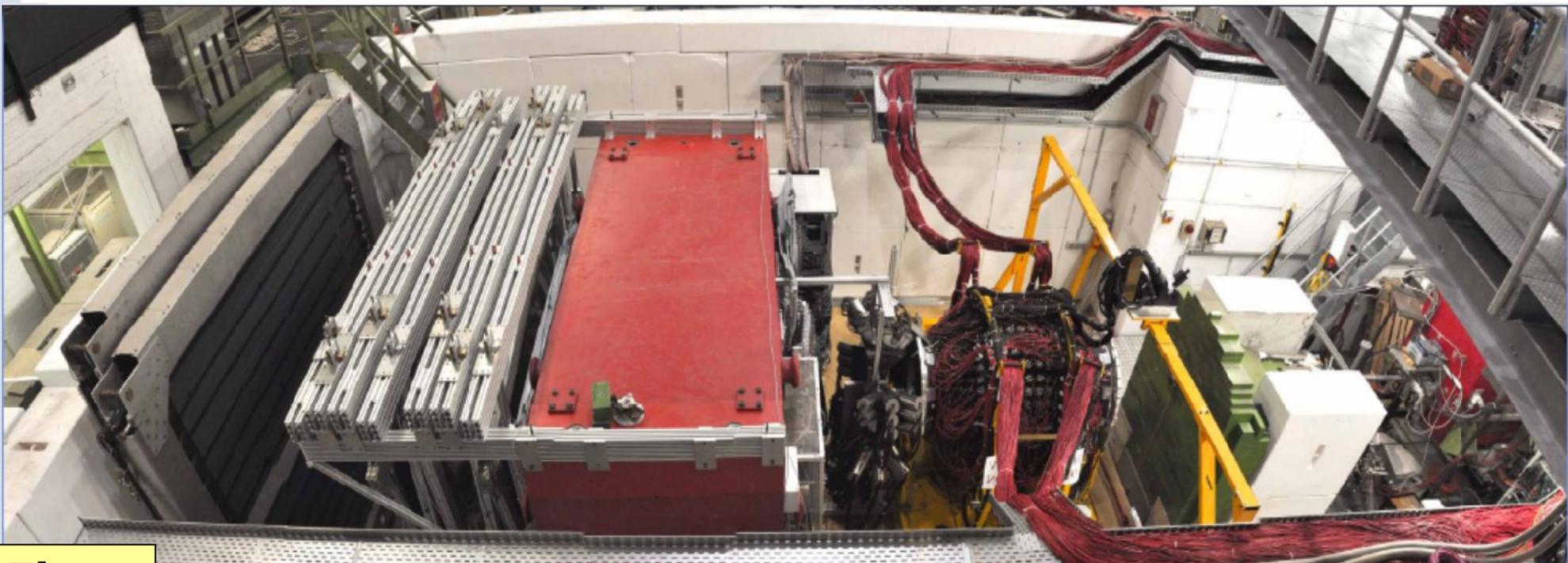
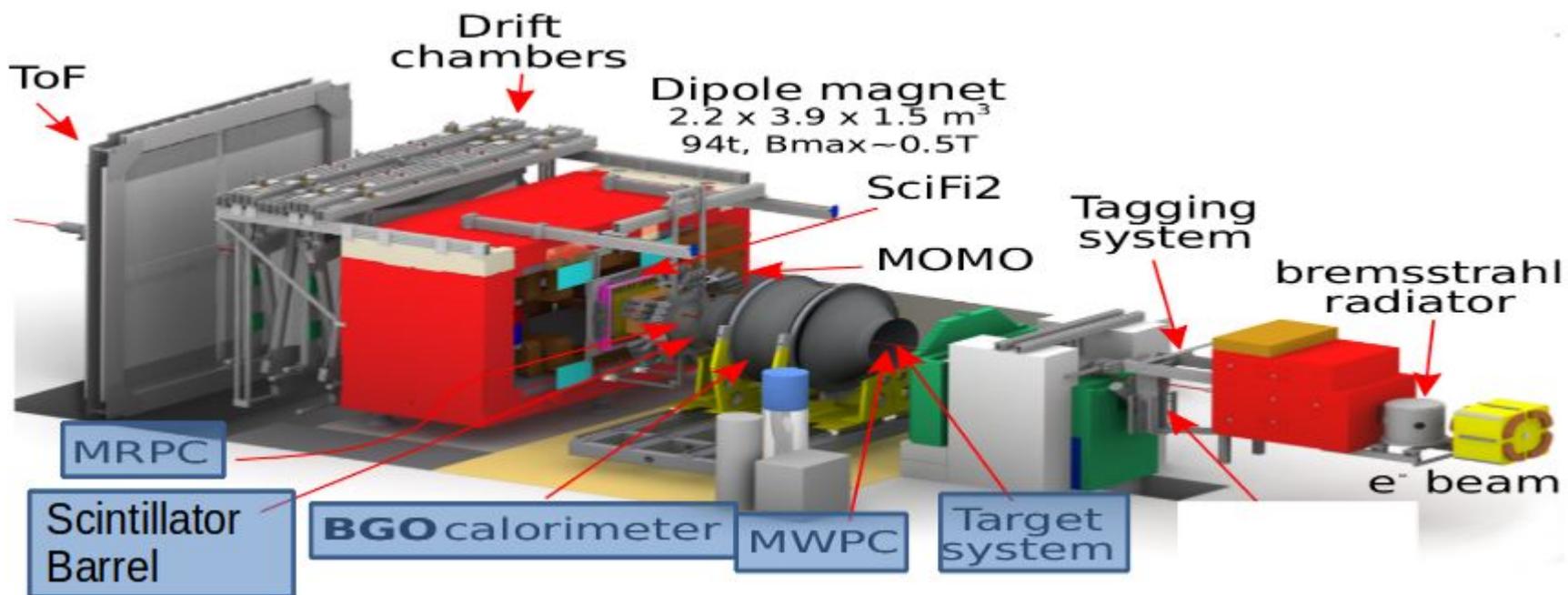


STATUS DI BGO-OD

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BGO-OD



BGO-OD

(In rosso le parti a resp. italiana)

Photon Tagger

In costruzione

Testati 30 canali su 120 - Feb. e Maggio 2013

Goniometro

Primi Tests positivi-Maggio 2013

Bersaglio criogenico

Commissioning - Feb.-Marzo 2012

- Regione centrale:

Calorimetro di BGO

Commissioning - Feb.-Marzo 2012

Barrel di scint. plastici

Commissioning - Giugno 2012

MWPC

Costruzione quasi completa

Testate in laboratorio (2012-2013)

Status del rivelatore BGO-OD (continua)

- Regione in avanti:

MRPC	In costruzione Tests prototipo Feb.-Marzo 2012; BTF Apr. e Ott. 2012	
MOMO	Commissioning Feb.-Marzo e Giugno 2012	Primi tests di tracciamento nello spettrometro
SciFi2	Commissioning Feb.-Marzo e Giugno 2012	
Dipolo mag.	Full Field raggiunto a Feb.2013	
3 Muri TOF	Primi tests di 2 muri - Maggio 2013	
Drift Ch.	Commissioning Giugno 2012	

- Rivelatori di flusso:

GIM(high eff) Tests positivi Maggio 2013

FluMO(low eff) Tests positivi Maggio 2013

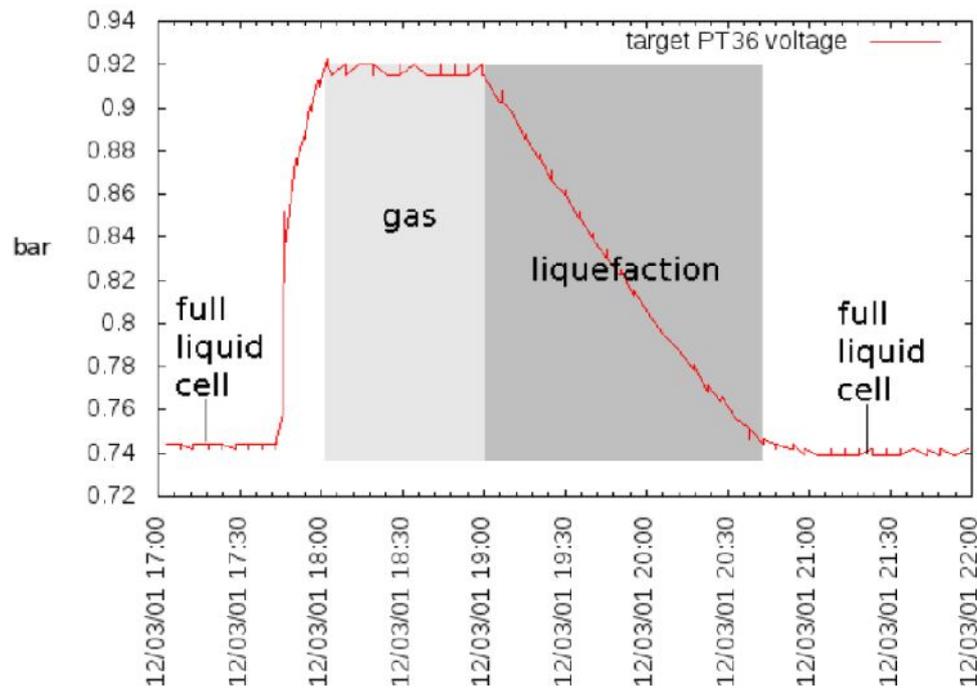
BERSAGLIO H2

⇒ **OK commissioning Feb.-Marzo 2012 e Giugno 2012**

8h per riempire il bersaglio partendo dalla temperatura ambiente

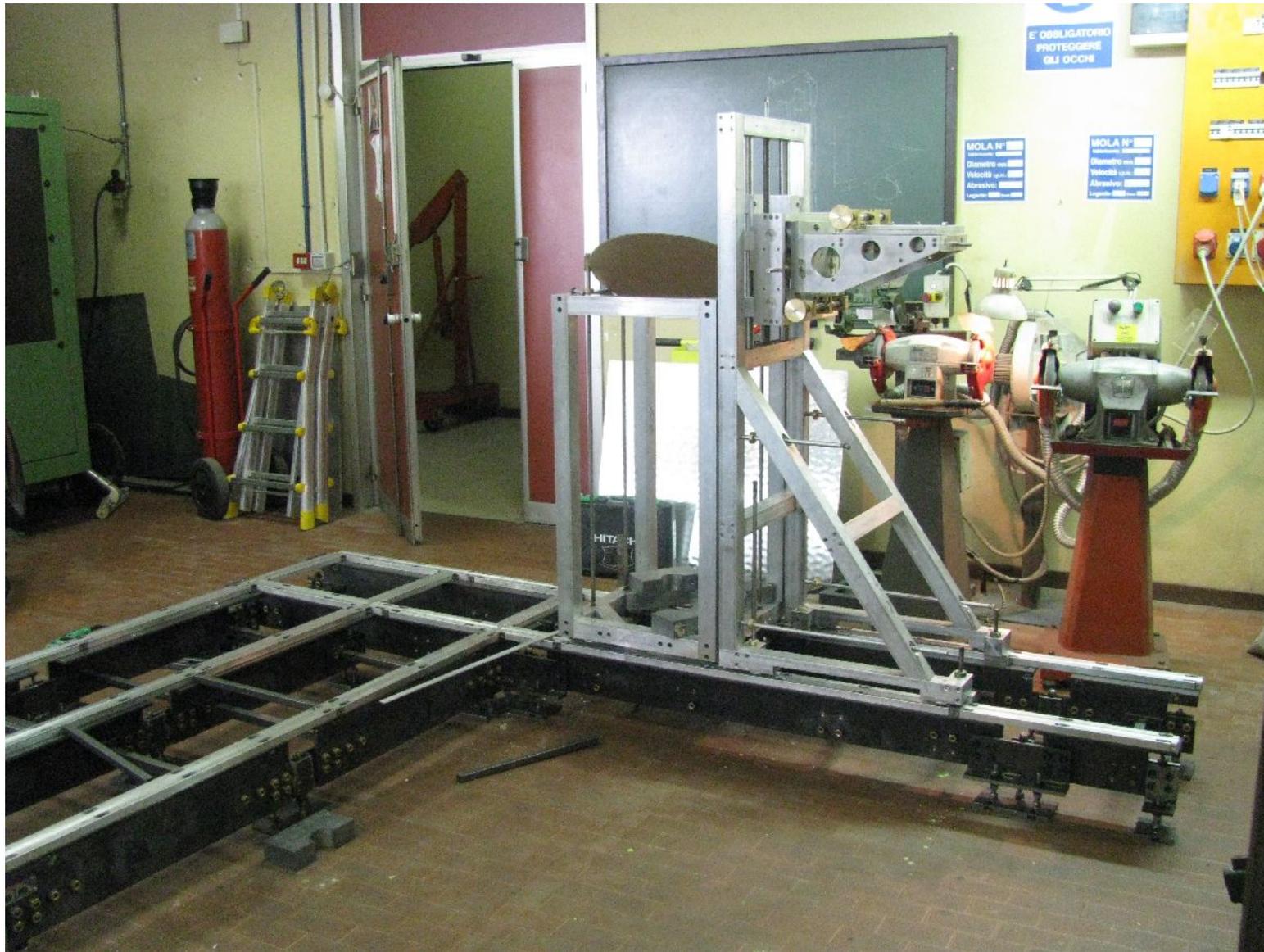
Per acquisire dati con bersaglio vuoto → aumentare la temperatura per produrre l'evaporazione dell'H₂ e poi sono sufficienti 2h per tornare dal gas al liquido

Il bersaglio di H₂ è stato sempre usato in tutti i tests successivi.

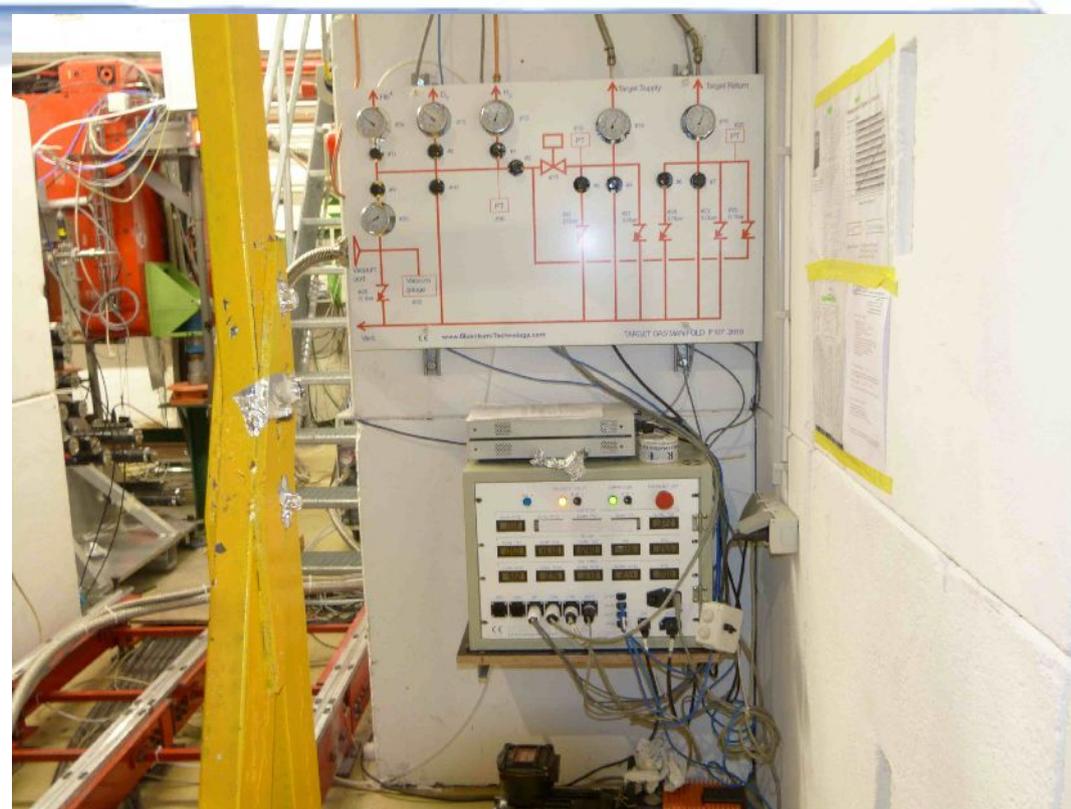
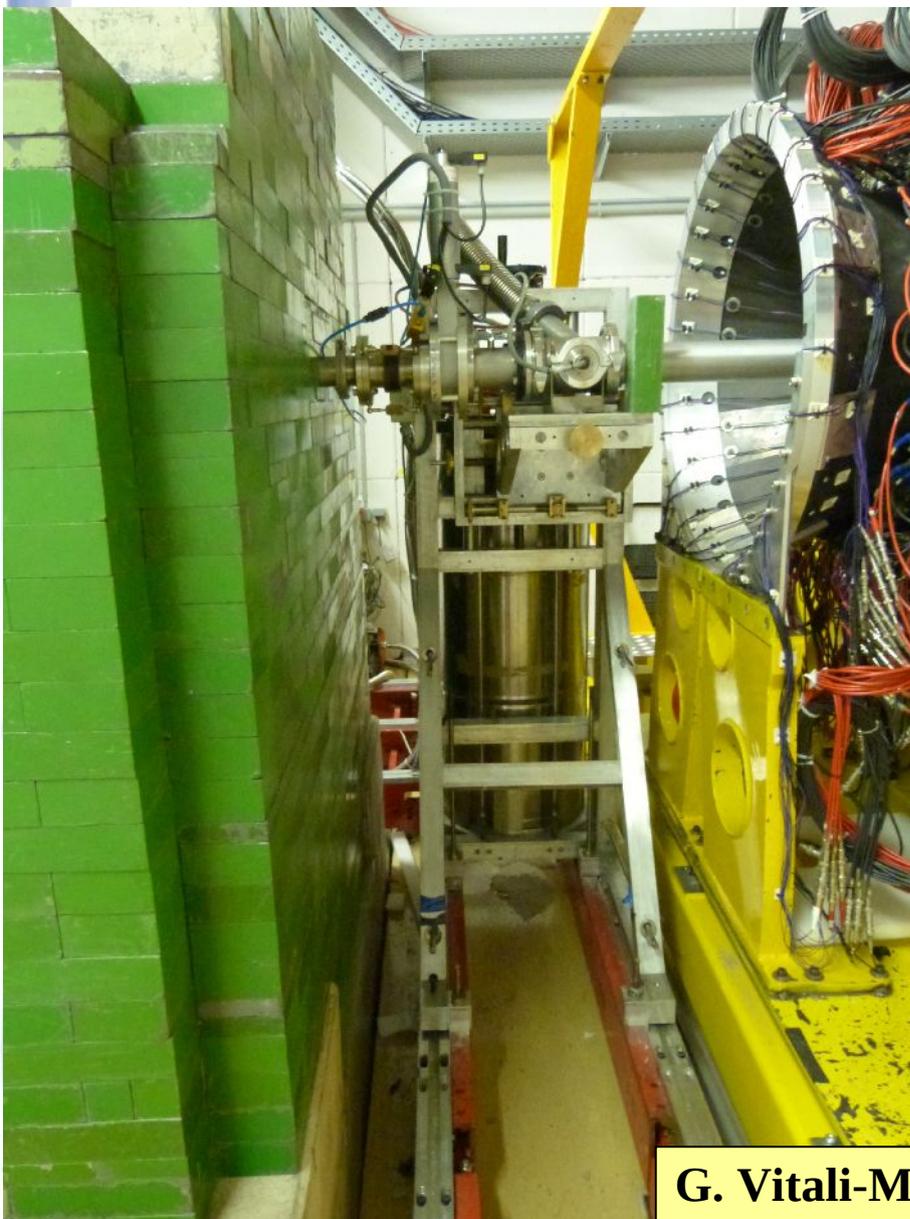


