EMC

Outline

- Backward EMC
- LYSO
- Forward EMC beam test

Presentations here from:
Gerald Eigen
Stefano Germani
Elisa Manoni
Sasha Rakitin
Ren-yuan Zhu
also Alejandro Pérez in DGWG

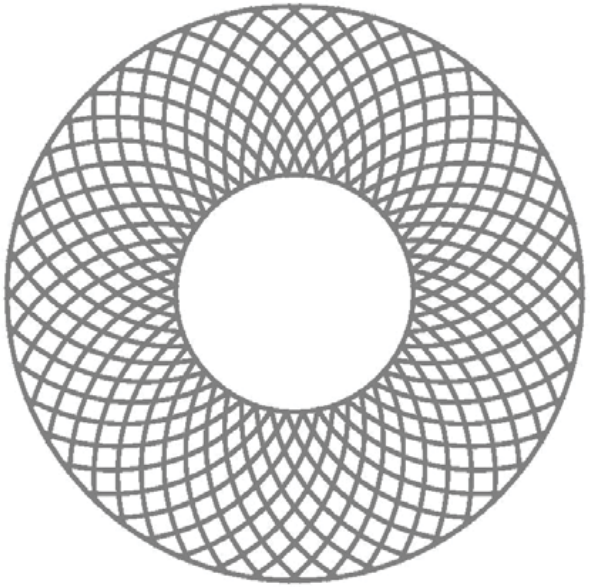
Backward EMC

Pb-scintillator sandwich (12 X_0) with Y11 WLS fiber readout

Left and right logarithmic spiral strips alternating with radial strips

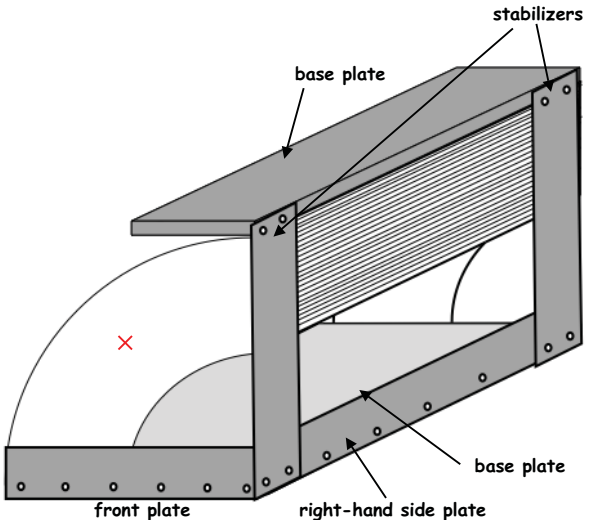
MPPC/SiPM photodetector

$\tau_{\rm scin} = 2.2$ ns, $\tau_{\rm fiber}$ = 2.3 ns, $\tau_{\rm MPPC} \sim 0.1$ ns; background suppression; potential use for TOF?



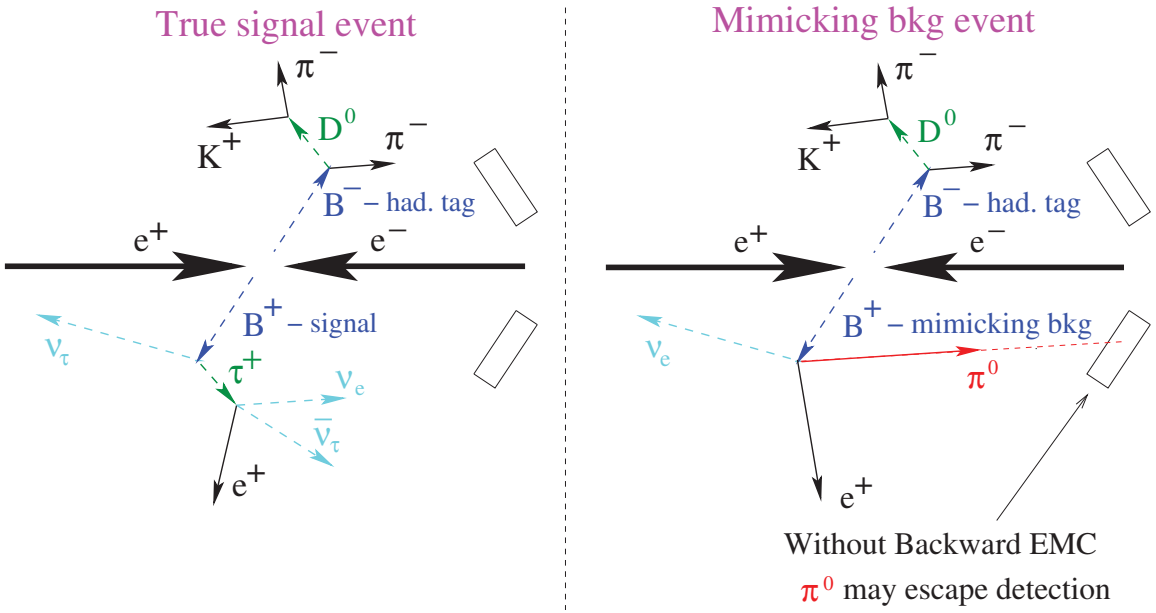
Prototype in preparation for beam test

- Based on a quadrant
- Materials, MPPCs in hand
- Machining spirals still to be done
- Reflective covering, edge painting under investigation



