Comentarios sobre las actividades en PWG-UD

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V Congreso de la Red Mexicana Científica y Tecnológica para ALICE-LHC (Red ALICE)

28/09/2018

PLAN OF THE TALK

- Introduction
- Cosmics
- Diffraction
- UPC
- Upgrade (FIT and ACORDE)
- Final comments

Introduction

ALICE Physics Working Groups

Physics Working Group	Public link (ALICE internal)	Conveners
Flow and Correlations	PWG-CF (internal)	Anthony Timmins, Ilya Selyuzhenkov, You Zhou
Dileptons and Quarkonia	PWG-DQ (internal)	Roberta Arnaldi, Torsten Dahms
Photons, Neutral Mesons	PWG-GA (internal)	Ana Marin, Dmitry Peresunko
Heavy Flavour	PWG-HF (internal)	Andrea Rossi, Alessandro Grelli
Jets	PWG-JE (internal)	Leticia Cunqueiro Mendez, Tatsuya Chujo
Light Flavour Spectra	PWG-LF (internal)	Alexander Kalweit, Stefania Bufalino
Ultraperipheral and Diffraction	PWG-UD (internal)	Evgeny Kryshen, Guillermo Contreras Nuno
Monte Carlo generators and Minimum Bias Physics	PWG-MM (internal)	Jochen Klein, Paolo Bartalini

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Introduction

- PWG-MM - Monte Carlo generators and Minimum Bias physics
  - Rivet and Generators (Redmer Bertens, Jochen Klein)
  - Luminosity (Jesus Guillermo Contreras Nuno, Martino Gagliardi)
  - Multiplicity (Anton Alkin, Valentina Zaccolo)
  - Underlying Event (Paolo Bartalini, Peter Christiansen)

Lucina Gabriela Espinoza (PhD student, UAS)

https://indico.nucleares.unam.mx/event/1426/contribution/7

Introduction

EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

ALICE

CERN

ALICE-PUBLIC-2016-To be specified

ALICE luminosity determination for pp collisions at $\sqrt{s} = 5$ TeV

ALICE Collaboration*

Abstract

Luminosity determination in ALICE is based on visible cross sections measured in van der Meer scans. In November 2015, the Large Hadron Collider provided proton-proton collisions at a centre-of-mass energy of $\sqrt{s} = 5$ TeV. A van der Meer scan was performed, where the cross section was measured for two classes of visible interactions, based on particle detection in the ALICE luminometers: the T0 detector with pseudorapidity coverage $4.6 < \eta < 4.9$, $-3.3 < \eta < -3.0$ and the V0 detector with pseudorapidity coverage $2.8 < \eta < 5.1$, $-3.7 < \eta < -1.7$. This document describes the experimental setup for such a measurement and reports its results. The analysis procedure used was described in a previous publication dedicated to the 13 TeV luminosity determination.

EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

ALICE

CERN

ALICE-ANA-2015-xxx
May 31, 2016

Analyses of van der Meer scans taken with pp collisions in 2015

A. Borissov[1], D. Caffarri[2], J. G. Contreras[3], L. G. Espinoza[4] M. Gagliardi[5], A. Konevskikh[6], I. Králik[7], Ch. Mayer[8] A. Morreale[9], H. Pereira da Costa[10], and J. Song[1]

1. Pusan National University, Pusan, South Korea
2. CERN
3. Faculty of Nuclear Sciences and Physical Engineering Czech Technical University in Prague, Czech Republic
4. Universidad Autonoma de Sinaloa, Culiacan, Mexico
5. Dipartimento di Fisica dell'Università and Sezione INFN, Turin, Italy
6. Institute for Nuclear Research, Academy of Sciences, Moscow, Russia
7. Institute of Experimental Physics, Slovak Academy of Sciences, Košice, Slovakia
8. The Henryk Niewodniczanski Institute of Nuclear Physics, Polish Academy of Sciences, Cracow, Poland
9. SUBATECH, Ecole des Mines de Nantes, Universit de Nantes, CNRS-IN2P3, Nantes, France
10. Commissariat à lEnergie Atomique, IRFU, Saclay, France.

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Introduction

PAG	Coordinators	Meetings
Ultra Peripheral Collisions	Michal Broz (Prague) and Christoph Mayer (Polish Academy of Sciences (PL))	Link (Tue 14h00)
Diffraction	R. Orava (Helsinki) and R. Schicker (Heidelberg)	Link (Thu 16h00)
Cosmics	B. Alessandro (INFN - Torino) and A. Fernandez (UAP-Puebla)	Link (Fri 17h00)

- Emma González Hernández (PhD student, cosmic charge ratio)
- Abraham Villatoro Tello (PhD student, selection of diffractive events)
- Sergio Paisano Guzmán (B.S. student, Central production of pi+pi- in diffractive events and rho0 photo-production)

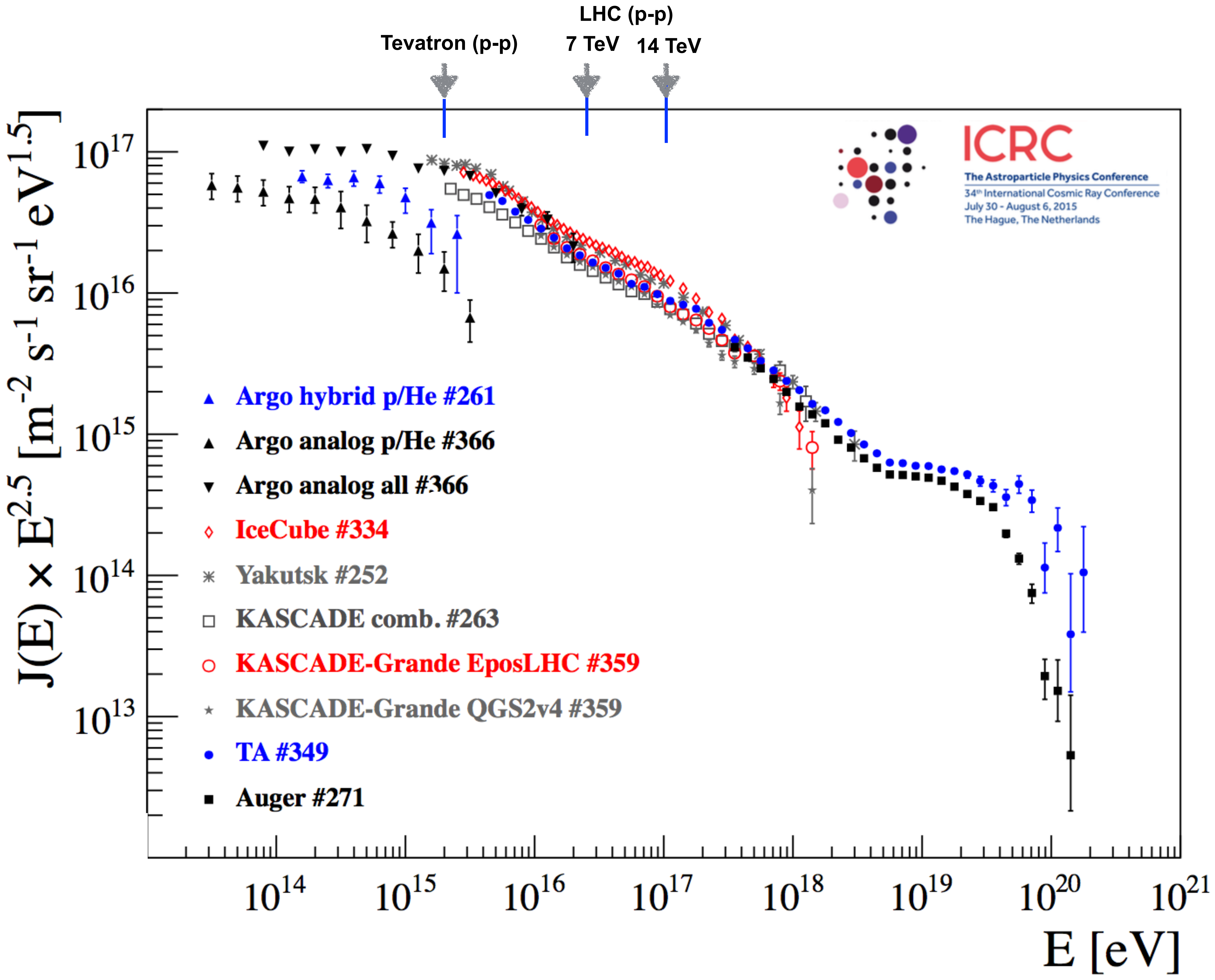
Cosmic rays (CR)

- constitute one of the most energetic forms of extraterrestrial radiation that the Earth receives from outer space. They arrive at Earth with an energy from few MeV (10^8 eV) to 100EeV (10^{20}eV)

- mainly composed by atomic nuclei

- at high energies, the origin of this radiation is unknown. Recently, the Pierre Auger Observatory found some clues on the extragalactic origin of the ultra-high energetic CR (Science **357**, 1266-1270 (2017))

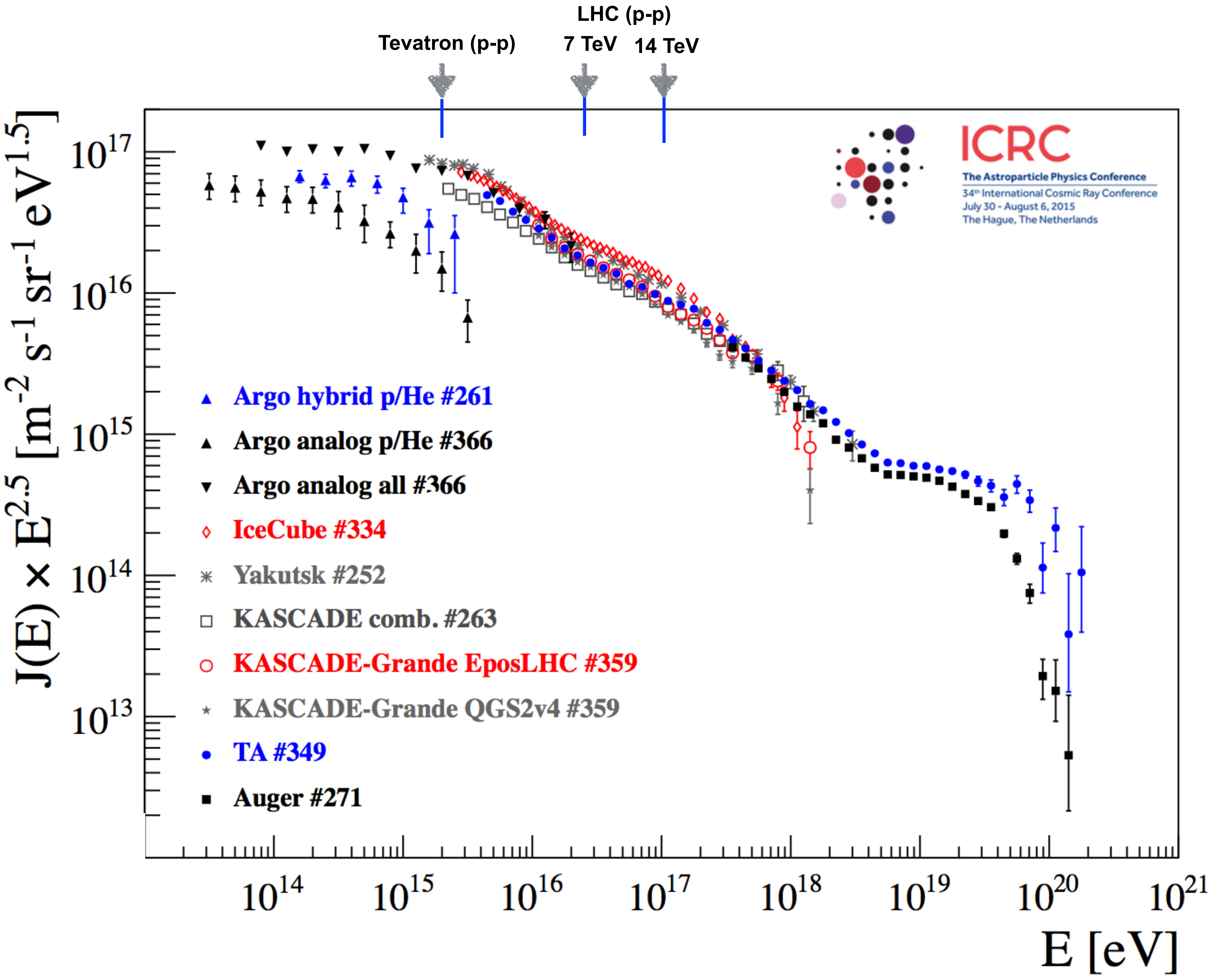
- details of CR acceleration mechanisms, composition, propagation, through the space, and features in their spectrum are not completely understood



LHC (p-p)
Tevatron (p-p)
7 TeV
14 TeV
ICRC
The Astroparticle Physics Conference
34th International Cosmic Ray Conference
July 30 - August 6, 2015
The Hague, The Netherlands
J(E) × E^2.5 [m^-2 s^-1 sr^-1 eV^1.5]
10^17
10^16
10^15
10^14
10^13
Argo hybrid p/He #261
Argo analog p/He #366
Argo analog all #366
IceCube #334
Yakutsk #252
KASCADE comb. #263
KASCADE-Grande EposLHC #359
KASCADE-Grande QGS2v4 #359
TA #349
Auger #271
10^14
10^15
10^16
10^17
10^18
10^19
10^20
10^21
E [eV]

$E^{-\gamma}$

$2.6 < \gamma < 3.3$



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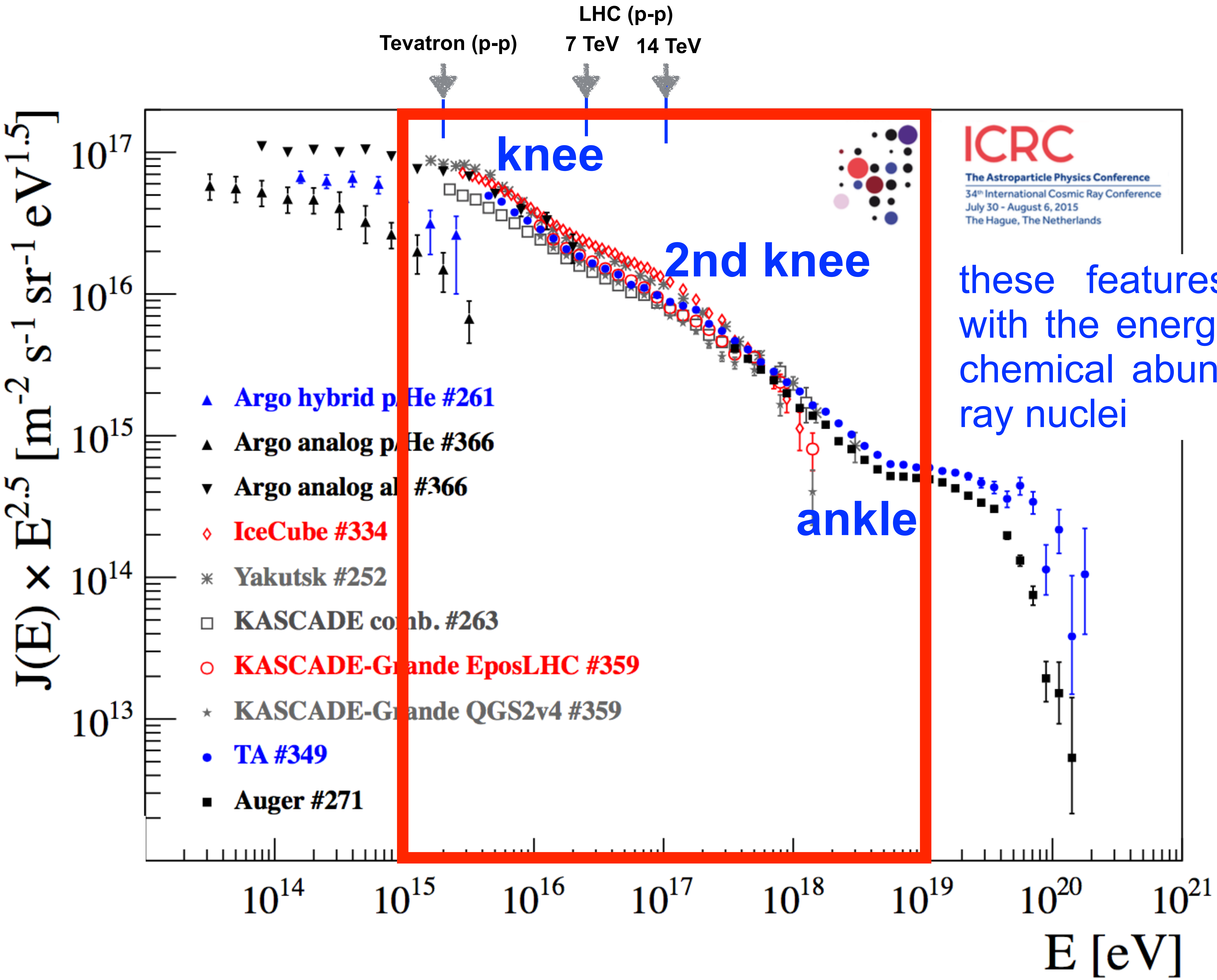
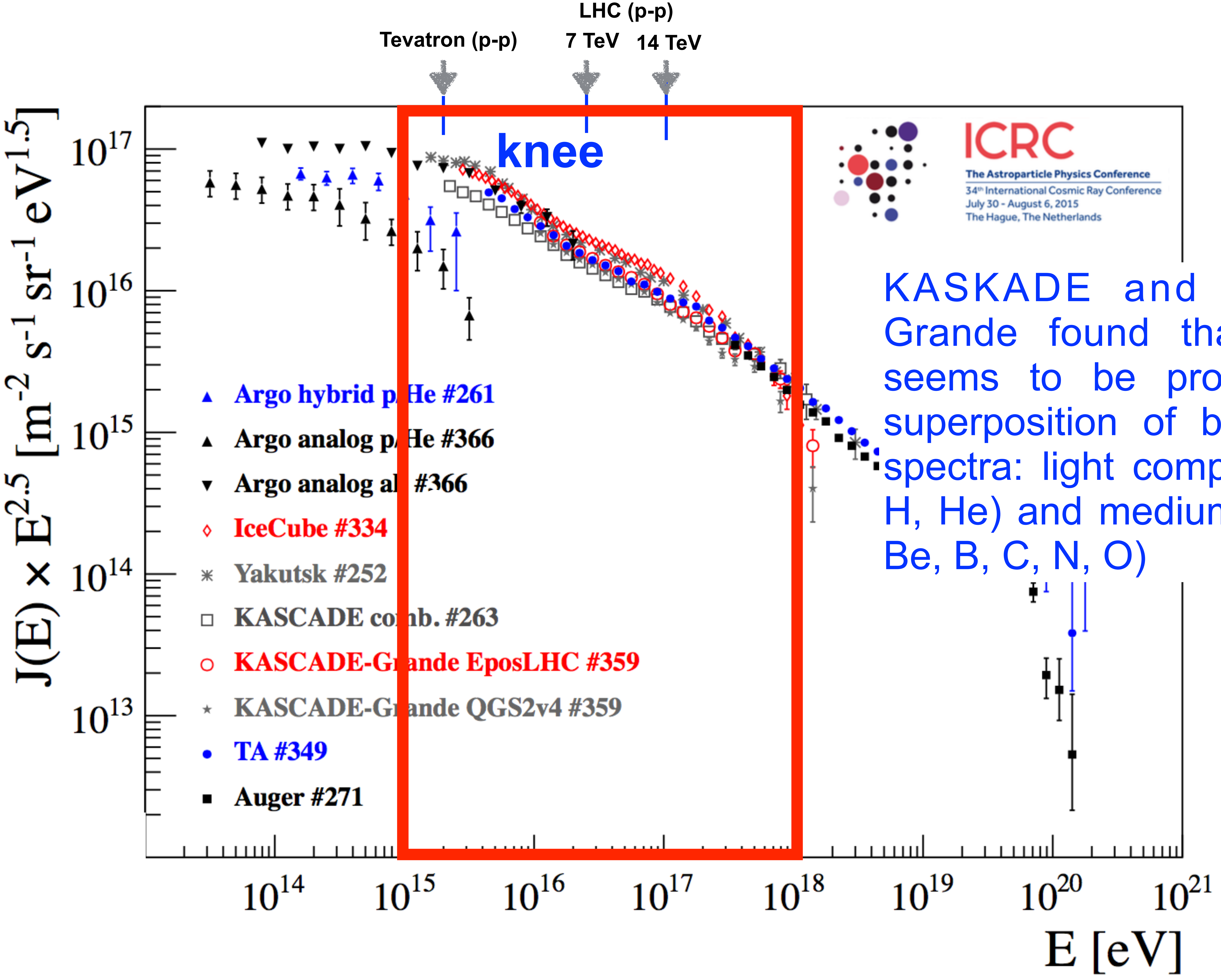


these features are connected with the energy evolution of the chemical abundance of cosmic-ray nuclei

$E^{-\gamma}$

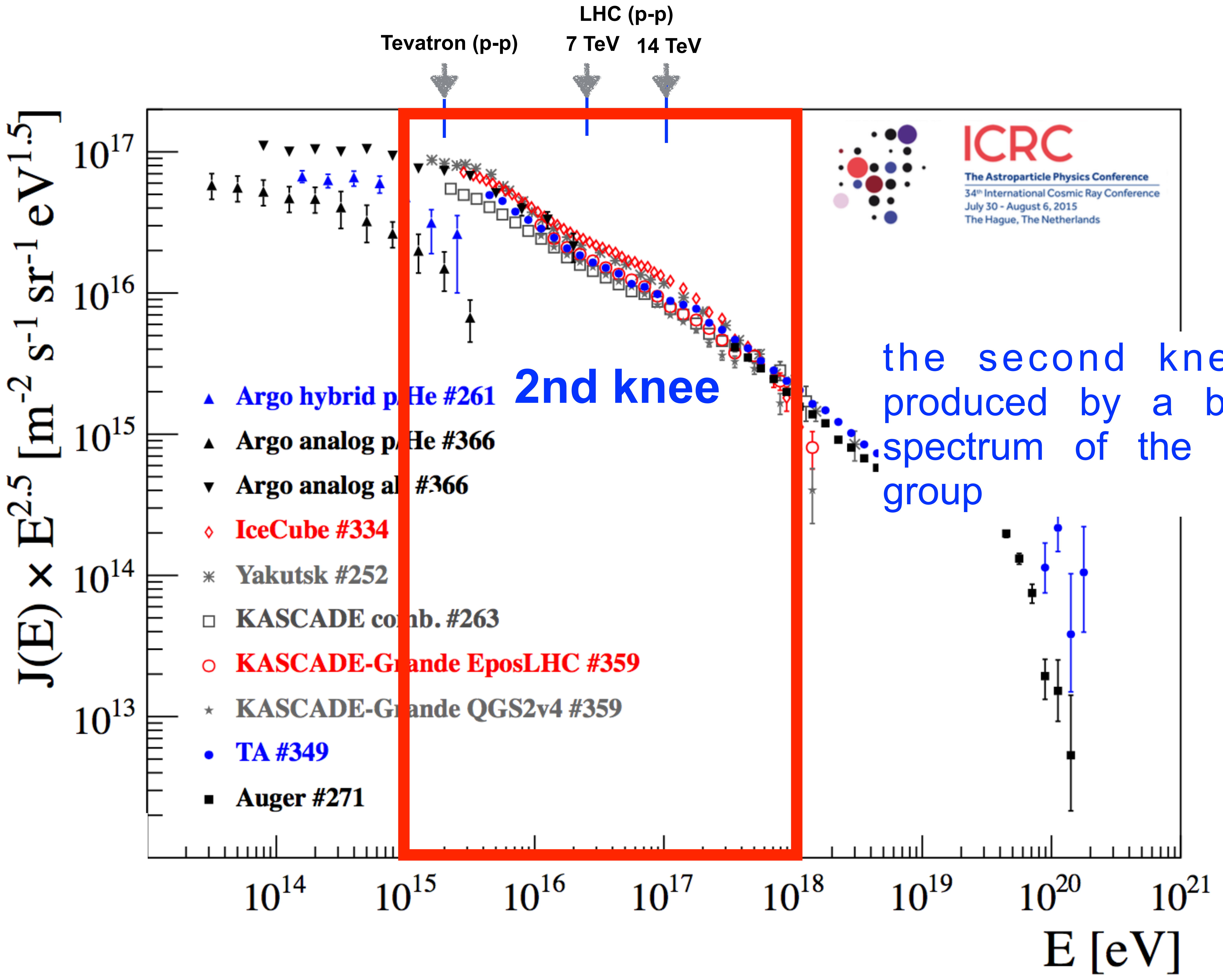
$2.6 < \gamma < 3.3$



KASKADE and KASKADE-Grande found that the knee seems to be produced by a superposition of breaks in the spectra: light composition (Z<3, H, He) and medium (3 < Z < 9, Be, B, C, N, O)

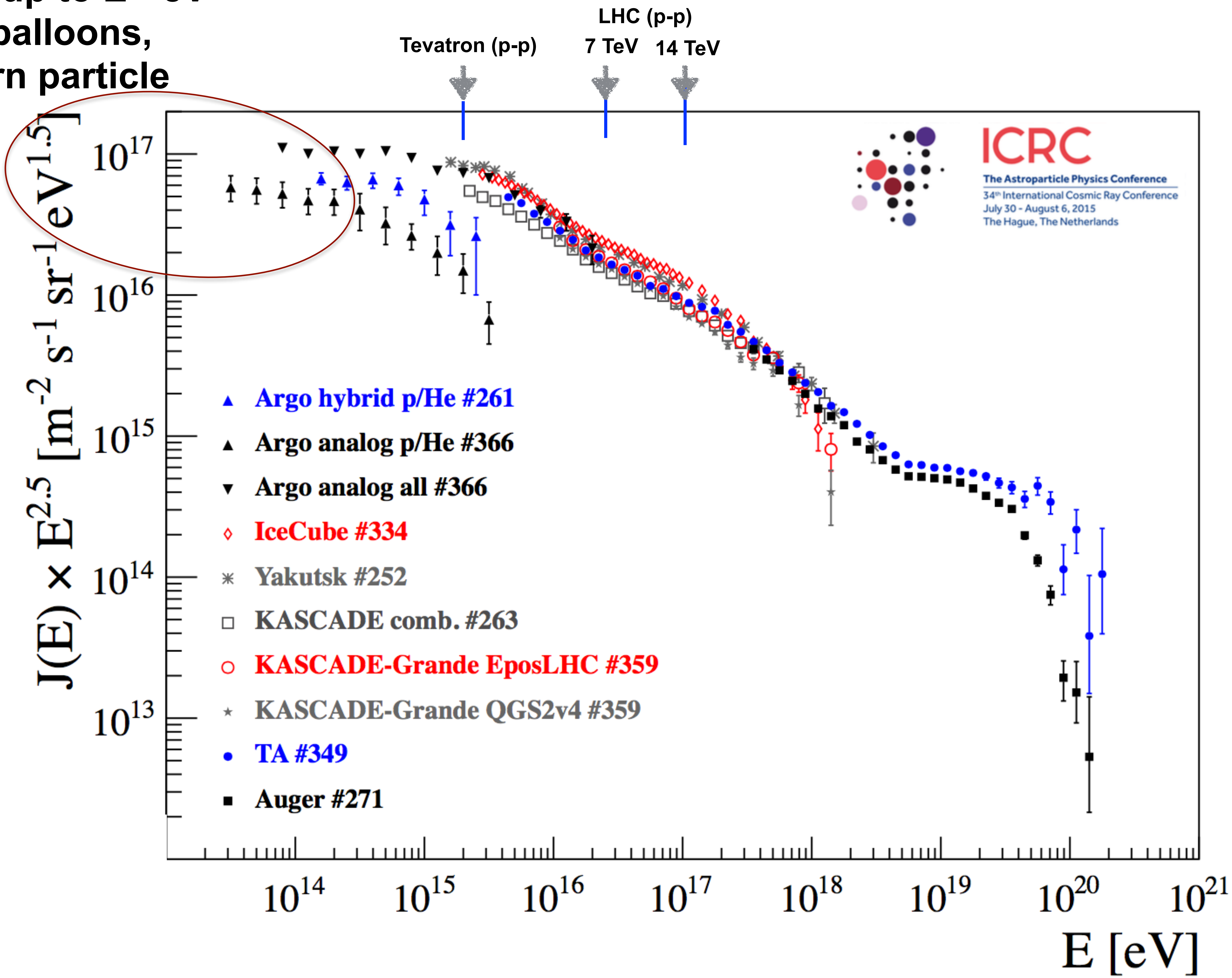
$E^{-\gamma}$

$2.6 < \gamma < 3.3$



the second knee may be produced by a break in the spectrum of the heavy mass group

Direct measurements up to E14 eV primary particles (balloons, satellites, space born particle detectors)



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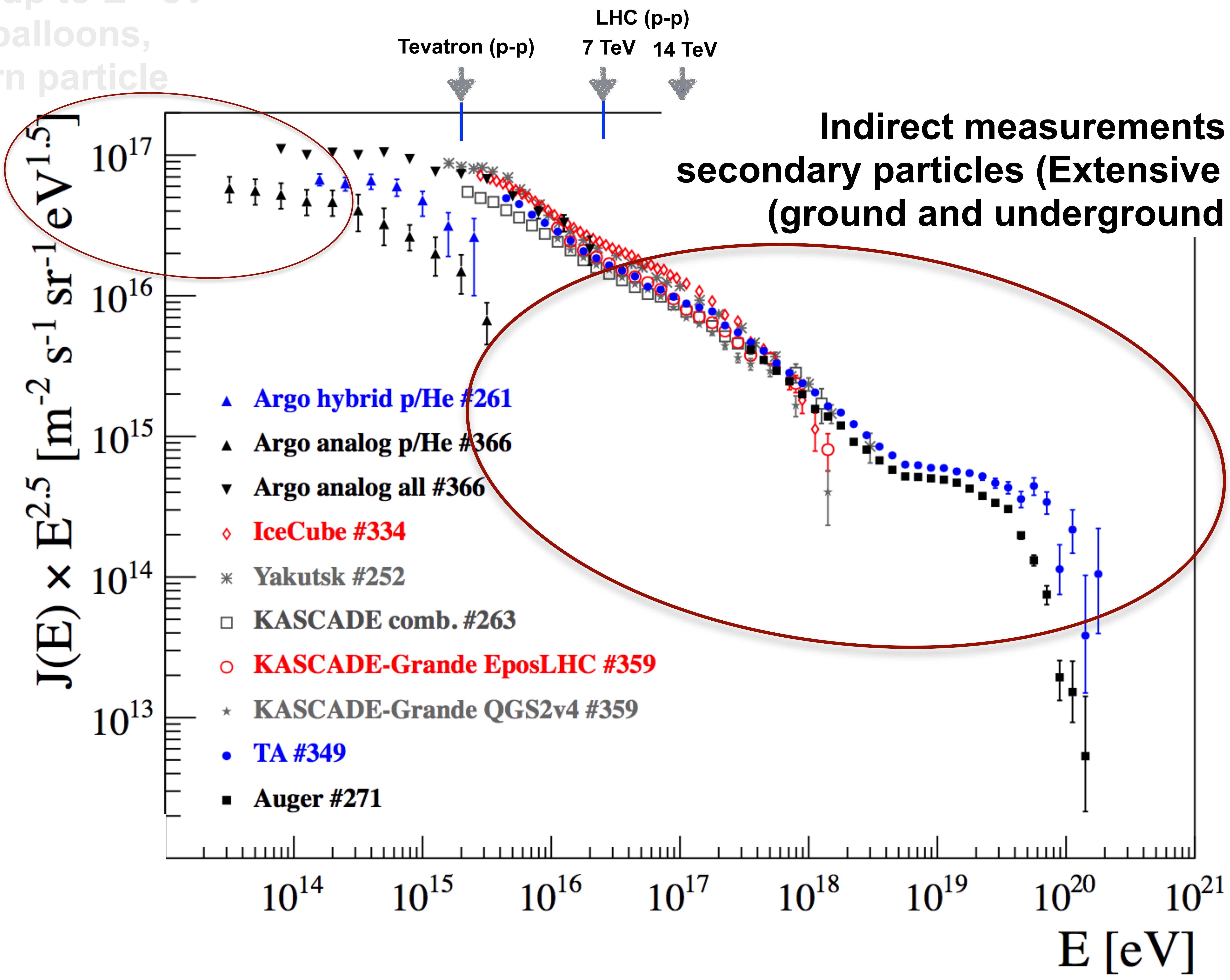

Indirect measurements $E>10^{14}$ eV secondary particles (Extensive Air Showers, EAS) (ground and underground experiments)

Direct measurements up to E^{14} eV primary particles (balloons, satellites, space born particle detectors)

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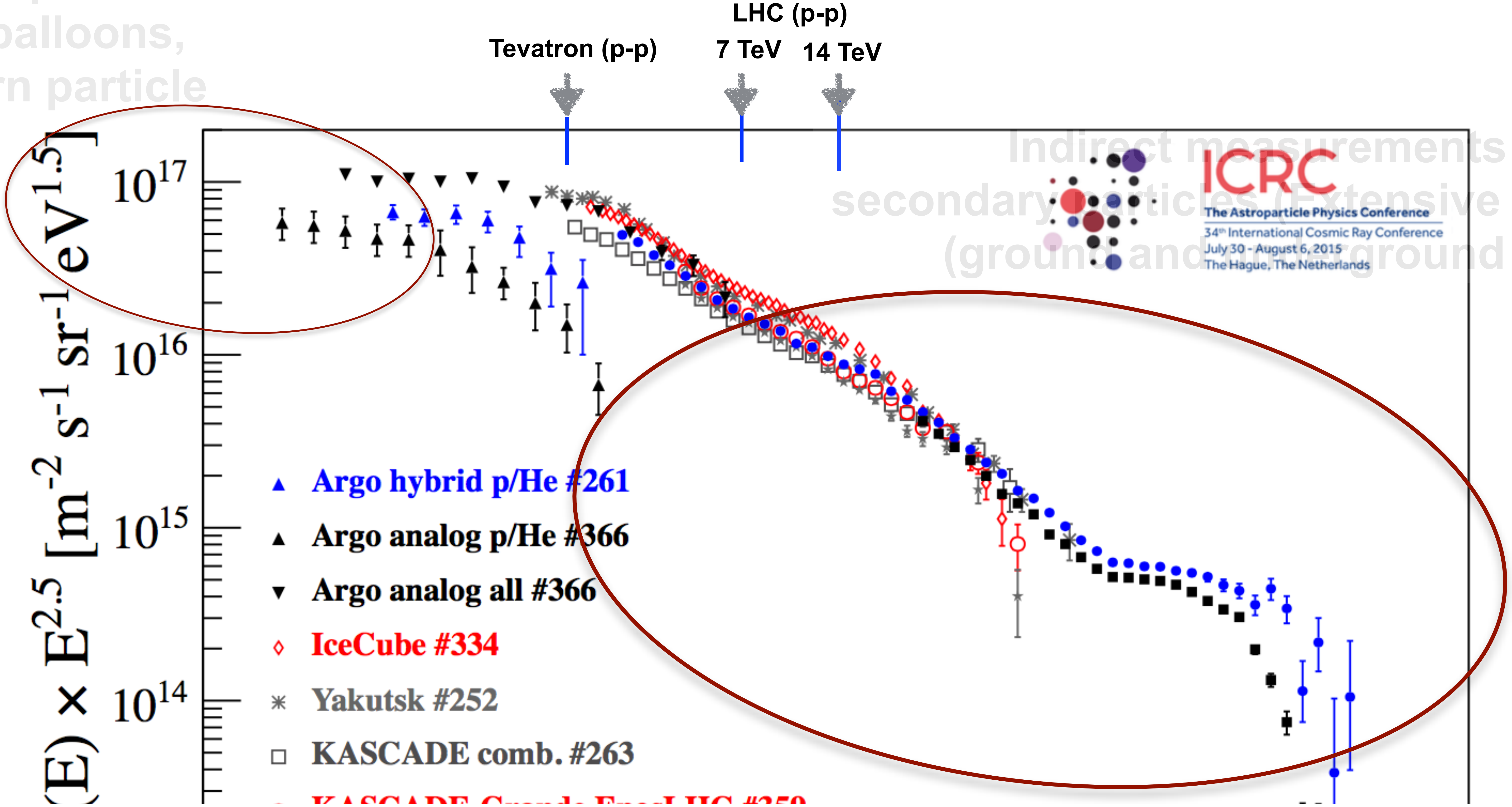
BUAP



Two classes of techniques to study EAS

1. particle detectors on the surface: particle counters, trackers and calorimeters
2. various telescopes to observe the electromagnetic emissions from the shower or from the interactions of the EAS with the atmosphere (Cherenkov radiation, radio, fluorescence light)

Direct measurements up to E^{14} eV primary particles (balloons, satellites, space born particle detectors)

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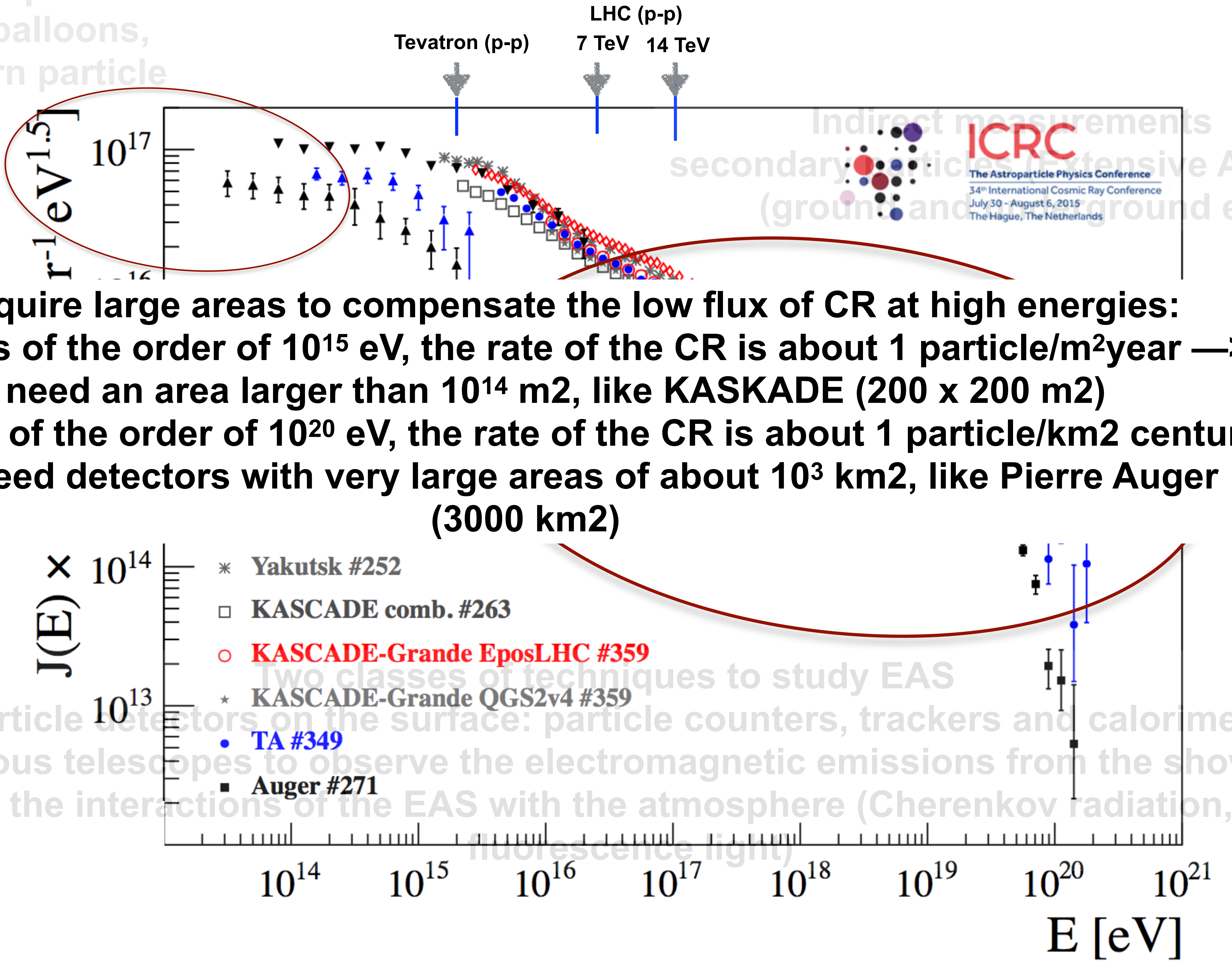

This will require large areas to compensate the low flux of CR at high energies:

- **for energies of the order of 10^{15} eV, the rate of the CR is about 1 particle/m^2year —> we need an area larger than 10^{14} m2, like KASKADE (200 x 200 m2)**
- **for energies of the order of 10^{20} eV, the rate of the CR is about 1 particle/km2 century —> we need detectors with very large areas of about 10^3 km2, like Pierre Auger (3000 km2)**

Two classes of techniques to study EAS

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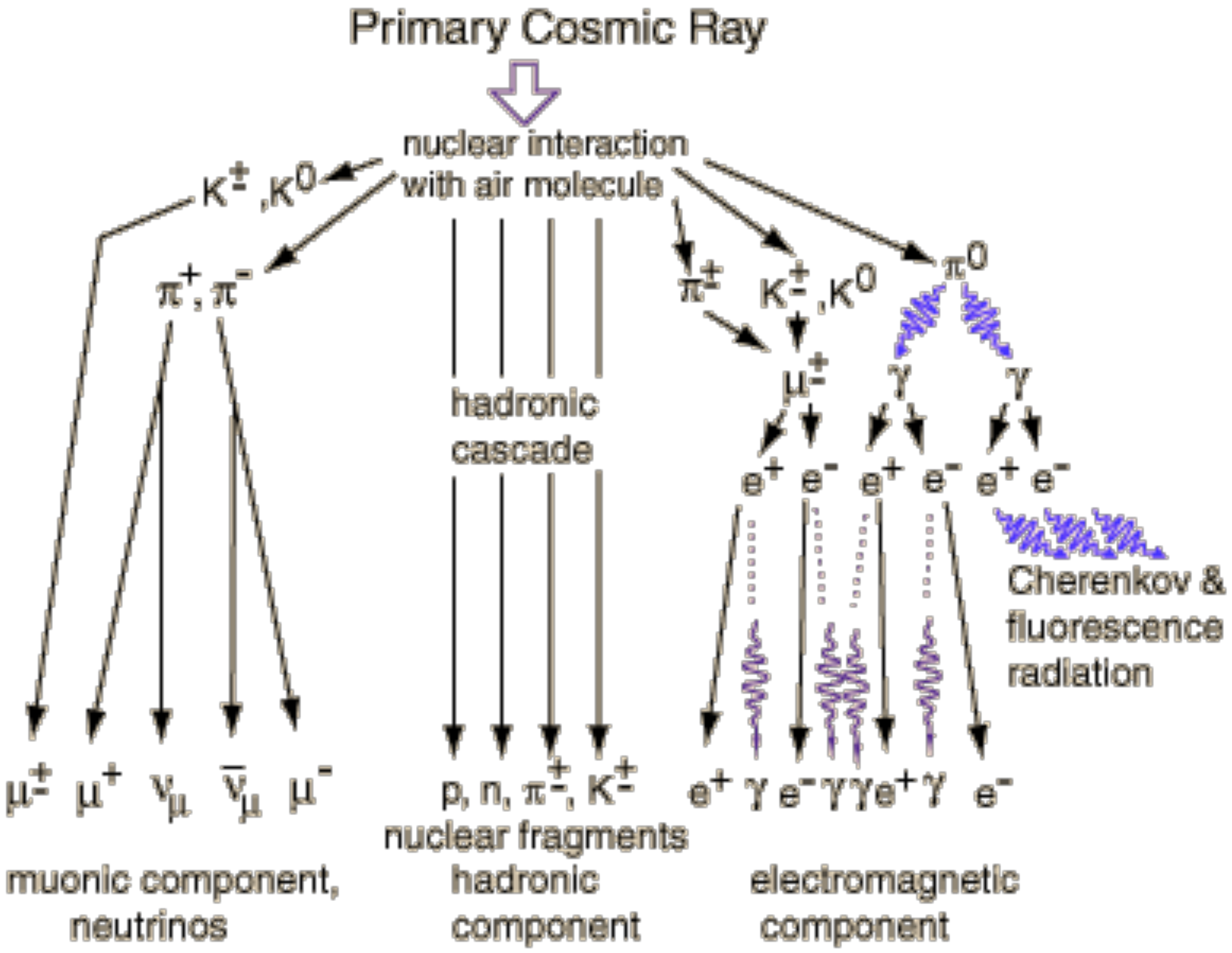
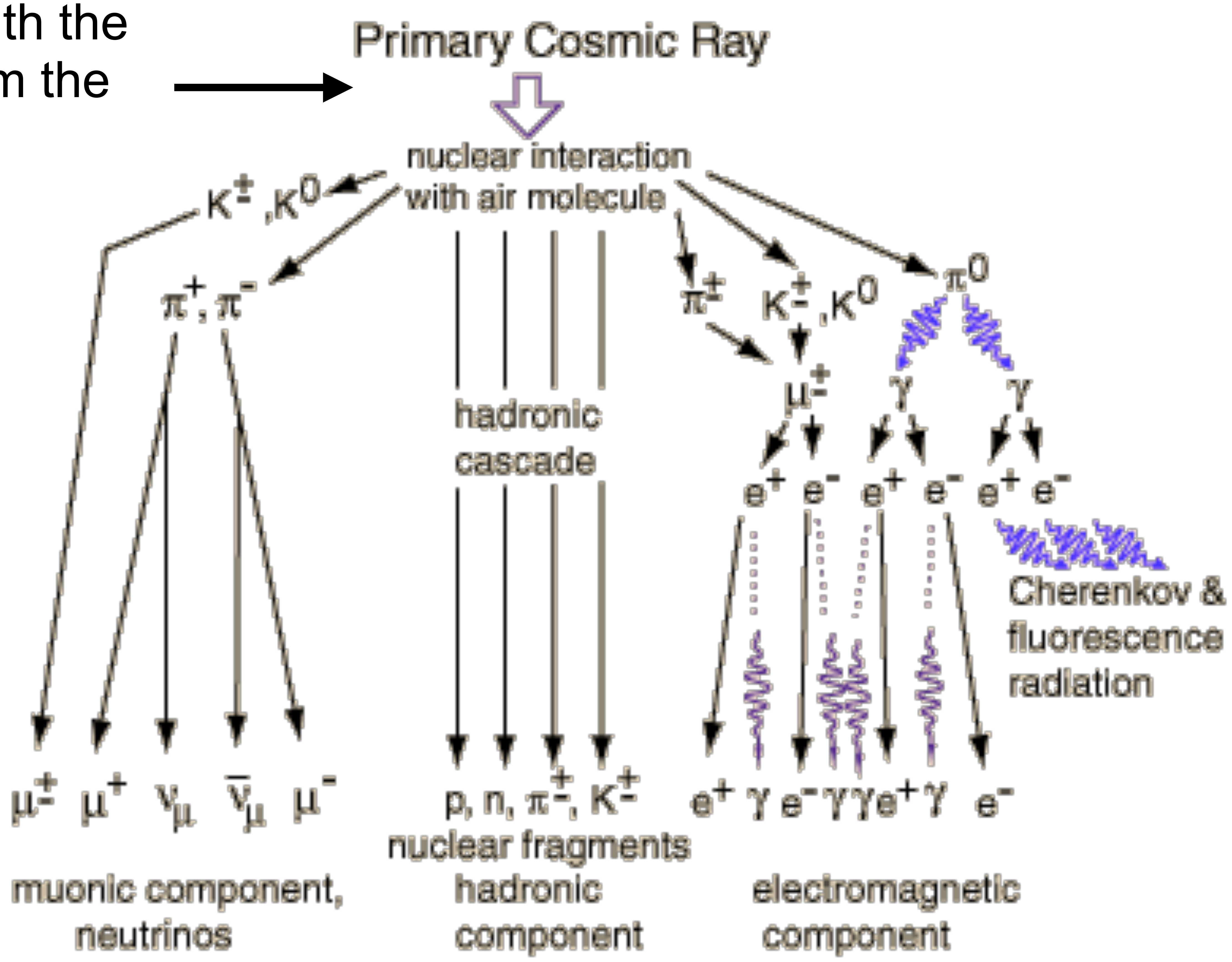
Particle detection



