Reporte de Actividades

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08 de Junio de 2012

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- UPC
- Cósmicos

International Conference on New Frontiers in Physics
10-16 June 2012 *Kolymbari, Crete, Greece*

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J/psi production in ultra-peripheral heavy-ion collisions at forward rapidity with the ALICE experiment

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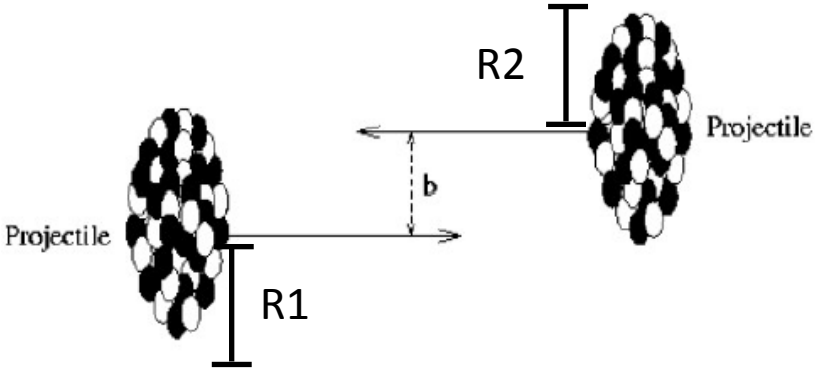
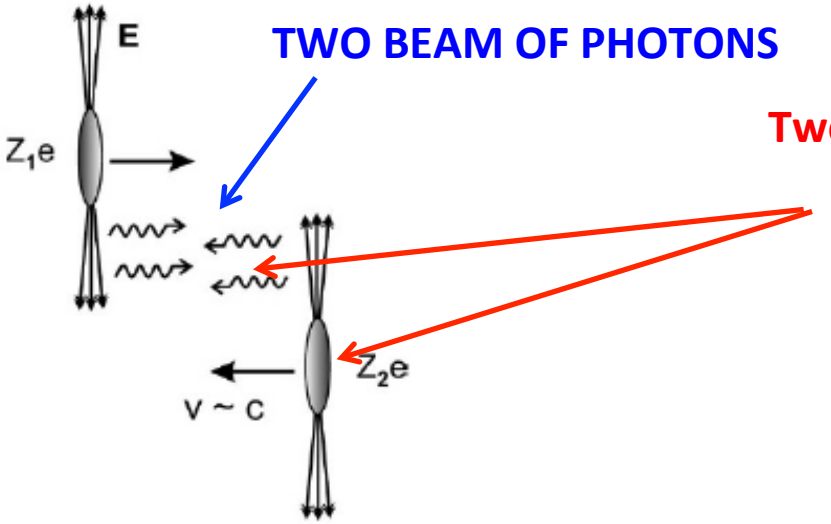
JUNE 15th - ICPF 2012

Physics Motivations

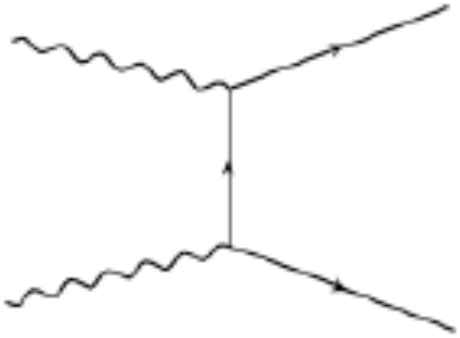


The ultra peripheral collisions occurs if b >R1+R2 ➔ the photons and nuclei can interact in several ways.

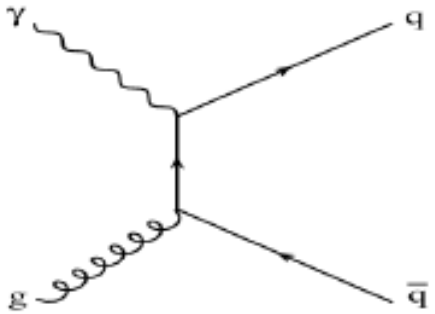
Physics Motivations



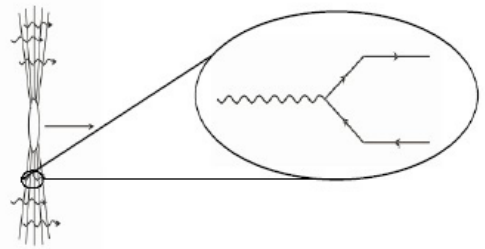
Two ions (or protons) pass by each other with impact parameters b > 2R



1. Electromagnetic interaction: $\gamma + \gamma$

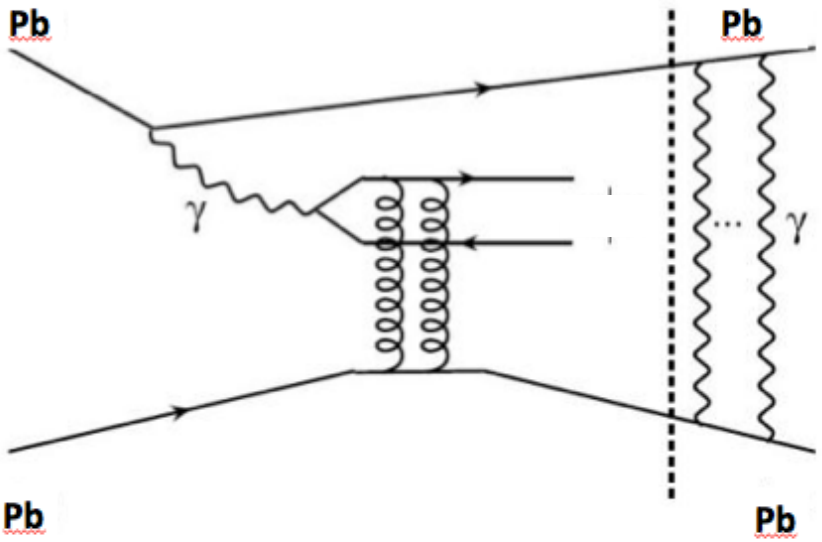


2. Direct photonuclear interaction: *γ +parton (γ+g → qq, g+q →jet+jet)*



3. Resolved photonuclear interaction (VMD), elastic or inelastic

Physics Motivations



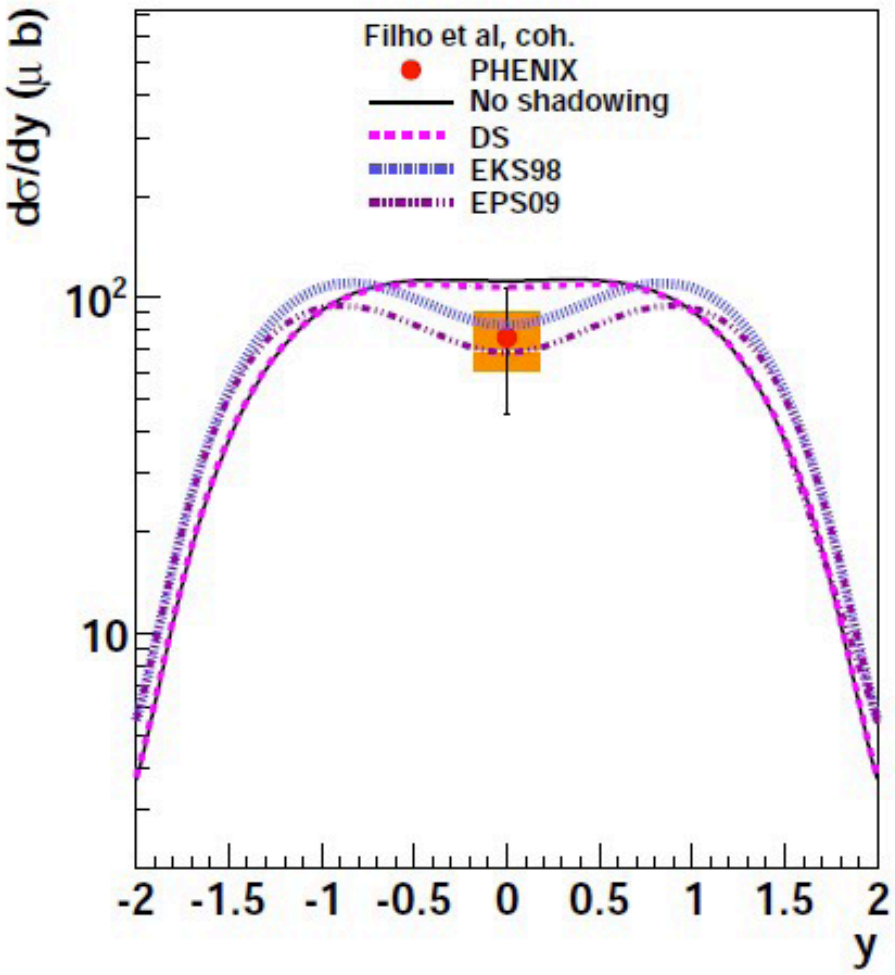
- J/psi, Y
- σ (γp→Vp) calculable from pQCD
- 2-gluon exchange
- Sensitive probe of g(x), $g^2(x)$

