EMC Summary

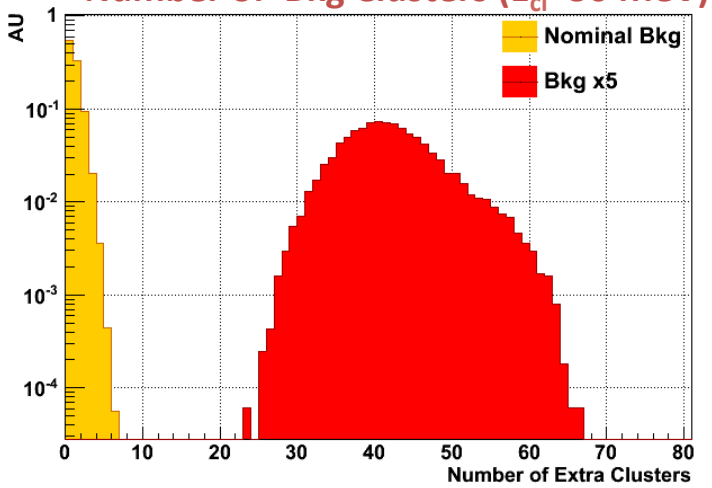
Frank Porter and Claudia Cecchi
For the EMC group

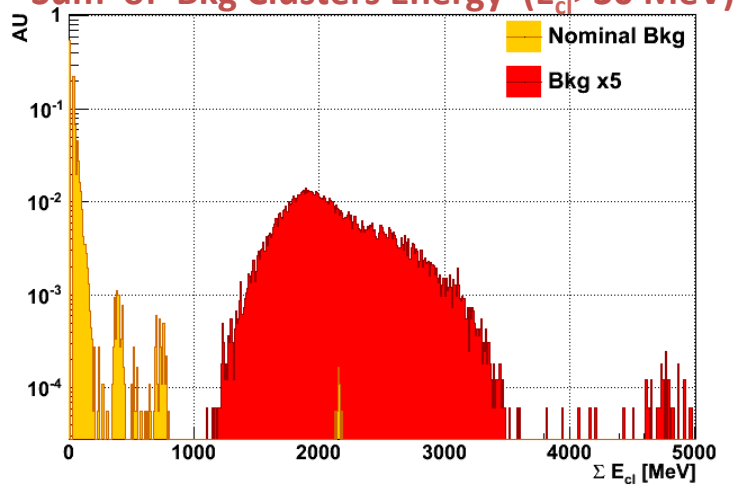
March 22, 2012

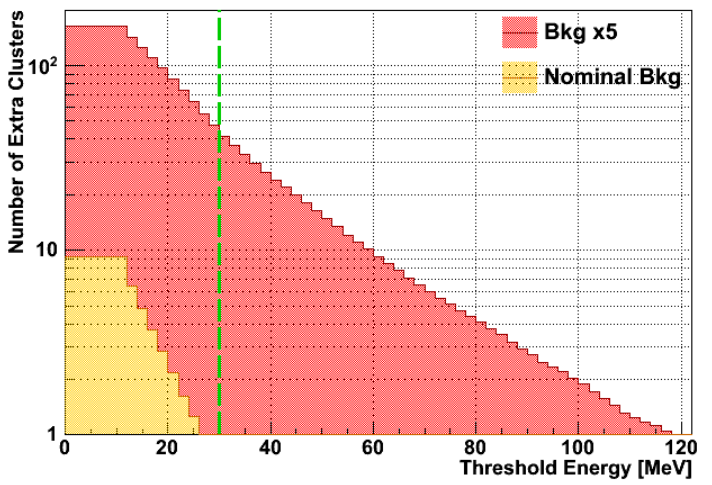
EMC at this meeting

- Valerio Bocci – Electronics
- Elisa Manoni – Physics performance with backgrounds
- Test beams – Claudia Cecchi, Pasquale Lubrano
- Gerald Eigen – Backward EMC
- Salvatore Fiore – Crystal irradiation tests
- Ren-Yuan Zhu – Current Status of BGO and PWO Crystals
- Paolo Gauzzi – Integration time studies on BGO and CsI
- Barrel calorimeter
  - Kevin Flood – report on visit to SLAC
  - TDR baseline for moving barrel
- Forward calorimeter – Baseline for TDR
  - Frank Porter – Introduction
  - Stefano Germani – fullsim studies
  - Chih-hsiang Cheng – fastsim studie s
  - Claudia Cecchi – costs

Fullsim backgrounds







- ✓ Large difference between nominal background and x5 safety factor
- ✓ High multiplicity with x5 background

[Stefano Germani]

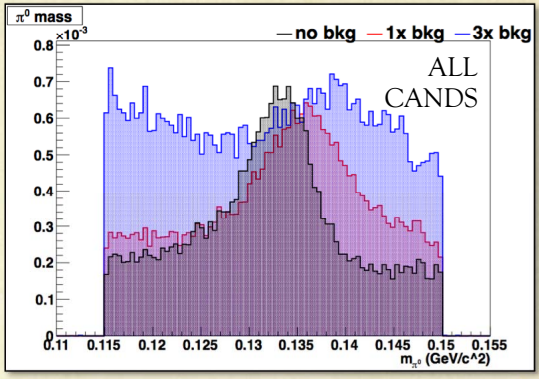
Physics performance with backgrounds

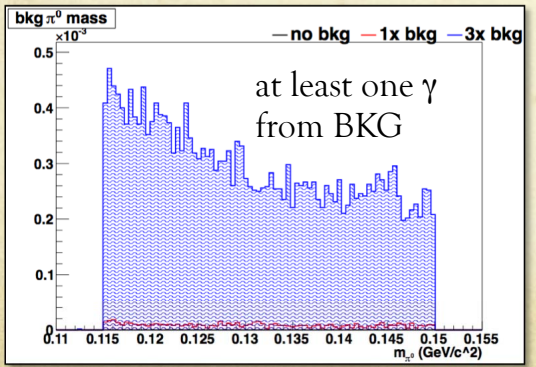
- Fastsim
- Backgrounds from radiative Bhabhas
- Compare $0\times$, $1\times$, $3\times$ backgrounds
- Breco in generic B^+B^-
  - efficiency
  - γ, π^0, Breco reconstruction
- $B^+ \to K^{*+}\nu\bar{\nu}$
  - efficiency
  - E_{extra}
  - Extra γ and π^0