Particle detection

the EAS is a cascade of particles produced by the interaction of a single high energy primary cosmic ray which interacts with the atmosphere at about 10 km high from the surface of the Earth



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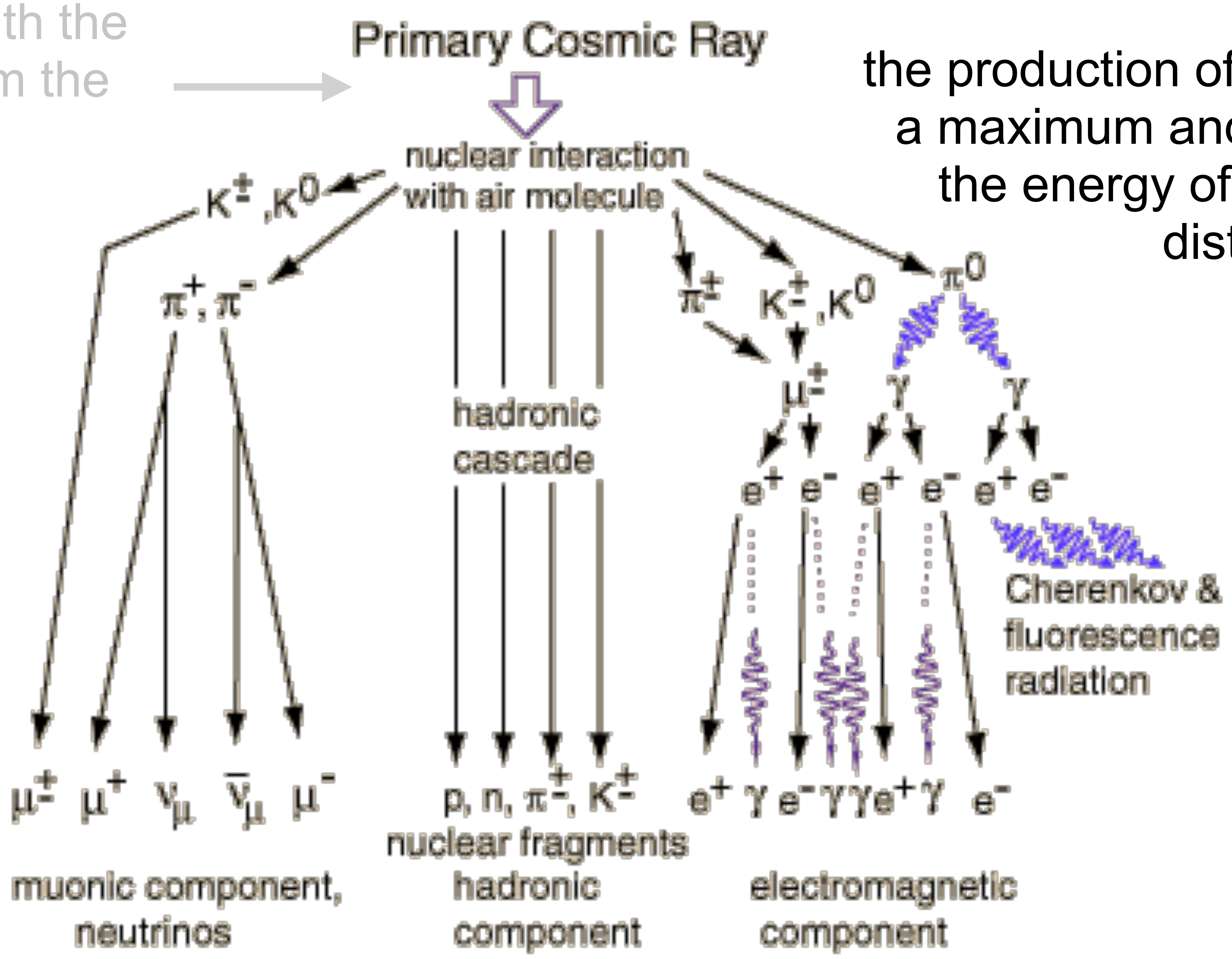

the production of secondary particles reaches a maximum and continues after the total of the energy of the primary cosmic ray is distributed to them

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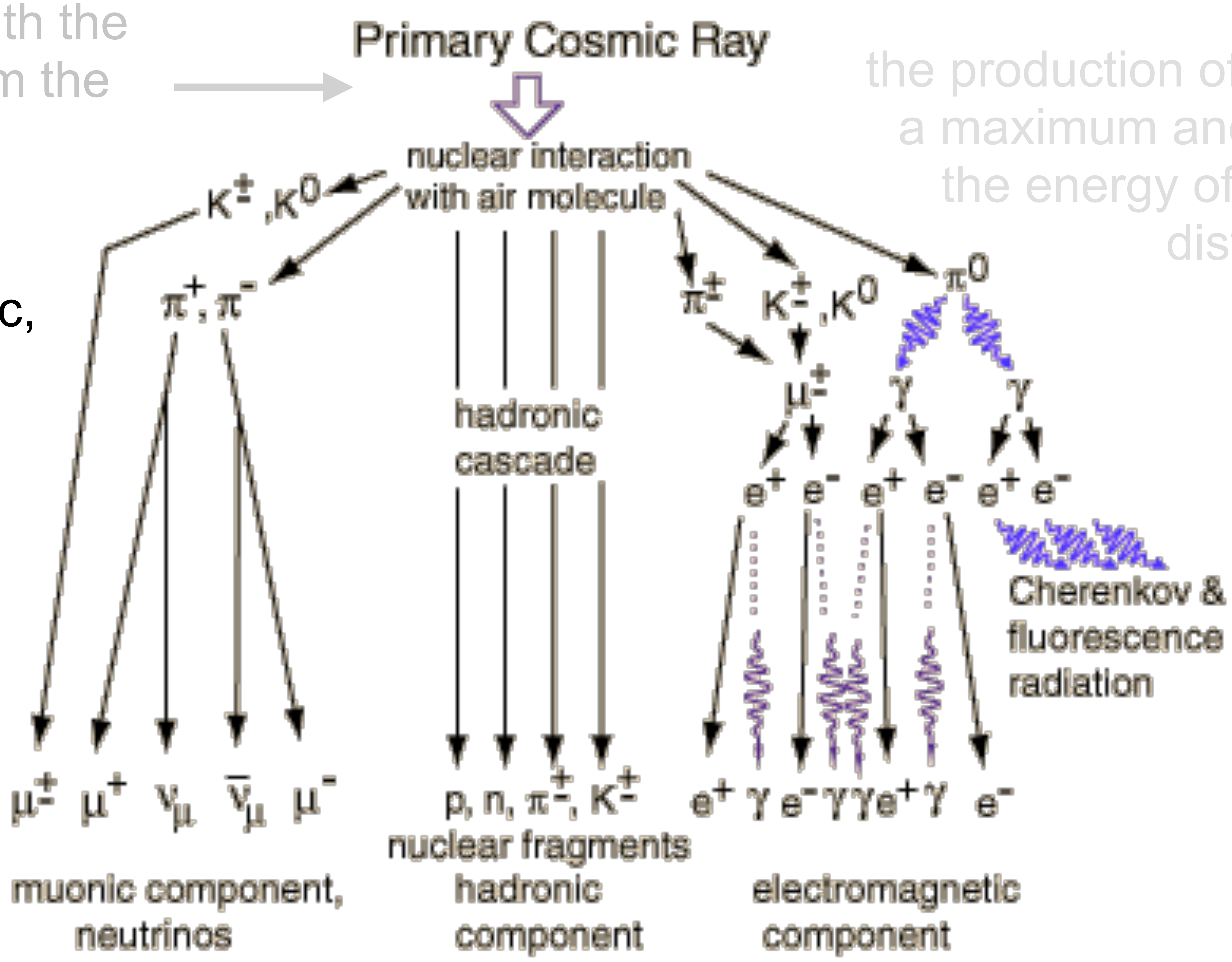
three components of the EAS: hadronic, muonic and electromagnetic



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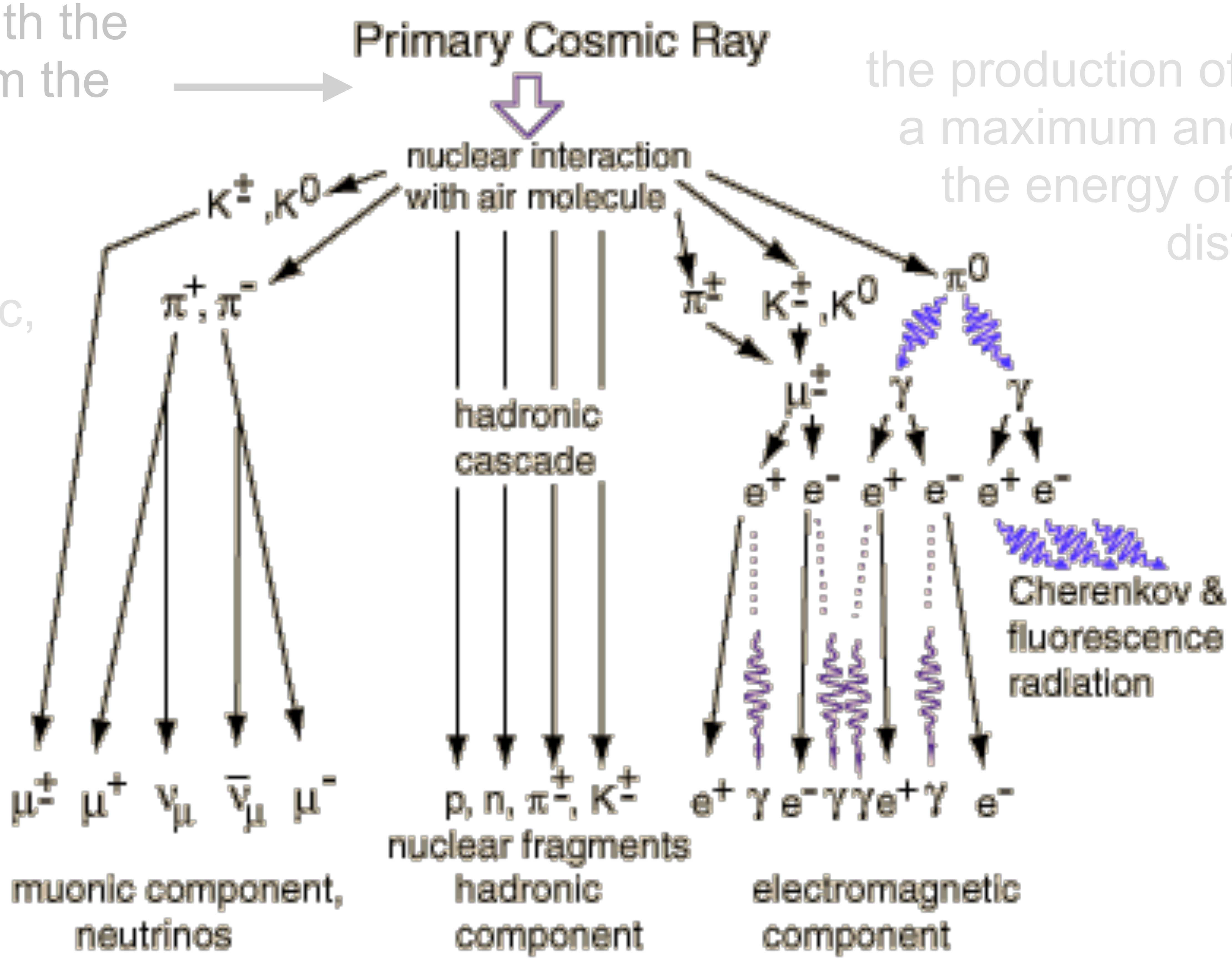

the hadronic particles stay close to the shower axis. after few interactions, most of the energy (hadronic) is transferred into the other components of the EAS

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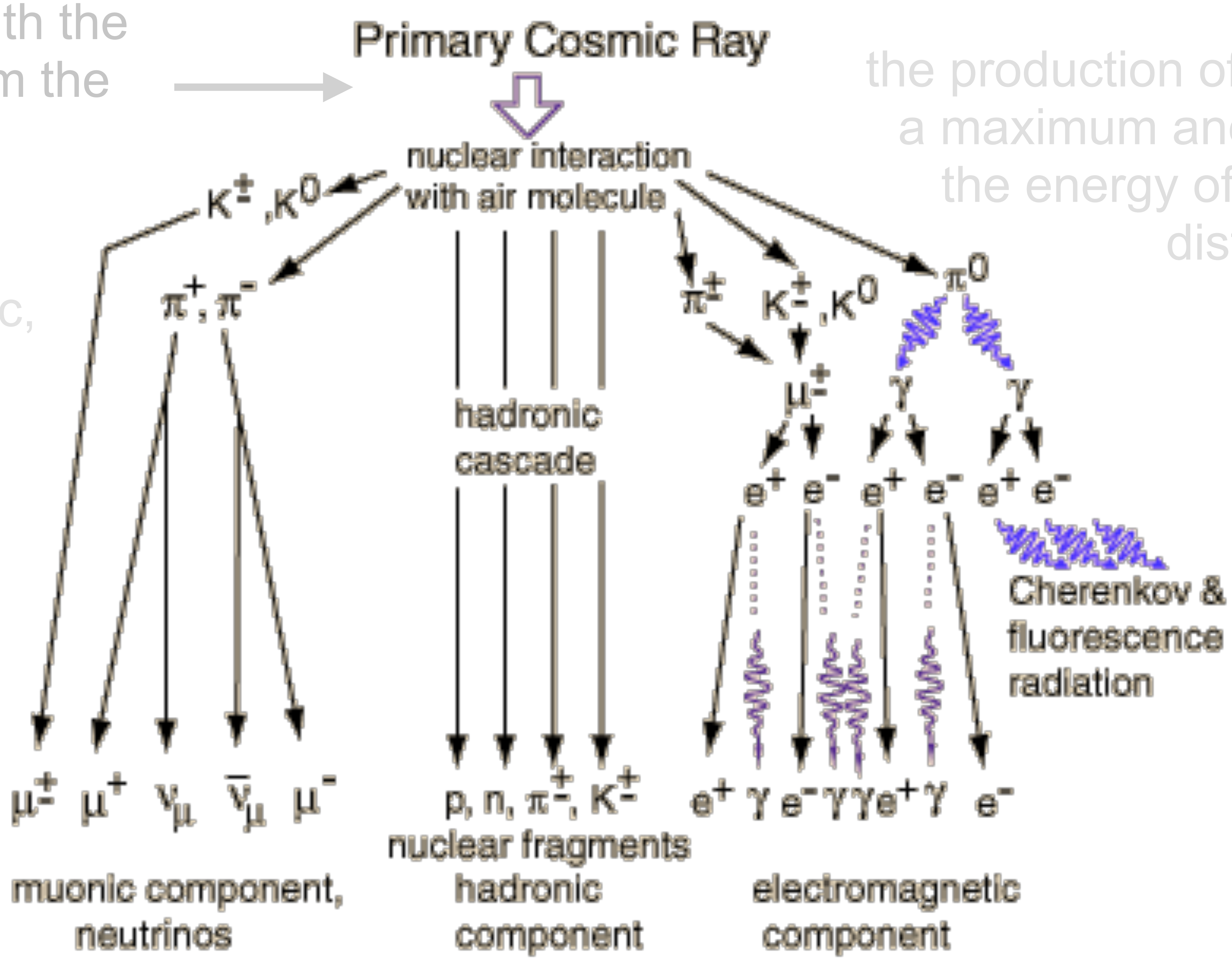

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the muonic component (~10% of the charged particles in EAS) is generated by the decay of charged pions and kaons

$$\pi^{\pm} \to \mu^{\pm} + \nu_{\mu}(\bar{\nu}_{\mu}),$$
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BUAP

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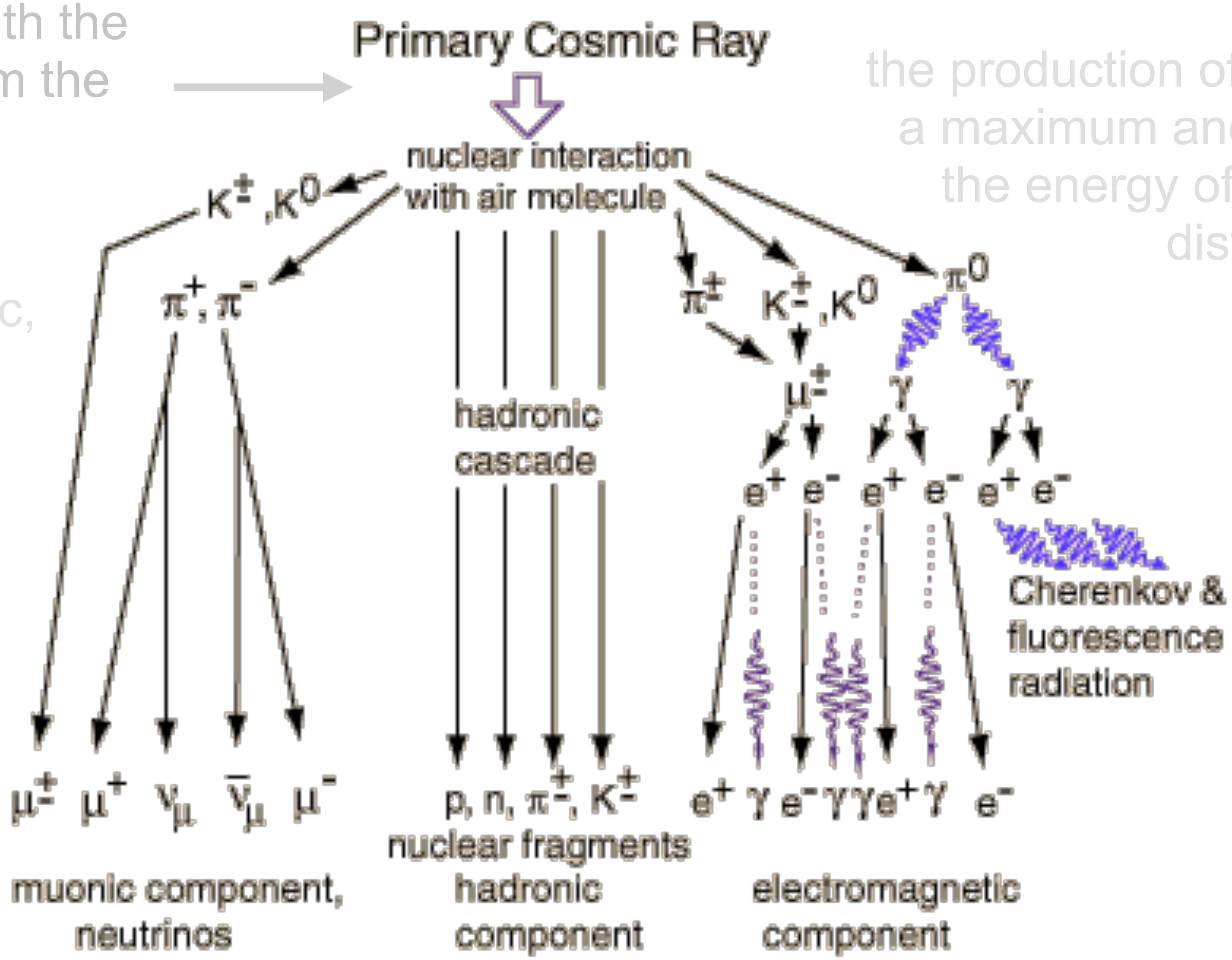

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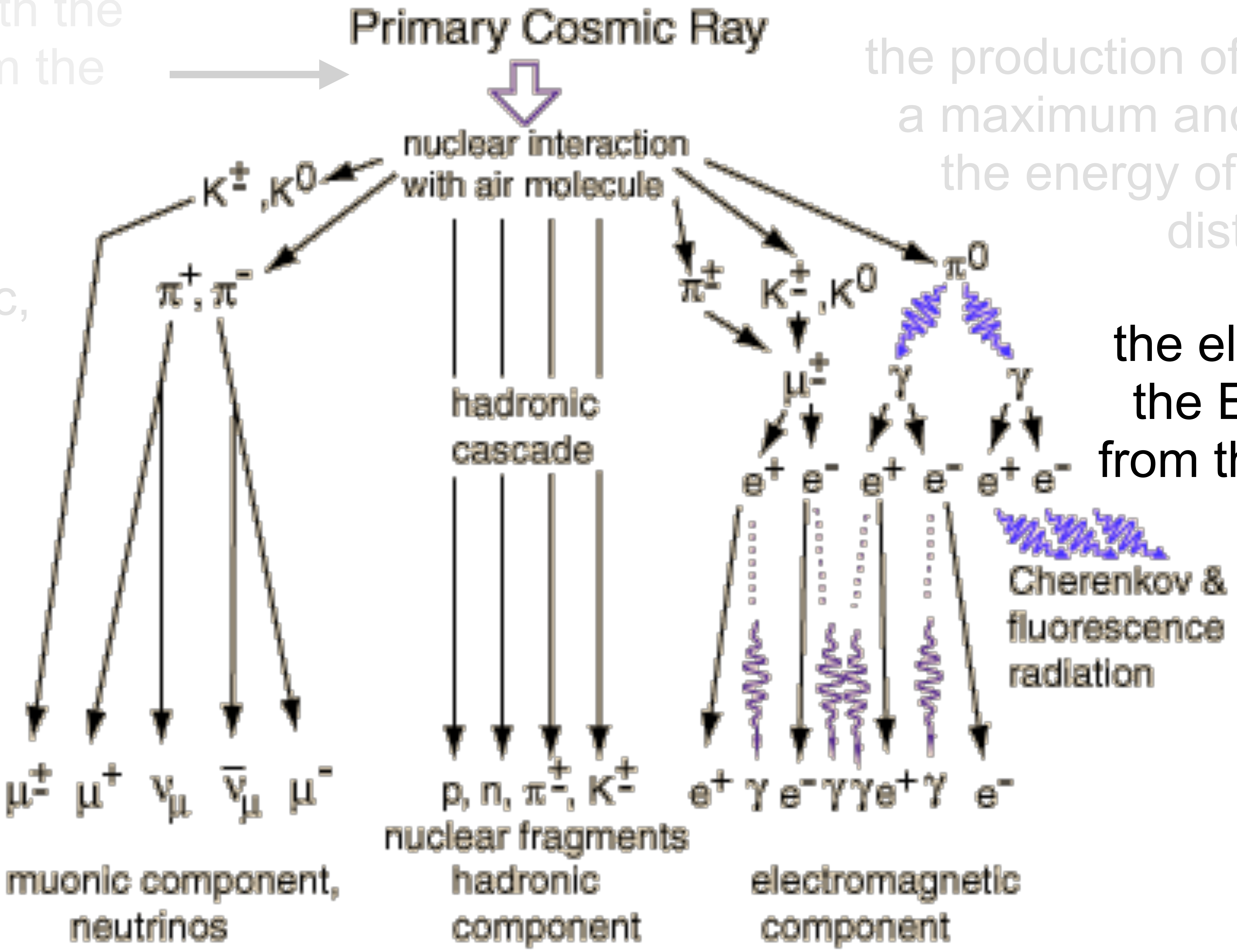

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the electromagnetic component of the EAS is produced by photons from the decay of neutral pions and kaons

$$\pi^0 \to \gamma + \gamma.$$

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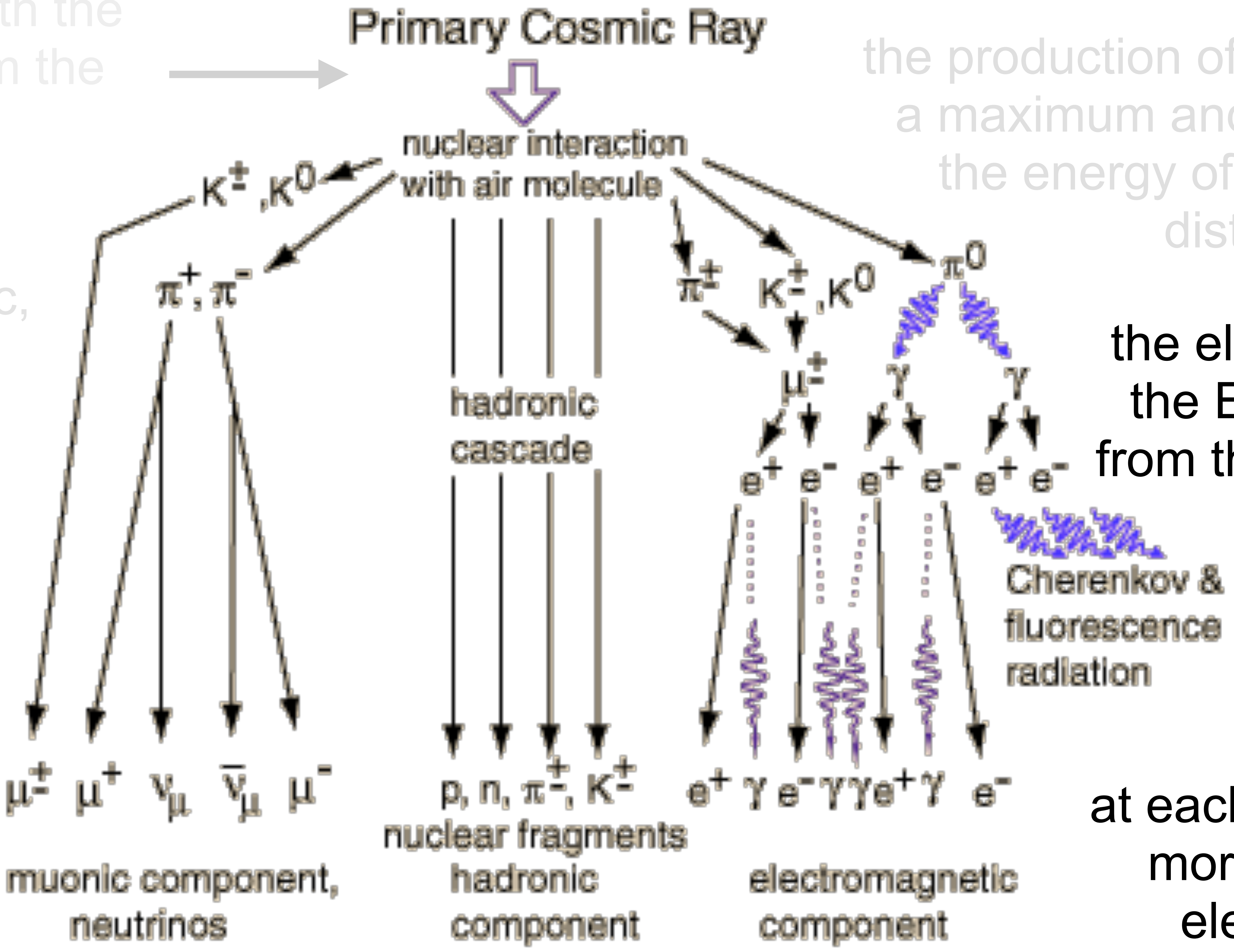

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$$\pi^0 \to \gamma + \gamma.$$

at each hadronic interaction, slightly more than 33.3% goes into the electromagnetic component

the hadronic particles stay close to the shower axis. after few interactions, most of the energy (hadronic) is transferred into the other components of the EAS

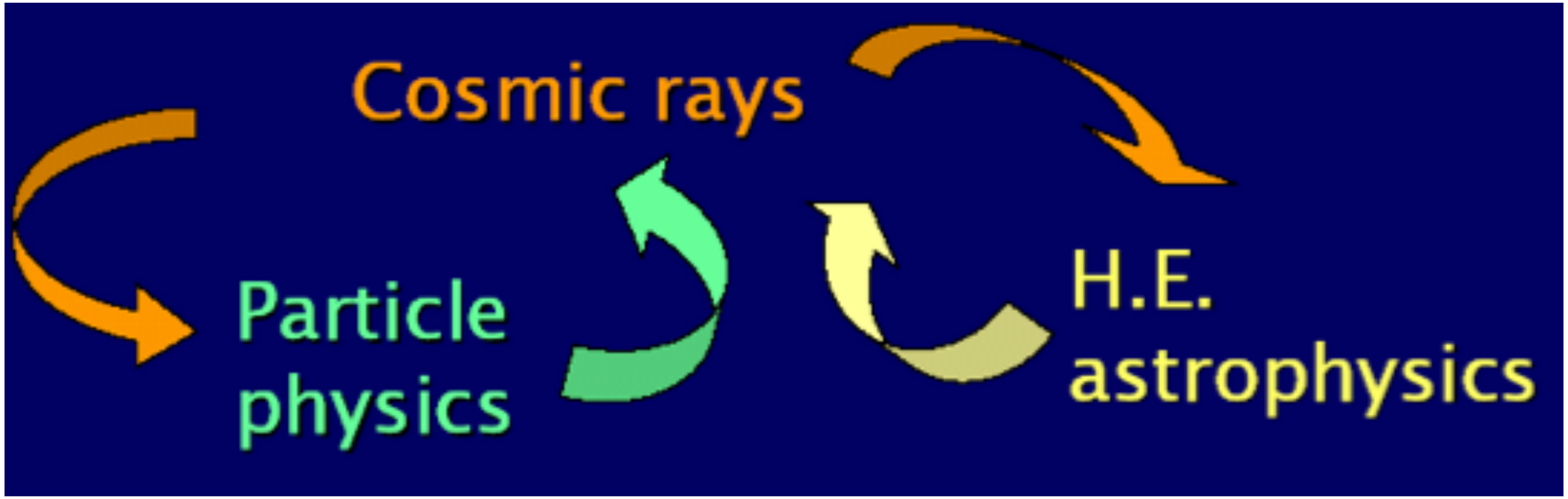
Particle detection

physical observables that can be reconstructed

- energy and composition of the primary cosmic ray (model dependent)
- size (density) of electromagnetic and muonic component
- angular variables of the EAS
- number of muons

Particle detection

BUAP



- DETECTION AND STUDY OF COSMIC RAY
- STUDY OF HIGH ENERGY INTERACTIONS IN p-p, Pb-Pb COLLISIONS TO EXTRAPOLATE INFORMATION FOR COSMIC RAY PHYSICS (hadronic interactions)

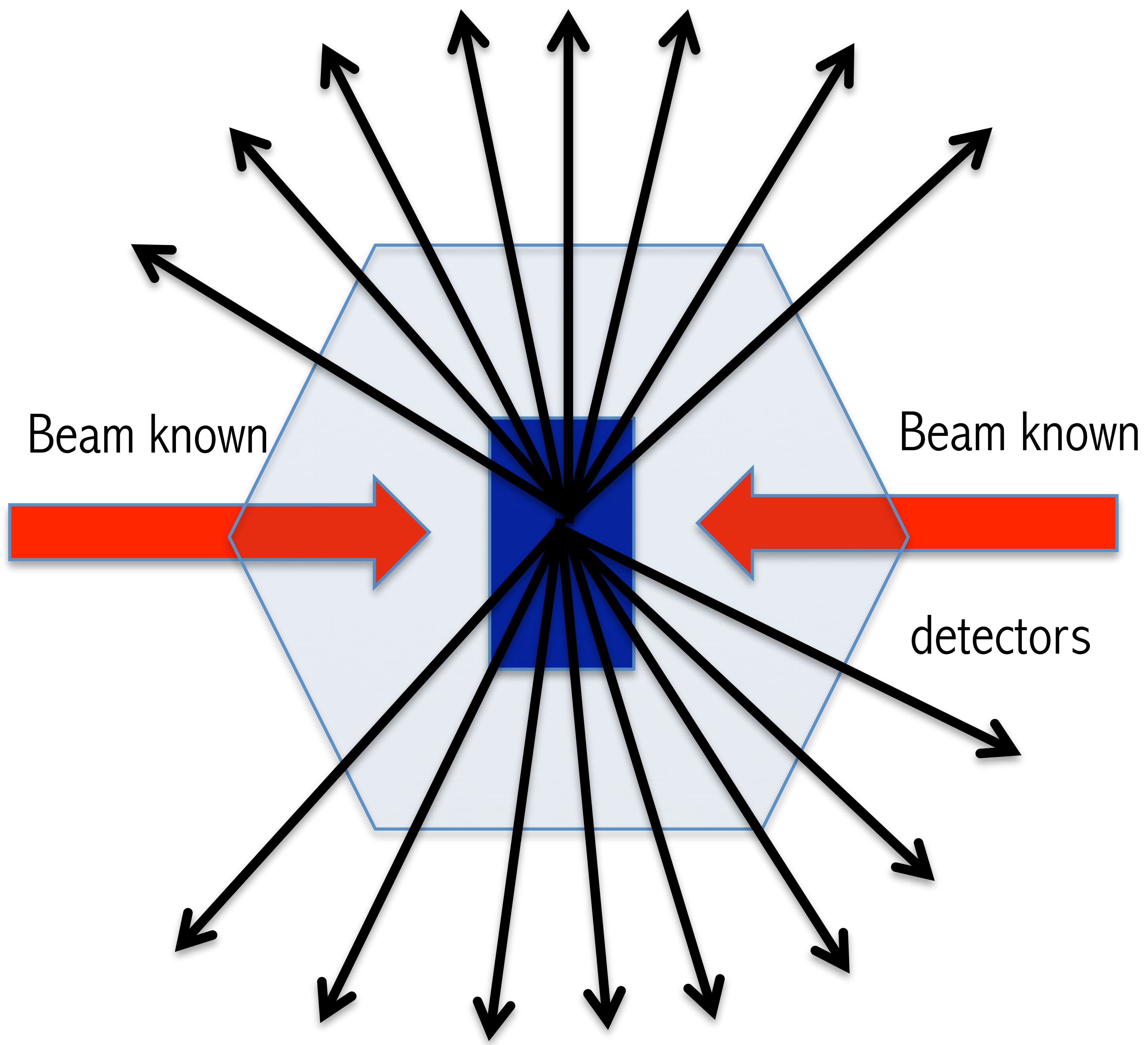
Particle detection

Particle	Year	Discovered	Technique
e^-	1897	Thomson	Discharge in gases
p	1919	Rutherford	Radioactivity
n	1932	Chadwik	Radioactivity
e^+	1933	Anderson	Cosmic-rays
$\mu^{+/-}$	1937	Neddermeyer, Anderson	Cosmic-rays
$\pi^{+/-}$	1947	Powell, Occhialini, Lattes	Cosmic-rays
$K^{+/-}$	1947	Rochester, Butler	Cosmic-rays
π^0	1949	Bjorklund	Accelerator
K^0	1951	Armenteros	Cosmic-rays
Λ^0	1950	Hopper	Cosmic-rays
anything else	1955 $\rightarrow$ today	various groups	Accelerators

Particle detection

ACCELERATOR PHYSICS:

BEAM KNOWN → DETECTION OF THE SECONDARIES
→ STUDY OF THE INTERACTIONS



Particle detection

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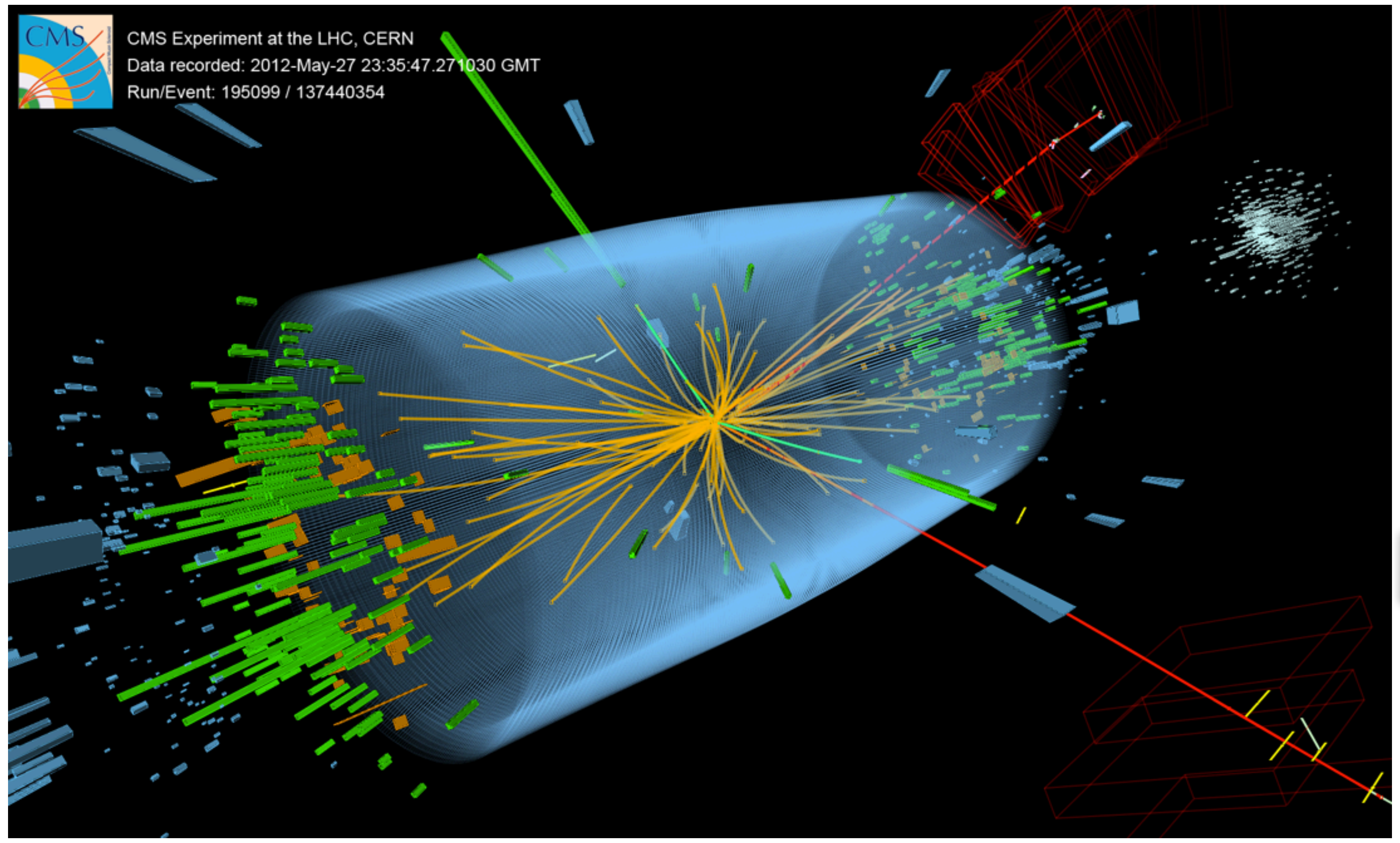
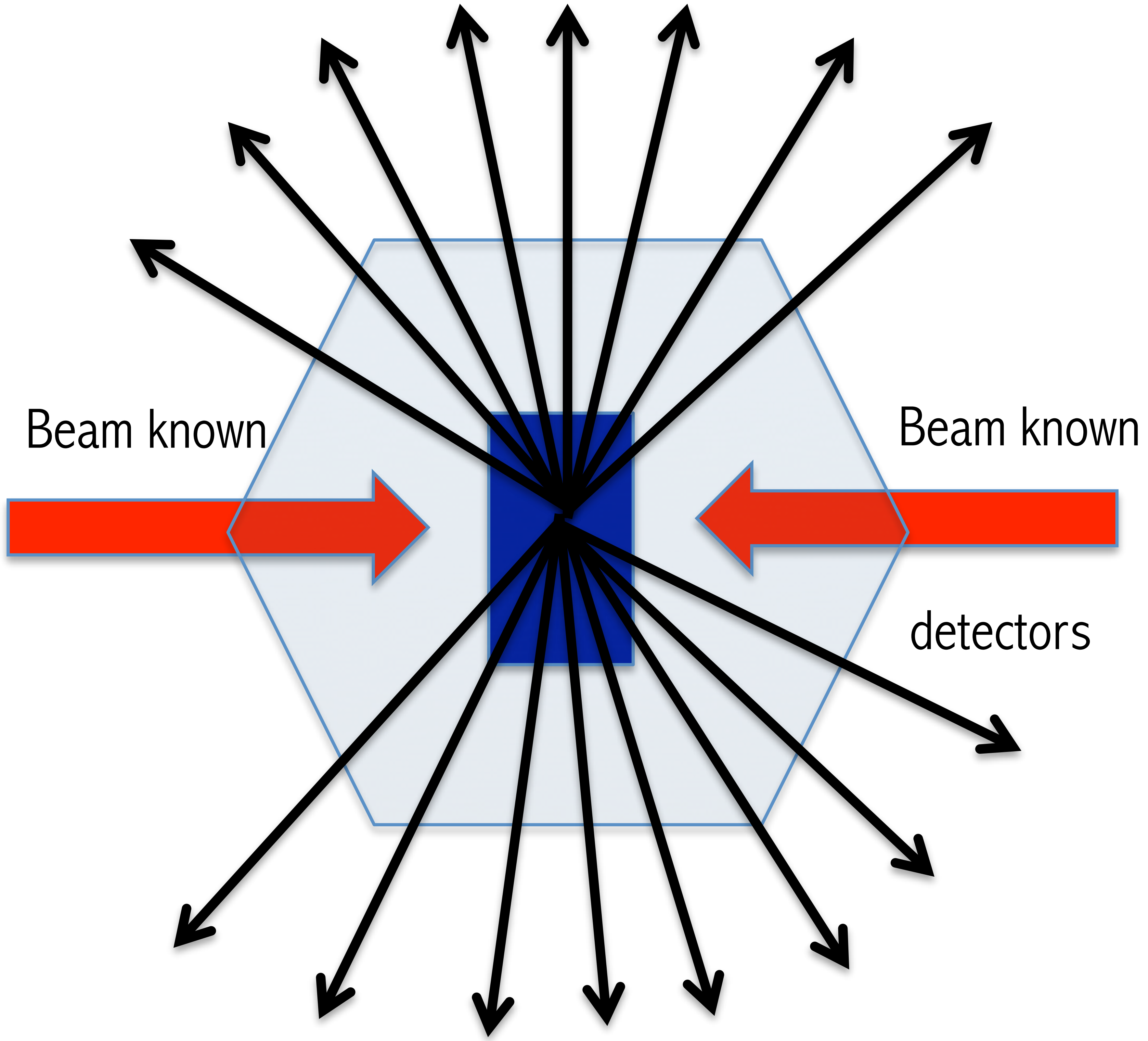
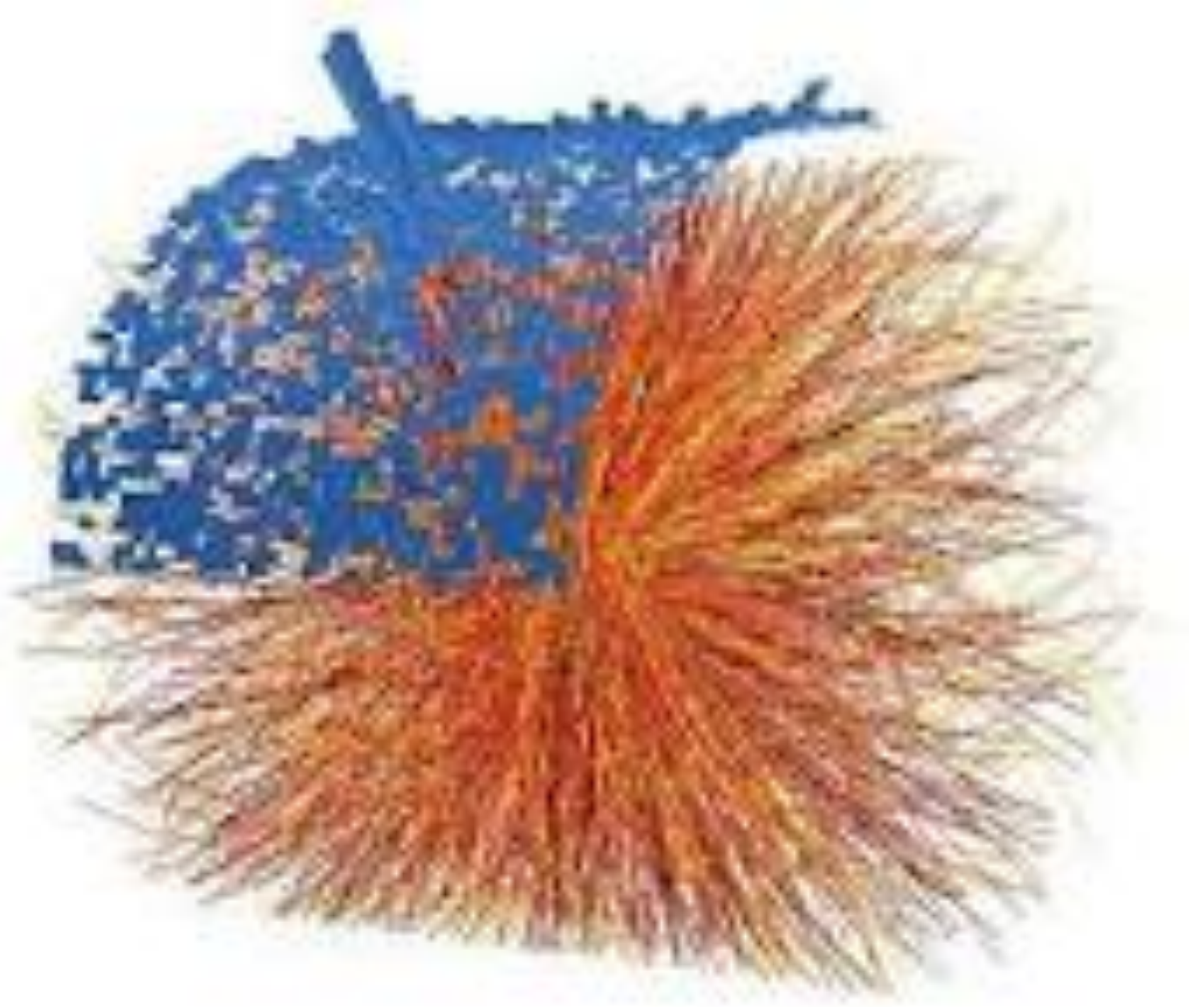




