

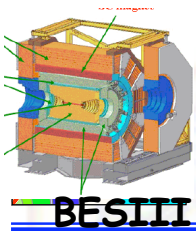
Status di BESIII

M.Anelli ,R. Baldini Ferroli, M.Bertani, A. Calcaterra, Y.Wang, A. Zallo, (LNF)
S. Pacetti (PG)

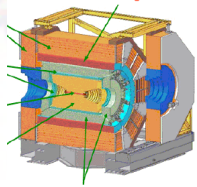
M. Destefanis, M. Greco, L. Fava, M. Maggiora, S. Spataro (TO)



Torino, CSN1, 24 settembre 2012



OUTLINE



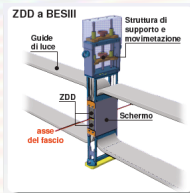
Status di BESIII



Risultati sperimentali



Attività` del gruppo italiano



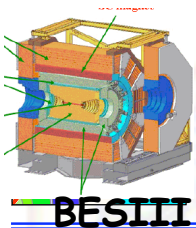
ZDD: status e upgrade



Stato del calcolo a Torino (M.Maggiore)



Richieste per il 2013 (referee)



Attività BESIII Italia

NEWS:

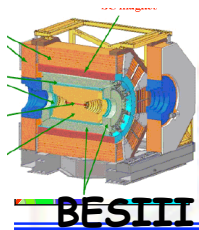
- a giugno è stato siglato accordo di collaborazione tra INFN e IHEP per la ricerca scientifica e la formazione dei giovani
- inoltrate (e approvate!) a INFN richieste al Ministero Affari Esteri per fondi di progetto di grande rilevanza scientifica e di mobilità nell'ambito della collaborazione Italia-Cina
- a LNF borsa di studio post doc (1-2 anni) per stranieri: dott Yadi Wang arrivata a Frascati il 2 settembre

LNF: M.Anelli, R. Baldini Ferroli, M.Bertani, A. Calcaterra, Y.Wang, A. Zallo (2-→3FTE)

PG: S. Pacetti (0.3% su DTZ)

TO: M. Destefanis, M. Greco, L. Fava, M. Maggiora, S. Spataro (2.3 FTE)
dal 2013 responsabilità nazionale a M.Maggiora

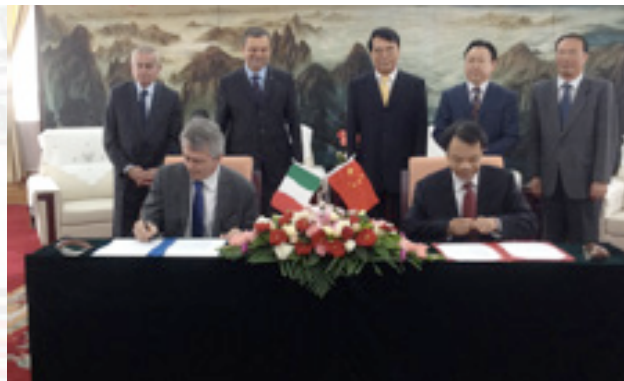
- ZDD: status e upgrade
- analisi dati: $J/\psi \rightarrow n\bar{n}, p\bar{p}$ (pubblicato PRD86 (5) 032014)
 $\psi', \psi'' \rightarrow n\bar{n}, p\bar{p}$ (in corso)
 J/ψ scan per misura fase appena iniziata
 $e^+e^- \rightarrow n\bar{n}$ scan bassa energia in programma
- upgrade di BESIII: proposta da LNF camera interna cilindrica a GEM
 - per il 2013 richieste s.j. per costruzione e test piccolo prototipo
- Farm di calcolo e proposta di nodi GRID- da inserire nel tier1 di Torino



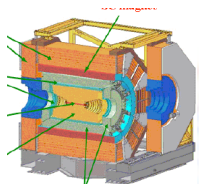
IHEP-INFN

FIRMATO L'ACCORDO DI PECHINO

Lunedì 18 Giugno 2012 10:00



E' stato firmato nella mattina del 18 giugno a Pechino - la notte tra domenica e lunedì in Italia - l'accordo tra l'INFN e l'Istituto cinese per le alte energie (IHEP) per la realizzazione di una collaborazione tra le due strutture di ricerca scientifica. L'accordo - che è stato firmato nell'ambito del viaggio del ministro Profumo in Cina - riguarda sia la ricerca che la formazione dei giovani. In particolare, l'insieme delle collaborazioni tra INFN e IHEP si configurerà come un vero e proprio istituto di ricerca virtuale unificato.



BESIII



Ministero degli Affari Esteri

Grande Rilevanza

PAESE: REPUBBLICA POPOLARE CINESE

Area tematica: Fisica

Identificativo ***

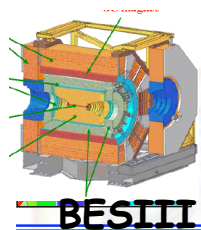
Elementi generali

Area di ricerca: Fisica delle Alte Energie
Titolo (In Italiano): Costruzione di un prototipo di rivelatore di tracce cariche di forma cilindrica con tecnica GEM (Gas Electron Multiplier) e lettura analogica dei dati
Titolo (In altra lingua): Construction of a cylindrical-shaped prototype of charged track detector employing the GEM technique with analogic readout
Parola chiave #1: Rivelatore particelle cariche
Parola chiave #2: Tecnica GEM
Parola chiave #3: Elettronica analogica

Ente proponente italiano

Struttura : Istituto Nazionale di Fisica Nucleare (INFN)
Dip./Ist.: Laboratori Nazionali di Frascati
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C.A.P.: 00044
Città : Frascati
Telefono : +39 0694031
Fax : +39 0694032582
Ente pubblico : sì, dip. Da Ministero della Istruzione, Università e Ricerca
Codice fiscale : 84001850589
Partita IVA
IBAN :
Banca :

approvato INFN, da inoltrare al MAE



Mobilità

ITALIA

Applied Basic Sciences (Chemistry, Mathematics and Physics)

Identificativo ***

Elementi generali

Area di ricerca

Applied Basic Sciences (Chemistry, Mathematics and Physics)

Titolo (in Italiano)

Valutazione sperimentale della fase tra interazioni forti ed elettromagnetiche

Titolo (in altra lingua)

Experimental study of the phase between strong and electromagnetic interactions

Parola chiave #1

interazioni elettromagnetiche

Parola chiave #2

interazioni forti

Parola chiave #3

charmonio

Ente proponente italiano

Struttura

Istituto Nazionale di Fisica Nucleare

Dip./Ist.

Sezione di Torino

Indirizzo

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Città

TORINO

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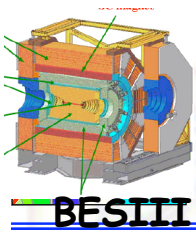
+39-011-6699579

Ente pubblico

si

Codice fiscale

84001850589



BESIII timeline

- Luglio 2008: prime collisioni e^+e^- in BESIII
- Nov 2008: $\sim 14\text{M}$ $\psi(2\text{S})$ eventi per calibrazione
- 2009: **106M $\psi(2\text{S})$** **4xCLEOc**
 225M J/ψ **4xBESII**
- 2010-11: **2.9 fb^{-1} $\psi(3770)$** **3.5xCLEOc**
- 2011: **0.5 fb^{-1} @4.01GeV** (D_s , XYZ)
- 2012: **0.4B $\psi(2\text{S})$**
 J/ψ : 1B eventi, lineshape,
 - scan sottosoglia per misura della fase relativa ampiezze e.m e forte, richieste dalla collab italiana, $14\text{pb}^{-1}/\text{pto}$, tot 5 punti
 - R scan @ **2.4, 2.8, 3.4 GeV**
- luminosita` di picco raggiunta: **$6.5 \times 10^{32} \text{ cm}^{-2}\text{s}^{-1}$ @ 3770MeV**

*il piu` grande set di
 J/ψ , $\psi(2\text{S})$ $\psi(3770)$
al mondo*

prossimo run: dicembre 2012 - giugno 2013
luminosita` prevista: **$7\text{-}8 \times 10^{32} \text{ cm}^{-2}\text{s}^{-1}$ @ 3770MeV**
 $E_{\text{cm}}=4.26, 4.36$ (spettroscopia XYZ)
 $\psi(3770)$, τ scan, R scan

Risultati pubblicati

χ_{cJ} decays and transitions

- 1) Search for hadronic transition $\chi_{cJ} \rightarrow \eta_c \pi^+ \pi^-$ and observation of $\chi_{cJ} \rightarrow K \bar{K} \pi \pi$. [arXiv:1208.4805]
- 2) Measurement of χ_{cJ} decaying into $p \bar{n} \pi^-$ and $p \bar{n} \pi^- \pi^0$. [arXiv:1208.3721]
- 3) Observation of χ_{cJ} Decays to $\Lambda \bar{\Lambda} \pi^+ \pi^-$. PRD86, 052004 (2012)
- 4) Two-photon widths of the $\chi_{c0,2}$ states and helicity analysis for $\chi_{c2} \rightarrow \gamma \gamma$. PRD85, 112008 (2012)
- 5) Observation of χ_{c1} decays into vector meson pairs $\phi \phi$, $\omega \omega$, and $\omega \phi$. PRL107, 092001 (2011)
- 6) Study of χ_{cJ} radiative decays into a vector meson. PRD83, 112005 (2011)
- 7) First Observation of the Decays $\chi_{cJ} \rightarrow \pi^0 \pi^0 \pi^0 \pi^0$. PRD83, 012006 (2011)

Studies of η , η' , $\eta(1405)$, η_c and η_c' mesons

- 8) Search for η and η' Invisible Decays in $J/\psi \rightarrow \phi \eta$ and $\phi \eta'$. [arXiv.1209.2469]
- 9) Observation of $e^+ e^- \rightarrow \eta J/\psi$ at center-of-mass energy $s^{1/2} = 4.009$ GeV. [arXiv.1208.1857]
- 10) Evidence for $\eta_c \rightarrow \gamma \gamma$ and Measurement of $J/\psi \rightarrow 3 \gamma$. [arXiv.1208.1461]
- 11) First observation of $\eta(1405)$ decays into $f^0(980) \pi^0$. PRL108, 182001 (2012)
- 12) Measurements of the mass and width of the η_c using $\psi' \rightarrow \gamma \eta_c$. PRL108, 222002 (2012)
- 13) Search for η_c' decays into vector meson pairs. PRD84, 091102 (2011)
- 14) $\eta \pi^+ \pi^-$ Resonant Structure around 1.8 GeV/ c^2 and $\eta(1405)$ in $J/\psi \rightarrow \omega \eta \pi^+ \pi^-$. PRL107, 182001 (2011)
- 15) Search for CP and P violating pseudoscalar decays into $\pi \pi$. PRD84, 032006 (2011)
- 16) Measurement of the Matrix Element for the Decay $\eta' \rightarrow \eta \pi^+ \pi^-$. PRD83, 012003 (2011)

Risultati pubblicati

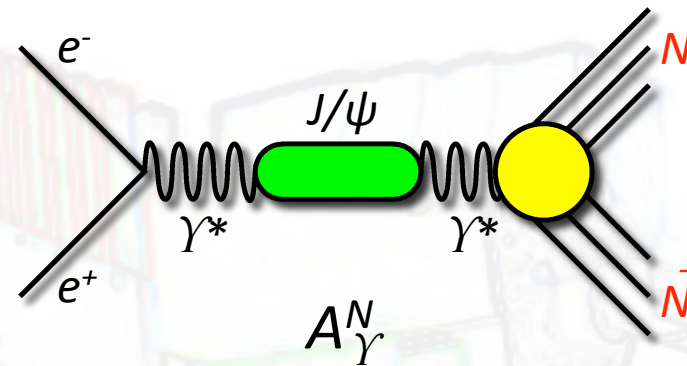
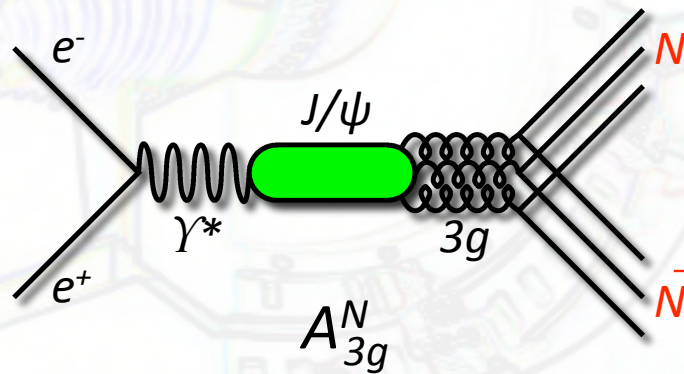
Decays of $c\bar{c}$ mesons

- 17) Measurement of χ_{cJ} decaying into $p\bar{n}\pi^-$ and $p\bar{n}\pi^-\pi^0$. [arXiv:1208.2320]
- 18) First observation of the isospin violating decay $J/\psi \rightarrow \Lambda \Sigma_0^- + c.c..$ PRD86, 032008 (2012)
- 19) Determination of the number of J/ψ events with $J/\psi \rightarrow$ inclusive decays. [arXiv:1207.2865]
- 20) First observation of the M1 transition $\psi(3686) \rightarrow \gamma \eta_c(2S)$. PRL109, 042003 (2012)
- 21) Study of $J/\psi \rightarrow p\bar{p}$ and $J/\psi \rightarrow n\bar{n}$ [arXiv:1205.1036] PRD86 (5), 032014 (2012)
- 22) Evidence for the Direct Two-Photon Transition from ψ' to J/ψ . [arXiv:1204.0246]
- 23) Precision measurement of the branching fractions of $J/\psi \rightarrow \pi^+\pi^-\pi^0$ and $\psi' \rightarrow \pi^+\pi^-\pi^0$. PLB710, 594 (2012)
- 24) Spin-Parity Analysis of $p\bar{p}$ Mass Threshold Structure in J/ψ and ψ' Radiative Decays. PRL108 112003 (2012)
- 25) Higher-order multipole amplitude measurement in $\psi(2S) \rightarrow \gamma \chi_{c2}$. PRD84, 092006 (2011)
- 26) Evidence for ψ' decays into $\gamma\pi^0$ and $\gamma\eta$. PRL105 261801 (2010)

Scalar mesons and new states

- 27) Search for a light Higgs-like boson A_0 in J/ψ radiative decays. PRD85 092012 (2012)
- 28) Study of $a_0^0(980) - f_0(980)$ mixing. PRD83, 032003 (2011)
- 29) Confirmation of the $X(1835)$ and observation of the resonances $X(2120)$ and $X(2370)$ in $J/\psi \rightarrow \gamma \pi^+\pi^-\eta'$. PRL106, 072002 (2011)

Risultati per $J/\psi \rightarrow p\bar{p}$ e $J/\psi \rightarrow n\bar{n}$



- ◆ Il canale dei tre gluoni è dominante: $|A_{3g}^N| > |A_{\gamma}^N|$
- ◆ Senza interazione elettromagnetica, la simmetria di isospin $\Rightarrow |A_{3g}^p| = |A_{3g}^n|$
- ◆ Le ampiezze EM del protone e neutrone sono opposte come i momenti magnetici
- ◆ Nell'ipotesi pQCD di ampiezze reali, il rapporto tra le frazioni di decadimento è

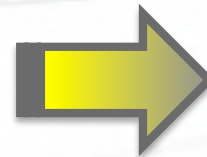
$$R = \frac{BR(J/\psi \rightarrow p\bar{p})}{BR(J/\psi \rightarrow n\bar{n})} = \left| \frac{A_{3g}^p + A_{\gamma}^p}{A_{3g}^n + A_{\gamma}^n} \right|^2 \approx 2$$

Recente risultato di BESIII

$$BR(J/\psi \rightarrow p\bar{p}) = (2.112 \pm 0.004 \pm 0.027) \times 10^{-3}$$

$$BR(J/\psi \rightarrow n\bar{n}) = (2.07 \pm 0.01 \pm 0.14) \times 10^{-3}$$

[PRD86 (5), 032014 (2012)]



$$A_{3g}^N \perp A_{\gamma}^N$$

Fase relativa $\sim 90^\circ$

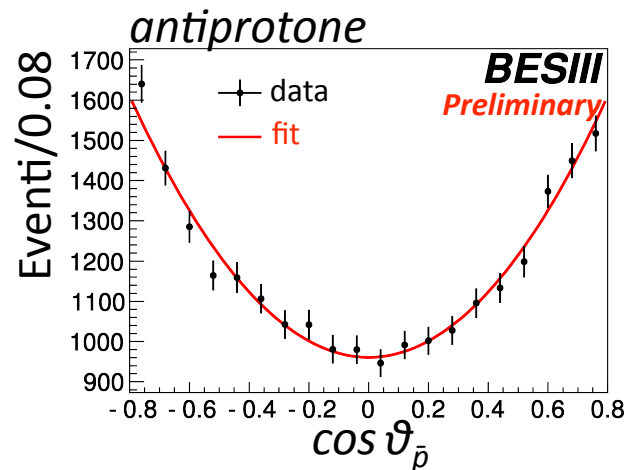
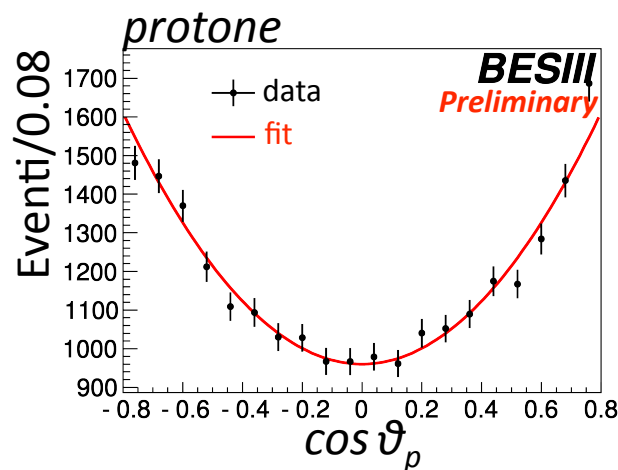
In corso ai LNF: $\psi' \rightarrow p\bar{p}$ e $\psi' \rightarrow n\bar{n}$