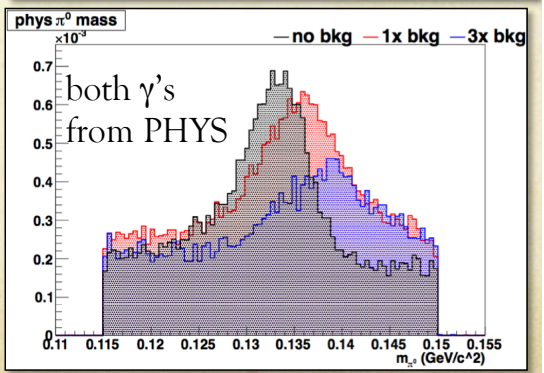
Physics performance with backgrounds – Breco

π^0 mass

- Huge combinatoric bkg from "background" π^0 in the 3x configuration
- "Phys" π^0 peak shifted with increasing machine bkg



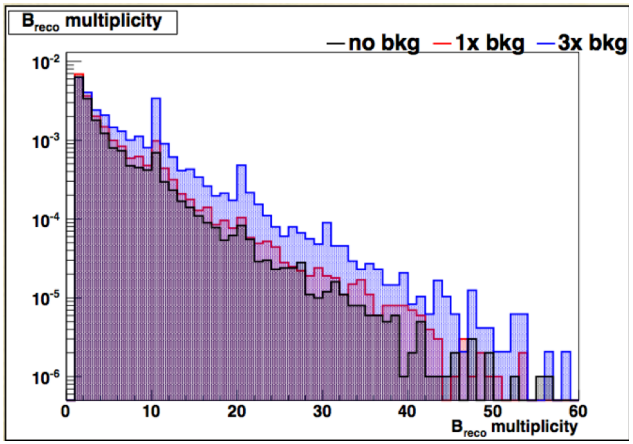




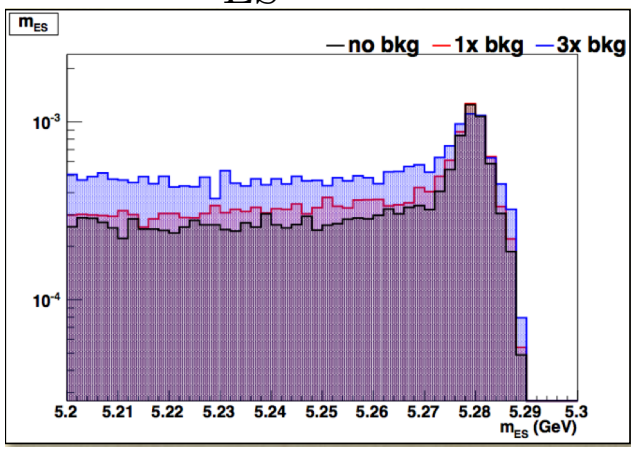
elisa manoni - infn pg

[Elisa Manoni]

