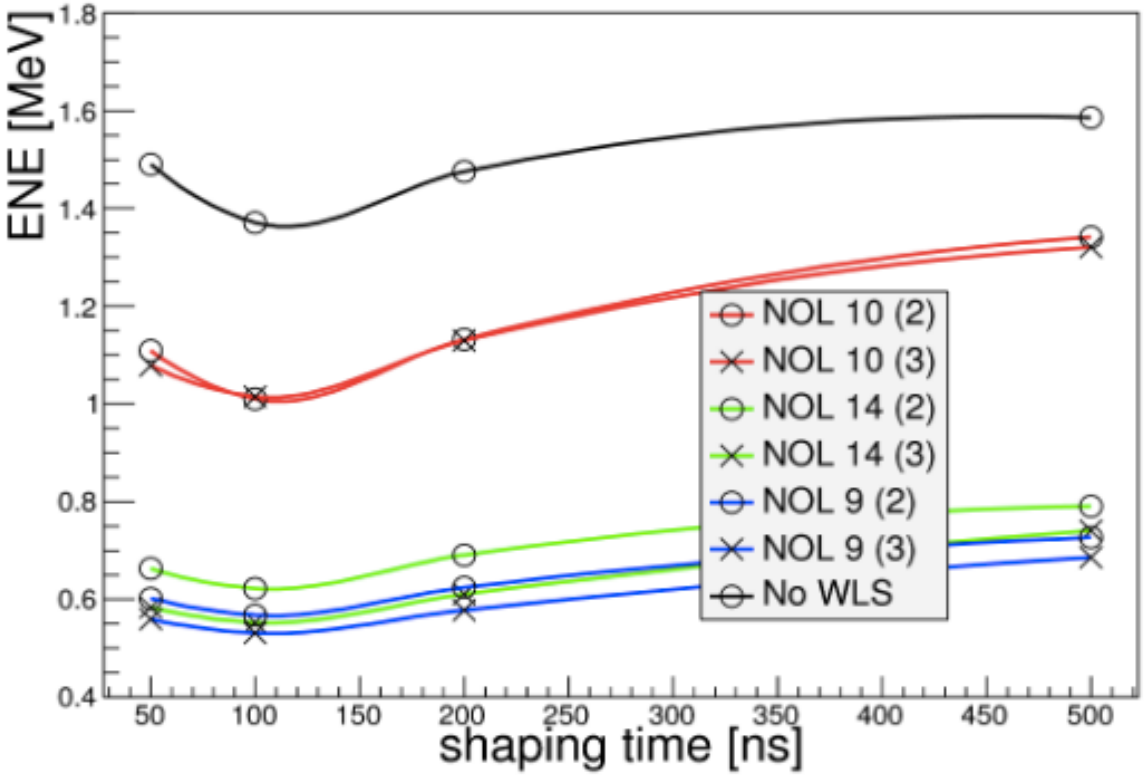
2, White porous Gore-Tex teflon was confirmed as the best reflector at UV range [1]. The thickness of the white teflon was studied. It is shown that 200 um is sufficient, further increase on thickness provides no more than 5% improvement on signal.

3, Novel wavelength shifting (WLS) plates containing nanostructured organosilicon luminophores [2] provides essential increase of light output.

[1] M.Janecek, IEEE Trans. Nucl. Sci. 59.3 (2012) 490.
[2] S.A. Ponomarenko, et al., Scientific Reports 4 (2014) 6549.

