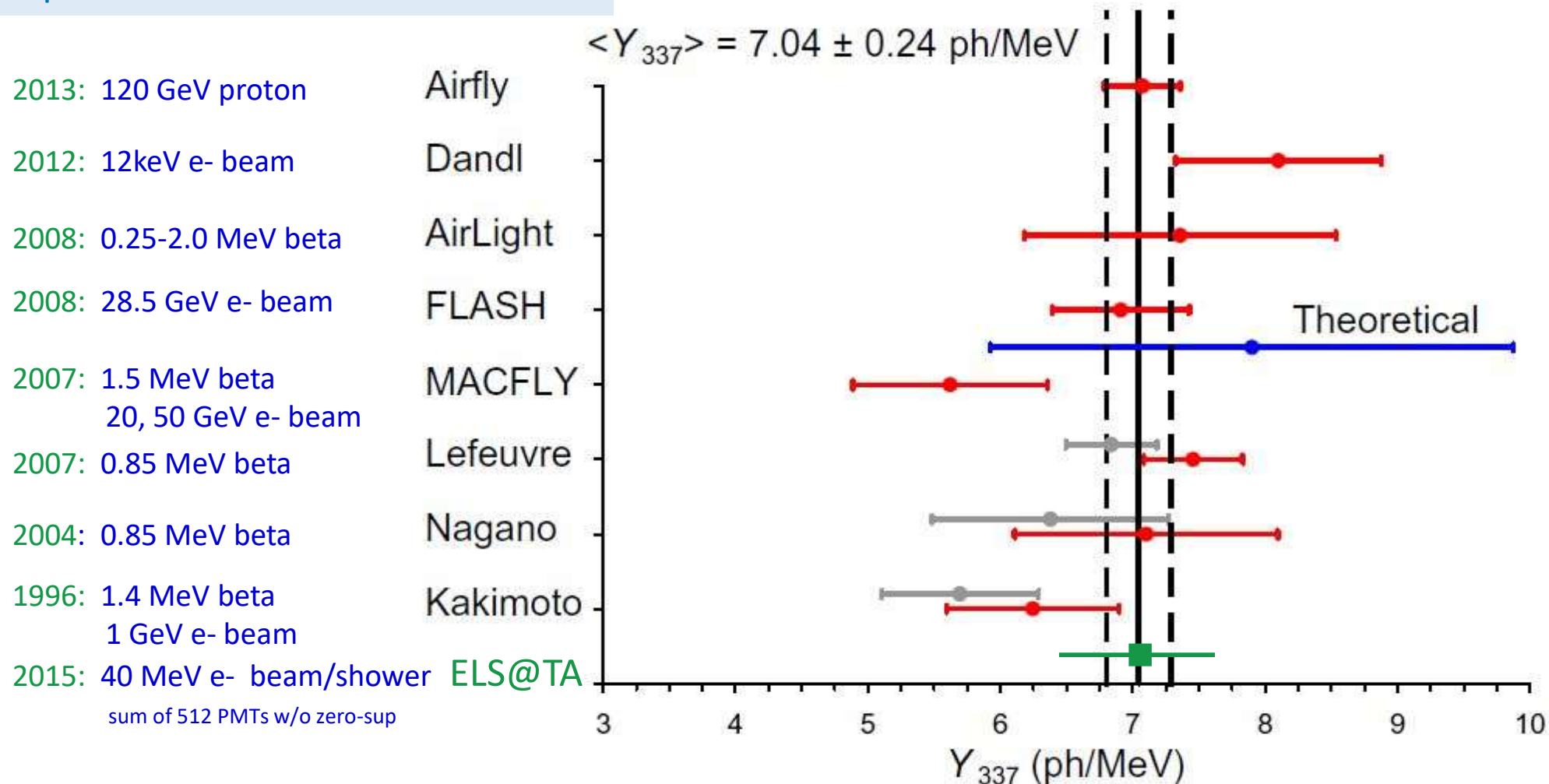


Status of sFLASH - Measurement of air fluorescence
yield from EM shower

in GCOS workshop, Wuppertal and online

zoom presentation by M.Fukushima, ICRR
JST 23:05-23:10 2022/07/14

Compilation of Air Fluorescence Yield



- Original figure is from J. Rosado, F. Blanco and F. Arqueros, ApP 55(2014) 51-62.
- Grey circle is original, and red circle is after RBA's correction.
- Green ELS value is by BK Shin et al. (TA) in the 34th ICRC in den Haag.

sFLASH Question: AFY of EM shower may be different from that of a single electron (P. Sokolsky). Inject 15GeV extracted electron beam of SLAC into alumina target of 0-3RL thick, and measure AF after target from 10m away by open PMT.