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MECCANICA BERSAGLIO



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Pannello di controllo valvole + scatola elettrica per lettura di sensori temperatura e pressione (remote control)

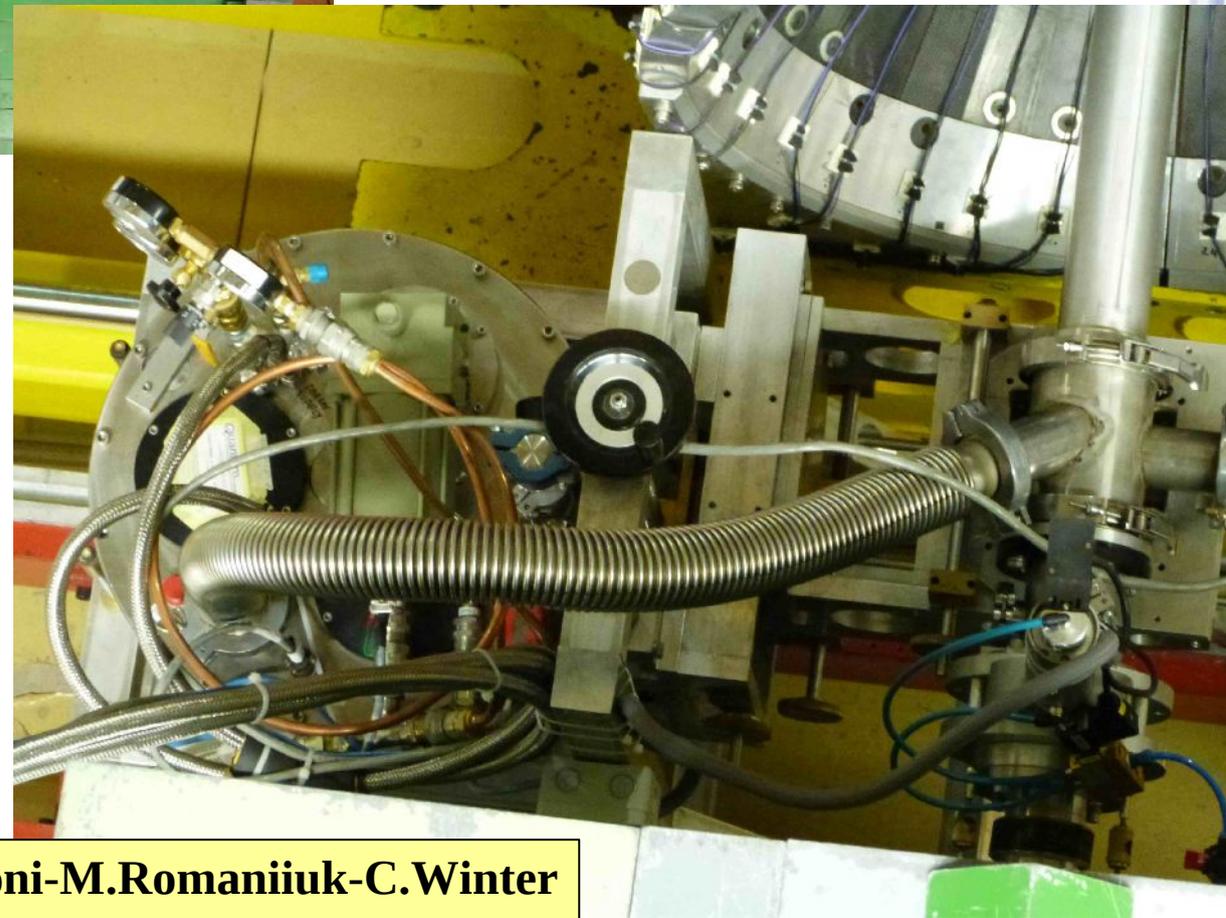
Side View: supporto con tavolo di allineamento + bersaglio inserito in BGO + binari

BERSAGLIO



**Top View: binari+BGO aperta+
bersaglio**

**Top View: criostato+bersaglio
inserito in BGO + collegamenti**



G. Vitali-M.Iannilli-M. Lucentini-R. Fratoni-M.Romaniuk-C.Winter

CALORIMETRO DI BGO

2009-2011 Installazione, cablaggio, read-out, D.A.Q.

⇒ **OK Commissioning del BGO Feb.-Marzo 2012**

+ Tests successivi (**Giugno 2012; Feb. 2013; Maggio 2013**)

In tutti i tests, ben ricostruita la massa invariante di due fotoni nella BGO, prodotti dal decadimento di π^0 o di η nel decadimento (v. dopo risultati tests):

$$\gamma + p \rightarrow \pi^0/\eta + p \rightarrow \gamma\gamma + p$$

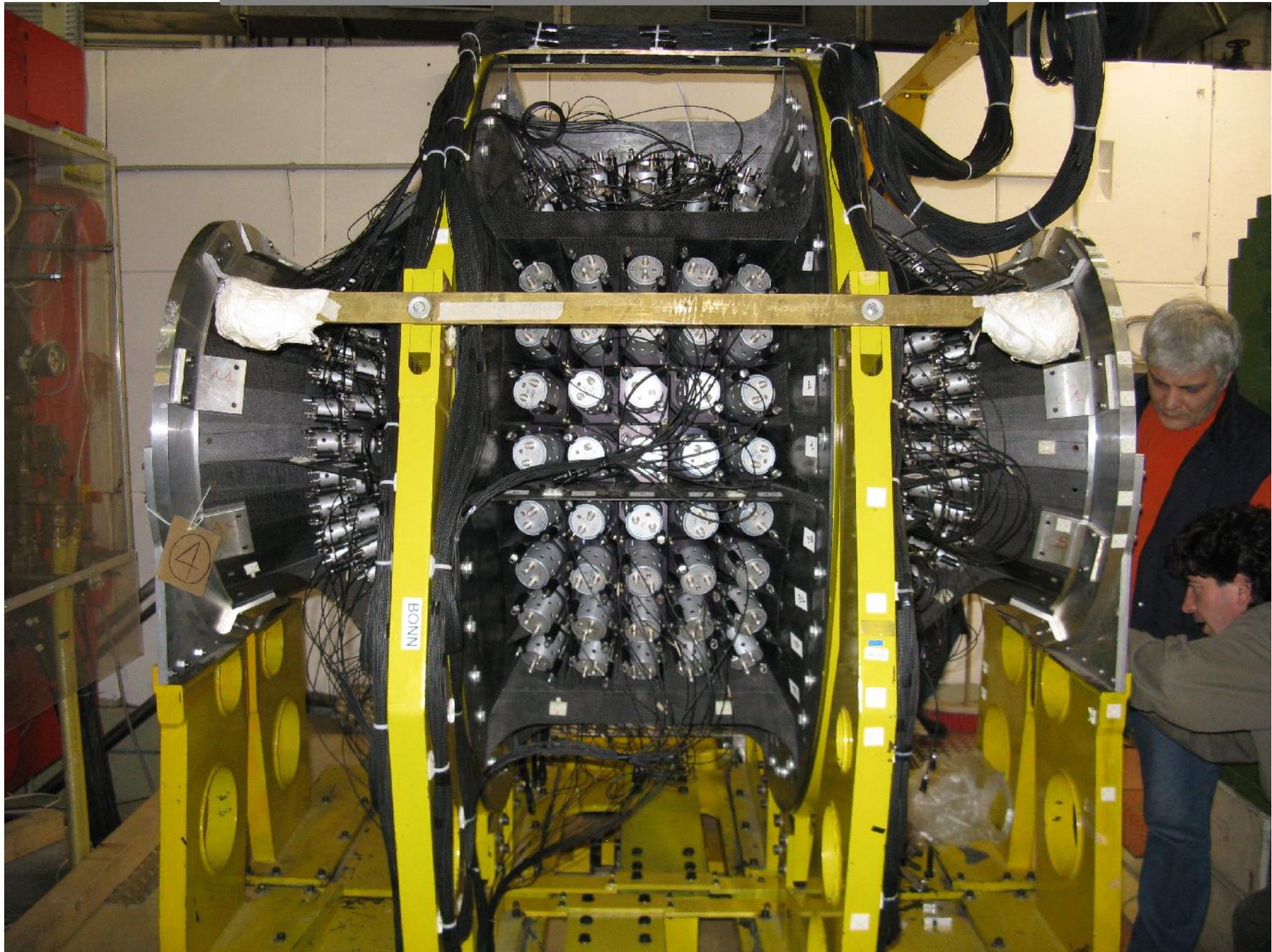
⇒ **OK Tests e simulazioni della risposta del BGO al campo magnetico**
v. **presentazione V. De Leo/F. Curciarello e P. Levi Sandri**

⇒ **OK Tests di linearità e risoluzione alla BTF (Ott. 2012)**
v. **presentazione V. De Leo/F. Curciarello**

⇒ **OK Progettazione, tests dei nuovi partitori di tensione della BGO;**
realizzazione e installazione di 64 partitori
v. **presentazione G. Nobili/S. Colilli/F. Giuliani**

⇒ **OK Progettazione sostegni meccanici per la BGO**
v. **presentazione G. Vitali/M. Iannilli**

CALORIMETRO DI BGO

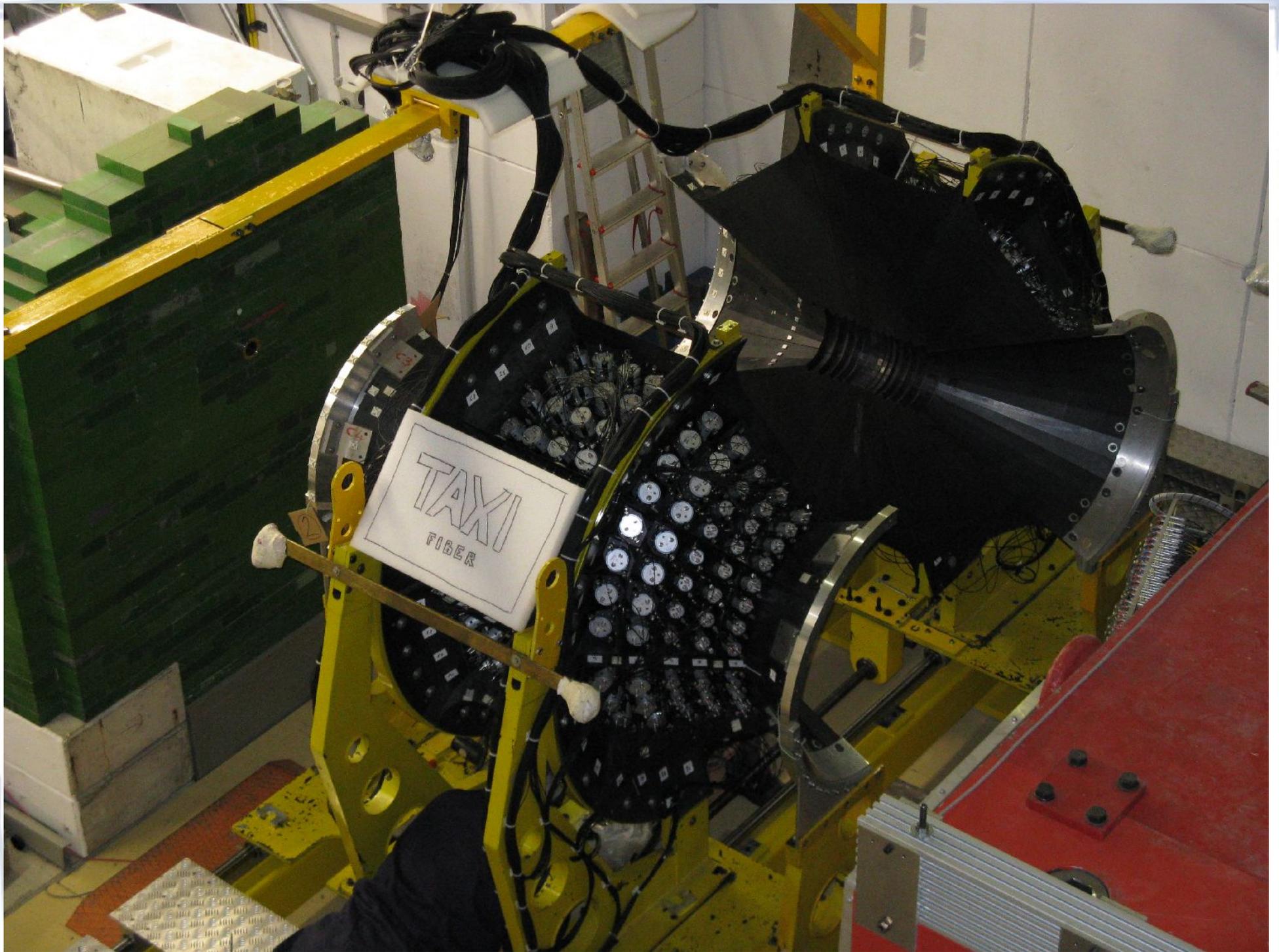


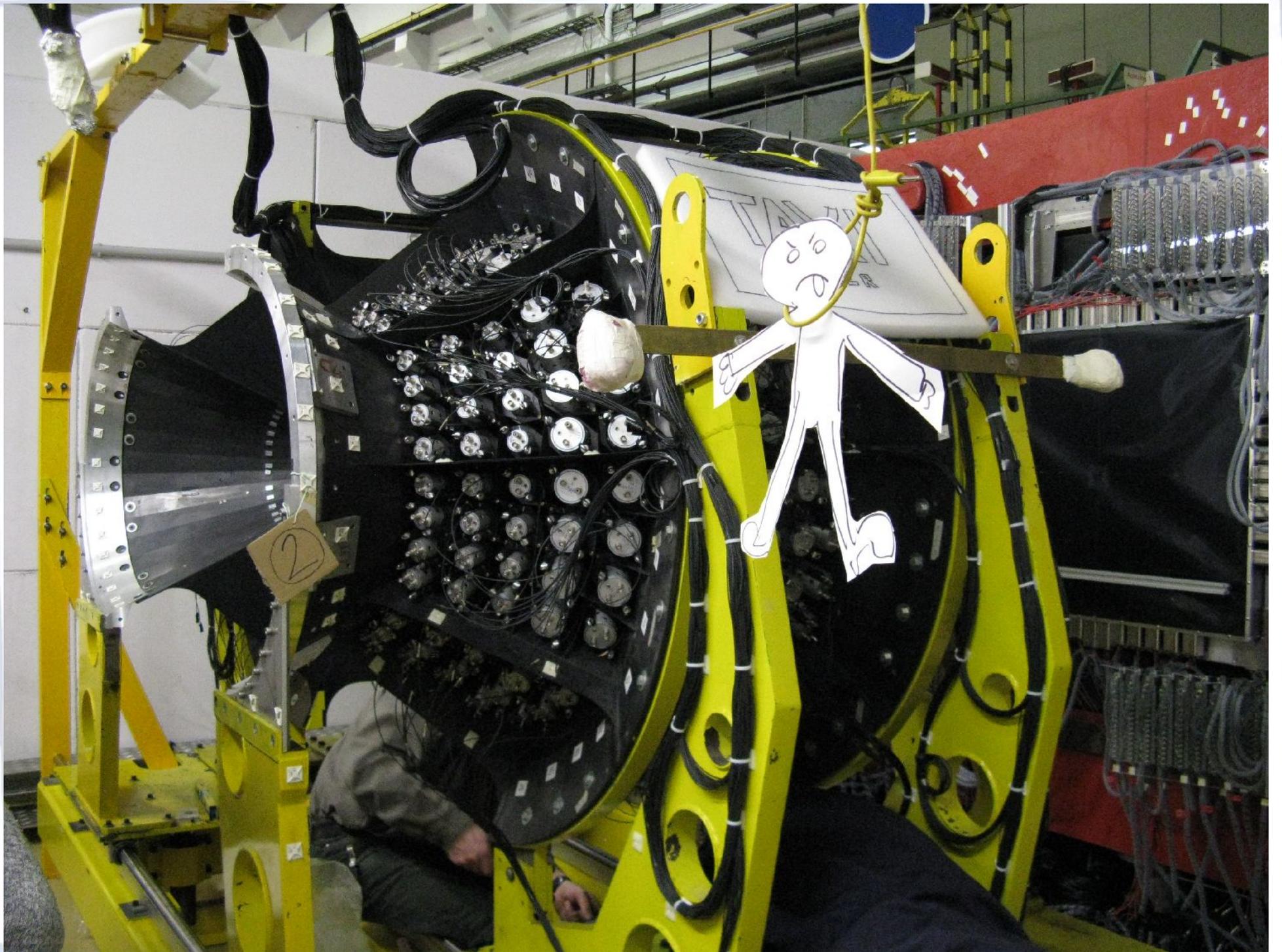
G. Nobili – S. Colilli – R. Fratoni – M. Lucentini – G. Vitali – M. Iannilli – W. Pesci – A. Viticchiè

VISTA DALL'ALTO DEL BGO



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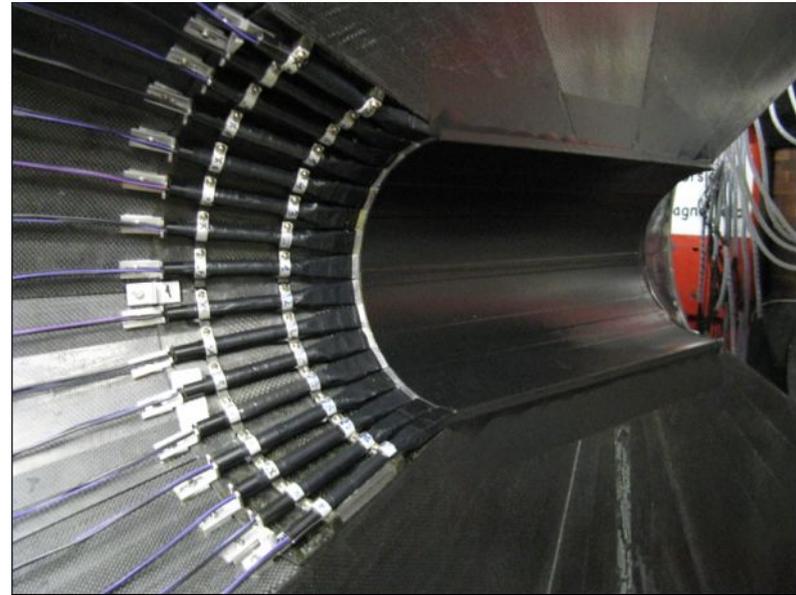
I NOSTRI EROI!!