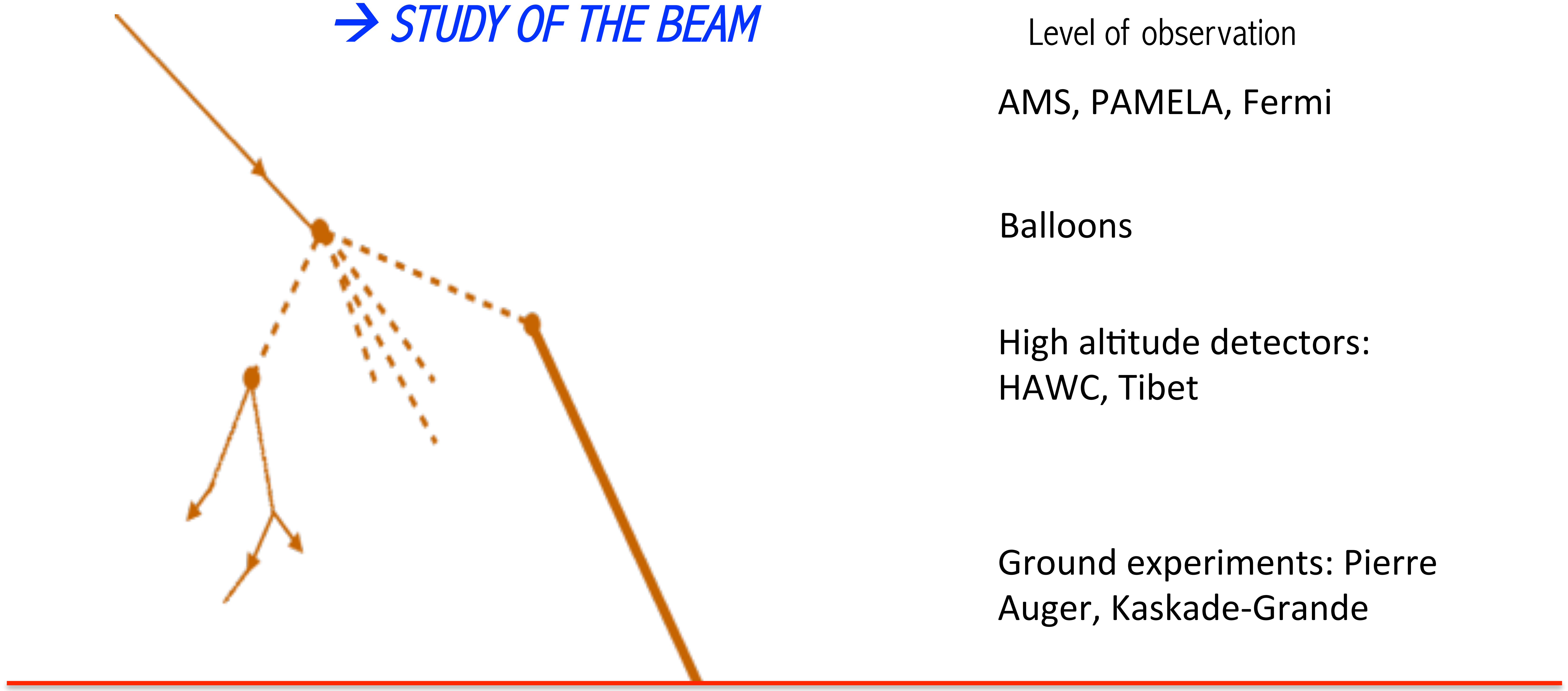


Particle detection

COSMIC RAY PHYSICS WITH EAS:

BEAM UNKNOWN → DETECTION OF THE SECONDARIES ARRIVING AT GROUND

→ *STUDY OF THE BEAM*



Level of observation

AMS, PAMELA, Fermi

Balloons

High altitude detectors: HAWC, Tibet

Ground experiments: Pierre Auger, Kaskade-Grande

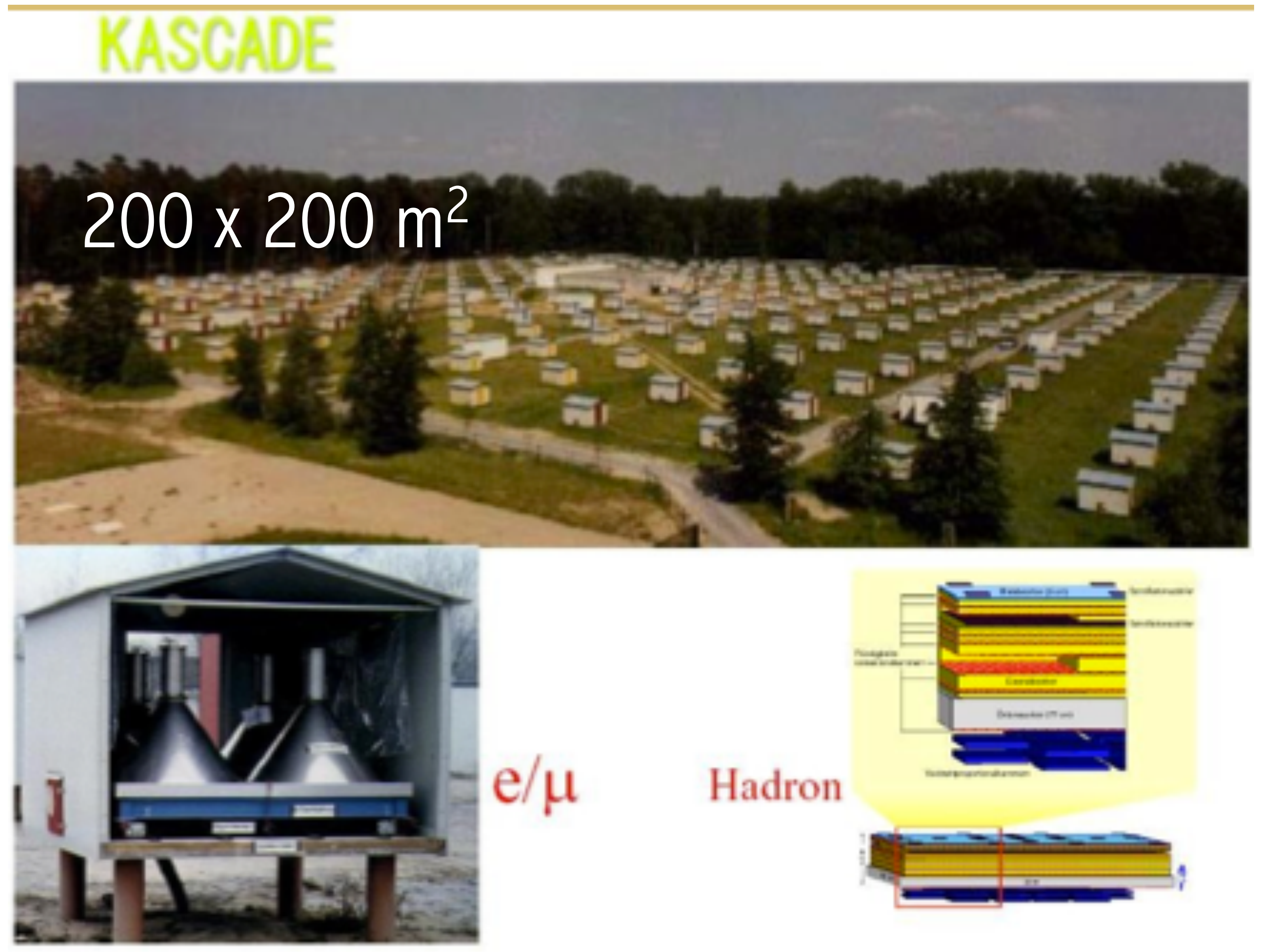
Under-ground experiments: Ice cube, Macro, LEP&LHC experiments

Direct measurements up to E ~ 10^{14} eV

- Primary particles (balloons, satellites)

Indirect measurements with (under)ground experiments to E > 10^{14} eV

- ☆ Cosmic ray interactions with atmosphere and Extensive Air Showers (EAS)
- ☆ Measurements around the knee (Eas-Top, Kaskade, Casa …) and beyond (Kaskade-Grande)
- ☆ Ultra high energy cosmic rays (Auger, HiRes)
- ☆ Underground experiments (Macro, Emma)
- ☆ **COSMIC RAY PHYSICS AT CERN (LEP: L3+C, ALEPH, DELPHI; LHC: CMS, ALICE)**



BUAP

- ✧ Small apparatus
- ✧ Low underground
- ✧ Detection of muons crossing the rock

★ These apparatus are not designed for cosmic ray physics ☹ :

❑ Small detectors compared with the standard cosmic ray apparatus:

  - ✧ Only muons are detected
  - ✧ Short live time of data taking

- ✓ Advantage: detectors with very high performances, presence of magnetic field ☺
- ✓ Why to study cosmic ray events with dedicated accelerator experiments? → remember that the only result out of LEP that did not agree "perfectly" with the Standard Model was the observation of too many multiplicity muon bundles.

Cosmo-ALEPH
Multi-muon bundles

Sensitive to primary energies $10^{14} - 10^{16}$ eV

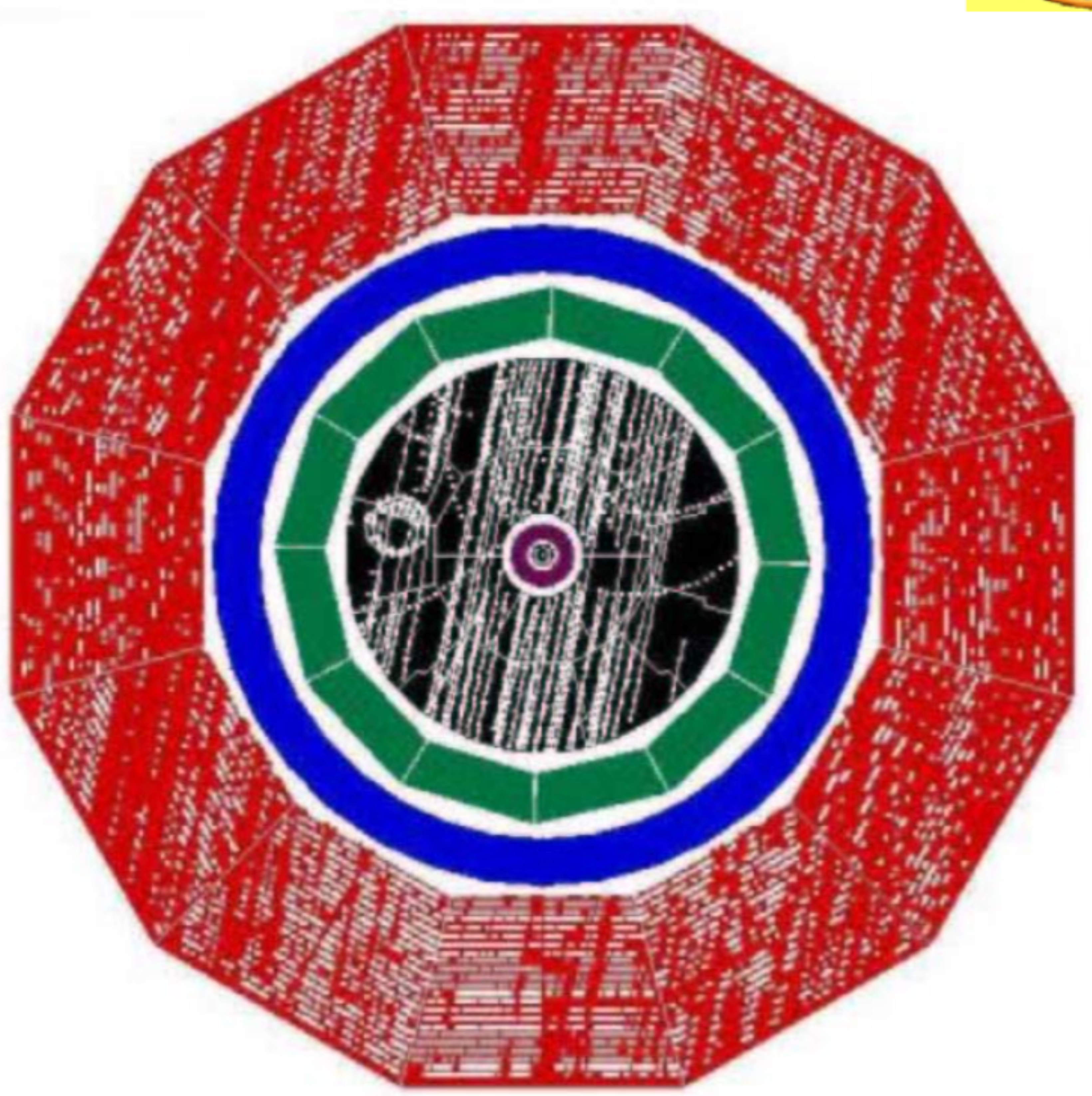
For $E>10^{14}$ eV at given energy more muons for heavier nuclei

High energy muons (E >70 GeV) are sensitive to dynamics of the first interactions

Test of interaction models

Simulation: CORSIKA, QGSJET

Difficulty: unknown core position (small detectors) => scattering of shower centers over some area (200×200 m^2) in MC



Multiplicities up to 150 in 16 m^2
TPC

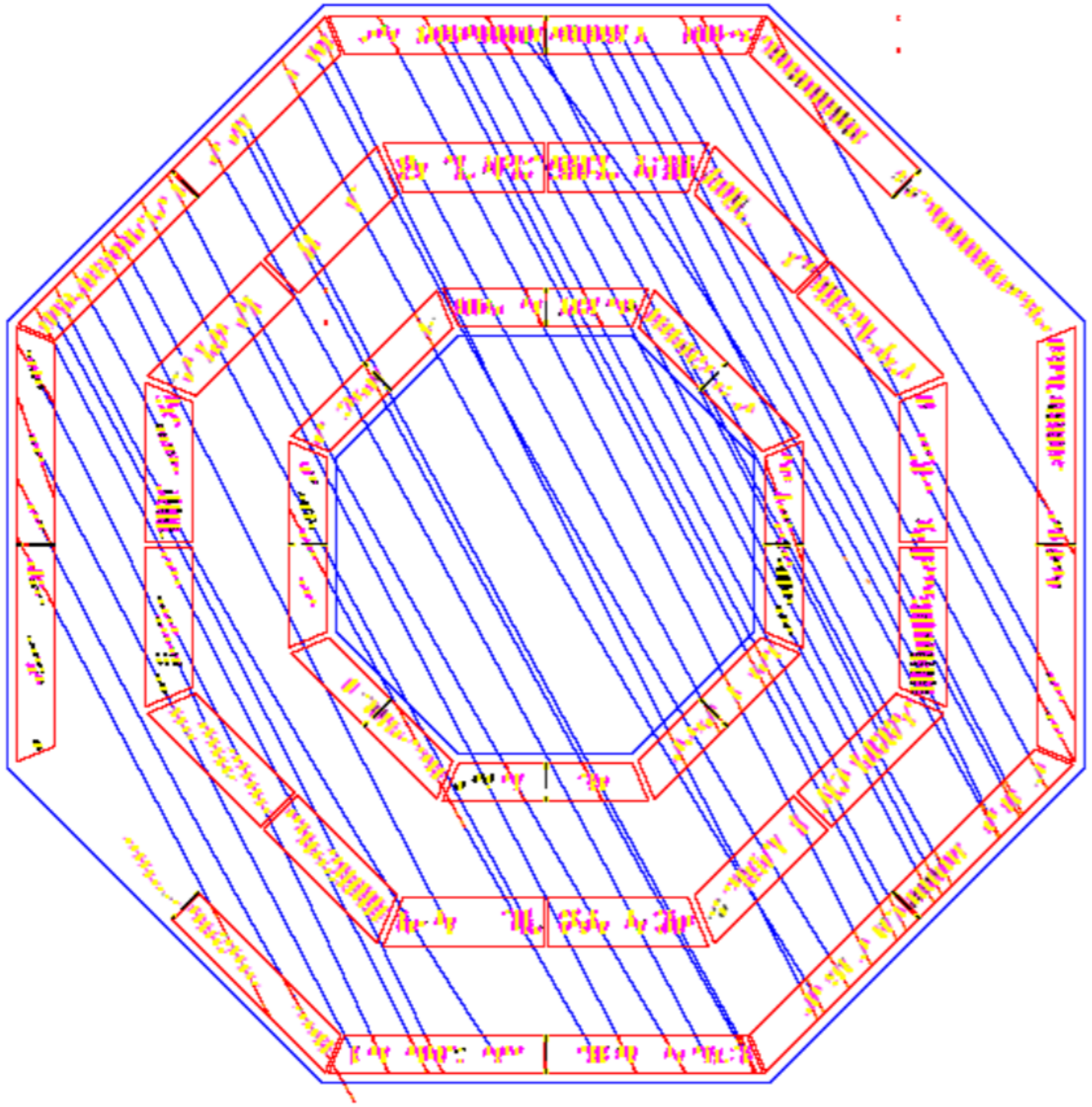
L3+C
Composition, Multi-muon bundles

L3+C can study multi-muon events also in coincidence with surface array.

Muon multiplicity can be studied as a function of shower size.

Muon momentum can be measured for individual muons in the bundle.

Analysis of the abovementioned items is still in progress …



L3+C
Composition, Multi-muon bundles

Some results:

Muon multiplicity in events with:

E>30TeV (surface array),

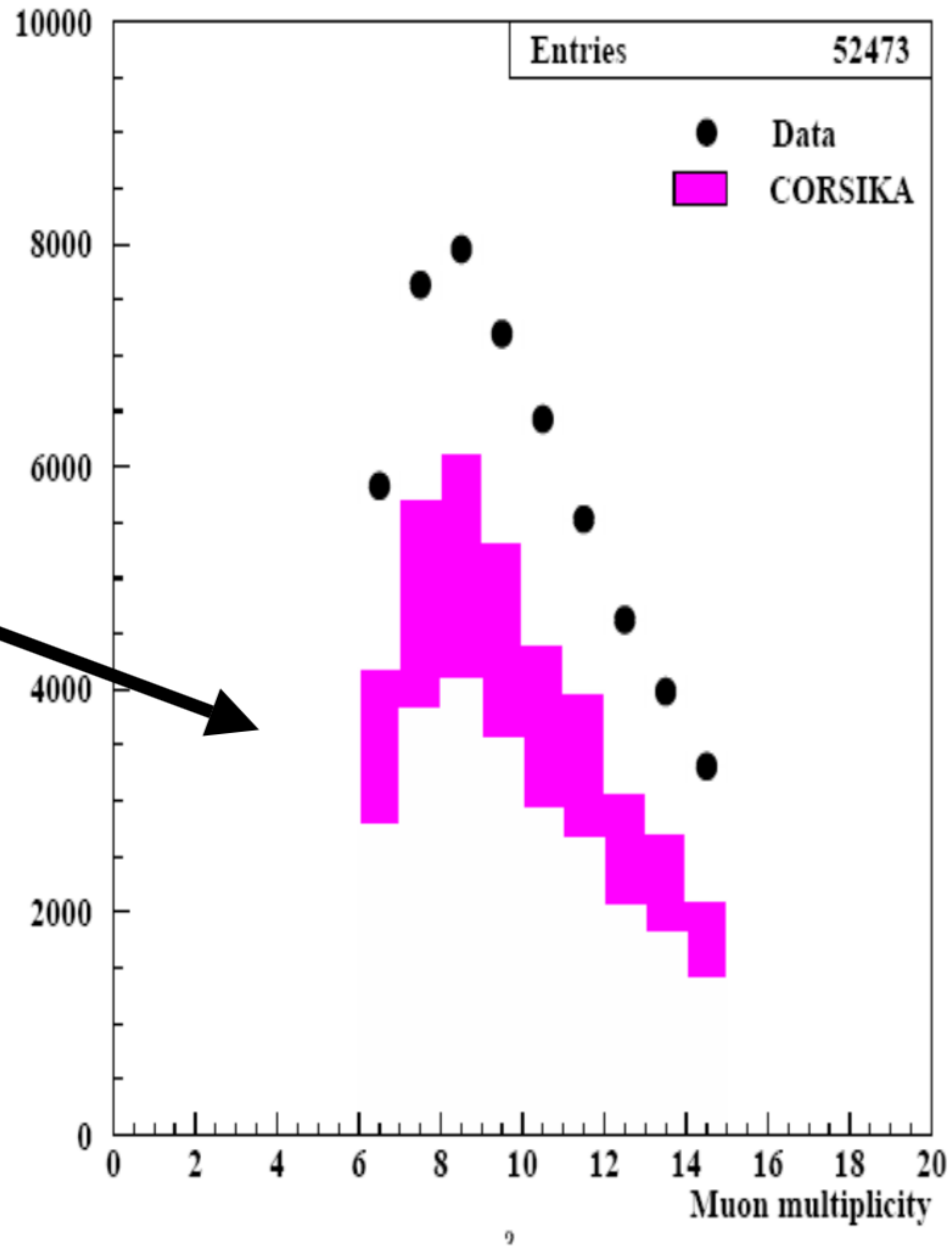
14>N(muons)>5,

N(muons, E>100GeV)>5

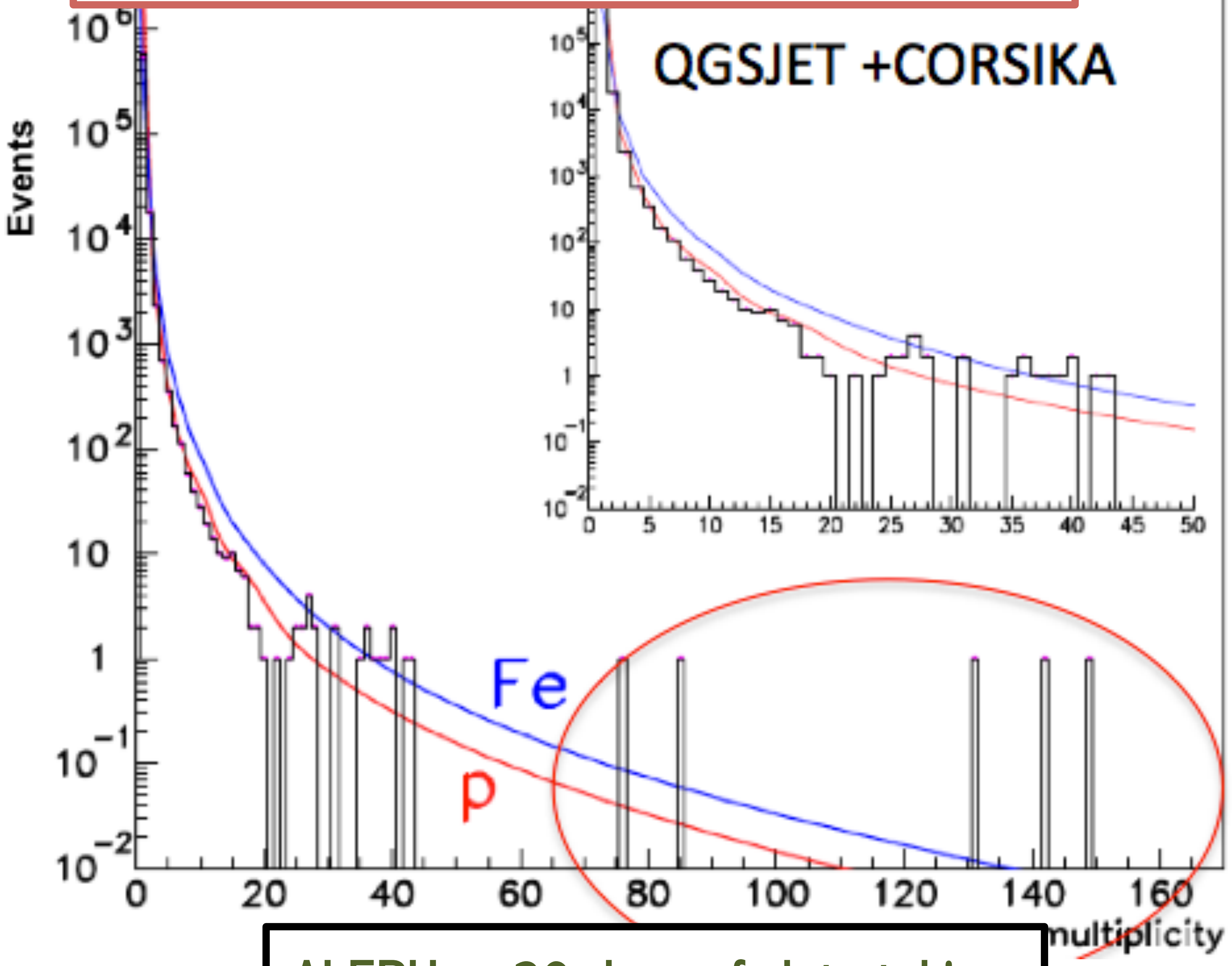
MC assuption:

p:He:CNO:Fe=2:2:1:1

Analysis indicates deviation from prediction of MC models (surplus of multi-muon data with large muon energies compared to MC simulation)



Astroparticle Physics 19 (2003) 513–523



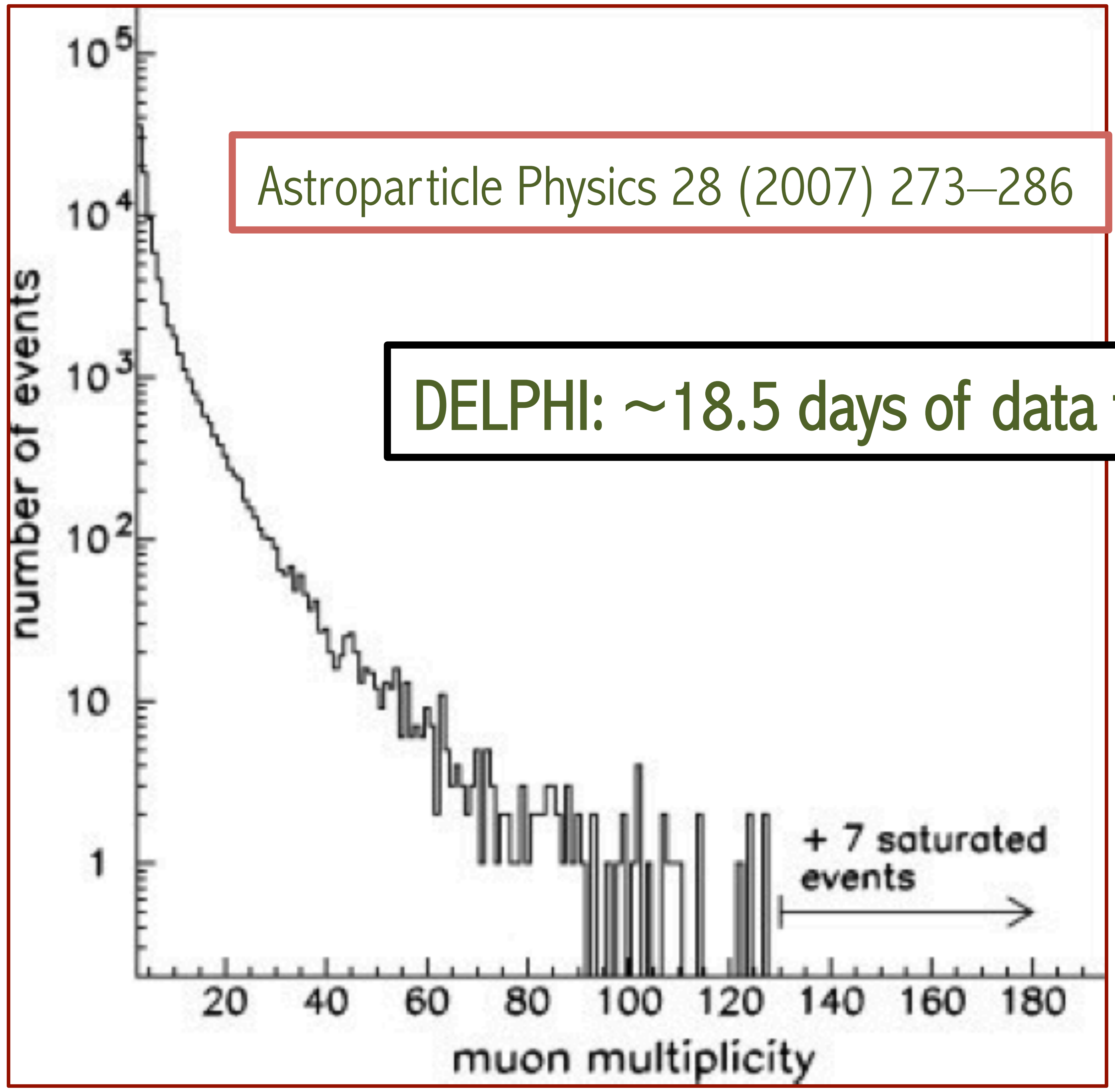
ALEPH: ~20 days of data taking

Data indicate that heavier component is needed to explain higher multiplicity muon bundles
These muon bundles are not well described (almost an order of magnitude above the simulation)

The conclusion is similar to Aleph :
However, even the combination of extreme assumptions of highest measured flux value and pure iron spectrum fails to describe the abundance of high multiplicity events.

BUAP

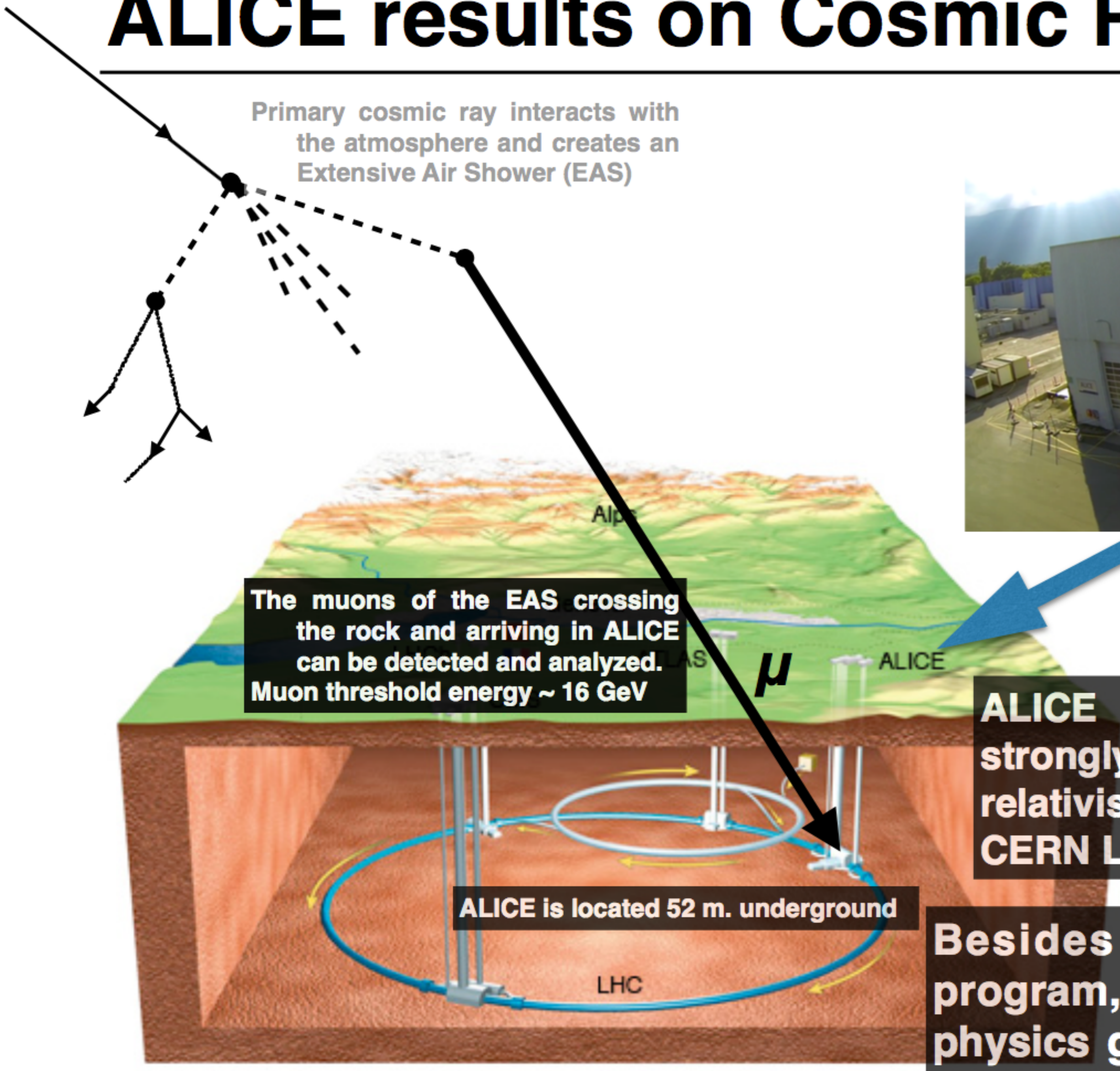
Astroparticle Physics 28 (2007) 273–286

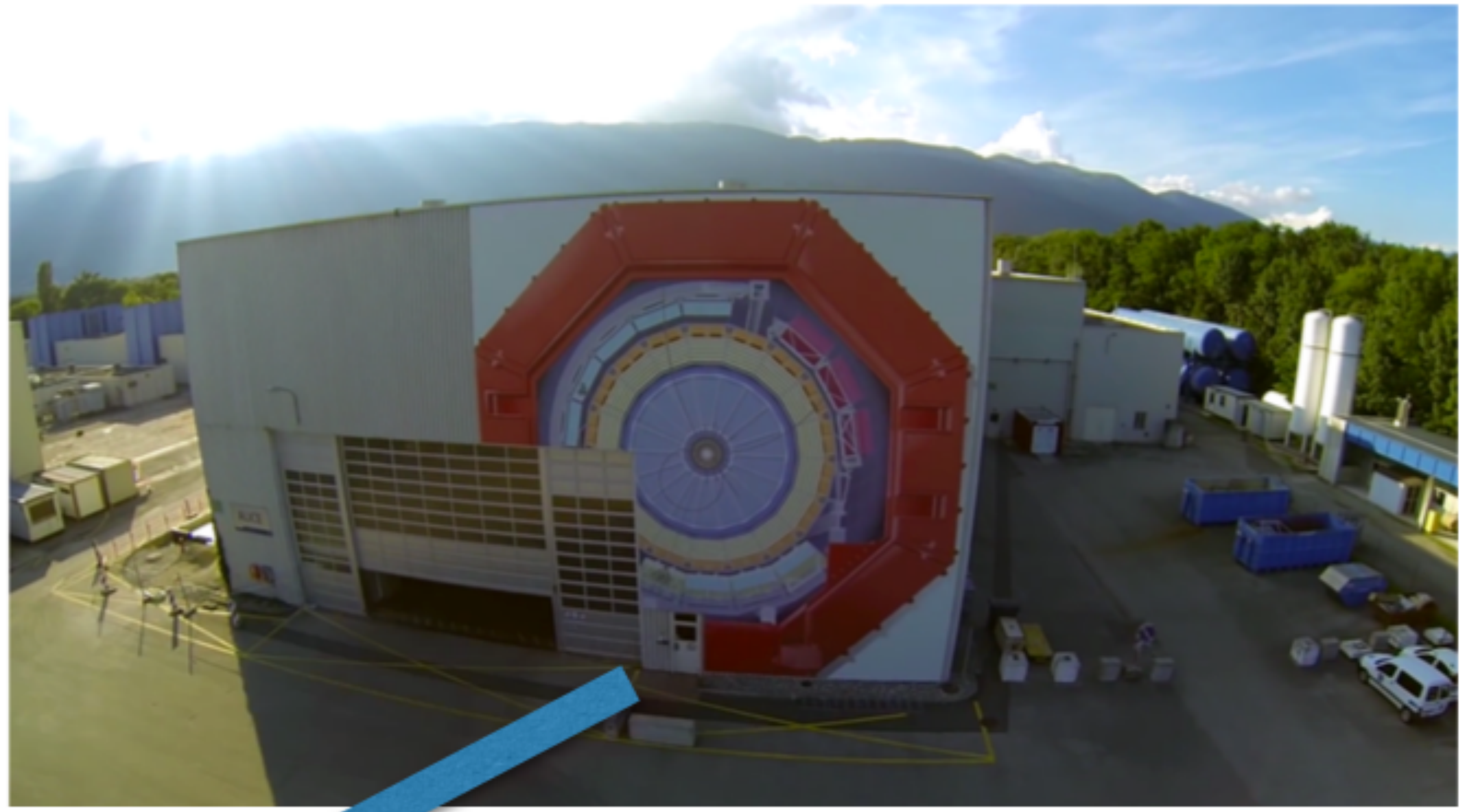


DELPHI: ~18.5 days of data taking

ALICE results on Cosmic Ray Physics

BUAP

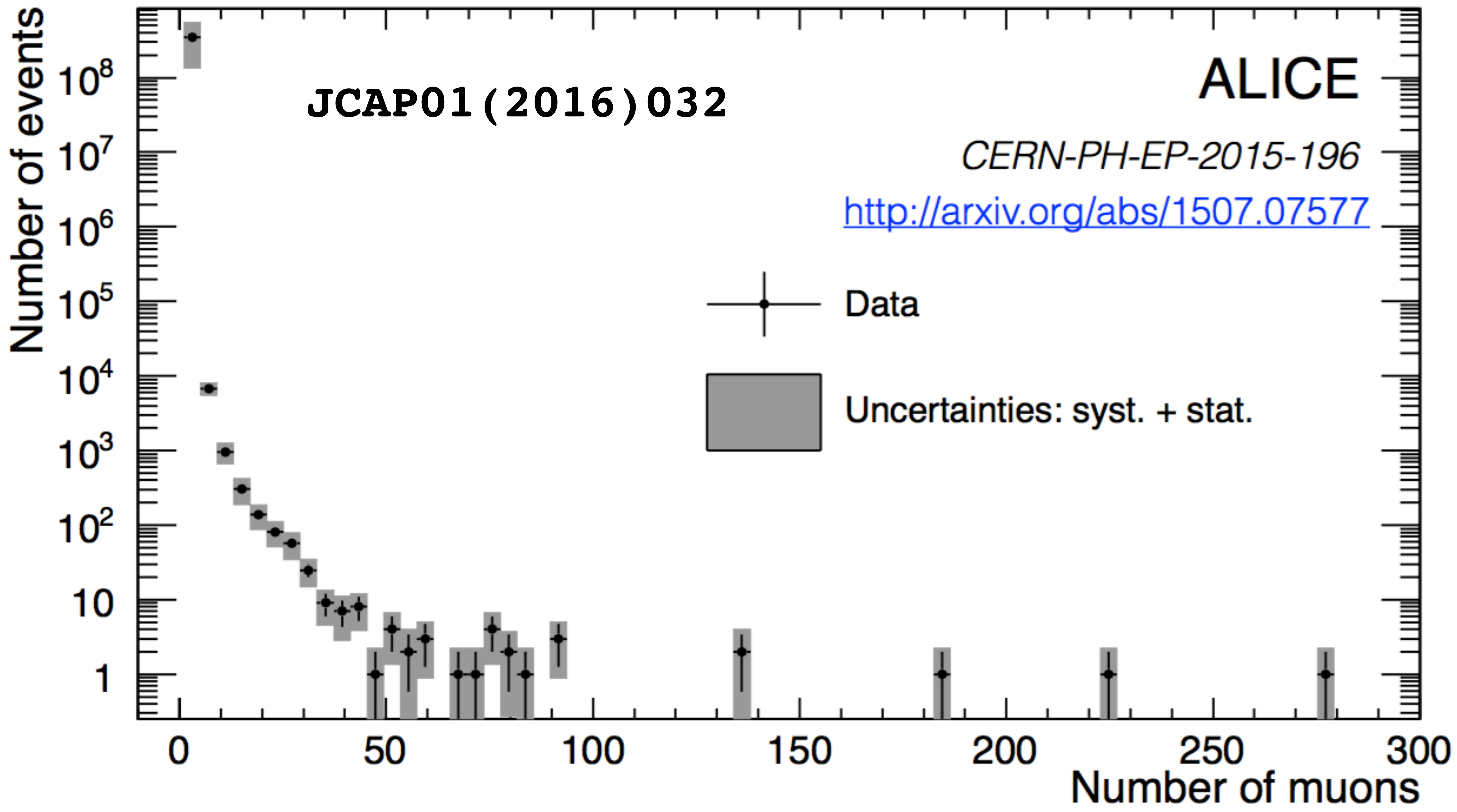




ALICE is designed to the study of strongly interacting matter in ultra-relativistic heavy-ion collisions at the CERN Large Hadron Collider (LHC)

Besides the heavy-ion physics program, ALICE has a dedicated physics group interested in Cosmic-ray physics.