Backward EMC - Physics impact

- Elisa Manoni: $B \to K^{(*)}\nu\bar{\nu}$ with hadronic tag. Results next slide.
- Alejandro Pérez: $B \to K^{(*)}\nu\bar{\nu}$ with semileptonic tag $B \to D^{(*)}\ell\nu$
  Conclusion: background reduction $O(10\%)$ with small effect on signal
- Sahsa Rakitin: $B \to \tau\nu$, Updating with various hadronic and semi-leptonic B tags, Analysis based on $E_{\rm extra}$ cut. Results forthcoming.



$B \to K^{(*)}\nu\bar{\nu}$ study for backward EMC

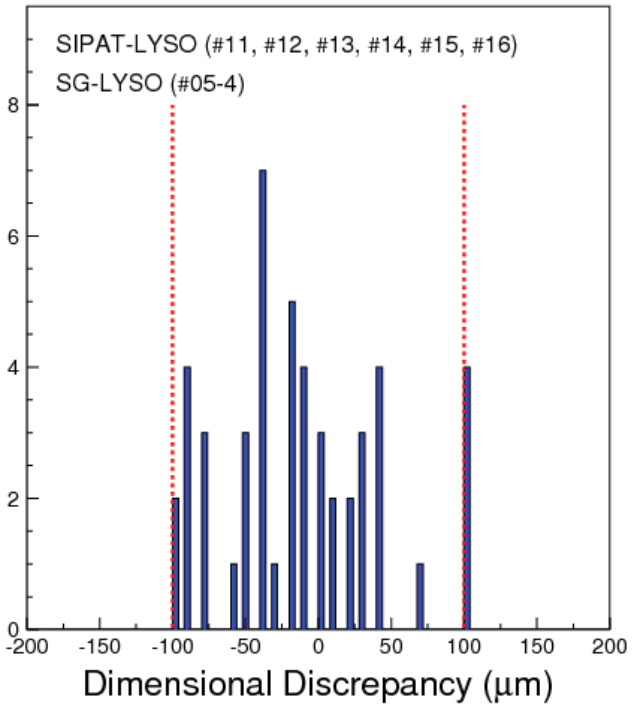
Hadronic tag, $E_{\rm extra,BWD} < 50$ MeV

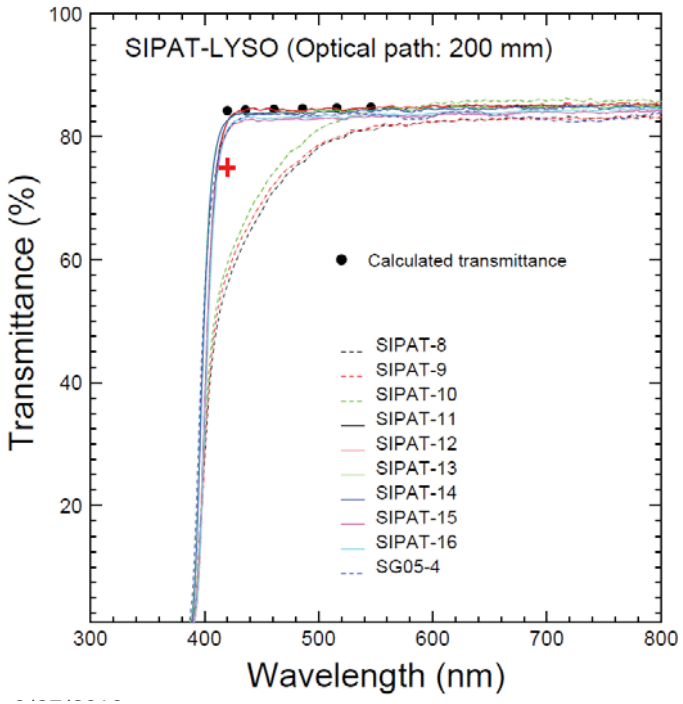
$B^0 \to K^{*0}\nu\bar{\nu}$					
Sample	$N_{\rm sel}$	$\varepsilon_{\rm tot}$	$N_{\rm sel,Bwd}$	$\varepsilon_{\rm tot,Bwd}$	$\delta\varepsilon/\varepsilon$
$B^0 \to K^{*0}\nu\bar{\nu}$	750	$(25.0 \pm 0.9) \times 10^{-5}$	742	$(24.7 \pm 0.5) \times 10^{-5}$	1.2%
B^0 had cocktail	105	$(33 \pm 3) \times 10^{-8}$	92	$(29 \pm 3) \times 10^{-8}$	12%
$S/\sqrt{B}$	73		77		
$B^+ \to K^{*+}(K^+\pi^0)\nu\bar{\nu}$					
Sample	$N_{\rm sel}$	$\varepsilon_{\rm tot}$	$N_{\rm sel,Bwd}$	$\varepsilon_{\rm tot,Bwd}$	$\delta\varepsilon/\varepsilon$
$B^+ \to K^{*+}\nu\bar{\nu}$	223	$(7.0 \pm 0.5) \times 10^{-5}$	217	$(6.8 \pm 0.5) \times 10^{-5}$	2.8%
B^+ had cocktail	38	$(10.0 \pm 1.6) \times 10^{-8}$	31	$(8.2 \pm 1.5) \times 10^{-8}$	18%
$S/\sqrt{B}$	36		39		