- ◆ La fase relativa tra B_{3g}^N e B_Y^N è consistente con zero [Suzuki, PRD63, 054021 (2001)]
- ◆ La teoria non prevede differenze tra J/ψ e $\psi' \Rightarrow B_{3g}^N \perp B_Y^N$ [Gerard, Weyers, PLB462 324 (1999)]
- ◆ La distribuzione angolare nel canale $N\bar{N}$ è $\propto (1 + \alpha \cos^2 \vartheta)$
 - ✧ $\alpha = 1$ implica la conservazione dell'elicità (pQCD)
 - ✧ $\alpha < 1$ potrebbe indicare effetti di violazione di isospin [Claudson, Glashow, Wise, PRD25, 1345 (1982)]

◆ PDG: $BR(\psi' \rightarrow p\bar{p}) = (2.76 \pm 0.12) \times 10^{-4}$

◆ Il decadimento $\psi' \rightarrow n\bar{n}$ non è stato mai osservato

Distribuzioni angolari del protone e antiprotone

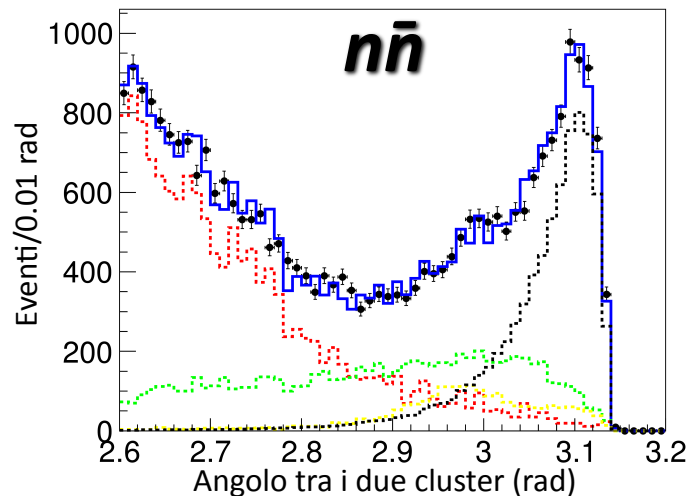


BESIII Preliminare

$BR(\psi' \rightarrow p\bar{p}) = (3.09 \pm 0.02 \pm 0.11) \times 10^{-4}$

$\alpha = 1.06 \pm 0.06 \pm 0.01$

In corso ai LNF: $\psi' \rightarrow p\bar{p}$ e $\psi' \rightarrow n\bar{n}$



Contributi del fondo

- ◆ $\psi' \rightarrow n\bar{n}$
- ◆ Continuo
- ◆ MC inclusivo
- ◆ $\psi' \rightarrow Y\chi_c, \chi_c \rightarrow n\bar{n}$ non incluso nel MC
- ◆ Totale

Molto Preliminare (stat. err. only)

$$BR(\psi' \rightarrow n\bar{n}) = (3.24 \pm 0.03) \times 10^{-4}$$

$$\frac{BR(J/\psi' \rightarrow p\bar{p})}{BR(J/\psi' \rightarrow n\bar{n})} \approx 0.95 \pm 0.11$$

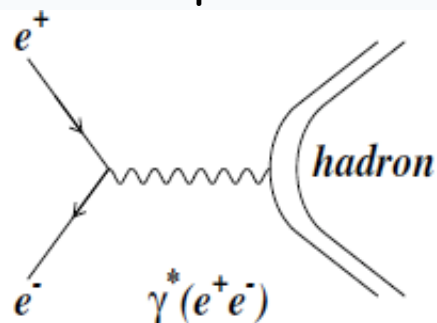
prima misura !

Uno studio preliminare di BESIII del processo $e^+e^- \rightarrow p\bar{p}$ alla massa della $\psi(3770)$ ha mostrato un inatteso fenomeno di interferenza distruttiva della stessa $\psi(3770)$ con il fondo non-risonante.

La misura di $e^+e^- \rightarrow n\bar{n}$ alla $\psi(3770)$ può confermare tale fenomeno con maggiore statistica e permette, per confronto con $e^+e^- \rightarrow p\bar{p}$, di ottenere la prima misura del fattore di forma magnetico del neutrone a $q^2 = (3.77 \text{ GeV})^2$

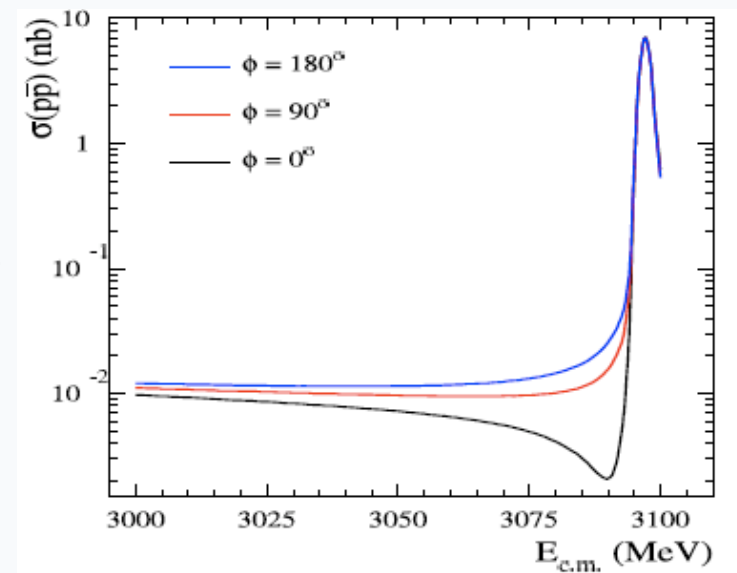
J/ψ Strong and Electromagnetic Decay Amplitudes

- If both real (pQCD), they must interfere ($\Phi_p \sim 0^\circ/180^\circ$)
- On the contrary $\Phi_p \sim 90^\circ \rightarrow$ No interference, Im strong amplitude
- $J/\psi \rightarrow NN(\frac{1}{2}^+\frac{1}{2}^-)$ $\Phi_p = 89^\circ \pm 15^\circ$ [1]; $89^\circ \pm 9^\circ$ [2]
- $J/\psi \rightarrow VP(1^-0^-)$ $\Phi_p = 106^\circ \pm 10^\circ$ [3]
- $J/\psi \rightarrow PP(0^-0^-)$ $\Phi_p = 89.6^\circ \pm 9.9^\circ$ [4]
- $J/\psi \rightarrow VV(1^-1^-)$ $\Phi_p = 138^\circ \pm 37^\circ$ [4]
- Results are model dependent
- Model independent test:
- look for interference pattern between resonant amplitude and the non resonant continuum



pQCD regime

$$A_{EM} \in \Re$$

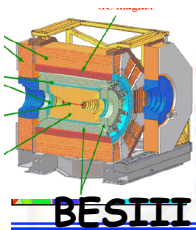


[1] R. Baldini, C. Bini, E. Luppi, Phys. Lett. B404, 362 (1997); R. Baldini et al., Phys. Lett. B444, 111 (1998)

[2] J.M. Bian et al., $J/\psi \rightarrow p\bar{p}$ and $J/\psi \rightarrow n\bar{n}$ measurement by BESIII, to be published on PRD

[3] L. Kopke and N. Wermes, Phys. Rep. 174, 67 (1989); J. Jousset et al., Phys. Rev. D41,1389 (1990).

[4] M. Suzuki et al., Phys. Rev. D60, 051501 (1999).

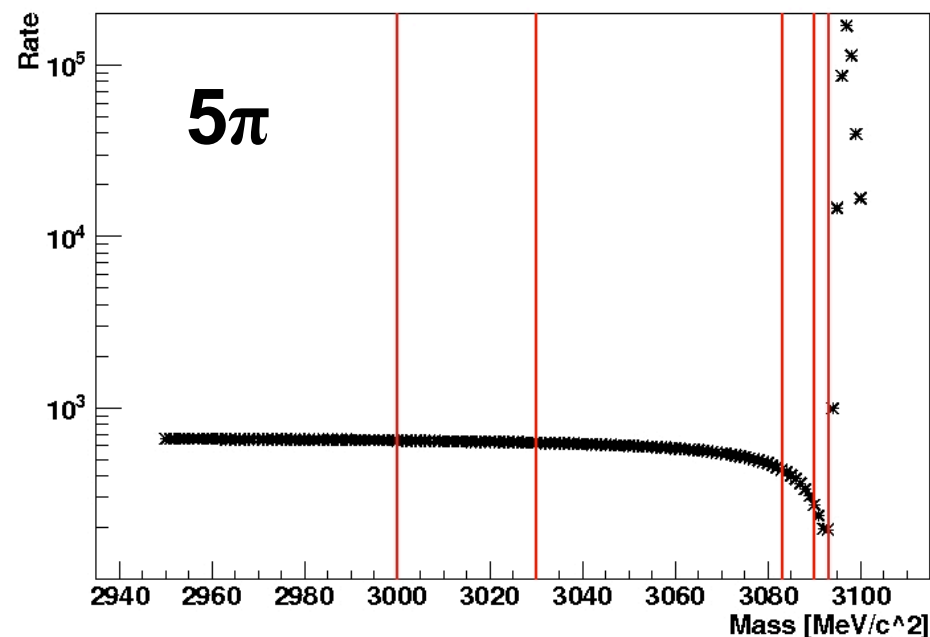


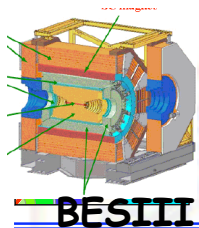
J/ψ scan: investigated processes for energy points selection

■ **Exclusive scenario:** could see interference effects

- $e^+e^- \rightarrow J/\psi \rightarrow pp, nn$ NN BR $\sim 2.17 \times 10^{-3}$ $\sigma_{\text{cont}} \sim 11 \text{ pb}$
- $e^+e^- \rightarrow J/\psi \rightarrow \rho\pi$ VP BR $\sim 1.69\%$ $\sigma_{\text{cont}} \sim 20 \text{ pb}$
- $e^+e^- \rightarrow J/\psi \rightarrow 2(\pi^+\pi^-)\pi^0$ BR $\sim 5.5\%$ $\sigma_{\text{cont}} \sim 500 \text{ pb}$

- Maximum interference: 0°
- 2 pts at low W
- fix the continuum
- fix the slope
- 2 pts at deep positions
- 1 pt Beginning of the BW

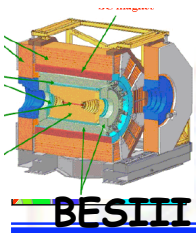




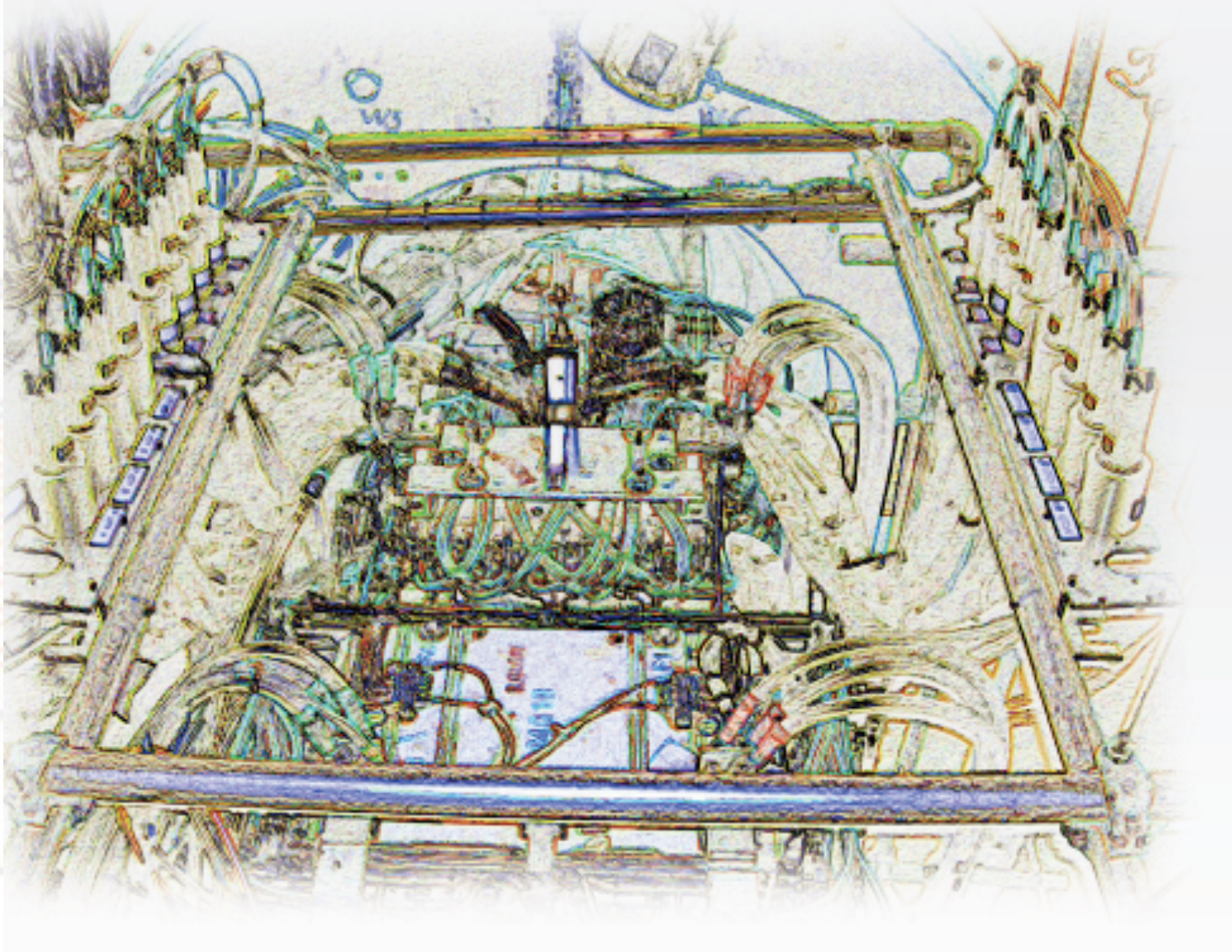
2012 data for J/ ψ phase scan

Dati raccolti a maggio 2012, appena iniziata l'analisi per la misura della fase

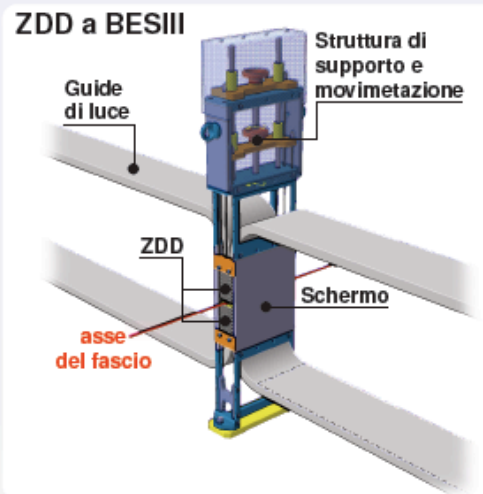
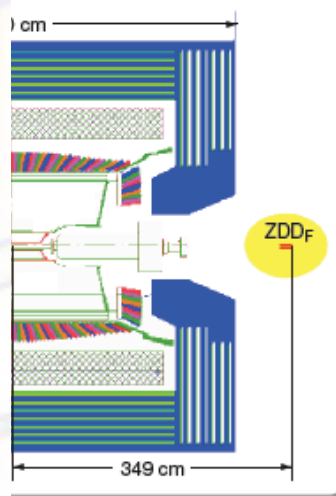
Energy requested [MeV]	Energy collected [MeV]	L_{int} [pb ⁻¹]
3050	3046	14.0
3060	3056	14.0
3083	3086	16.5
3090	3085	14.0
3093	3088	14.0
3097	3097	79.6