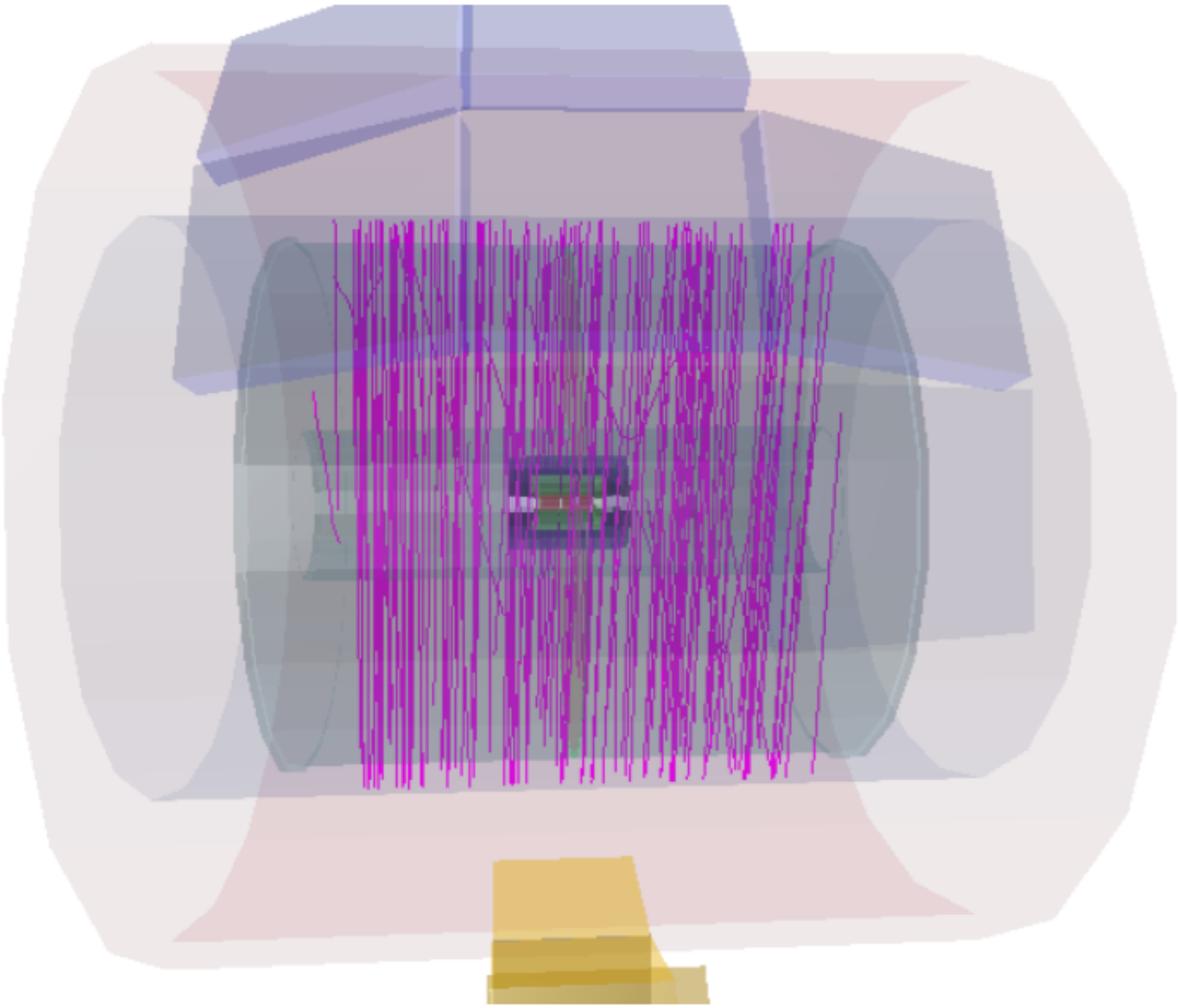
ALICE results on Cosmic Ray Physics

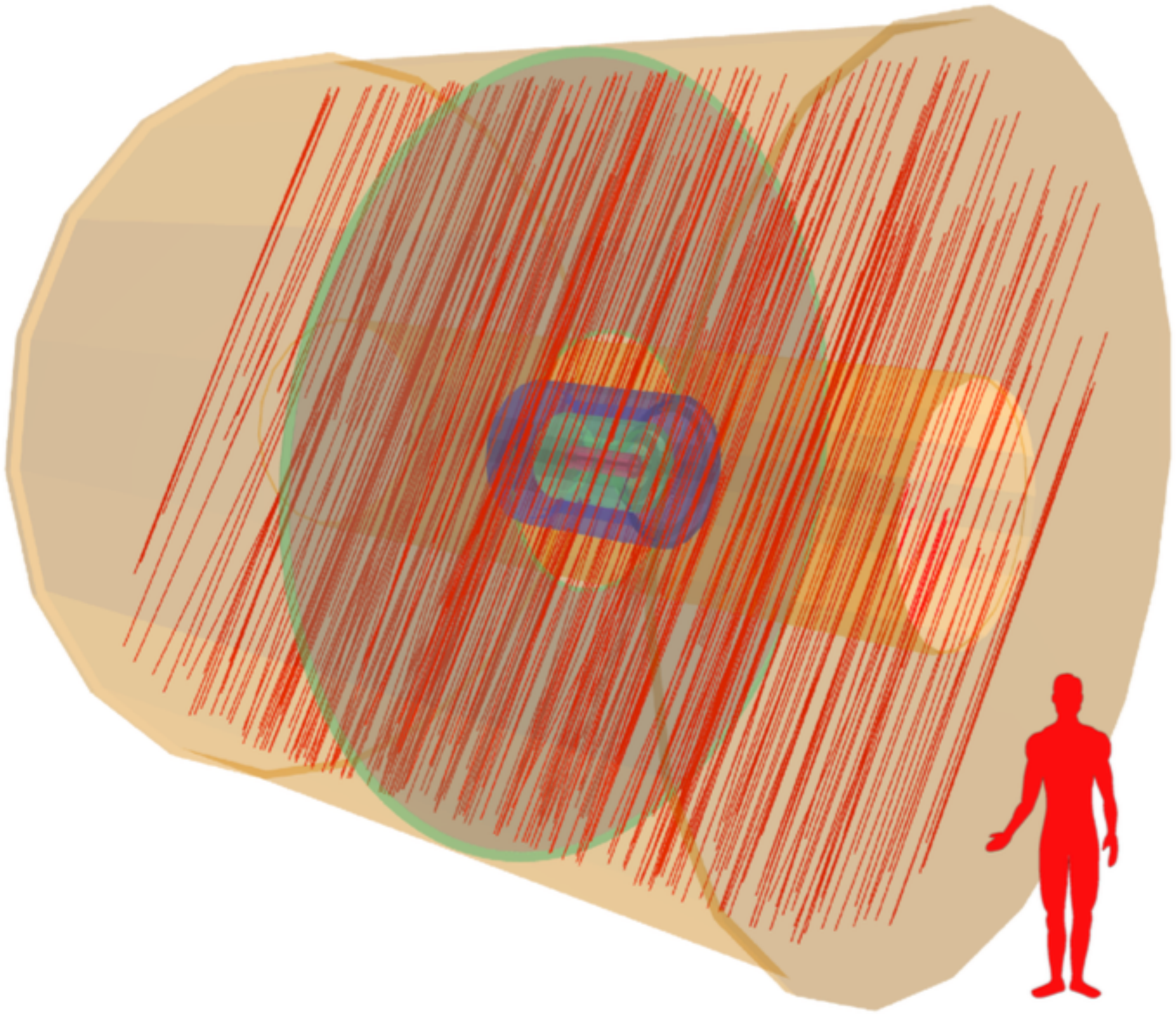


We find a smooth distribution up to #μ < 70 and 5 events with more than 100 atmospheric muons (HMM)

ALICE results on Cosmic Ray Physics

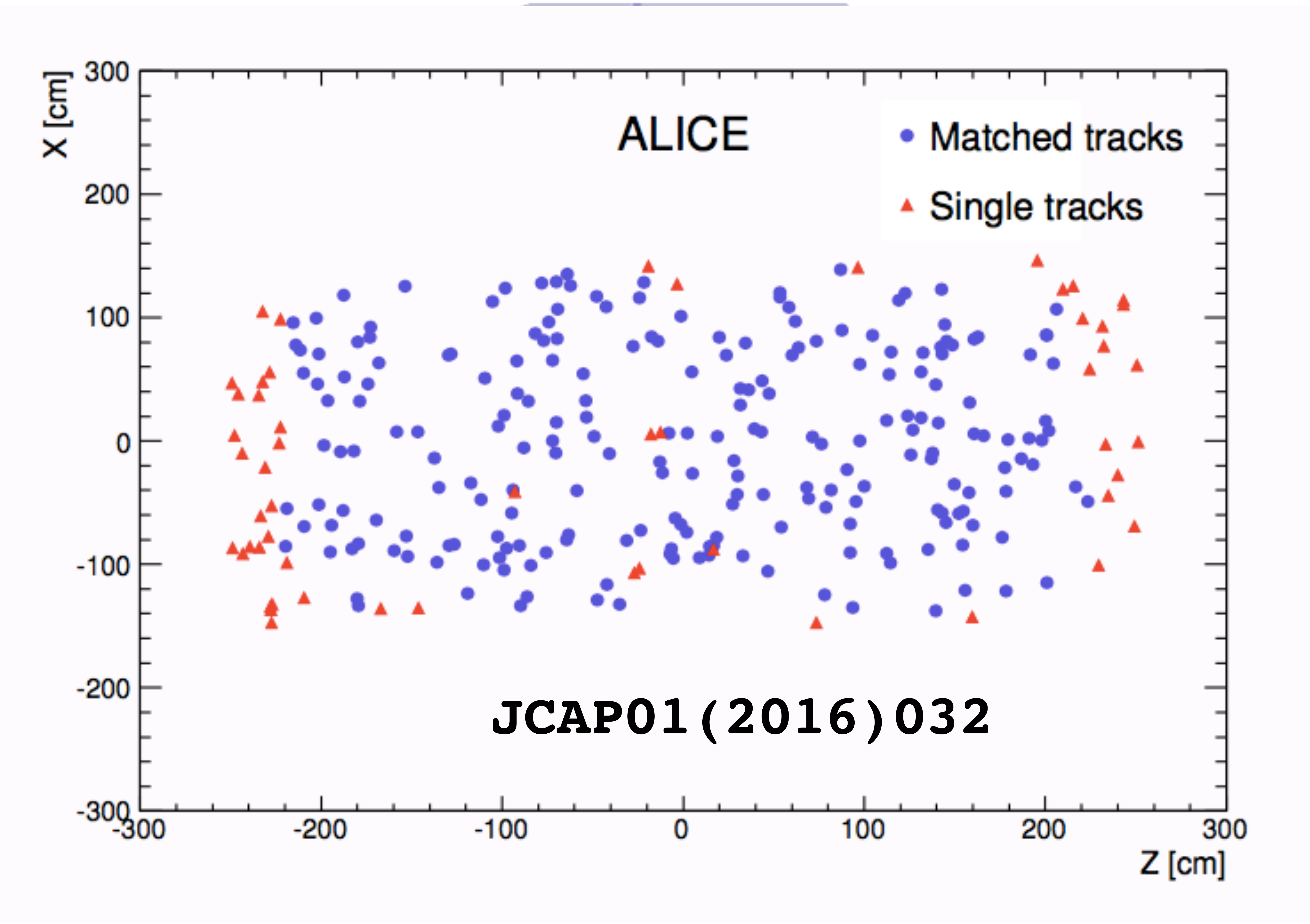
BUAP

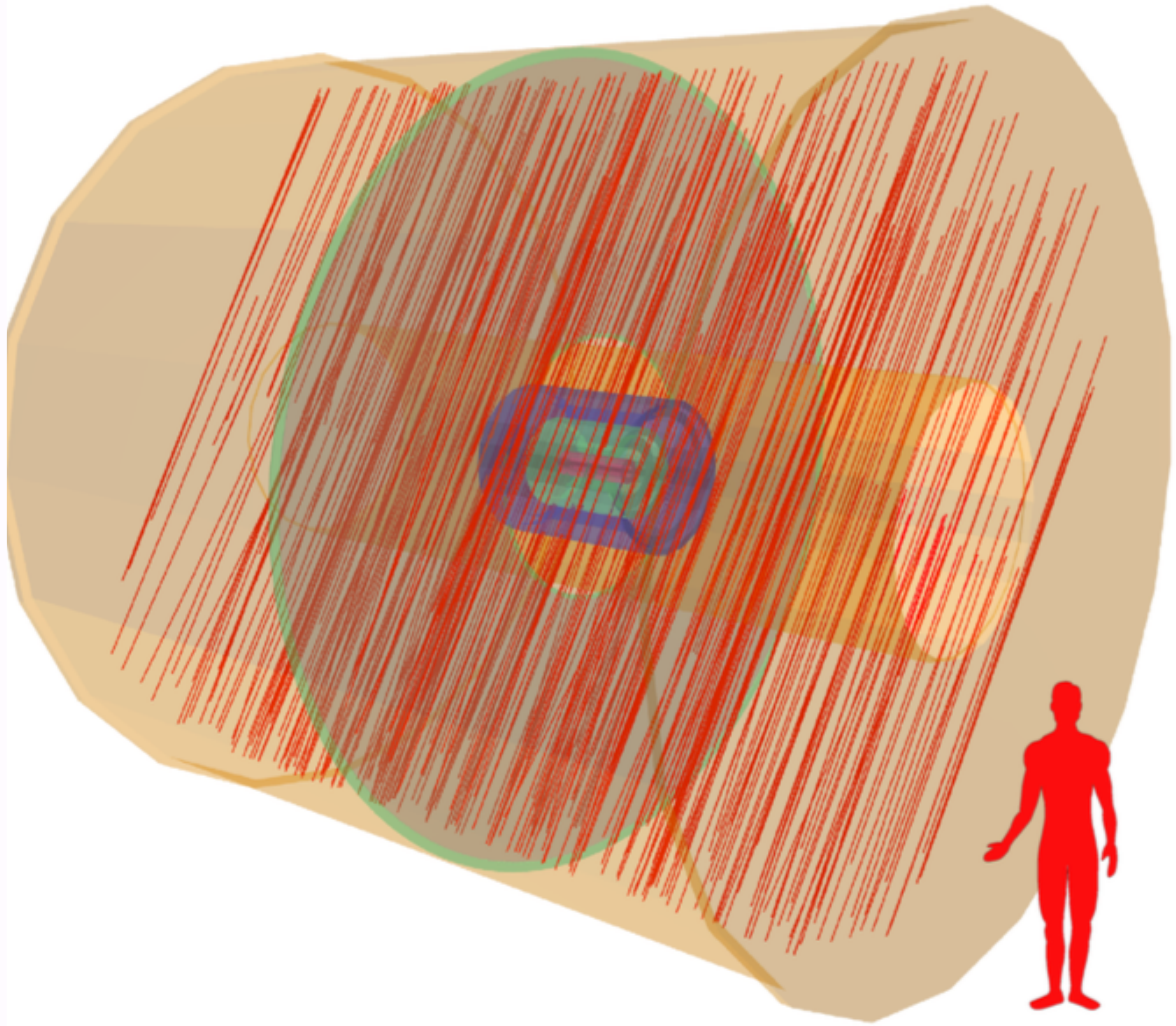




ALICE collected 5 events with more than 100 atmospheric muons during 30.8 days of data taking

ALICE results on Cosmic Ray Physics



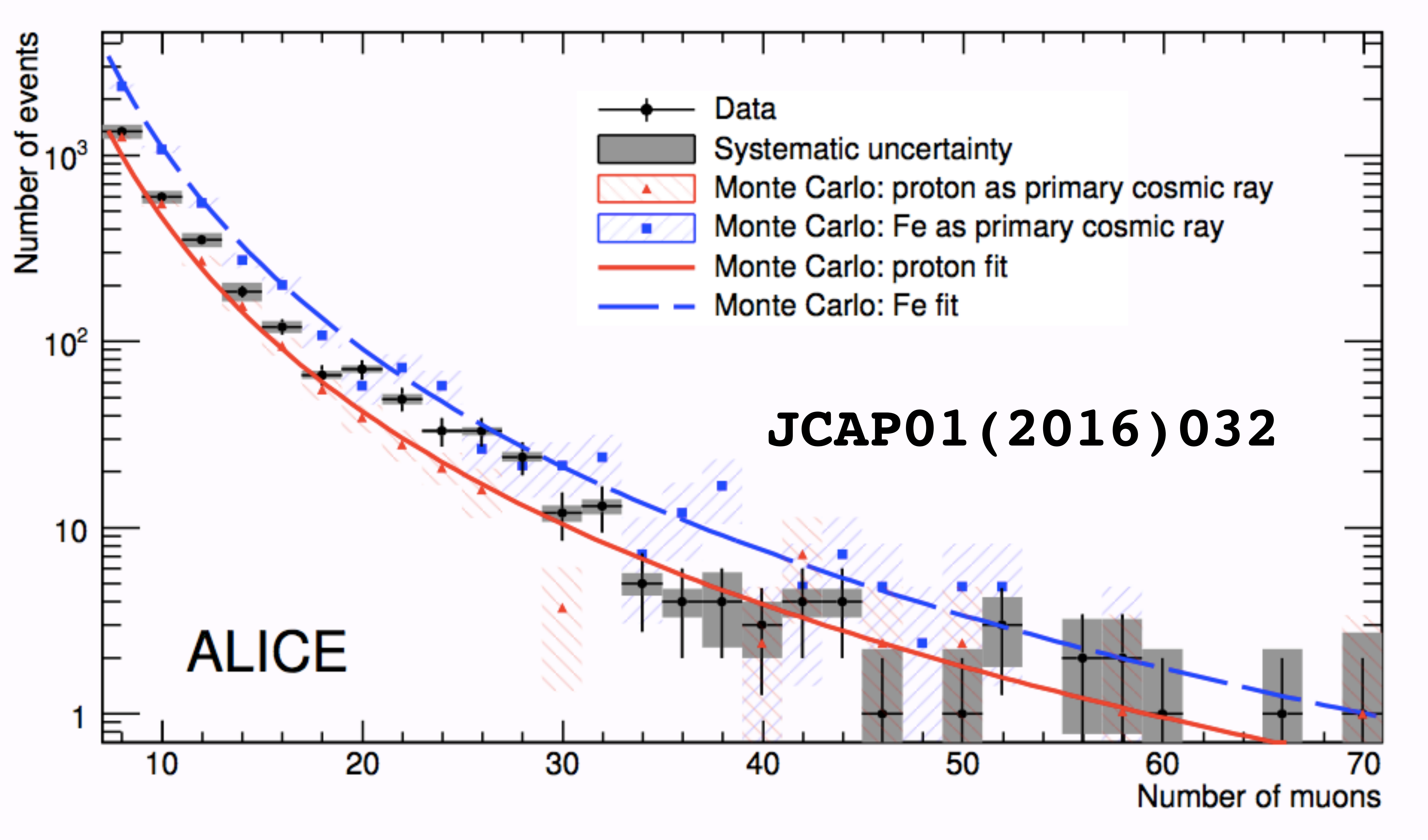


ALICE collected 5 events with more than 100 atmospheric muons during 30.8 days of data taking

ALICE results on Cosmic Ray Physics

BUAP

To compare the data with MC, the simulated distributions obtained with proton and iron primary cosmic-rays were fitted with a power-law function.



The data approach the proton curve (low multiplicities). High multiplicity data lie closer to the iron curve. This suggests that the average mass of the primary cosmic-ray flux increases with increasing energy.

ALICE results on Cosmic Ray Physics

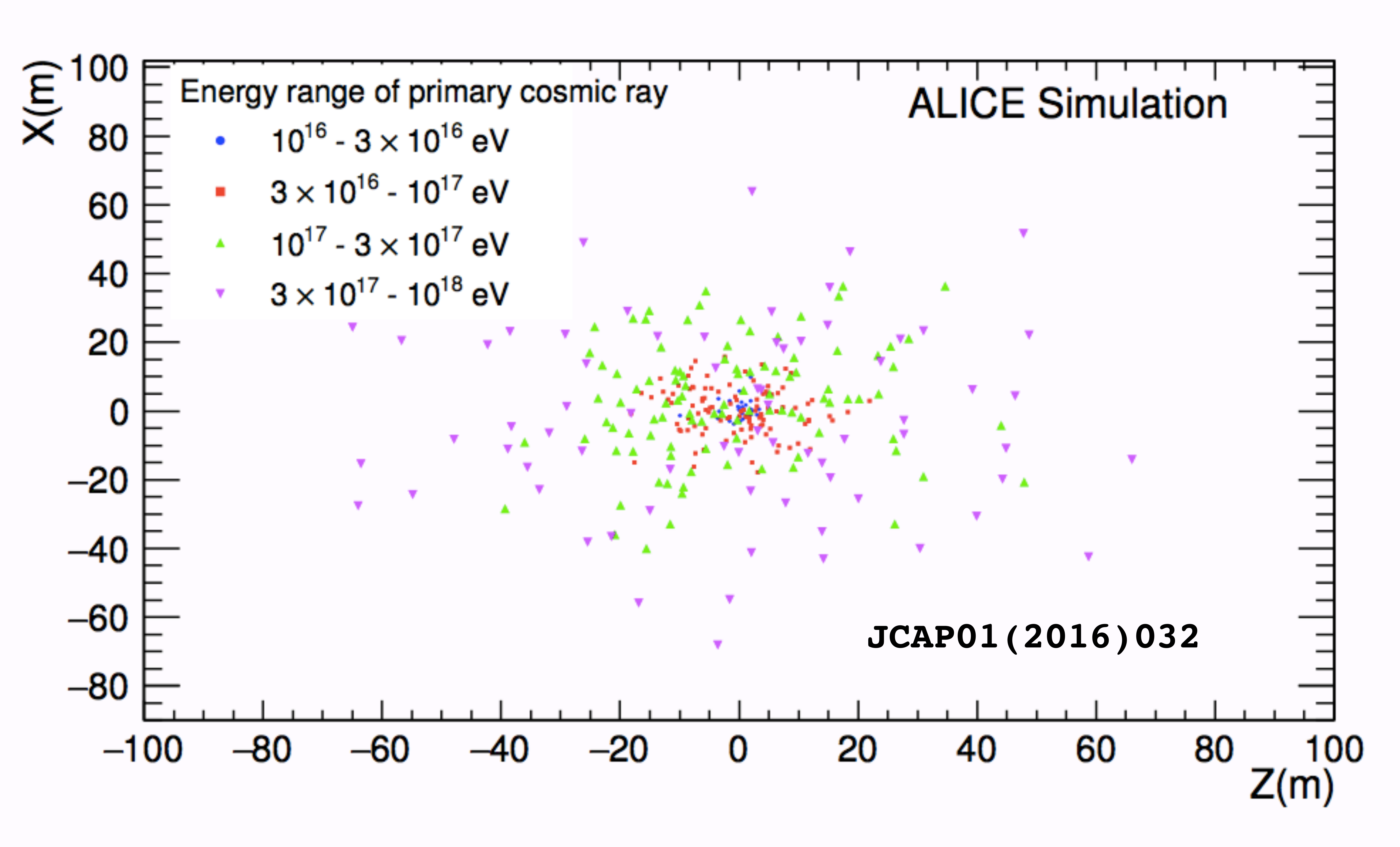
BUAP

HMM events	CORSIKA 6990 QGSJET II-03 proton	CORSIKA 6990 QGSJET II-03 iron	CORSIKA 7350 QGSJET II-04 proton	CORSIKA 7350 QGSJET II-04 iron	Data
Period [days per event]	15.5	8.6	11.6	6.0	6.2
Rate [$\times 10^{-6}$ Hz]	0.8	1.3	1.0	1.9	1.9
Uncertainty (%) (syst + stat)	13	16	8	20	49

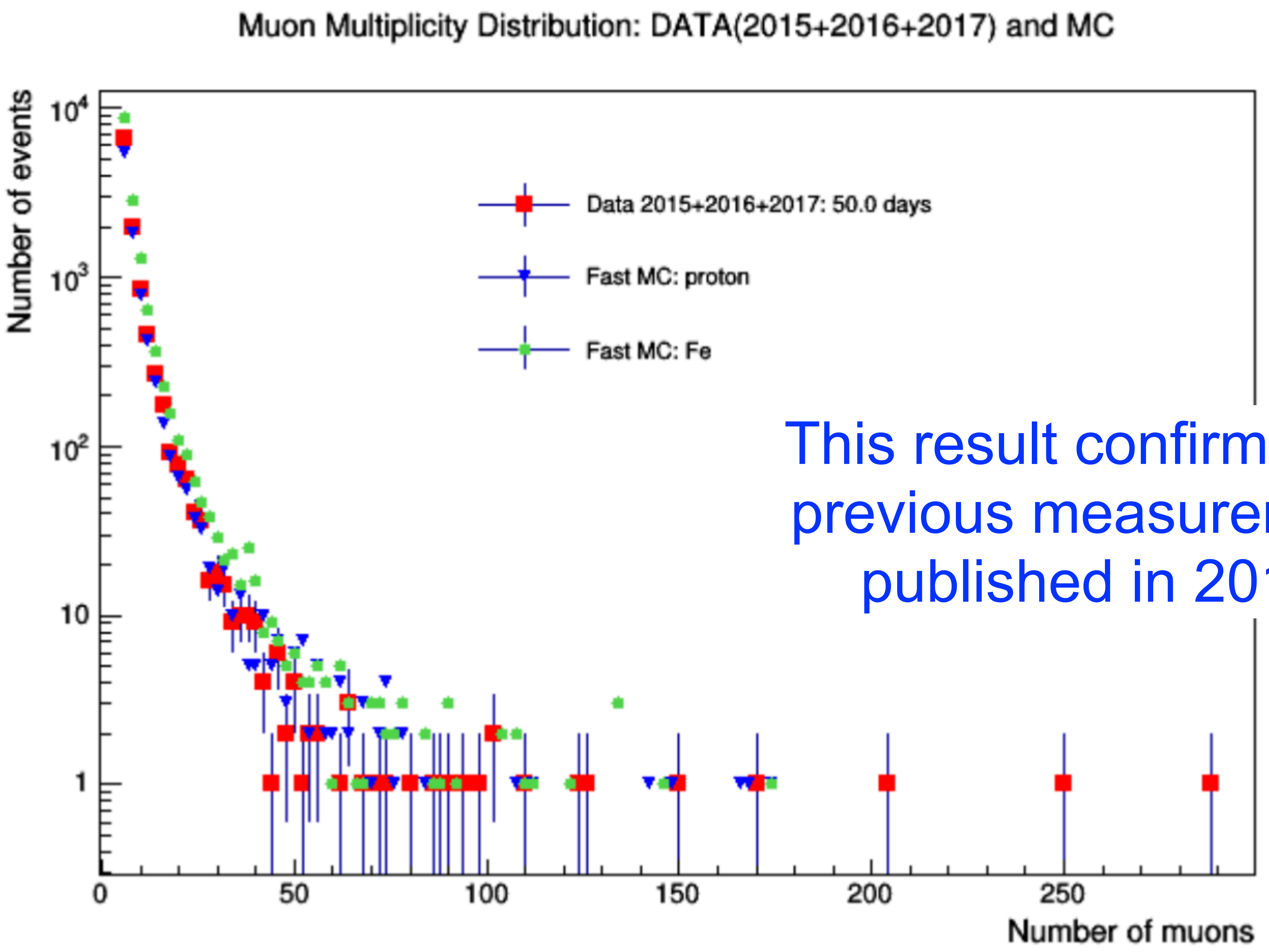
- Pure **iron** sample simulated with **QGSJET II-04** model reproduces HMM event rate in close agreement with the measured value.
- Independent of the version model, the rate of HMM events with pure proton cosmic-ray composition is more difficult to reproduce.
- This result is compatible with recent measurements which suggest that the composition of the primary cosmic-ray spectrum with energies larger than 10^{16} eV is dominated by heavier elements: Phys. Rev. Lett. **107** (2011) 171104.

COSMIC-RAY PHYSICS

BUAP



COSMIC-RAY PHYSICS



This result confirms our previous measurement published in 2016

COSMIC-RAY PHYSICS

BUAP

Steps

1. Simulation of Extensive Air Showers (EAS) with Corsika. We can setup the generation to use QGSJET or EPOS models. Hereafter all the simulations are done with CORSIKA+EPOS.

3. Random location of the core of the EAS at the surface inside of a square of 200 x 200 m^2

5. Propagation of muons through the rock molasses to ALICE. This is done with AliRoot.

7. Active detectors: TPC, TOF and ACORDE.

9. Reconstruction done with standard OCDB for cosmics

COSMIC-RAY PHYSICS

BUAP

Details of the simulation with CORSIKA

1. Two hypotheses for primary cosmic ray composition: proton (light) and fe (heavy)

2. Energy range: 10^{14} - 10^{18} eV

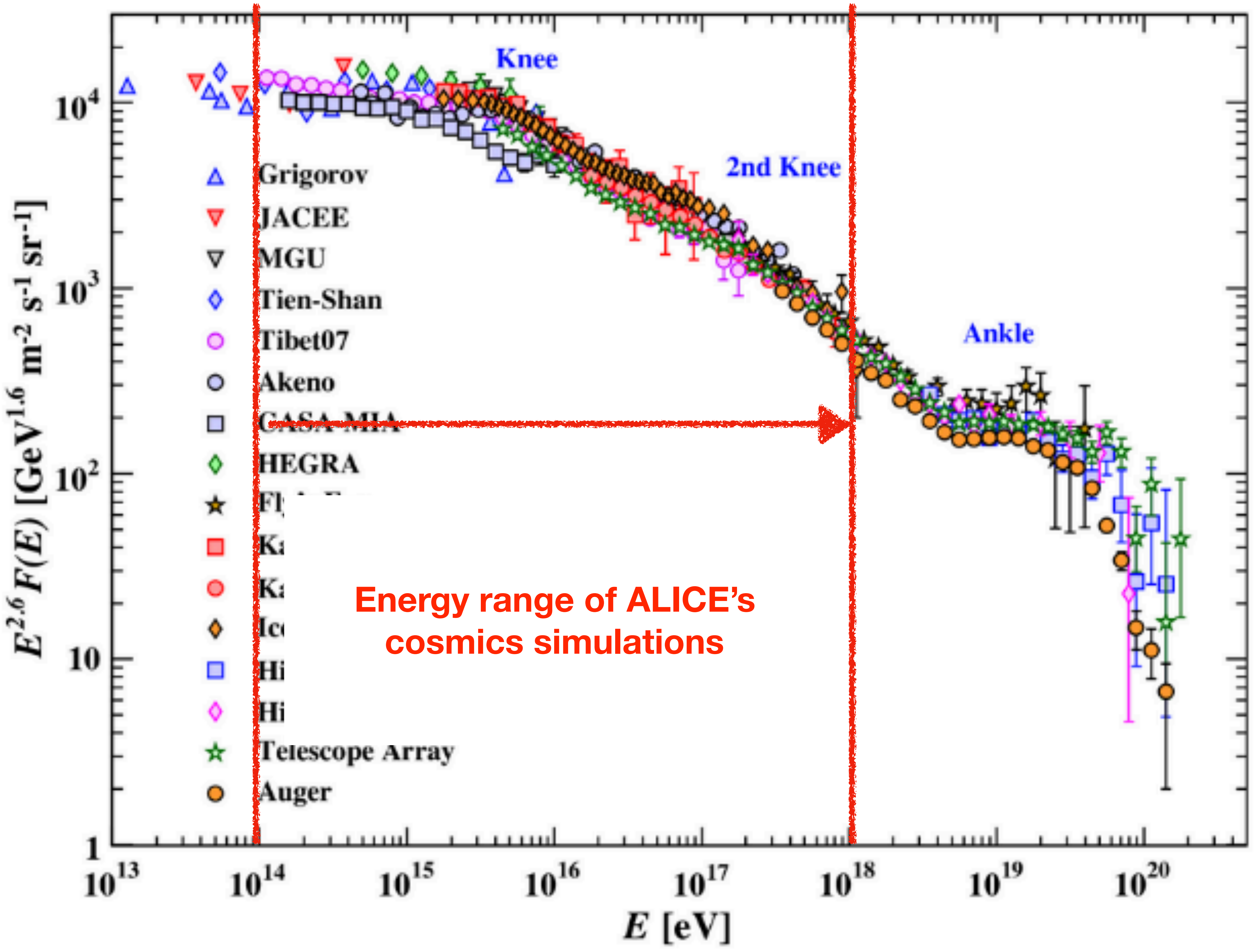
3. Number of total days simulated: 50 days. This is equivalent to the data sample collected by ALICE during cosmic runs in 2015, 2016 and 2017. This is 62.3% more data than the used for ALICE cosmic paper with Run-1 data.

4. Model: EPOS

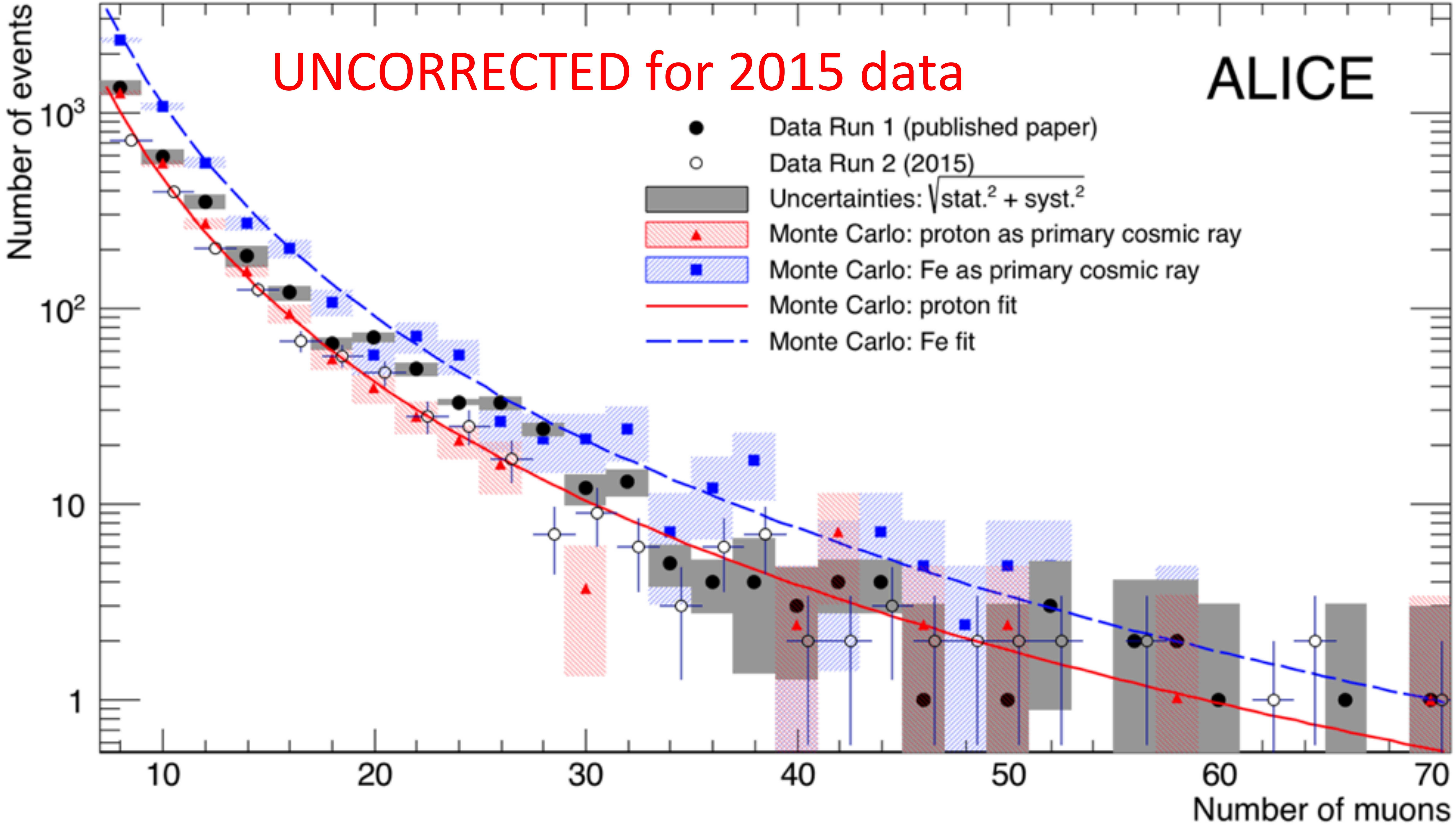
COSMIC-RAY PHYSICS

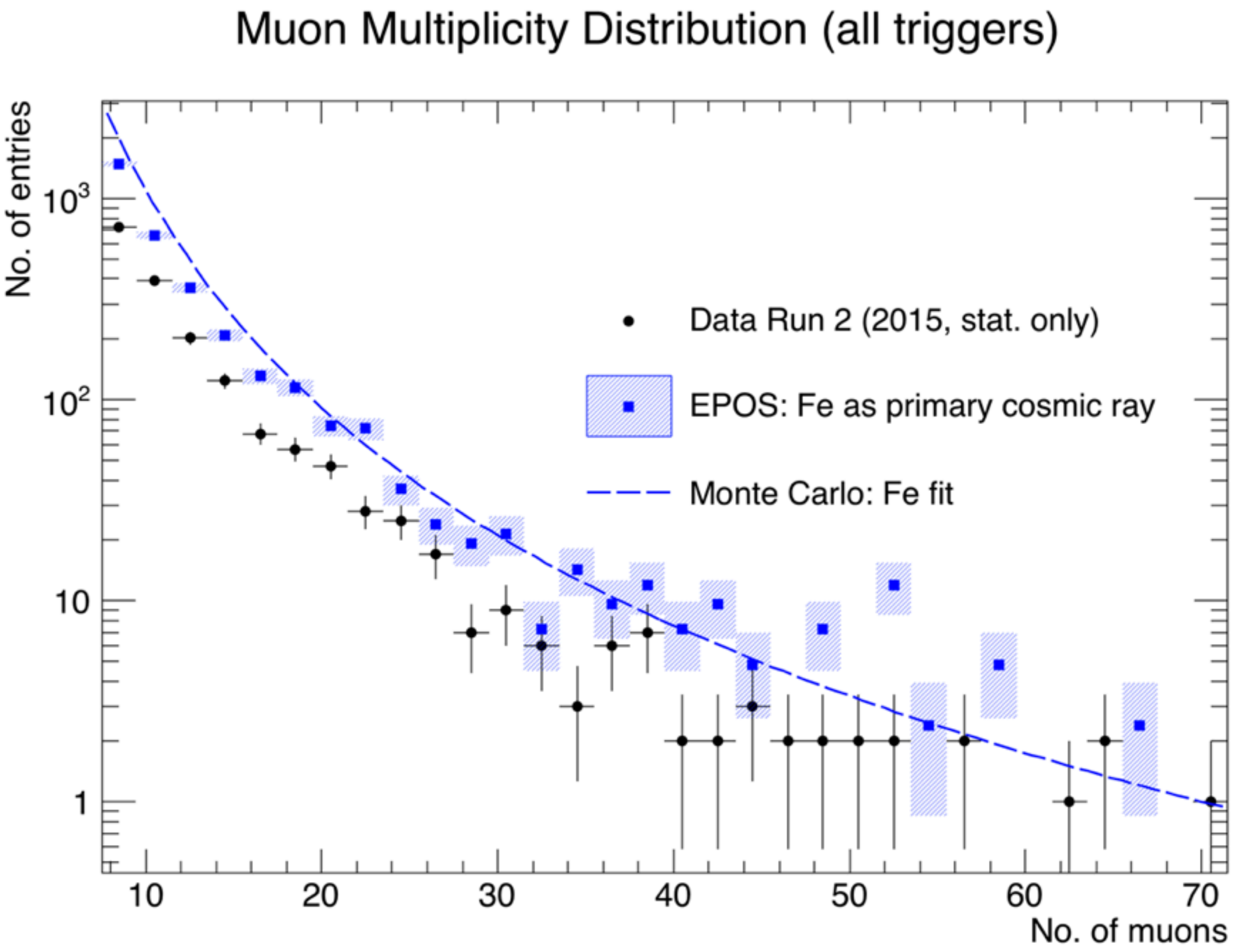
Number of simulated events to be propagated to ALICE with AliRoot

Energy range (eV)	Number of events
10^{14} - 10^{15}	24,188,879
10^{15} - 3×10^{15}	463,517
3×10^{15} - 10^{16}	67,872
10^{16} - 3×10^{16}	5,966
3×10^{16} - 10^{17}	679
10^{17} - 3×10^{17}	59
3×10^{17} - 10^{18}	7



For this talk:
- **number of simulated days: 30**
- **primary cosmic ray composition: fe**

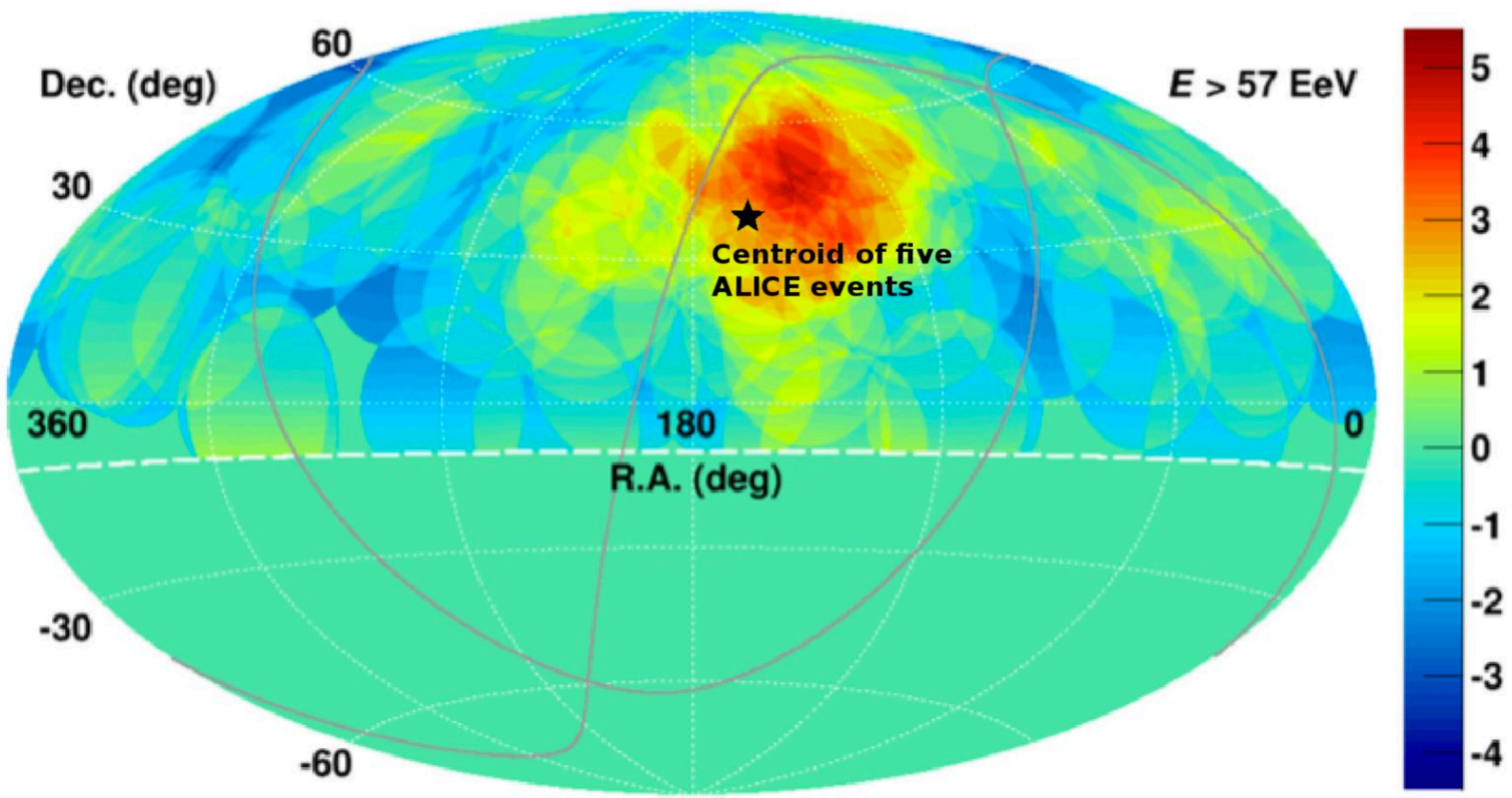

UNCORRECTED for 2015 data
ALICE
Number of events
Number of muons
Data Run 1 (published paper)
Data Run 2 (2015)
Uncertainties: $\sqrt{stat.^2 + syst.^2}$
Monte Carlo: proton as primary cosmic ray
Monte Carlo: Fe as primary cosmic ray
Monte Carlo: proton fit
Monte Carlo: Fe fit
1
10
10^2
10^3
10
20
30
40
50
60
70


Muon Multiplicity Distribution (all triggers)
No. of entries
No. of muons
Data Run 2 (2015, stat. only)
EPOS: Fe as primary cosmic ray
Monte Carlo: Fe fit
10
20
30
40
50
60
70
1
10
10^2
10^3

WHERE DO THE MUON BUNDLES COME FROM?