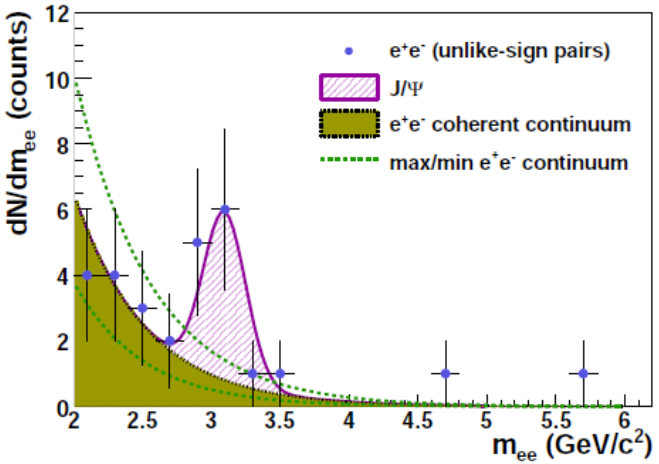
$$\left.\frac{d\sigma(\gamma A \to V A)}{dt}\right|_{t=0} = \frac{\alpha_s^2 \Gamma_{ee}}{3\alpha M_V^5} 16\pi^3 \left[xG_A(x,Q^2)\right]^2 \text{ , with } Q^2 = M_V^2/4 \text{ , and } x = M_V^2/W_{\gamma A}^2$$

Ryskin, Roberts, Martin, Levin, Z. Phys C 76 (1997) 231, Frankfurt LL, McDermott MF, Strikman M, *J. High Energy Physics* 02:002 (1999) and Martin AD, Ryskin MG, Teubner T *Phys.Lett.* B454:339 (1999)

Physics Motivations

PHENIX - RHIC RESULTS

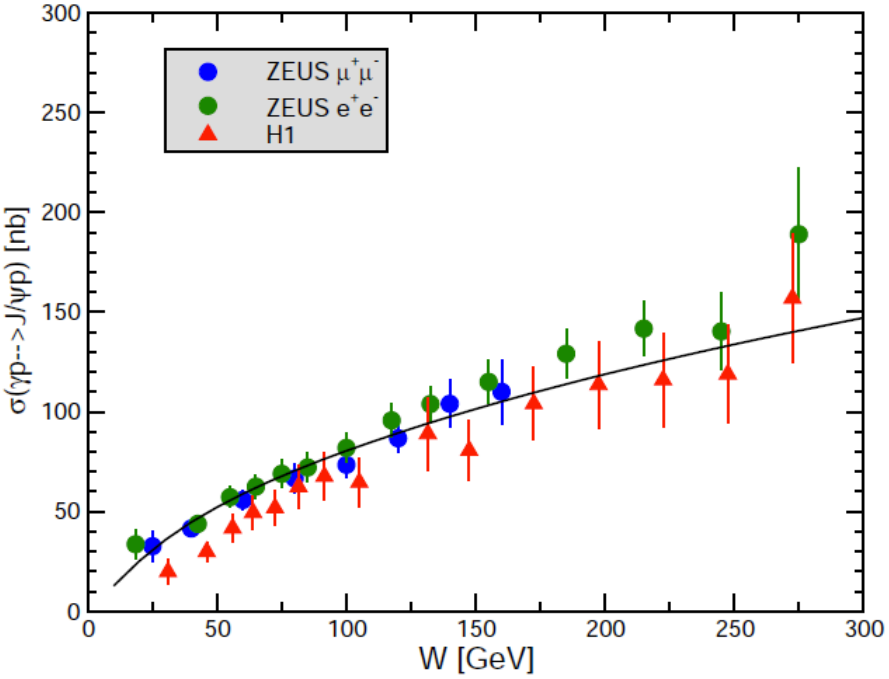


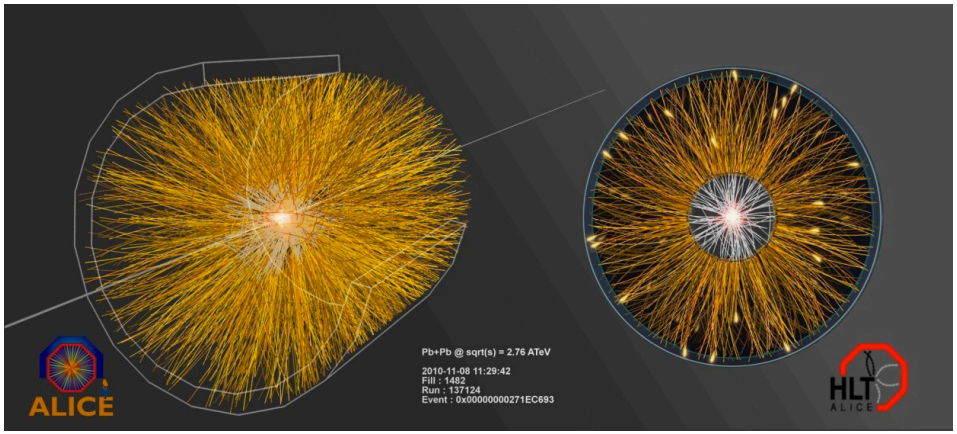


- Two processes
  - **Coherent:** $\gamma + A \rightarrow J/\psi + A$
  - **Incoherent:** $\gamma + A \rightarrow J/\psi + X$, dominated by $\gamma + N \rightarrow J/\psi + N$
- Predicted cross sections
  - Models differ by the way shadowing is taken into account

Au+Au collisions at 200 GeV
PHENIX study:
PLB Vol 679, issue 4, p. 321-333

Physics Motivations





H1: A. Aktas *et al.* Eur.Phys. J.C46:585-603,2006
ZEUS:S. Chekanov et al., Nucl. Phys. B695 (2004) 3.
A. Martin et al. Phys.Lett. B 662:252-258, 2008

LHC: W,max ~ 950 GeV

HERA: W,max ~ 300 GeV

RICH : W,max ~ 34 GeV

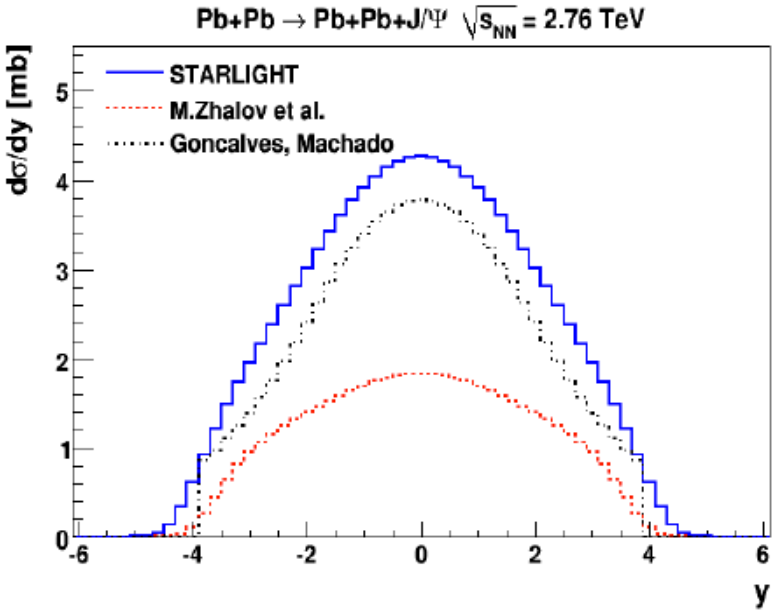
Physics Motivations

Probe the gluon distribution of the nuclei

Total J/ψ cross section: 23 mb (STARLIGHT) *v* 10.3 mb Strikman, Zhalov, et al.

$$\frac{d\sigma_{\gamma T \to J/\psi T}(t=0)}{dt} = \frac{16\Gamma_{ee}\pi^3}{3\alpha_{em}M_{J/\psi}^5}\left[\alpha_s(\mu^2)xG_T(x,\mu^2)\right]^2$$