History of sFLASH experiments

2008 -	SLAC	FLASH experiments
2016 Sept	SLAC	sFLASH 2016 3-15 GeV electron, target RL:0-3 thick
2018 Nov	SLAC	sFLASH 2018 15GeV electron, target RL:0-10 thick

Today, preliminary results of sFLASH 2016 is reported.

sFLASH Collaborators

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K. Reil⁴, D. Saltzberg⁸, B. K. Shin⁵, P. Sokolsky¹, S. Thomas¹, G. B. Thomson¹, S. Wang³

For today's report, I borrowed several slides from sFLASH collaborators. Many thanks for them.

Setup Overview (1)

Tunnel Protect background light

2016/September



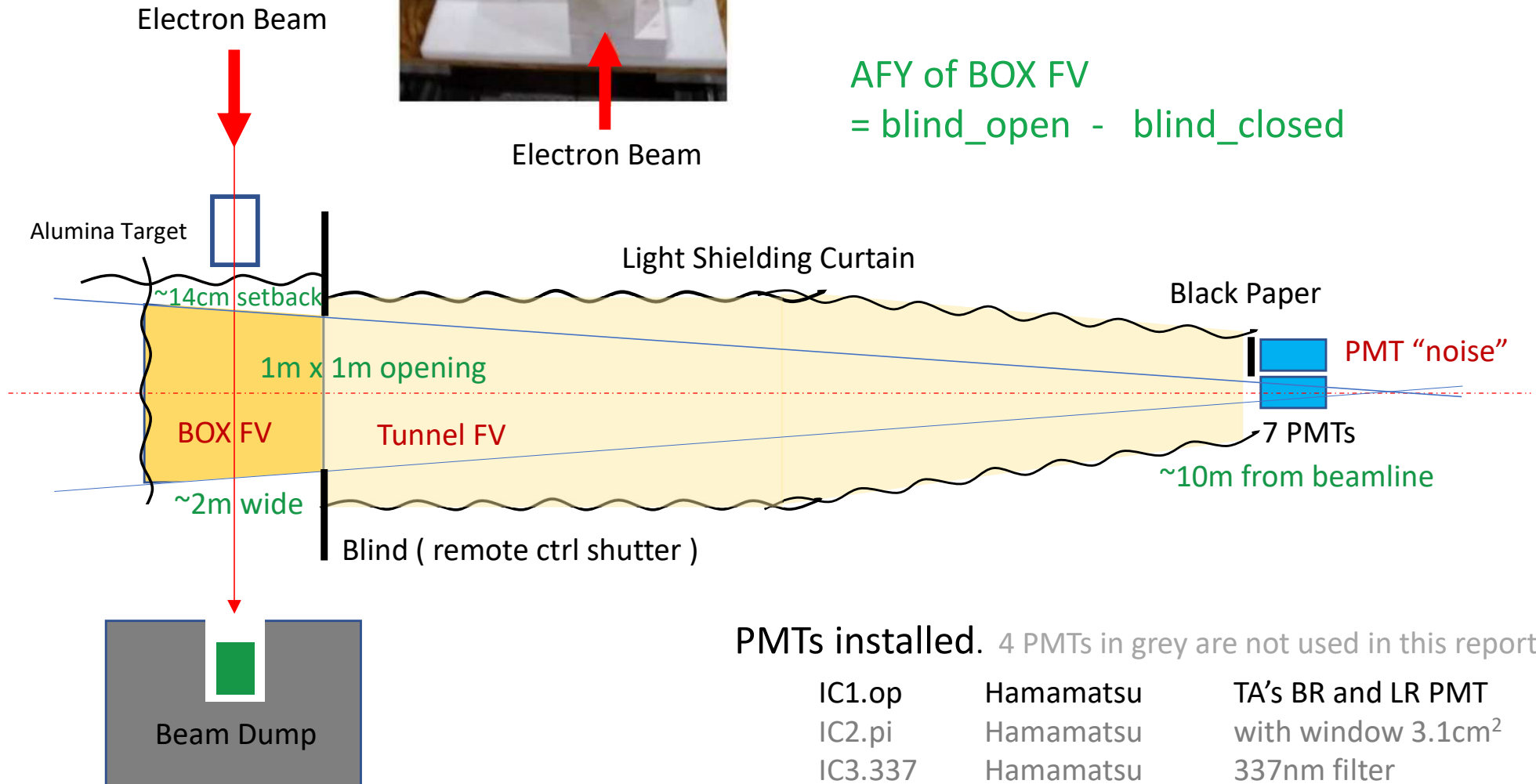
PMT positioning 10 m
away from beam shower.

Shower generated
with target.