I NOSTRI MARTIRI...



RIVELATORE A BARREL



⇒ OK Commissioning del Barrel Giugno 2012

$(dE/dx)_{\text{BARREL}} \% E_{\text{BGO}}$

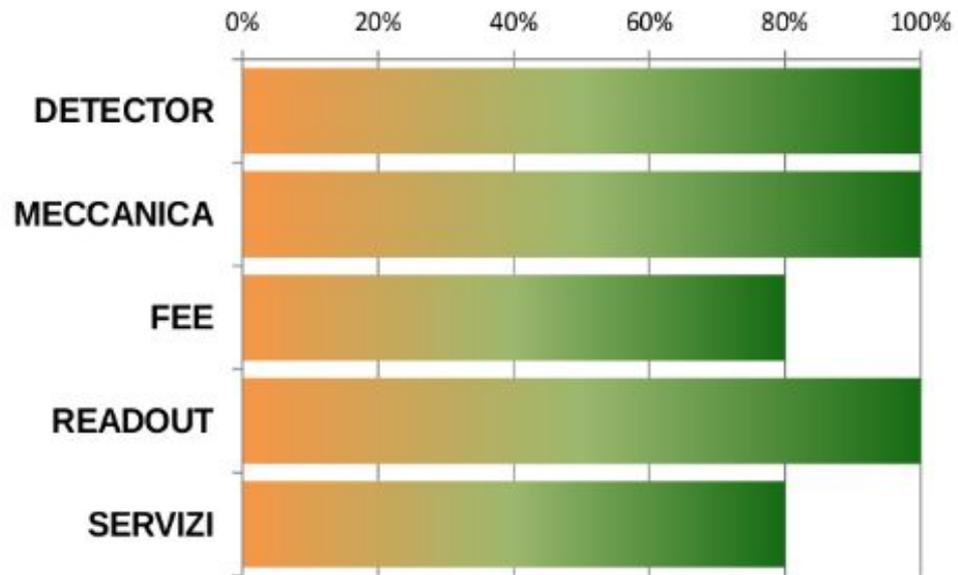
➔ pion/proton identification

➔ Neutral/charged discrimination

⇒ V. presentazione F. Ghio

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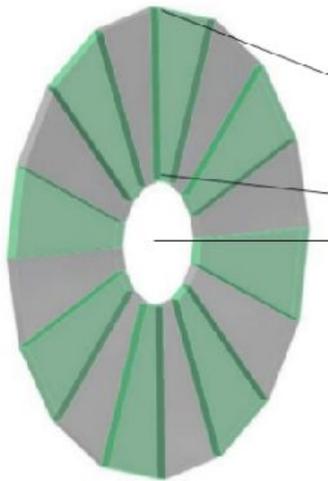
MWPC



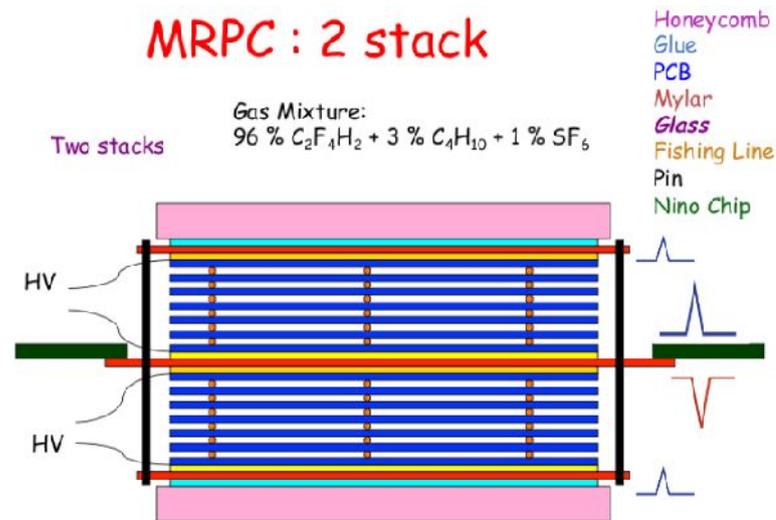
⇒ V. presentazione A. Braghieri



MRPC (Multigap Resistive Plate Chamber)



MRPC : 2 stack



Giugno 2011: Test a Bonn del prototipo (rettangolare 100x200 mm²)

2012-2013: Acquistati vetri e PCB

2012-2013: Acquistati 12 TDC Caen

⇒ **OK 16-22 Aprile 2012 e 6-12 Ottobre 2012: Test del prototipo alla BTF**

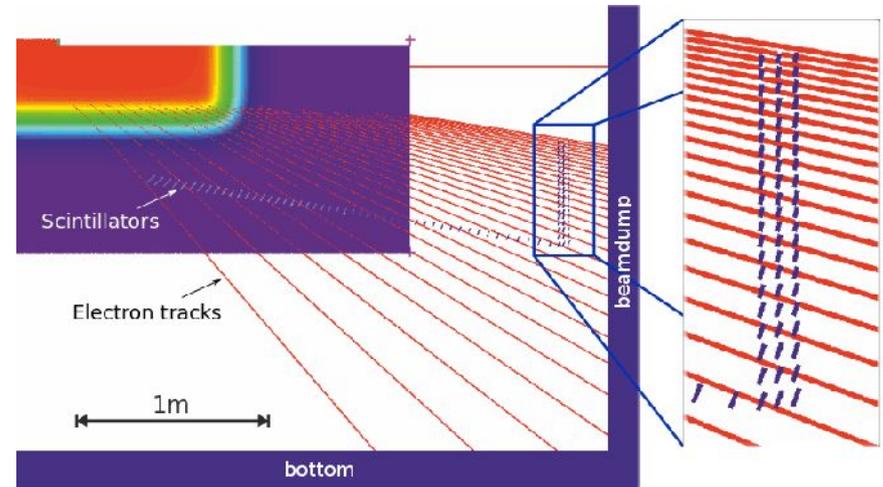
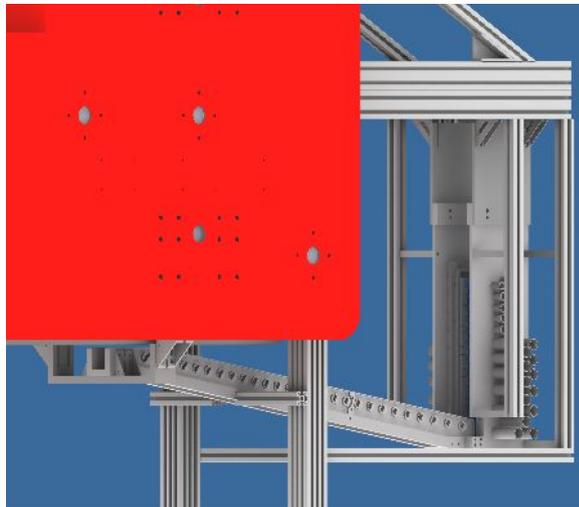
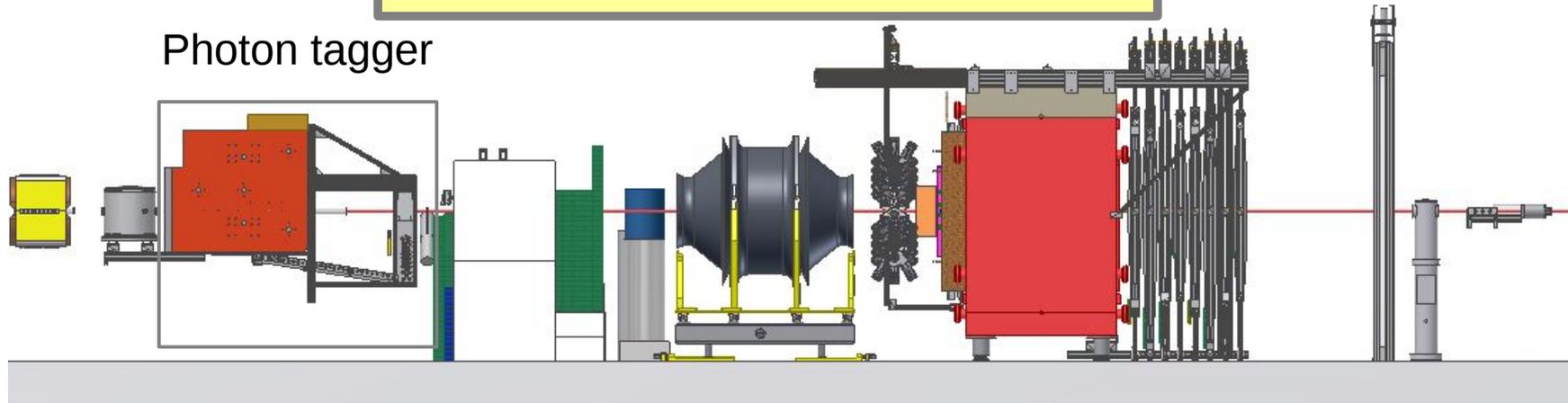
⇒ **OK Tests del prototipo con cosmici**

⇒ **OK Progettazione e installazione della meccanica a Bonn Nov. 2012**

⇒ **V. presentazione R. Messi/D. Moricciani**

PHOTON TAGGER

Photon tagger



High energy e^- (\rightarrow low en. γ): focal plane is not accessible: tagging hodoscope is split into a horizontal part (covers 10-32% E_0) and a vertical part (covers 32-90% E_0)

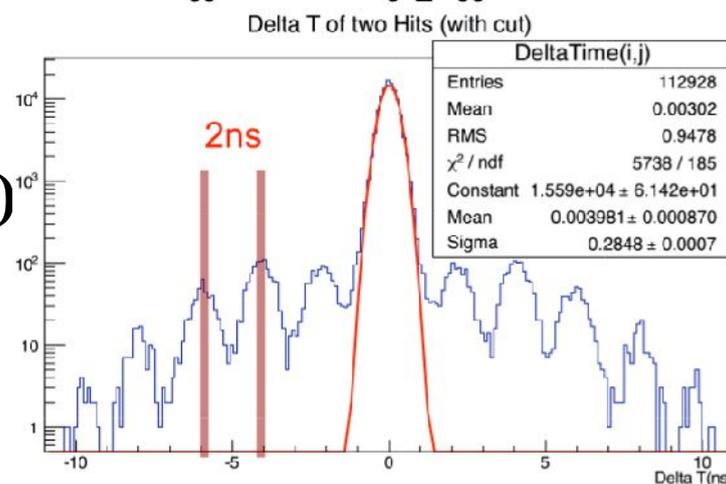
120 plastic scintillators (54 horizontal, 66 vertical), adjacent scintillators overlap by 55%
trigger on double coincidences

PHOTON TAGGER

⇒ Commissioning di 30 scintillatori (tagger vert.)
in Feb. e Maggio 2013:

- OK correlazione tra scintillatori adiacenti
- OK struttura temporale del fascio (bunch a 2.ns)
- OK elettronica: active splitters, discriminators boards, coincidence logic e readout (FPGA boards e firmware)

Run 8308: trigger condition bgo_taggerProto



- il materiale presenta danneggiamenti che peggiorano la risoluzione temporale

⇒ altri 36 scintillatori (tagger vert.) pronti a Gatchina: inizio luglio a Bonn

⇒ rimanenti 54 scintillatori (tagger orizz.) in lavorazione a Gatchina

⇒ Nel frattempo nuovi scintillatori ordinati a ditta esterna: consegna luglio

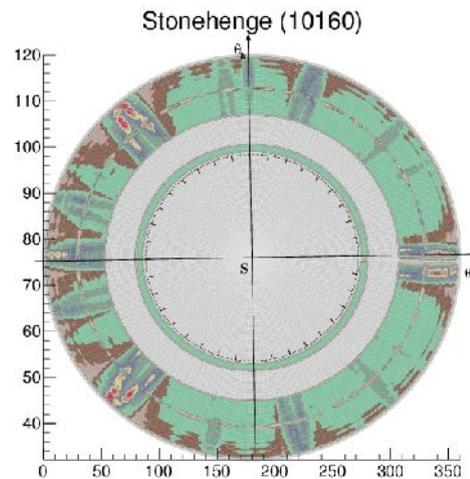
TEST 9-15 SETTEMBRE 2013

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GONIOMETRO

⇒ **OK Commissioning in Feb. e Maggio 2013: estratti i primi plot “Stonehenge”**

⇒ **Necessari ancora alcuni giorni di test per trovare i corretti offset angolari del goniometro e del cristallo rispetto al fascio.**

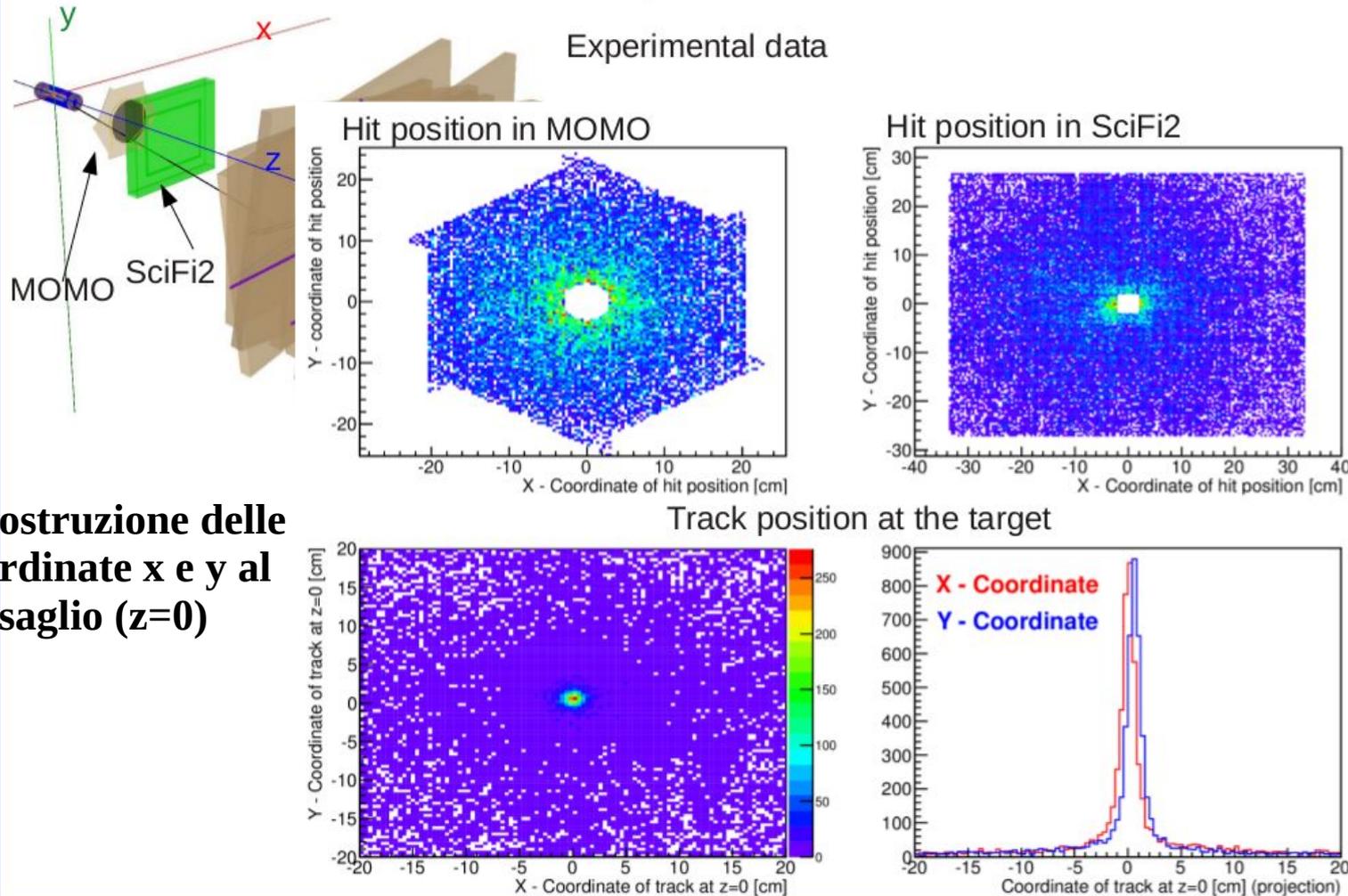


SciFi2 & MOMO

(Prima del dipolo)

Commissioning in Feb.-Marzo 2012 e Giugno 2012

Particle tracking - SciFi2 & MOMO



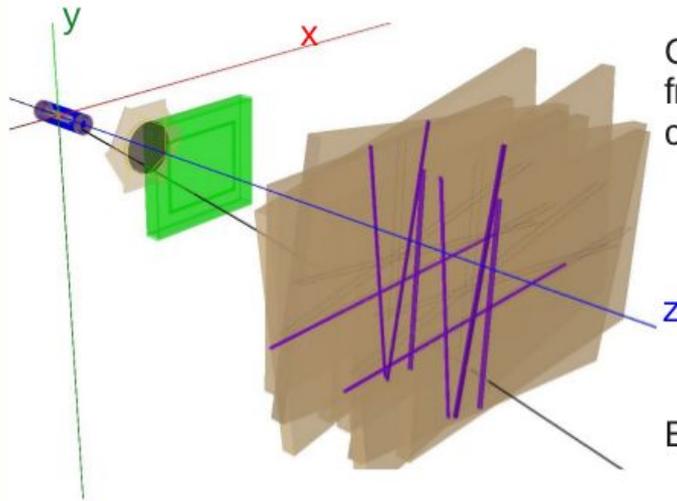
Ricostruzione delle coordinate x e y al bersaglio (z=0)