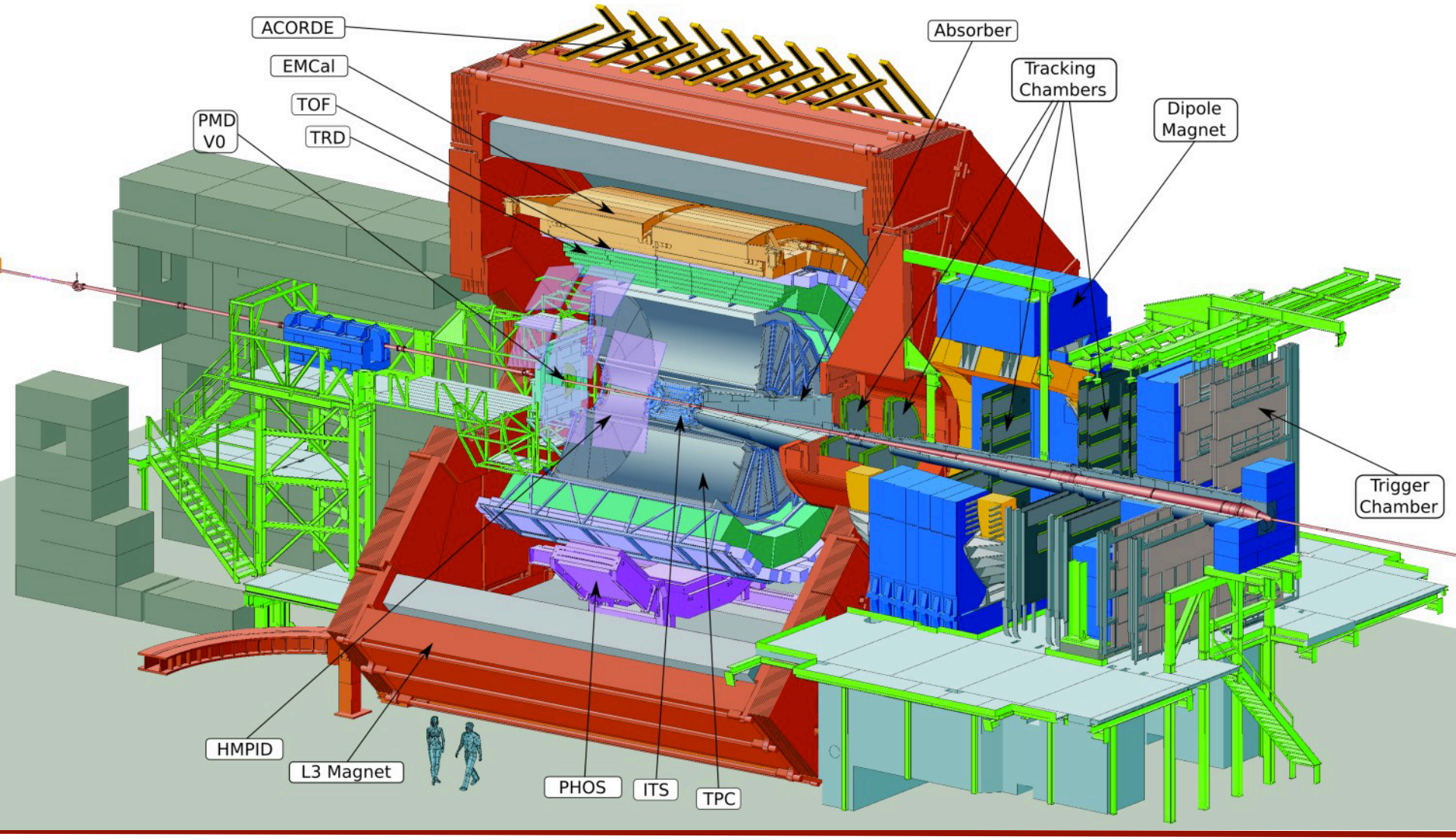
At leading order perturbative QCD, it depends quadratically on the gluon distribution



Should provide a measure of the nuclear gluon shadowing

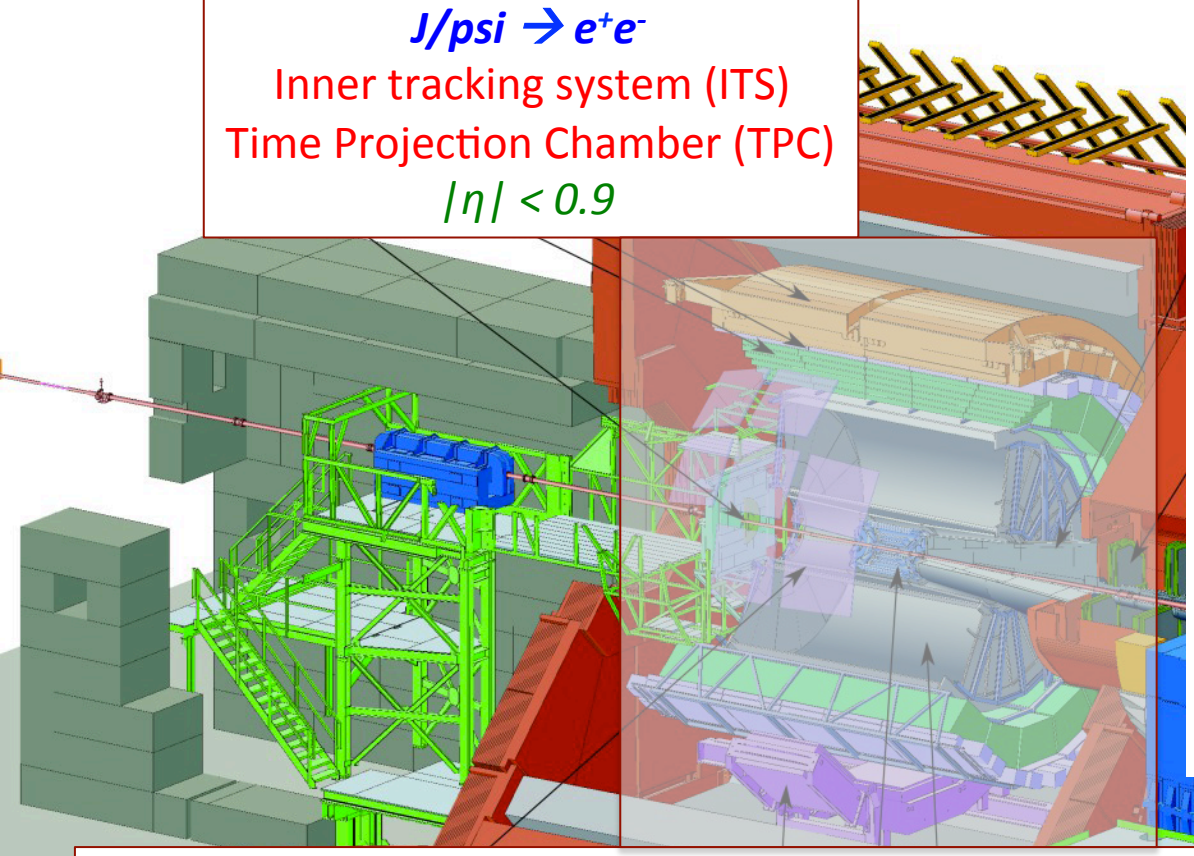
STARLIGHT: S.R.Klein, J.Nystrand
Phys. Rev. C 60 (1999) 014903.
L. Frankfurt, M. Strikman, M. Zhalov
Phys. Lett. B 626 (2005) 72.
V.P. Goncalves, M.V.T. Machado
Phys. Rev. C 84 (2011) 011902.

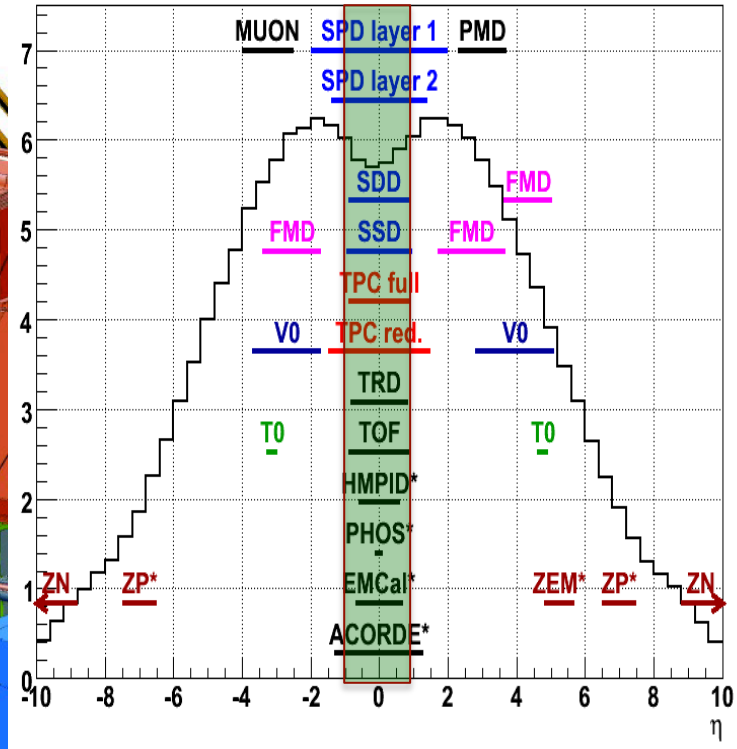
ALICE detector



ALICE detector

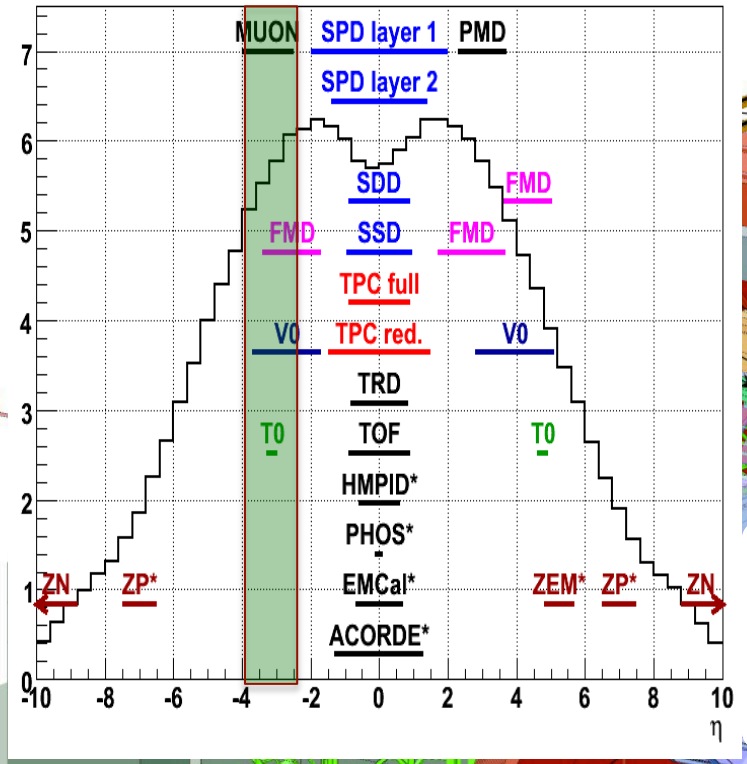
J/psi → e^+e^-
Inner tracking system (ITS)
Time Projection Chamber (TPC)
$|\eta| < 0.9$