$$\frac{\left.\frac{S}{\sqrt{B}}\right|_{\rm Back} - \left.\frac{S}{\sqrt{B}}\right|_{\rm Noback}}{\left.\frac{S}{\sqrt{B}}\right|_{\rm Noback}} = \begin{cases} (5.4 \pm 1.9)\% & \text{for } K^{*0}\nu\bar{\nu} \\ (7.2 \pm 4.1)\% & \text{for } K^{*+}(K^+\pi^0)\nu\bar{\nu} \end{cases}$$

LYSO crystal status

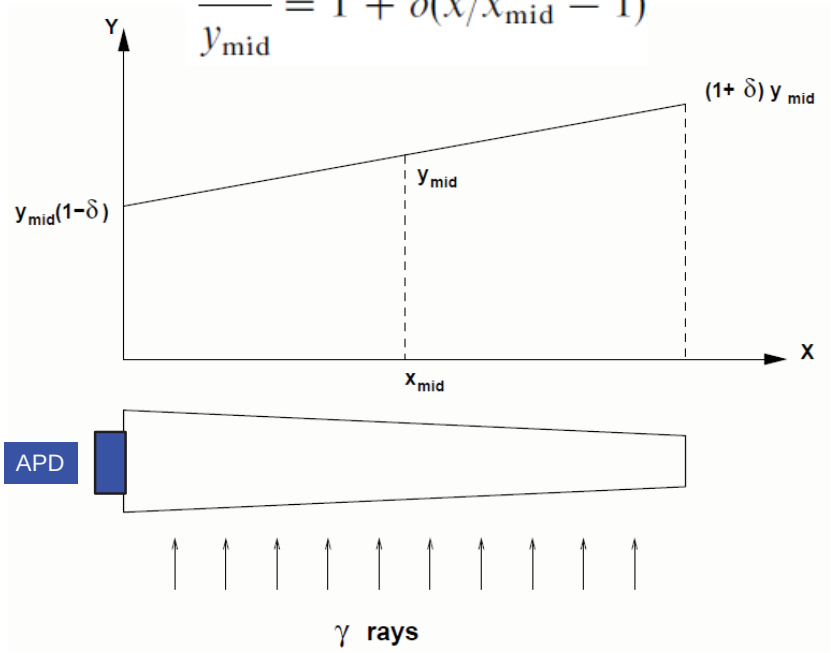
- 25 full size crystals for beam test, from Saint-Gobain and SIPAT
- Characterize each for mechanical dimensions, light transmission vs wavelength, uniformity, light output and resolution with PMT and APD readout

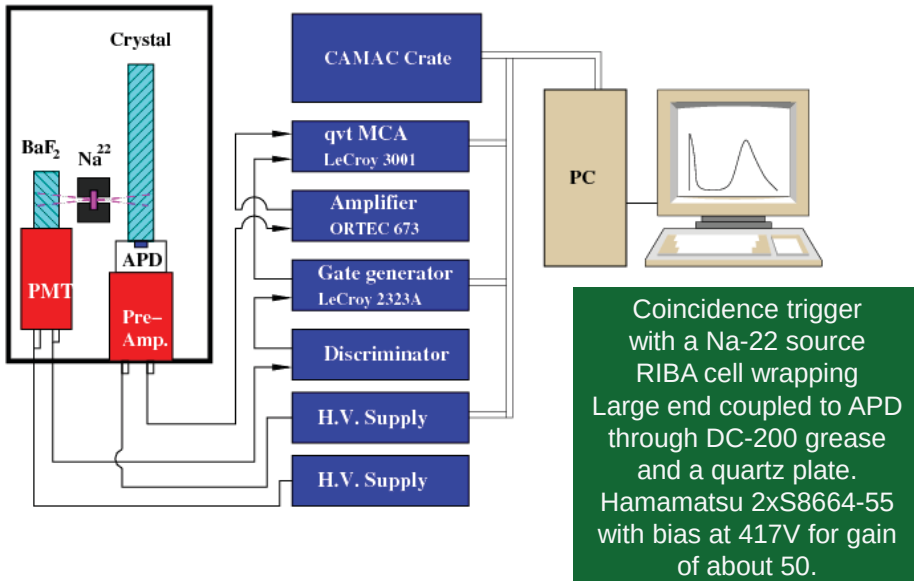




LYSO uniformization

$$\frac{y}{y_{\mathrm{mid}}} = 1 + \delta(x/x_{\mathrm{mid}} - 1)$$





Coincidence trigger with a Na-22 source
RIBA cell wrapping
Large end coupled to APD through DC-200 grease and a quartz plate.
Hamamatsu 2xS8664-55 with bias at 417V for gain of about 50.