DRIFT CHAMBERS

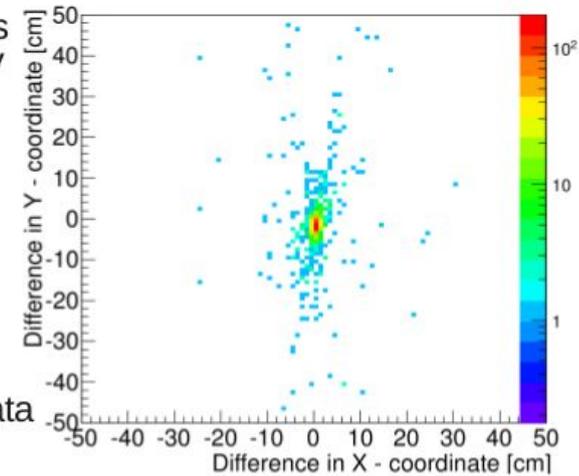
(Dopo il dipolo)

Commissioning in Feb.-Marzo 2012 e Giugno 2012

Particle tracking – Drift chambers



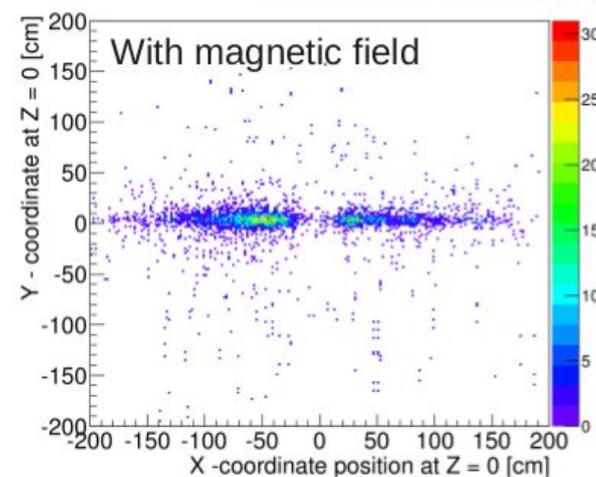
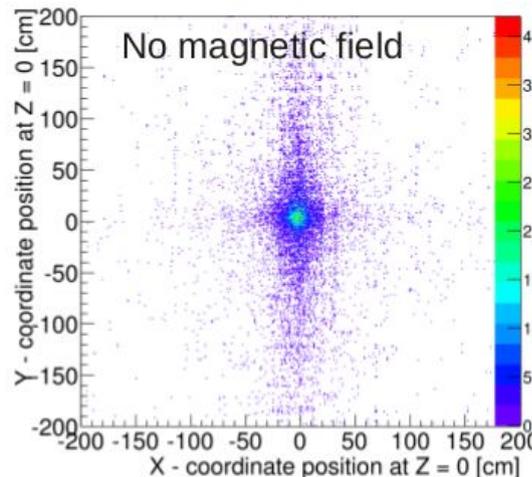
Compare Tracks from XY and UV combinations:



Experimental data

DC track position
At target centre:

Ricostruzione delle coordinate x e y al bersaglio (z=0)



TOF WALLS

- 2 walls
- 14 bars vert., 8 bars hor.
- Scintillator dimensions:
 - 3400mm x 210mm x 60mm (horizontal bars)
 - 2700mm x 200mm x 45mm (vertical bars)
- Time resolution $\sim 500\text{ps}$
- Upgrade using former GRAAL ToF detectors (time resolution $\sim 200\text{ps}$) in progress

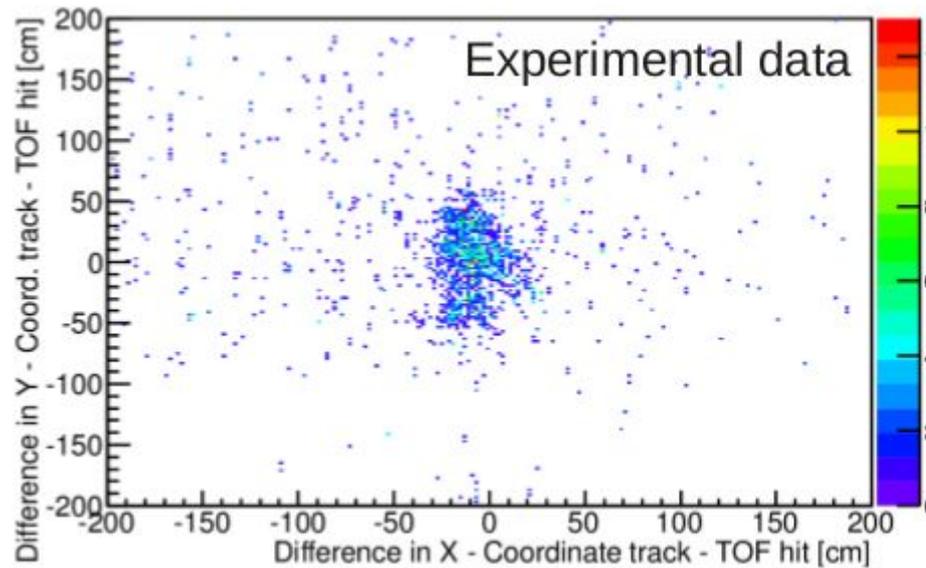


**Tests a Maggio 2013 → problemi con HV e con acquisizione
Manca il terzo muro (ex-Graal) da assemblare**

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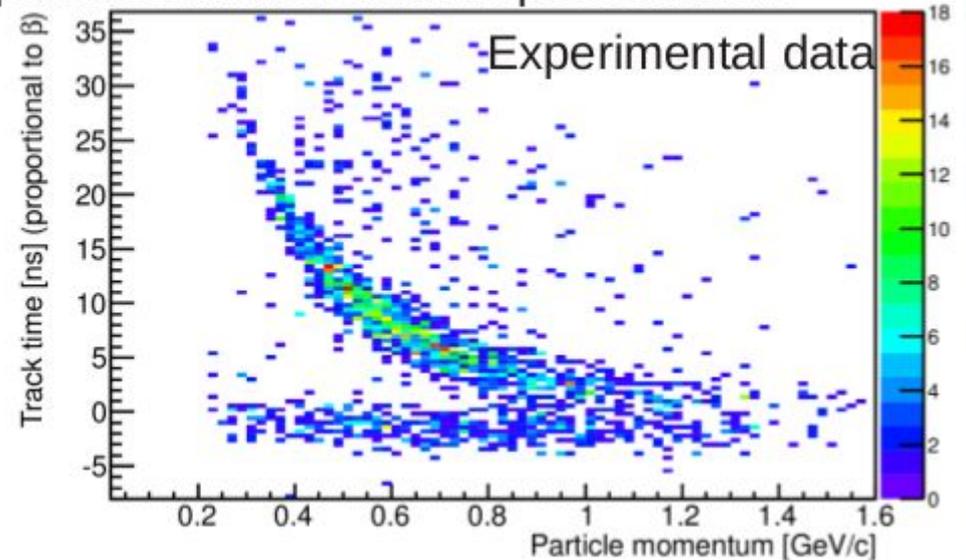
Tracciamento di particelle cariche in avanti Drift Chambers – TOF – SciFi2 - MOMO

- Connect Tracks to hits in the TOF Wall



Differenza tra la coordinata misurata e quella attesa nel TOF prolungando al TOF le tracce ricostruite nelle DC (Δy vs. Δx)

- First (preliminary) identification of particles in the forward spectrometer:



TOF vs. Momentum (ricostruito da SciFi2-MOMO e DC)

FLUX MONITORS

GIM (Gamma Intensity Monitor): efficiency close to 100%
Lead Glass (Cerenkov effect to discriminate charged particles/e.m. showers generated by photons)
One single lead block + 2" PM

⇒ **Installato e testato a Feb. e Maggio 2013**

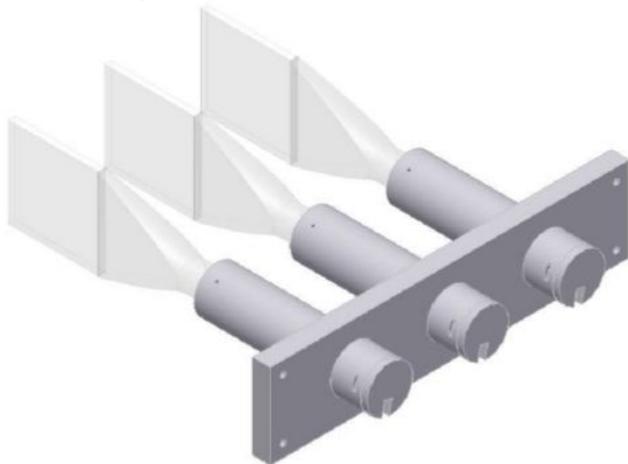
⇒ **Installata tavola per estrazione (inserito solo per brevi runs per calibrare il FluMo).**



FLUMO (Flux Monitor)

Three scintillators + a Copper foil between first/second scint.
Low intensity runs to extract the efficiency of the FluMo

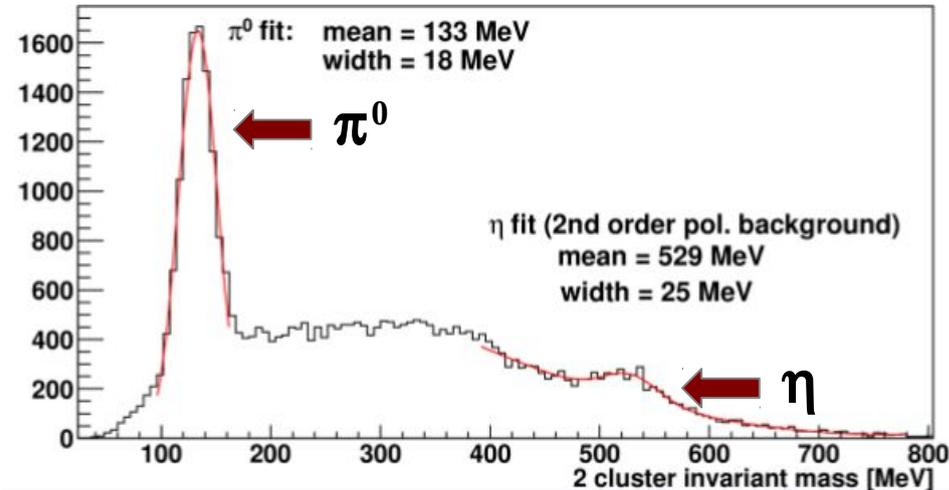
⇒ **Installato e funzionante (nuovi partitori per sopportare alti rate). Testato in Feb. and May 2013**



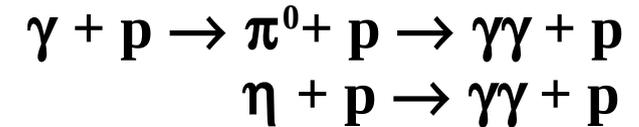
RISULTATI DA BEAM TESTS FEB-MARZO 2012

BGO – NO Barrel – Old Tagger Detector

Due cluster neutri nella BGO



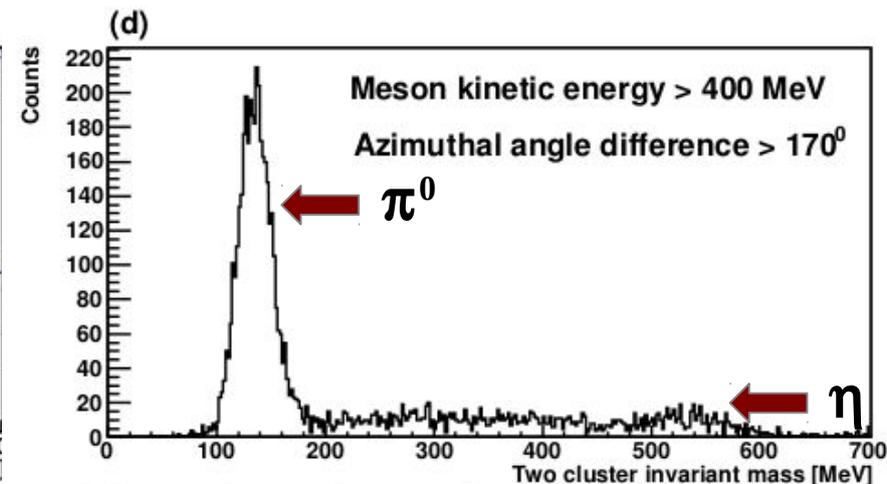
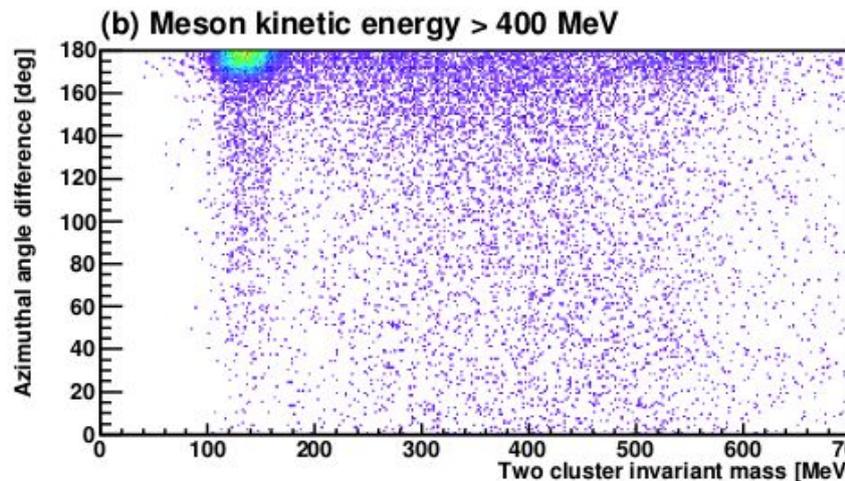
Massa invariante di due cluster neutri



Candidato cluster neutro = cluster ad alta molteplicità (≥ 3 cristalli)

Candidato cluster carico = cluster a bassa molteplicità (< 3 cristalli)

Due cluster neutri + 1 cluster carico nella BGO con tagli cinematici sulla correlazione angolare