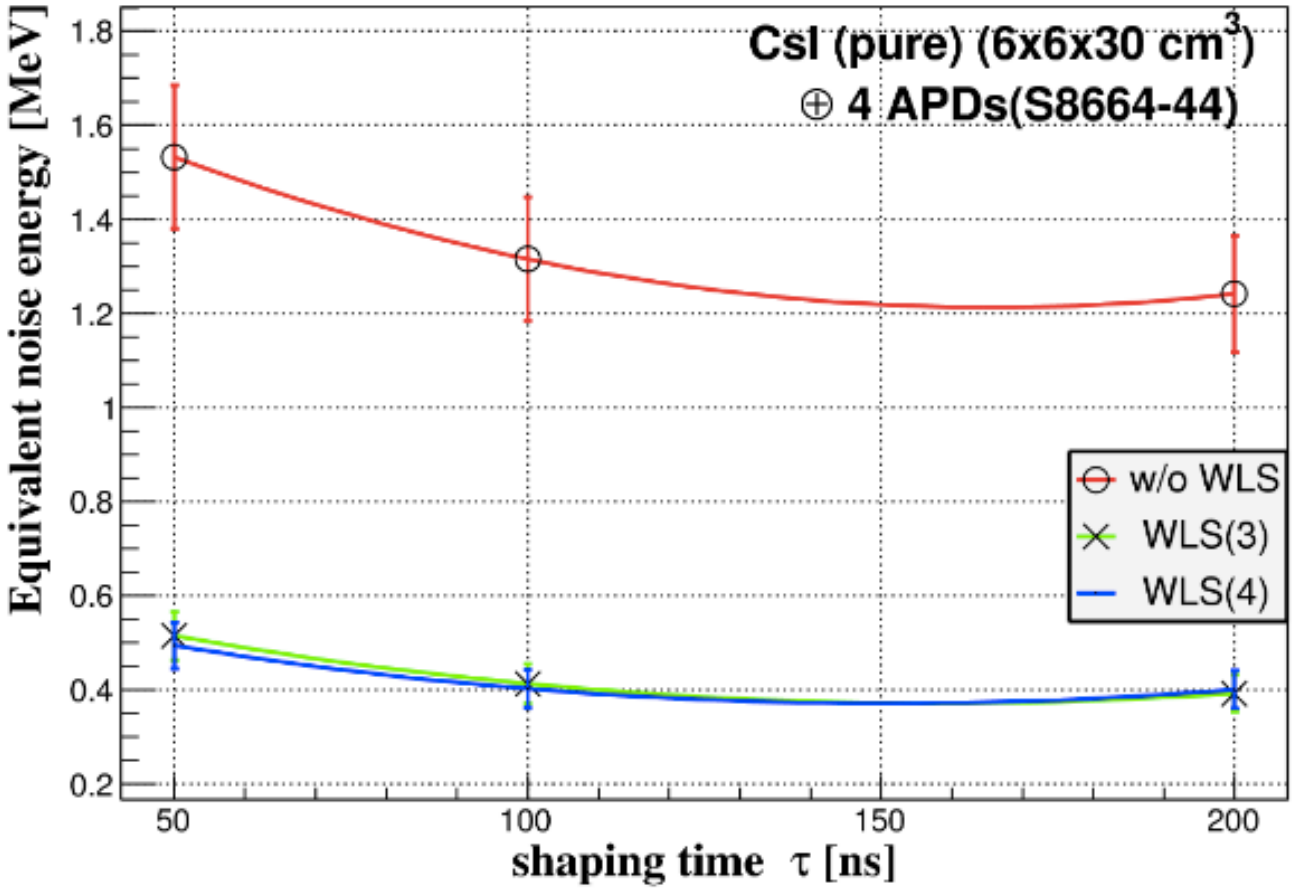
Results with WLS plates





NOL-9 turns out to be the best WLS that provides an enhancement on signal by a factor of about 3.

4 new small APD's + new WLS (3)/(4)