Breco multiplicity

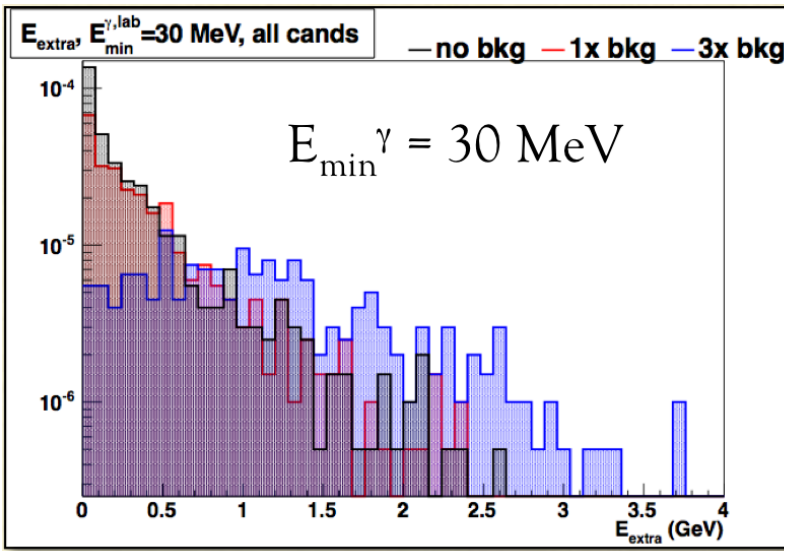


Breco M_{ES}

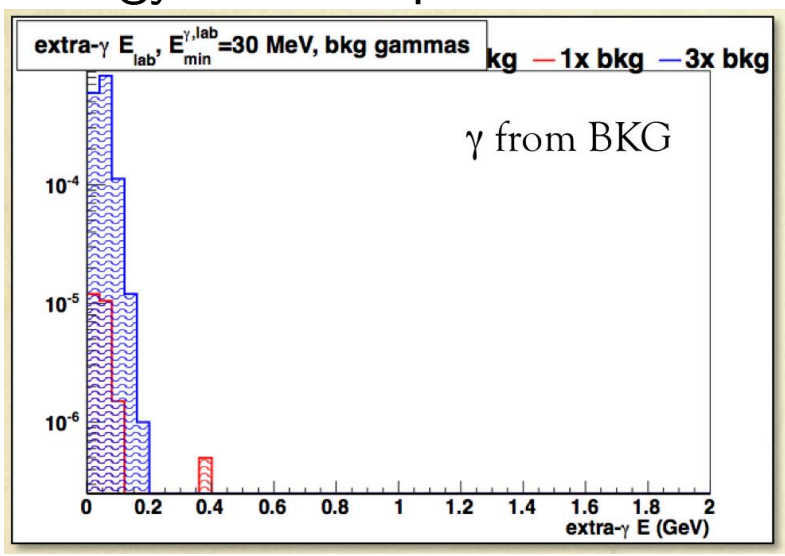


Physics performance with backgrounds – $B^+ \to K^{*+}\nu\bar{\nu}$

E_{extra}



Energy of extra photons

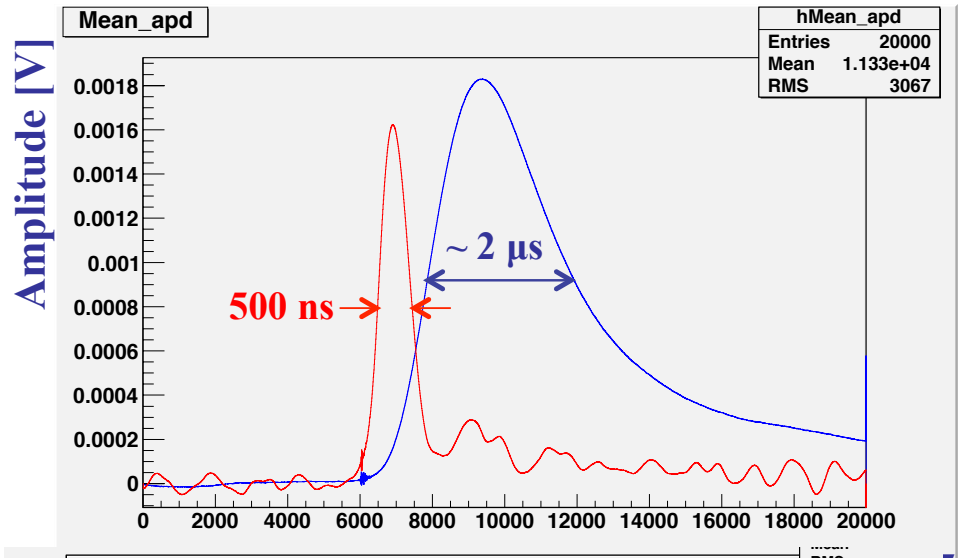


[Elisa Manoni]

Optimizing integration and shaping times (CsI(Tl))

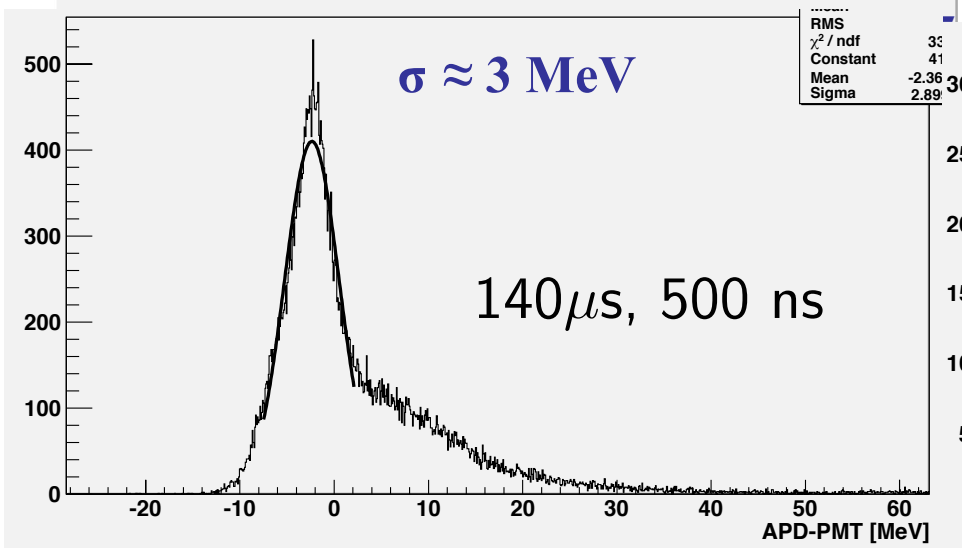
1) CSP Cremat integr. time = 140 µs + shaping time = 500 ns

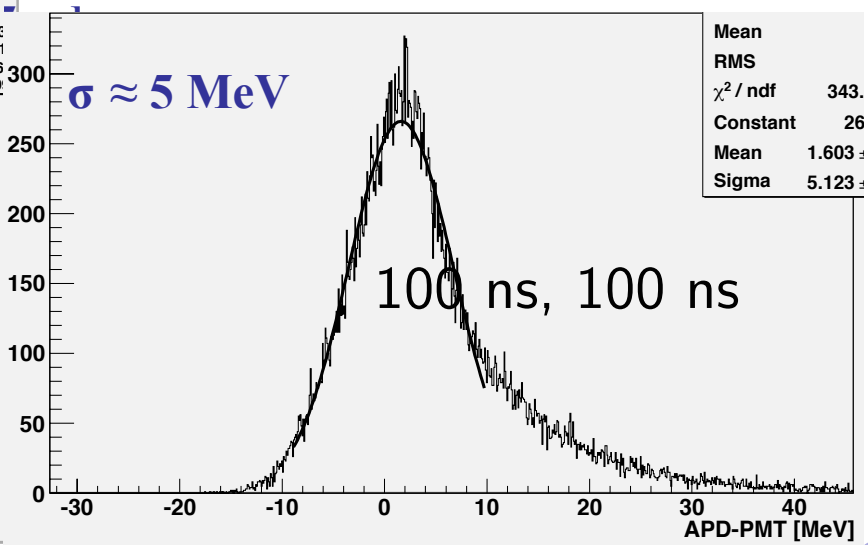
2) CSP Hamamatsu integr.time = 100 ns + shaping time = 100 ns