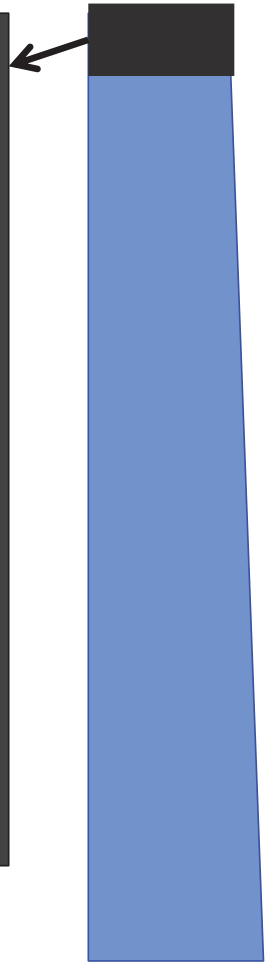
Definition of uniformity δ

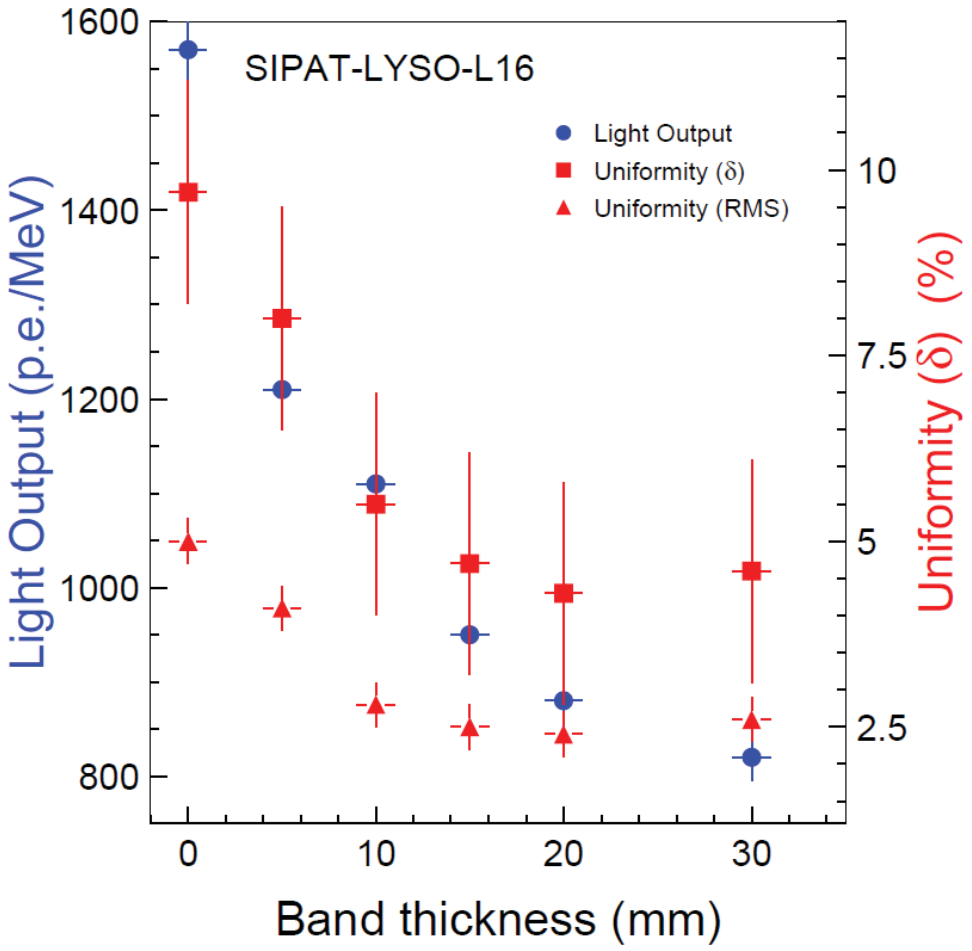
Apparatus to measure uniformity with Na^{22}