Alumina Target
Al₂O₃ 90% + SiO₂ 10%

$$\text{AFY of BOX FV} = \text{blind_open} - \text{blind_closed}$$



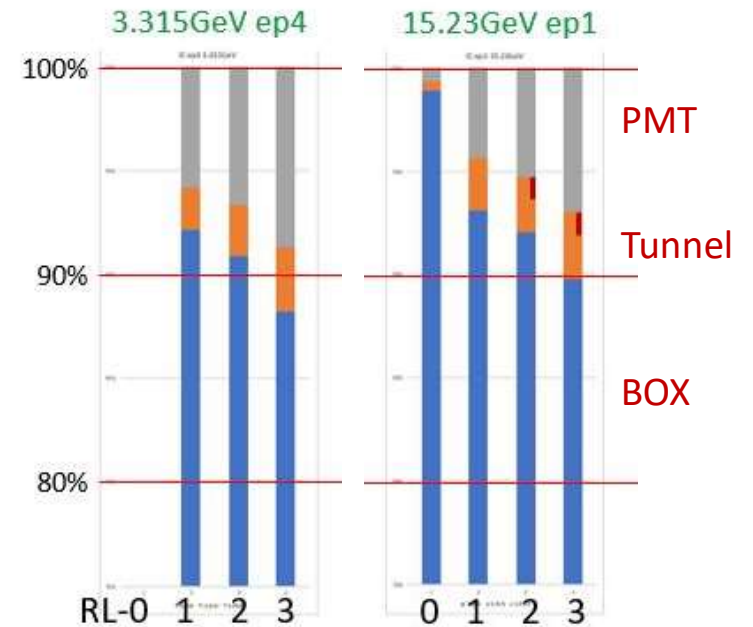
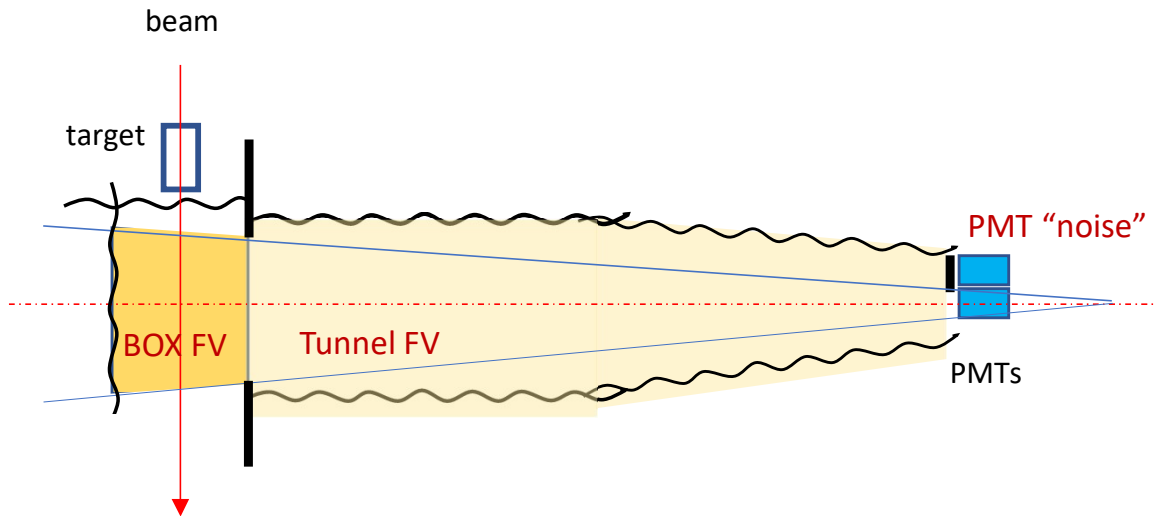
PMTs installed. 4 PMTs in grey are not used in this report

IC1.op	Hamamatsu	TA's BR and LR PMT
IC2.pi	Hamamatsu	with window 3.1cm ²
IC3.337	Hamamatsu	337nm filter
IC4.op	Hamamatsu	TA's BR and LR PMT
MH5.op	Photonis	TA's MD PMT (ex-HiRes)
MH6.op	Photonis	
MH7.op	Photonis	

$$rAFY = \frac{\int \text{PMT waveform}}{\int \text{Beam Current monitor}} \cdot \frac{1}{(dE \cdot \Omega) \cdot G4}$$