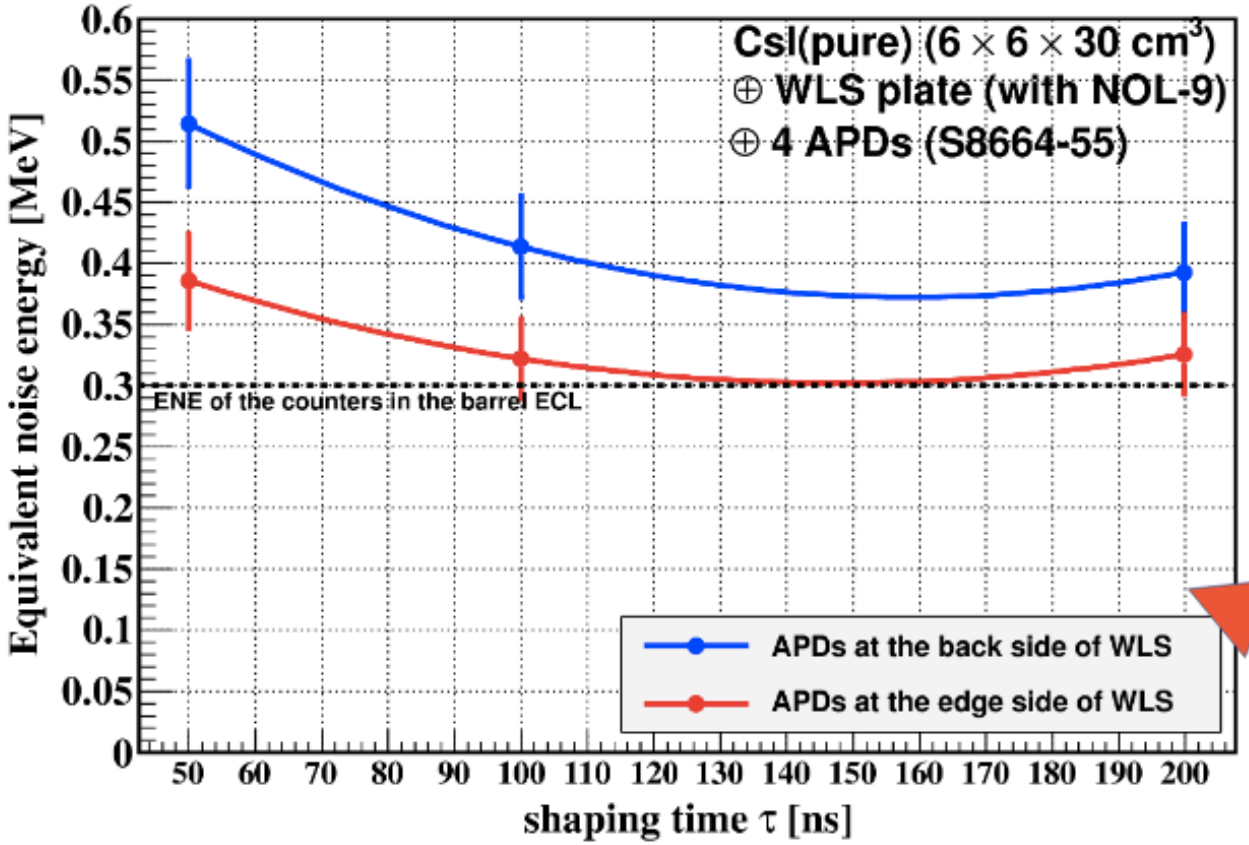


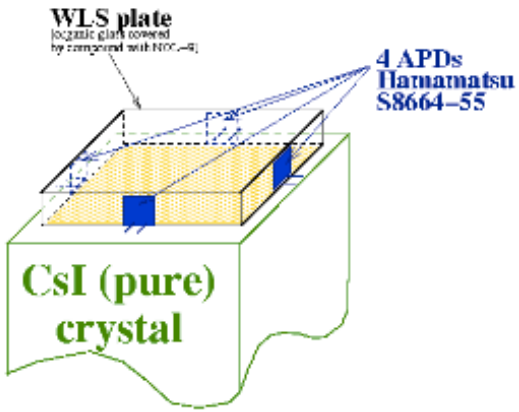
Error originates from the relative temperature gain variation ((1/G)*(dG/dT)), accuracy of simulation of cosmic peak position and statistical accuracy of the data.

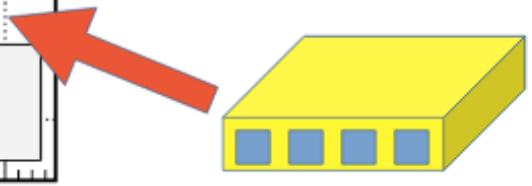
Between the crystal and APD's, we applied WLS. The APD's are coupled to the backside of WLS by OKEN optical grease. However, no optical grease is used between crystal and WLS.

A factor of about 3 is earned on signal intensity by the use of WLS. No obvious difference between WLS (3) and (4) has been observed.

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.

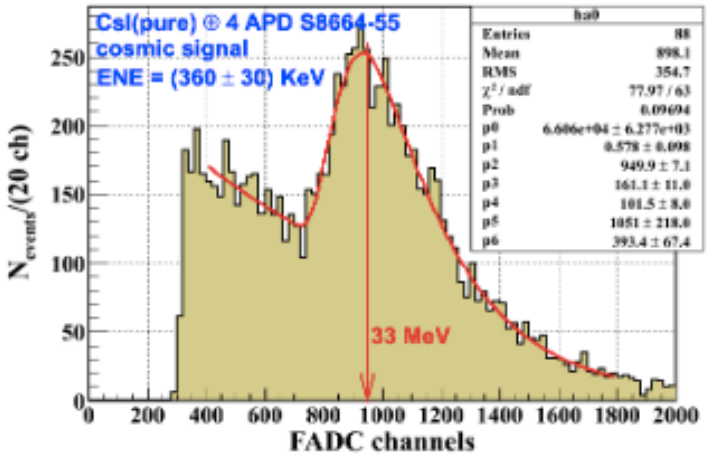
A factor of 1.3 is earned by this configuration.