Average over 100000 waveforms

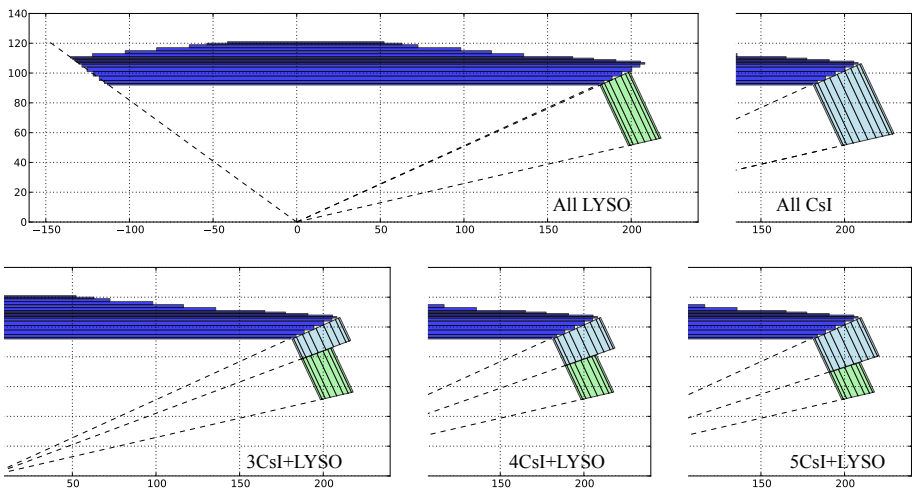
[Paolo Gauzzi]





Forward EMC

- LYSO in a thin structure is technically optimal for forward EMC. This is current baseline
- If we can't mitigate backgrounds, the barrel performance is degraded, and a highly performant forward calorimeter is difficult to justify (i.e., pay for).
- Alternative forward schemes under discussion:
  - BaBar endcap structure or new structure
  - Hybrid LYSO/existing *BABAR* endcap crystals, Possible staging
  - Pure CsI (in existing structure)
  - BGO (in existing or new structure)
  - PWO (in existing or new structure)



[Chih-hsiang Cheng]

Crystal radiation hardness tests (L3 BGO)

Radiation tests at Calliope [Salvatore Fiore]