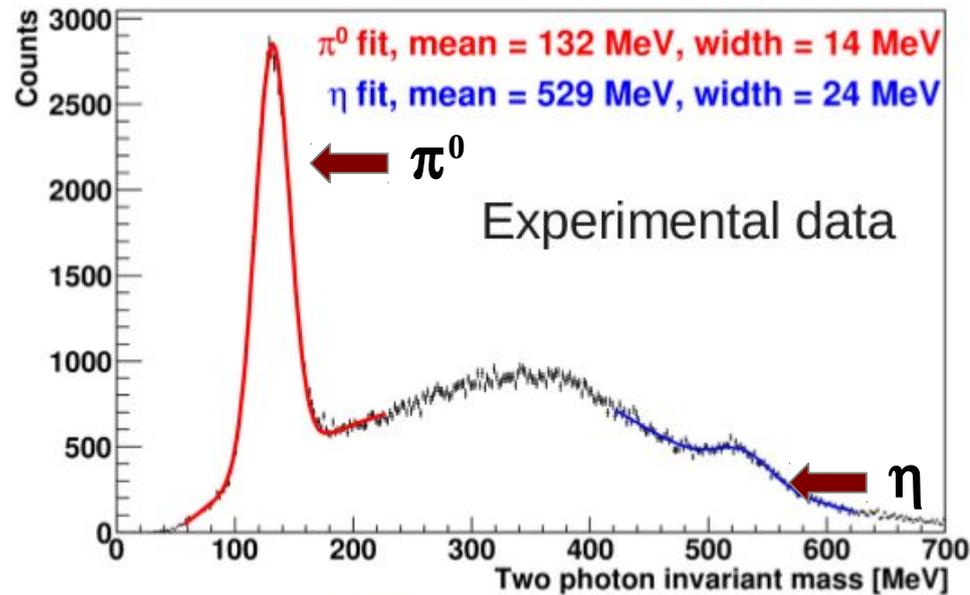


Massa invariante di due cluster neutri

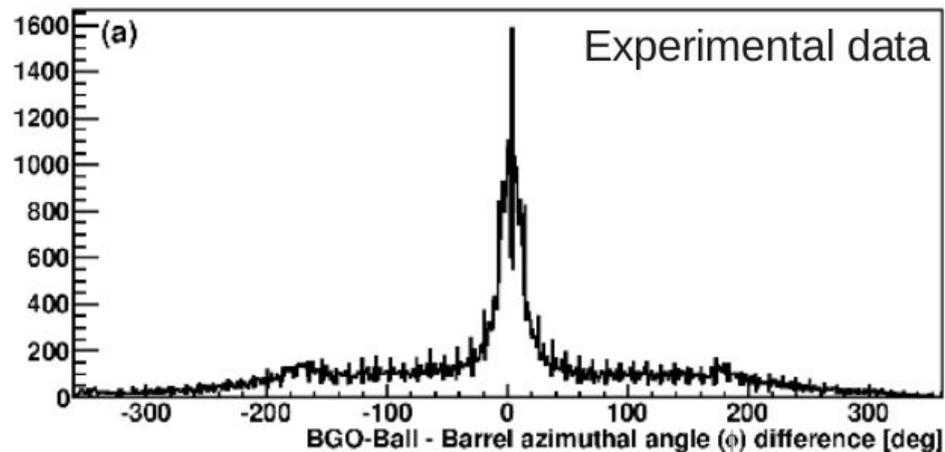
RISULTATI DA BEAM TESTS GIUGNO 2012

BGO – Barrel – Old Tagger Detector

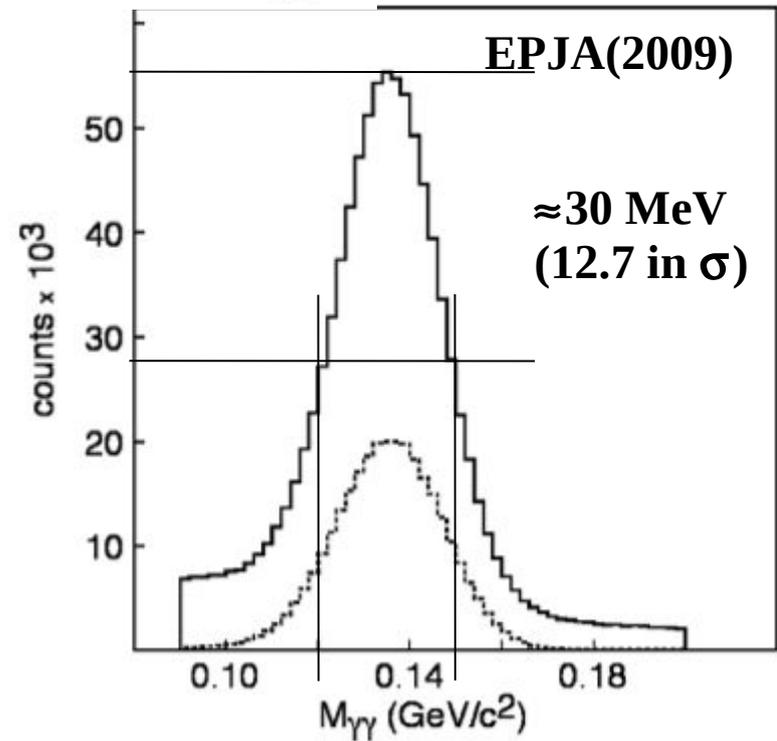
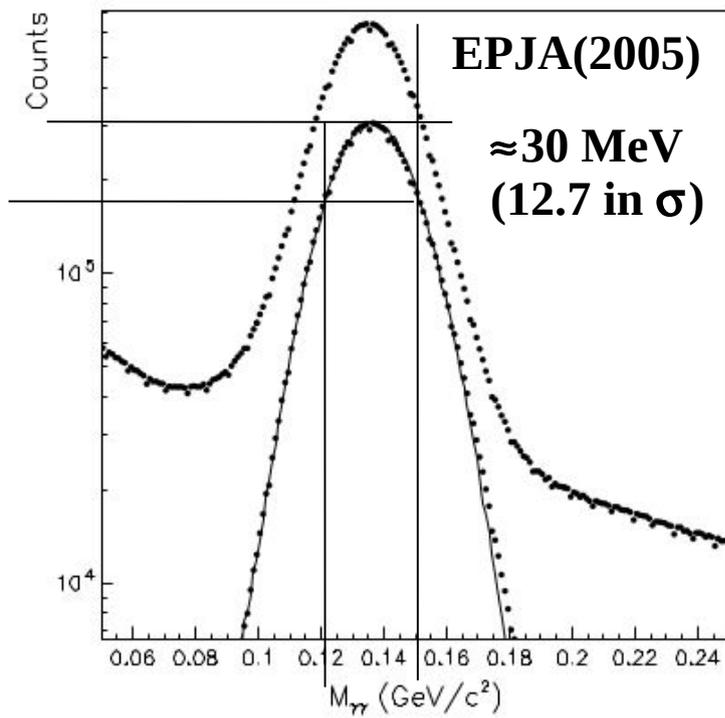
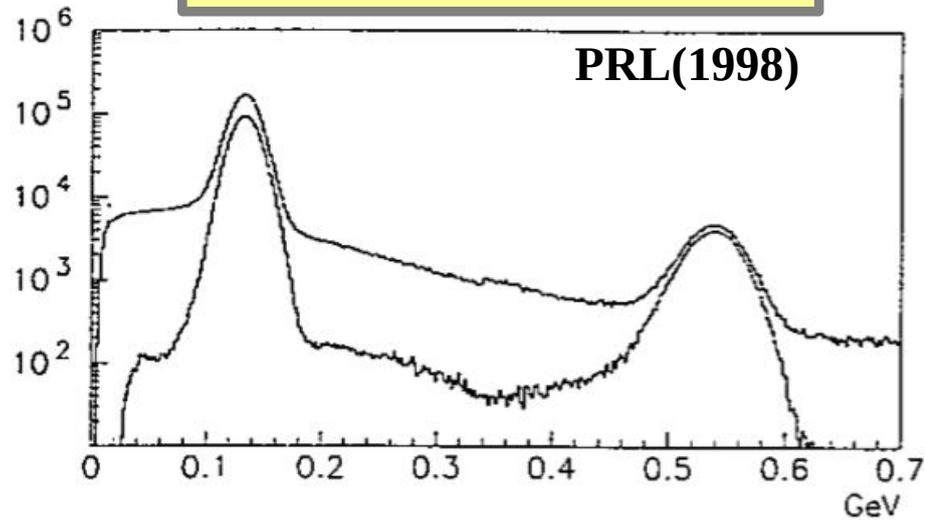
Due cluster neutri in BGO + 1 cluster carico in BGO/Barrel con tagli cinematici:
particle identification in Barrel



Massa invariante di due cluster neutri

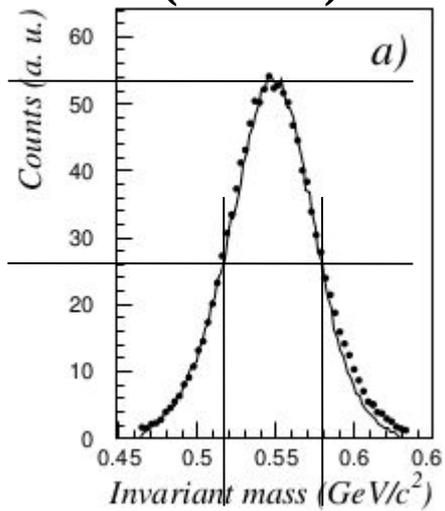


GRAAL – π^0 Mass

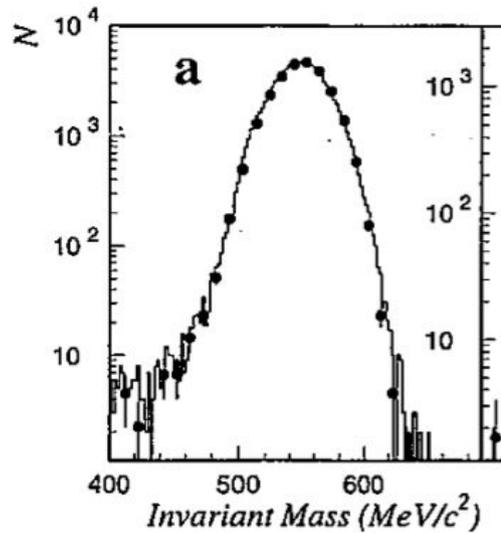


GRAAL – η Mass

≈ 62 MeV
(26 in σ)

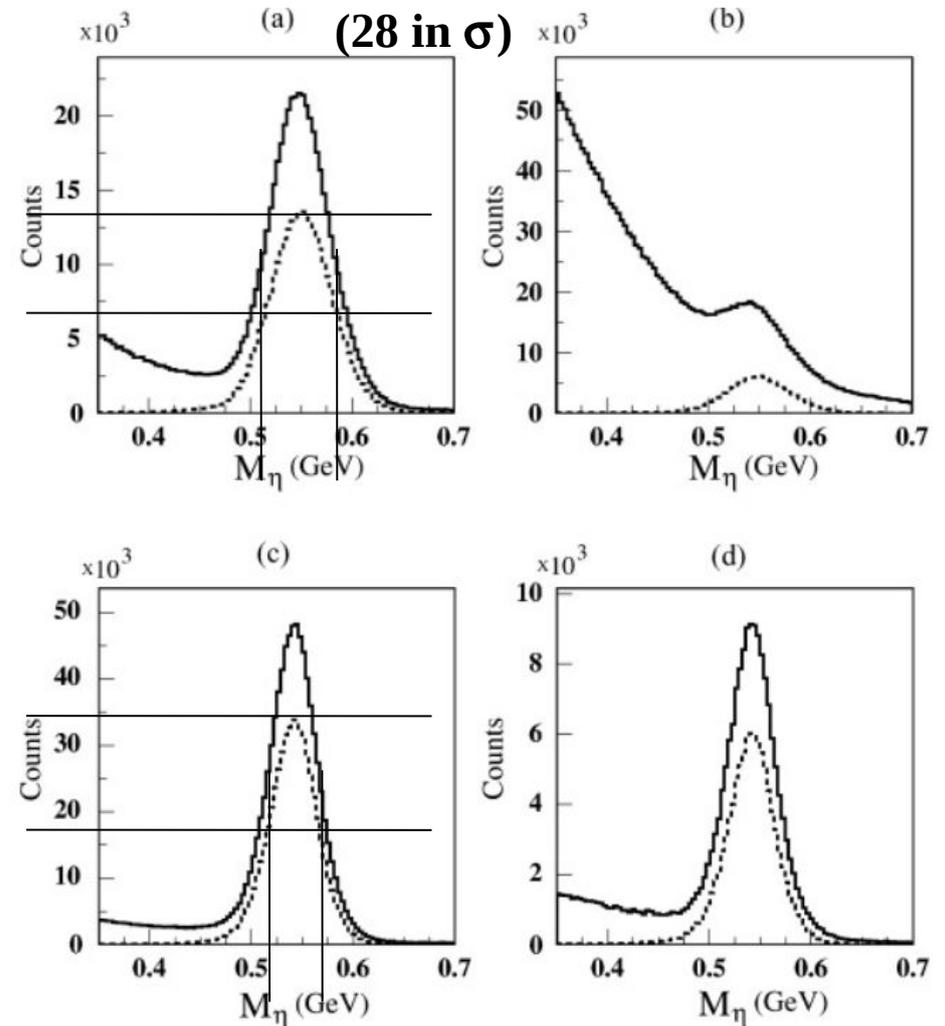


EPJA(2007)



PLB(2002)

≈ 65 MeV
(28 in σ)

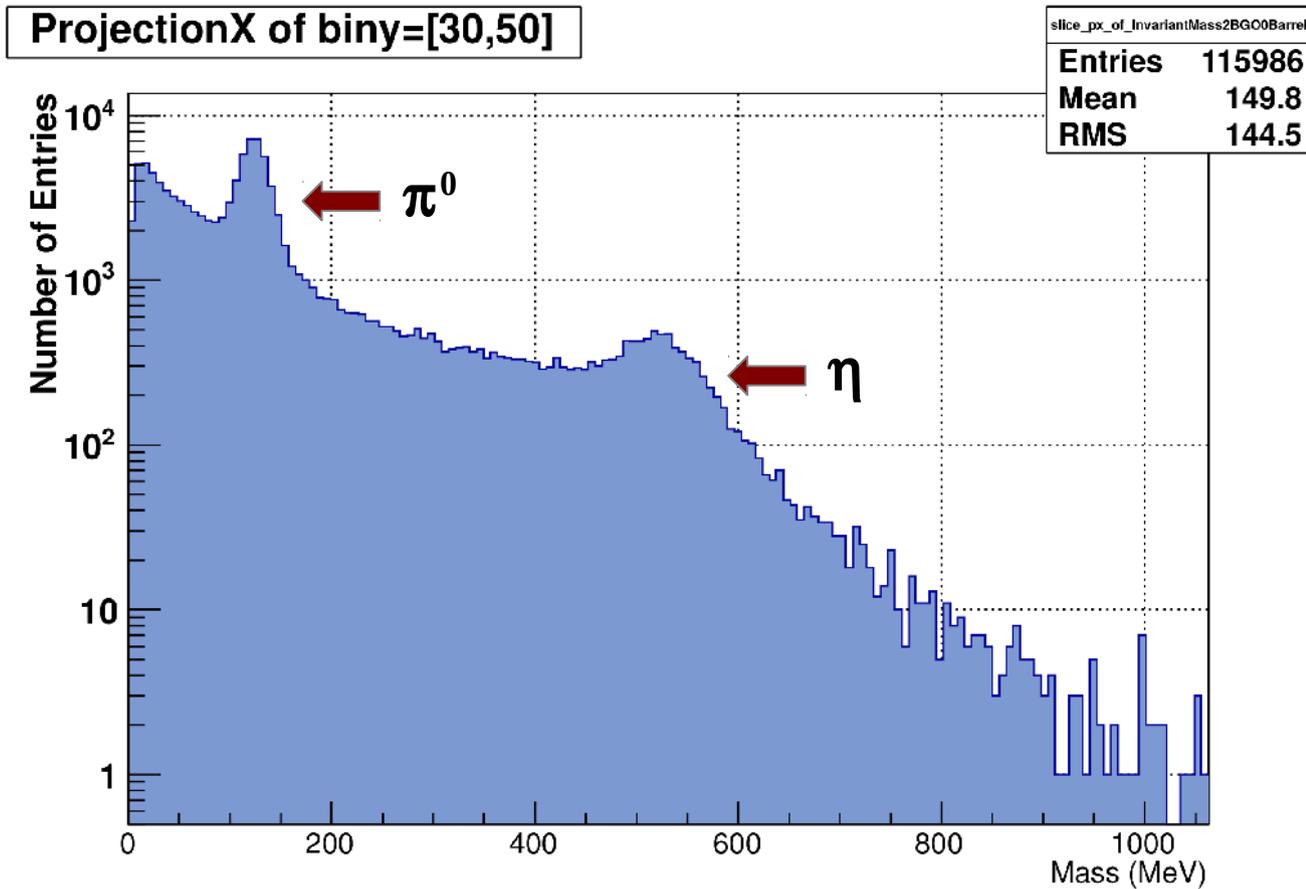


PRC(2008)

RISULTATI DA BEAM TESTS GIUGNO 2012

BGO – NO Barrel Identif.

Trigger BGO && Tagger – 9 channels of the new Tagger Prototype (200 MeV close to η photo production threshold):
2 clusters in BGO not geometrically associated to an in-time signal in the barrel

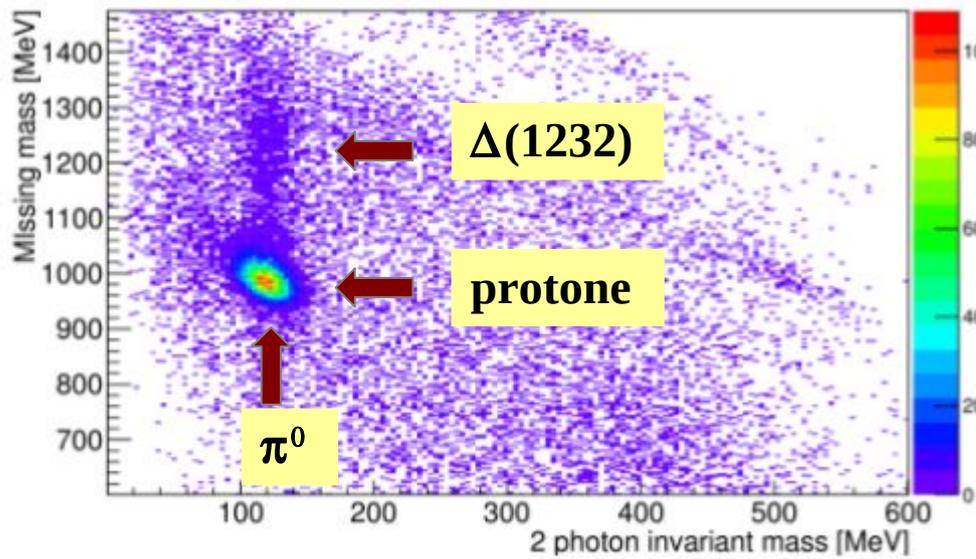


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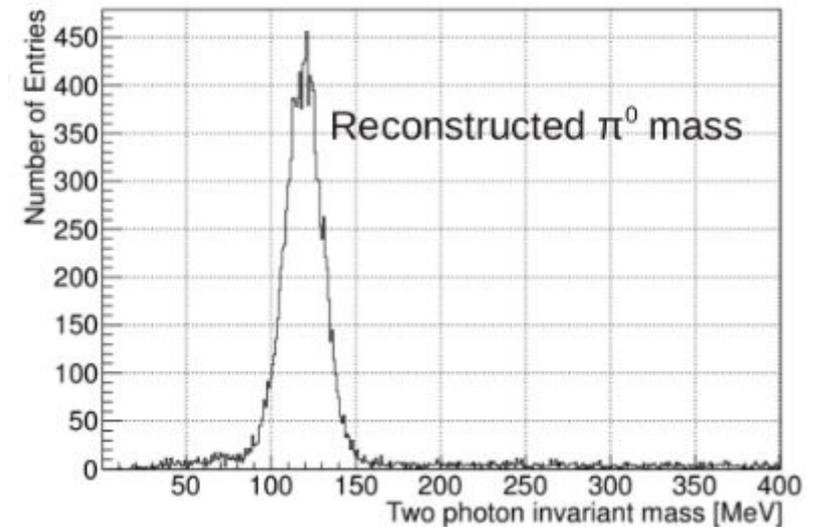
RISULTATI DA BEAM TESTS FEB. 2013

BGO – 30 Scintill. New Tagger

Il nuovo rivelatore di Tagging non copriva bene la regione dell' η



Massa mancante da due fotoni nella reazione $\gamma + p \rightarrow \gamma\gamma + X$ vs. Massa invariante di due fotoni