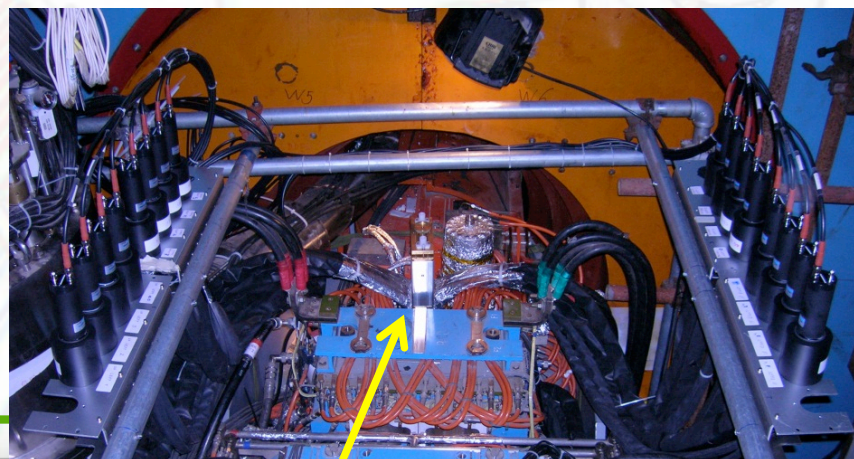
Status of ZDD at BESIII



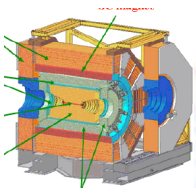
ZDD timeline e status



ZDD: Pb(40%/) Sci.Fi (60%)
 2 moduli, sopra e sotto beam pipe
 dimensioni: 14x4x6 cm³
 segnale portato ai PM da bundle di fibre in chiaro (2m)



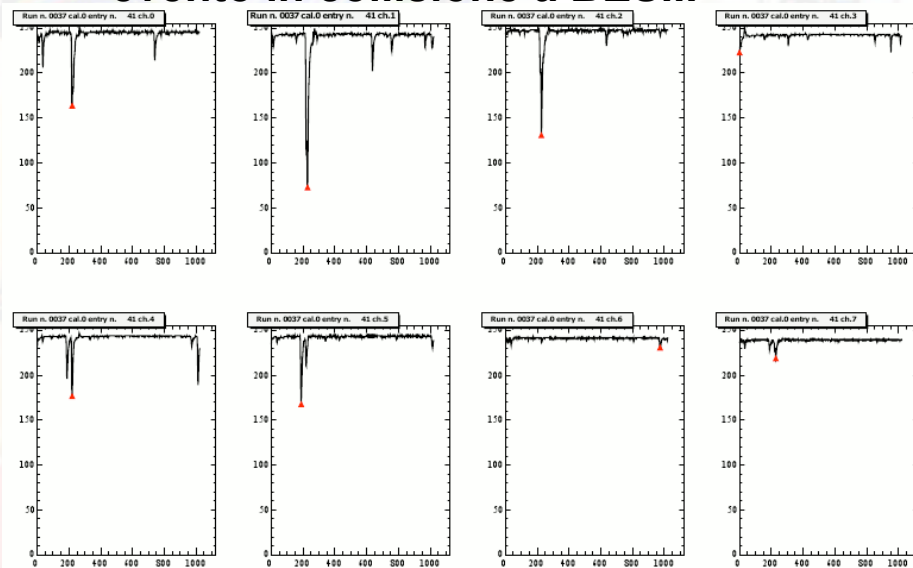
- 01-06/2011: costruzione e messa in opera della stazione ZDD a LNF
- 06-08/2011: test con raggi cosmici e BTF @ LNF: $\sigma_E/E=12.4\%$ @E=450MeV
- agosto 2011: spedizione a Pechino e installazione a BEPCII
- **2012: debugging con cosmici e dati on-line @ BEPCII**
 - ha funzionato come luminometro
 - presa dati stand-alone su PC dedicato con trigger L1 di BESIII
 - problemi hardware/firmware CAEN FADC e risoluzioni
 - attualmente nelle mani del gruppo online di BESIII per inserimento nel DAQ generale



BESIII

2011-2012 ZDD data taking I

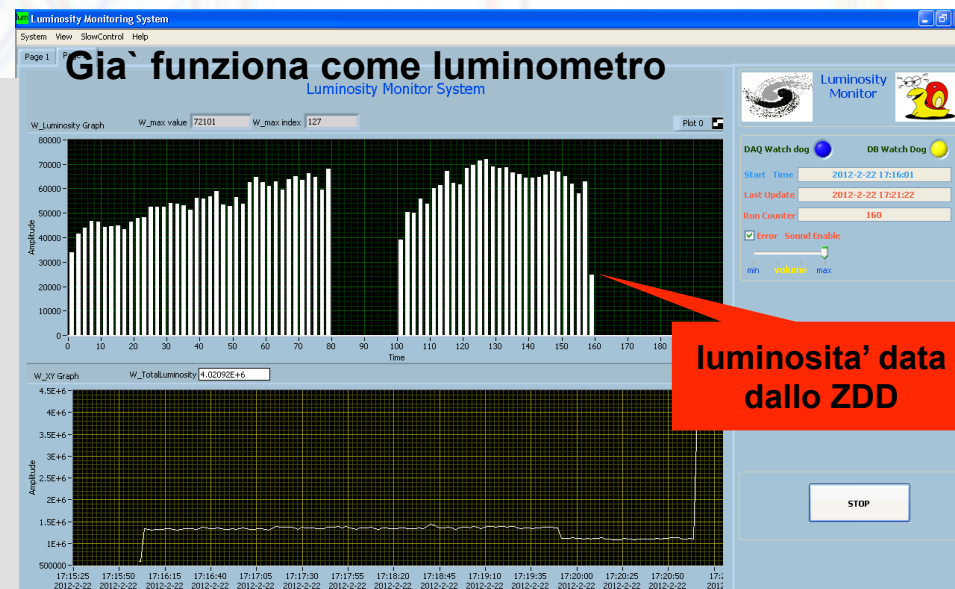
evento in collisione a BESIII

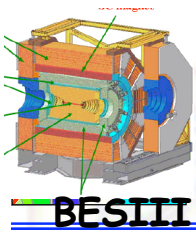


- ZDD ha acquisito dati con trigger L1 di BESIII in modo automatico e contemporaneamente a BESIII
- DAQ separato, su PC con DAQ asincrona dal trigger L1 che il PC non poteva vedere
- Ogni run di BESIII ha il suo corrispettivo run dello ZDD con lo stesso numero
- Ma a livello di singolo evento la correlazione BESIII/ZDD è molto ardua: lo ZDD perde circa 0.5% di eventi rispetto a BESIII

PERCHE' PERSI I TRIGGER ?

- Tutti i trigger L1 di BESIII (LVPECL) inviati allo ZDD dopo conv. a NIM in (vecchio) hardware NIM
- Colli di bottiglia nella lettura (USB), DAQ sul PC con priorità generica, → pipe fillup nei moduli, risolto da passaggio a BESIII DAQ
- Faults nell'hardware NIM (?): fatte board VME LNF (SELF) per la conversione e distribuzione del trigger
- si sta costruendo anche board di amplificazione e shaper per passare a crate VME → no crate NIM





Preparazione ZDD per run 2012-2013

Perchè DAQ separato in 2011-2012?

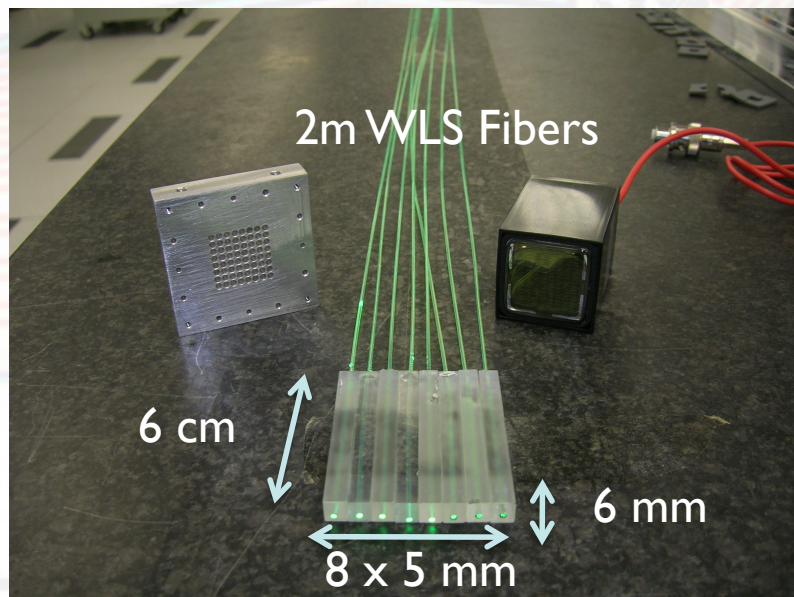
- Mancanza di tempo:
 - ZDD installato agosto 2010, con ripartenza prevista a novembre
 - Test in cosmici settembre ottobre: hanno permesso di verificare l'hardware e di capire come usare il FlashADC: necessità di usare il controller CAEN ed il PC
 - Problemi di firmware su FADC CAEN V1721 risolti nei mesi successivi
- BESIII-DAQ disposto a integrare il V1721, ma solo dietro nostra ricetta “completa”: disponibile ora, dopo “pratica” durante le collisioni

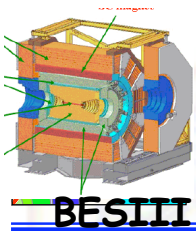
Lavori in corso per ZDD in DAQ globale

- moduli amplificazione/shaper per passaggio FEE NIM->VME
- Il gruppo DAQ di BESIII ha preso in carico l'inserimento dello ZDD in collaborazione con Sandro
 - Necessari 2 circuiti ausiliari di conversione dei segnali di trigger (CHK e FULL) da commissionare a SELF (URGENTE: richiesta aggiuntiva 2012)
 - interazione LNF e gruppo DAQ IHEP per far funzionare il tutto
- Due giovani cinesi per la manutenzione dello ZDD a IHEP !

Upgrade ZDD

- Upgrade del sistema ZDD in corso con materiale di recupero nei laboratori e materiale precedentemente acquistato: tracciatore sottile di strip di scintillatore lette da fibre shiftanti 1mm, lunghe 2m per discriminare fotoni vs e^+ da conversione sulla ciambella,
- ▶ Lettura con MAPMT, elettronica in lavorazione presso SELF (servizio elettronica Frascati)
 - ▶ determinazione del punto di impatto e^+ → correzione E ricostruita per l'energia persa nello sciame → migliore soppressione dei fondi
 - ▶ attività finanziata da DTZ, sinergia con altri gruppi (LHCb, SuperB, Gr2, BESIII)





Upgrade Camera Deriva interna

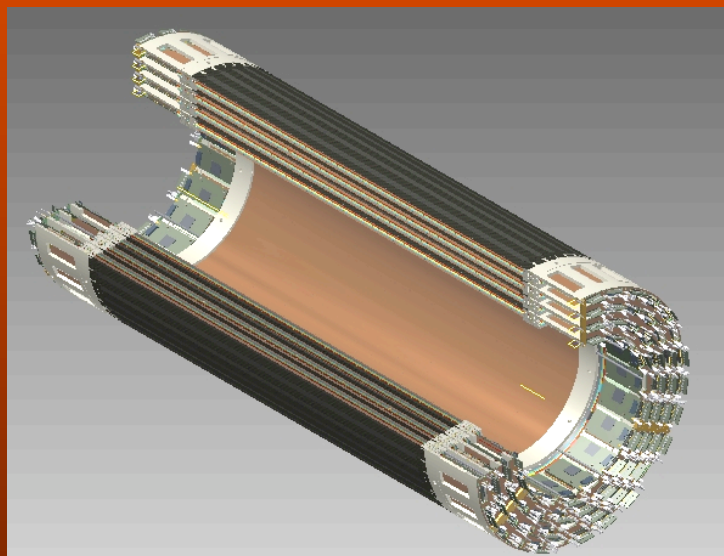
Durante ultimo run: problemi di noise e di invecchiamento della camera a deriva interna in parte migliorati con aggiunta di vapore acqueo

Prevista comunque una sostituzione della camera per i run successivi al 2013, 2 soluzioni possibili:

1. una camera a deriva analoga
2. una camera a GEM cilindrica a la KLOE-2, proposta dal gruppo LNF, da costruire in Cina (?)
 - Workshop operativo su CGEM a LNF 24-27 ottobre 2012
 - Richieste S.J. a CSN1 e ai servizi LNF per il 2013 di 3Ke per R&D su prototipo GEM piana ($10 \times 10 \text{ cm}^2$) con lettura analogica (consulenza di G.Bencivenni)
- Decisione verra` presa dalla collaborazione BESIII entro la fine dell'anno in corso

PROGRESS ON THE CGEM PROPOSAL

BESIII Italian Collaboration



16-19 September 2012, BESIII Software Meeting, Beijing

GEM detector features

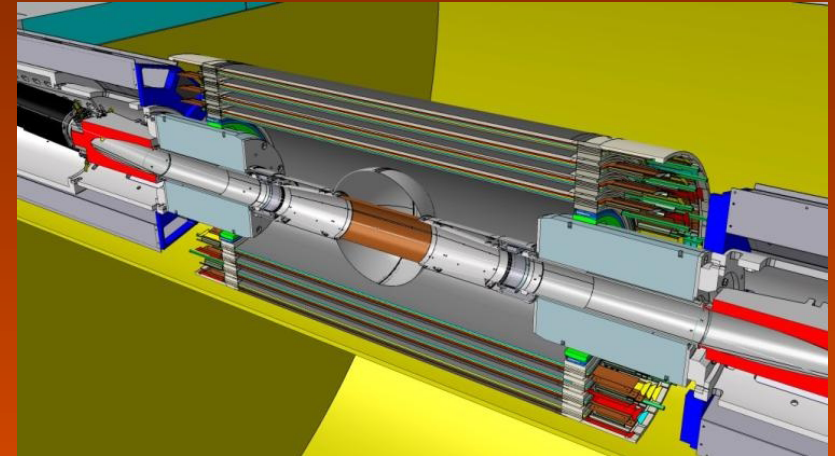
23

- ❑ **flexible geometry** → arbitrary shape: rectangular, cylindrical ...
- ❑ **ultra-light structure** → very low material budget: $<0.5\%$ X_0 /chamber
- ❑ **gas multiplication separated from readout stage** → arbitrary readout pattern: pad, strips (XY, UV), mixed ...
- ❑ **high rate capability**: >50 MHz/cm²
- ❑ **high safe gains**: $> 10^4$
- ❑ **high reliability**: low discharge, $P_d < 10^{-12}$ per incoming particle
- ❑ **rad hard**: up to 2.2 C/cm² integrated over the whole active area without permanent damages (corresponding to 10 years of operation at LHCb1)
- ❑ **high spatial resolution**: down to $60\mu\text{m}$ (COMPASS with analog readout Nucl.Phys.Proc.Suppl. 125 (2003) 368-373)
- ❑ **good time resolution**: down to 3 ns (with CF₄)

KLOE-2 Inner Tracker

To improve vertex reconstruction of K_s , η and η' and K_s - K_L interference measurements:

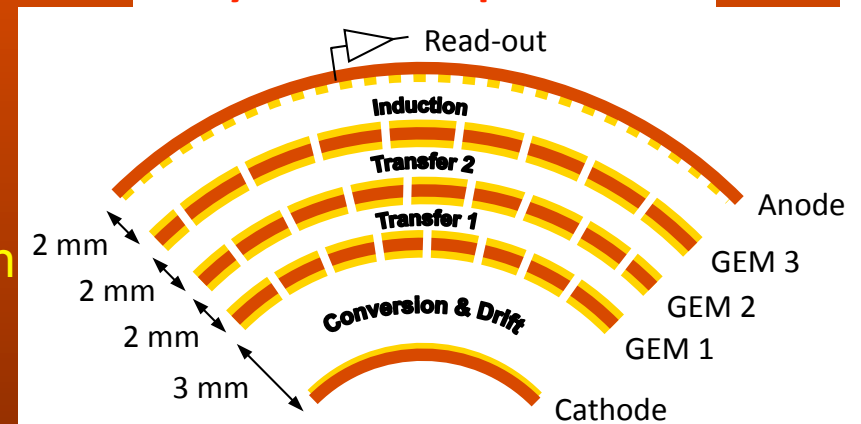
1. $\sigma_{r\phi} \sim 200 \mu\text{m}$ and $\sigma_z \sim 350 \mu\text{m}$
2. low material budget: $< 2\% X_0$



Cylindrical GEM detector is the adopted solution

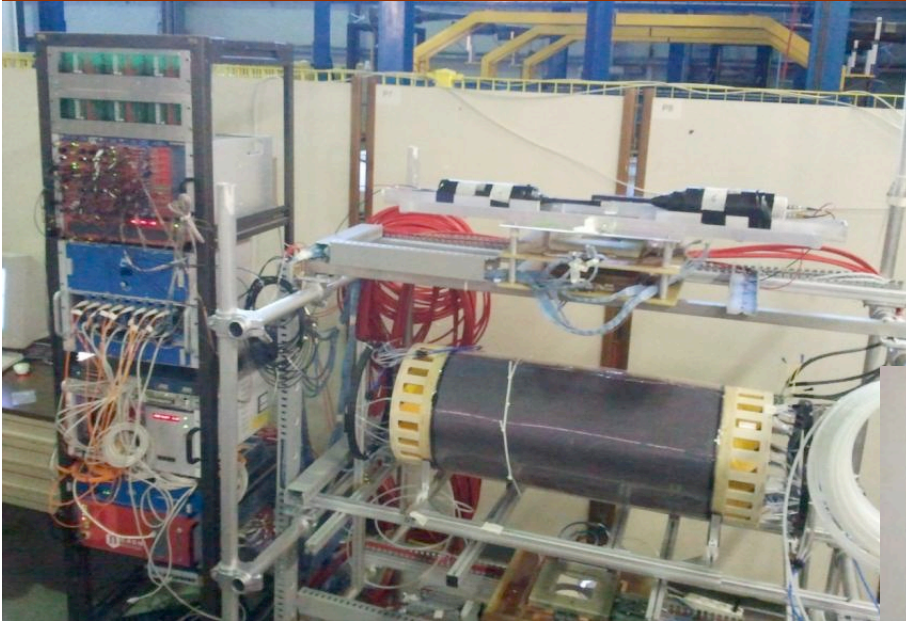
- ❑ 4 CGEM layers :from IP to DC Inner wall
- ❑ 700 mm active length
- ❑ XV strips-pads readout ($\sim 40^\circ$ stereo angle)
- ❑ $< 2\% X_0$ total radiation length in the active region