= 2.5h irradiation @ ~8rad/h

Recovery #1

= 2.4h irradiation @ ~8rad/h

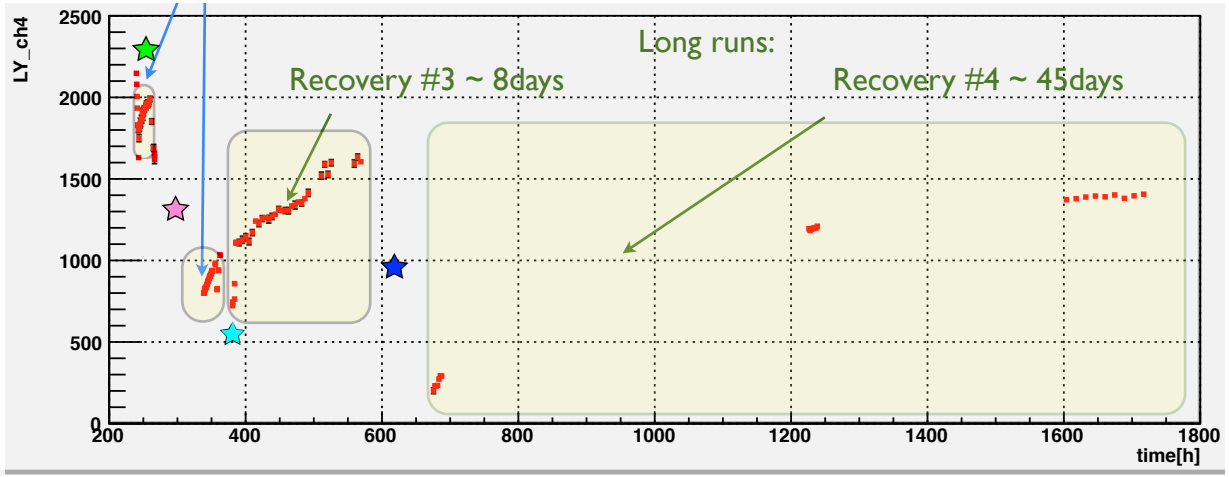
Recovery #2

= 1day irradiation @ 10rad/h

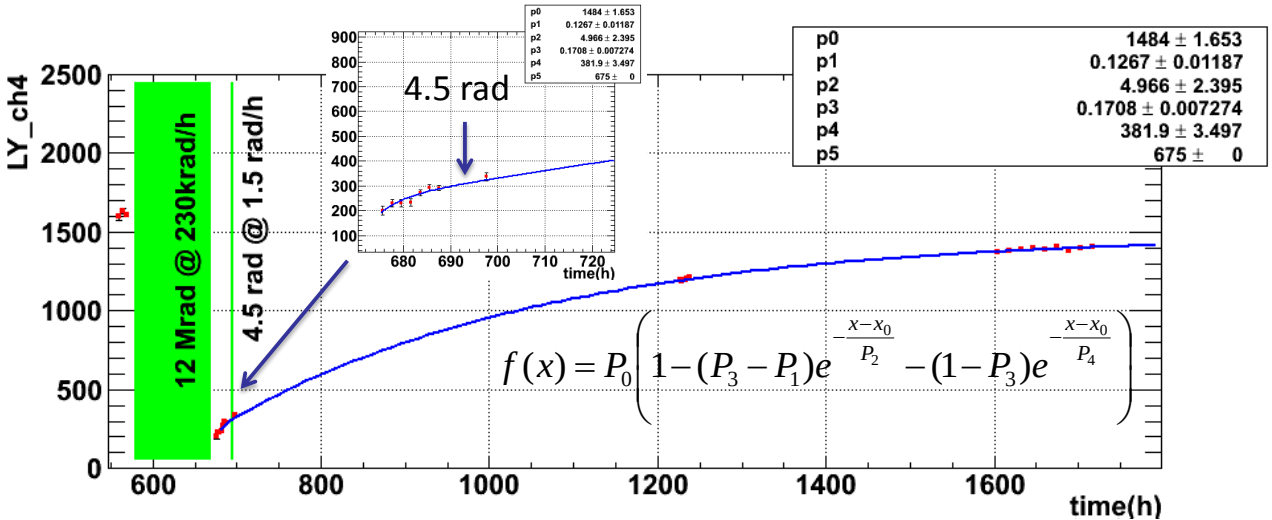
Recovery #3

= 3days irradiation @ Mrad/h

Recovery #4



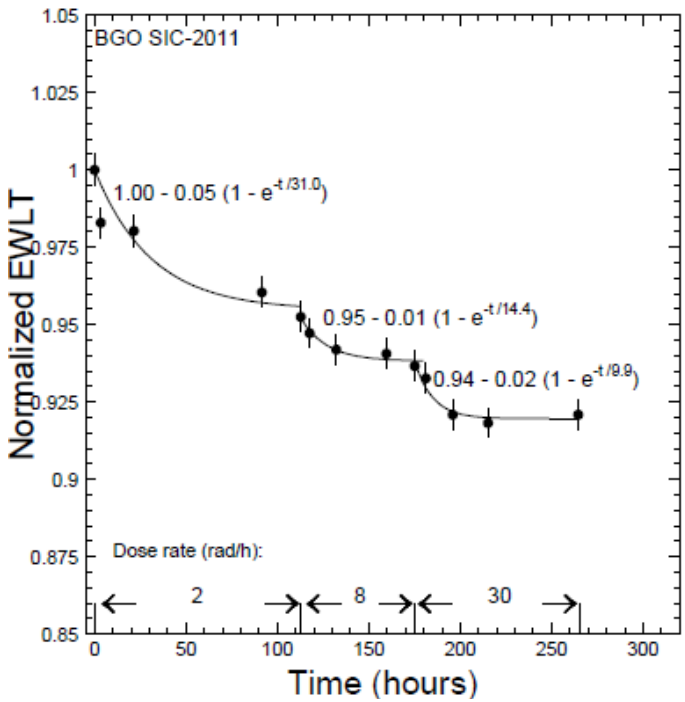
- This sample shows large LY attenuation (1/5 of the pre-irradiation value) after 12 Mrad irradiation at 230 krad/h
- Two-component LY recover
- No visible effect from subsequent short low-rate irradiation



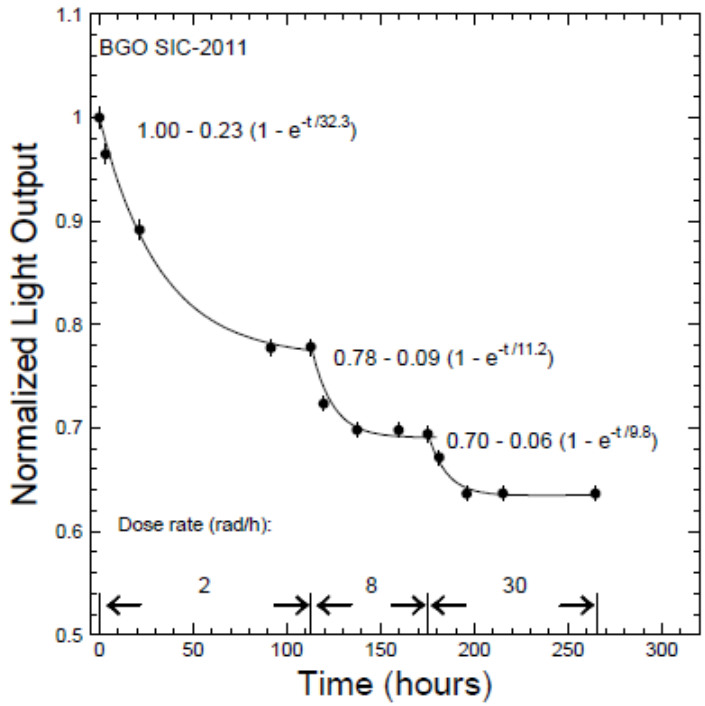
Crystal radiation hardness tests (BGO)

- BGO (and PWO) response depends on dose rate
- Light yield correlates with transmission [Salvatore Fiore, Renyuan Zhu]
- Radiation tests with em particles; some data exists for neutrons