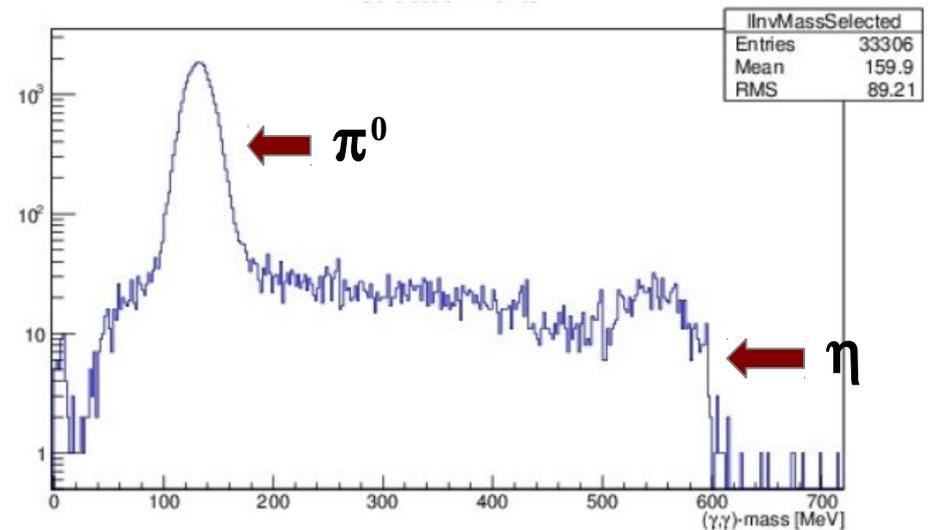
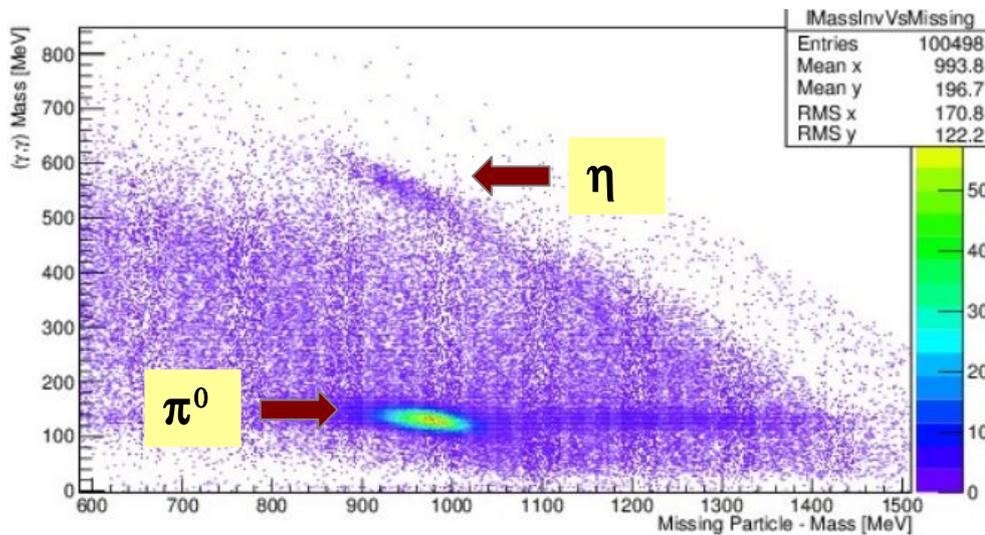


Massa invariante di due fotoni

RISULTATI DA BEAM TESTS MAGGIO 2013

BGO – 30 Scintill. New Tagger

Il rivelatore di Tagging copre la soglia di fotoproduzione dell' η



Massa invariante di due fotoni vs. Massa mancante da due fotoni nella reazione $\gamma + p \rightarrow \gamma\gamma + X$

Massa invariante di due fotoni

$$m_{\pi^0} = 133 \text{ MeV} \pm 17 \text{ MeV } (\sigma)$$

$$m_{\eta} = 544 \text{ MeV} \pm 30 \text{ MeV } (\sigma)$$

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Joint PAC of MAMI and ELSA 2012, Dec. 6th-7th

P. Levi Sandri G. Mandaglio

ELSA/6-2012-BGO

Proposal to the PAC

Measurement of the Σ beam asymmetry in

$$\gamma + p \rightarrow \eta' + p$$

RATE B

A. Fantini A. Braghieri

ELSA/5-2012-BGO

Proposal to the PAC

**η PHOTOPRODUCTION MEASUREMENTS
WITH BGO-OD**

RATE A

V. Vegna J. Hannappel

ELSA/4-2012-BGO

Proposal to the PAC

Vector Meson Photoproduction at BGO-OD

**RATE A
for $\omega n/\phi n$**

T. C.Jude D. Elsner

ELSA/7-2012-BGO

Proposal to the PAC

**Associated Strangeness Photoproduction with
the BGO-OD**

**RATE A
for $K^+\Lambda$**

\Rightarrow V. presentazione A. Fantini/G.Mandaglio

Joint PAC of MAMI and ELSA 2012, Dec. 6th-7th

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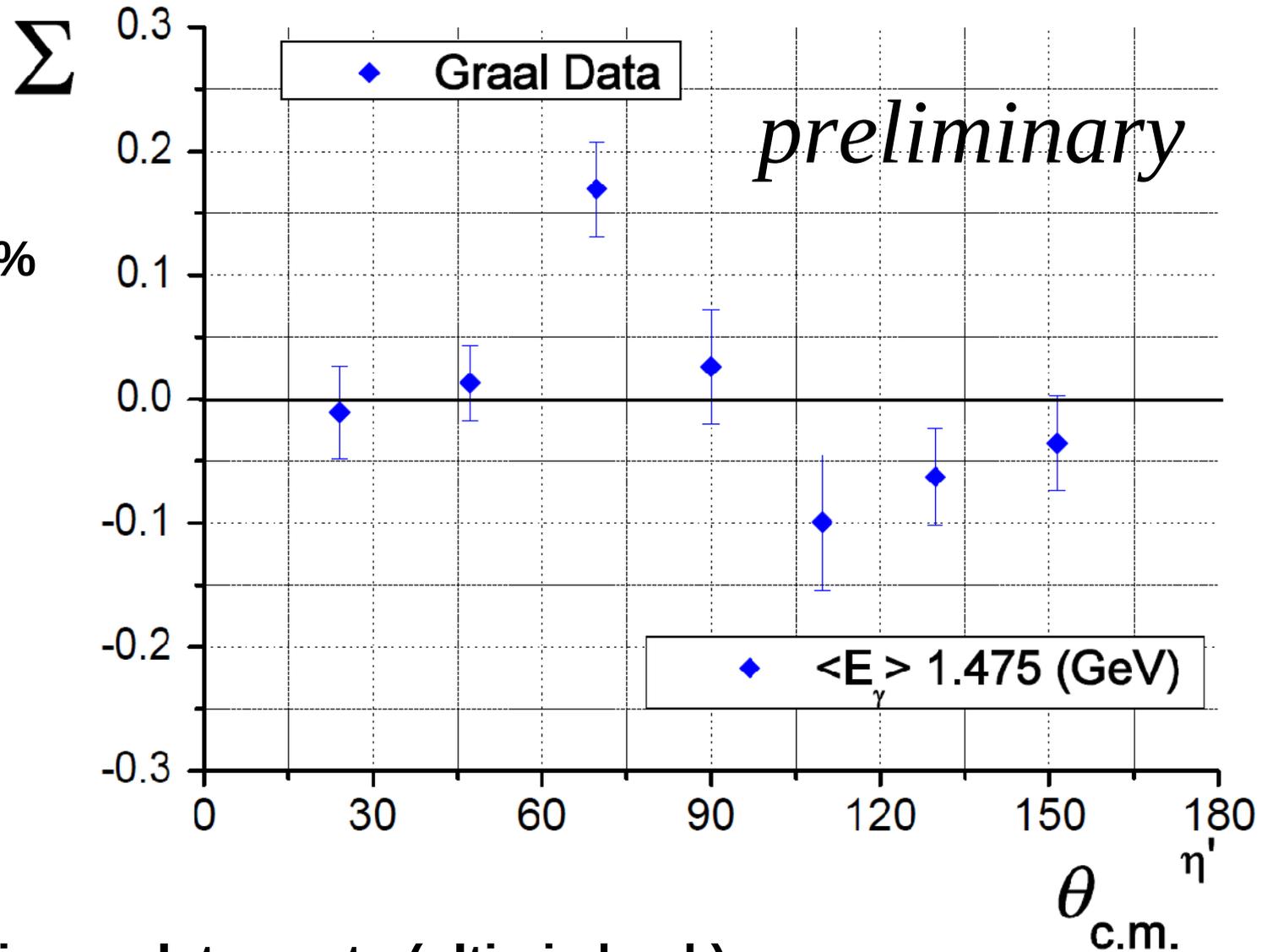
**Associated Strangeness Photoproduction with
the BGO-OD**

**RATE A
for $K^+\Lambda$**

\Rightarrow V. presentazione A. Fantini/G.Mandaglio

Asimmetrie di fascio $\gamma p \rightarrow \eta' p$ (GRAAL)

Background < 2%
Software Sys. ~ 1 %



Lavoro in corso di completamento (ultimi check).
Scrittura dell'articolo in progress.

SCHEDULE PROSSIMI MESI

(Confermato solo fino alla fine di settembre)

July 1 - 6	BGO-OD Tests & "student experiment"
July 7-14	Test Accelerator
July 15 - August 5	CB beamtime
Aug 5 – 11	Test Accelerator
August 12 - Sep 9	CB beamtime
SEP 9 -15	BGO-OD Test Beamtime
SEP 15 – 29	BGO-OD full hall access → Intervento tecnico Nobili/Colilli/Vitali/Iannilli
Sep 30 - Oct 21	CB beamtime
Oct 21 – 27	BGO-OD Test Beamtime
Oct 28 – Nov 17	BGO-OD full hall access → Intervento tecnico Nobili/Colilli/Giuliani? Intervento tecnico Messi/Vitali(Iannilli)?
Nov 18 - Dec 15	BGO-OD First Production Run

Richieste straordinarie

ISS - Consumo – 3KE	⇒ Accettata
LNF - Consumo - 3KE	⇒ Accettata
RM2 - Riparazioni e Manutenzione - 1KE	⇒ Accettata
PV - Inventario – 4KE	⇒ Da rimandare
PV - Inventario – 3.5KE	⇒ Da rimandare

CONCLUSIONI

- Buona parte dei rivelatori necessari è stata costruita e testata su fascio
- Alcuni ritardi sul rivelatore di tagging (recuperabili entro la fine dell'anno)
- Bersaglio, BGO, barrel sono stati testati e continuano ad essere usati in ogni test, confermando la buona ricostruzione della massa invariante di due fotoni nella BGO e l'identificazione di particelle cariche.
- Alcuni ritardi sul muro di TOF (danneggiato dall'incendio)
- Comincia a essere testato il software di ricostruzione e tracciamento delle particelle cariche in avanti.
- Test a settembre, ottobre e nov-dic.
- Interventi tecnici a settembre e novembre

**GRAZIE
DELL'ATTENZIONE!**

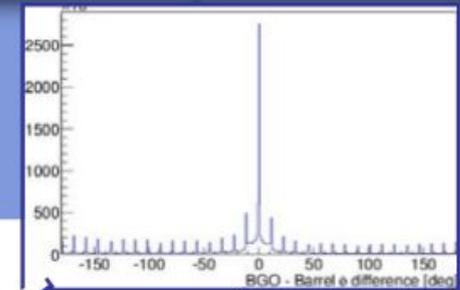
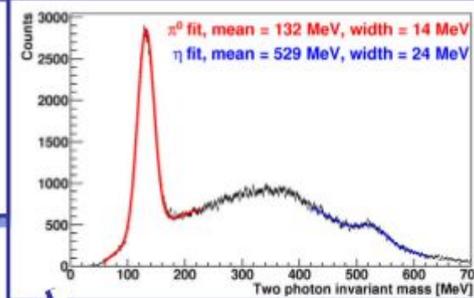
TRASPARENZE DI BACKUP

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Central region and tagger system

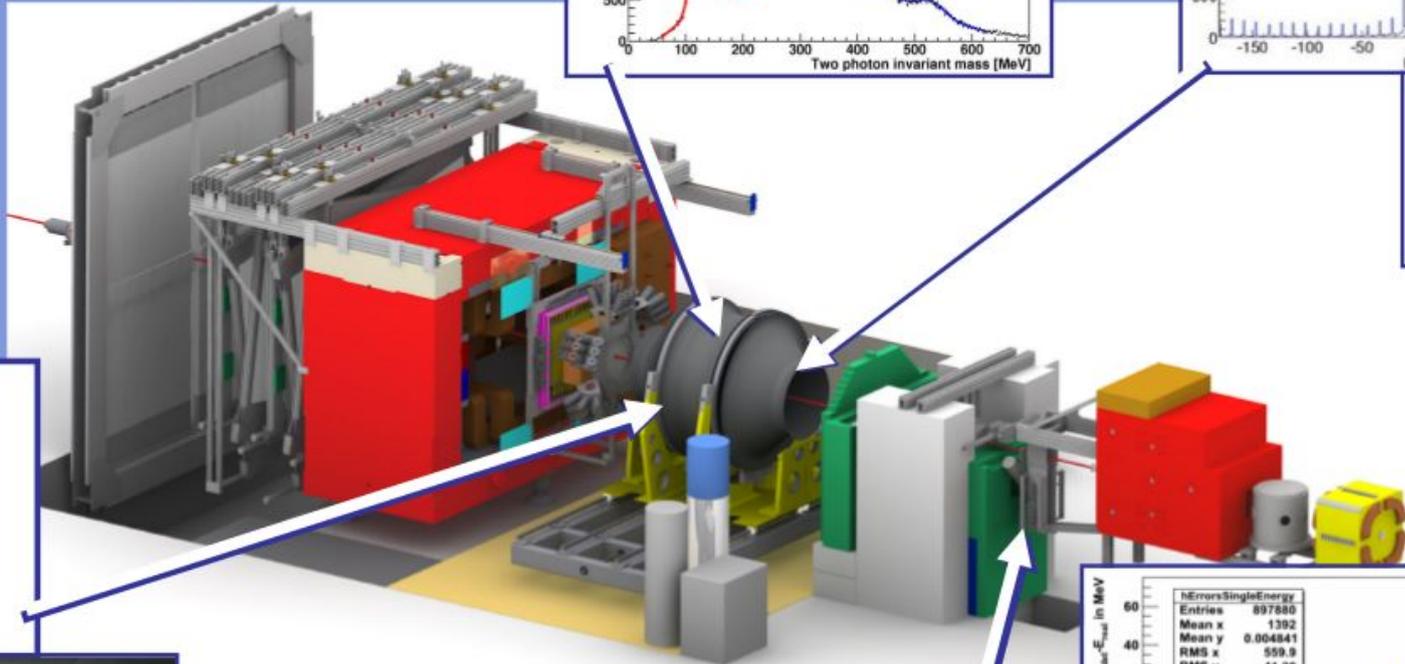
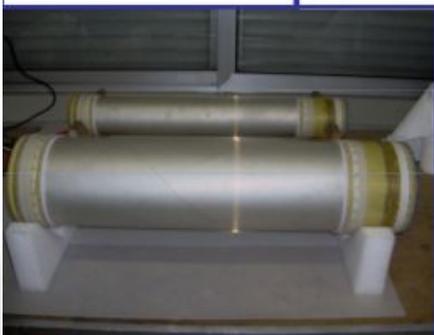
$\text{Bi}_4\text{Ge}_3\text{O}_{12}$
= Bismuth germanate

BGO calorimeter
480 crystals, $0.9 \times 4\pi$
 $\theta_{\text{lab}} = 25^\circ \dots 155^\circ$,
trigger logic, sADC



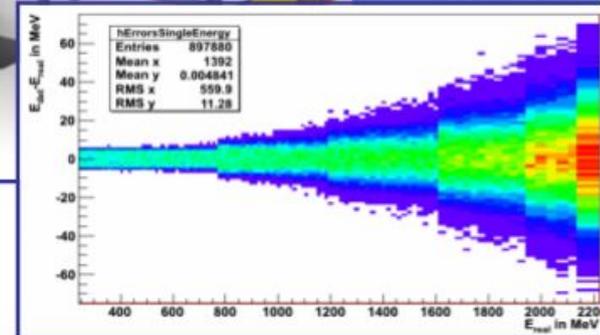
32 strip
scintillator
Barrel,
charge id

MWPC
inner tracking
2 layers,
 $\theta_{\text{lab}} = 8^\circ \dots 163^\circ$,
 $\Delta\phi = 2^\circ$,
 $\Delta z = 300\mu\text{m}$



Target system
 LH_2 , LD_2

Tagging system
120 scintillator bars,
 $10\% \dots 90\% E_{\text{beam}}$



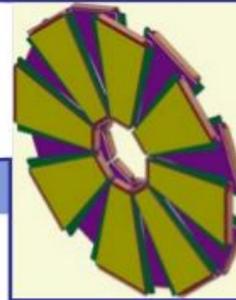
KHuK Jahrestagung – → tools for lin. and circ. pol. beams in preparation

Forward region

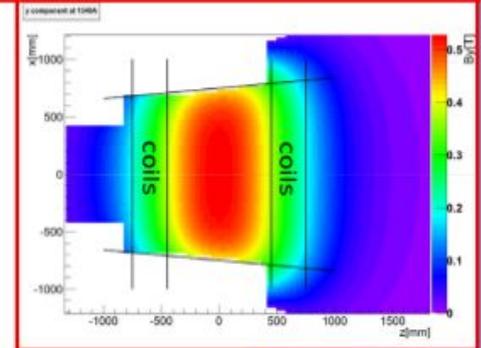


ToF, ~3m x 3m,
2 walls ~500ps
1 wall ~250ps

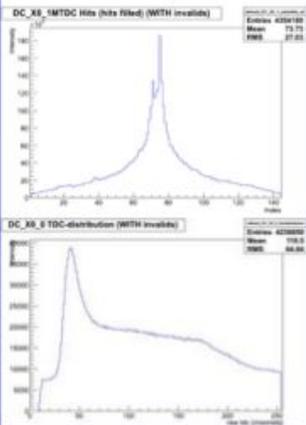
MRPC, 480ch
 $\theta_{lab} = 8^\circ - 25^\circ$,
(1cm², 50ps)



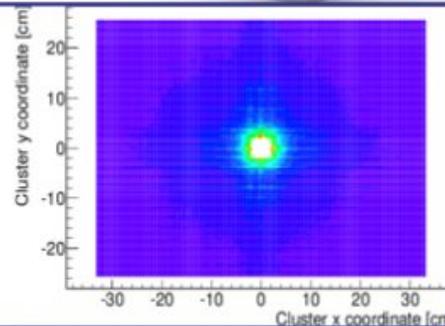
Open Dipole magnet, 94 t,
2.2 x 3.9 x 1.5 m³, $B_{max} \approx 0.5$ T,
permanent loan from DESY
field map measured at GSI