From Maciej Rybczyński, **ISMD 2017**

Anisotropy of arrival directions



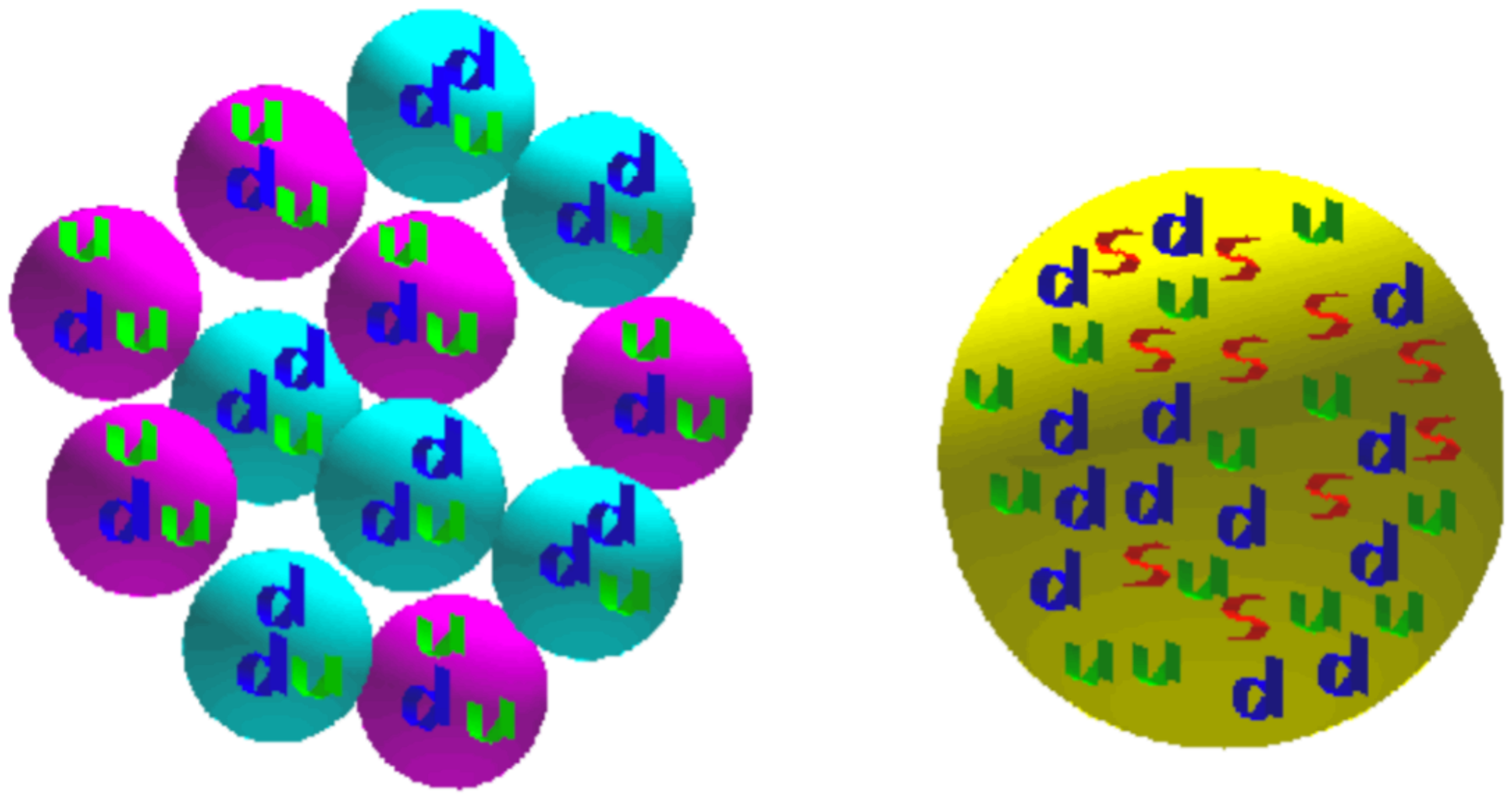
Aitoff projection of the UHECR map in equatorial coordinates taken from Telescope Array Collaboration data **[The Astrophysical Journal Letters 790 (2014) L21]**

WHERE DO THE MUON BUNDLES COME FROM?

From Maciej Rybczyński, ISMD 2017

Strange quark matter

Roughly equal numbers of u, d, s quarks in a single ‘bag’ of cold hadronic matter.



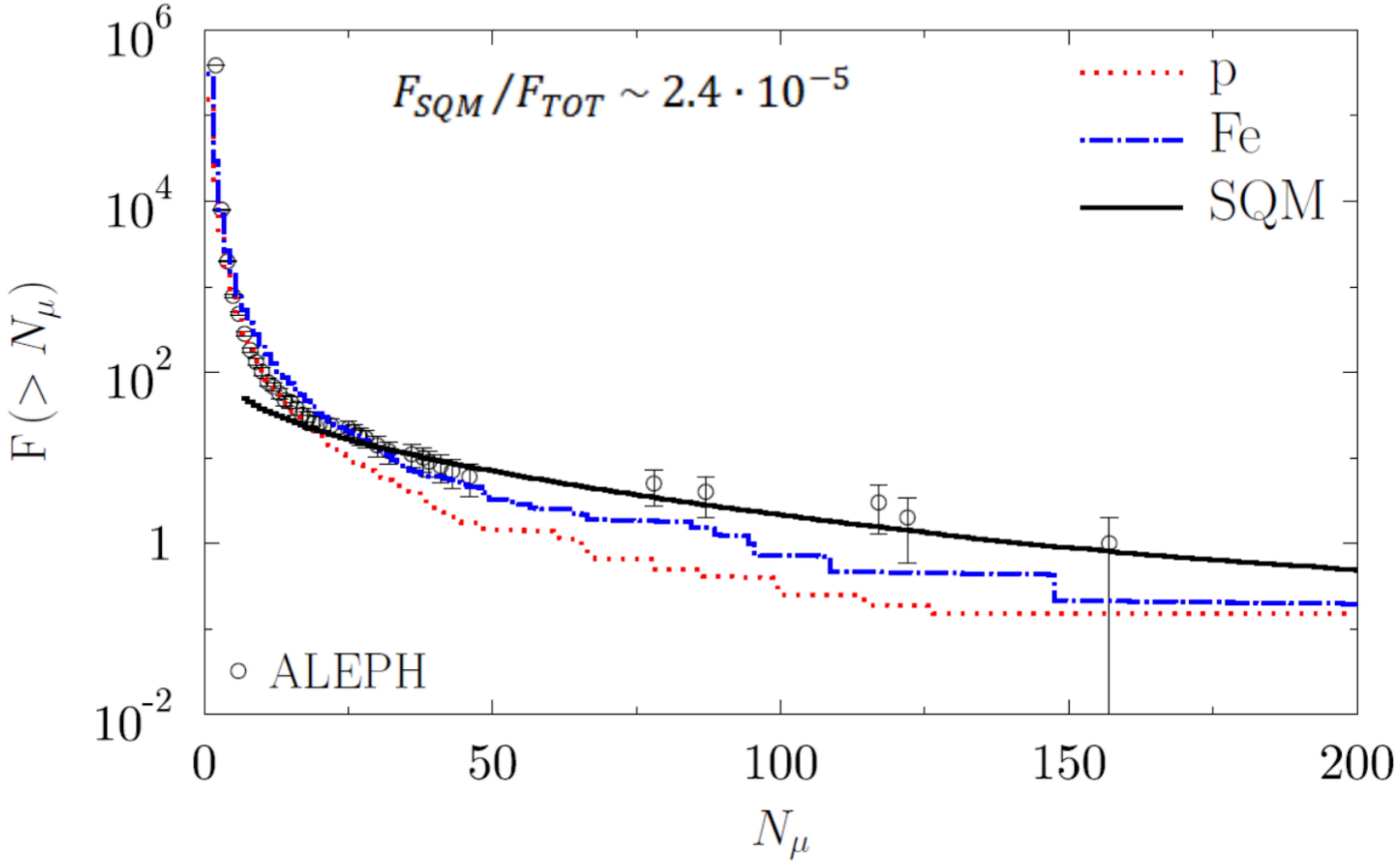
Nucleus (^{12}C)	Strangelet*
Z=6, A=12	A=12 (36 quarks)
Z/A = 0.5	Z/A = 0.083

*small lump of Strange Quark Matter

WHERE DO THE MUON BUNDLES COME FROM?

From Maciej Rybczyński, ISMD 2017

High multiplicity muon bundles from strange quark matter

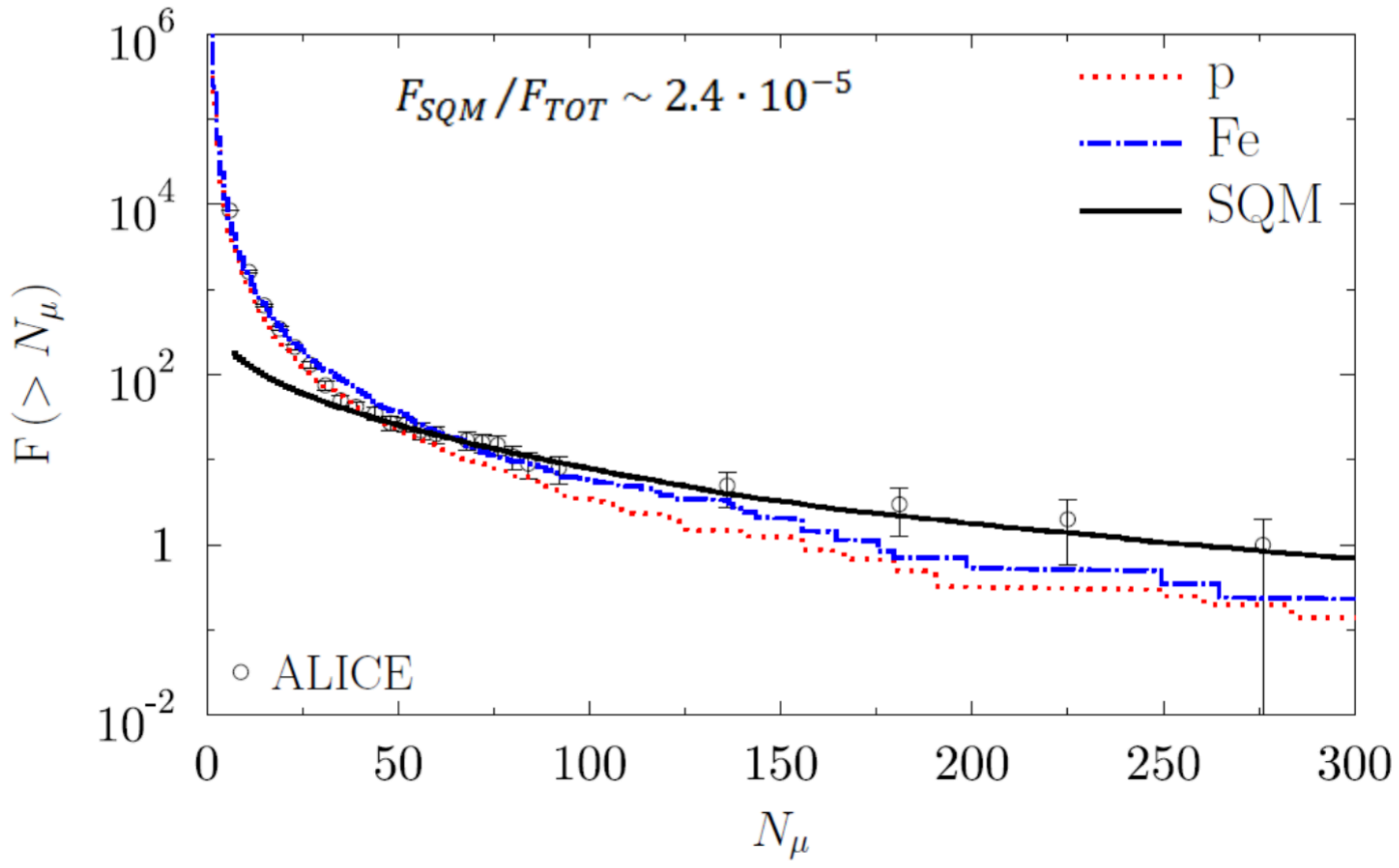


Integral multiplicity distribution of muons the ALEPH data (circles) published in Astr. Phys. 19 (2003) 513. Monte Carlo simulations for primary protons (dotted line); iron nuclei (dashed dot line) and primary strangelets with mass A taken from the $A^{-7.5}$ distribution (full line) with abundance of the order of $2 \cdot 10^{-5}$ of the total primary flux.

WHERE DO THE MUON BUNDLES COME FROM?

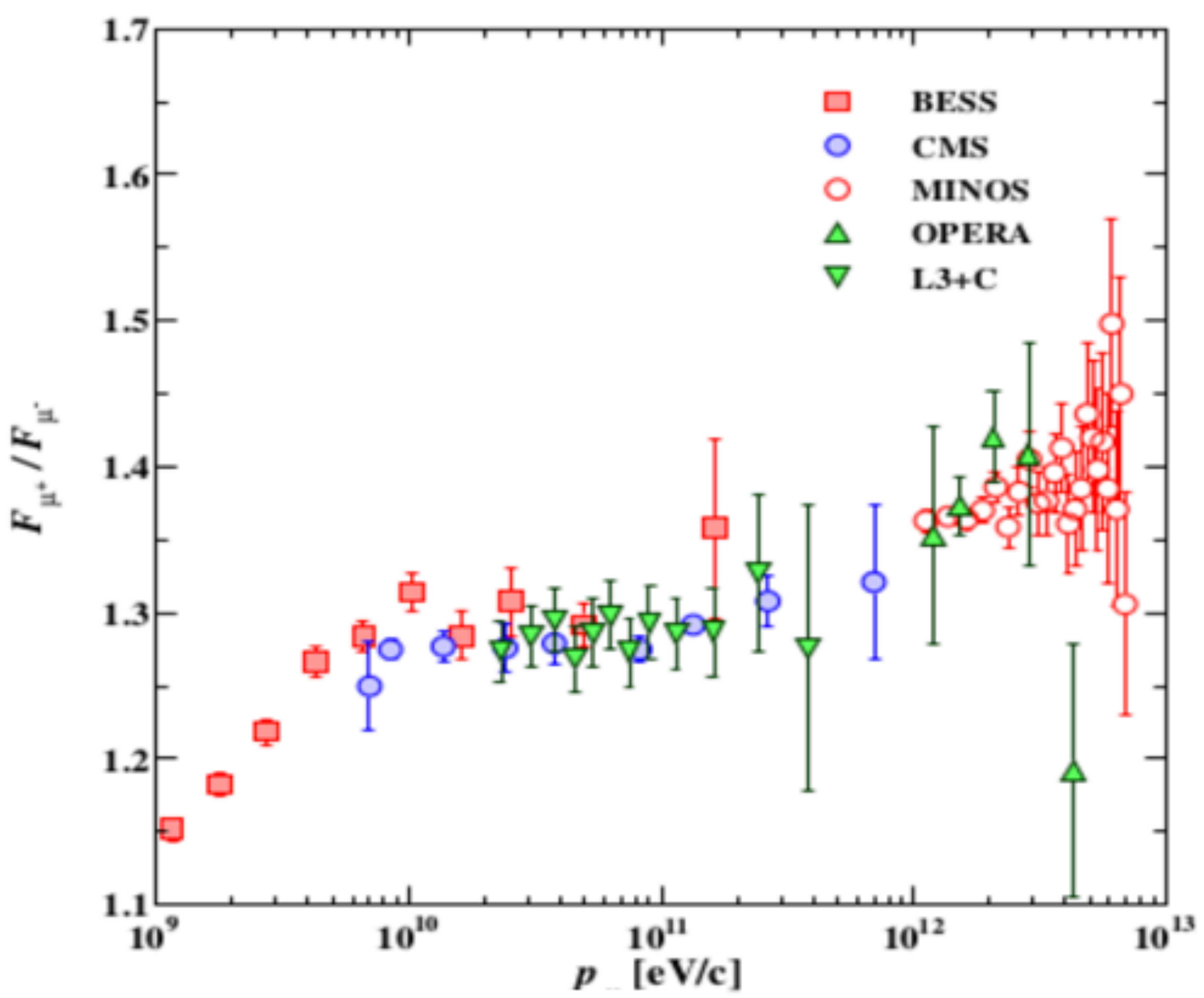
From Maciej Rybczyński, ISMD 2017

High multiplicity muon bundles from strange quark matter



Integral multiplicity distribution of muons for the ALICE data (circles) published in JCAP 01 (2016) 032. Monte Carlo simulations for primary protons (dotted line); iron nuclei (dashed dot line) and primary strangelets with mass A taken from the $A^{-7.5}$ distribution (full line) with abundance of the order of $2 \cdot 10^{-5}$ of the total primary flux.

Cosmic charge ratio



The ratio μ^+/μ^- is defined as the ratio of the number of positively charged muons to the number of negatively charged muons that reach the surface of the Earth.

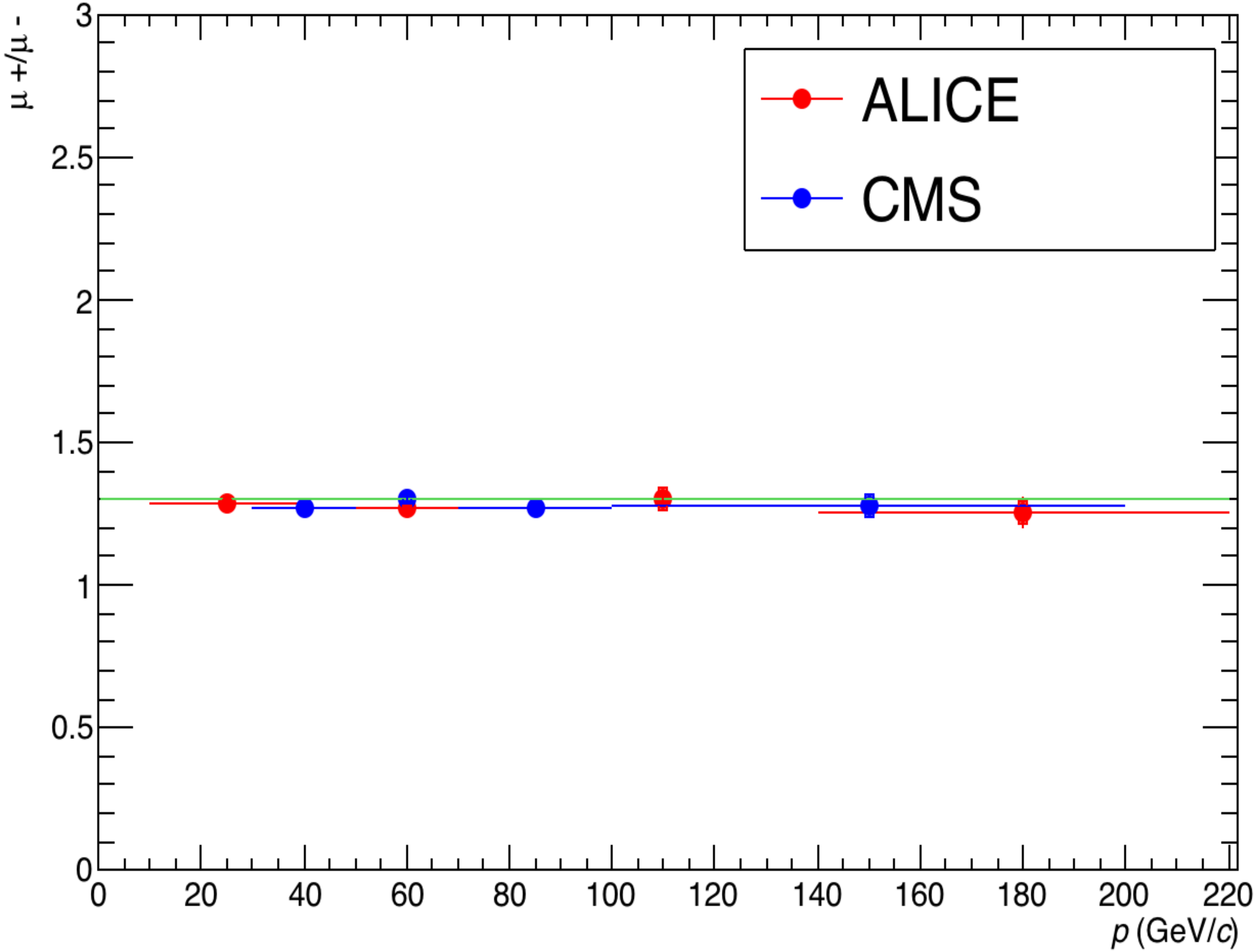
Several contributions

- composition of the primary cosmic ray (ratio protons over heavy component)
- hadronic interaction features
- atmospheric conditions (low energy, below few GeV)
- contribution of muons from charmed particle decays (prompt muons, very high energy)

This ratio can be used to

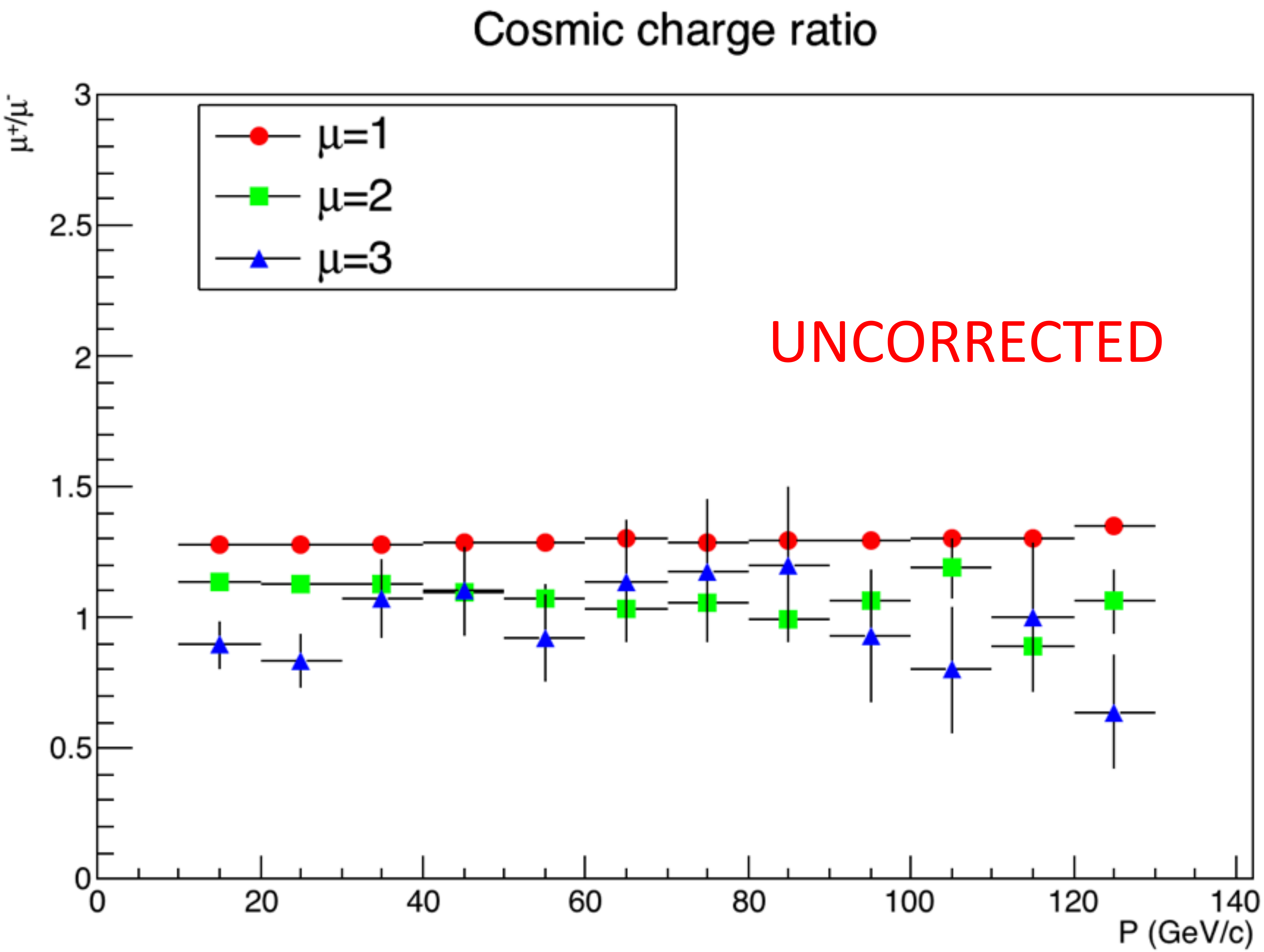
- improve the understanding of the mechanism of multiple production of pions and Kaons in the atmosphere
- better understand the features of high energy hadronic interactions in the forward region
- improve the Monte Carlo models of hadronic interactions (constrain predictions at higher energies)

Muon Charge Ratio



What about this ratio for multi-muon events?

- we could observe muons coming from heavy-nucleus component of the primary cosmic ray
- the cosmic charge ratio for single muon events is around 1.28 —> this reflects larger abundance of protons (light cosmic ray component) over heavier elements (Fe)
- for multi-muon events, do this effect must be diminished ?
- at high energies, the heavy flavor component of the EAS and the primary cosmic ray composition may be significant.


Cosmic charge ratio
μ+/μ-
μ=1
μ=2
μ=3
UNCORRECTED
3
2.5
2
1.5
1
0.5
0
20
40
60
80
100
120
140
P (GeV/c)

Description of Monte Carlo sample

- momentum range: 5 - 500 GeV (flat distribution)
- theta: 0-20 degrees
- Magnetic field: B > 0
- simulated ratio = 1.27
- number of events: 701,195

Event and track selection

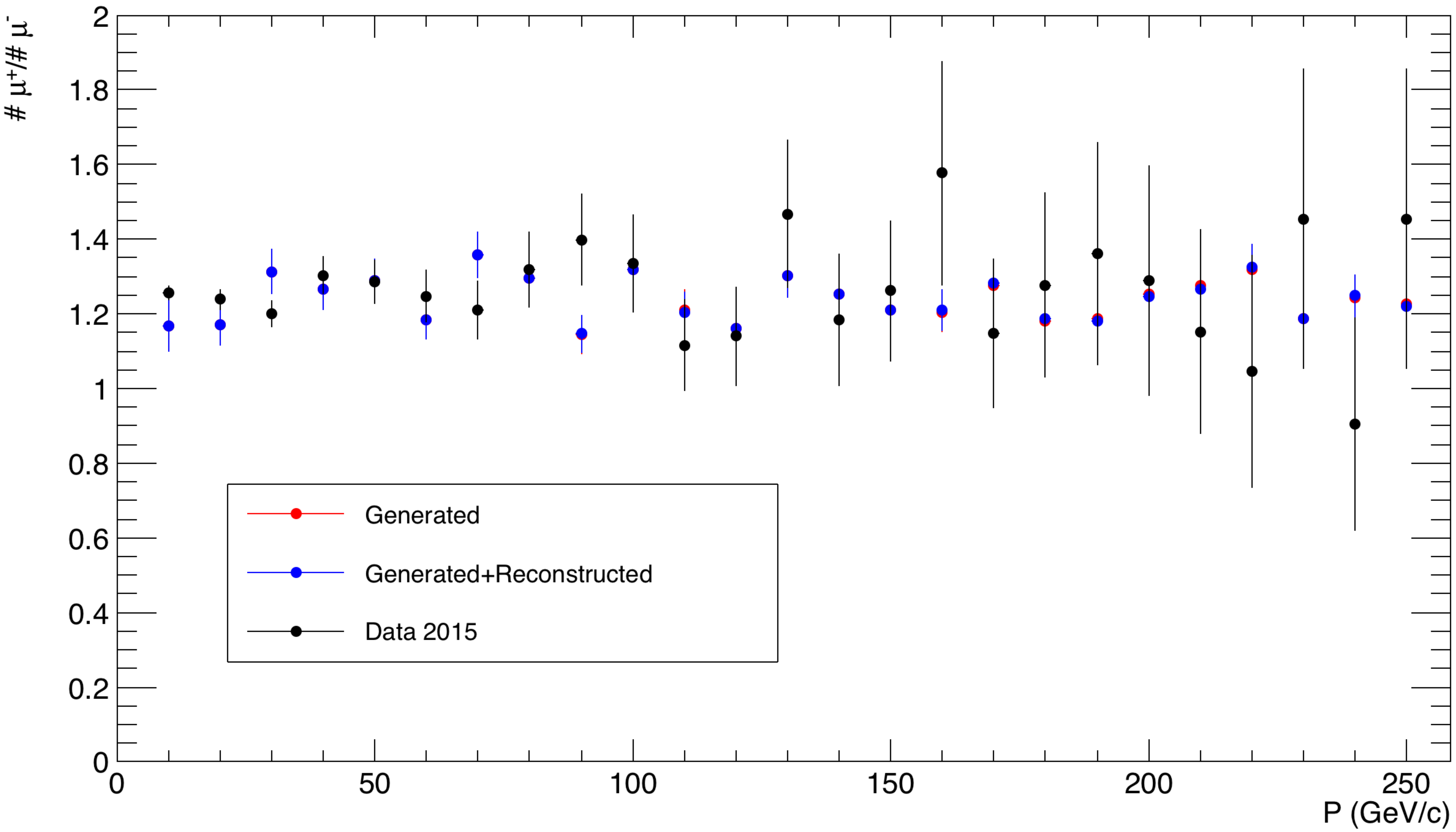
- number of tracks per event = **2** (this means 1 reconstructed muon)
- #TPC clusters per track > 50
- distance between matched tracks < **6** cms
- no cut in XZ plane (full TPC area)

Description of Data sample

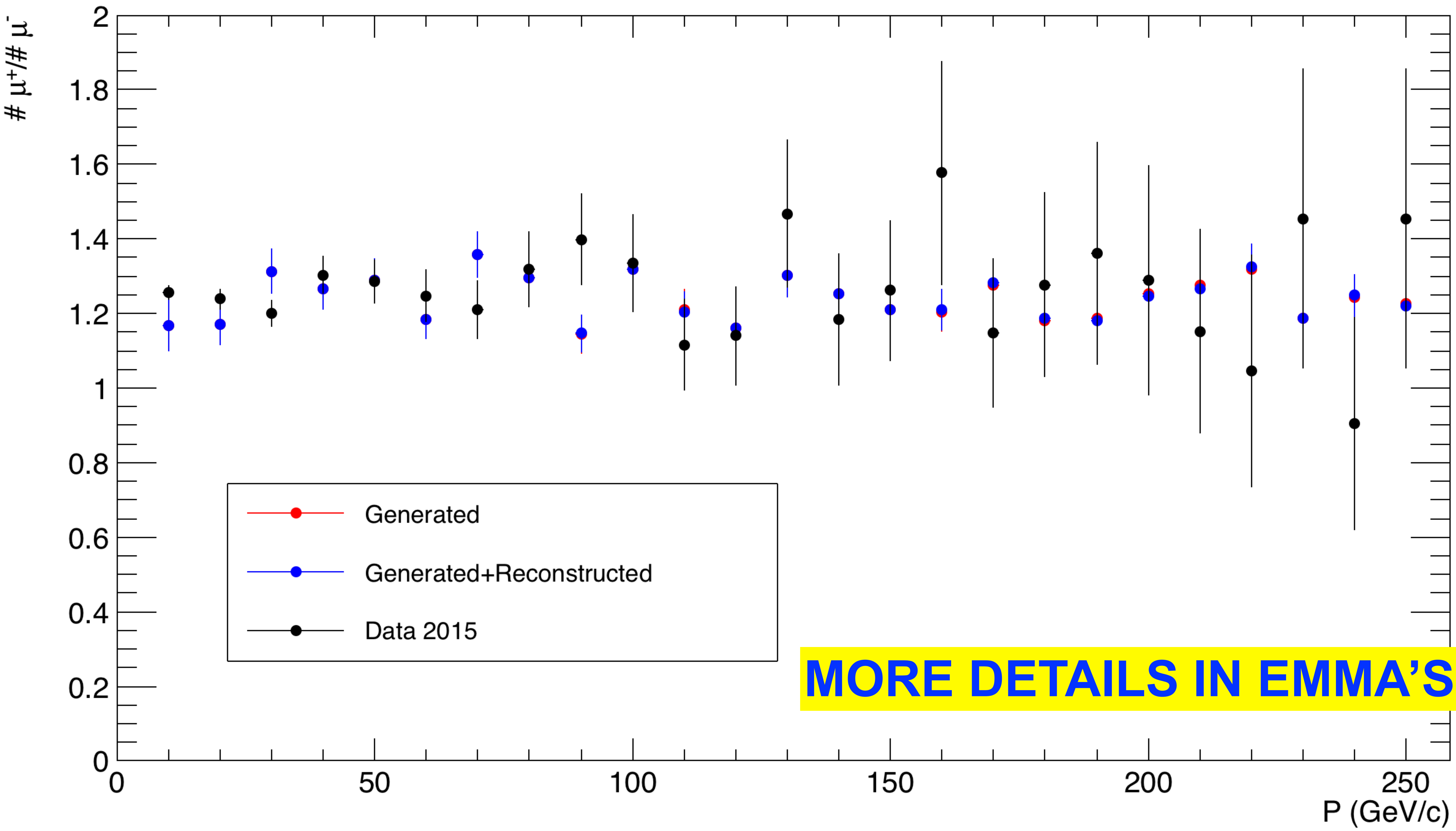
- momentum range: 5 - 500 GeV (flat distribution)
- theta: 0-20 degrees
- Periods: LHC15adfk (B<0) & LHC15cdfm (B>0)
- number of events: 2,987,480

Event and track selection

- number of tracks per event = **2** (this means 1 reconstructed muon)
- #TPC clusters per track > 50
- TOF trigger: OB3
- distance between matched tracks < **6** cms
- no cut in XZ plane (full TPC area)



μ+/# μ-
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
50
100
150
200
250
P (GeV/c)
Generated
Generated+Reconstructed
Data 2015



MORE DETAILS IN EMMA'S SLIDES

BUAP

EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

ALICE

CERN

ALICE-ANA-2018-XXX
April 12, 2018

Analysis of multimuons in cosmic ray events taken with ALICE central barrel detectors in 2015 and 2016

B. Alessandro[1], A. Fernández Téllez[2], E. González Hernández[2],
M. Rodríguez Cahuantzi[2], K. Shtejer Diaz[3] and M. Sitta[4]

1. Istituto Nazionale di Fisica Nucleare (INFN) Sezione di Torino, Italy
2. Fac. Ciencias Físico Matemáticas, B. Universidad Autónoma de Puebla, México
3. Center of Technological Applications and Nuclear Development (CEADEN), Cuba and Joint Institute for Nuclear Research - JINR, Dubna, Russia
4. Universitá del Piemonte Orientale and INFN Sezione di Torino, Italy

Email: alessandro@to.infn.it

Abstract

In this analysis note we describe the performances of the involved detectors in taking cosmic data in the central barrel of Alice and the study of cosmic muons, in particular the multimuon events. The data sample analyzed corresponds to 42.3 effective days of data taking collected during 2015 and 2016.

BENEMÉRITA UNIVERSIDAD AUTÓNOMA DE PUEBLA 1578

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MORE DETAILS IN EMMA'S SLIDES

Diffraction

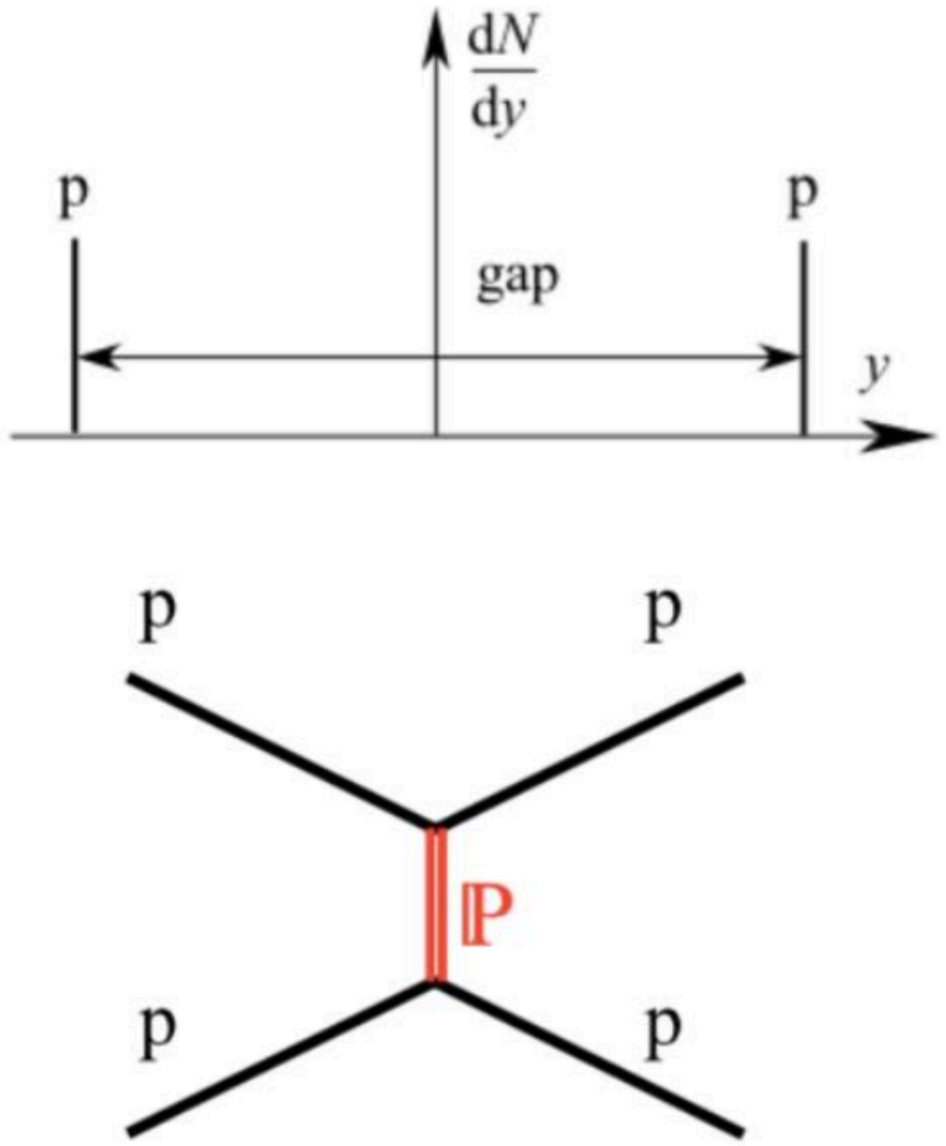
- In a diffractive reaction, no colour is exchanged between the particles colliding at high energies.
- Diffraction is elastic (or quasi elastic) scattering caused by the absorption of components of the wave function of the incoming particles
- p-p -> p-p, p-p -> pX (single proton dissociation, Single Diffractive), p-p -> XY (both protons dissociate, Double Diffractive), or Central Diffractive, p-p->p+X+p
- A diffractive process is characterized by a rapidity gap. Experimentally, there is no defined way to distinguish rapidity gaps caused by Pomeron exchange from those caused by other colour-neutral exchanges, so the separation is model dependent.

Diffraction

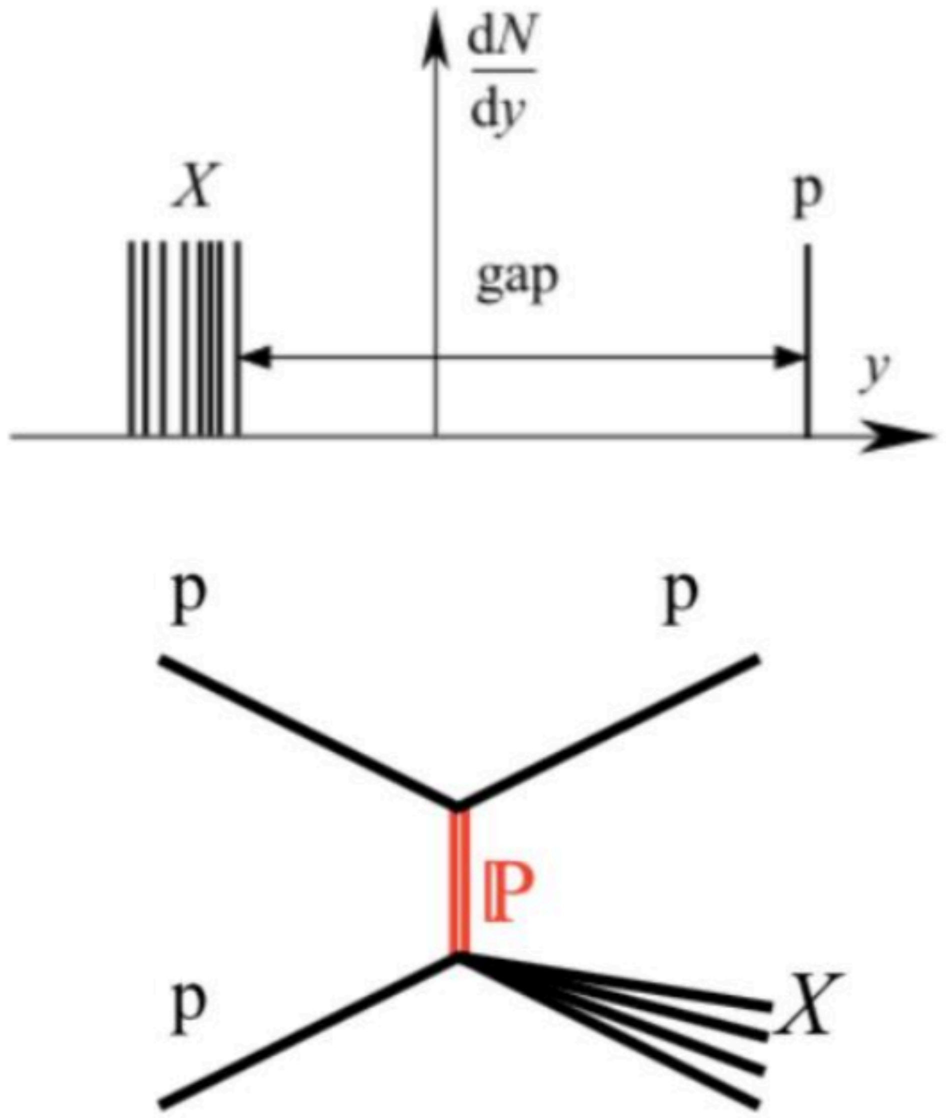
Measuring SD and DD with ALICE

Strategy: Measure gap distribution over **8 units in η** using the central barrel and forward detectors.