LYSO uniformization

Uniformization: < 5% Possible

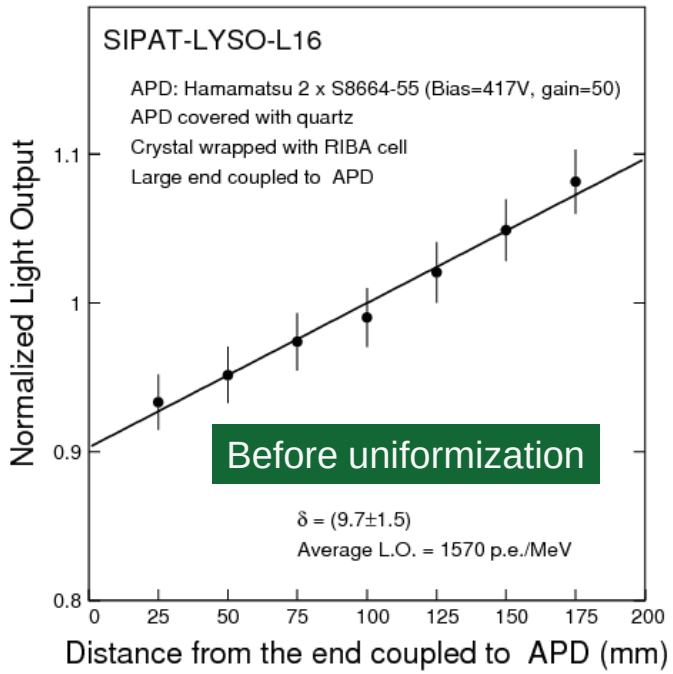
A black band is paint on the smallest side surface of the crystal with a width up to 30 mm from the small end.

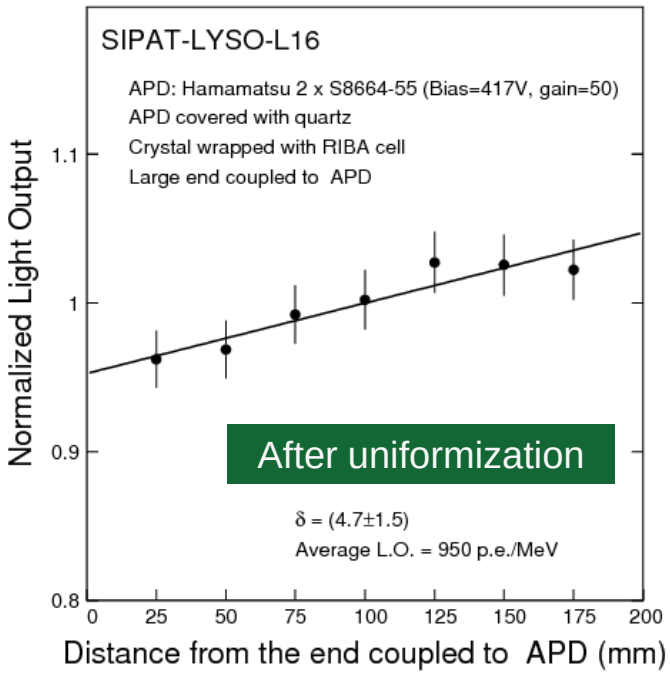




LYSO uniformization

Uniformity of < 5% achieved by 15 mm black paint with 40% loss of the light output.





Can get uniformity of $\delta < 5\%$ with a 15 mm black band on one side at small end. Cost is 40% light loss.

LYSO resolution (0.5 MeV)

Sample ID		Energy resolution (%) (Mean value of σ at 7 locations)
SIPAT-11	Before	15.5
	After	27.4
SIPAT-12	Before	15.1
	After	26.7
SIPAT-13	Before	14.9
	After	22.6
SIPAT-14	Before	14.9
	After	24.7
SIPAT-15	Before	13.7
	After	21.5
SIPAT-16	Before	13.5
	After	20.9
SG-05-04	Before	17.3
	After	23.8