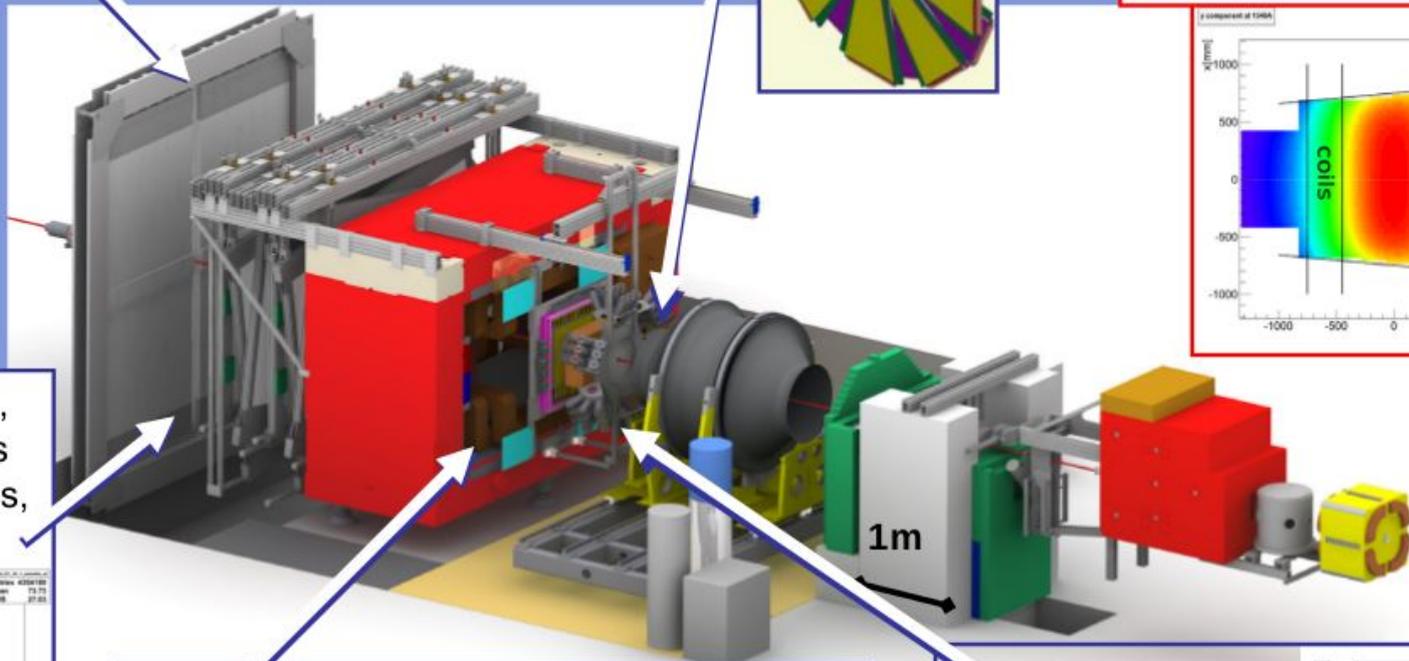
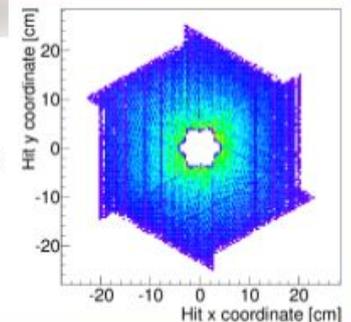
Drift chambers,
8 double layers
in 4 orientations,
res. $\approx 300 \mu\text{m}$



SciFi2 detector,
640 scint. fibres,
 $\varnothing_f = 3$ mm,
66 x 51 cm²
v- & h-plane



MOMO,
672 scint. fibres,
 $\varnothing_f = 2.5$ mm, $\varnothing 44$ cm
3 layers, 6 mod.

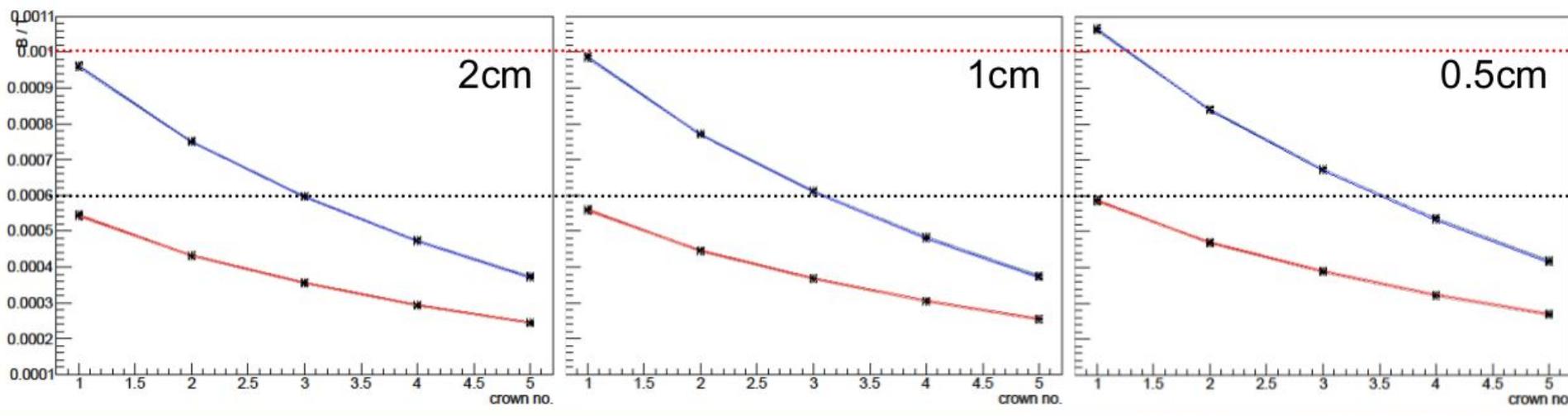
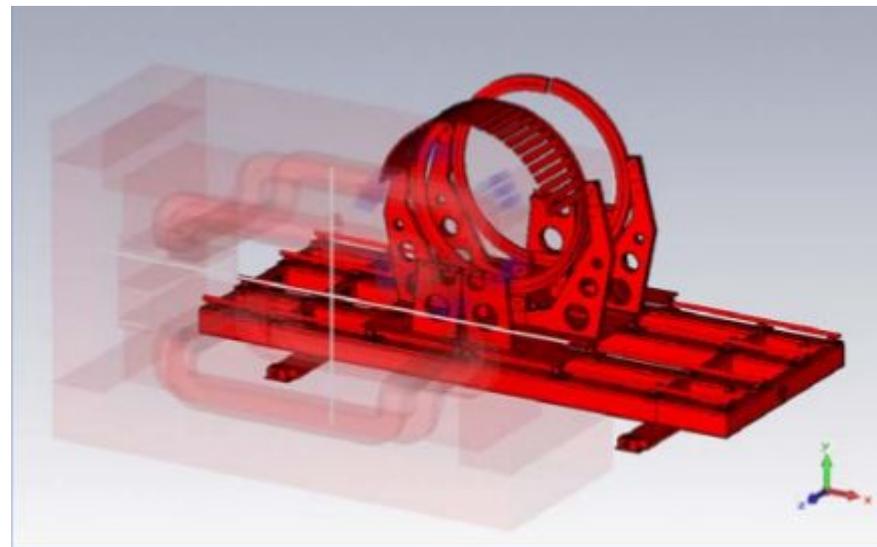


1m

Studiati vari spessori delle barre

Simulation@I = 1340 A
with Magnet, Scifi2, Momo, BGO (iron parts)

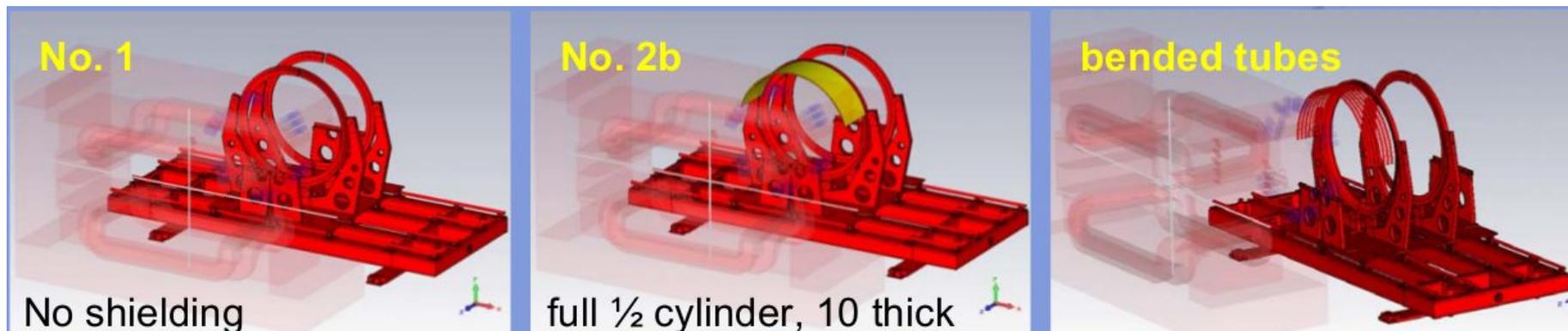
24 bars
5cm x 50cm
thickness: 2cm, 1cm, 0.5cm



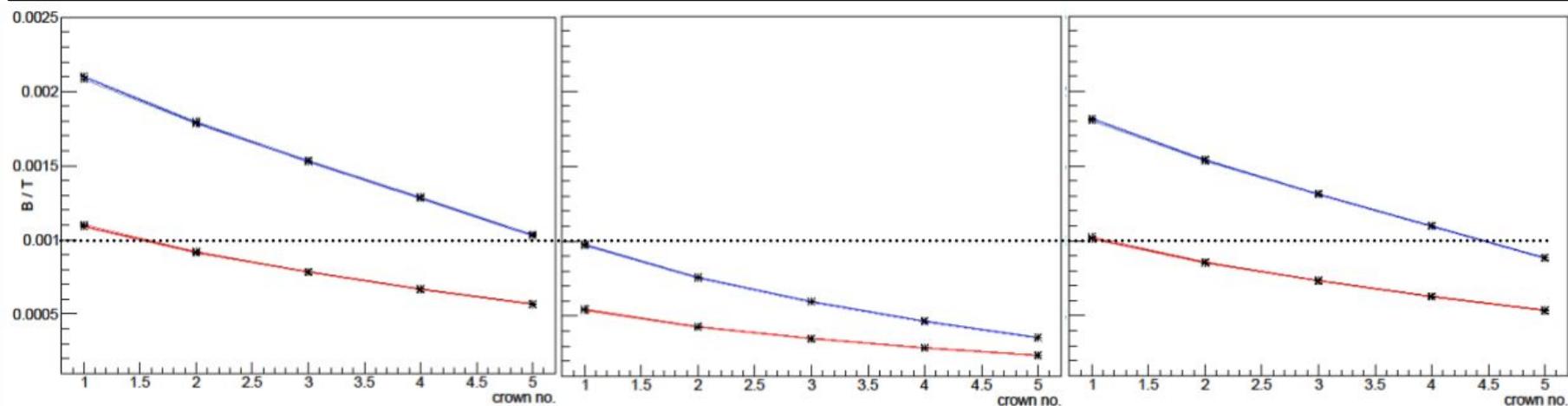
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Studiate altre soluzioni possibili, più stabili meccanicamente

Simulation@I = 1340 A with Magnet, Scifi2, Momo, BGO (iron parts)



Valori del campo per 3 cristalli dell'emisfero superiore (blu) e inferiore (rossa) in fz. di θ

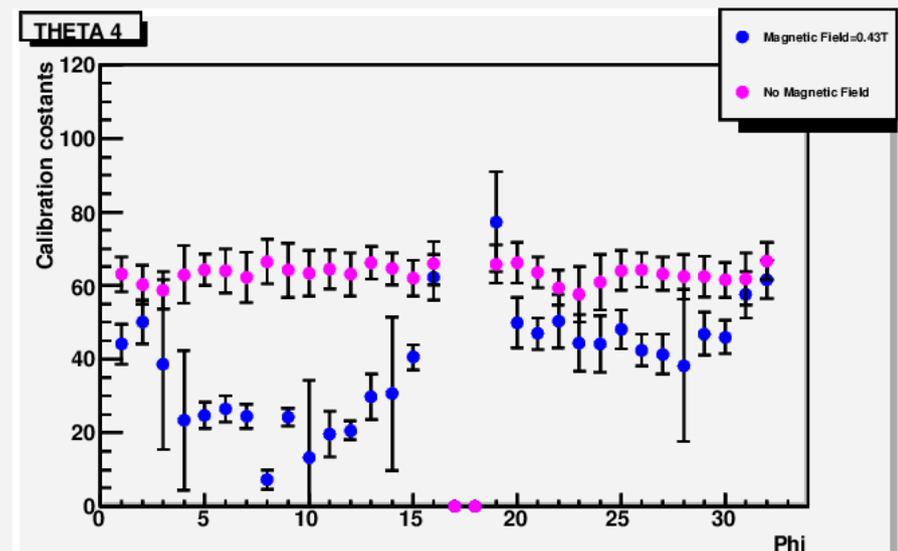
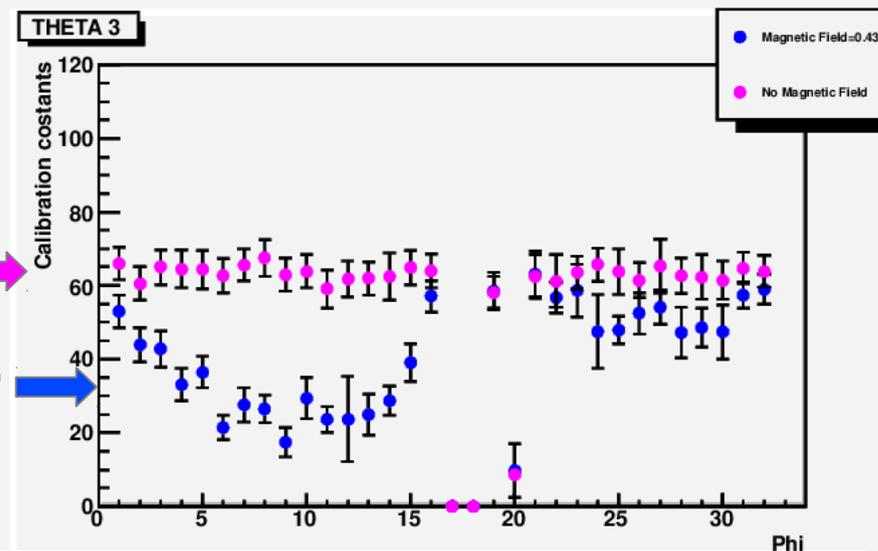
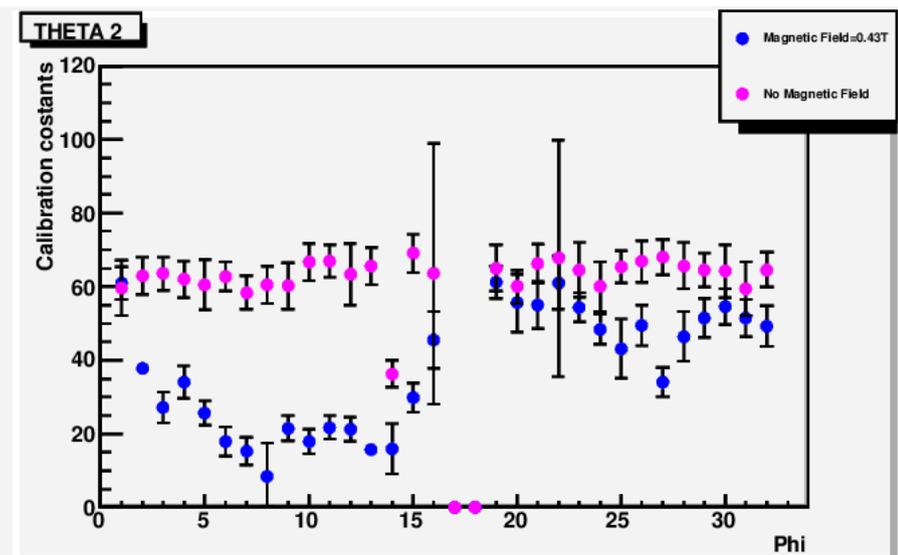
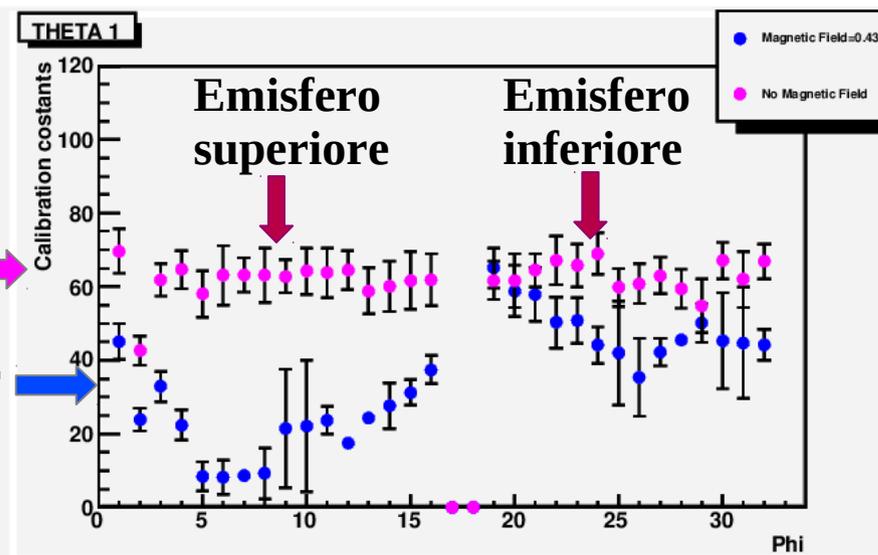


La soluzione con i tubi curvi, più stabile meccanicamente, non produce risultati soddisfacenti.