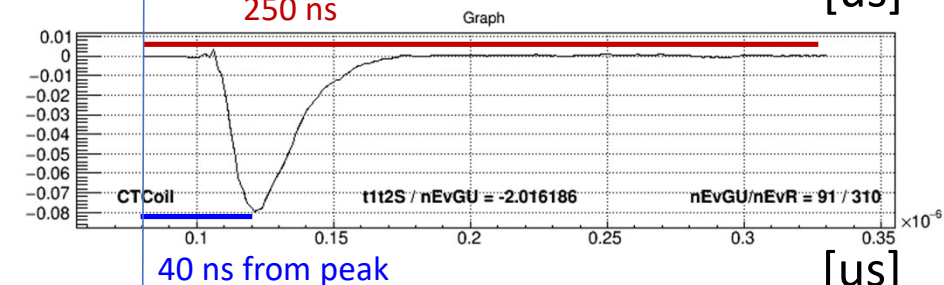
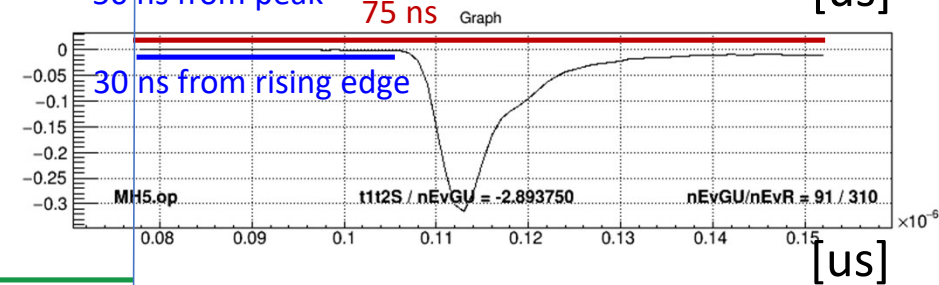
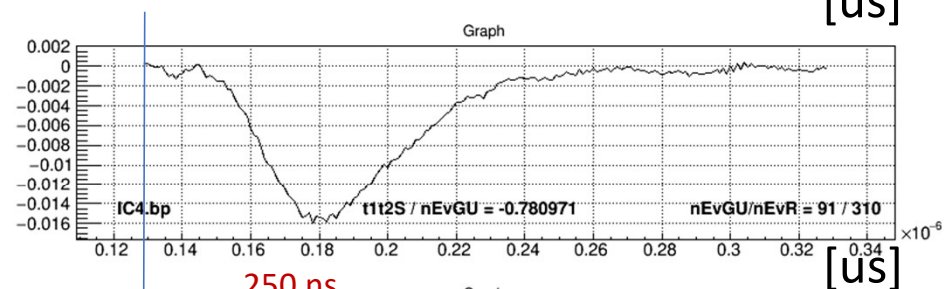
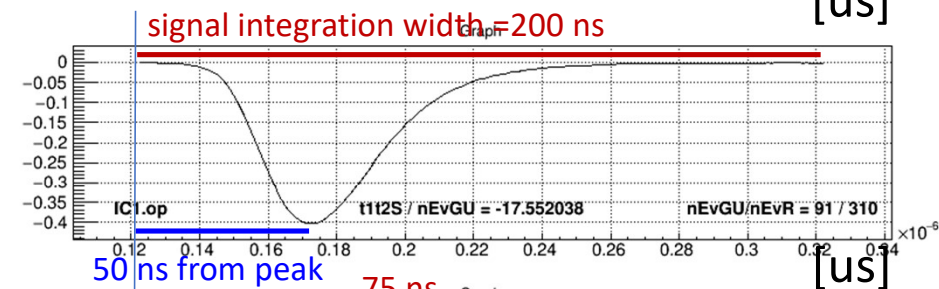
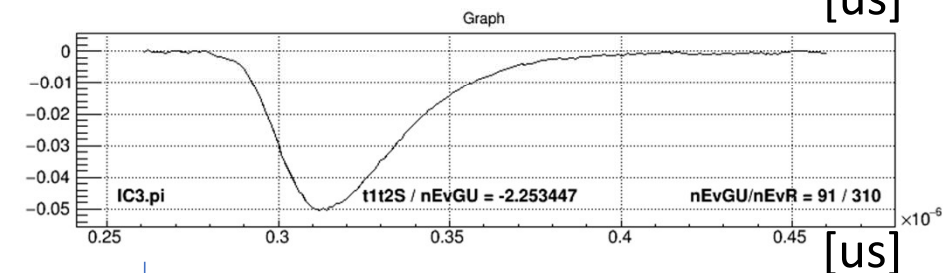