Light transimission



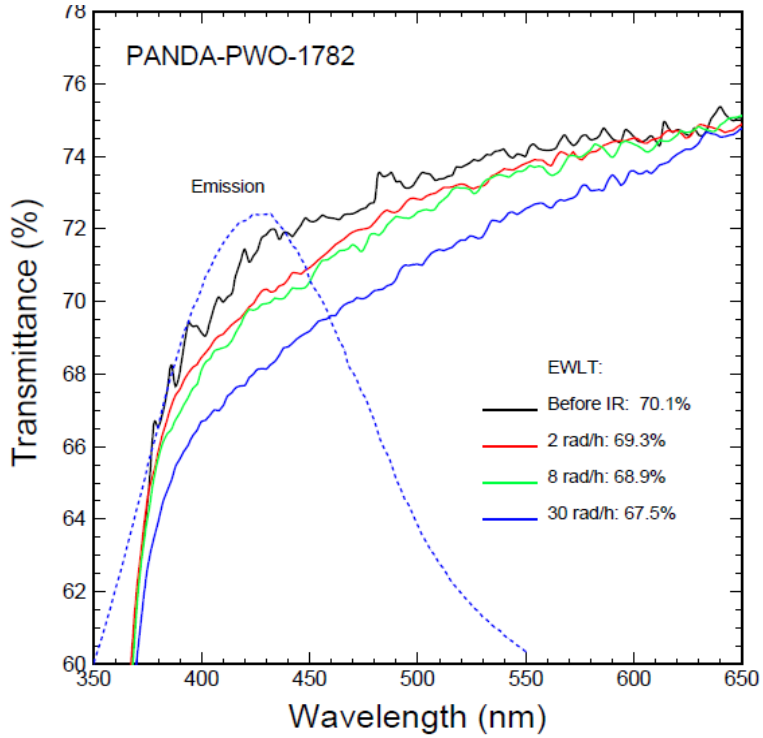
Light output



[Ren-Yuan Zhu]

Crystal radiation hardness tests (PWO)

Dose rate dependence

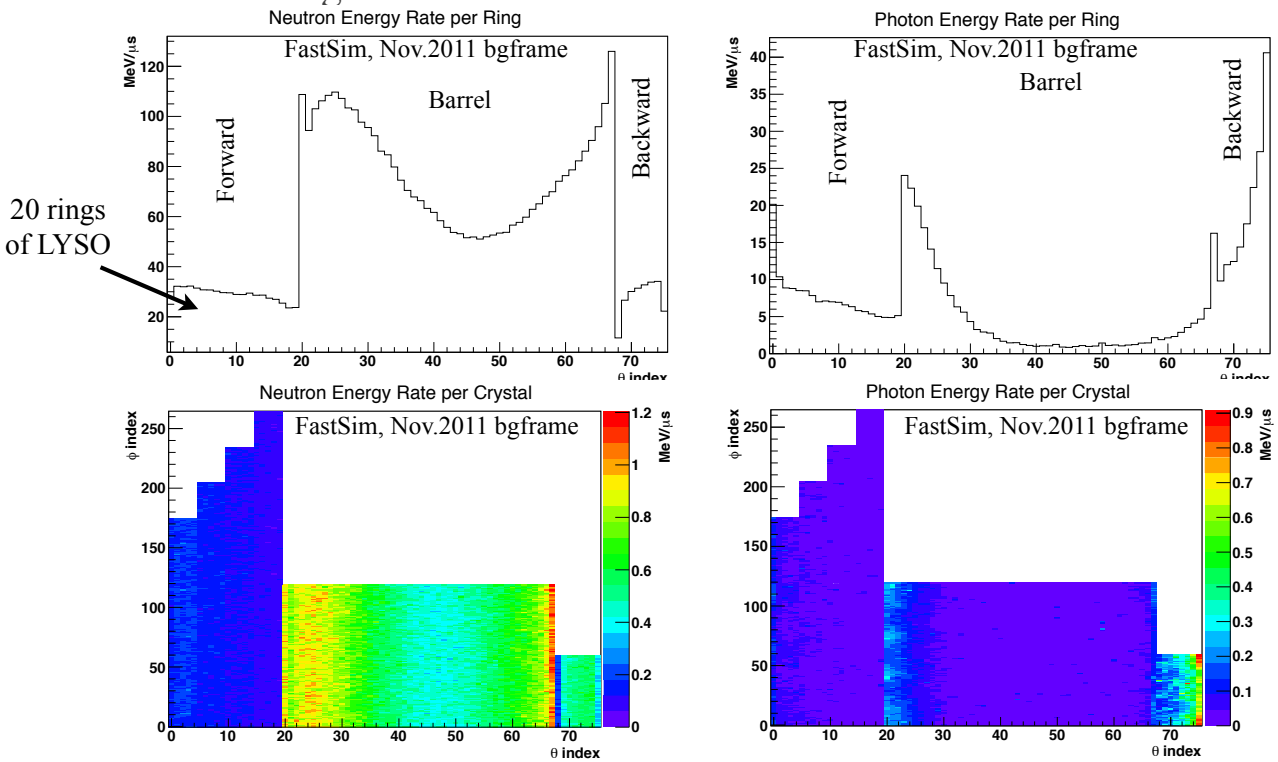


Samples	L.O. (p.e./MeV)	L.O. loss (%)				EWLT loss (%)			
		2 rad/h	8 rad/h	30 rad/h	7160 rad/h	2 rad/h	8 rad/h	30 rad/h	7160 rad/h
PWO B-1757	12.0	2	8	14	42	0.8	2.0	3.4	9.9
PWO B-1782	13.2	3	12	17	46	1.1	1.7	3.7	10.0

Background energy Map

- Fastsim energy, doses factror of 4–5 less than fullsim
- Believed to be due to 8 MeV γ energy cuttoff in background frame production
- To be tested removing cut

- After clustering



~ 1 MeV/μs/crystal at forward/backward ends of the barrel. ***A factor of 4-5 lower than FullSim.***

[Chih-hsiang Cheng]

Forward EMC – Cost estimates

	Crystals (M$)	Readout (M$)	Calibration system (M$)	Mechanical structure (M$)	Total (M$)
LYSO	11.9	0.9 (2 APD)		1.5	14.3
CsI pure	2.7	0.75 (photopentode)		0.25	3.7
BGO	3.6	0.9 (2 APD)	1	1.5	7.0
PWO	2.0	2.5 (2 LAAPD)	1	1.5	7.0

3 CsI(Tl) + 6 LYSO	6.19	0.49	0.25	6.93
4 CsI(Tl) + 5 LYSO	4.95	0.40	0.25	5.60
5 CsI(Tl) + 4 LYSO	3.84	0.31	0.25	4.40

[Claudia Cecchi]