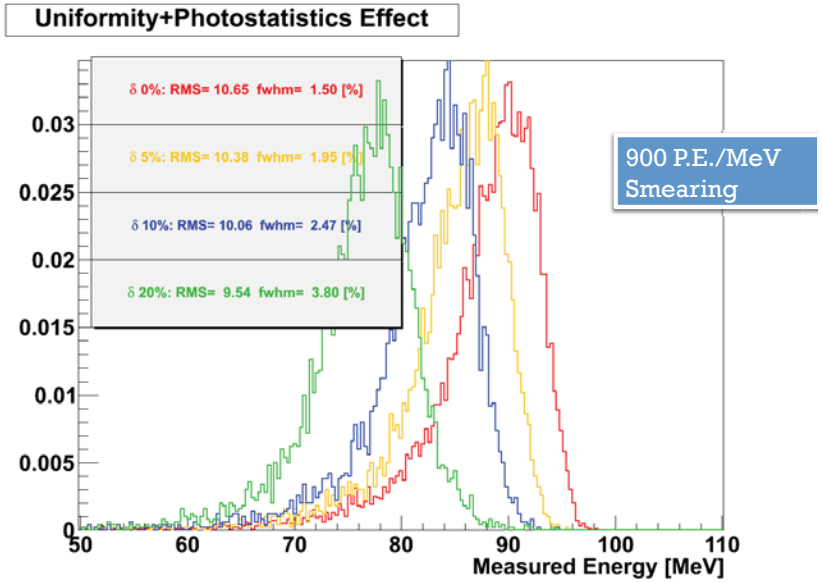
APD photodetector

“Before” and “After” refer to uniformization

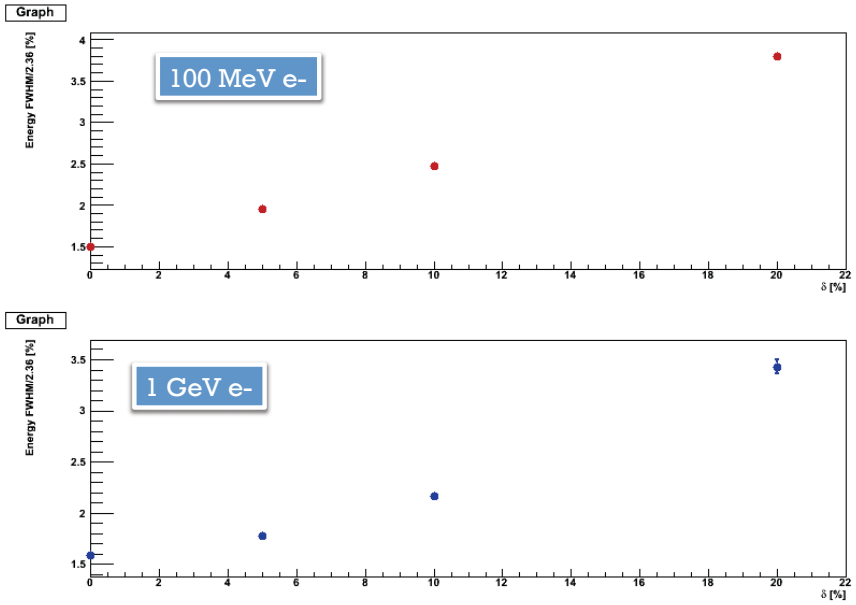
Uniformity requirement (Preliminary)

Stefano Germani

Unif.+Photostatistics Effect @ 100 MeV



Resolution vs δ

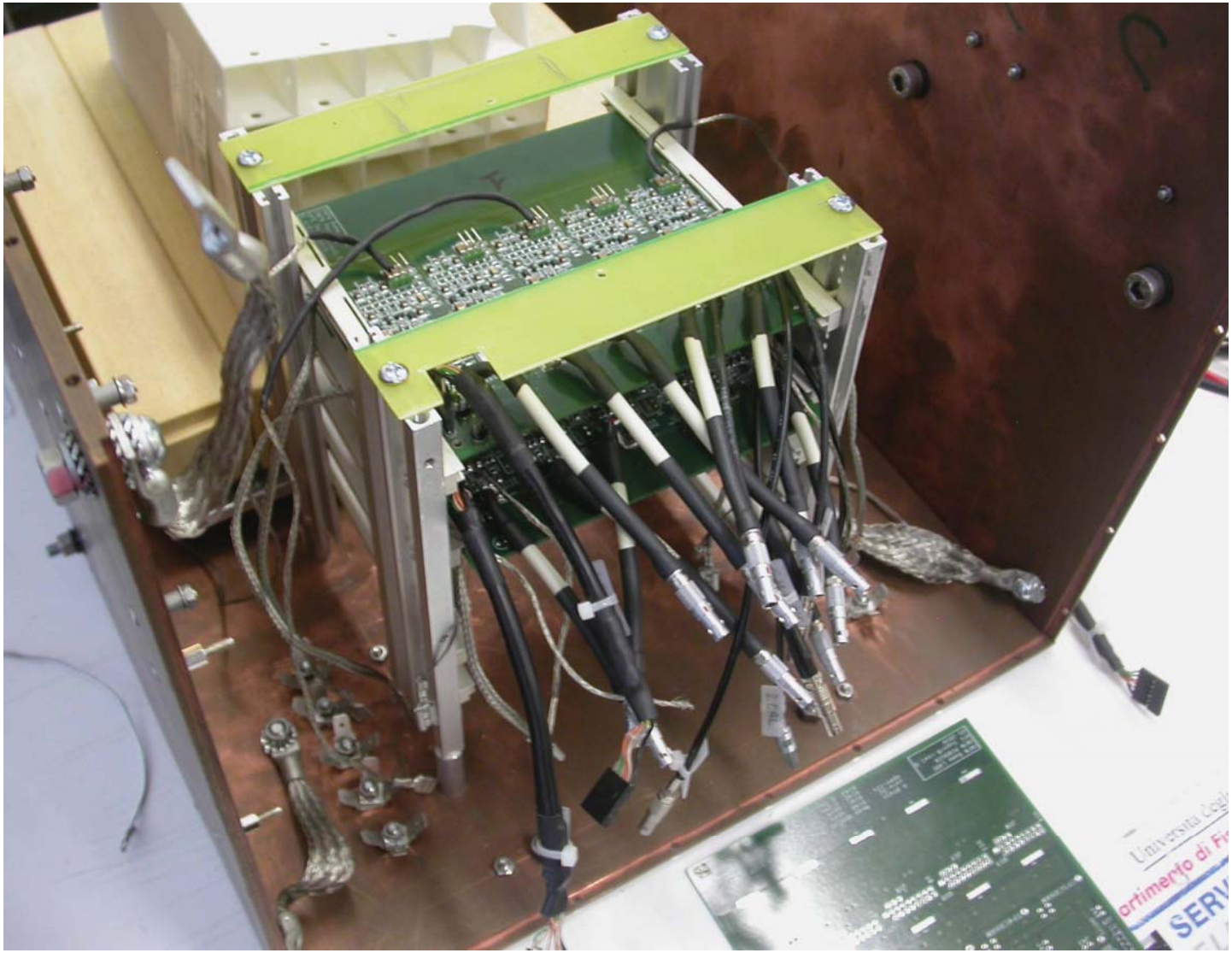


Resolution continues to improve below $\delta = 5\%$, though less than linearly.