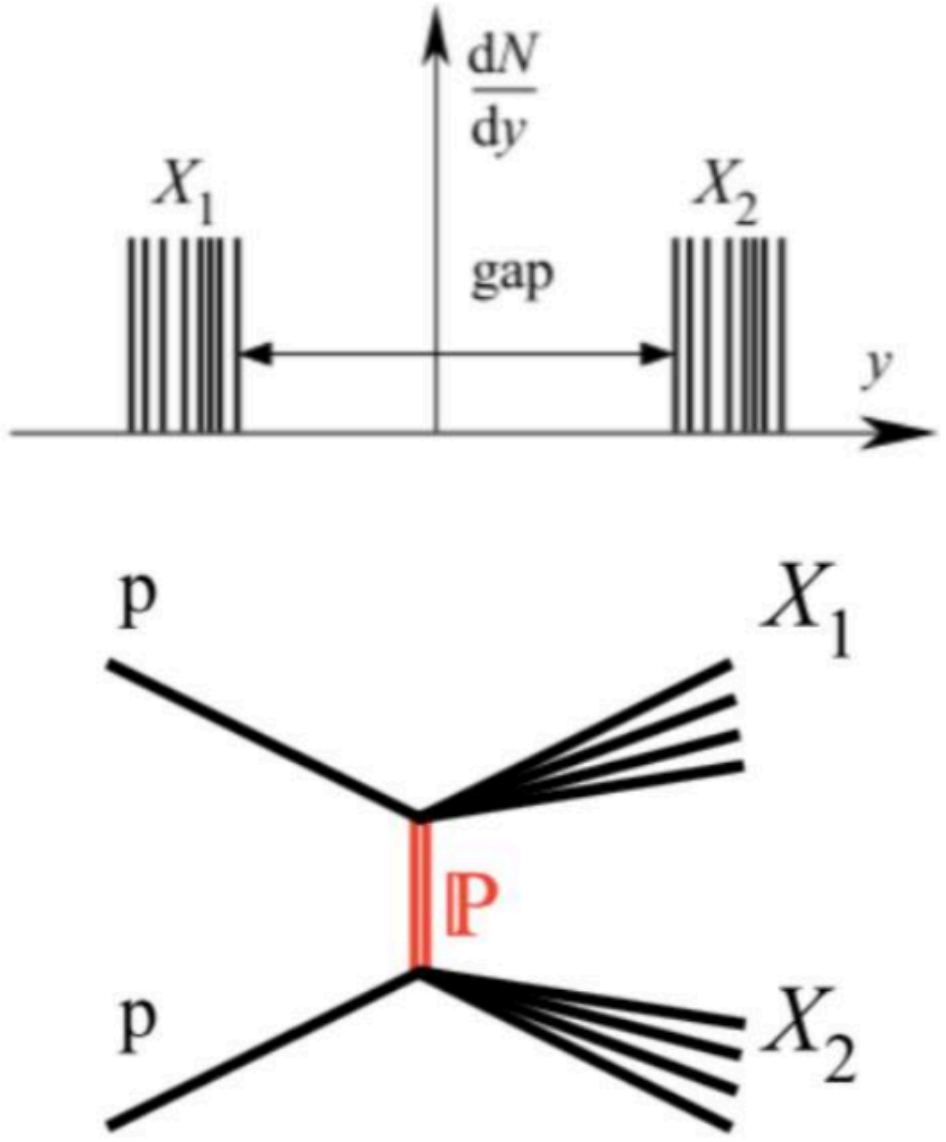
Elastic



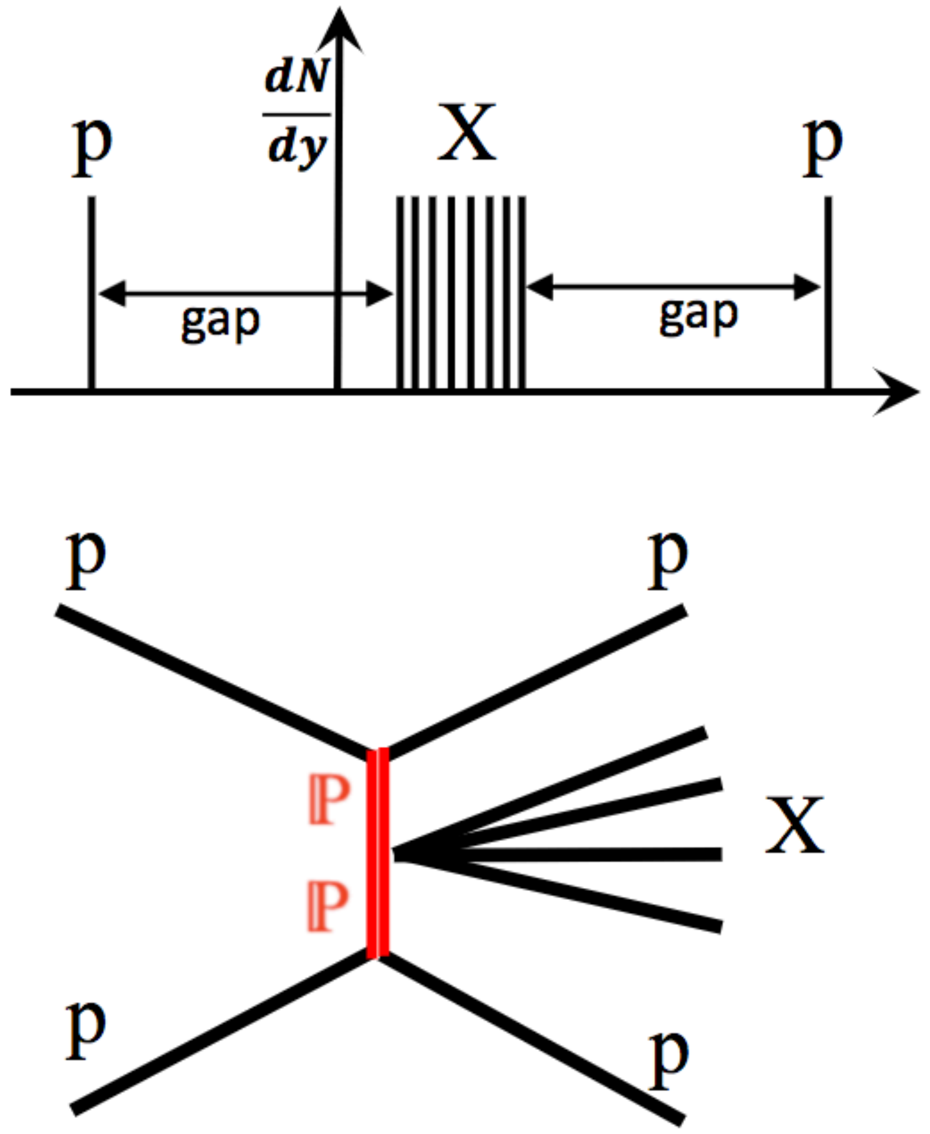
Single Diffractive



Double Diffractive



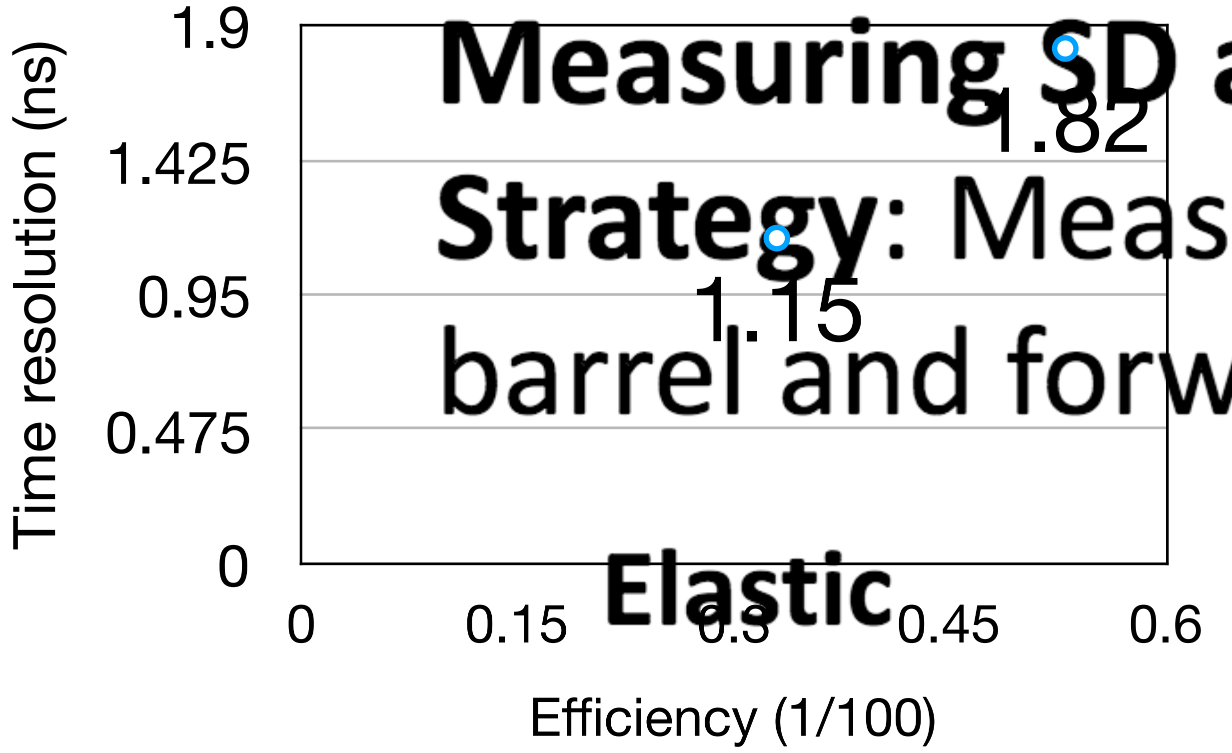
Central Exclusive Production



Dates: 23/05/2018 - 31/05/2018
Place: T10-CERN

Diffraction

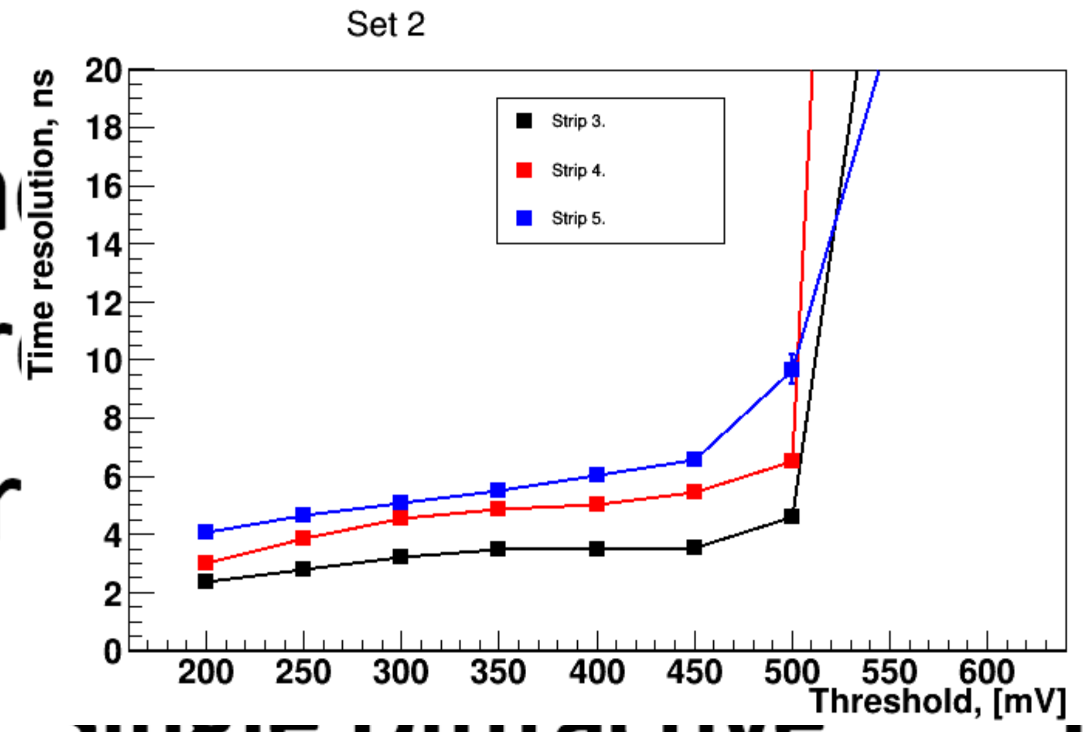
strange behavior, but better resolution than ITEP strips



Measuring SD an

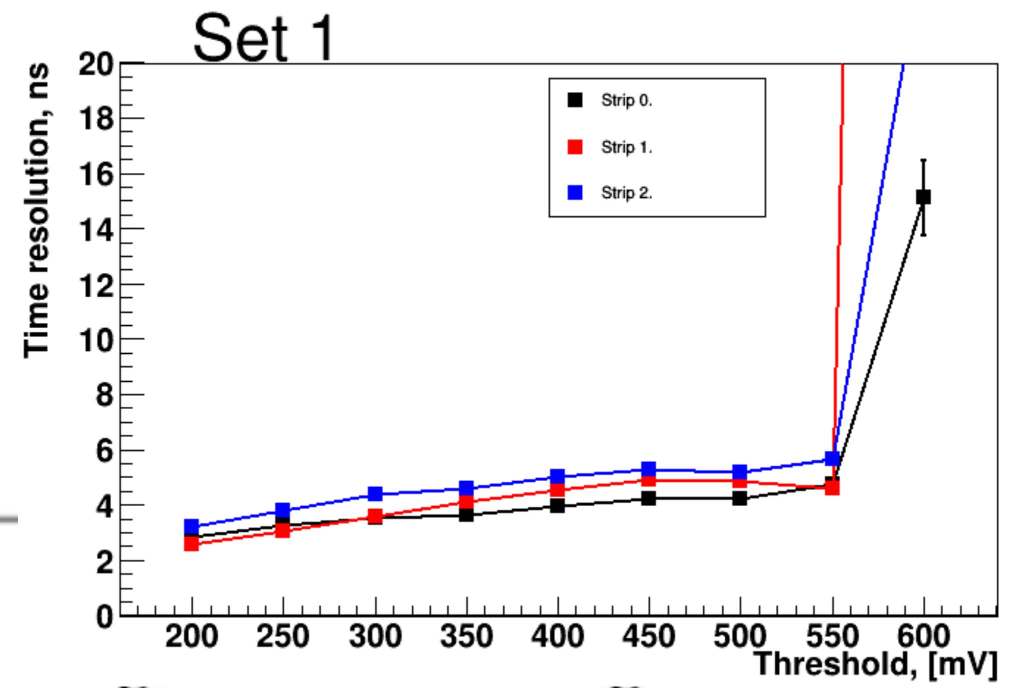
Strategy: Measur... er **8 units in η**

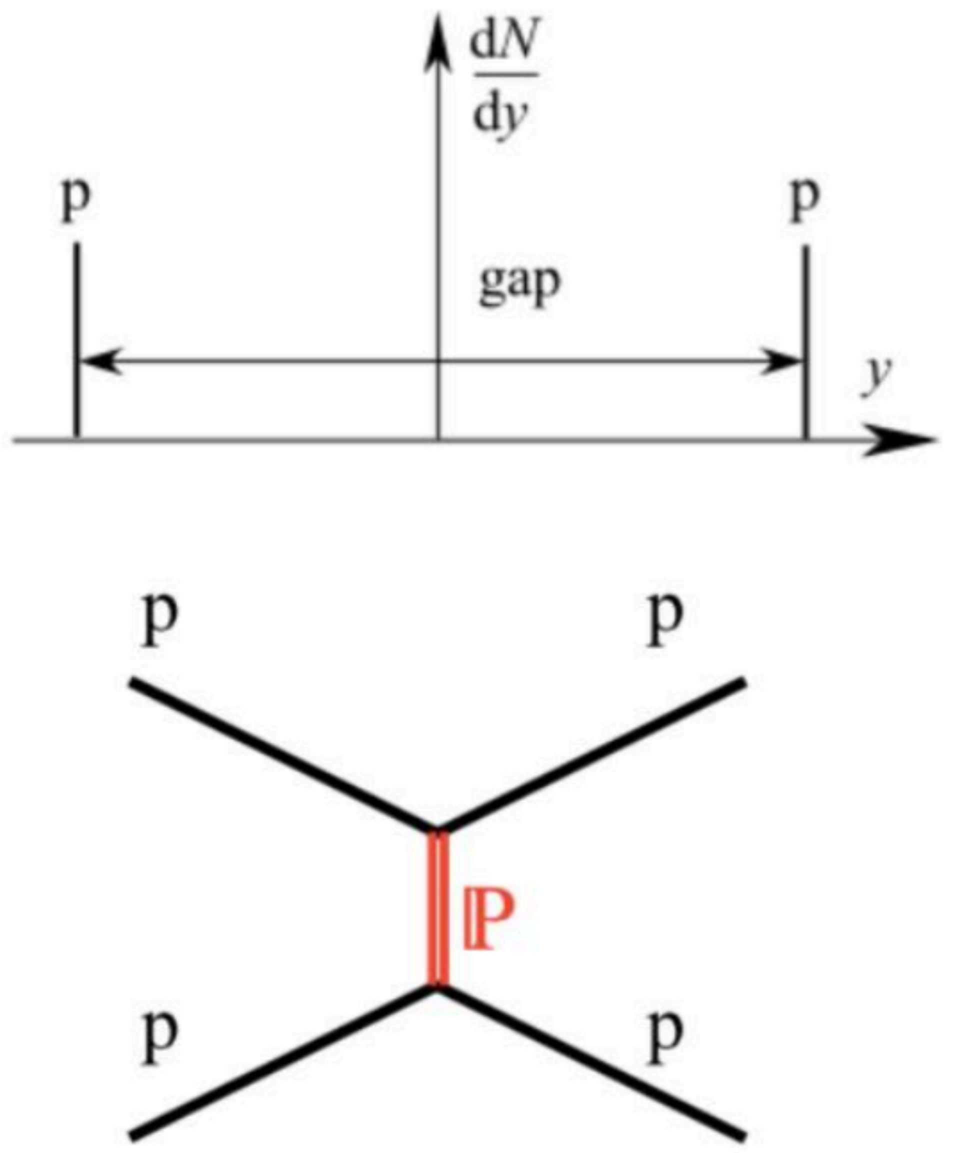
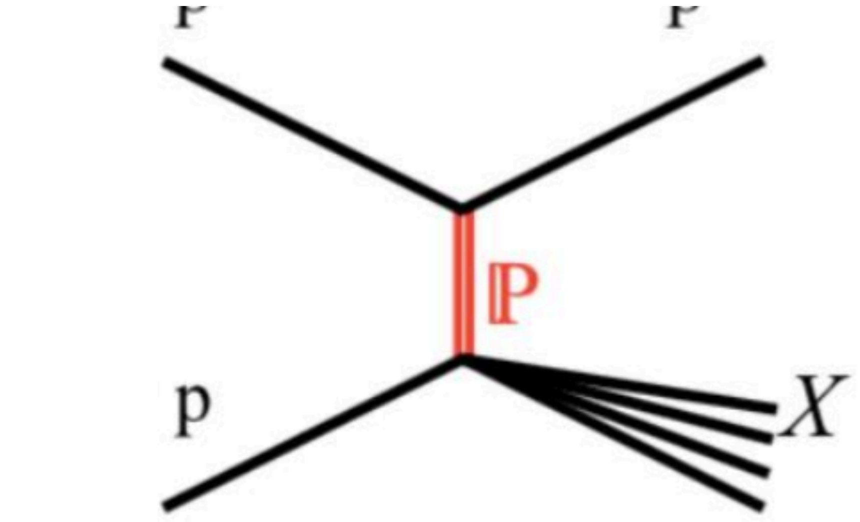
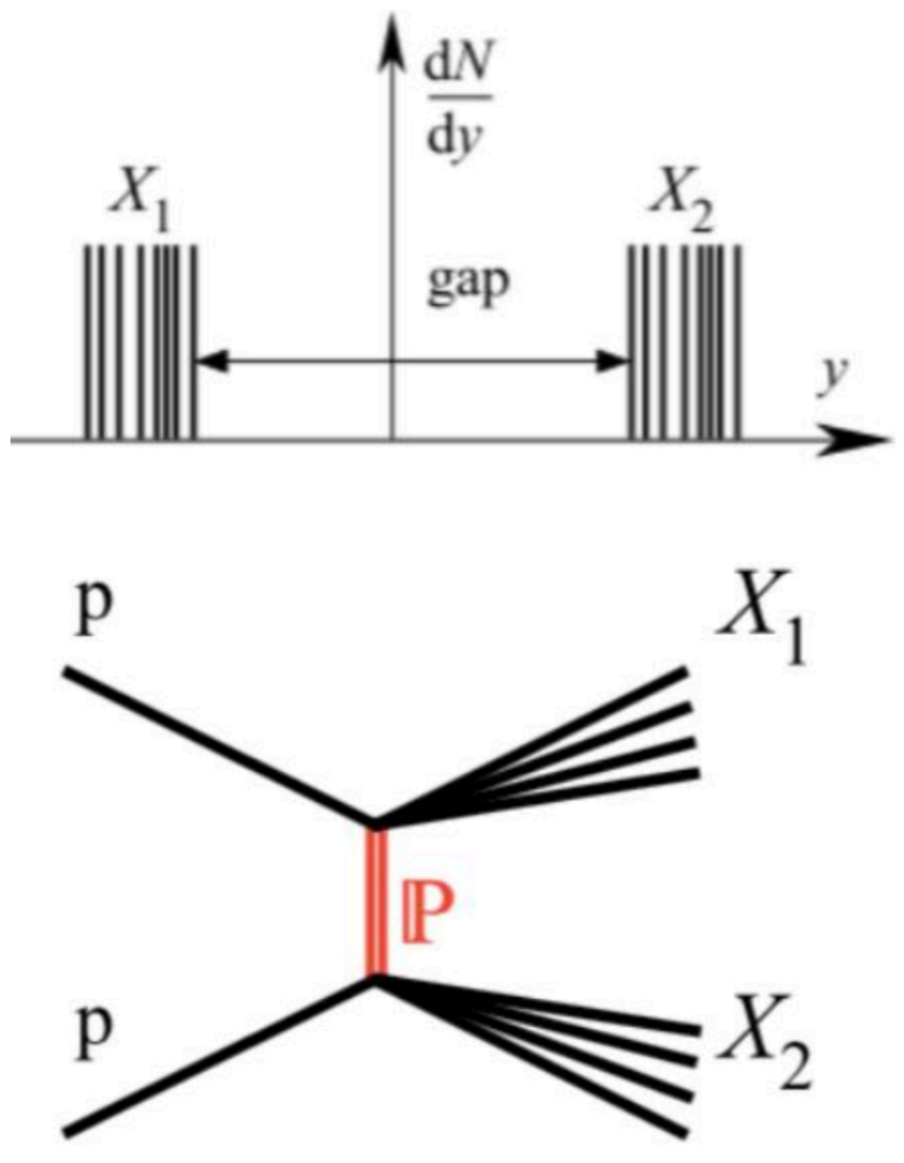
barrel and forwar

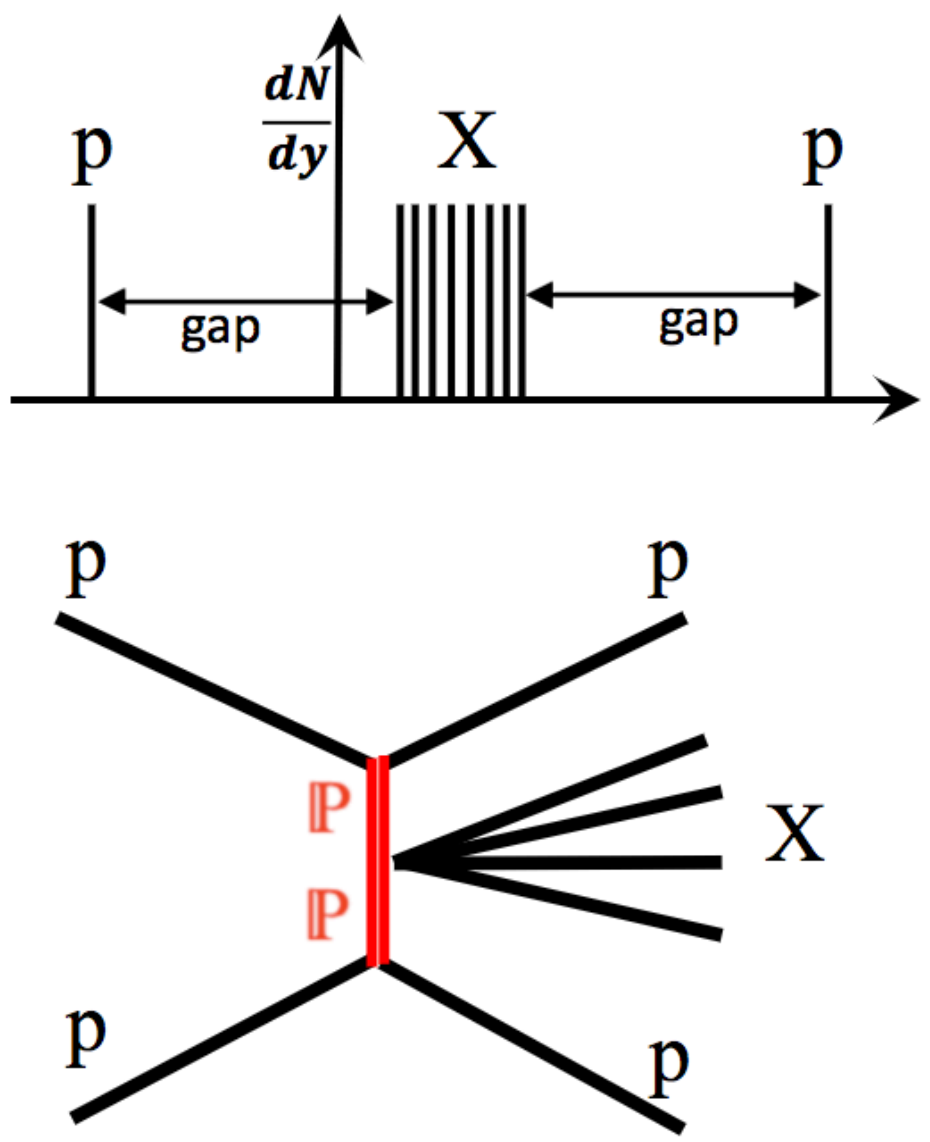


MORE DETAILS IN SERGIO'S SLIDES

Elastic | **Single Diffractive** | **Double Diffractive** | **Central Exclusive Production**

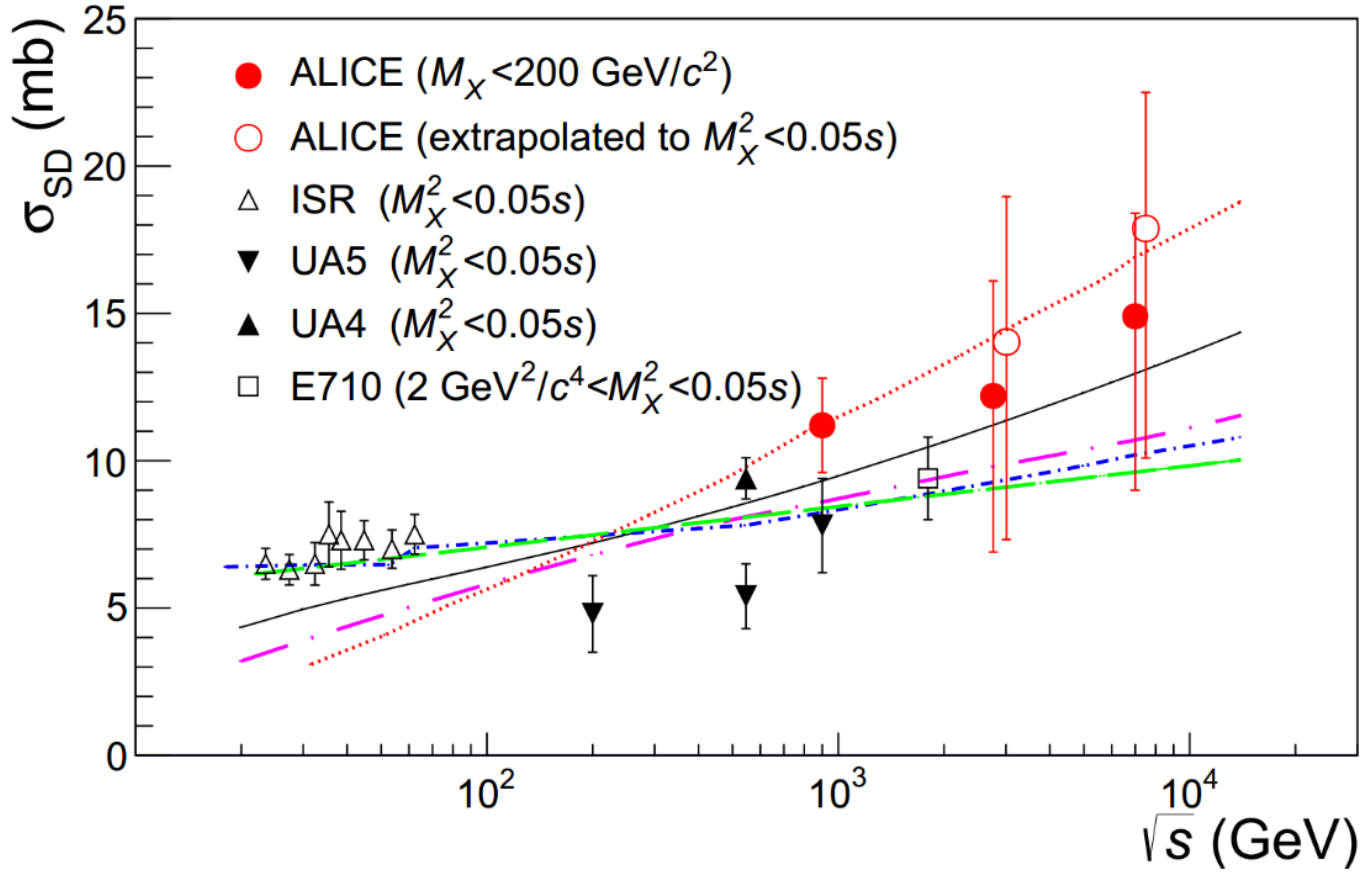


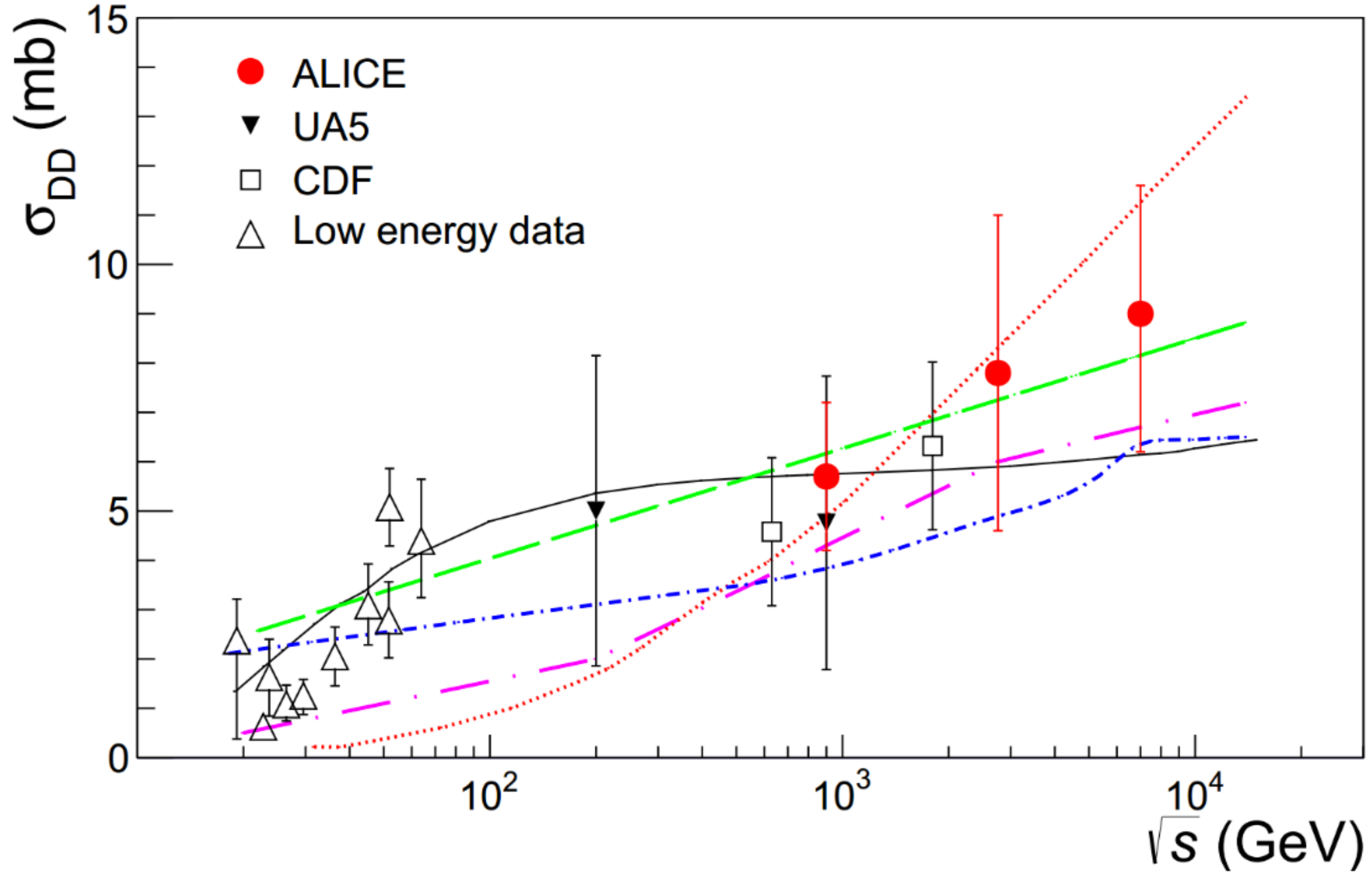






Diffraction

➢ Within large uncertainties ALICE measurements are in agreement with the measurements from UA5, UA4 and CDF.





MORE DETAILS IN ABRAHAM'S SLIDES

Diffraction

EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

ALICE-ANA-2016-xxx
October 31, 2017

MORE DETAILS IN ABRAHAM'S SLIDES

Analysis note on the ALICE measurement of the diffractive cross sections at 13 TeV

Ernesto Calvo Villar[1], Arturo Fernández Téllez[3], Matti Mikael Mieskolainen[2], Risto Orava[2], Mario Rodríguez Cahuantzi[3], Arseniy Shabanov[4], Abraham Villatoro Tello[3]

1. Pontificia Universidad Católica del Perú (PUCP), Lima, Perú
2. Helsinki Inst. of Physics, Helsinki, Finland
3. Benemérita Universidad Autónoma de Puebla, México
4. Russian Academy of Sciences, Russia

For Run 3 and HI, an upgrade of the ACORDE detector is proposed.
The new ACORDE will be made of RPC gas detectors.
It will be used to trigger muon bundles (large acceptance)
Also it could be used as a trigger for heavy mesons in lead-lead collisions

ACORDE Upgrade

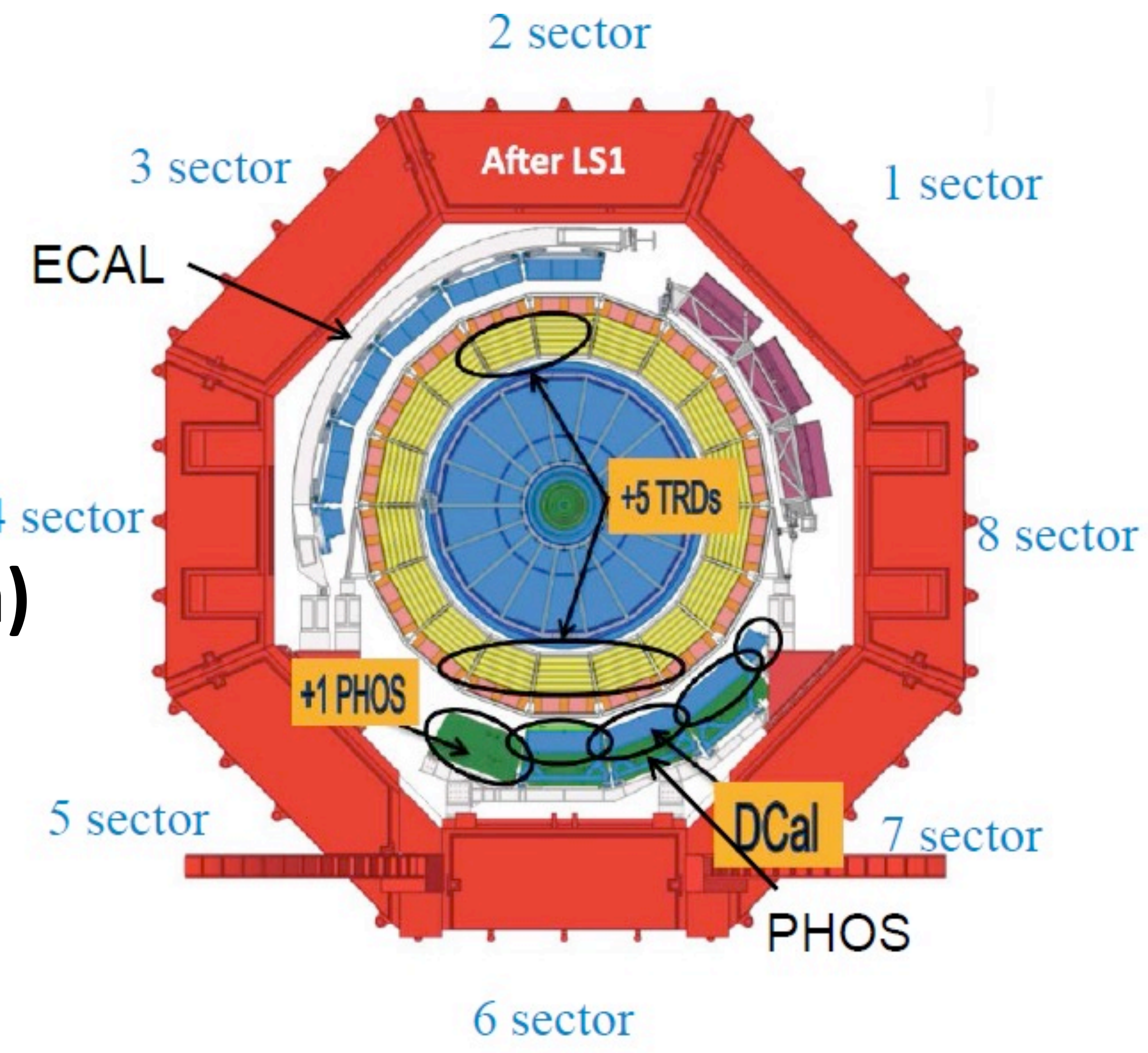
Plans for RUN3, RUN 4

New detector system placed at the outer ALICE magnet yoke faces using:

Scintillator strips modules (ITEP) or/and
RPCs modules (BUAP)

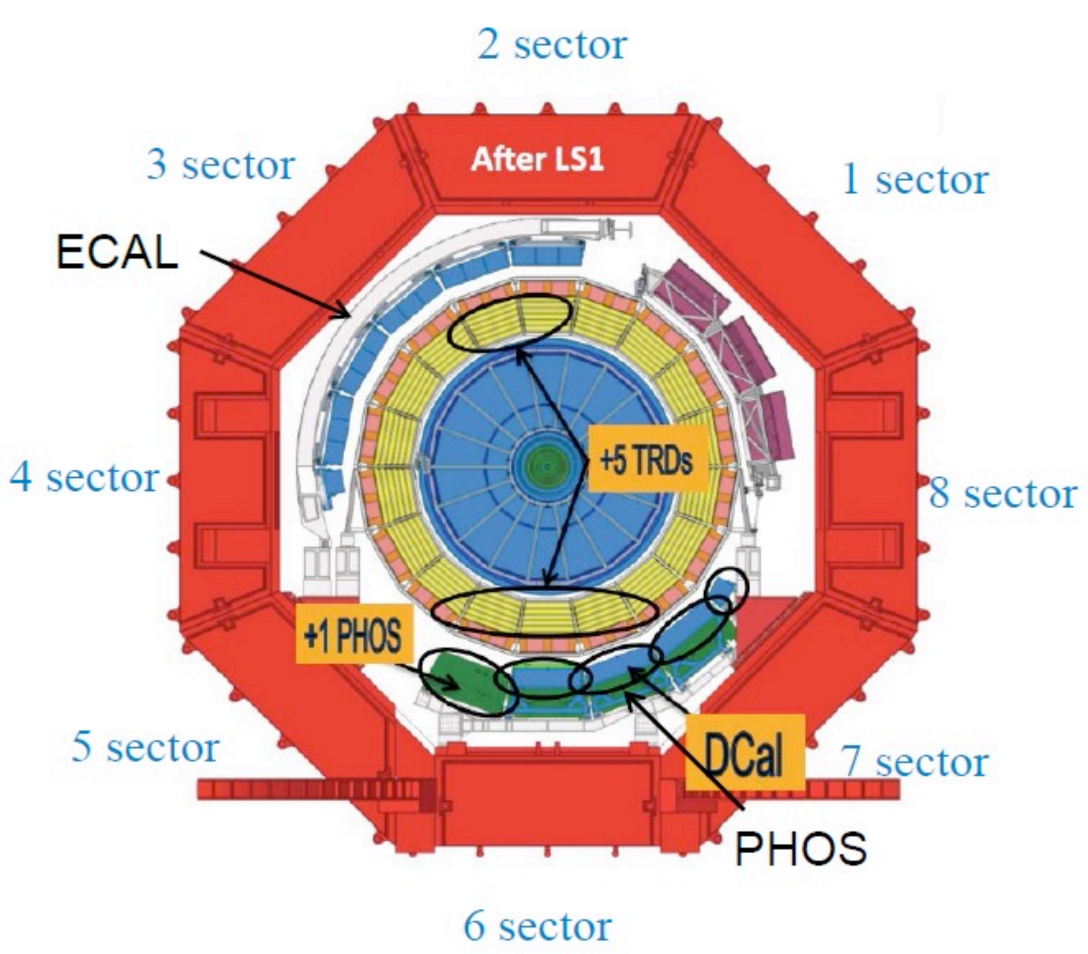
Contributions from:

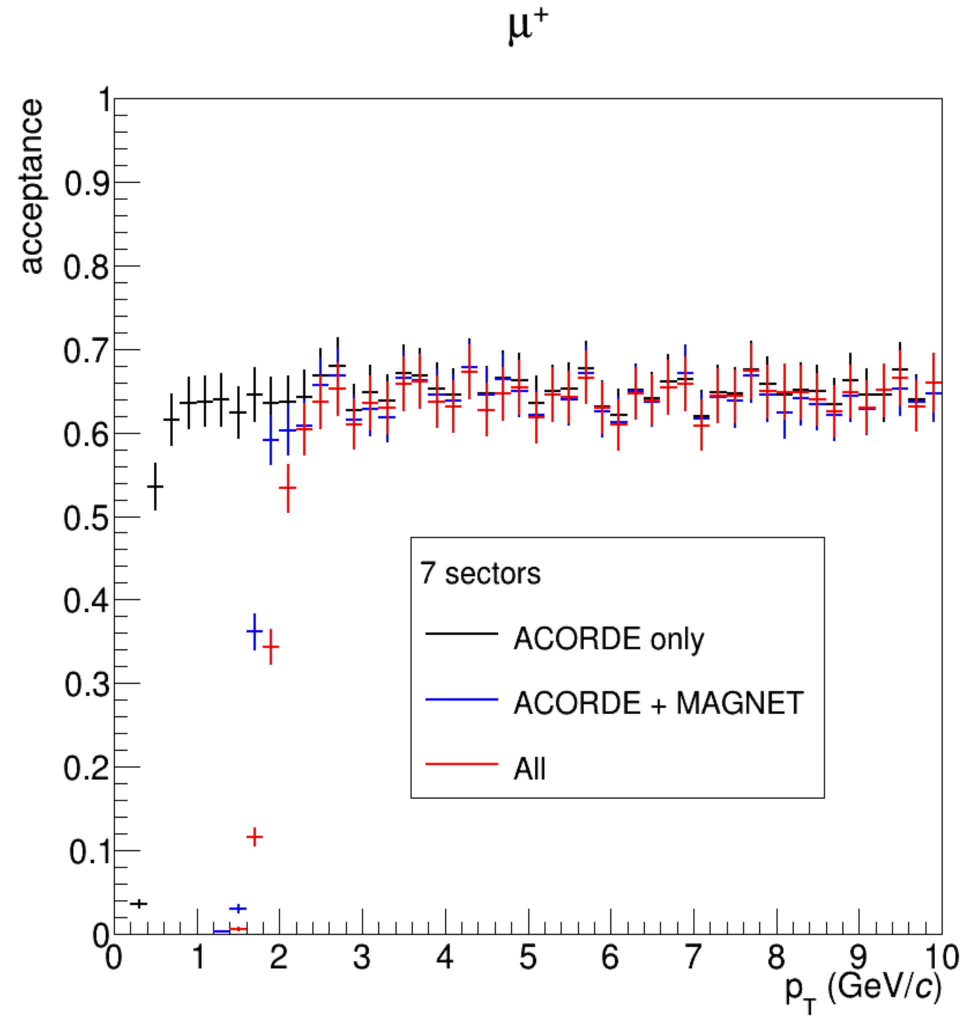
- A. Akindinov, S. Kiselev (ITEP-Moscow, Russia)



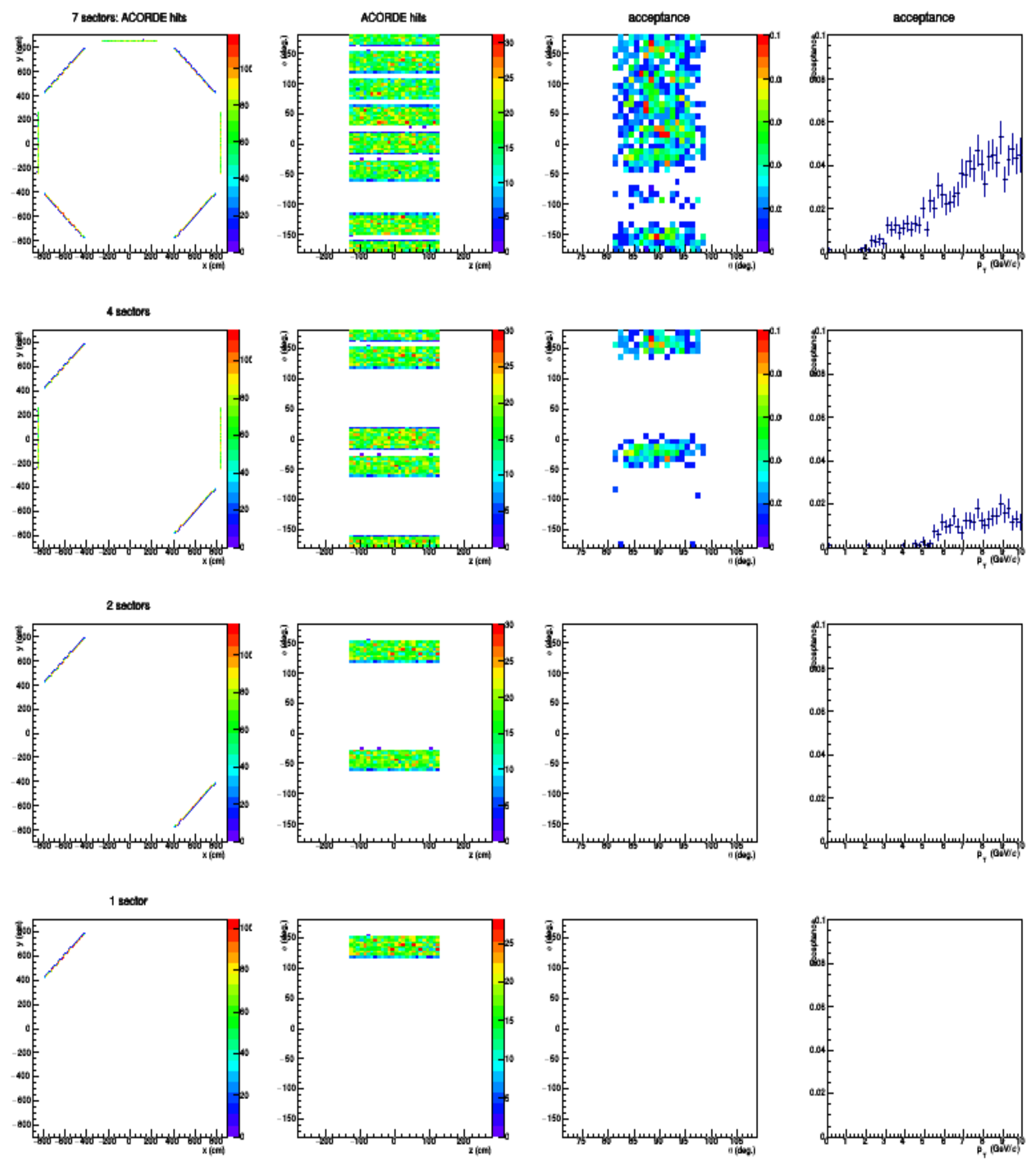
BUAP
D. Blanco Lira (MSc. student, A. Fernández Tellez, M.I. Martínez Hernández, M. Rodríguez Cahuantzi, G. Tejeda Muñoz

UNACH
Karen Salomé Caballero Mora, Pedro Alfonso Valencia Esquipula (MSc. student)





The acceptance of muons with an included magnetic field for ALICE: a) consisting only of ACORDE only, b) consisting of ACORD and a magnet (ACORDE + MAGNET), c) with all sub-detectors (All).