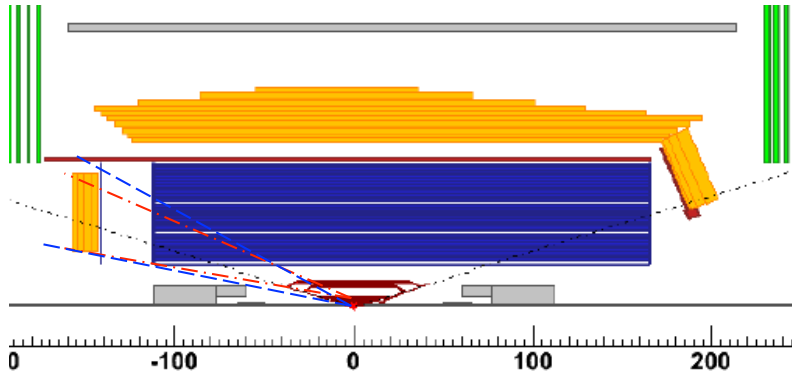
Forward EMC Advisory Committee

Advisory Committee on Forward Technology

Giuseppe Finocchiaro
Chris Hearty, chair
Eugenio Paoloni
Matteo Rama
Bill Wisniewski

- First meeting yesterday, backgrounds and costs
- Should detector performance be optimized on 5$\times$ background?
- Present backgrounds are too high; how much can we shield?
- How much can we mitigate with smarter clustering, electronics?
- Meet again on Wednesday

Backward EMC



Coverage (milliradians)
[Gerald Eigen]
$z_{\min} = 132$ cm (active detector, need $O(1)$ cm for support) closer is better to close gap to barrel

	Lab	CM
Full coverage	231–463	218–432
Partial	204–517	190–482
Gap to barrel	517–694	

- Preamps built, to be tested
- Then tests on wrapped radial strips with MPPCs for light yield and uniformity $\Rightarrow$ decison on preamps
- Calibration system, tests of notched fiber scheme very promising, electronics linearity, uniformity
- TDR nearly complete

Barrel EMC [Kevin Flood]

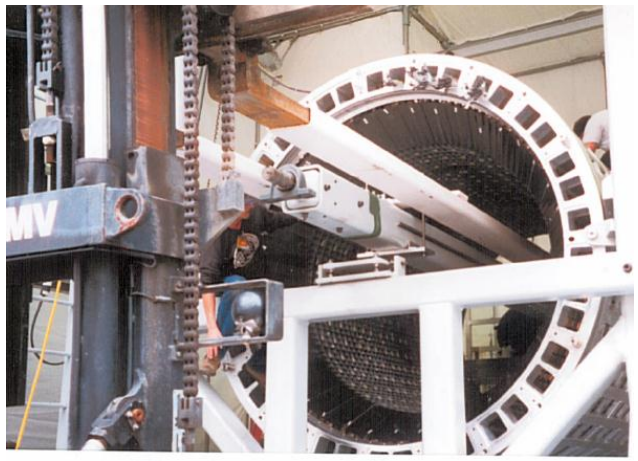
Exists, but need to get it to Italy!

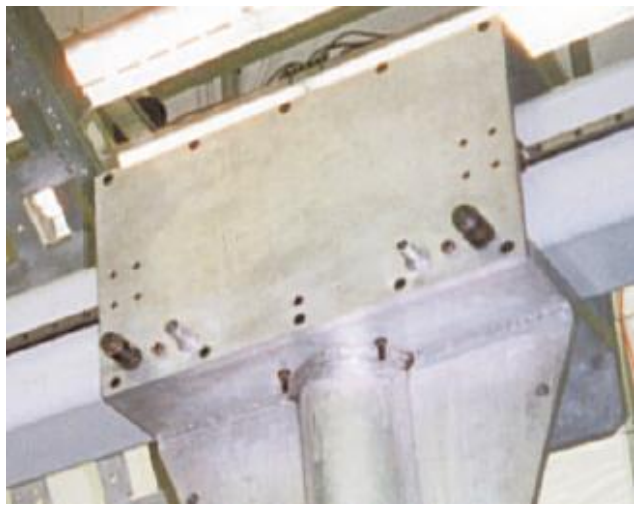
Big question: can we ship it intact?

(new) Baseline answer: No, we'll disassemble to 21-crystal modules

Barrel Disassembly 5

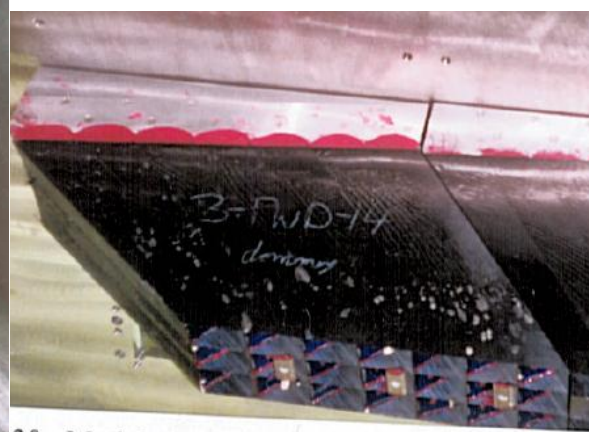
- Insert the rotator shaft
- Attach the mounting plate for the rotator arm subassembly to the rotator shaft
- Rotator shaft is held up by two stands





Barrel

- Even if don't take all apart, do we need to disassemble enough to inspect glue joints?
- Barrel disassembly to modules for shipping takes 1–1.5 years and $\sim$ 1 M\$
- Probably $O(1\ \mathrm{year})$ for reassembly in Italy