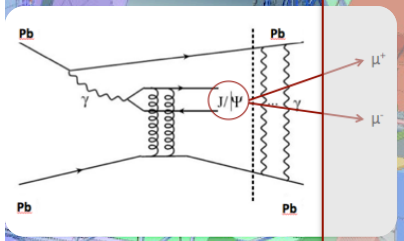




Central rapidity: TOF trigger requiring a hit multiplicity to be between 2 and 6, vetoing signals from both VZERO detectors, and with at least 2 hits in SPD. In addition, at least one of the triggered tracks by TOF has the angular correlation $150^0 < \Delta\phi < 180^0$ ➔ ~8 M central barrel UPC triggers collected in 2011

ALICE detector



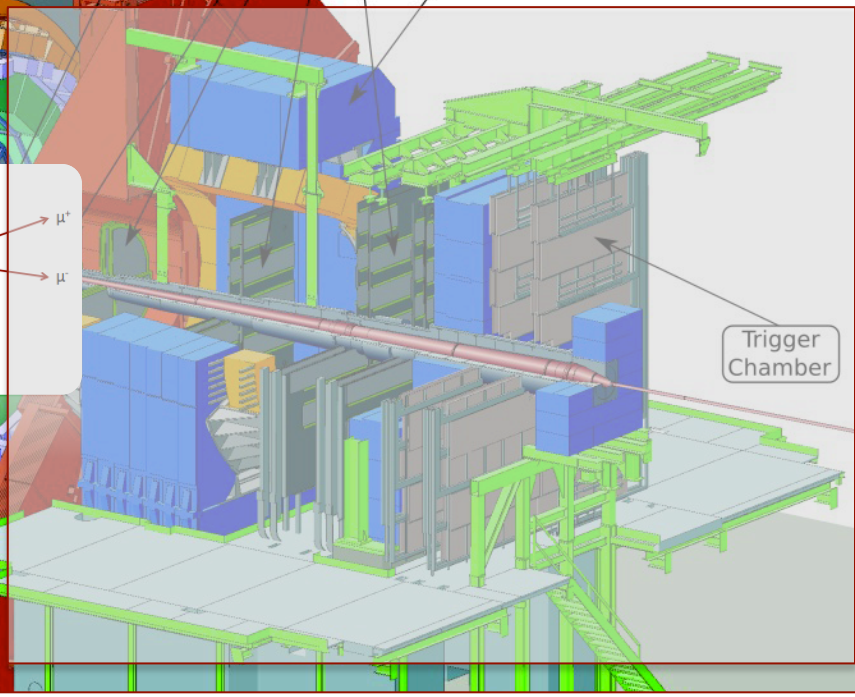


J/psi → $\mu^+\mu^-$

Inner tracking system (ITS)

Time Projection Chamber (TPC)

$-4 < \eta < -2.5$

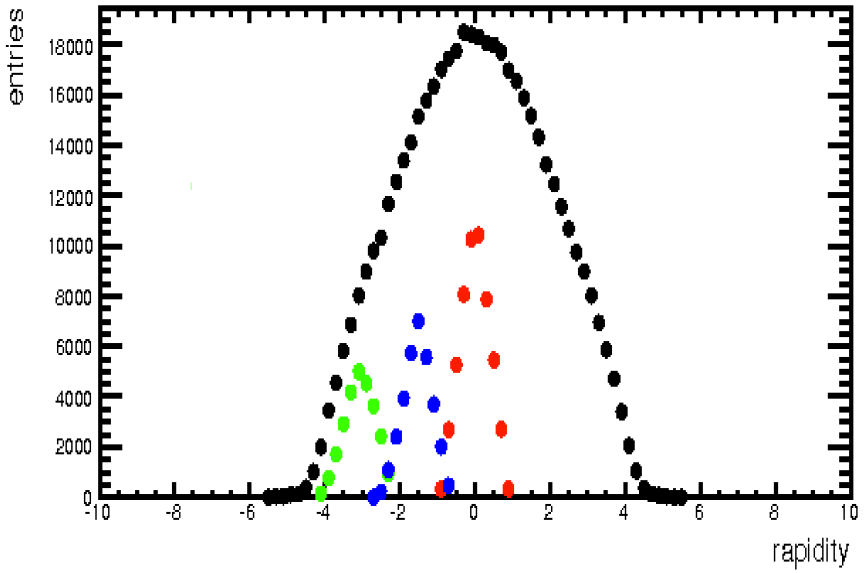


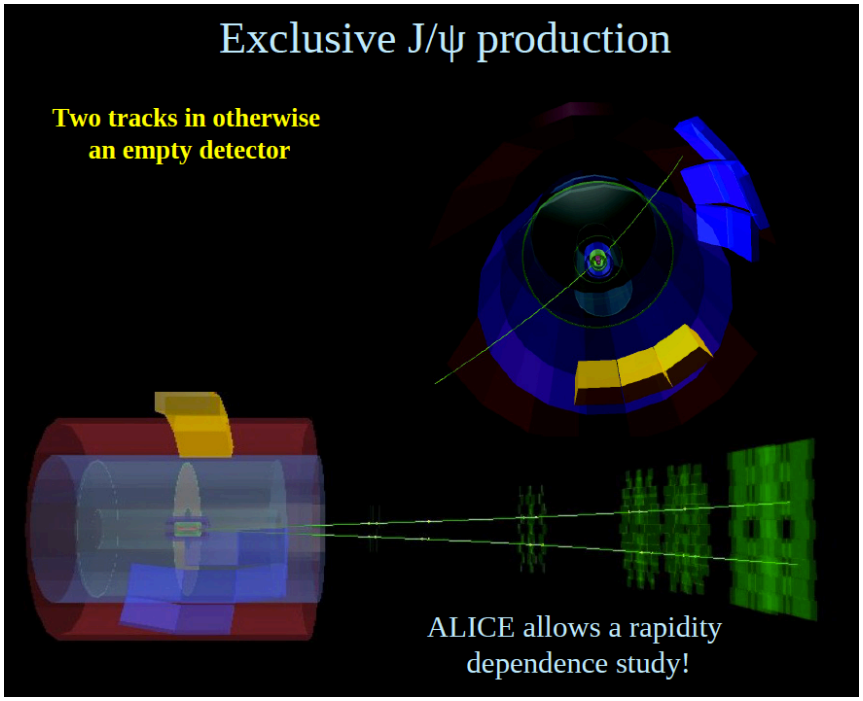
Forward rapidity: Muon arm + VZERO trigger: at least one muon candidate + veto on VZERO-A.

~ 3.4 M muon UPC triggers collected in 2011

Analysis of data

Starlight simulations for coherent J/psi





Three J/psi analysis are possible in ALICE

1. **Both dileptons (muons or electrons) at central rapidity, -0.9<y<0.9**
2. **Both muons at forward rapidity, -4.0 <y< -2.5**
3. **One forward muon and the other at mid-rapidity**

Analysis of data

Luminosity determination

of UPC-fwd. triggers analyzed: 3,161,675 (~ 97.01% of the available statistic)

1 VLN

$$L_{VLN} = \frac{N_{L2a}^{MUP1}}{N_{L0b}^{MUP1}} \cdot \frac{f_{found} N_{VLN}}{\sigma_{VLN}} \qquad (1)$$

where

- N_{L2a}^{MUP1} is the number of *CMUP1-B* triggers at L2a level.
- N_{L0b}^{MUP1} is the number of *CMUP1-B* triggers at L0b level.
- f_{found} is the ratio between the number of CMUP1-B triggers found in the analysis respect to the number of L2a triggers.
- N_{VLN} is the number of L0b VLN triggers.
- $\sigma_{VLN} = 4.1 - 4\% + 7\%\ b$ is the CVLN cross section measured and reported at https://indico.cern.ch/getFile.py/access?contribId=0&resId=0&materialId=slides&confId=187635.

In this case, there is no trigger livetime correction associated to N_{VLN} as it was measured from a trigger class at L0b.

2 1ZED

$$L_{ZDC} = \frac{N_{L2a}^{MUP1}}{N_{L0b}^{MUP1}} \cdot \frac{f_{found} N_{ZDC}}{\sigma_{ZDC}} \qquad (2)$$

where

- N_{L2a}^{MUP1} is the number of *CMUP1-B* triggers at L2a level.
- N_{L0b}^{MUP1} is the number of *CMUP1-B* triggers at L0b level.
- f_{found} is the ratio between the number of CMUP1-B triggers found in the analysis respect to the number of L2a triggers.
- N_{ZDC} is the number of 1ZED triggers.
- $\sigma_{ZDC} = 371.4 \pm 0.6(stat.) + 24 - 19(syst.)b$ is the cross section measured and reported at https://aliceinfo.cern.ch/ArtSubmission/node/100

In this case, there is no trigger livetime correction associated to N_{ZDC} as it was measured from a trigger input rather than from a trigger class.