Cylindrical Triple GEM

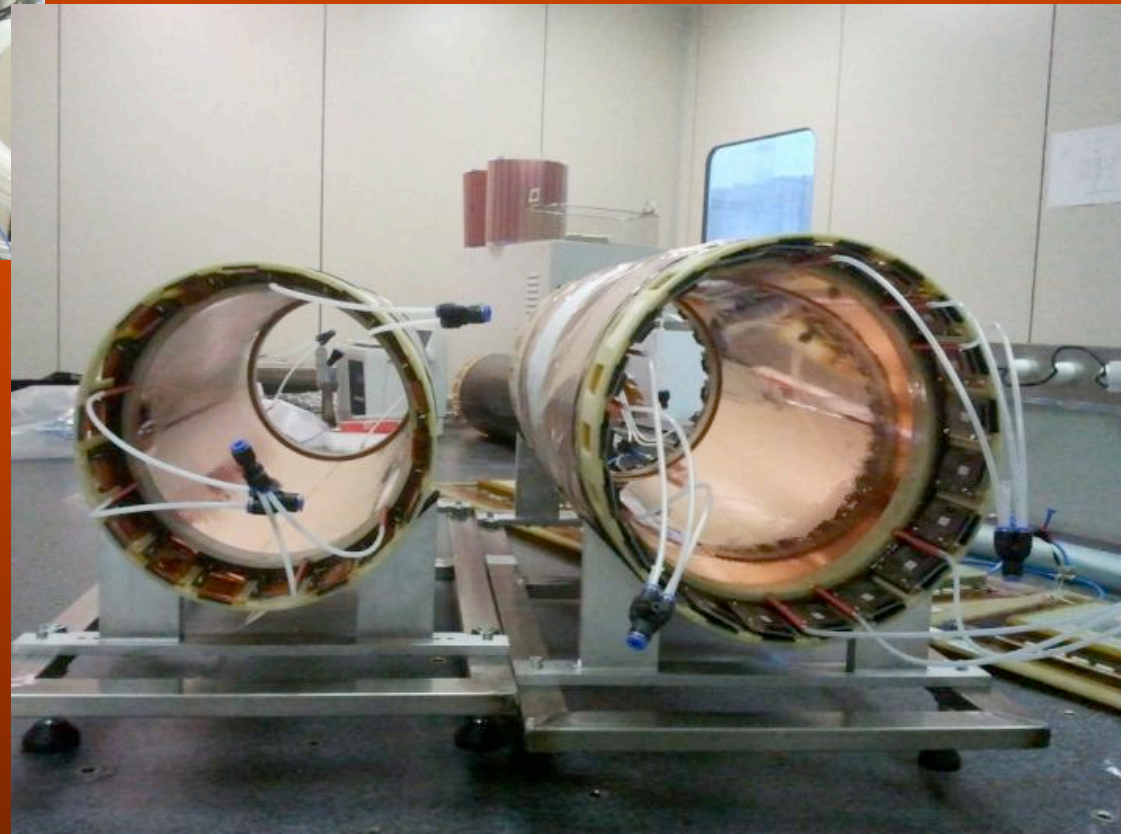


$K_s \rightarrow \pi^+ \pi^-$ vertex resolution will improve of about a factor 3 from present 6mm

Layer 1 & Layer2



The installation in KLOE is
foreseen by the end of 2012

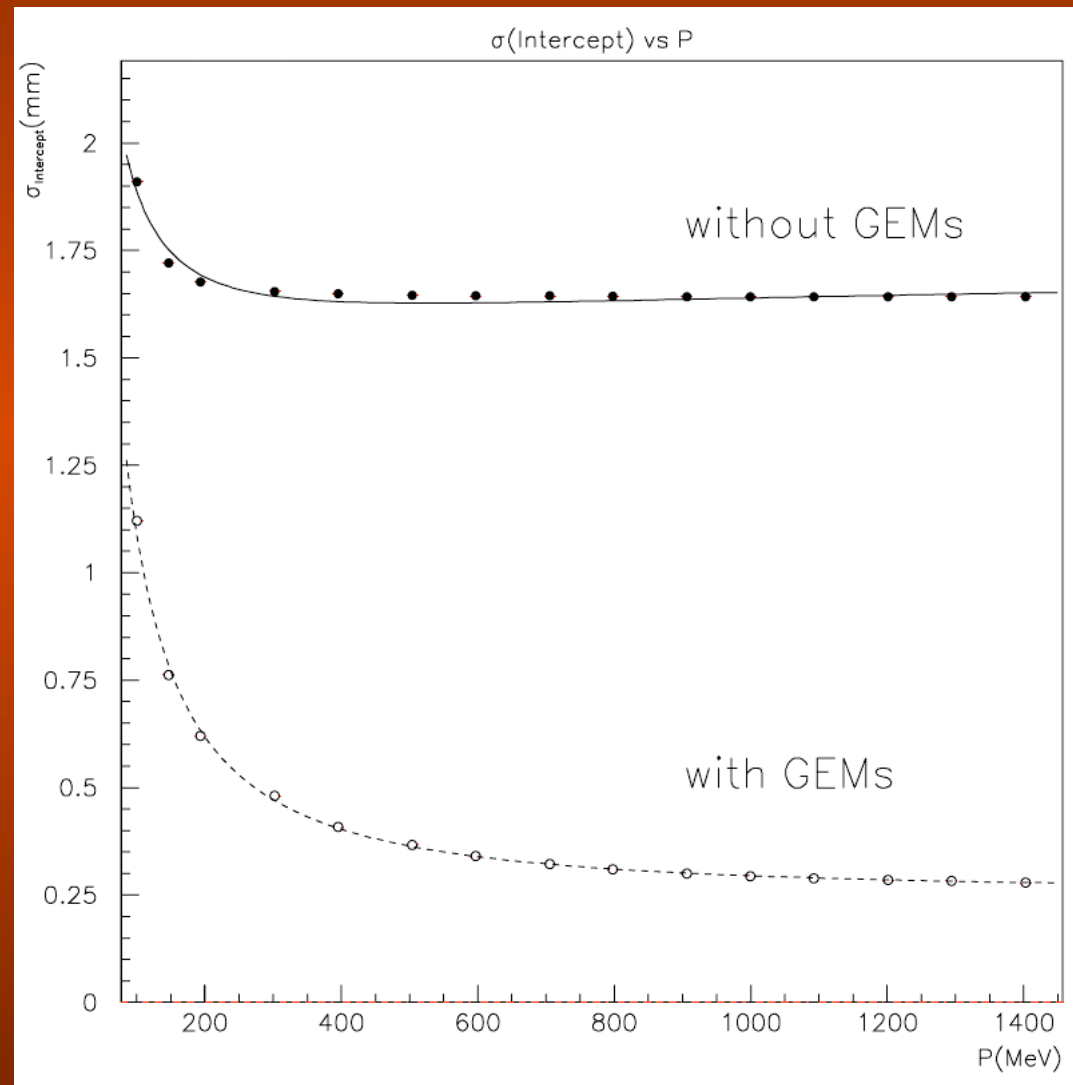


A Cylindrical_GEM at BESIII

in case a new inner chamber is needed ?

- ❑ The manufacture of a Cylindrical GEM, which fulfills many BESIII needs, is on going at LNF and will be installed in KLOE-2 by the end of this year
- ❑ BESIII inner chamber is a bit smaller:
 - ❖ makes a Cylindrical GEM easier to be built,
 - ❖ enough space to allocate 4 triple-GEM,
 - ❖ equivalent to the present 8 layers,
 - ❖ much better vertex reconstruction,
 - ❖ however, new tools (molds) are needed
 - ❖ more material (0.45 $\rightarrow$ 1.5 % X_0): P resolution under evaluation
 - ❖ Expertise from KLOE2 and CERN

Z Resolution (toy MC)



BESIII GEM

possible geometrical parameters

ayer	Int.diam (mm)	Length (mm)	Foils
1	126	N. strips ~ 12000	2
2	192		
3	258	870	2
4	324		2

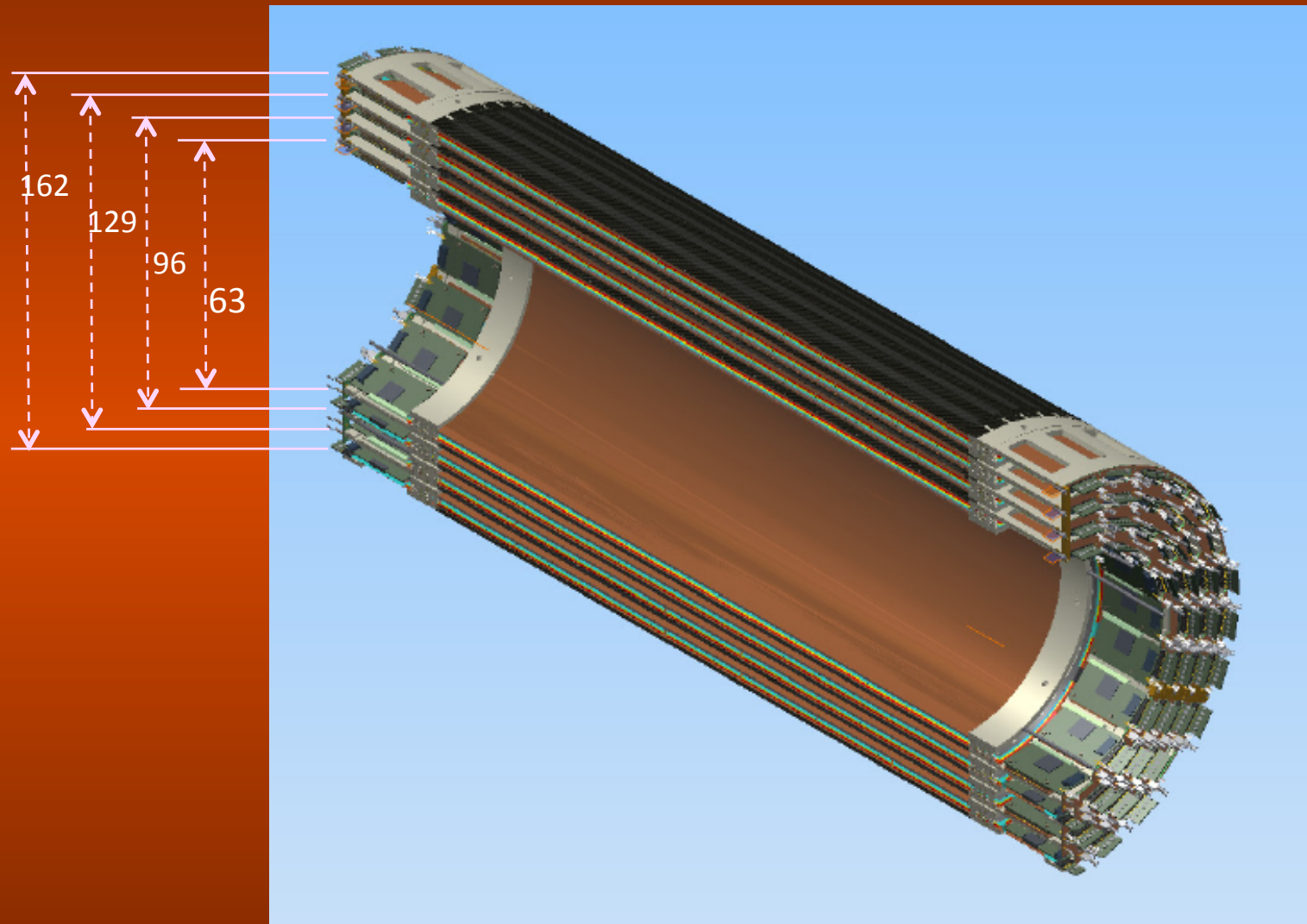
(KLOE2 ~ 30000)

Stereo angle ~ 40° (like KLOE2)

KLOE - IT dimensions

	Ext diam (mm)	Int diam (mm)
Layer 1	290	244
Layer2	340	294
Layer3	390	344
Layer4	440	394

Pictorial view of IT for BESIII



Cost, Timing, Prototype a very preliminary guess

- ❑ KLOE2 CGEM cost, including tests and R&D ~ 7500 KRMB
BESIII ~ 3000 KRMB
- ❖ Construction Toolings (II) and others available
- ❖ Molds ~ 600 K RMB (x 1/4 ?)
- ❖ GEM ~ 900 KRMB
- ❖ Readout ~ 1500 KRMB (Italy?)
- ❑ KLOE2 CGEM construction and R&D ~ 3 years
BESIII ~ 1.5-2 year, including readout analog R&D
- ❑ INFN and IHEP have asked MAEs financial support for an analog readout CGEM prototype
- ❑ CGEM miniWorkshop October 25-26 in Frascati
(LNF, Bari, BESIII, CMD2, Rui De Oliveira)

Conclusions

- ❑ CGEM could be a solution for a new Inner Tracker
- ❑ A relevant gain is achieved in the longitudinal view
- ❑ Transverse momentum resolution worsening should be at most 10 %
- ❑ Cost and time schedule rough estimation
- ❑ A dedicated workshop in October at LNF
- ❑ A prototype with analog readout is foreseen

In caso la proposta CGEM in BESIII fosse accettata dalla collaborazione, nel 2013 vorremmo costruire a LNF un piccolo prototipo planare (10x10cm²) per R&D con lettura analogica

BESIII computing in Italy today

- Italian mirror BES3 DB @ TO: online since 09/2010
- Italian BESIII computing farm @ TO (SLC 5.6/64):
 - WN: 64 cores Xeon 2.13/2.53GHz; servers: DB 8 cores; open access (SSH) 8 cores
 - storage: 12TB NFS/ISCSI
 - activities: J/ψ phase studies; BOSS analysis $e^+e^- \rightarrow p \bar{p}, n \bar{n}$
- BOSS framework full documentation @ TO (single worldwide):
 - doxygen updated to BOSS 6.6.2, hosted by TO INFN central web server:
 - http://bes3.to.infn.it/BESIII_Doxygen_Documentation.html
- BOSS 6.6.2 released:
 - validation in progress

Mass production of simulated RAW events

- **BESIII experiment organised activity:** mostly performed (now) @ IHEP batch computing farm

- **mass simulation of the RAW events (to be performed for a single BOSS version):**

- each job generates a single file: 50K events
- processing time: 14 – 19 h
- input: a few parameters
- output: a single file, 255 – 350 MB, ROOT, *.rtraw
- output ratio: 5 - 10 KB/s
- final destination: IHEP storage

- **cumulated volume of simulated RAW data (for a single BOSS version):**

- J/ψ : 1.1 TB
- ψ' : 0.65 TB
- ψ'' : 1.12 TB



Reconstruction of simulated RAW events

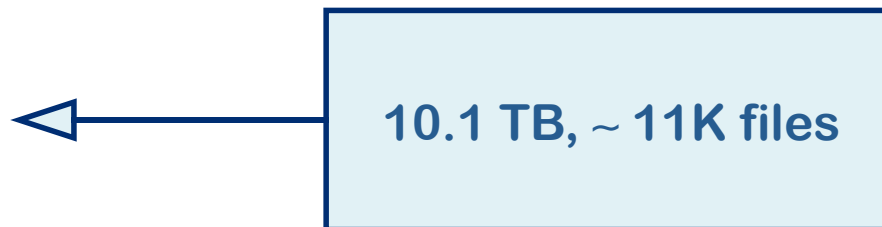
• **BESIII experiment organised activity:** performed @ IHEP batch computing farm

• **mass simulation of the RAW events (to be performed for each BOSS version):**

- processing time: 8 – 12 h
- input: one .rtraw file (simulated data) and some random trigger files (raw data)
- input file sizes: 255 – 350 MB (simulated), 1.5 – 2 GB (random trigger)
- read mode: sequential (simulated), random (raw data)
- output: one file, 900 MB, ROOT, *.dst
- output ratio: < 50 KB/s
- location input and output files: local or IHEP storage (simulated), IHEP storage (50TB raw data)

• **cumulated volume of simulated RAW data (for a single BOSS version):**

- J/ψ : 3.8 TB
- ψ' : 2.3 TB
- ψ'' : 4.0 TB



Mass simulation and reconstruction

event type	Simulation				Reconstruction			
	event size	wall time per Ev	output file size	wall time per file	event size	wall time per Ev	output file size	wall time per file
	[KB]	[sec]	[MB]	[hours]	[KB]	[sec]	[MB]	[hours]
J/ψ	5.1	1.0	255	14	18	0.6	900	8
ψ'	6.5	1.28	325	18	23	0.8	1150	10
ψ''	7.0	1.4	350	19	25	0.9	1250	12

- **simulations significantly contributes to BESIII data size:**

- current BESIII storage @ IHEP: 2.3 PB (1.2 PB used by ~ 100M files)