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

The result with Shaper-FADC

The rising time (T_{rising} ≈ 160 ns) of the signal from Clear Pulse (≈ CR-3RC) with τ = 50 ns is approximately the same as that of Shaper-FADC (CR-4RC) with τ ≈ 30 ns.

4 S8664-55 (edge side)	**(360 ± 30) keV**
1 S8664-1010 (back side)	**(540 ± 50) keV**
2 S8664-1010 (back side)	**(440 ± 40) keV**
2 S8664-1010 (back side)	**expected to be (380 ± 40) keV**



One Large size APD S8664-1010 is old. It has triple dark current, which is the reason why the ENE with 2 S8664-1010 is not suppressed by a factor of $\sqrt{2}$.

Plan of the CsI(pure)+APD studies in U-Tokyo

- Study of the various position configurations of 4 APDs at the edge facets of the WLS plate.
- Study of the beveled-edge WLS plate + slanted APD coupling.
- Test various optical greases to couple APD to WLS plate (made of PMMA).
- Find the optimal optical cement/glue to couple APD to WLS plate.
- Elaborate final mechanics, how to couple WLS plate to the crystal.

Plan of the CsI(pure)+APD studies in BINP

- Organize setup for the studies of CsI(pure)+APD counter.
- Measure $g(U_{BIAS})$ and $F(U_{BIAS})$ of APD S8664-55 and S8664-1010 for the light with λ = (300 – 700) nm. Formulate the request to Hamamatsu company how to modify internal structure of APD (thicker incident p-layer) to minimize F while keeping high quantum efficiency and acceptable neutron radiation hardness.
- Try WLS(NOL-9) with several donor luminophores (it has been already prepared) for better matching of the CsI(pure) emission and NOL-9 absorption spectra.
- Test WLS(NOL-10 with modified donor luminophore). Try new NOLs with larger wavelength of the re-emitted light (LumInnoTech Co. is working on the NOL re-emitting at ~700 nm).
- Try to mat the facet of the CsI(pure) crystal under WLS plate to increase signal (light collection efficiency).
- Test optical filters between CsI(pure) crystal and WLS plate to reject long scintillation decay time component and suppress pile-up noise.
- Develop 4-channel preamplifier with the scheme compensating temperature variations of the APD gain (tuning bias voltage). Test temperature stability of the signal from the counter with this preamp.
- Elaborate design for the counter (crystal+filter+WLS+APDs+preamp.+connector+shielding box). Measure characteristics of this version of the counter.

Studies are to be done in BINP, but concrete schedule is difficult to issue now

- Study of the spectral characteristics of the short/long scintillation light decay time components of CsI(pure) crystal.
- Works with version of the Shaper-DSP board having shaping time τ = 30 ns.
- Test beam studies of the calorimeter prototype assembled from 20—25 counters.

Plans in Italy

Measure the decay time of the different peaks of the emission spectrum in order to distinguish and cut the slow component of the light

Couple a crystal + APD+ filter + WLS and measure again CR to extract S/N → resolution (LAAPD in the standard position)

Implement a final version of the waveform in the Digitizer code to produce MC events with background

Study of the performance with full sim (single photons + physics channels)

Conclusions and outlook

- A reliable simulation of the background is mandatory to understand the impact of the FWD upgrade

- The R&D has shown that S/N ratio is compatible with our request. The best coupling of crystals to APD and to WLS have to be defined

- The slow component of the light remains the real problem against pile-up → te use of a proper filter before the WLS can help in this purpose

- Digitizer has been modified and a MC production with bckg has to be scheduled to have a full sim in order to study the performance of the whole detector

- Planning presented in the different institutions involved in the upgrade study will be coordinated in order to have
    - -cross check of the different measurements
    - -not overlap
    - -efficiently use man power and money (material for beam test)

Reasonable time schedule would be June 2016