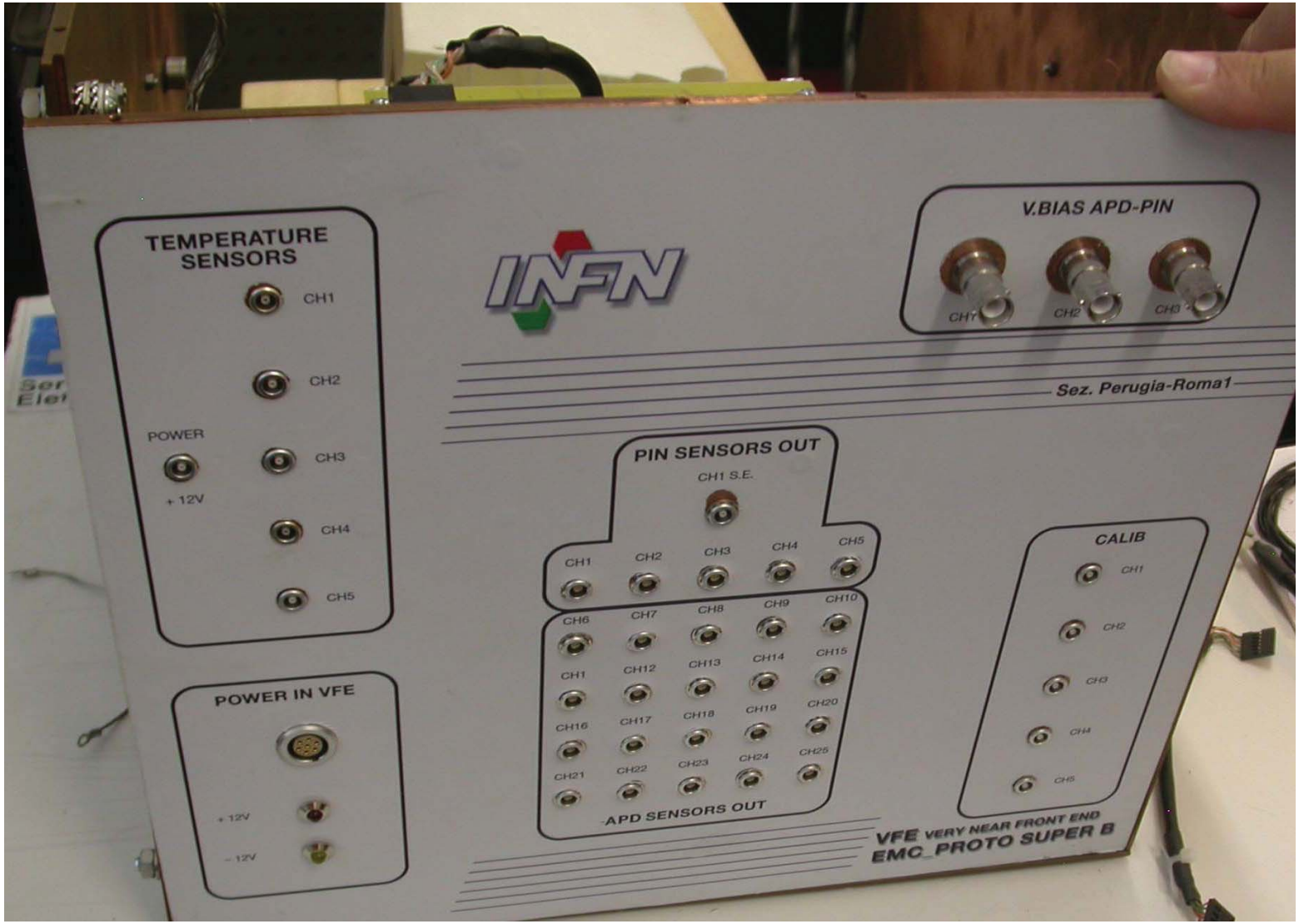
Beam test

- CERN beam test Oct 11-31, 2010; Frascati beam test (lower energy) to be scheduled in early 2011.
- 5×5 LYSO array in prototype alveolar, readout with PIN diodes or APDs, prototype electronics.
- 12 crystals from Saint-Gobain; 13 from SIPAT. Delays from SIPAT mean last crystals will be delivered after first day(s) of schedule
- 12 CsI(Tl) crystals on loan from CLEO will be used to catch shower leakage