J / ψ (3097) → μ + μ-. 4 variants of ACCORD with 1, 2, 4, and 7 sectors (bottom up). 1 and 2 columns: distribution of hits on the surface of ACCORD; 3 and 4 columns: acceptance.

The new ACORDE :

7 sensitive sectors on the outer magnet faces at 8.5 m from the beam

the sector: a plane with 2 modules at z=0, $\Delta\phi = 34^o$, $\Delta\theta = 17^o$

the module: a sensitive plane 2.6 x 2.6 m^2 = 6.72 m^2 , $\Delta\phi = \Delta\theta = 17^o$

•Muons with p_T < 1.6 GeV/c do not reach the ACORDE surface, mostly due to energy losses inside the magnet

•To reconstruct heavy quarkonia J/ψ and ϒ by their di-muon decay mode requires at least 4 ACORDE sectors, preferably those located in azimuthally opposite positions behind the calorimeters, which, together with the magnet, reduce the hadron background

•The overall background is low, mostly due to the magnet material, which makes the matching of muon tracks and muon identification a feasible task.

•The deviation of muon tracks because of multiple scattering requires that the width of scintillation strips in ACORDE is 6 cm.

Infrastructure preparation and strips constructing

Plastic: 2600x60x10 mm^3 (produced at IHEP, Russia)

- Grooved for fibre placing in ITEP
- Metalized Mylar as a reflecting layer
- Black photo-paper is used for light isolation (2 layers)
- Outer layer of a polyethylene heat-shrink film f… afety


Groove milling


Storage

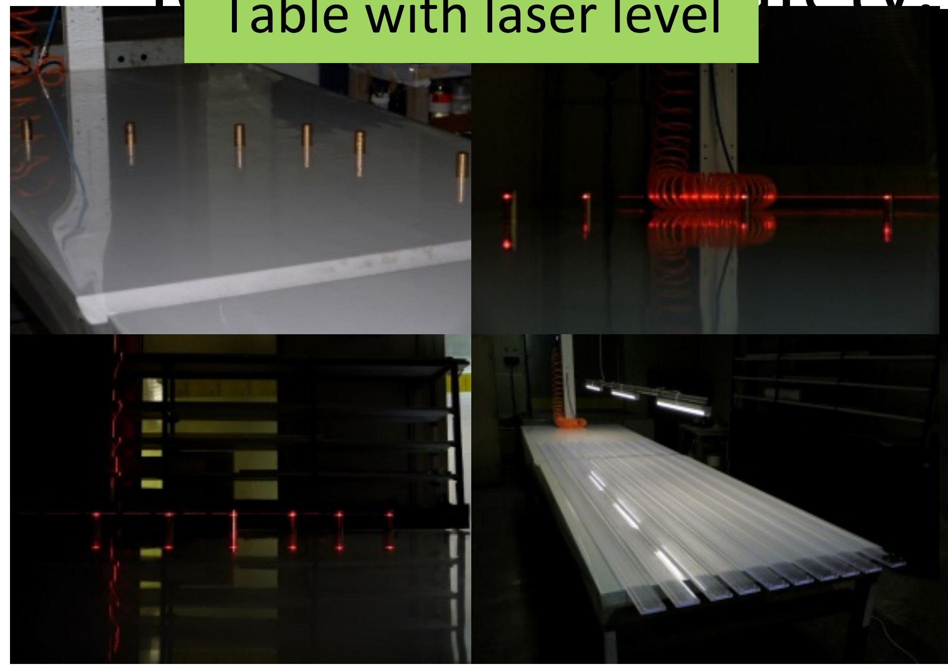
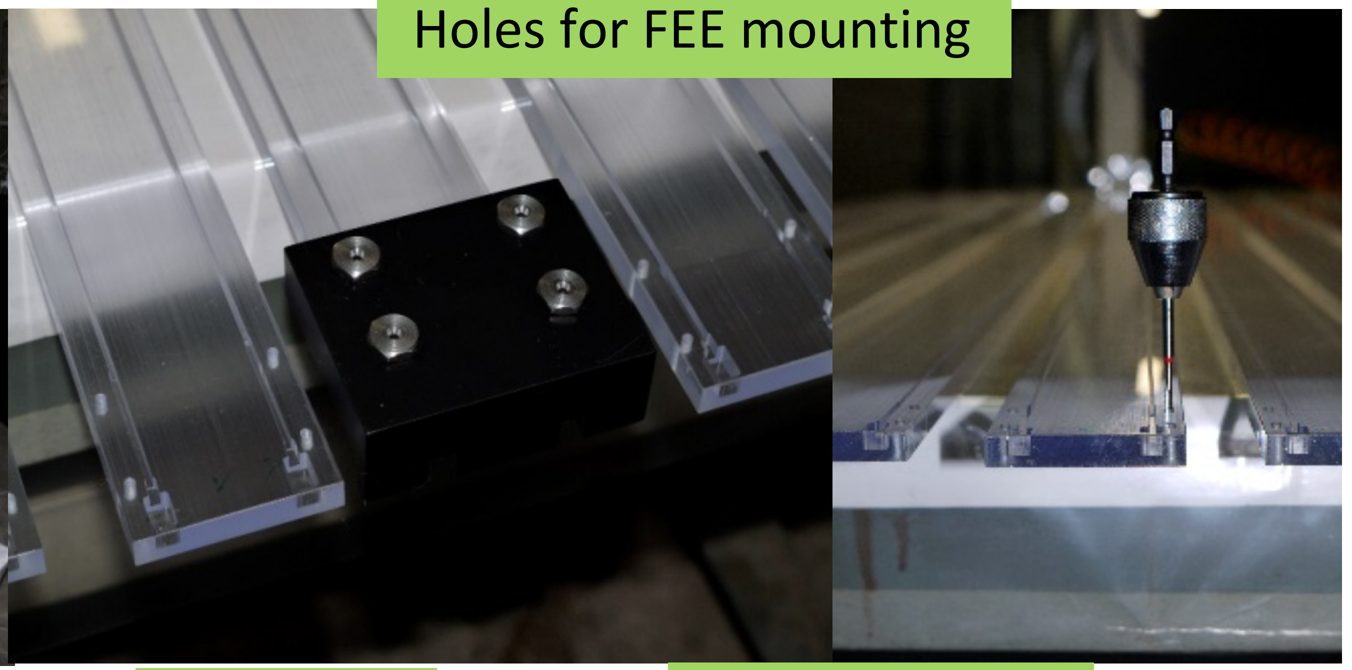
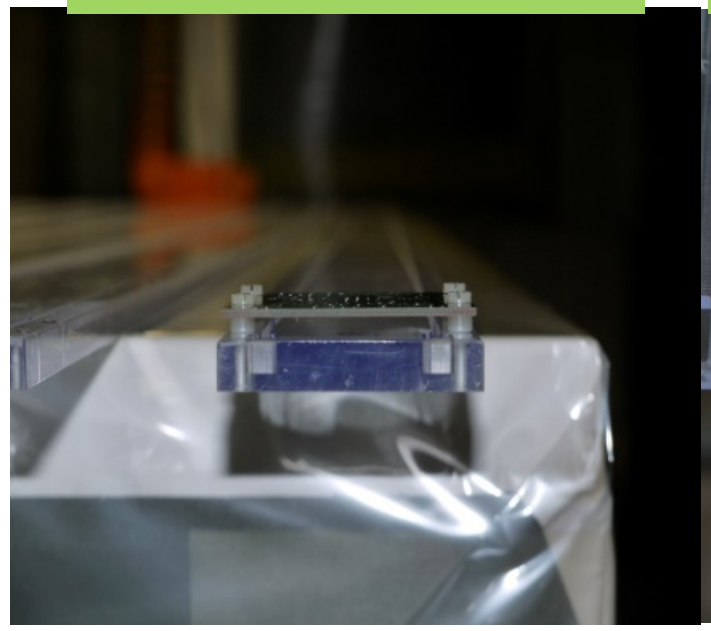


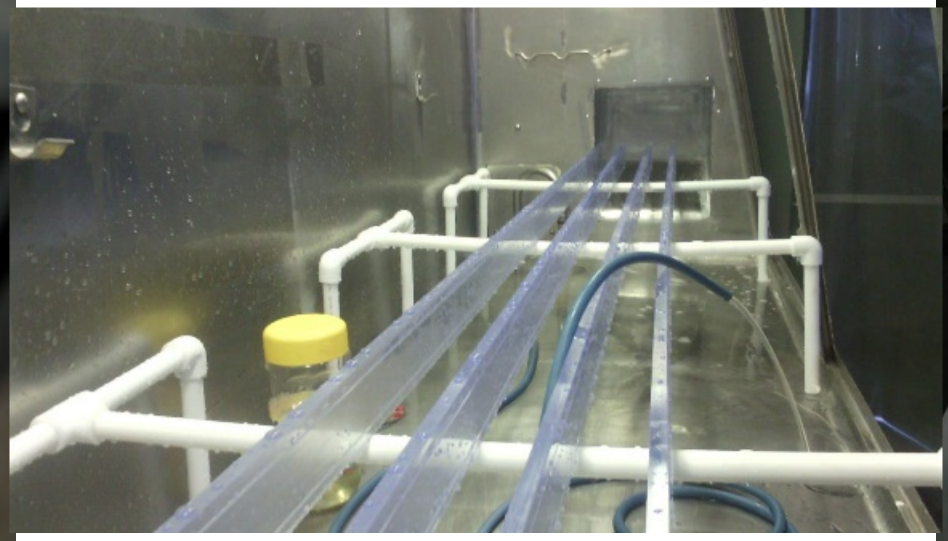
Table with laser level


Glue dosing system

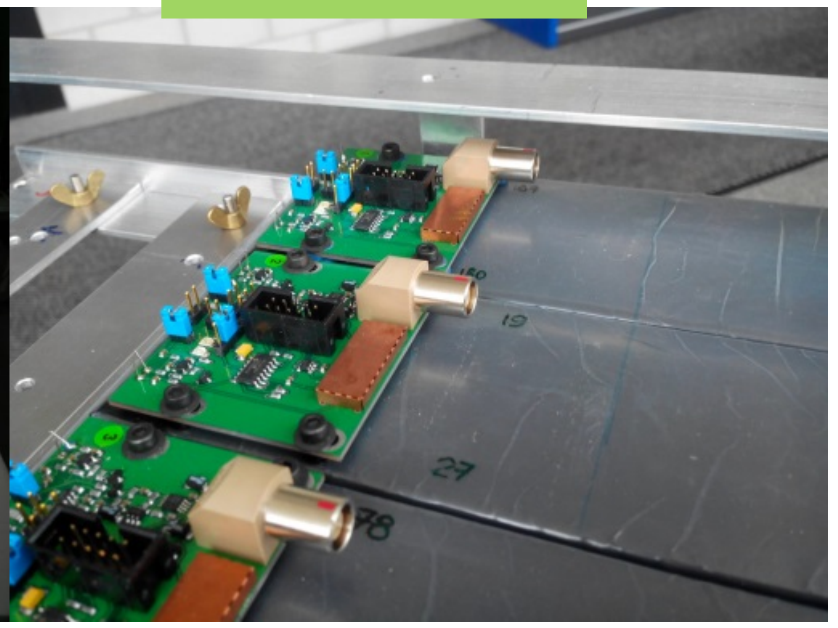

Holes for FEE mounting


FEE placement check


Fiber placement check


Washing before assembly


Assembly

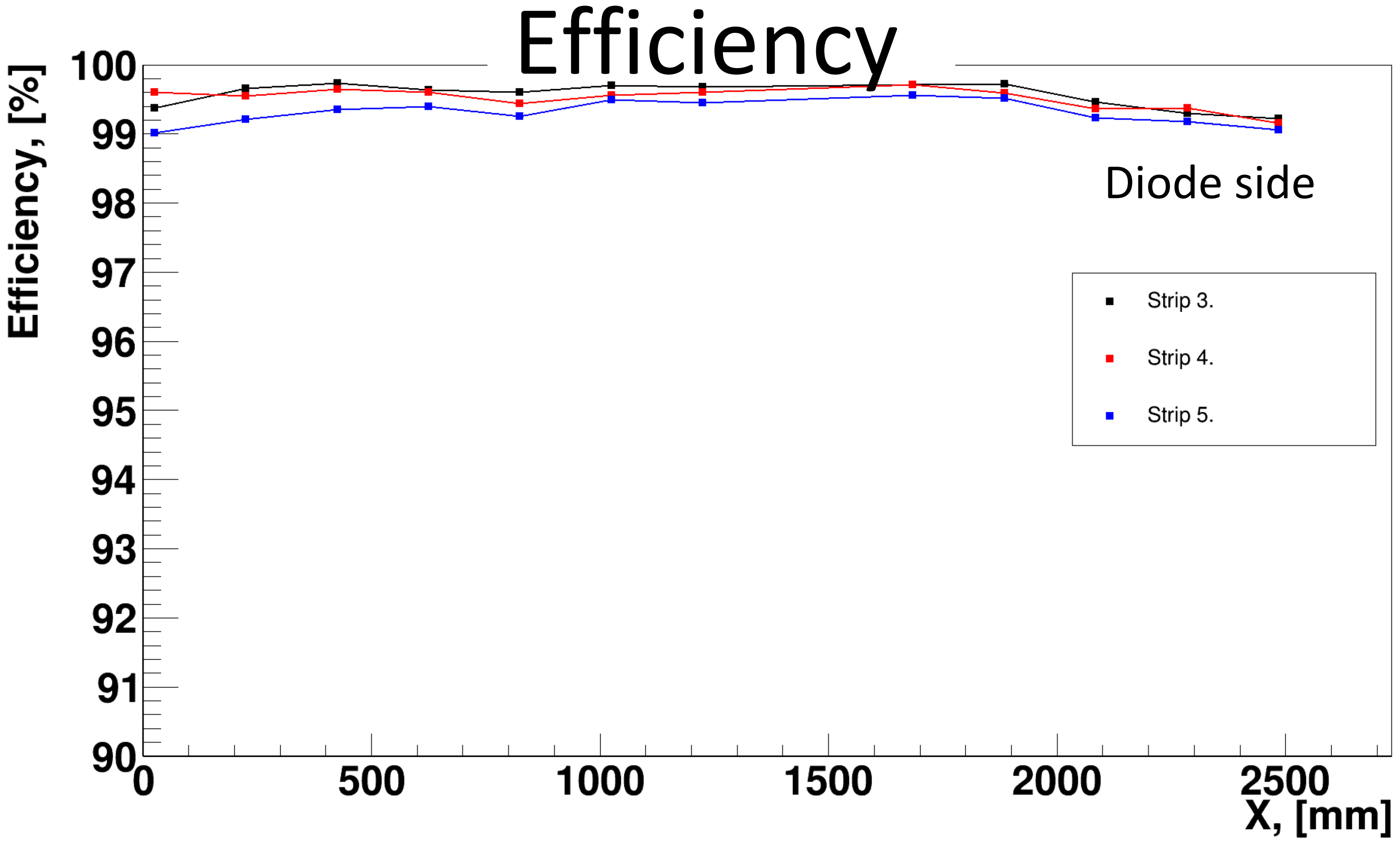

FEE placement

Beam tests

<u>Assembled and tested 6 strips.</u>

Strips were tested at T10.
Beam conditions: 5 GeV π^- , 1,5 kHz/cm^2 .
Events triggered by two finger scintillators in front and back.
Triggers sizes: front: 2x2 cm^2, back: 1x1 cm^2.

Efficiency measurement along the strips.
Efficiency is on the level 99.6%, lower closer to the diodes.



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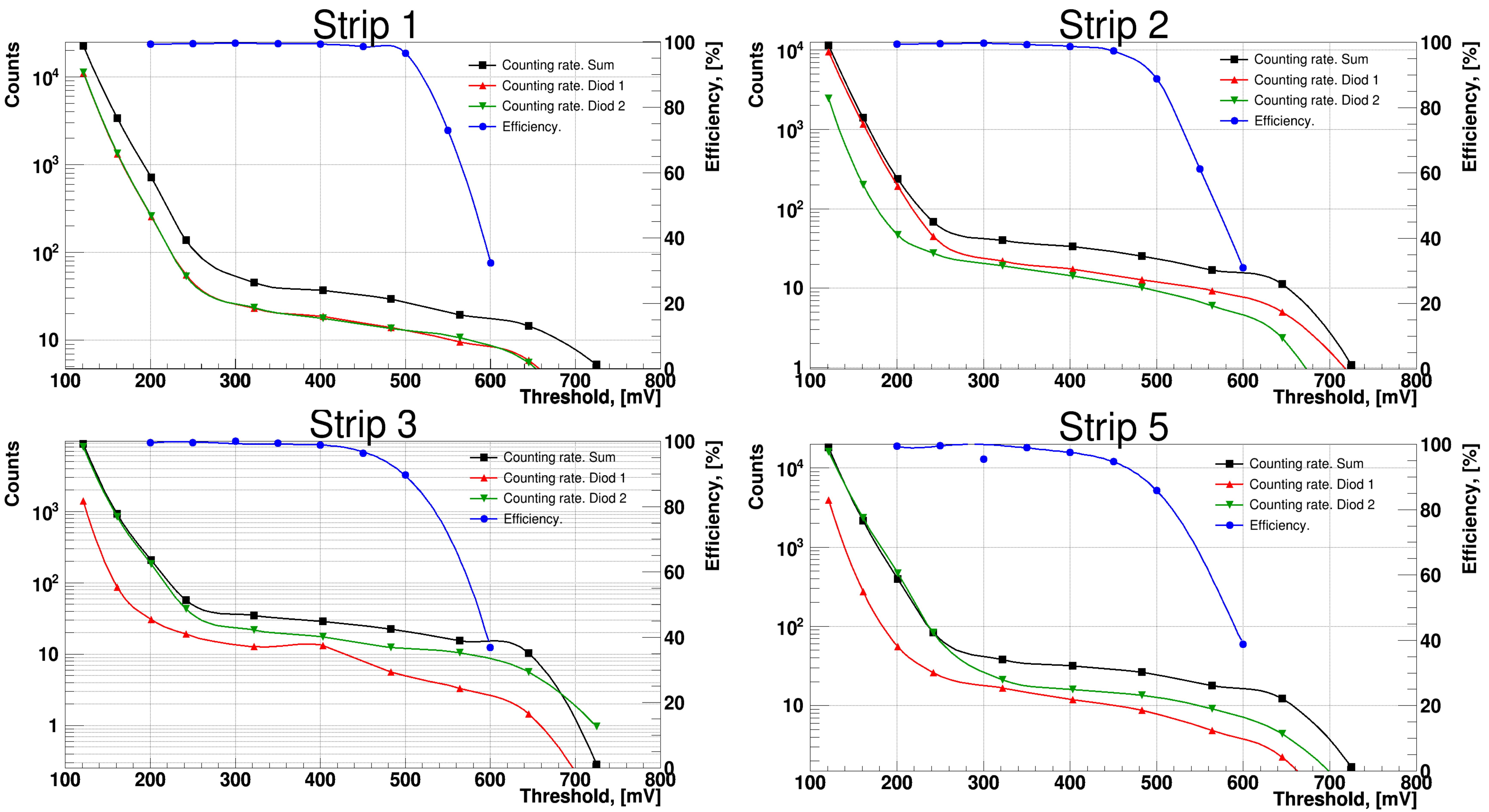
Beam tests results

Efficiency and counting rate as function of the threshold.
Wide working range of the threshold setting for all strips.



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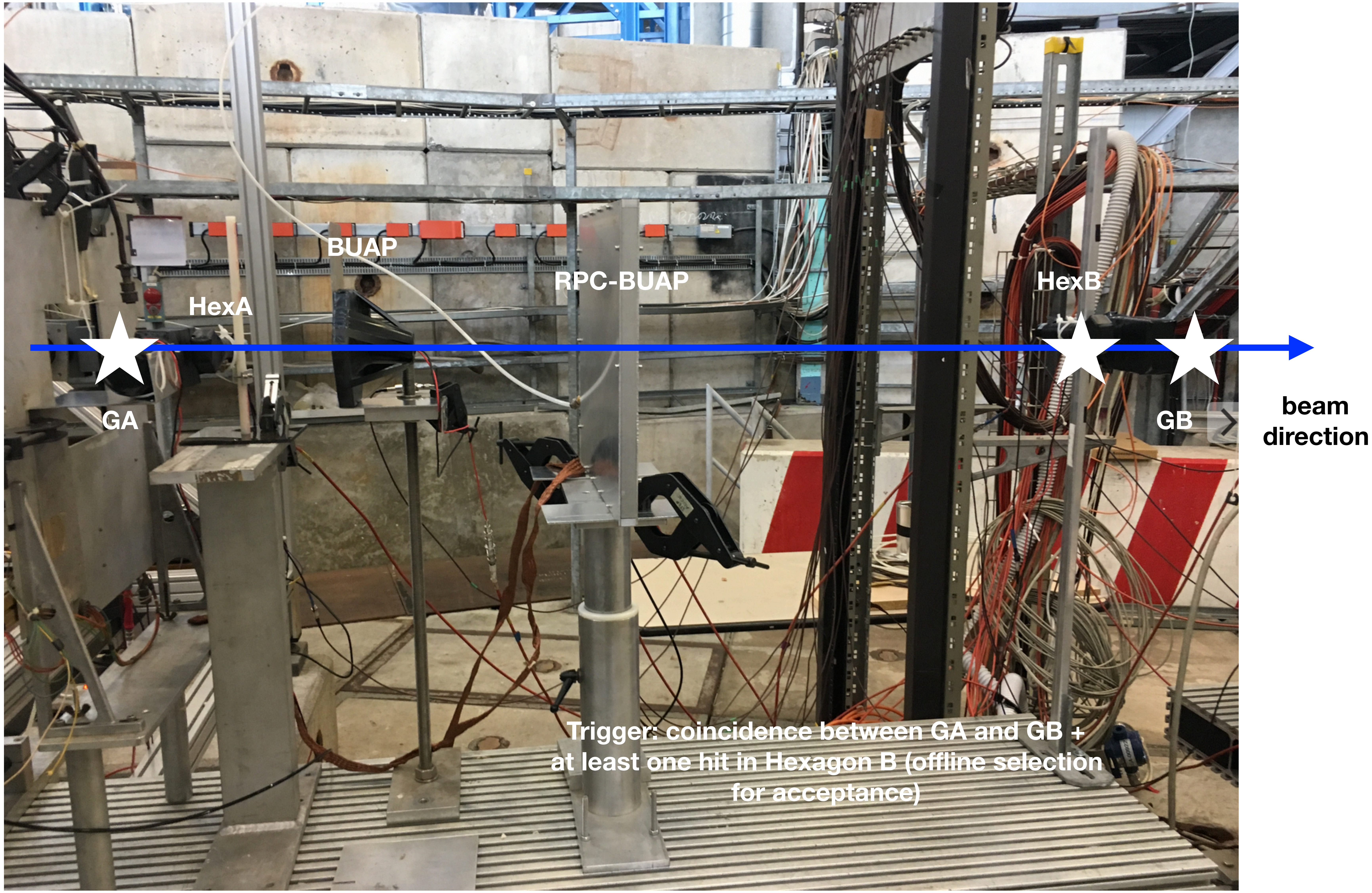
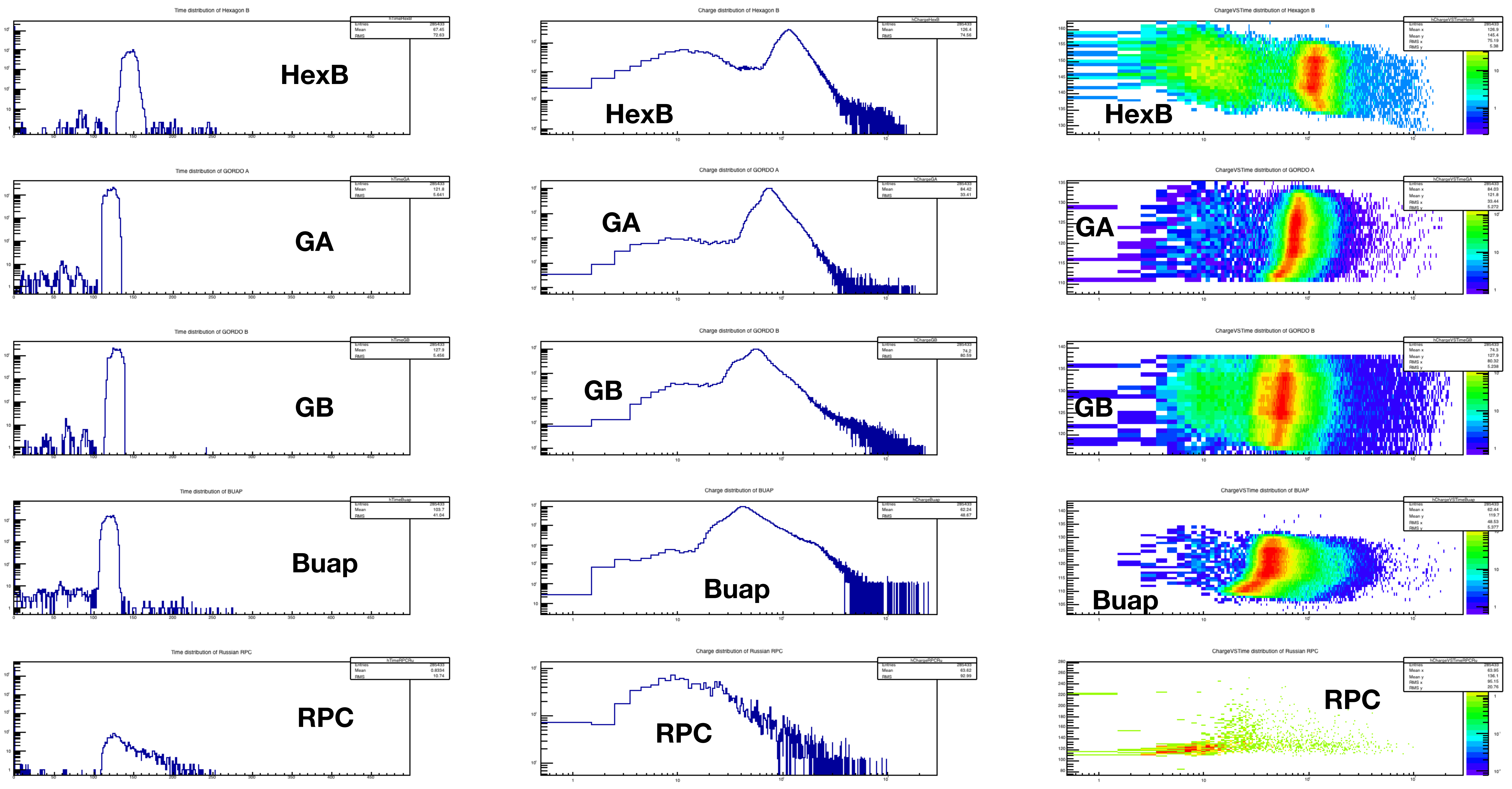
Dates: 23/05/2018 - 31/05/2018
Place: T10-CERN



Dates: 23/05/2018 - 31/05/2018
Place: T10-CERN

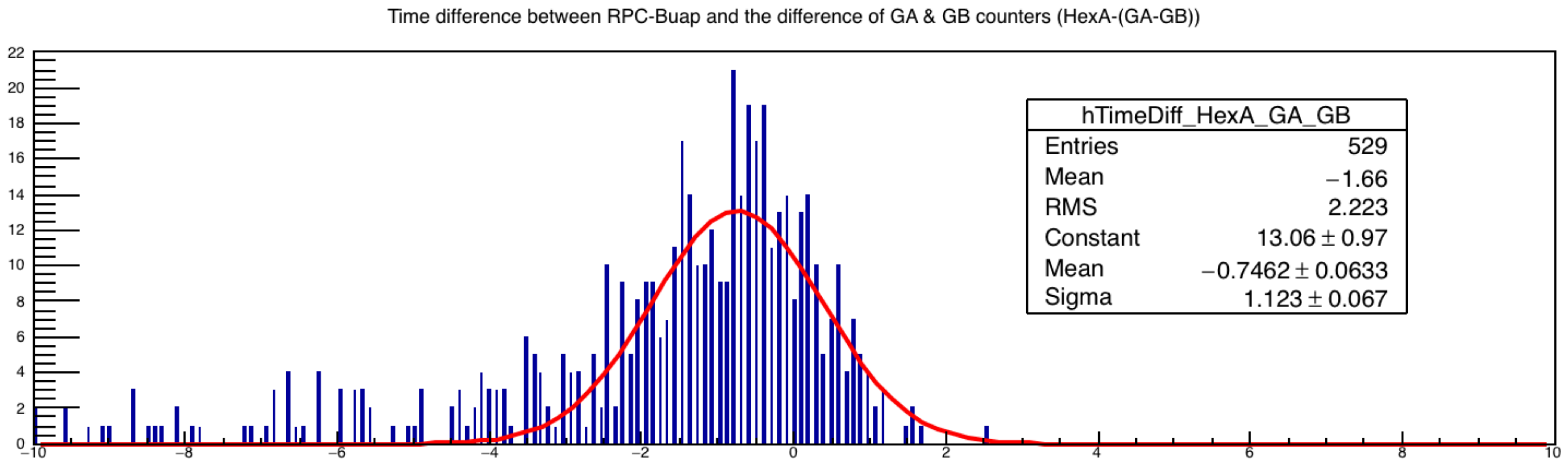
BUAP

HPTDC time | ADC value (max) | time vs charge



F: RPC voltage 12000 V. First run with RPC in beam test. Possible gas leaking (53% efficiency)

Dates: 23/05/2018 - 31/05/2018
Place: T10-CERN



In this case, the total sigma is 1.23 ns.
We need to extract only the RPC time resolution:

$$\sigma_T^2 = \sigma_{RPC}^2 + \sigma_{GA}^2$$

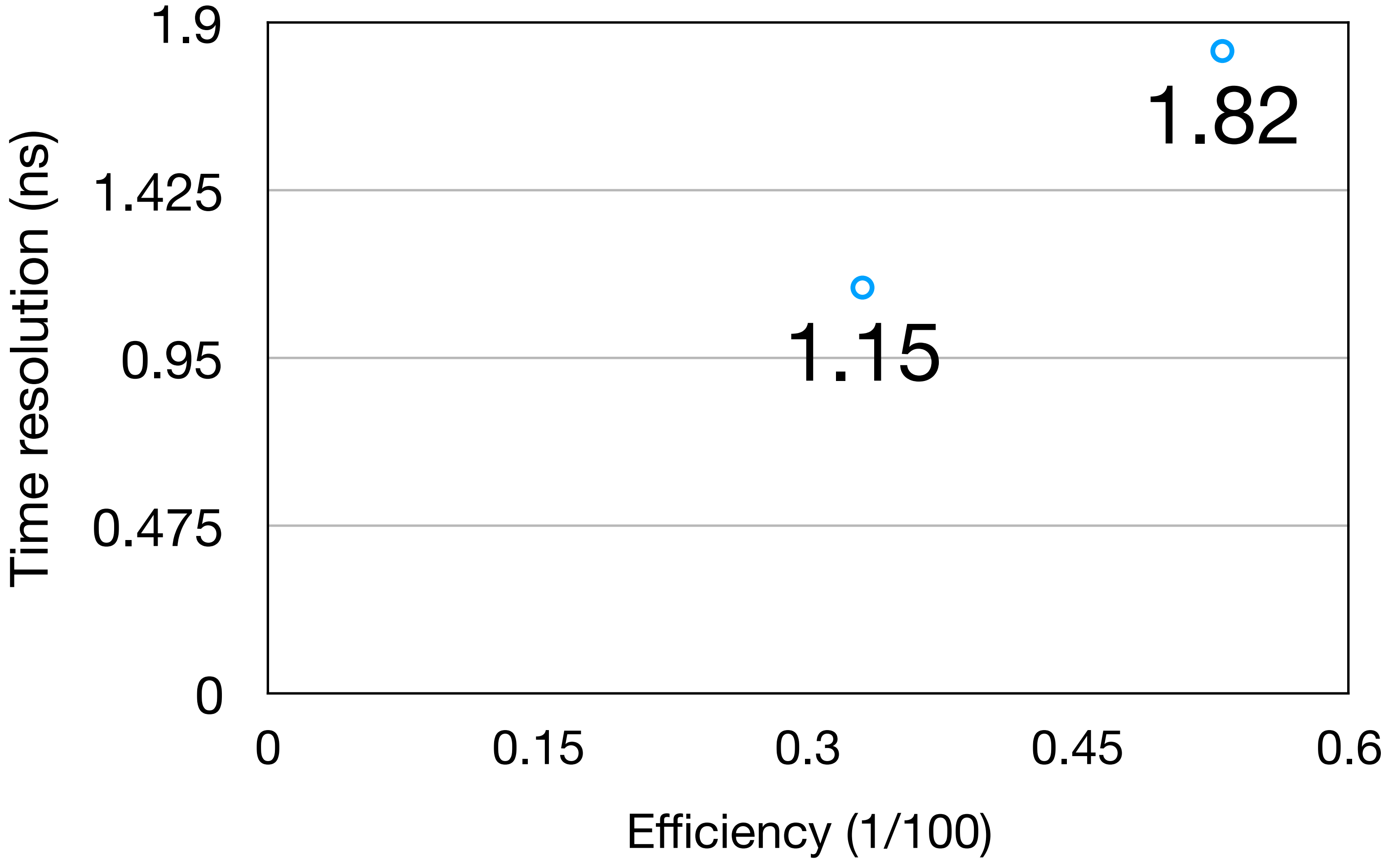
$$\Rightarrow \sigma_{RPC} = \sqrt{\sigma_T^2 - \sigma_{GA}^2} = \sqrt{1.23^2 - 0.43^2} = \sqrt{1.51 - 0.18} = \sqrt{1.33}$$

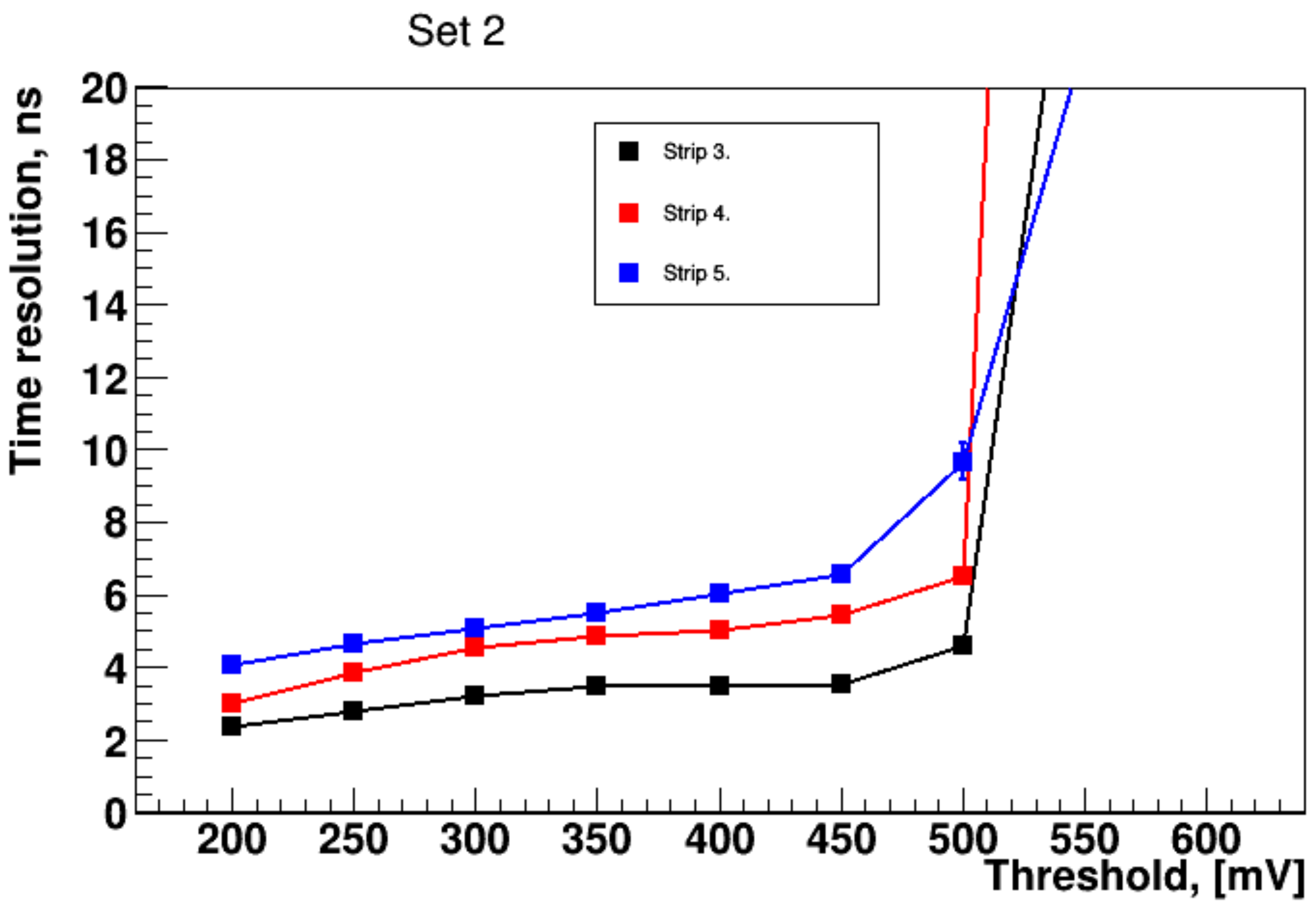
$$\Rightarrow \sigma_{RPC} = 1.15\ ns$$

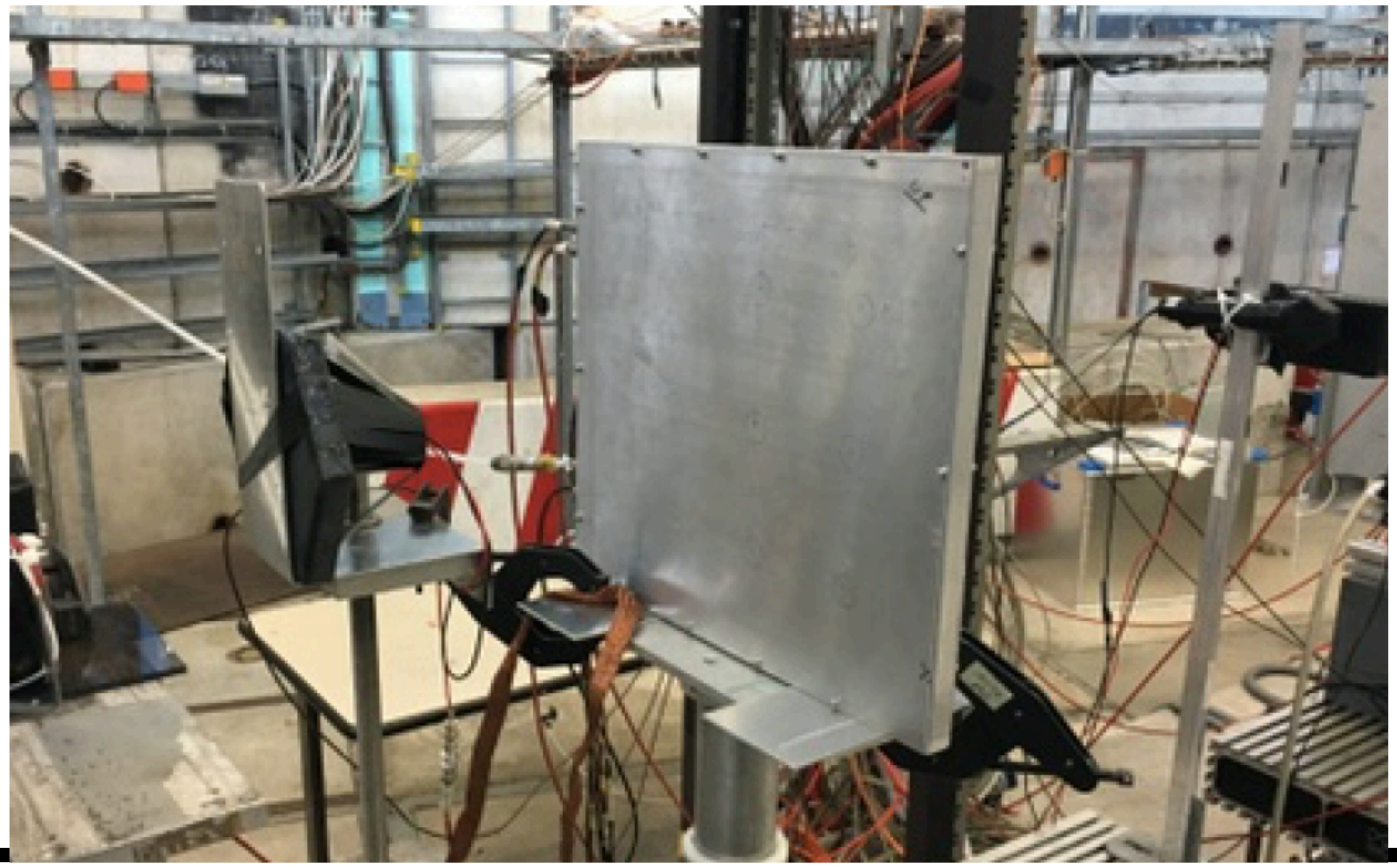
Dates: 23/05/2018 - 31/05/2018
Place: T10-CERN