Extras

Reference - Crystal Properties

Crystal	LY[1]	X_0 cm	r_M cm	Rad hard	$d(LY)/dT$ %/°C	τ_{decay} ns	λ_{max} nm
NaI(Tl)	1	2.59	4.13	no	-0.2	230	410
LYSO(Ce)	0.83	1.14	2.07	yes	-0.2	40	402
CsI(Tl)	1.65	1.86	3.57	no	0.3	1300	560
CsI	0.036	1.86	3.57	maybe	-1.3	35	420
BGO	0.21	1.12	2.23	rate dep.	-0.9	300	480
$PbWO_4$	0.0029	0.89	2.00	rate dep.	-2.7	10	420

(Mostly from RPP)

[1]Relative to NaI(Tl), small crystals, corrected for QE, room T

Test Beams of 5×5 LYSO array

- Frascati test beam
  - After this meeting
  - First test with uniformized crystals
- Mainz test beam
  - Requesting time from October 8
  - Good beam spread
  - Array with two APDs per crystal (summed in readout)

Charge for advisory committee

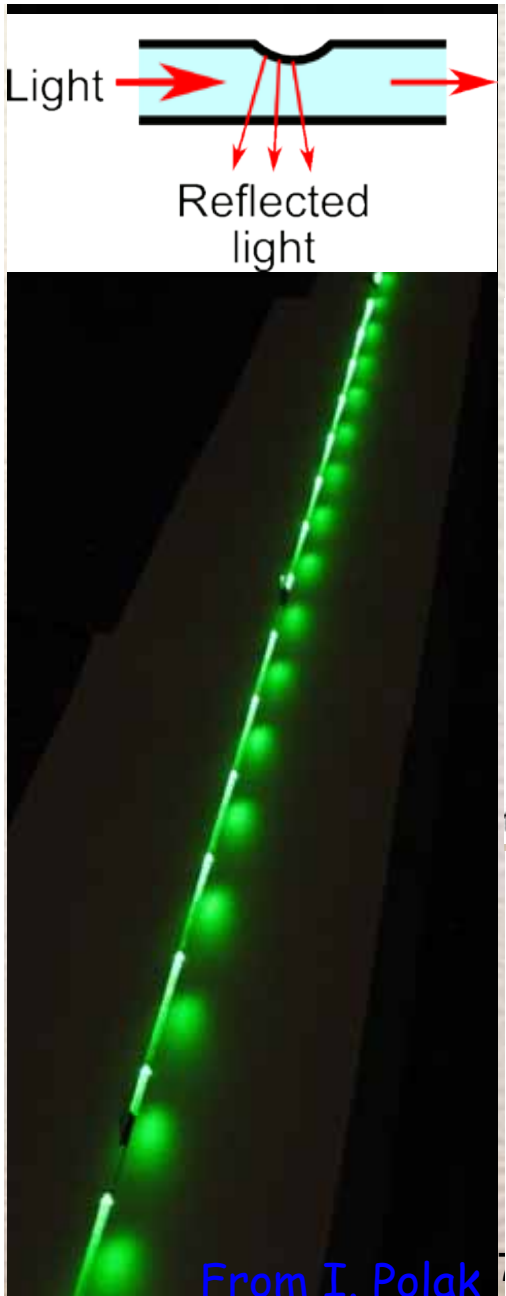
Provide input on the following questions:

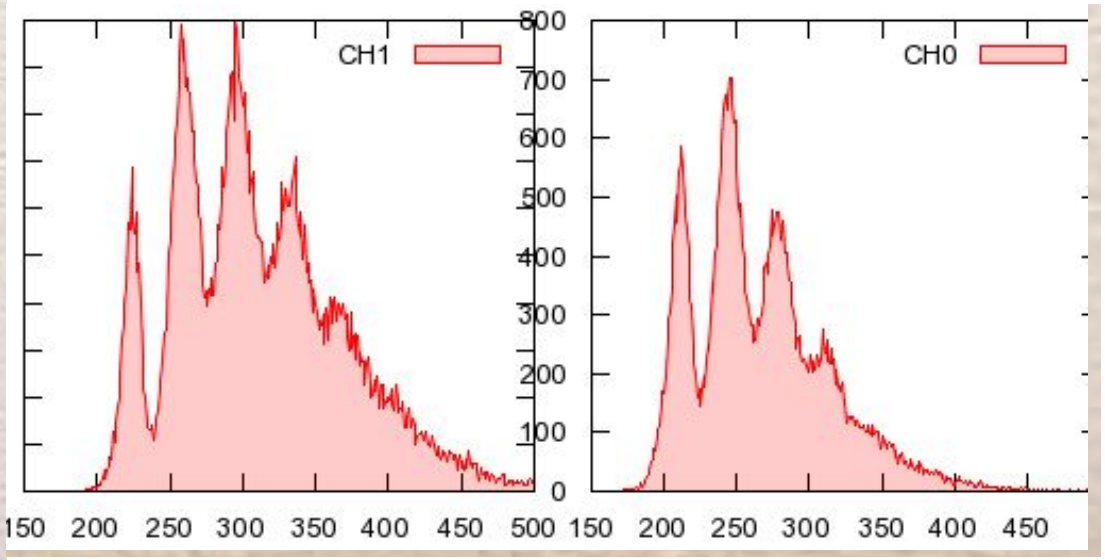
1. Five times background seems to be a reasonable criterion for radiation hardness, providing a safety margin for the survival of the detector. However, as a criterion for optimizing detector cost/performance, this seems less clear. What should the criterion be for this optimization?
2. Can the present backgrounds be significantly mitigated?
3. A set of costs for various forward calorimeter technologies has been developed, based on some assumptions. Are these assumptions and costs plausible? If not, what revisions should be made?

The focus should be on the baseline choice in the TDR. Independent of this choice, the TDR will also include a discussion of potential alternatives and the R&D being pursued.

Backward EMC Calibration

[Gerald Eigen]





(two best of 36)