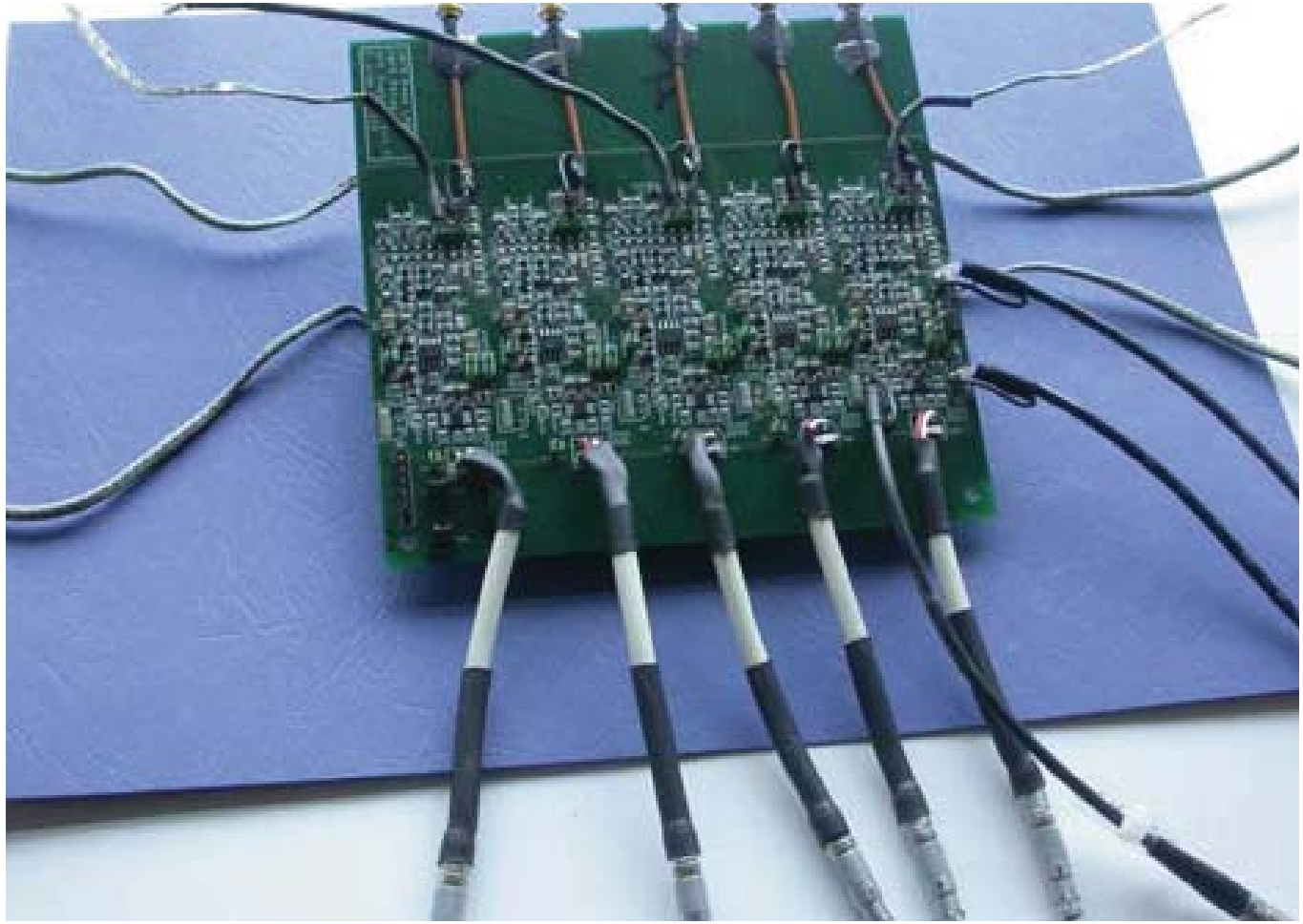
Beam test



Beam test


TEMPERATURE SENSORS
CH1
CH2
POWER
+ 12V
CH3
CH4
CH5
INFN
V.BIAS APD-PIN
CH1
CH2
CH3
Sez. Perugia-Roma1
PIN SENSORS OUT
CH1 S.E.
CH1
CH2
CH3
CH4
CH5
CH6
CH7
CH8
CH9
CH10
CH1
CH12
CH13
CH14
CH15
CH16
CH17
CH18
CH19
CH20
CH21
CH22
CH23
CH24
CH25
APD SENSORS OUT
CALIB
CH1
CH2
CH3
CH4
CH5
POWER IN VFE
+ 12V
- 12V
VFE VERY NEAR FRONT END
EMC_PROTO SUPER B

Beam test



Front end board with five readout channels

Summary

- Development of backward EMC prototype ongoing
- Physics impact of backward EMC is 5-10% as veto device; more studies to be reported
- LYSO
  - Crystals from two vendors are meeting specifications
  - Preliminary requirement study on uniformization supports $\delta < 5\%$
  - Proof-of-principle procedure exists to meet $\delta < 5\%$, cost is 40% of light
- CERN test beam for LYSO