- **expected cumulated data growth up to 2020: 6.4 PB**

- real data (.raw): **3.6 PB**
 - reconstructed data (.dst): **1.8 PB**
 - simulated and reconstructed data (.rtraw + ..dst): **1.0 PB**

Computing requirements

Assuming **2000** cores with 10% error jobs and 100% working efficiency

J/ψ inclusive mc: 1 s/event **J/ψ** inclusive rec: 0.6 s/event

ψ' inclusive mc: 1.28 s/event **ψ'** inclusive rec: 0.8 s/event

ψ'' inclusive mc: 1.4 s/event **ψ''** inclusive rec: 0.9 s/event

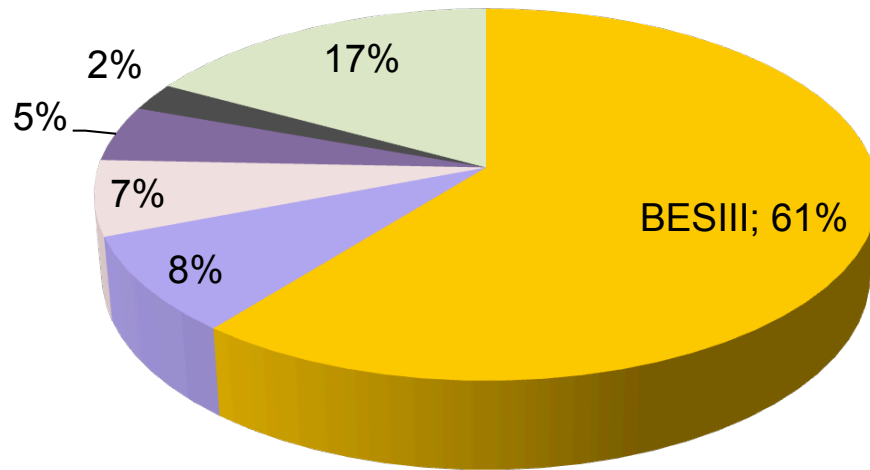
real data	1.2 G J/ψ (days)	500 M ψ' (days)	2.9 fb ⁻¹ ψ'' (days)
CPU time	~ 16	~ 10	~ 26

MC data	simulation (days)	reconstruction (days)	total (days)
1.2 billion J/ψ inclusive	7	5	12
500 million ψ' inclusive	4.5	2.5	7
1 billion ψ'' events	8	5	13

Job statistics

2012/01 — 2012/05

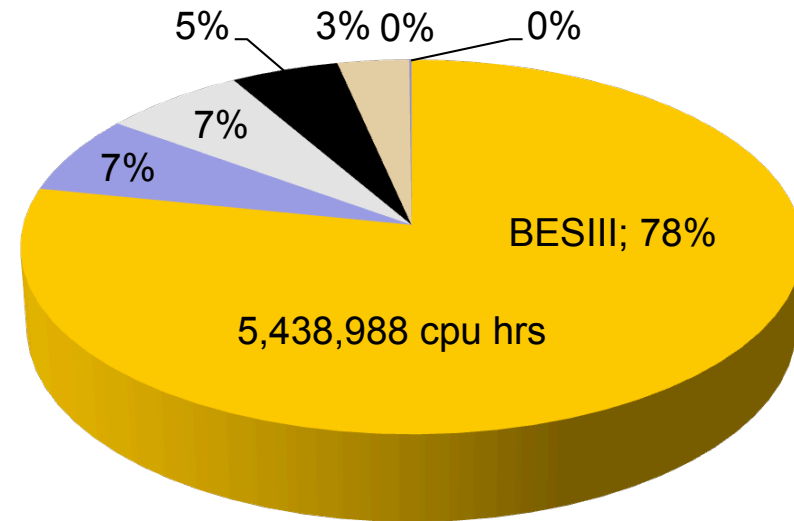
CPU Resources



■ BESIII ■ YBJ ■ DYB
■ CMS ■ ATLAS ■ OTHER

Total: 5,202 cores
BESIII: 3,196 cores
Others: 2,006 cores

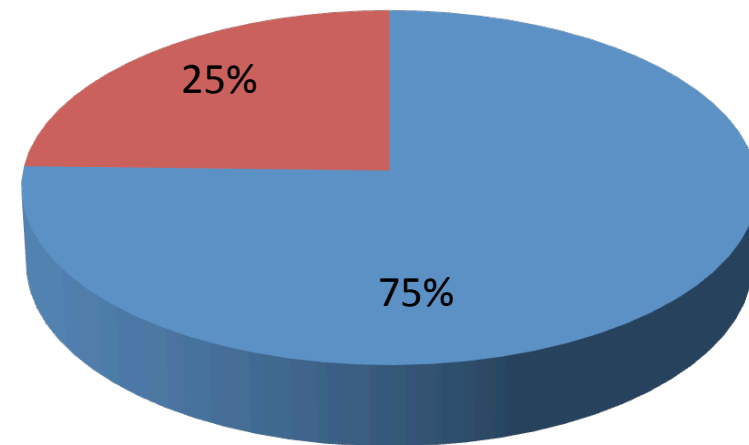
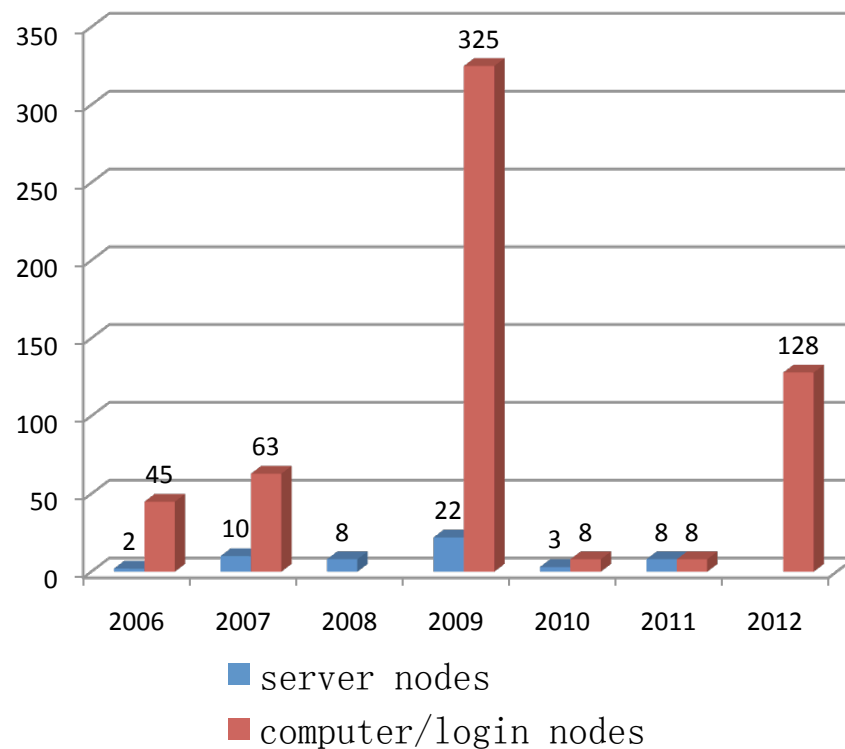
Job CPU Time (cpu hr)



■ BESIII ■ YBJ ■ CAC ■ CMS
■ DYB ■ GPU ■ ATLAS

Total : 6,980,368 cpu hrs
BESIII : 5,438,988 cpu hrs
Others: 1,541,380 cpu hrs

BESIII @ IHEP computing resources status



■ out of the warranty period
■ in the warranty period

Warranty period : 3 years

About 75% of resources should be discontinued!

Distributed computing requirements

- BESIII current computing resources: ~ 3300 CPU cores, ~1000 more under deployment
- assuming:
 - CPU usage rate: 78%
 - working efficiency: 90%to process both real data processing and MC generation @ IHEP,
120 days are needed for each single BOSS version!
- institutions should provide external sites for distributed computing
- BESIII Collaboration goal from distributed computing in the near future is:
25,000 CPUcores * day (i.e. 1/6 of total CPU power)
enough to provide the generation of ~1 G Ψ'' MC
- if goal won't be reached: BESIII will purchase CPU time elsewhere
(Amazon Web Services, Tsinghua University, etc)
- contributions to distributed computing count as service work

Sites status

Site	Type	Job slots	Storage	Status
JINR	GLite	2100 (shared with LHC)	3.5 TB	Active for BOSS grid jobs
UCAS	PBS	96	1 TB	Active for BOSS grid jobs
IHEP-PBS	PBS	96	200 TB	Active for BOSS grid jobs
PKU	PBS	168	> 10 TB	Active for BOSS grid jobs
USTC	PBS	128	160 TB	Active for BOSS grid jobs
UMN	SGE	400	> 100 TB	Active for grid jobs
WHU	PBS	100	25 TB	In progress
SDU	PBS	>100	>2TB	In progress
NSCCSZ	LSF	?	?	In progress

5 sites are able to accept BOSS jobs, 1 site is able to accept simple grid jobs (need CVMFS installation for BOSS deployment), and 3 more new sites are joining.

Minimum requirements to distributed computing sites

•minimal computing resources:

- CPU: >100 cores SLC5-64 (2K HS06)
- GRID enabled storage (SE): > 5 TB
- storage to host random trigger real data: ~ 25 TB
- network to and from IHEP: > 80 Mbit/s

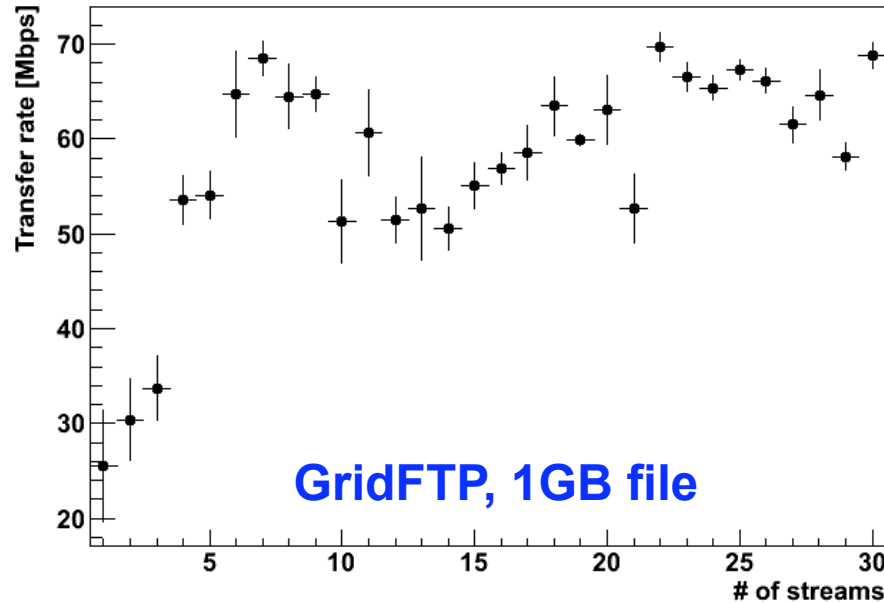
•basic service level:

- provide grid system or at least local cluster system with BOSS deployed: **accept MC and analysis jobs**
- provide grid enabled storage system:
 - temporary store MC results
 - accept DST data for analysis
- ensure enough bandwidth:
 - allow data transfer with IHEP
 - cooperate on improving network performances (thanks to INFN-TO CC!!)
- Shared file system among WNs to store random trigger data:
 - enable background mixing in production jobs

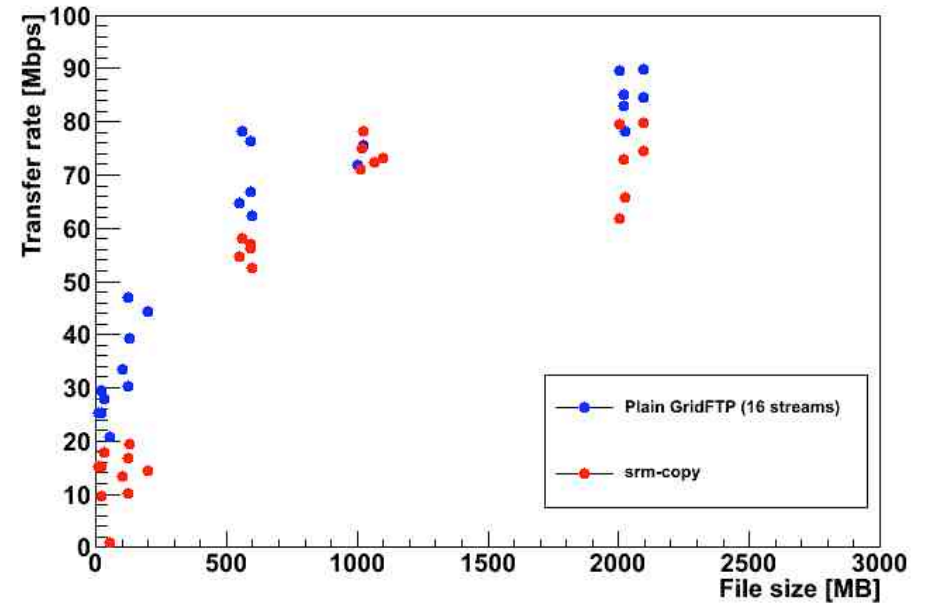
Network performances

JINR - IHEP

Throughput vs # of streams

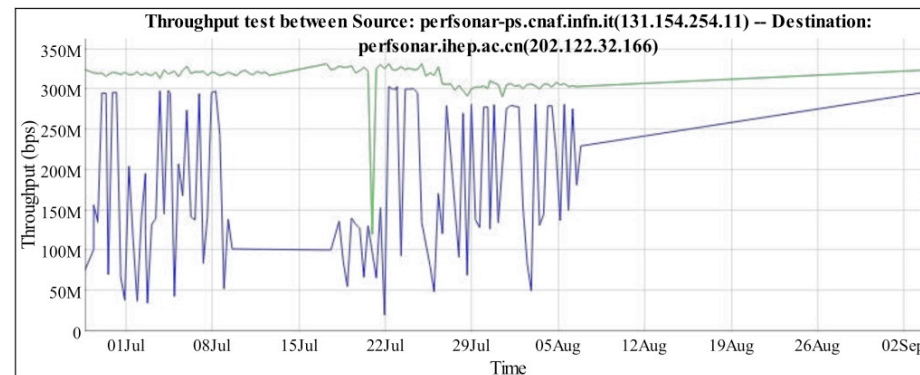


Throughput vs File size



INFN - IHEP

Goal reached
thanks to
INFN-TO CC
and IHEP CC!



<- 1 month

1 month ->

Timezone: GMT+0200 (CEST)

2012/09/03 21:48:54:

Throughput(Src-Dst):297.06Mbps

Graph Key

Src-Dst throughput

Dst-Src throughput

Richieste alla CSN1

per la creazione di un sito di BESIII computing a Torino

•WNs:

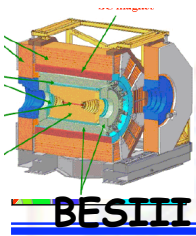
- CPU: 2000 HS06, costo standard GRID-INFN: 28 K€

•server/WNs:

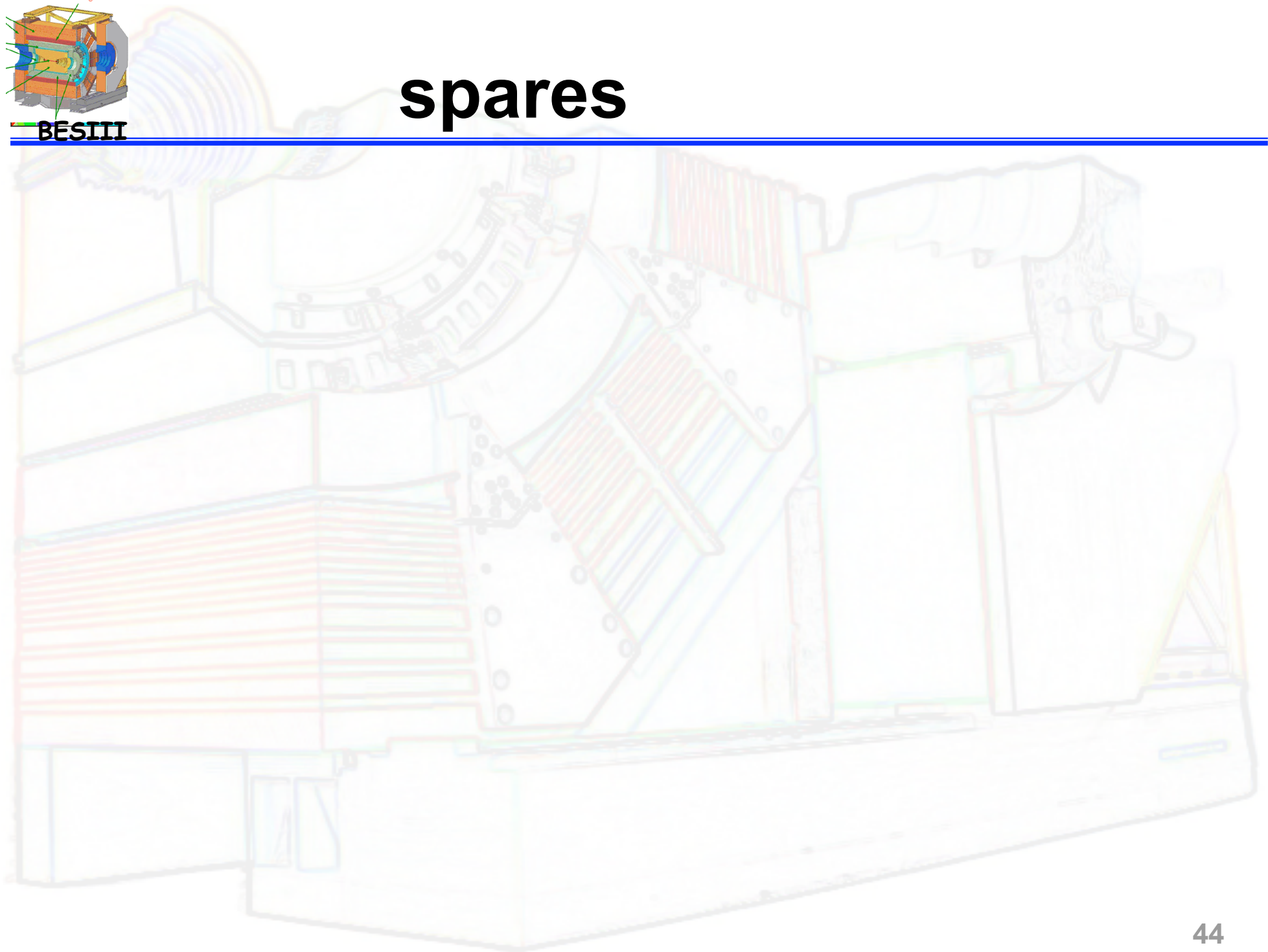
- storage: 21TB netti, costo standard GRID-INFN: 7.5 K€
- server per SE: 2x8 cores xeon, FC: 4.5 K€