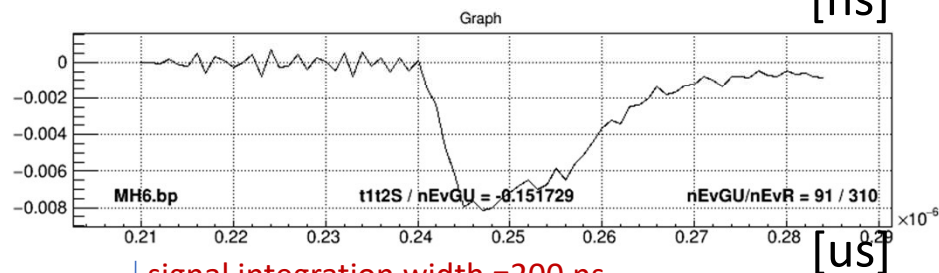
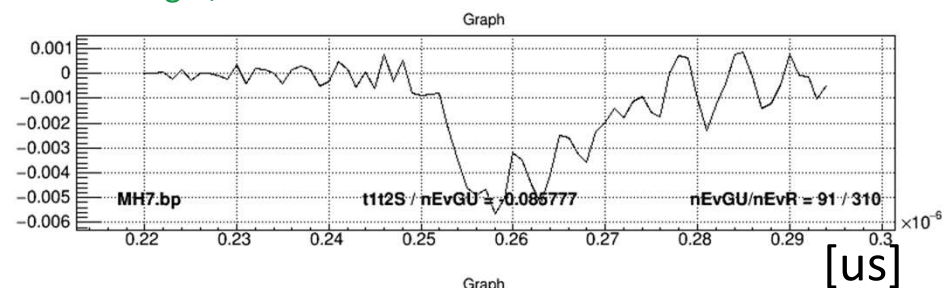
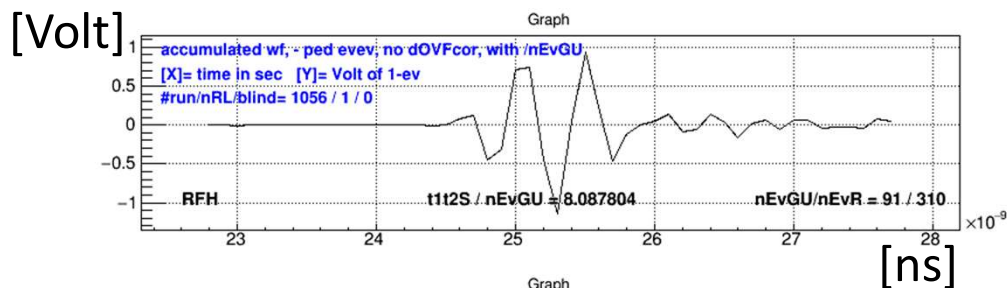
\propto PMT charge \propto # of beam electrons
 \propto energy deposit in the fiducial box of size $\sim 1\text{m}^3$