3 MB

$$L_{MB} = f_D \cdot \frac{N^{MB}(0-90\%)}{0.90 \cdot \sigma^{MB}} \qquad (3)$$

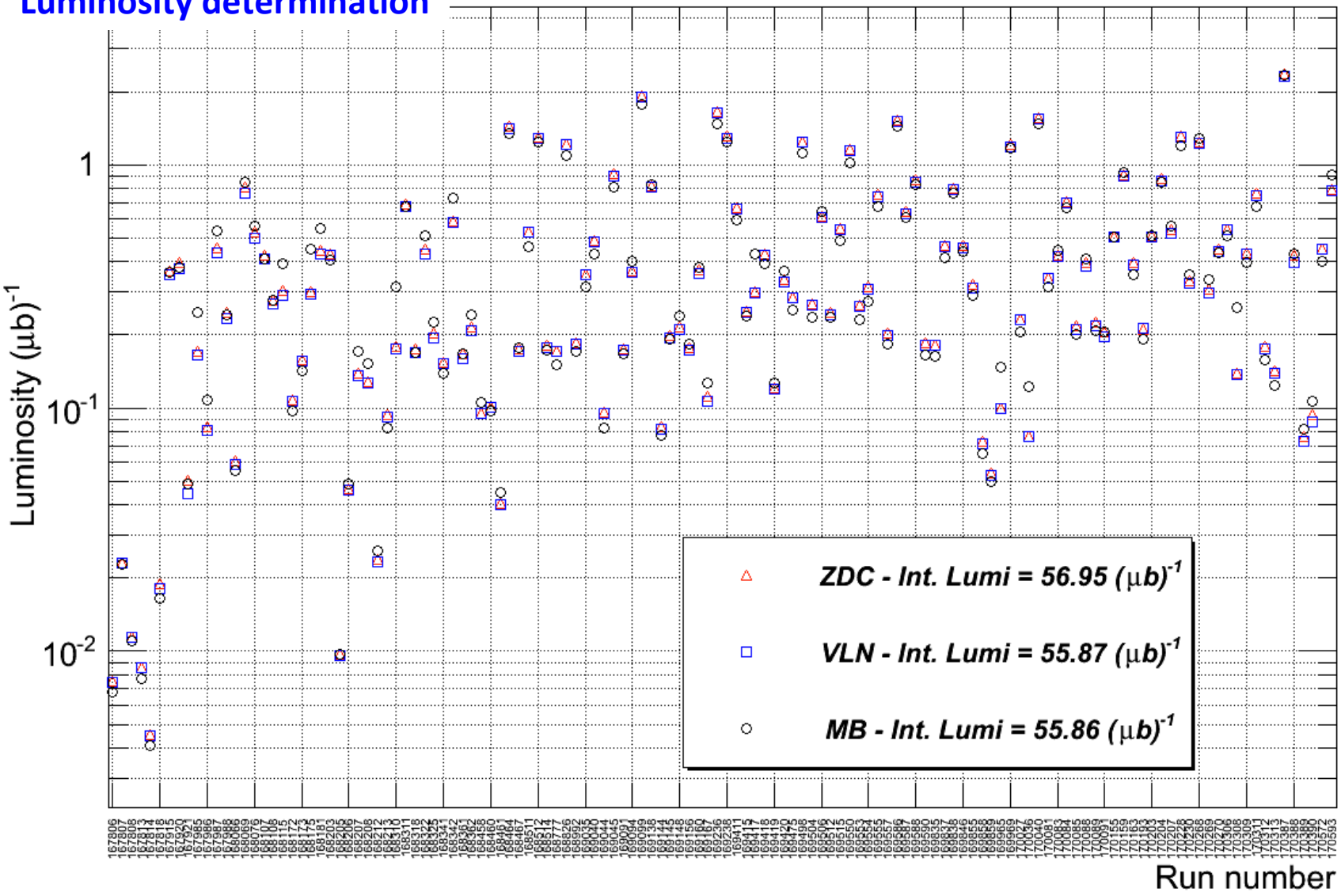
where

- $f_D = \frac{\#\ of\ CPBI1(L0b)\ triggers}{\#\ of\ CPBI2_{B1}(L0b)\ triggers}$
- $N^{MB}(0-90\%)$ is the number of MB triggers found between 0 and 90 % of centrality.
- $\sigma^{MB} = 7.45\ b$.

Because the J/ψ candidates collected by the *MUP1* trigger class and the MB events were measured in the same trigger group, they share the same trigger livetime.

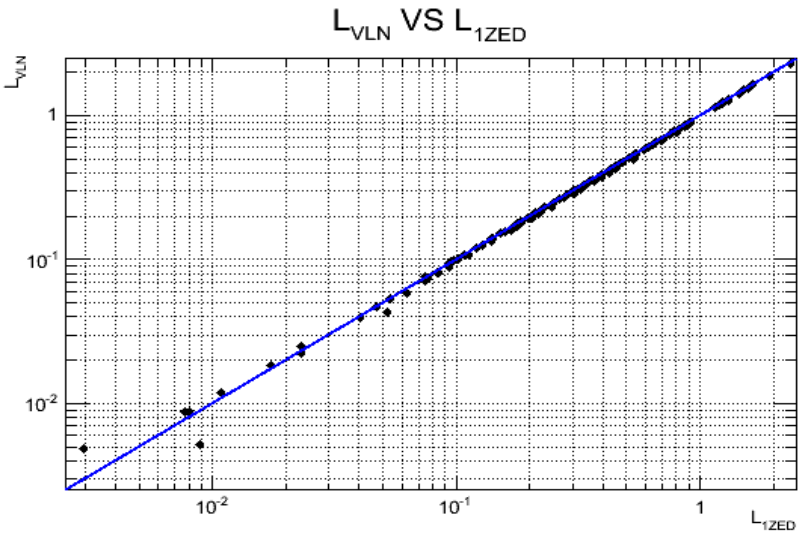
Analysis of data

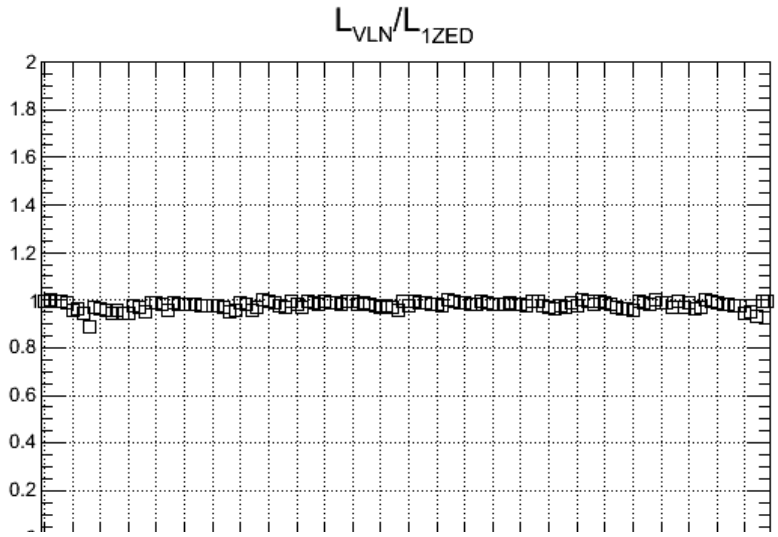
Luminosity determination



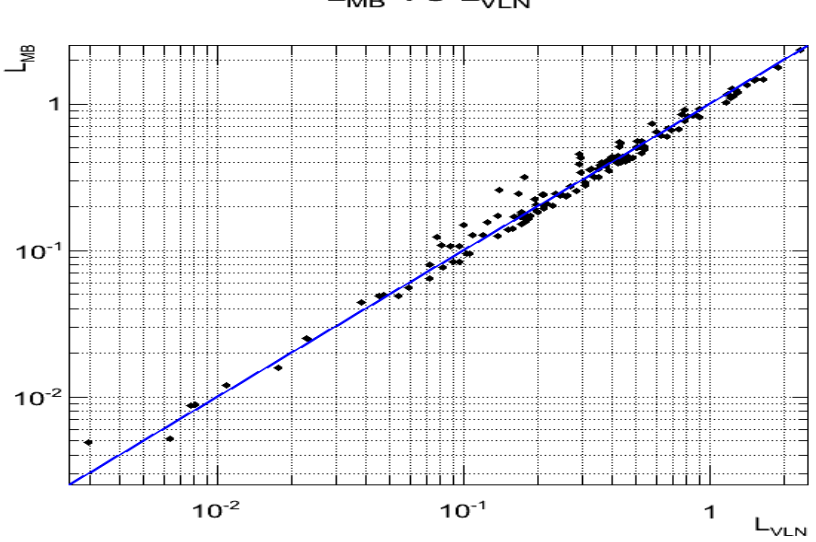
Analysis of data

Luminosity determination





There is good agreement run per run between the VLN and ZDC methods.



Analysis of data

Signal yield extraction

Strategy

1.- Analyze the MC production of UPC events in the forward region (lhc11h period).

2.- Fit the invariant mass spectrum of the J/Ψ (MC) to estimate the values of *sigma, alpha* and *n* for the Crystal Ball model (CB).