•richieste decadute:

- tapelibrary: i referee del calcolo suggeriscono l'utilizzo di nastri al CNAF

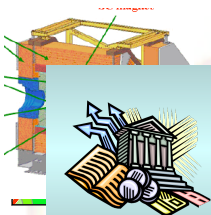


spares



RICHIESTE FINANZIARIE 2013





Richieste finanziarie per il 2013 @LNF

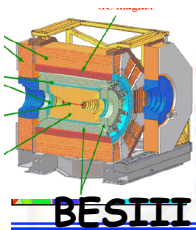
	Richieste (K€)	S.J. appr GEM
Missioni estere (2->3FTE)	43.0→50.0	8.0
Missioni interne	6.0	
<i>Consumo metabolismo, manutenzione ZDD R&D prototipo GEM</i>	6.0	3.0
<i>Inventario TDC per strip ZDD</i>	5.0	
Totale LNF	67.0	11.0



Richieste finanziarie per il 2013 @TO / PG

TORINO	Richieste(K€)
Missioni estere	53.5
Missioni interne	11.0
Mat. Consumo	2.0
<i>nastri LTO per storage dati LNF+TO</i>	2.5
<i>metabolismo</i>	
Inventario	
<i>nodo grid</i>	40.0
Totale TO	109

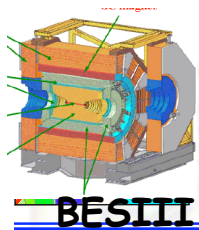
Perugia/ DOT1	Richieste(K€)
Missioni estere (2meeting in Cina, 1 turno)	6.0
Missioni interne (4 a LNF, 1 a To)	2.0
Totale PG	8.0



Dettagli richieste Missioni Estere, 2013



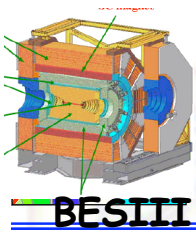
- partecipazione alle riunioni di collaborazione, IB meeting, discussione analisi dati e simulazioni, discussione pubblicazioni e release risultati per conferenza
TO : $2\text{meeting/anno} \times (7\text{d in Cina} + \text{viaggio} + \text{fee}) \times 3\text{p} = 11.0 \text{ K€}$
LNF : $2\text{meeting/anno} \times (7\text{d in Cina} + \text{viaggio} + \text{fee}) \times 4\text{p} = 15.0 \text{ K€}$
PG/dot1: $2\text{meeting/anno} \times (7\text{d in Cina} + \text{viaggio} + \text{fee}) \times 1\text{p} = 3.6 \text{ K€}$
- partecipazione a BESIII Physics Workshop: discussione analisi dati e simulazioni, discussione pubblicazione e release risultati per conferenze
LNF=TO: $2\text{meeting/anno} \times (7\text{d in Cina} + \text{viaggio} + \text{fee}) \times 3\text{p} = 11.0 \text{ K€}$
- partecipazione Working group europeo fattori di forma (D/NL):
LNF=TO: $2\text{meeting/anno} \times (3\text{d in D/NL} + \text{viaggio} + \text{fee}) \times 3\text{p} = 7.5 \text{ K€}$
- partecipazione meeting BESIII-EU NL):
LNF=TO: $3\text{meeting/anno} \times (3\text{d in D/NL} + \text{viaggio} + \text{fee}) \times 2\text{p} = 4.5 \text{ K€}$
- turni di presa dati: Token turni richiesto da BESIII: 10turni/persona
LNF=TO: $1\text{periodo/persona/anno} \times (10\text{d in Cina} + \text{viaggio}) \times 5\text{p} = 11.5\text{K€}$
PG/dot1: $1\text{ periodo/anno} \times (10\text{d in Cina} + \text{viaggio}) \times 1\text{p} = 2.2 \text{ K€}$
- lavoro fuori sede di un PostDoc/Ricercatore @ IHEP: sviluppo sw ricostruzione, analisi e simulazione
TO: $3\text{periodi/anno} \times (15\text{d} + \text{viaggio}) \times 1\text{p} = 8.0$
- attività coordinamento CGEM (S.J.) @ IHEP:
LNF: $2\text{periodi/anno} \times (8\text{d in Cina} + \text{viaggio}) \times 2\text{p} = 8.0 \text{ K€}$



Dettagli richieste Missioni Interne 2013



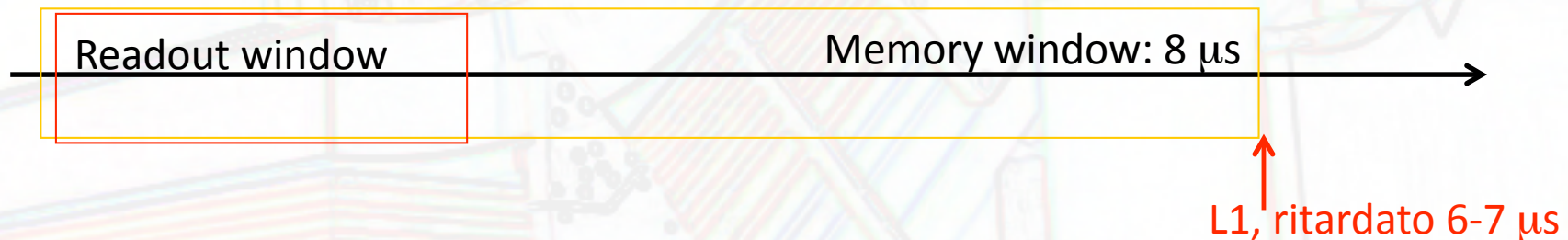
- riunioni di coordinamento software/fisica TO<->LNF:
analisi dati, sviluppo codice simulazioni
LNF: 2 riunioni/anno x (2d + viaggio) x 4pp = 4.5 K€
TO: 4 riunioni/anno x (3d + viaggio) x 2pp = 5.5 K€
PG/dot1: 1 meeting a To, 4 a LNF = 2.0 K€
- partecipazione alle riunioni CSN1
LNF: 1riunioni/anno x (2d + viaggio) x 2pp = 1.5 K€
TO: 1riunioni/anno x (2d + viaggio) x 2pp = 1.5 K€
- lavoro fuori sede di un PostDoc/Ricercatore di TO @ LNF:
sviluppo sw ricostruzione, analisi e simulazione
TO: 4periodi/anno x (5d + viaggio) x 1p = 4.0 K€



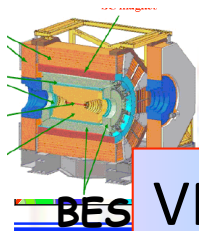
2011-2012 ZDD data taking II

PROBLEMI DI FIRMWARE SU FADC CAEN V1721

- “readout window” addizionale, introdotta da CAEN su richiesta BESIII → ha funzionato OK *ma solo se non si usa la data compression CAEN* (Zero Length Encoding)



- Minima readout window ancora troppo grande per BESIII DAQ, introdotta ZLE
- (ZLE + readout windows) → dati fantasma (problema non grave, v. sotto)
- **Più grave:** sporadica corruzione dati (1 byte perduto): caso raro, $1/10^5$ eventi, ma che crea molte difficoltà nell'algoritmo di decompressione → perdita 2 eventi per volta
- CAEN ha prodotto un nuovo firmware che risolve sicuramente il primo problema
- Da verificare all'inizio della presa dati se risolve anche il secondo!



VME crate with CAEN controller, MCC board for BES-III L1 trigger distrib., 2 CAEN V1721 FADC's with **NIM trigger input**

ZDD DAQ PC

USB connection, OK for cosmics/test beams, less so for HEP req.ments

L1 reformatted to NIM standard

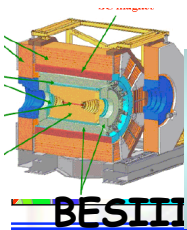
PM signals to digitizers

NIM crate

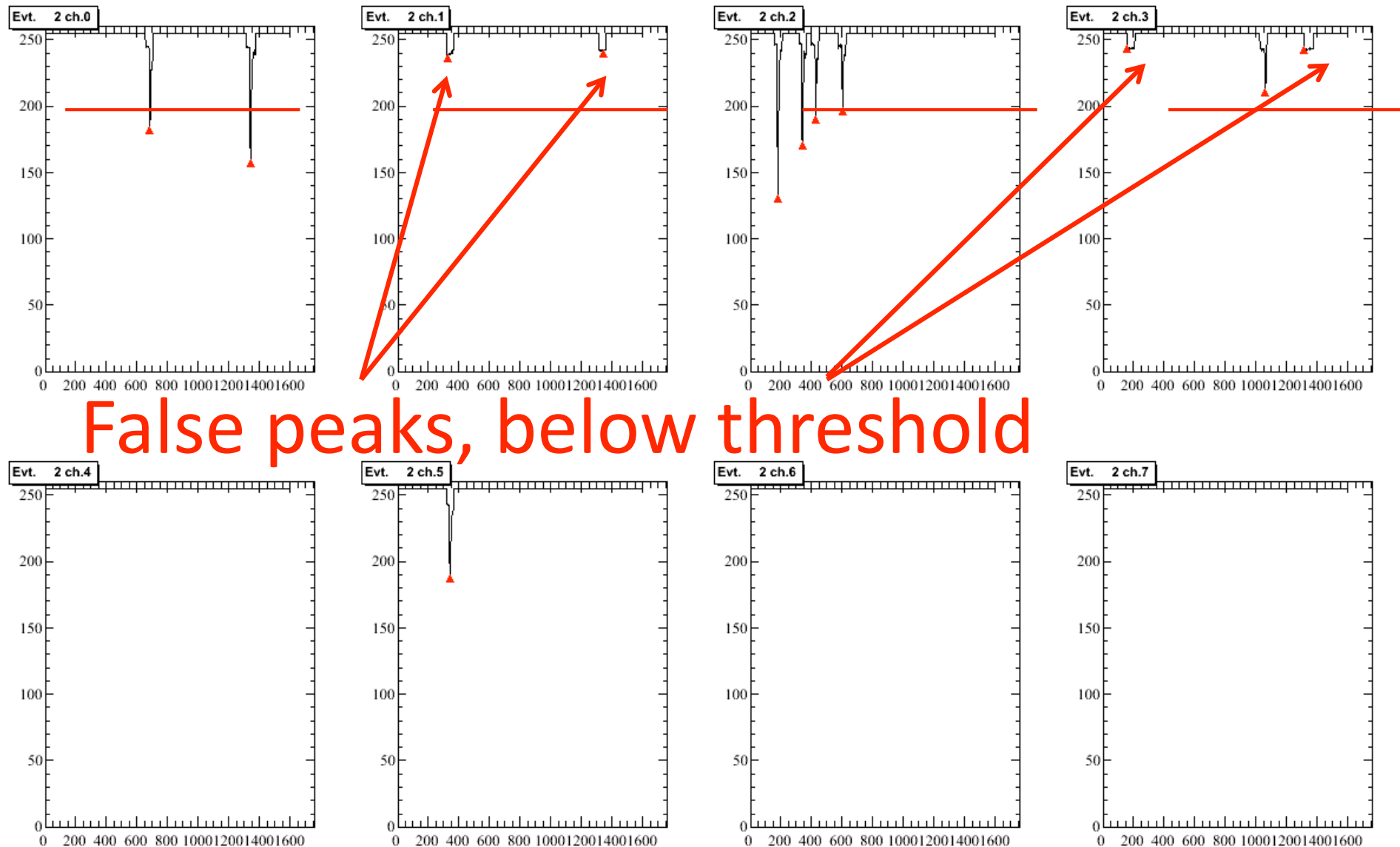
Trigger conversion and fanout (old hdwr)

ZDD channel amplifiers/shapers, made in 2010 by SELF-LNF

BESIII L1 standard (LVPECL) from MCC card



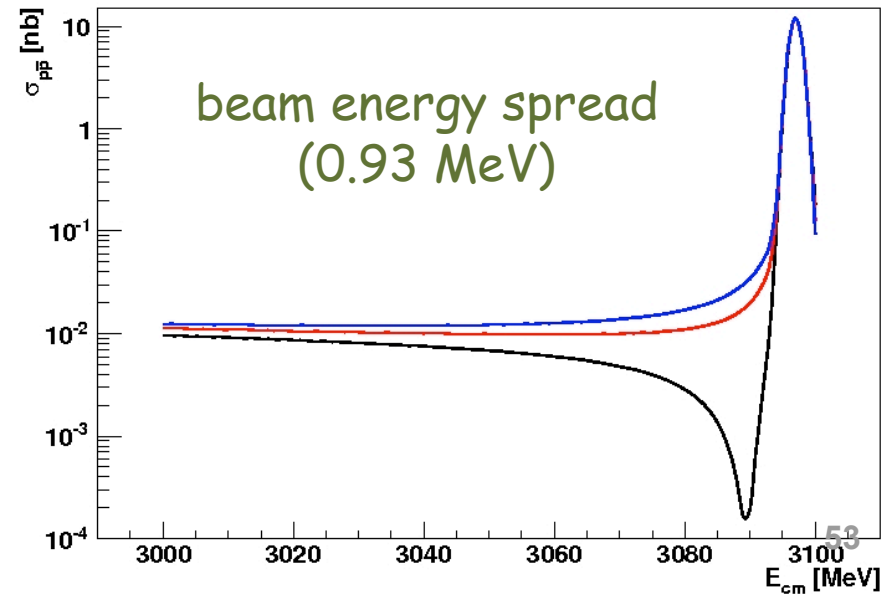
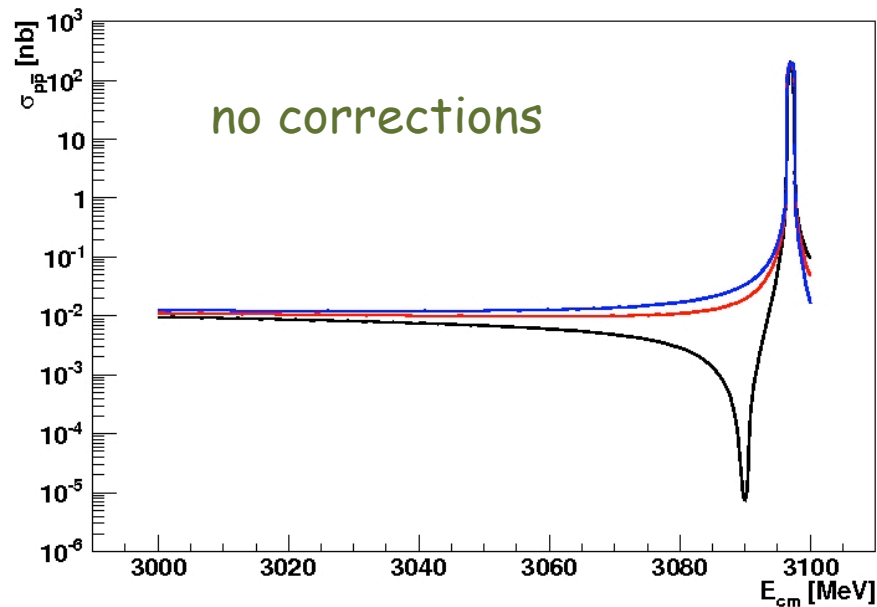
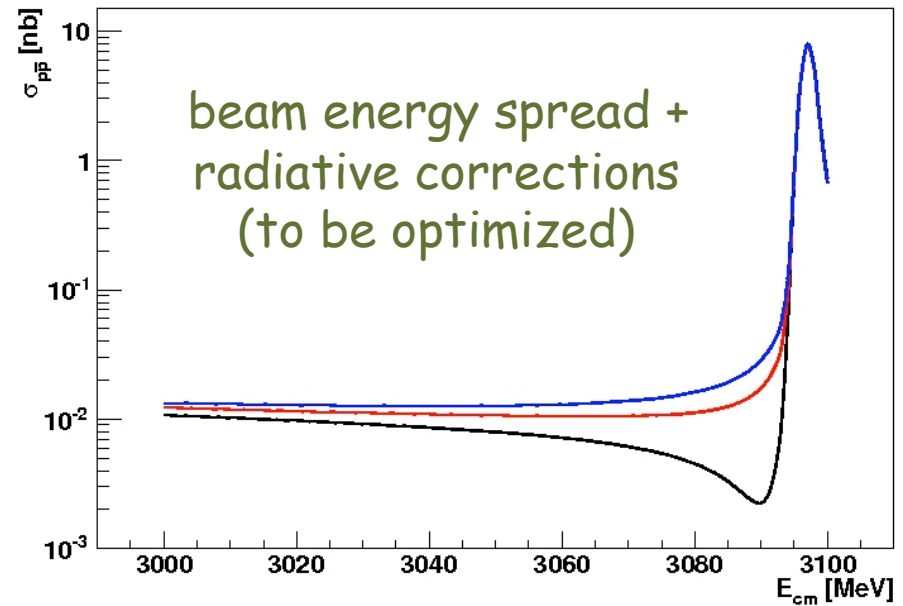
One event in the Bottom Block (8 PMs)