then normalized at 1-RL target



Averaged waveforms over 91 good beam spills of run 1056, and wf integration range

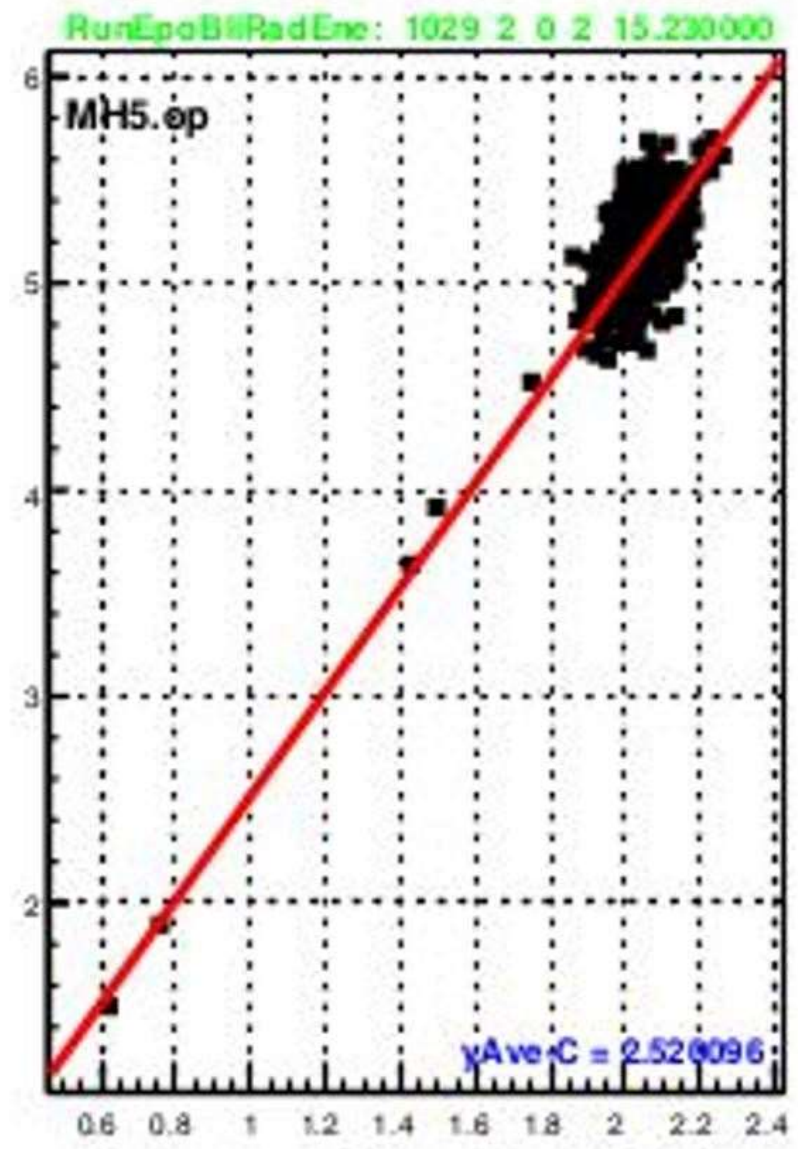
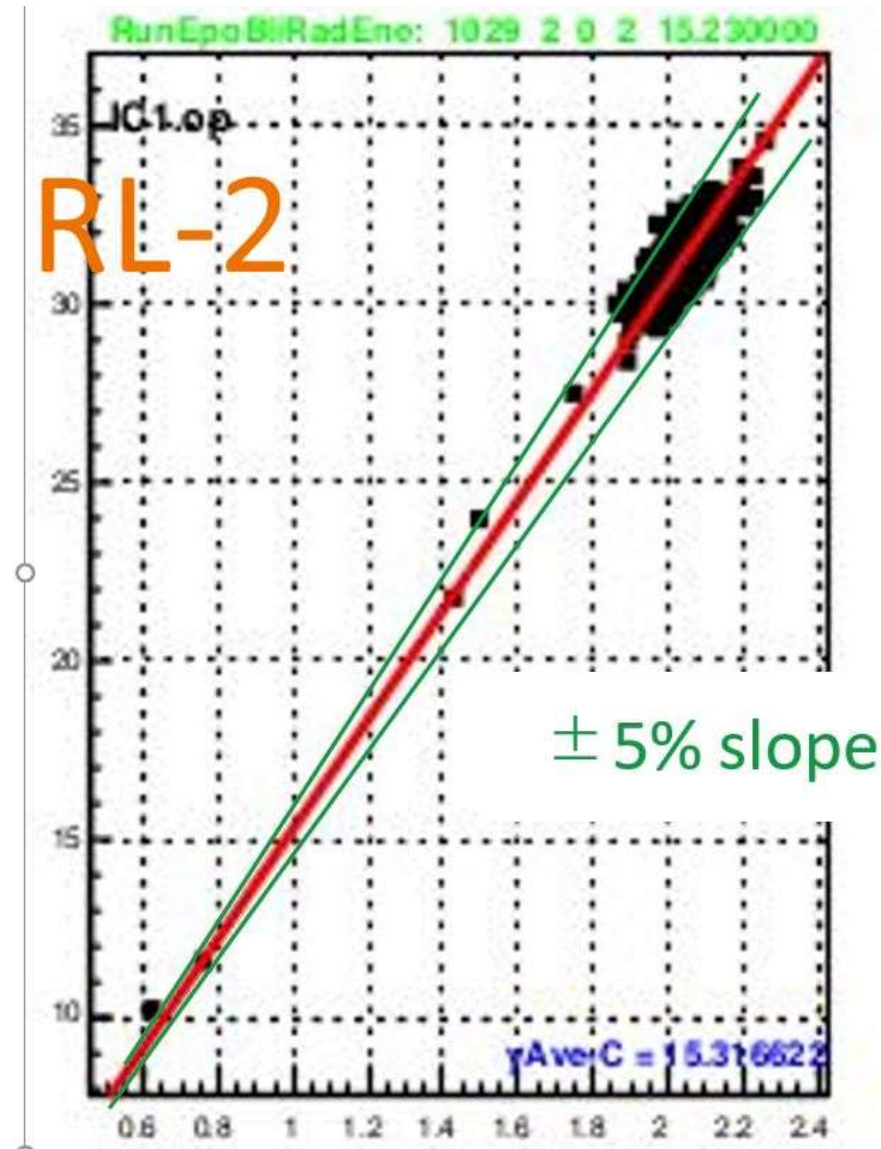
~15GeV on 1-RL target,