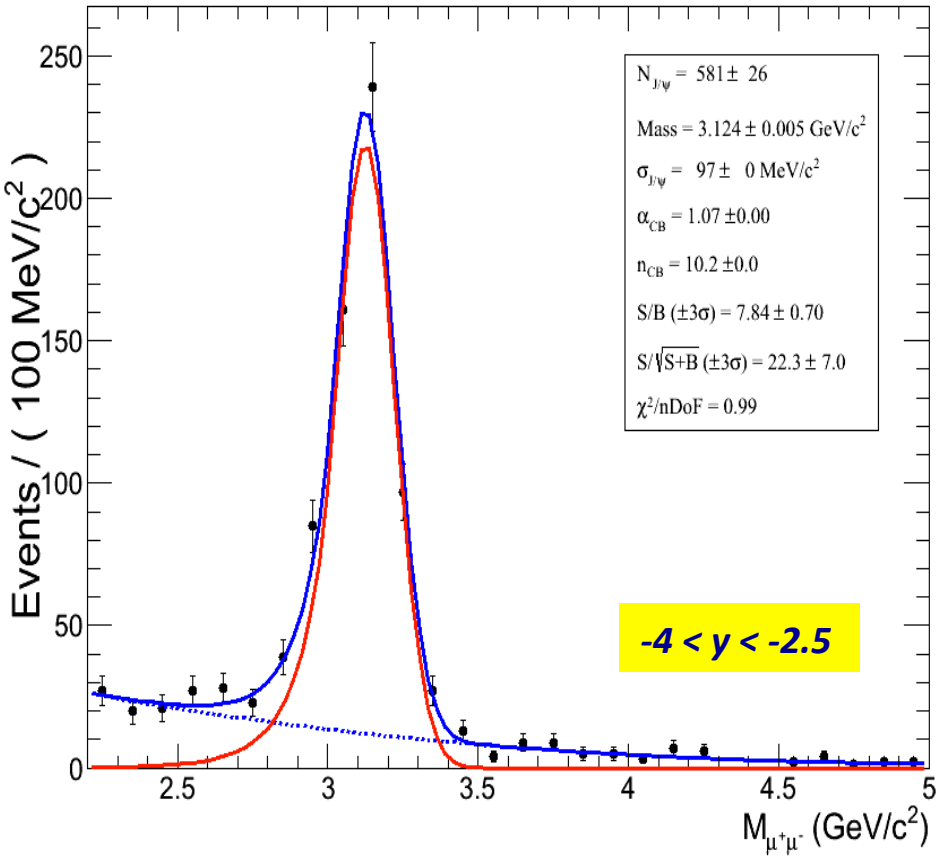
$$f(x;\alpha,n,\bar{x},\sigma) = N \cdot \begin{cases} e^{-\frac{(x-\bar{x})^2}{2\sigma^2}} & for\ \frac{x-\bar{x}}{\sigma} > -\alpha \\ A \cdot (B - \frac{x-\bar{x}}{\sigma})^{-n} & for\ \frac{x-\bar{x}}{\sigma} \leq -\alpha \end{cases}$$

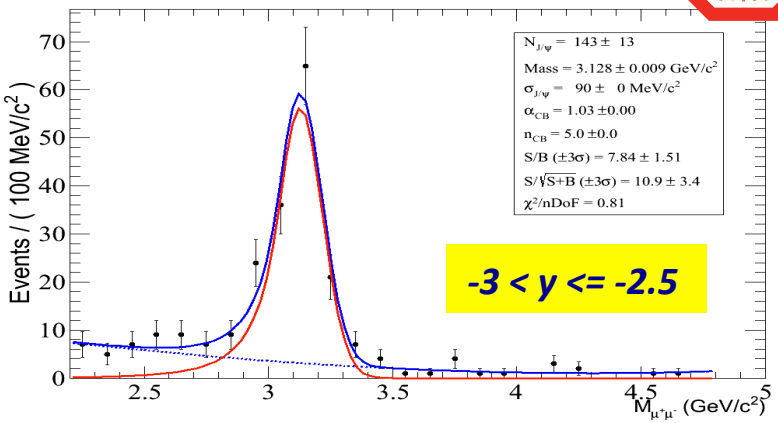
where

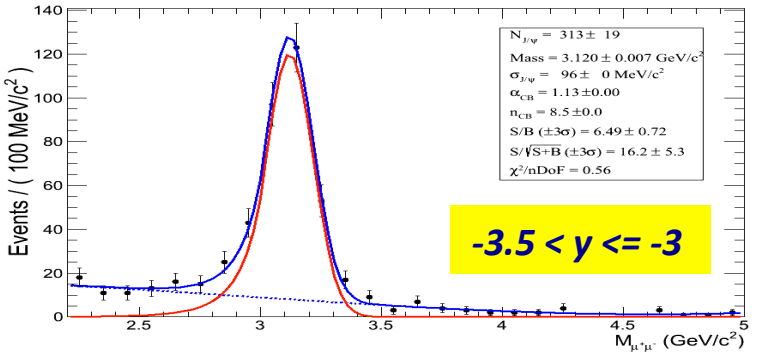
$$A = \left(\frac{n}{|\alpha|}\right)^n \cdot e^{\left(\frac{-|\alpha|^2}{2}\right)} \quad , \quad B = \frac{n}{|\alpha|} - |\alpha| \quad ,$$ **and *N* is a normalization factor**

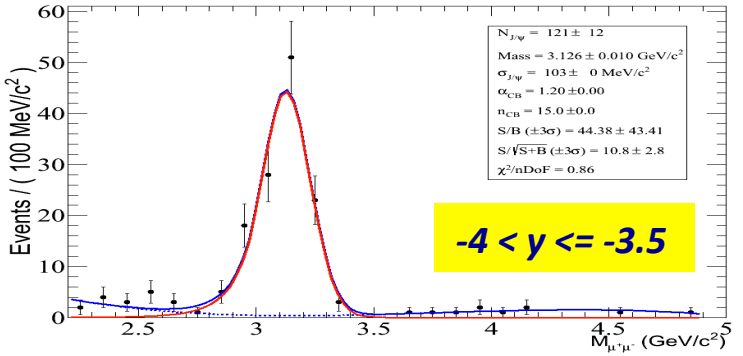
3.- Fit the invariant mass spectrum of the dimuons (lhc11h-data) using the model CB + exponential function (or polynomic functions) fixing the values of *sigma, alpha* and *n* from step 2.

Analysis of data









- Exactly two tracks in the MUON ARM.
- VZERO-C in coincidence with MUON trigger but VZERO-A vetoed.
- At least one track matches the trigger.
- At least one track with pt > 1 GeV/c

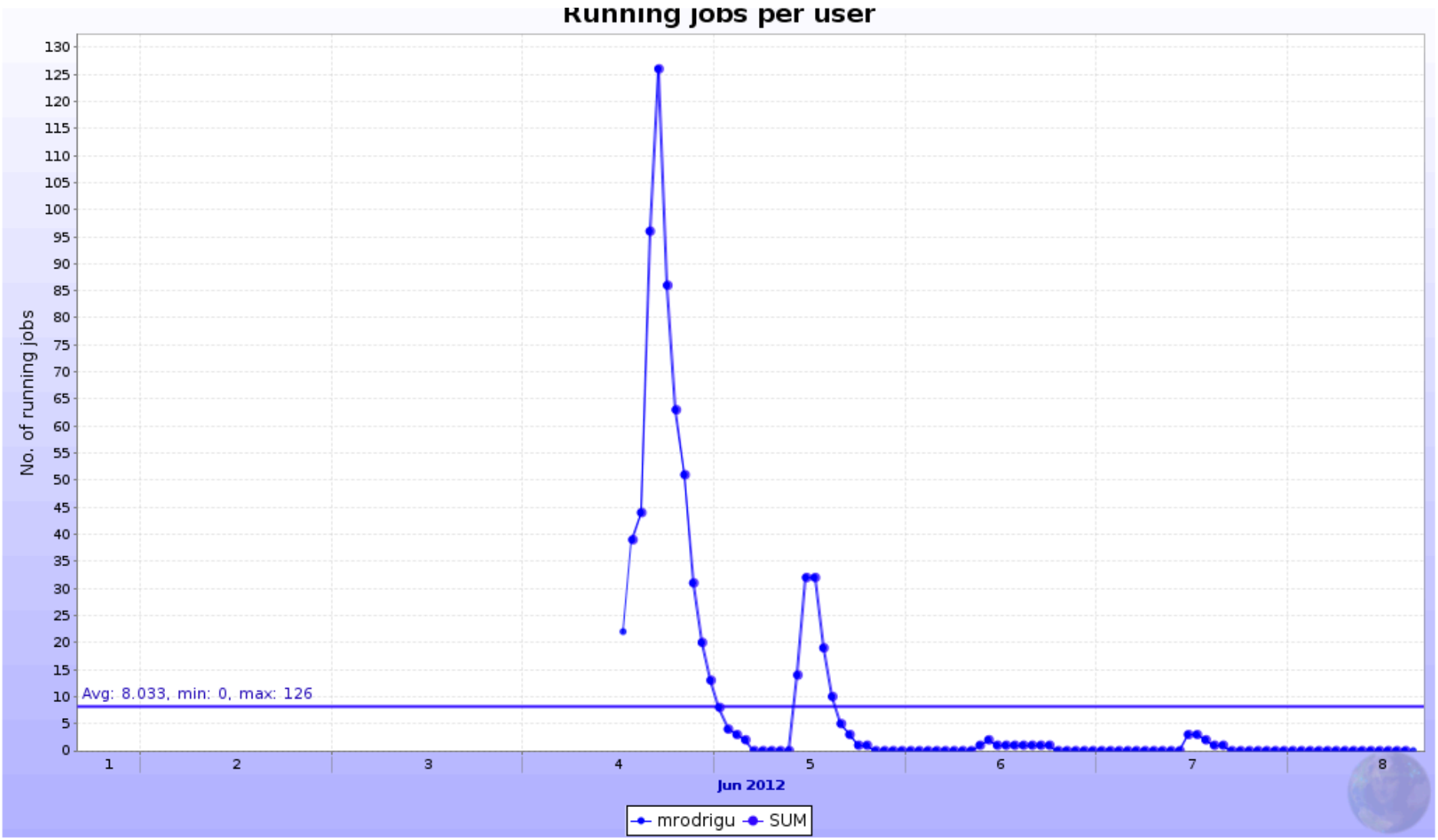
Summary

- The ALICE experiment allows the study of vector meson photo production in ultra peripheral nucleus-nucleus collisions.