Simulated Yields for $e^+e^- \rightarrow p\bar{p}$

- $\Delta\varphi = 0^\circ$
- $\Delta\varphi = 90^\circ$
- $\Delta\varphi = 180^\circ$

continuum reference
 $\sigma \sim 11 \text{ pb}$

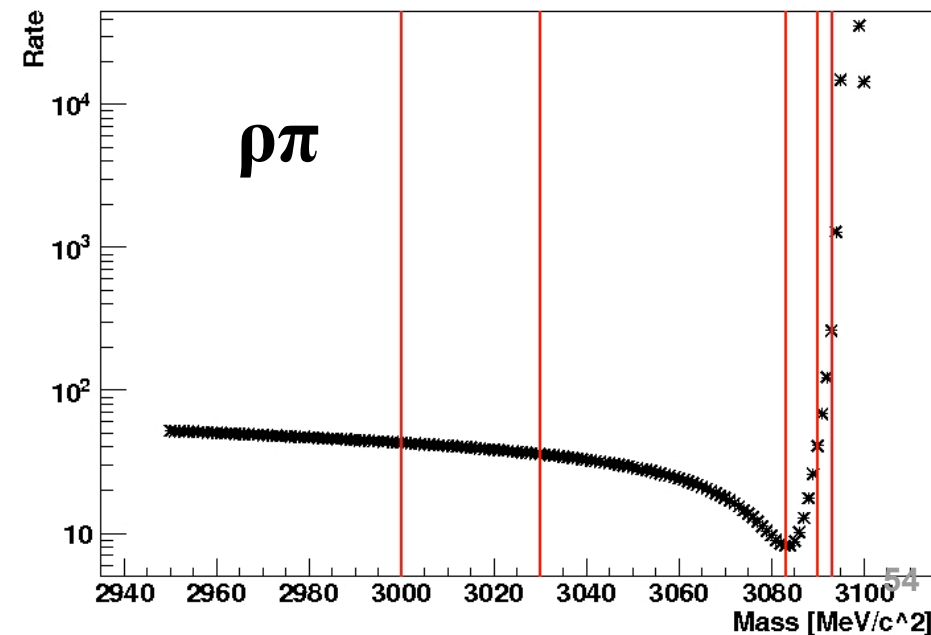
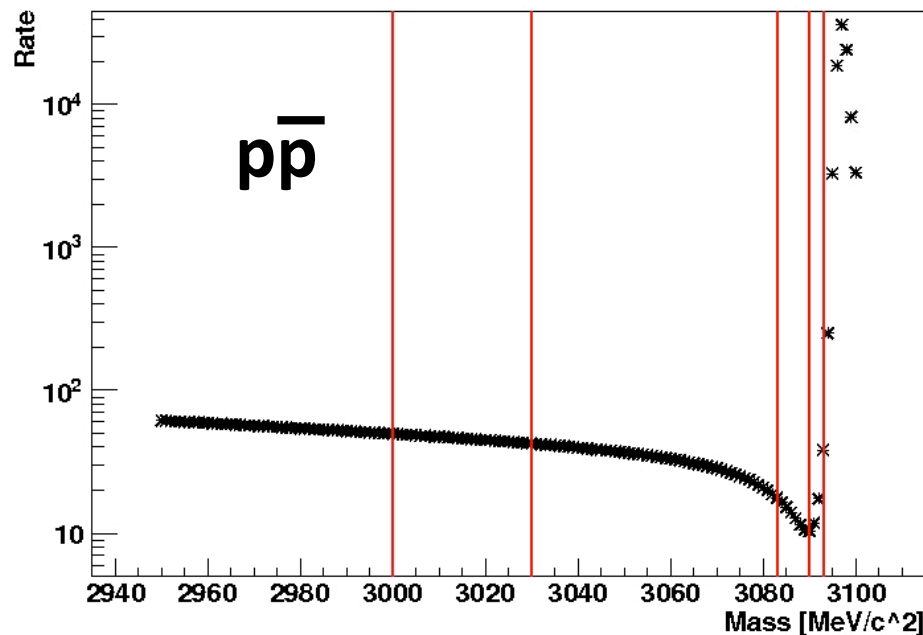
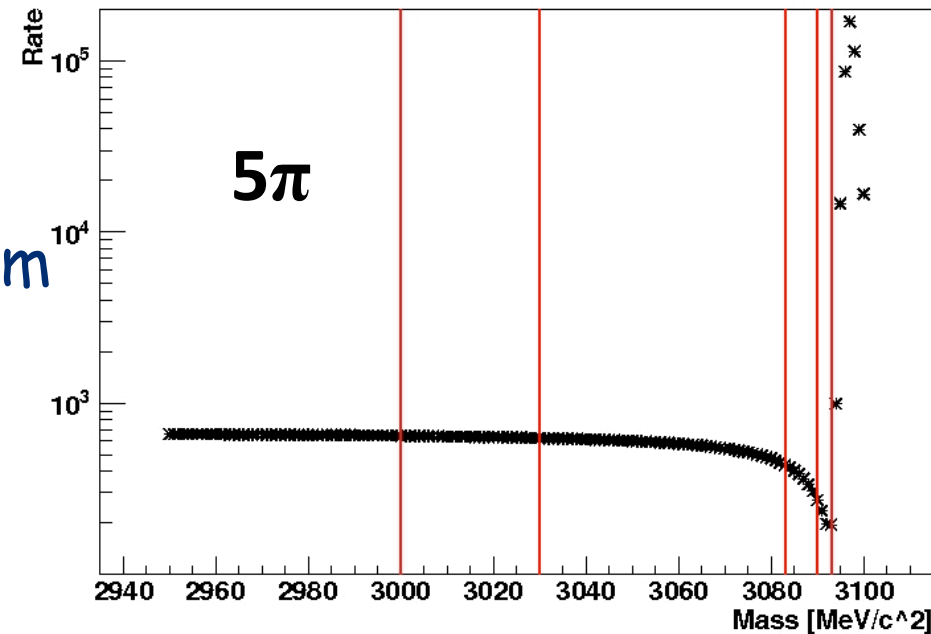


Scan energies selection

Depends on the process

Maximum interference: 0°

- 2 pts at low W
- fix the continuum
- fix the slope
- 2 pts at deep positions
- 1 pt Beginning of the BW



p $\bar{p}$

J/ ψ phase scan

$$\Delta\varphi = +90^\circ$$

$$\sigma_{\text{cont}} = 11 \text{ pb}$$

$$B_{\text{out}} = 2.17 \cdot 10^{-3}$$

3 parameters:

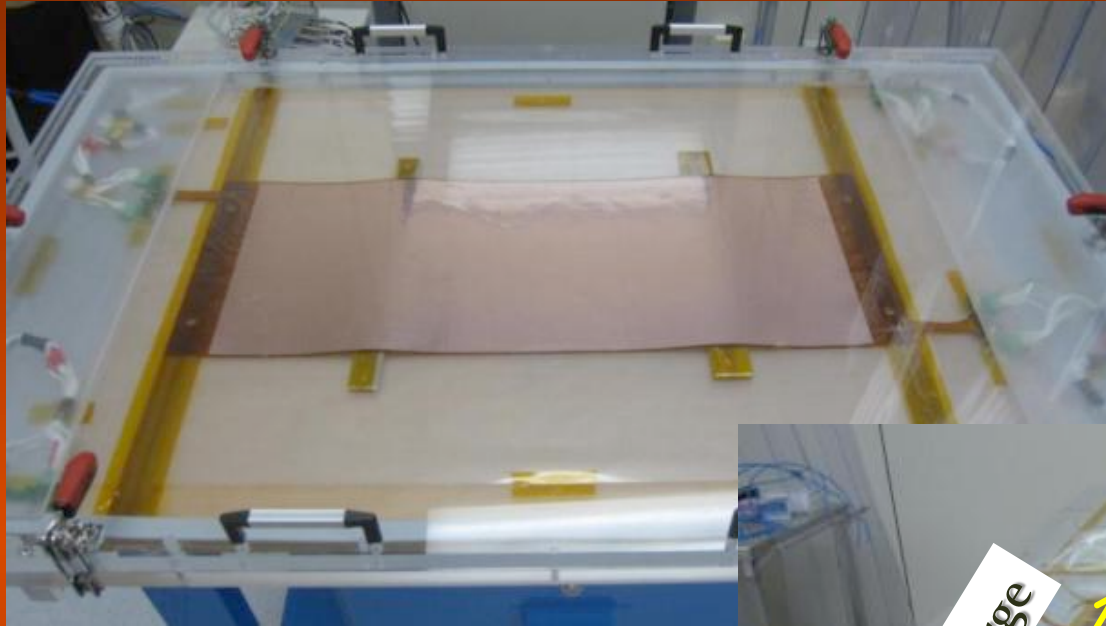
φ , σ_{cont} and B_{out}

Points	Par	Inj. eff.	$\Delta\phi$ [°]	$\Delta\sigma$ [pb]	ΔB_{out}
5	3	0.7	29.3	1.3	$0.7 \cdot 10^{-3}$
5	3	0.8	26.7	1.3	$0.7 \cdot 10^{-3}$
6	3	0.8	6.1	0.9	$0.4 \cdot 10^{-5}$
12	3	0.7	6.3	0.9	$0.7 \cdot 10^{-4}$
12	3	0.8	5.9	0.9	$0.7 \cdot 10^{-4}$

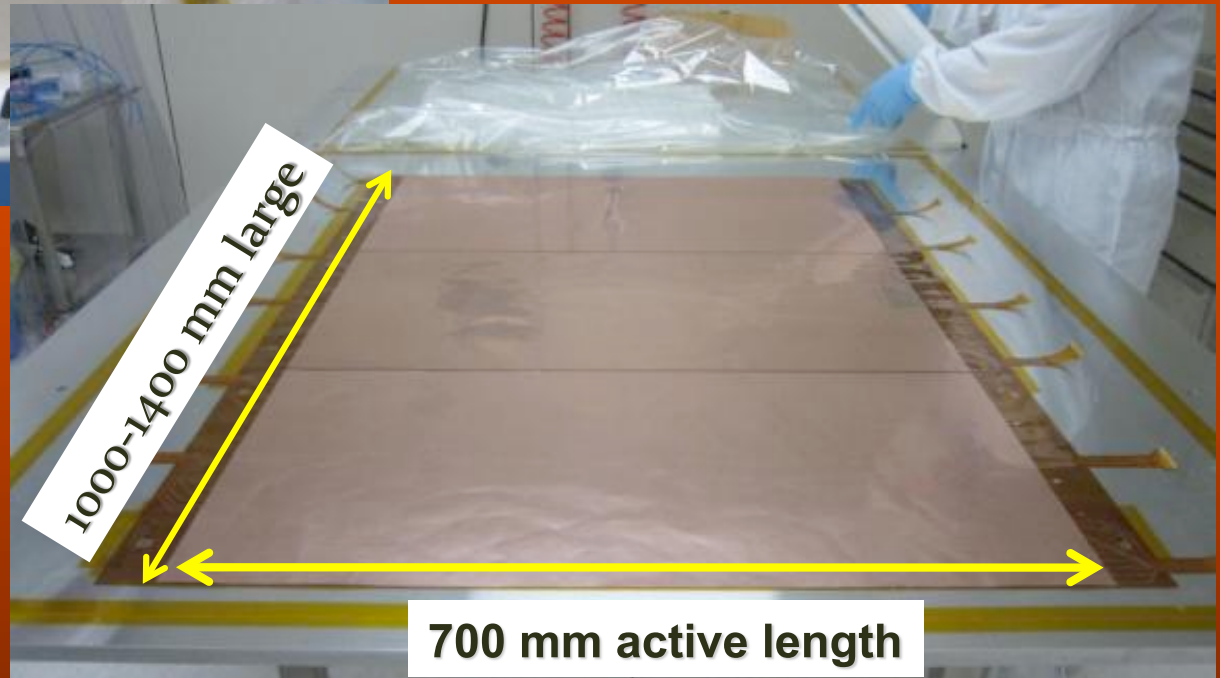
3 parameters: 3096.9 needed

(1 point more with high statistics)

The Large GEM Foils



Before gluing each GEM foil, it is tested with HV (up to 600V) in a N₂ flushed plexiglass box, to reduce RH below 10%



3 GEM foils spliced and envelopped in a vacuum bag

Anode Readout

57

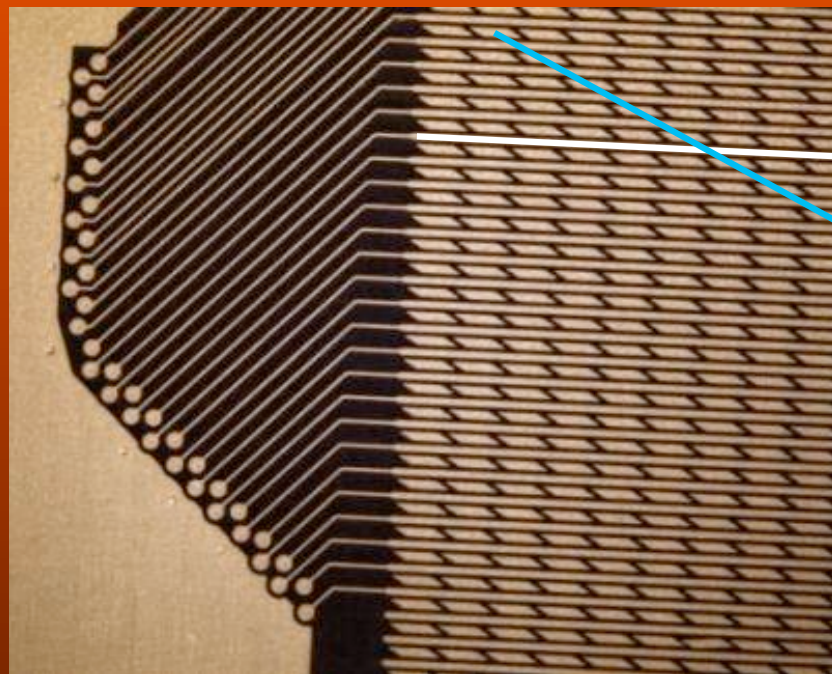


2-D readout with XV strips
on the same plane

X pitch $650\mu\text{m}$ $\rightarrow$ X res $190\mu\text{m}$

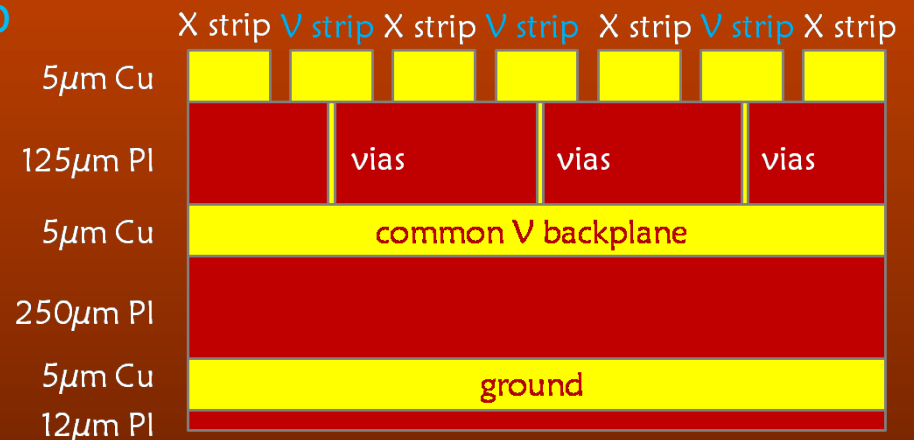
V pitch $650\mu\text{m}$ $\rightarrow$ Y res $350\mu\text{m}$