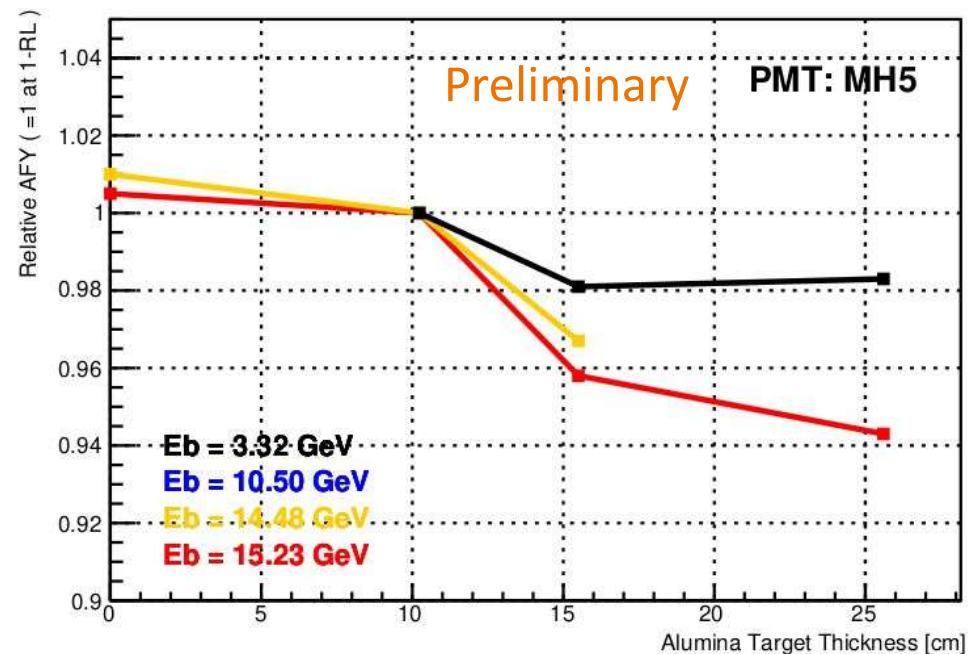
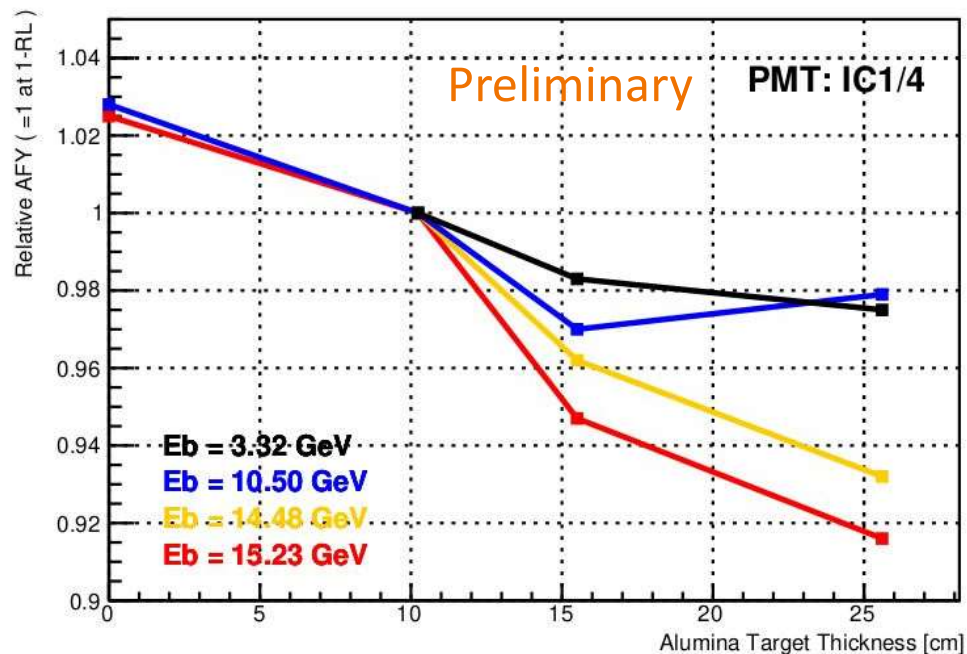


90 ns for pedestal estimate

Event by event waveform charge integration (= intQ[nVs]), and obtain rAFY:

1. determine pedestal
 2. digital OVF detected and corrected
 3. - ped and sum over chs
 4. divide by beam intQ
 5. intQ of blind-open minus intQ of blind-closed
 6. divide by $dE \cdot \omega$ by G4 from BK
- * relative AFY as abs. calib. Not applied.





1. Preliminary Results

- Large negative rAFY slope over target-RL.
- Slope is beam energy dependent.
- Slope is smaller for MH PMT (ex-HiRes)
- 10.5 GeV is being checked

2. Near Future

- Add 3.3 GeV 0-RL data.
- Extend MH integration gate.
- Install PMT calibration; rAFY \rightarrow absolute AFY
- Assign stat and sys errors
- ...