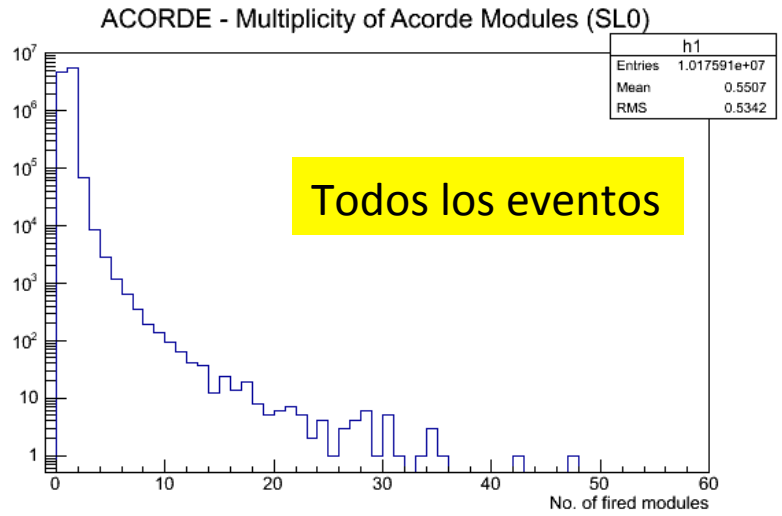
- Exclusive J/Ψ is being studied by ALICE at both central and forward rapidity → access to info on gluon density.

- Measurements of absolute and differential cross sections is almost finished.

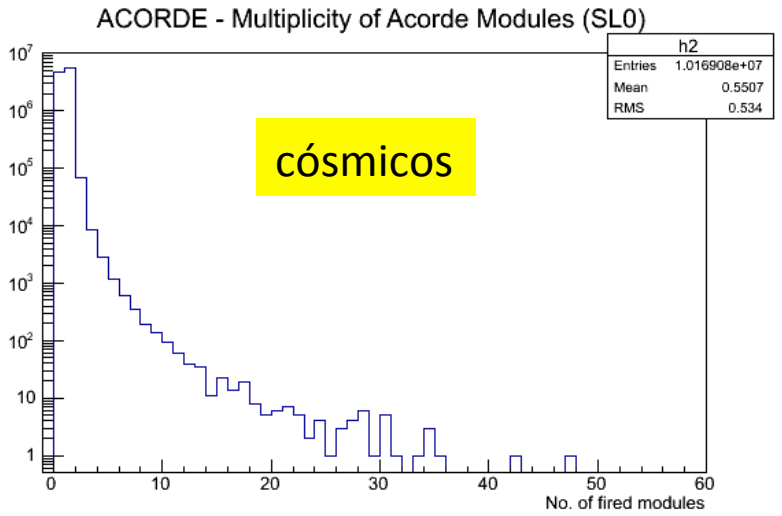
Cósmicos


Running jobs per user
No. of running jobs
130
125
120
115
110
105
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
Avg: 8.033, min: 0, max: 126
1
2
3
4
5
6
7
8
Jun 2012
mrodrigu
SUM