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⇒ Tests con il campo magnetico alla max. intensità (0.43T) per vedere se i cristalli dell'emisfero inferiore possono essere calibrati (perchè lo schermo porterà i cristalli dell'emisfero superiore a una situazione analoga)

Valore delle costanti di calibrazione vs. Angolo azimuthale ϕ nelle prime 4 corone



No field →
Field@0.43T →

No field →
Field@0.43T →

SPETTRI DI SORGENTE – RISPOSTA AL CAMPO MAGNETICO (0.43T)

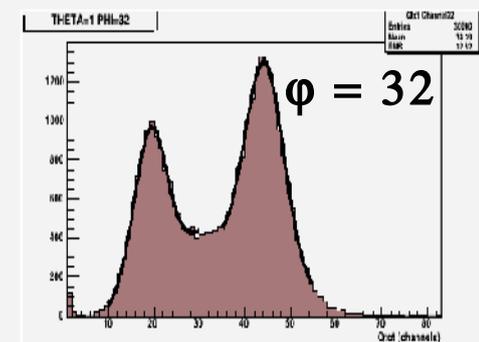
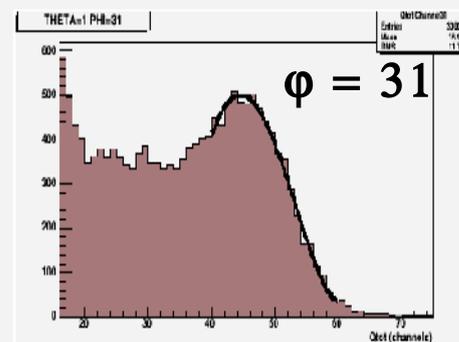
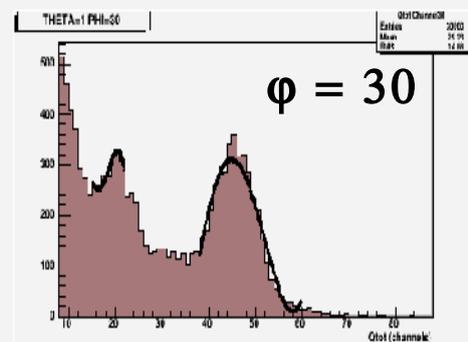
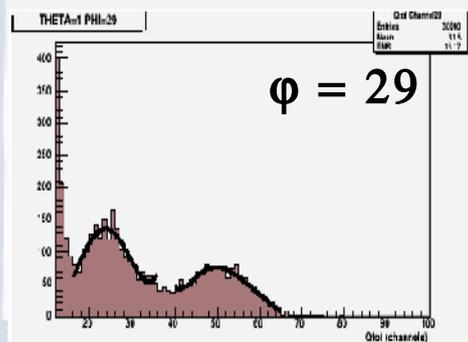
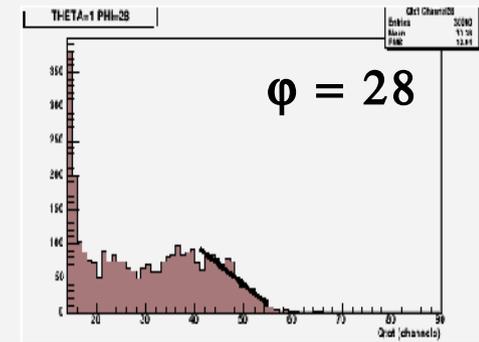
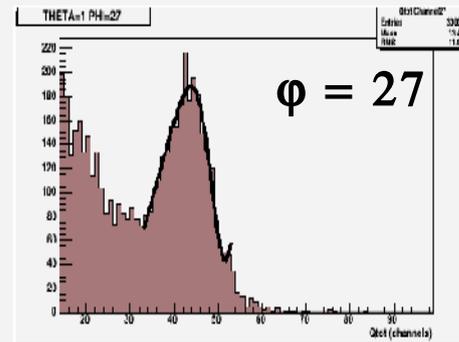
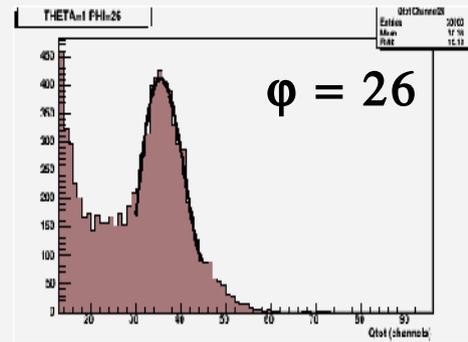
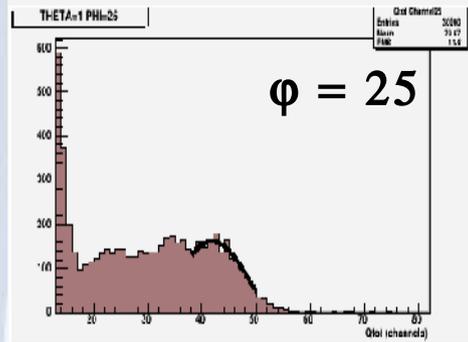
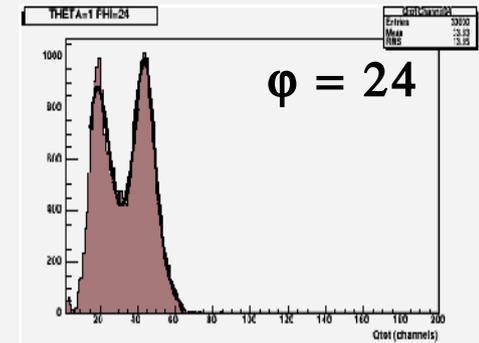
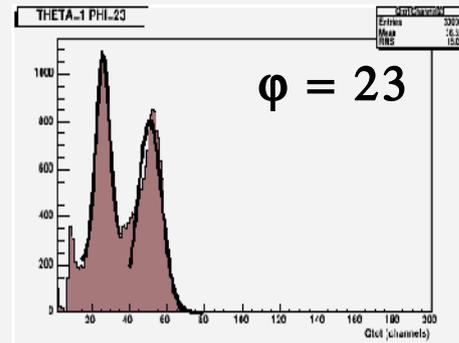
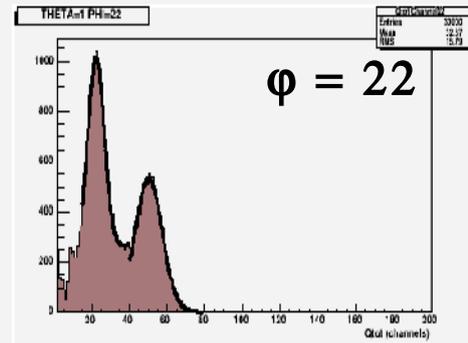
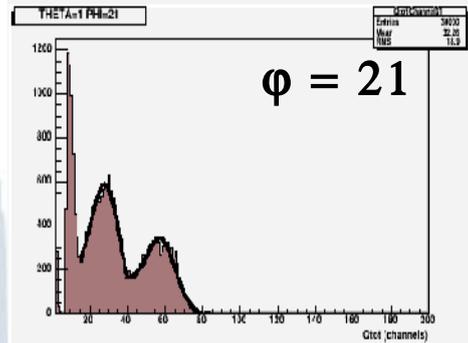
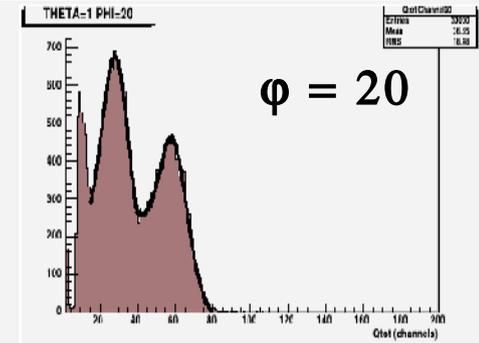
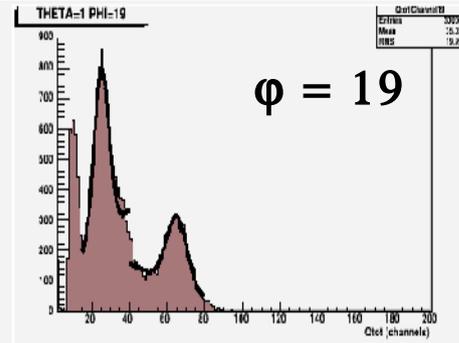
$\theta = 1$

Corona più vicina al dipolo

Emisfero inferiore

I cristalli possono essere calibrati

⇒ Soluzione di schermo accettabile



BGO- CALIBRATION CONSTANT CORRECTIONS

Due to the finite integration window, only a fraction of the signal is acquired.

$$Q_{\text{TOT}}^{\text{MEAS}} = R Q_{\text{TOT}}^{\text{TRUE}}$$

Calibration constants must be corrected because different integration windows are used for calibration and acquisition:

$$c.c.^{\text{MEAS}} = \frac{1.275 \text{ MeV}}{Q_{\text{TOT}}^{\text{MEAS,CAL}}}$$

$$Q_{\text{TOT}}^{\text{MEAS,CAL}} = R_{\text{CAL}} Q_{\text{TOT}}^{\text{TRUE,CAL}}$$

$$c.c.^{\text{CORR}} = \frac{1.275 \text{ MeV}}{Q_{\text{TOT}}^{\text{TRUE,CAL}}} = \frac{1.275 \text{ MeV}}{Q_{\text{TOT}}^{\text{MEAS,CAL}}} * R_{\text{CAL}} = c.c.^{\text{MEAS}} * R_{\text{CAL}}$$

$$Q_{\text{TOT}}^{\text{TRUE,ACQ}} = \frac{Q_{\text{TOT}}^{\text{MEAS,ACQ}}}{R_{\text{ACQ}}}$$

$$c.c.^{\text{CORR WIND}} = c.c.^{\text{MEAS}} * \frac{R_{\text{CAL}}}{R_{\text{ACQ}}}$$

CALIBRATION CONSTANT CORRECTIONS

$$E^{\text{TRUE,ACQ}} = c.c.^{\text{CORR}} * Q_{\text{TOT}}^{\text{TRUE,ACQ}} = c.c.^{\text{CORR}} * \frac{Q_{\text{TOT}}^{\text{MEAS,ACQ}}}{R_{\text{ACQ}}} = c.c.^{\text{MEAS}} * R_{\text{CAL}} * \frac{Q_{\text{TOT}}^{\text{MEAS,ACQ}}}{R_{\text{ACQ}}} =$$

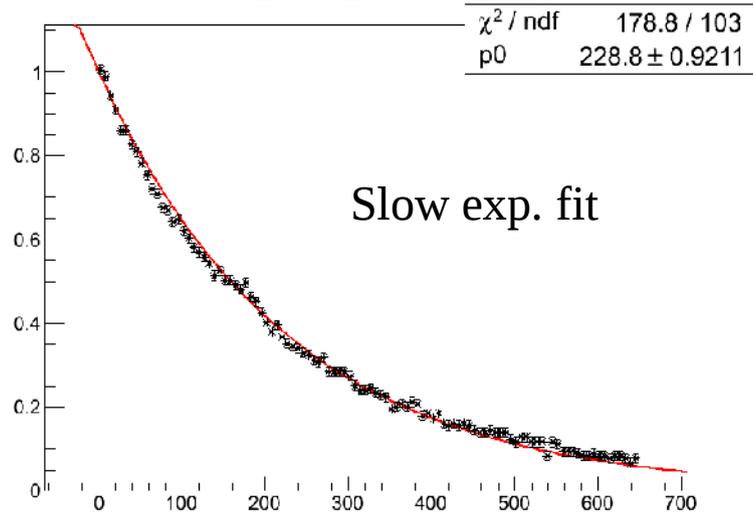
$$\frac{1.275 \text{ MeV}}{Q_{\text{TOT}}^{\text{MEAS,CAL}}} * \frac{R_{\text{CAL}}}{R_{\text{ACQ}}} * Q_{\text{TOT}}^{\text{MEAS,ACQ}} = c.c.^{\text{CORR}} * Q_{\text{TOT}}^{\text{MEAS,ACQ}}$$

N.B. In order to measure the percentage of signal acquired in a window, it is necessary to make assumptions about the shape of the signal (one simple exponential or two exponentials, slow and fast)

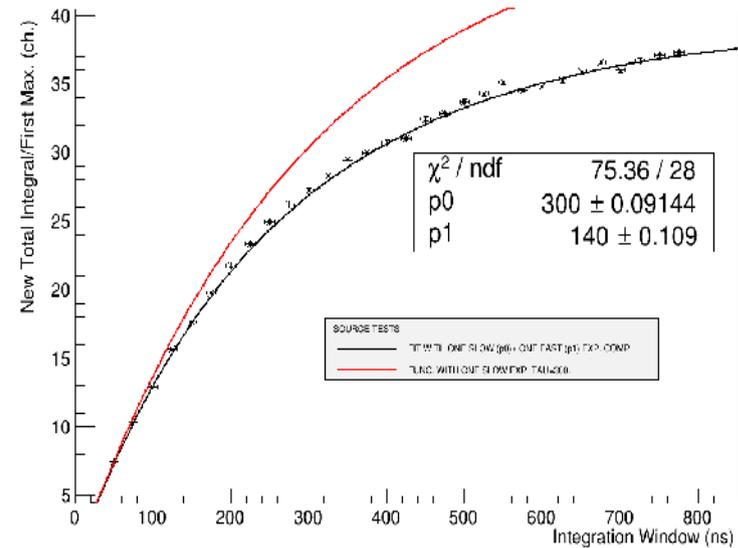
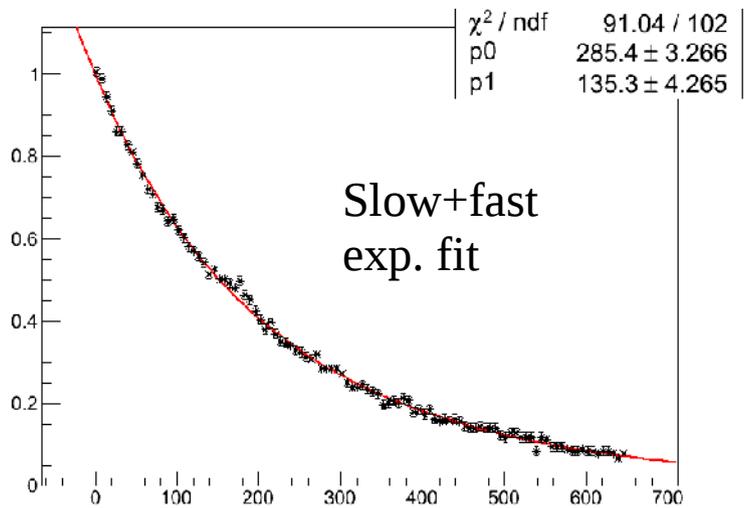
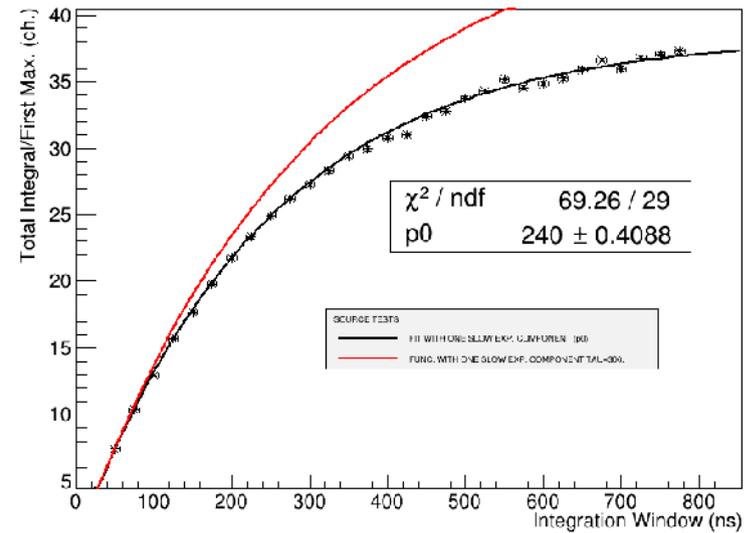
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SINGLE OR DOUBLE EXP. FIT OF THE SAMPLED BGO SIGNAL

SIGNAL TIME SAMPLING



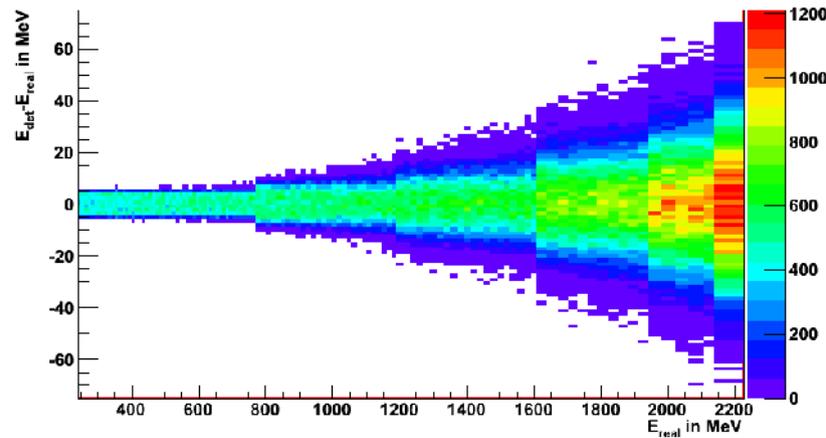
QTOT/FIRST_MAX vs. WINDOW LENGTH



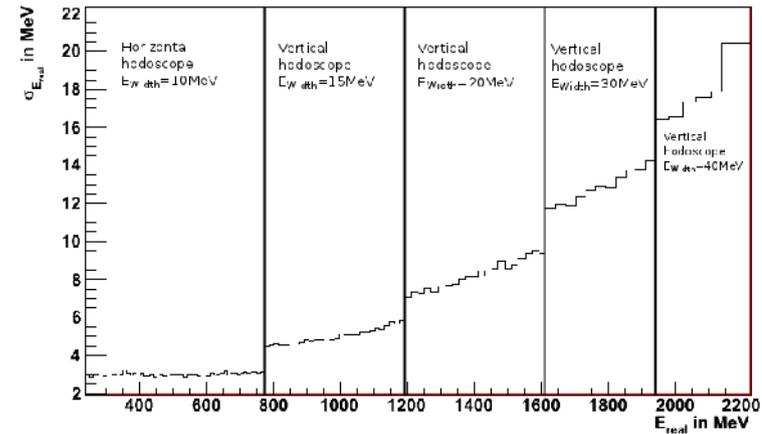
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TAGGER ENERGY RESOLUTION

b) single event energy difference



d) RMS absolute



Energy range	10% E_0	32% E_0	32% E_0	49% E_0	49% E_0	67% E_0	67% E_0	81% E_0	81% E_0	90% E_0
Energy width	0.4% E_0	0.6% E_0	0.6% E_0	0.8% E_0	0.8% E_0	1.3% E_0	1.3% E_0	1.7% E_0	1.7% E_0	1.7% E_0
$E_0 = 2400$ MeV										
Energy range	240 MeV	768 MeV	768 MeV	1176 MeV	1176 MeV	1608 MeV	1608 MeV	1944 MeV	1944 MeV	2160 MeV
Energy width	10 MeV	15 MeV	15 MeV	20 MeV	20 MeV	30 MeV	30 MeV	40 MeV	40 MeV	40 MeV

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Il nuovo rivelatore di Tagging non copriva bene la regione dell' η

Particle identification with the BGO ball

- Photon tagger & BGO cluster analysis for $\gamma p \rightarrow p\pi^0$ (V. Vegna, Preliminary, experimental data)