3. Summary

The slope feature persists after numerous checks such as beam intensity dep (extinction), analog saturation, digital overflow, back-scattering from alumina and beamdump, "BG" subtraction, Cherenkov background, beam-PMT synch., temp-press-humid. effect, error in target RL, prolonged signal (tail), inaccuracy of multiple scattering in simulation, ΔE tracking energy threshold etc..

The AFY of EM shower is NOT represented by a superposition of an energy - & particle(e, p, e+) - independent single AFY value.

Taken as AFY of free air shower, the feature may be internally inconsistent, and a "correction" to the shower parameter (E, Xmax,...) is not obvious.

Follow-up experiments are needed to understand the problem. The results will be useful in designing GCOS. Presented data is preliminary. Thanks for your listening.

RESERVED

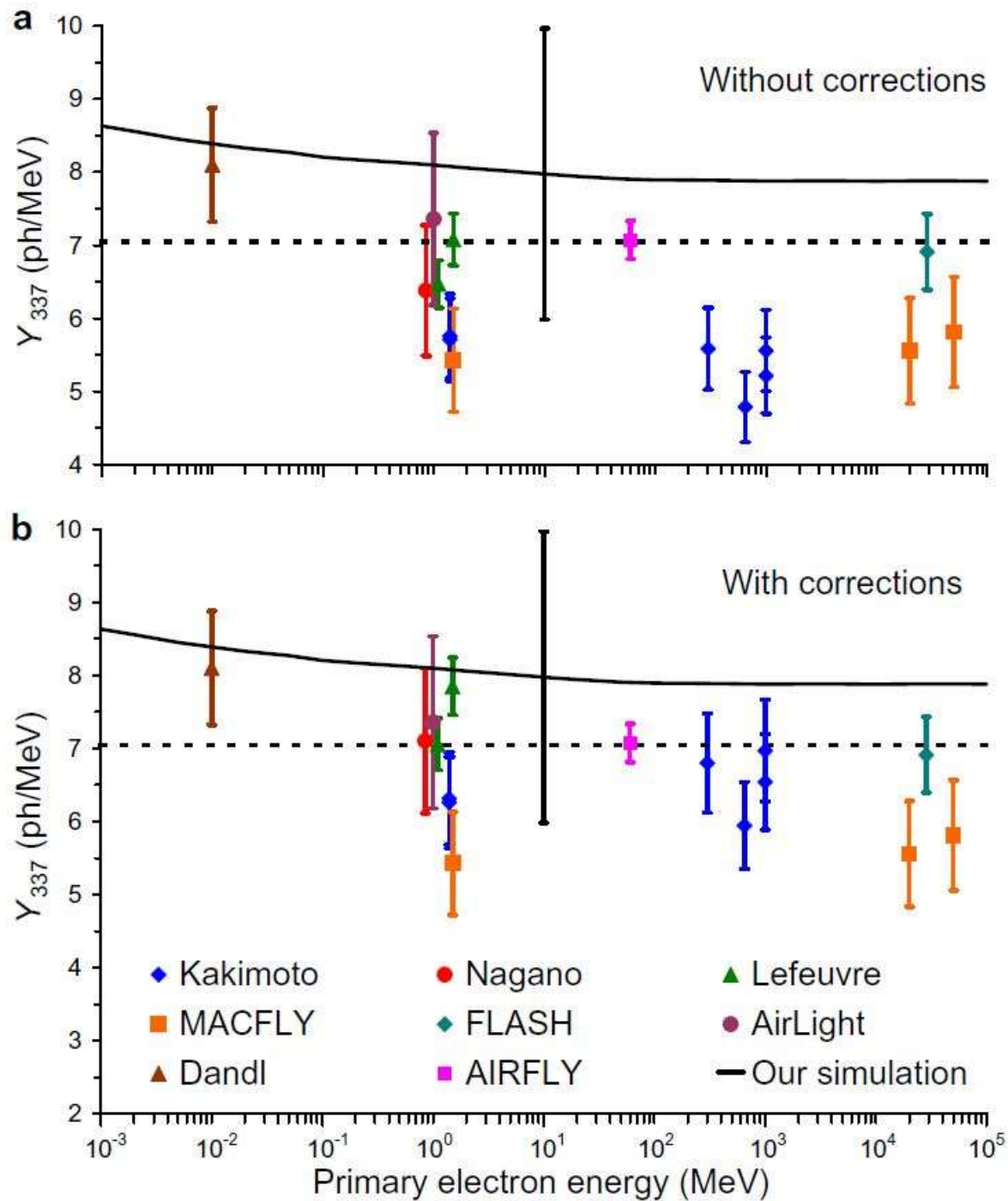


Figure is from J. Rosado, F. Blanco and F. Arqueros, ApJ 770(2023) 111-120