Multilayer Kapton circuit
realized at CERN



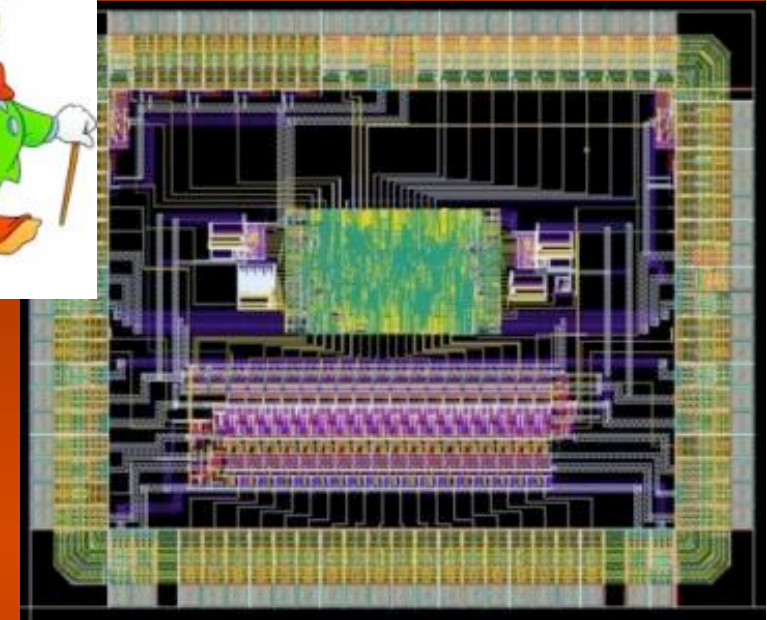
X strip

V strip



GASTONE: the IT dedicated FEE chip

Sensitivity (pF)	20 mV/fC
Z_{IN}	400 Ω (low frequency)
C_{DET}	1 – 50 pF
Peaking time	90 – 200 ns (1-50 pF)
Noise (erms)	800 e^- + 40 e^-/pF
Channels/chip	64*
Readout	LVDS/Serial
Power consum.	≈ 0.6 mA/ch



- ❑ Mixed analog-digital circuit (KLOE-2 dedicated);
- ❑ Low input equivalent noise, low power consumption and high integrated chip;

❑ 4 blocks:

- charge sensitive preamplifier
- shaper
- leading-edge discriminator (prog. thr.)
- monostable (stretch digital signal to match the trigger timing of the experiment)

0.35 CMOS technology- no Rad-Hard



Costruction toolings (I)



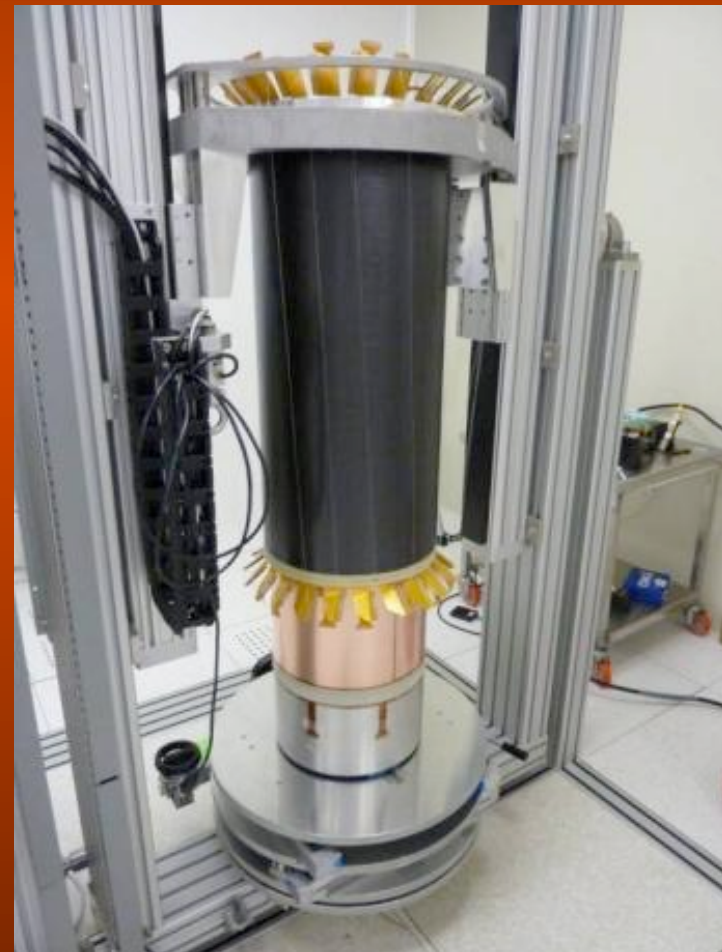
Special molds for cylindrical electrodes (cathode, GEMs, anode readout) constructions.
N.5 molds per layer (total 20 molds)

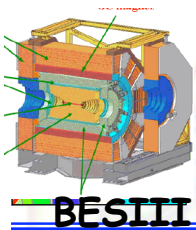


Costruction toolings (II)



Vertical Insertion System for the cylindrical electrodes insertion and final detector assembly



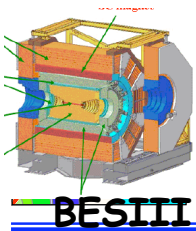


IHEP-INFN

FIRMATO L'ACCORDO DI PECHINO

Lunedì 18 Giugno 2012 10:00

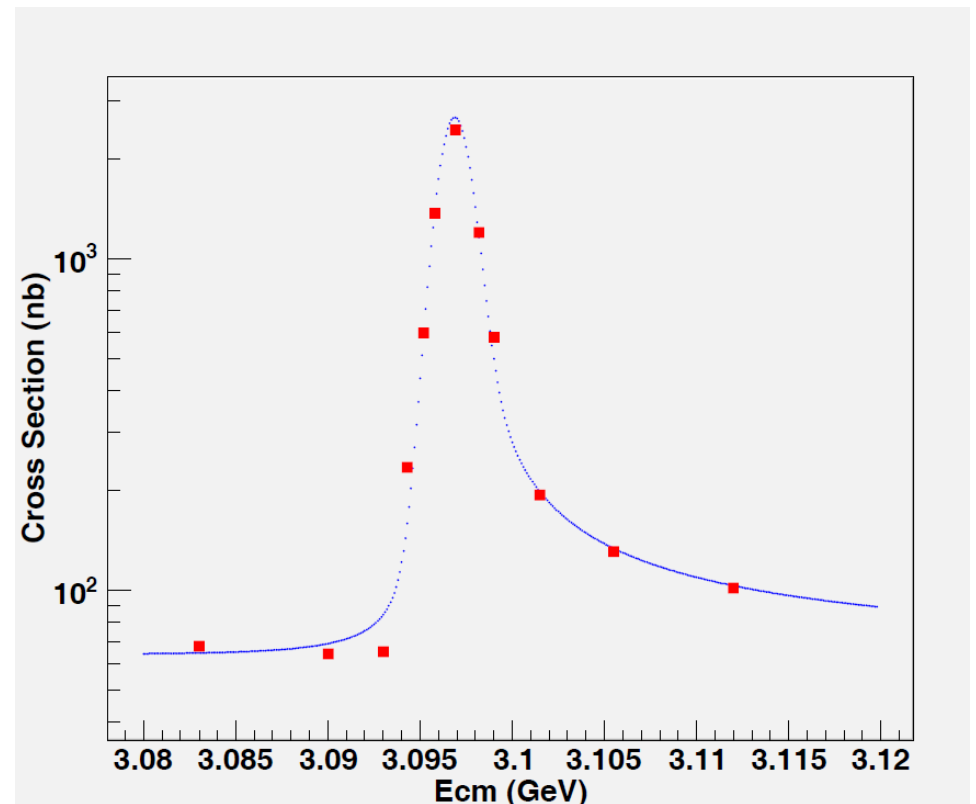
Un istituto virtuale che svilupperà la collaborazione scientifica tra l'Italia e la Cina in un settore in cui il nostro paese è all'avanguardia nel mondo. L'Istituto Nazionale di Fisica Nucleare e L'Istituto per la Fisica delle Alte Energie (IHEP) di Pechino hanno ratificato, in un incontro a Roma, il loro protocollo di accordo per la ricerca e per la formazione dei giovani. Una collaborazione che entrerà nell'agenda del prossimo viaggio del ministro Profumo in Cina a giugno. L'insieme delle concrete iniziative comuni costituirà, appunto, una sorta di Istituto virtuale unico di ricerca: anche per questo un italiano andrà a Pechino, presso l'IHEP, a rappresentare stabilmente l'INFN e coordinarne i rapporti con gli omologhi cinesi. L'incontro di Roma ha messo in luce il forte interesse cinese a realizzare esperimenti congiunti su neutrini e materia oscura ai Laboratori del Gran Sasso e da parte italiana un analogo interesse per il laboratorio cinese di Dayabay. Si collaborerà anche sulla fisica degli acceleratori e il computing (approfondendo il lavoro comune che si sta già facendo sulla GRID). La collaborazione continuerà anche su esperimenti già avviati come ARGO (che si trova sull'altopiano tibetano) e AMS, il rivelatore di raggi cosmici che è stato portato un anno fa sulla Stazione Spaziale Internazionale. Un discorso a parte riguarda la formazione, sia per i giovani dottorandi che per il post-doc. INFN e IHEP hanno già scambi di giovani ricercatori (sono presenti ad esempio giovani cinesi ai laboratori di Frascati e del Gran Sasso), ma i due istituti vogliono approfondire questo impegno comune, utilizzando per questo anche il neonato Gran Sasso Science Institute, la nuova scuola sperimentale di dottorato internazionale di cui l'INFN è il soggetto attuatore.



Status of J/psi lineshape data taking

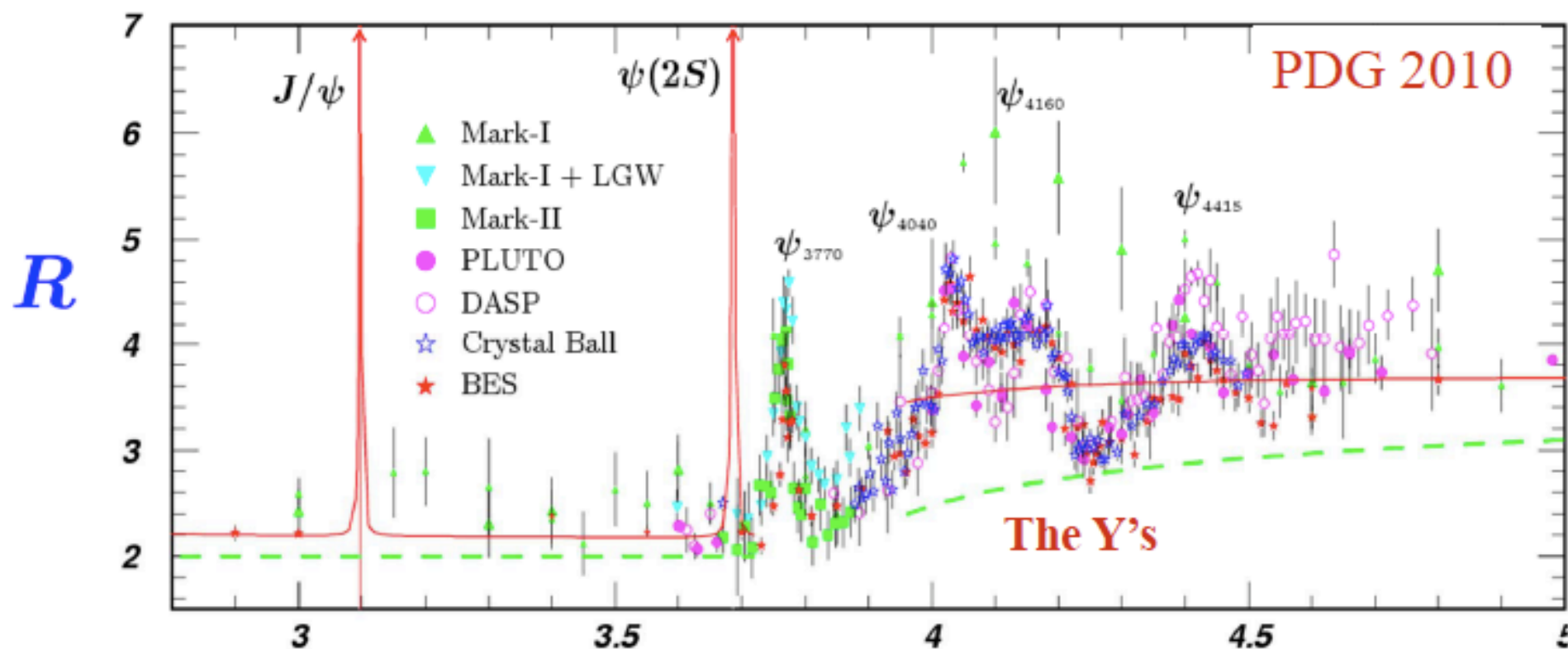
- It's a tough experiment, twice fast scan @J/psi and $\psi(2S)$ peak to verify the beam energies, and also to determine the beam energy spread
- 4 days data taking, 12 energy points

(from Haiming)
No eff. correction



Features of the BEPC Energy Region

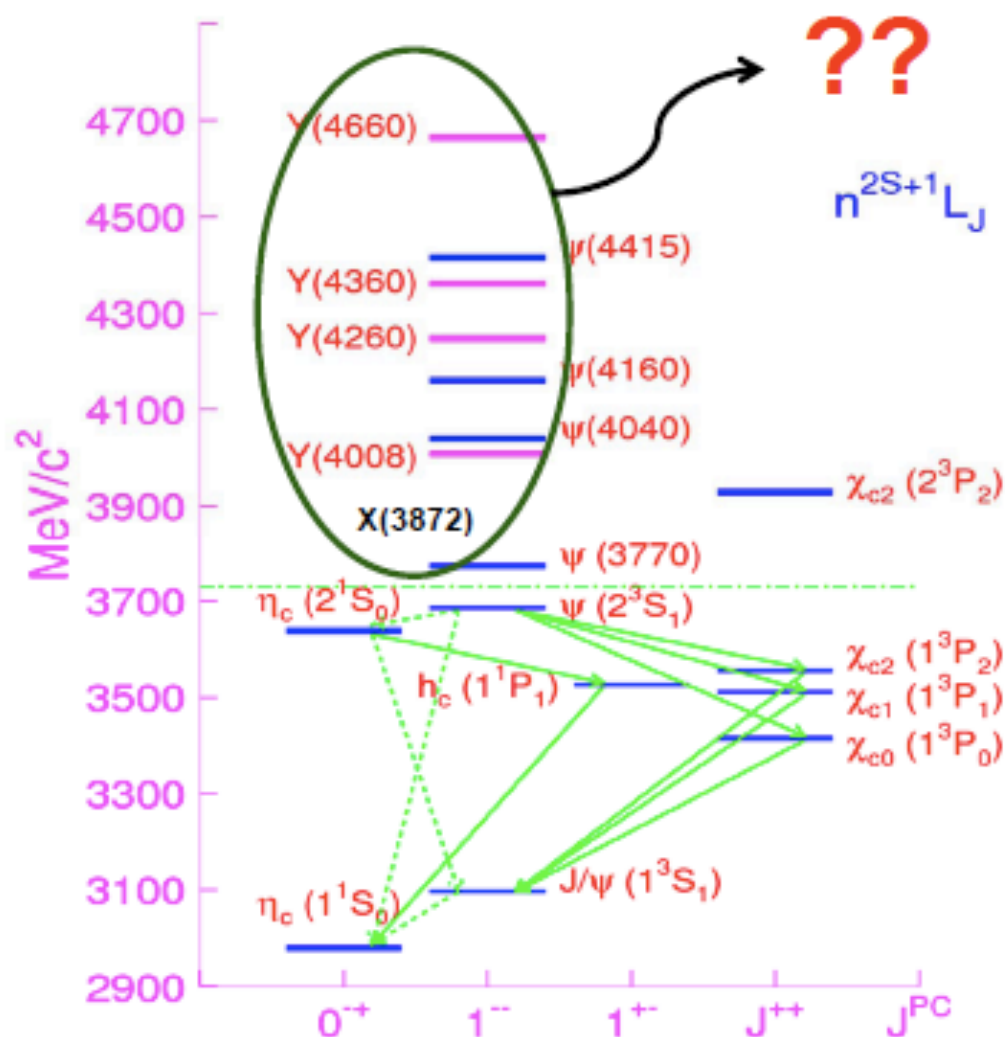
- Rich of **resonances**: charmonia and charmed mesons
- **Threshold** characteristics (pairs of τ , D , D_s , ...)
- **Transition between** smooth and resonances, perturbative and non-perturbative QCD
- Energy location of the: **glueballs**, **exotic states** and **hybrids**



Charmonium physics

- Clean environment, largely produced.
- A transition region from pQCD to non-pQCD.
- Study production, decays, transition.
- New states above open charm threshold.

Current charmonium spectrum



The BESIII Detector

NIM A614 (2010)

Drift Chamber (MDC)

$$\sigma_{P/P} (^{\circ}/_o) = 0.5\%(1\text{GeV})$$

$$\sigma_{dE/dx} (^{\circ}/_o) = 6\%$$

Time Of Flight (TOF)

$$\sigma_T: 90 \text{ ps Barrel}$$
$$110 \text{ ps endcap}$$

Super-conducting
magnet (1.0 tesla)

Muon Counter
8- 9 layers RPC
 $\delta R\Phi = 1.4 \text{ cm} \sim 1.7 \text{ cm}$

EMC: $\sigma_{E/\sqrt{E}} (^{\circ}/_o) = 2.5 \% (1 \text{ GeV})$
(CsI) $\sigma_{z,\phi} (\text{cm}) = 0.5 - 0.7 \text{ cm}/\sqrt{E}$