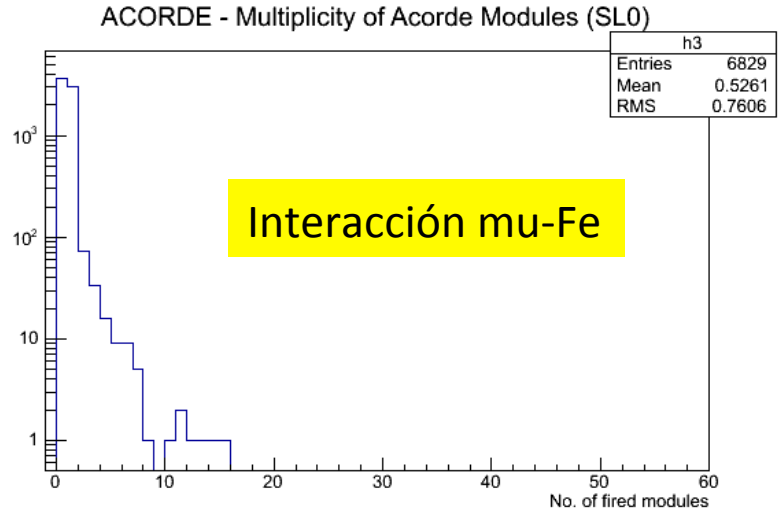
Cósmicos



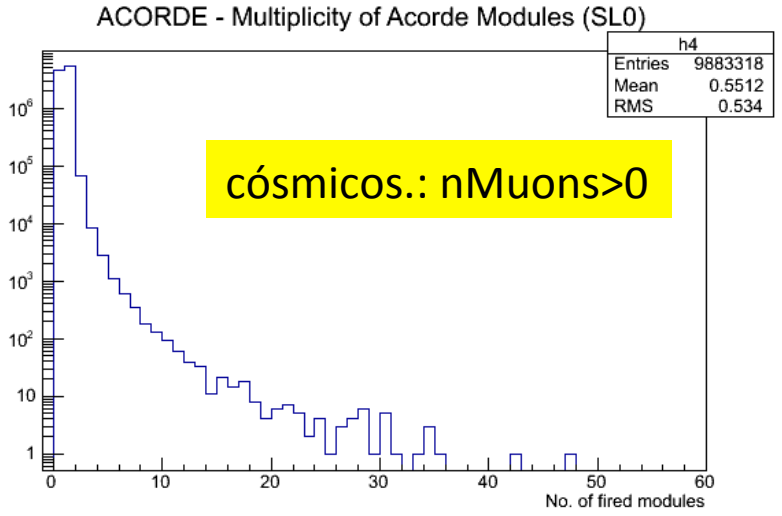
Todos los eventos



cósmicos

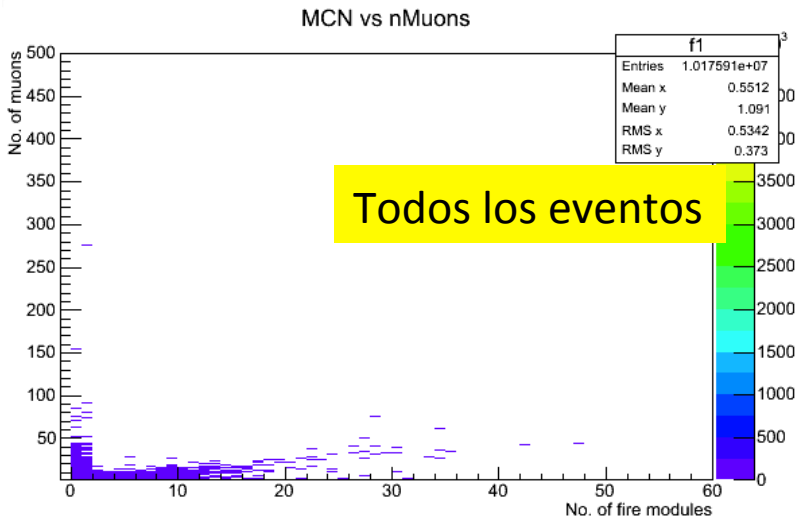


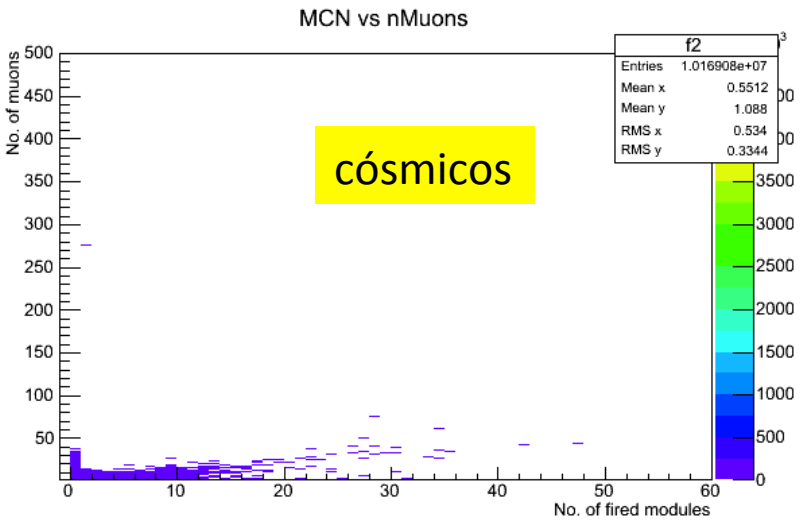
Interacción mu-Fe

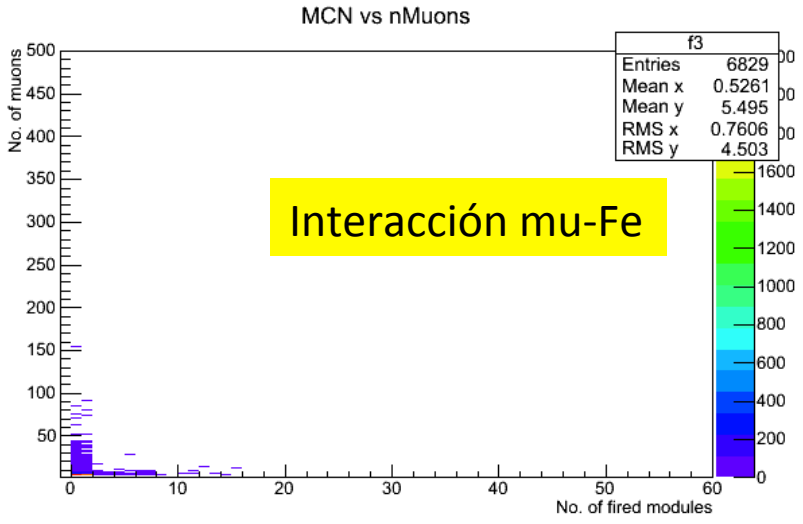


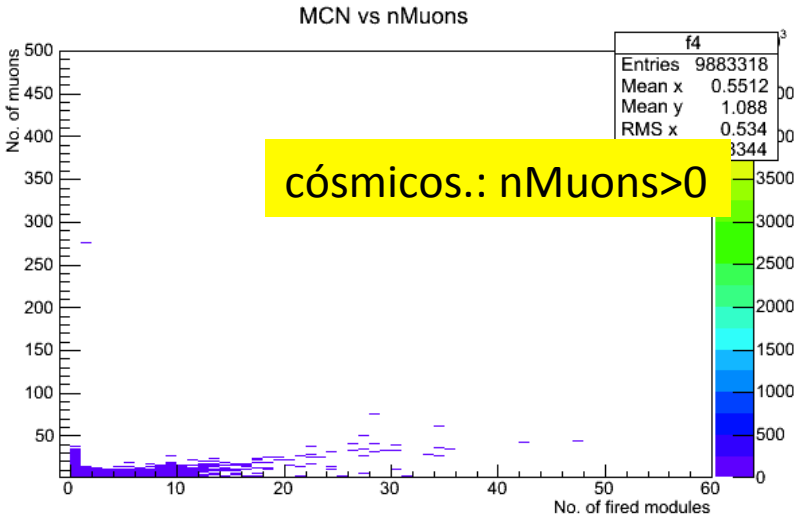
cósmicos.: nMuons>0

Cósmicos

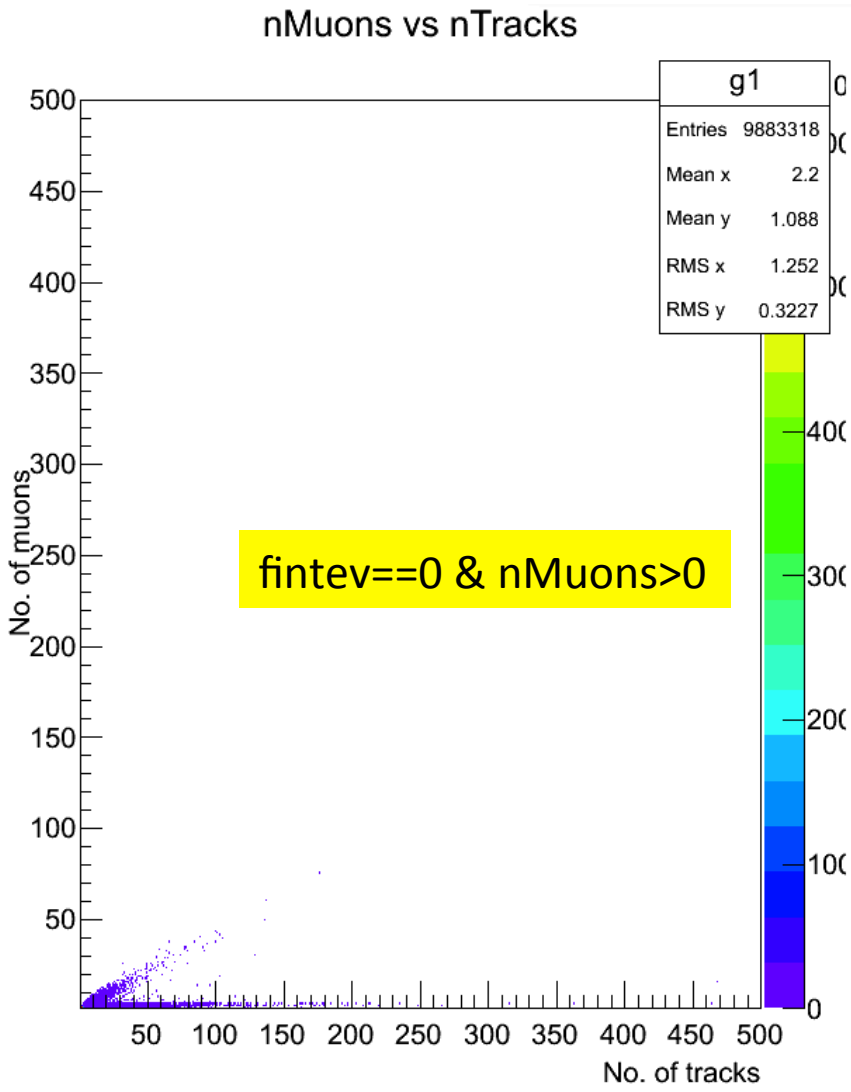

MCN vs nMuons
f1
Entries 1.017591e+07
Mean x 0.5512
Mean y 1.091
RMS x 0.5342
RMS y 0.373
No. of muons
No. of fire modules
Todos los eventos

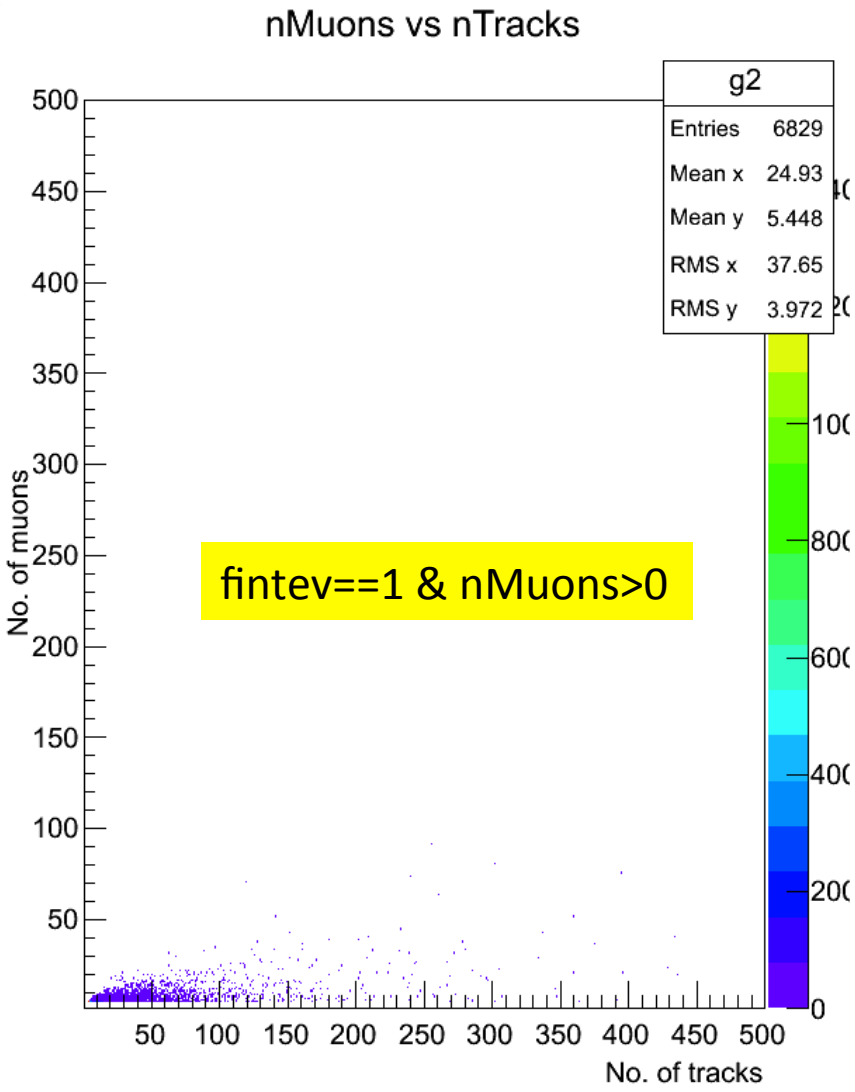

MCN vs nMuons
f2
Entries 1.016908e+07
Mean x 0.5512
Mean y 1.088
RMS x 0.534
RMS y 0.3344
No. of muons
No. of fired modules
cósmicos


MCN vs nMuons
f3
Entries 6829
Mean x 0.5261
Mean y 5.495
RMS x 0.7606
RMS y 4.503
No. of muons
No. of fired modules
Interacción mu-Fe


MCN vs nMuons
f4
Entries 9883318
Mean x 0.5512
Mean y 1.088
RMS x 0.534
No. of muons
No. of fired modules
cósmicos.: nMuons>0

Cósmicos


nMuons vs nTracks
g1
Entries 9883318
Mean x 2.2
Mean y 1.088
RMS x 1.252
RMS y 0.3227
No. of muons
No. of tracks
fintev==0 & nMuons>0


nMuons vs nTracks
g2
Entries 6829
Mean x 24.93
Mean y 5.448
RMS x 37.65
RMS y 3.972
No. of muons
No. of tracks
fintev==1 & nMuons>0

Comentarios finales

- IR A CONFERENCIA EN CRETA
- PRIMERA PARTE DE LA TESIS A ENVIAR DOMINGO
- SE APLICÓ A POSTDOC CON EL GRUPO DE STRASBOUG Y SE ENVÍO ANTEPROYECTO A GINES PARA SUBATECH