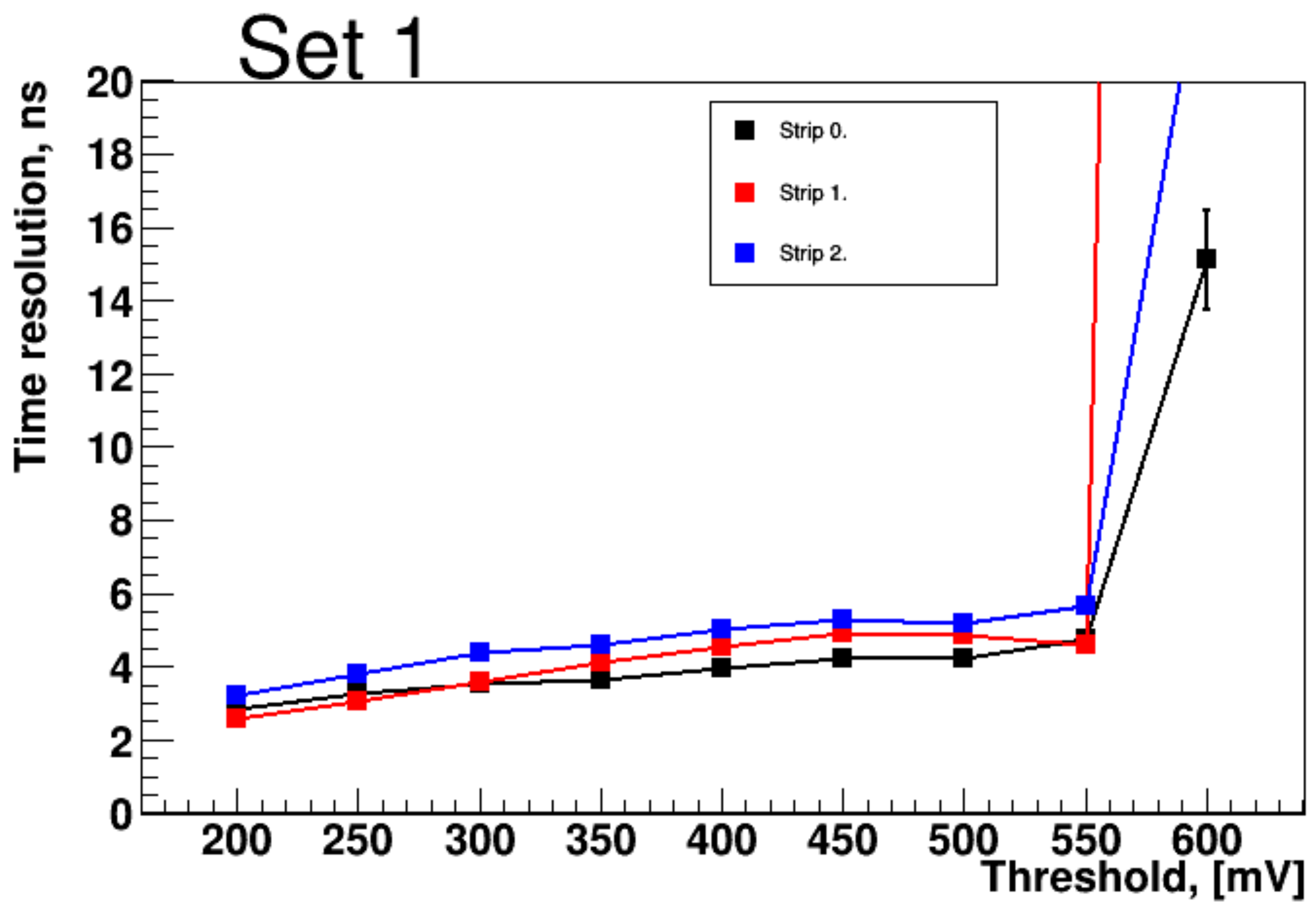
MORE DETAILS IN GUILLERMO’s SLIDES

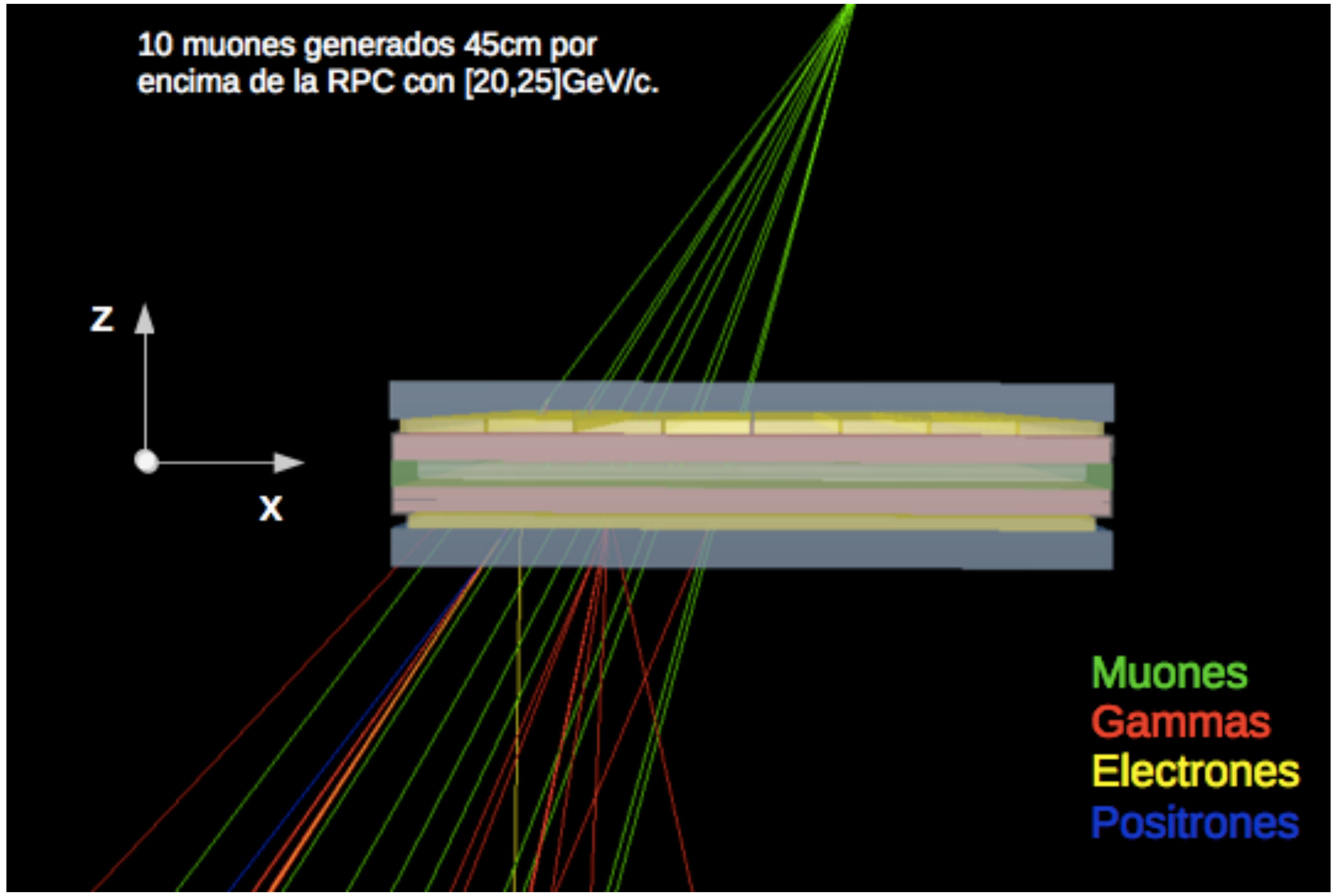
strange behavior, but better resolution than ITEP strips

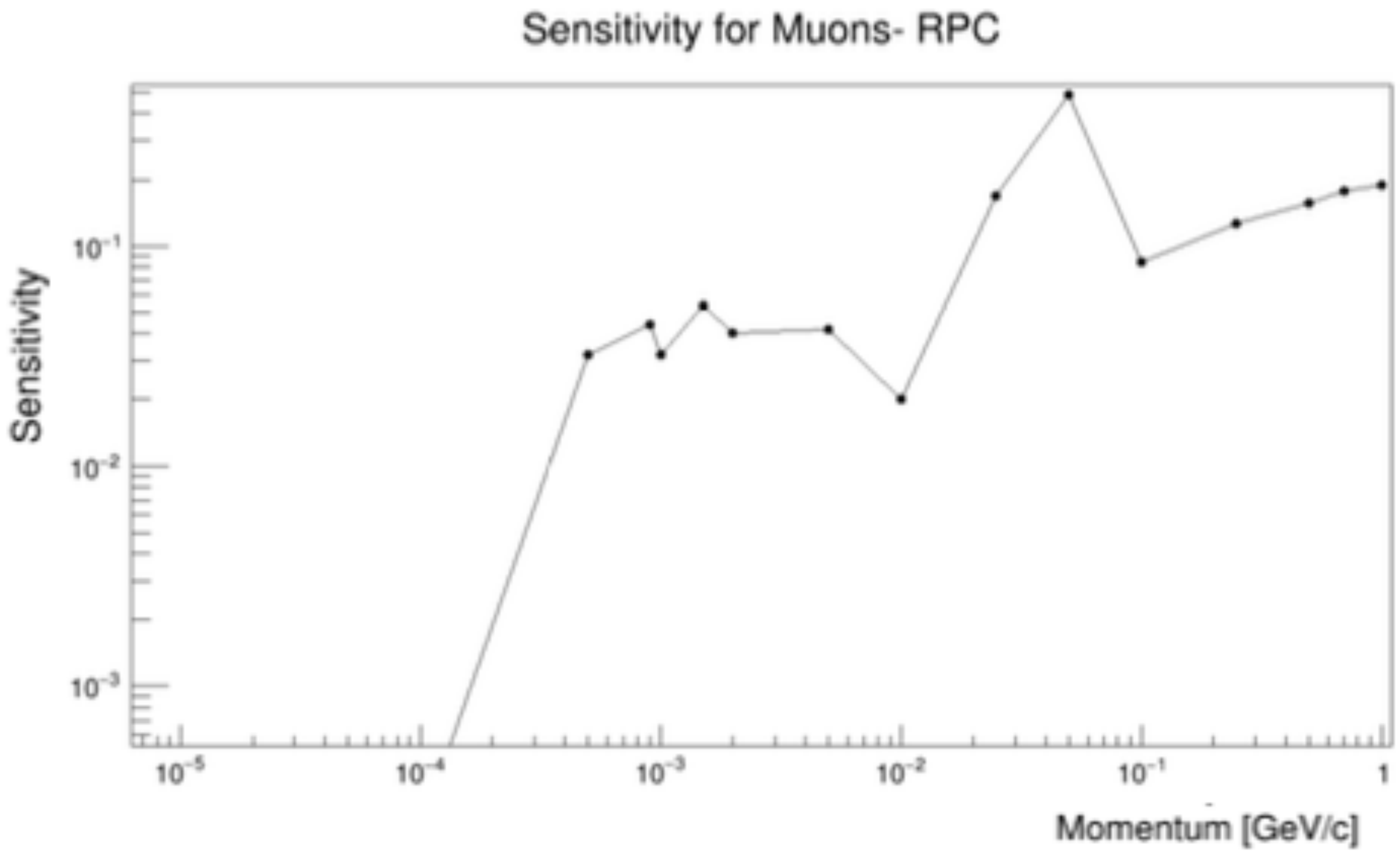


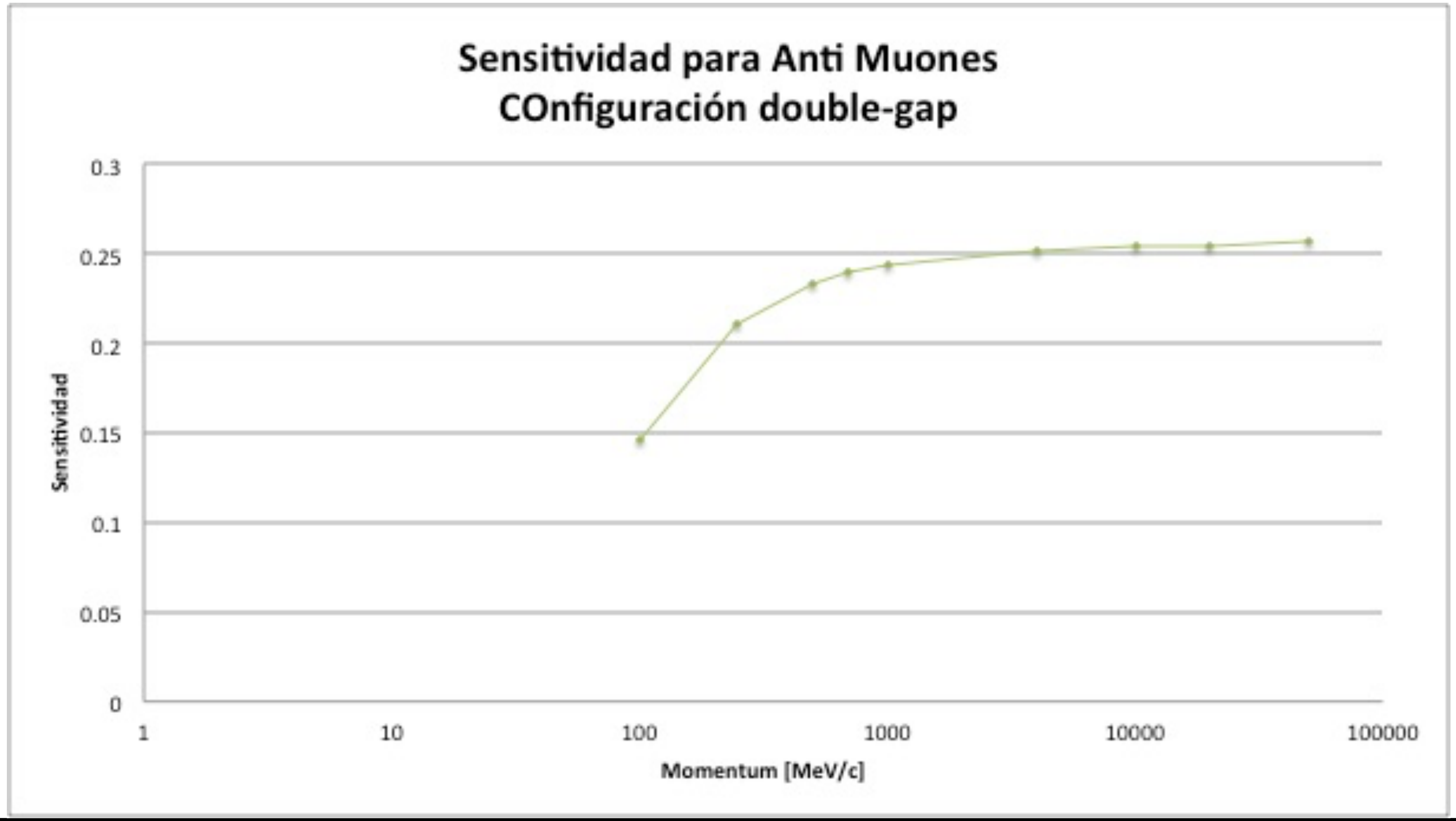












MSc. thesis of Daniela Blanco. A publication is in preparation.

Event plane resolution for higher order harmonics flow with the V0+ detector

<u>Mario Rodríguez Cahuantzi</u>
Autonomous University of Puebla (BUAP-MX)

Lizardo Valencia Palomo
University of Sonora (DIFUS-MX)

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AliGenTunedOnPbPb

AliGenTunedOnPbPb → Parametrization based on 5.5 TeV PbPb data // pi,K, p , K0, lambda, phi, Xi, Omega spectra, v2, v3, v4 (no jets!)

Two samples (AliFITv5 and AliFITv6)
Detectors: FIT, ITS (upgrade), MFT, PIPE (upgrade) and MAGNET (B=0.5 T)
Y max: 10
Centrality range: 0-10%, 10-20%, 20-30%, 30-40%, 40-50% and 50-60%

Centrality (%)	**Number of generated events**
0-10	3,950
10-20	3,980
20-30	3,980
30-40	4,000
40-50	4,000
50-60	3,980
Total	23,890

Warning: This analysis is based on HITS information. No ESD is implemented for V0+

3

Geometry of the V0+ detector

First implementation of the V0+ detector geometry

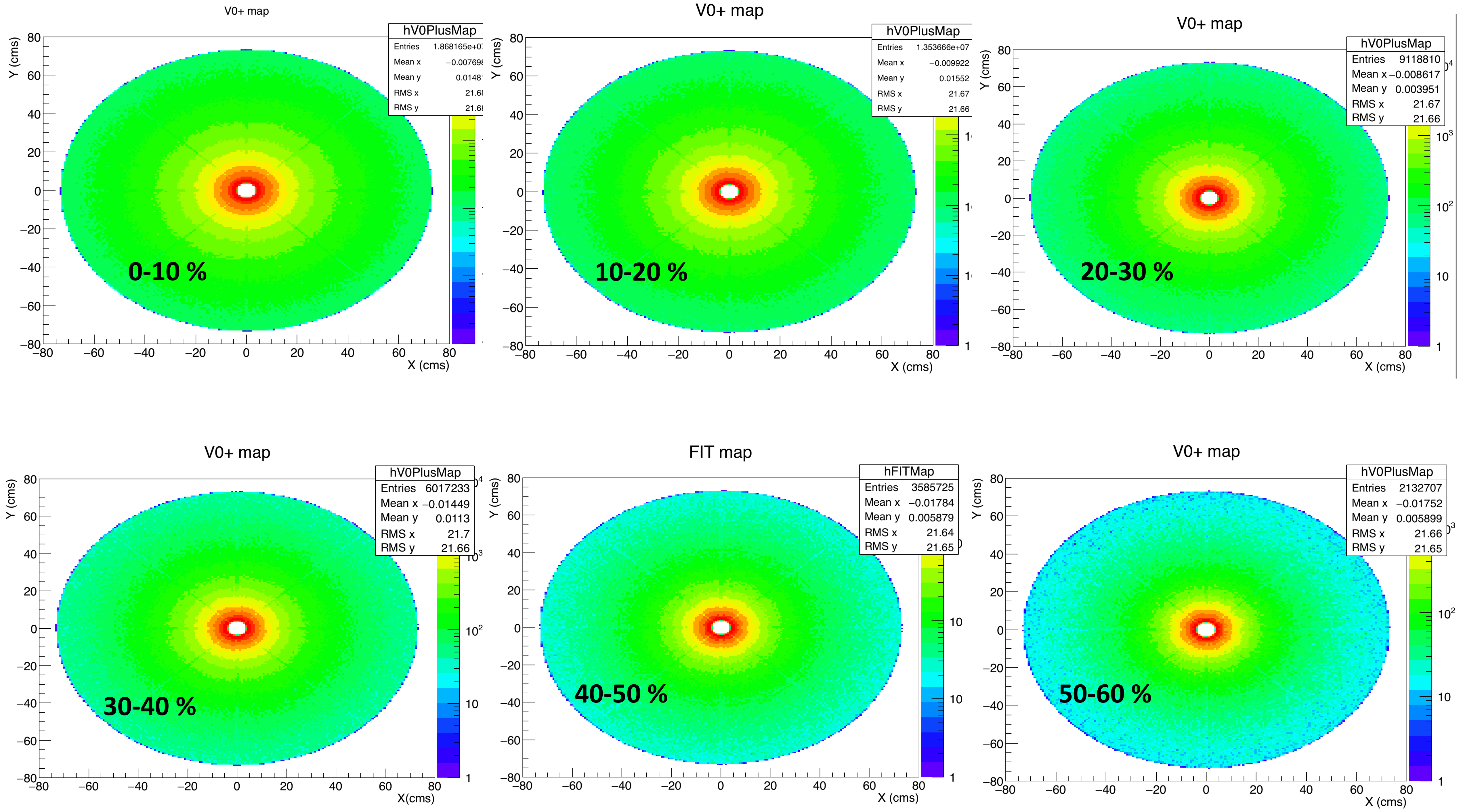
- available in AliFITv5
- Five rings → this is V0A (Run 1,2) + 1 ring
- Eight cells per ring → slices of 45^0 in the azimuthal angle
- pseudorapidity coverage of $2.2 < \eta < 5.1$.

Second implementation of the V0+ detector geometry

- available in AliFITv6: five rings with a pseudorapidity coverage of $2.2 < \eta < 5.1$.
- Sixteen cells per ring → slices of 22.5^0 in the azimuthal angle

4

Geometry of the V0+ detector



AliFITv5

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Geometry of the V0+ detector

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4

Azimuthal anisotropy

$$E\frac{d^3N}{dp^3} = \frac{1}{2\pi}\frac{d^2N}{p_T dp_T d\eta}\left\{1+2\sum_{n=1}^{\infty} v_{n(p_T,\eta)} \mathrm{Cos}[n(\varphi-\Psi_n)]\right\}$$

E: energy of the particle
p: momentum
p_T: transverse momentum
φ: azimuth angle
Ψ_n: azimuth angle of the symmetry plane (n[th]-harmonic)
v_n: differential flow

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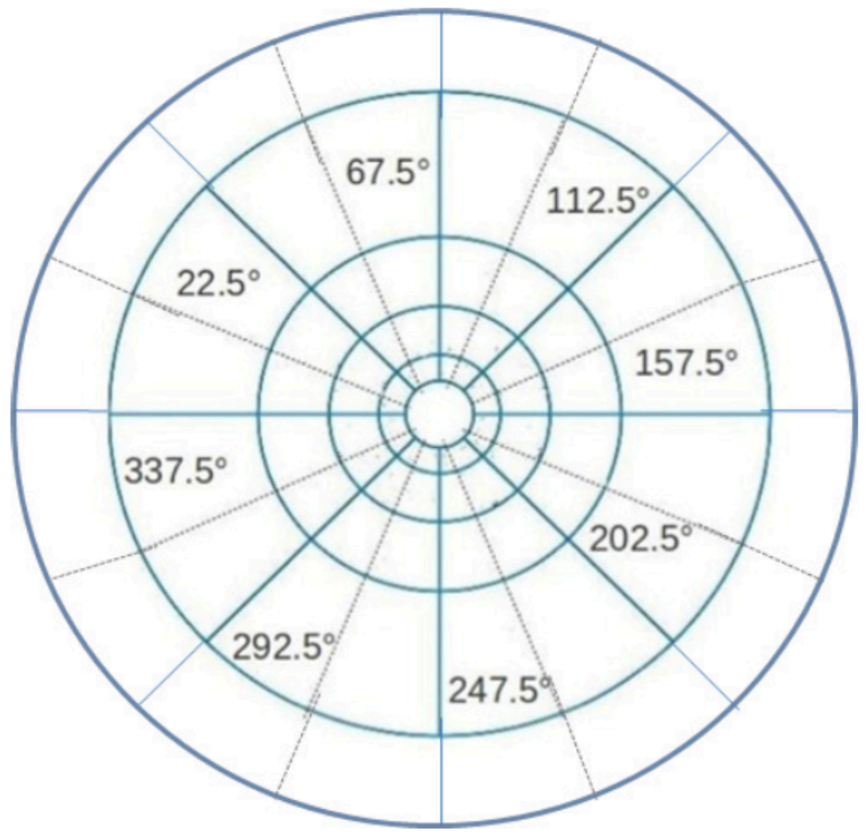
Azimuthal anisotropy

To compute the EP resolution, we assumed the angles showed in figure.

$$\Psi = \frac{1}{n}\mathrm{ATan2}\left[\frac{\sum_{i=1}^{m} w_i \mathrm{Sin}(n\varphi_i)}{\sum_{i=1}^{m} w_i \mathrm{Cos}(n\varphi_i)}\right]$$

Φ_i → cell angle
w_i → multiplicity in *i-cell*
n → *order of the azimuthal anisotropy*



$$\mathrm{Cos}\left(n * [\Psi_{V0+} - \Psi_{MC}]\right)$$

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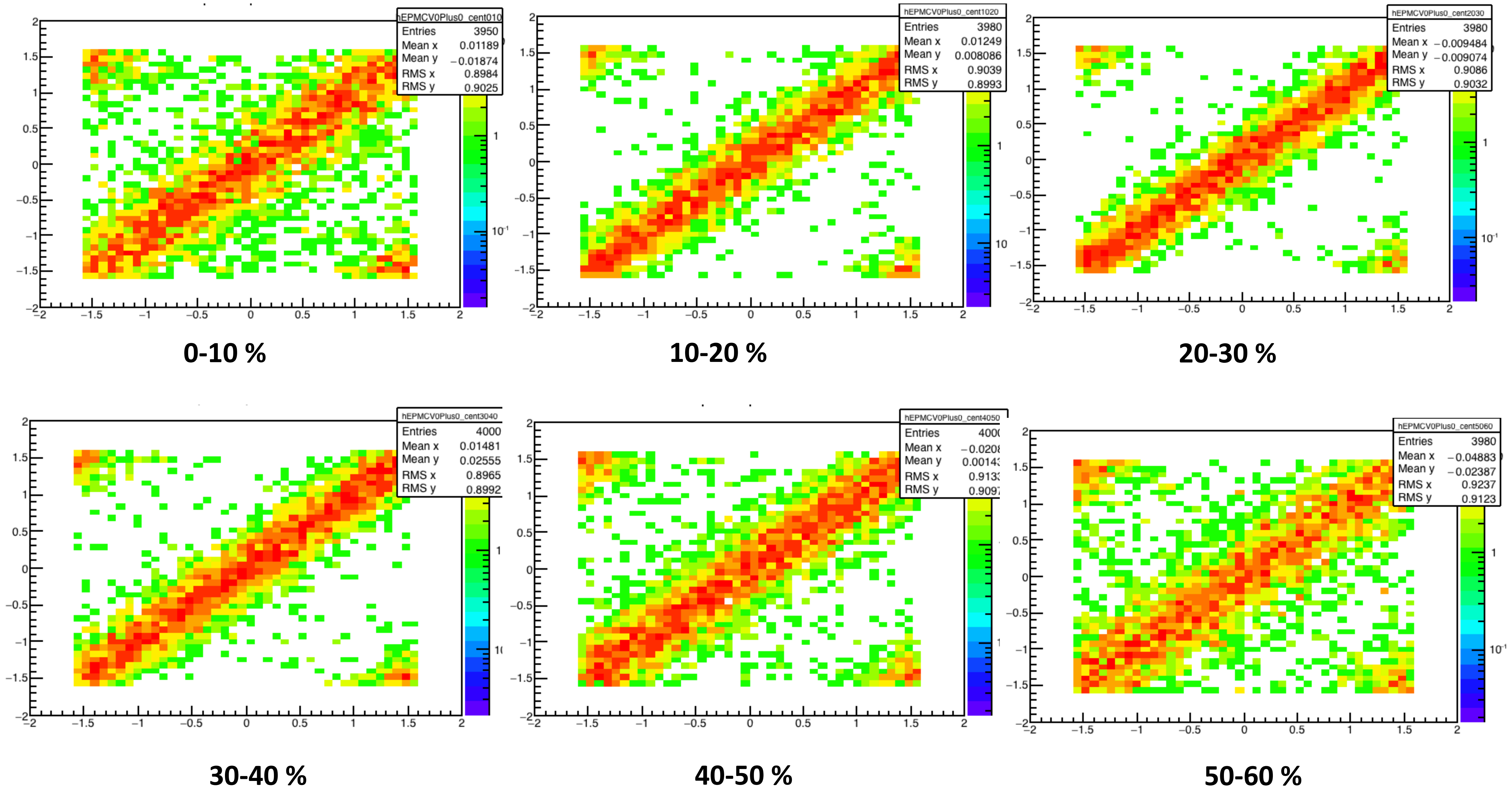
Elliptic flow



AliFITv5

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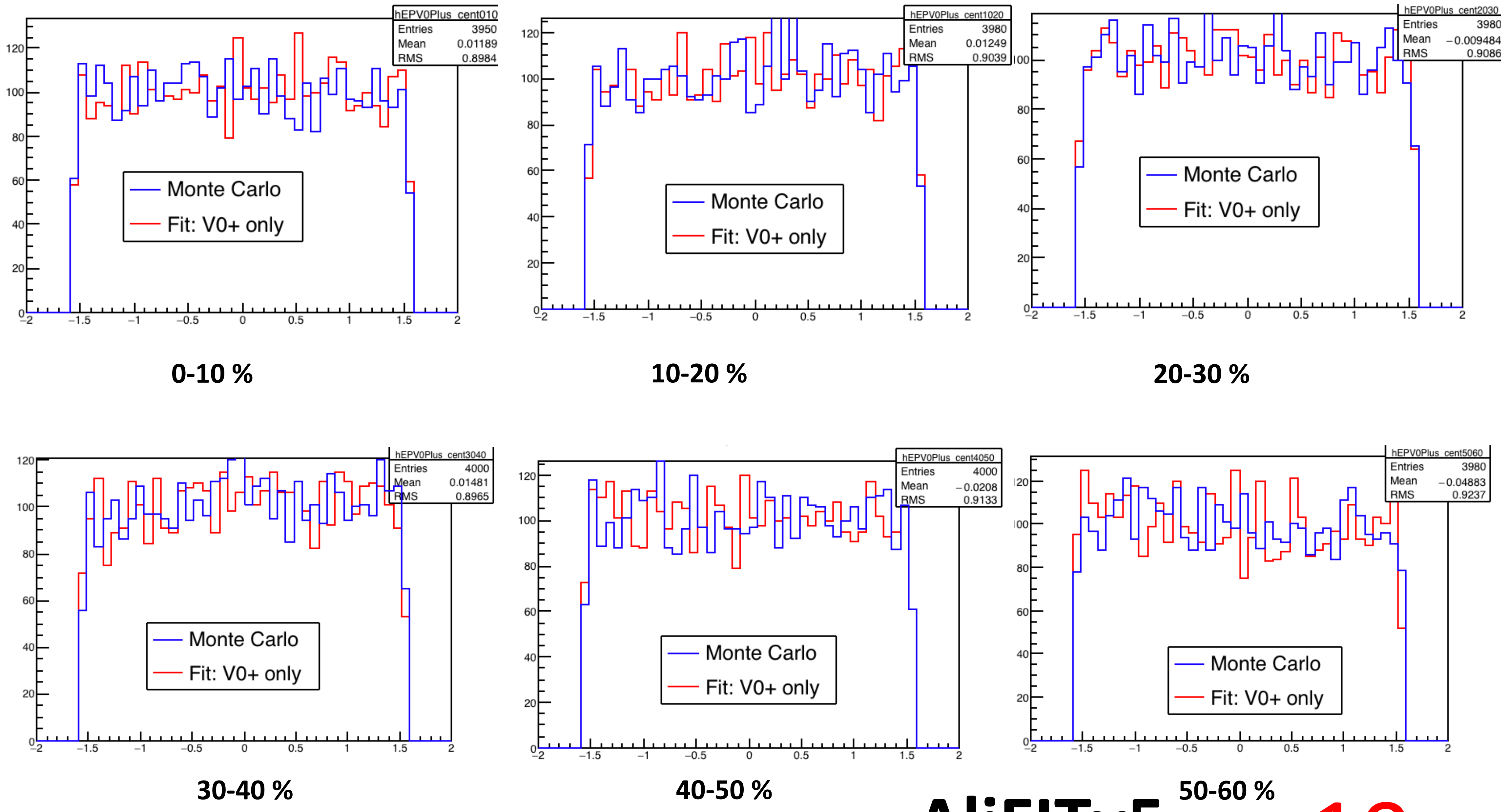
Elliptic flow



AliFITv5

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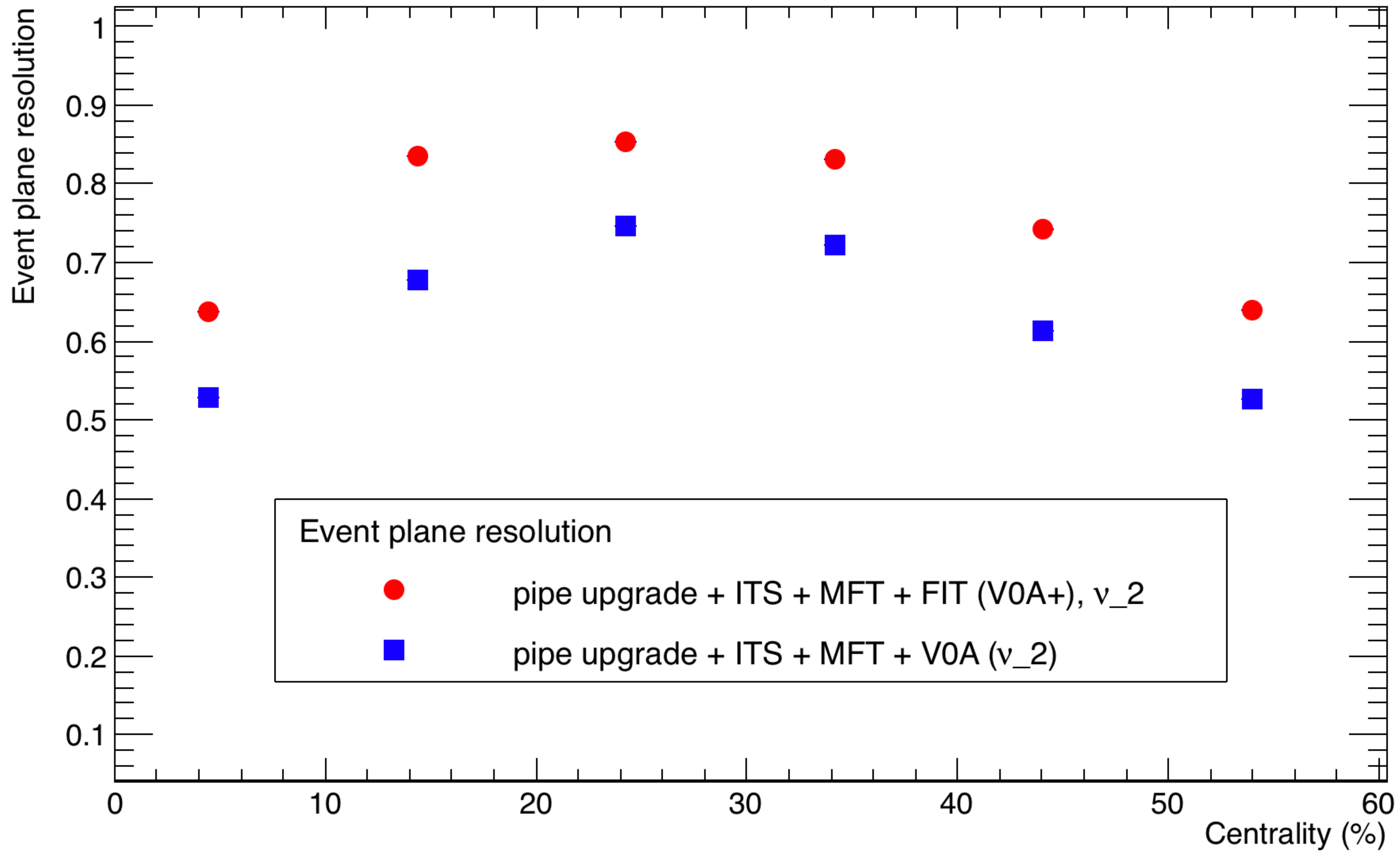
Elliptic flow



AliFITv5

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Elliptic flow

Configuration 1. This is the original AliFITv6 and has 5 rings, with 16 cells per ring. 80 cells

Configuration 2. Rings 1 to 4 have 8 cells each one and ring 5 has 16 cells. 48 cells

Configuration 3. It has rings 1 to 3 with 8 cells per ring and rings 4 and 5 with 16 cells each one. 56 cells

Configuration 4. This is the original AliFITv5 and has 5 rings, with 8 cells per ring. 40 cells

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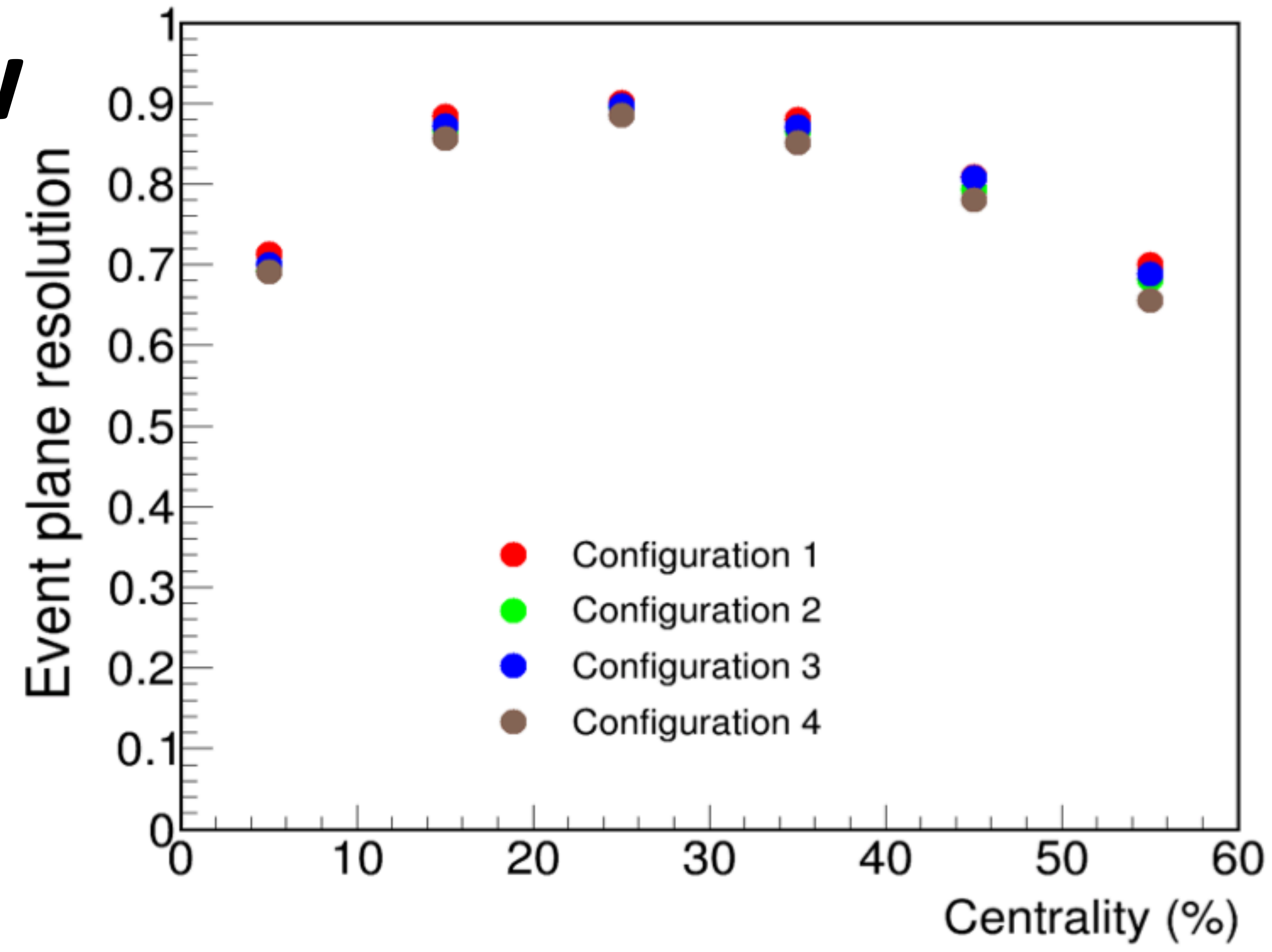
Elliptic flow



Layout	Event plane resolution						
	0-10%	10-20%	20-30%	30-40%	40-50%	50-60%	
Config. 1	0.712	0.883	0.9	0.879	0.809	0.7	80 cells
Config. 2	0.692	0.867	0.893	0.865	0.792	0.681	48 cells
Config. 3	0.7	0.871	0.896	0.87	0.808	0.688	56 cells
Config. 4	0.69	0.856	0.884	0.851	0.78	0.655	40 cells

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Elliptic flow

Configuration 1. This is the original AliFITv6 and has 5 rings, with 16 cells per ring. 80 cells

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Configuration 3. It has rings 1 to 3 with 8 cells per ring and rings 4 and 5 with 16 cells each one. 56 cells

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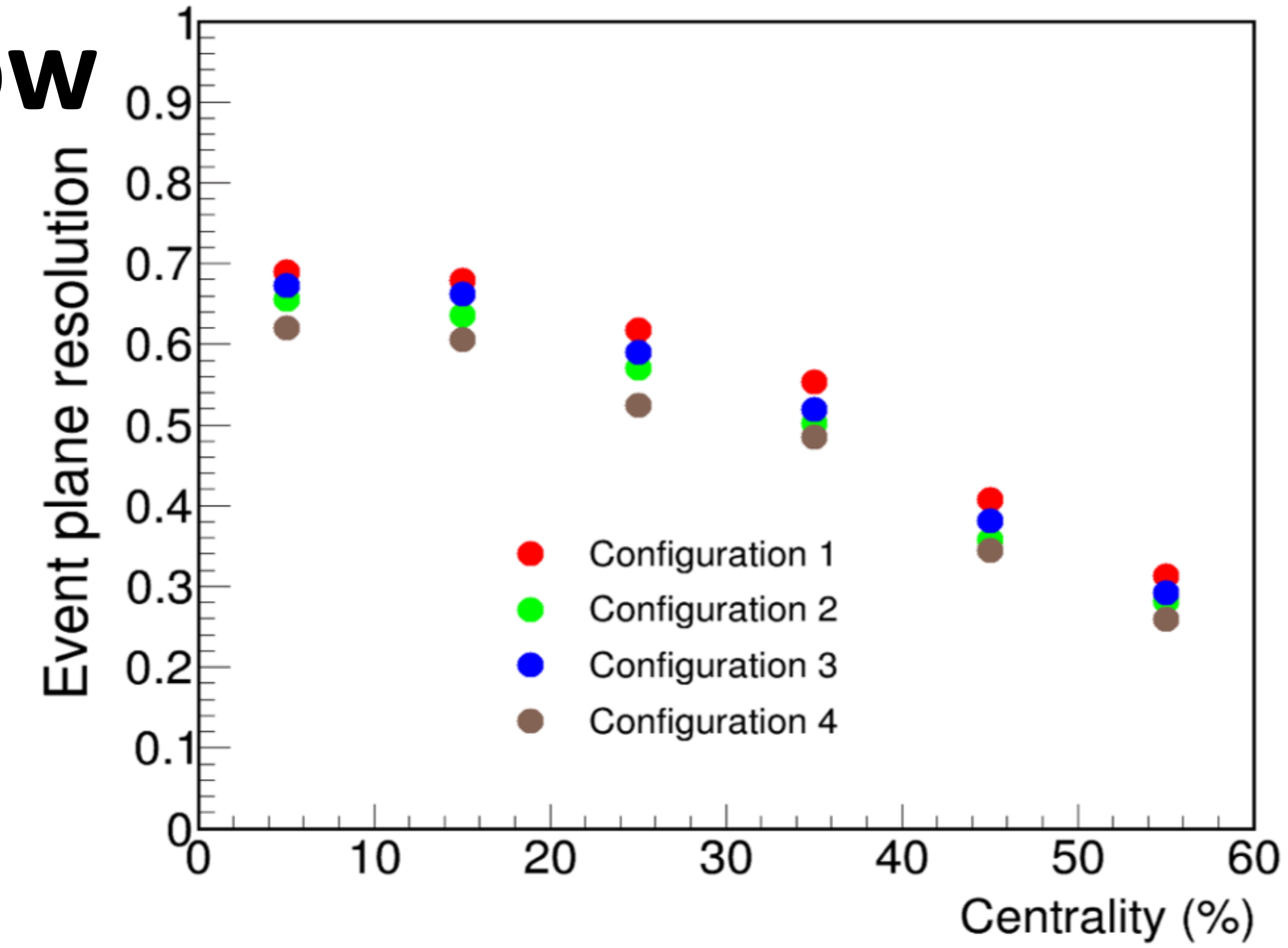
Triangular flow



Layout	Event plane resolution					
	0-10%	10-20%	20-30%	30-40%	40-50%	50-60%
Config. 1	0.69	0.679	0.617	0.553	0.408	0.312
Config. 2	0.655	0.636	0.57	0.502	0.357	0.281
Config. 3	0.672	0.661	0.59	0.518	0.38	0.291
Config. 4	0.619	0.605	0.524	0.484	0.344	0.259

80 cells
48 cells
56 cells
40 cells 15

Elliptic flow

Configuration 1. This is the original AliFITv6 and has 5 rings, with 16 cells per ring. 80 cells

Configuration 2. Rings 1 to 4 have 8 cells each one and ring 5 has 16 cells. 48 cells

Configuration 3. It has rings 1 to 3 with 8 cells per ring and rings 4 and 5 with 16 cells each one. 56 cells

Configuration 4. This is the original AliFITv5 and has 5 rings, with 8 cells per ring. 40 cells

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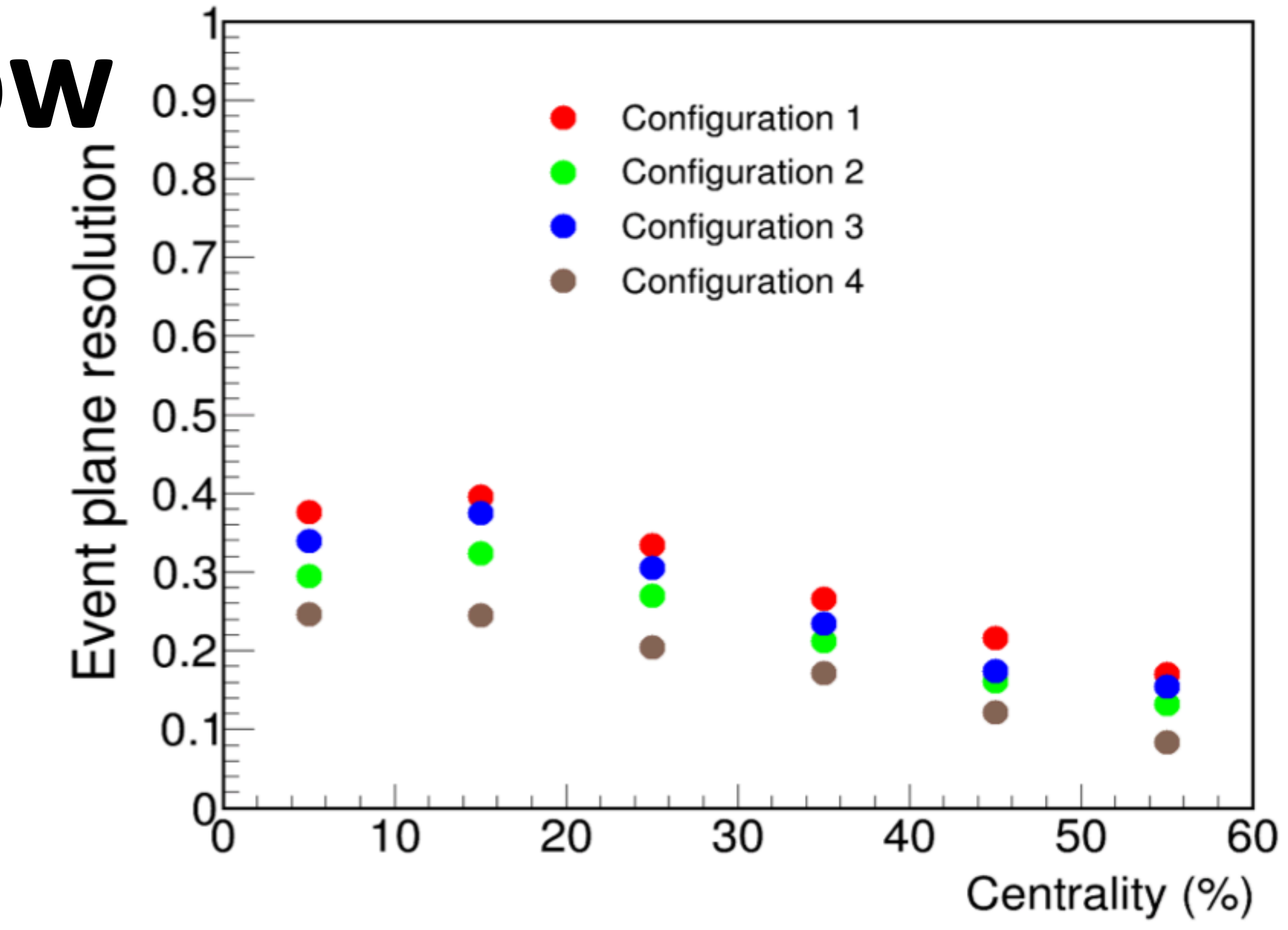
Quadrangular flow



Elliptic flow

Configuration 1. This is the original AliFITv6 and has 5 rings, with 16 cells per ring. 80 cells

Configuration 2. Rings 1 to 4 have 8 cells each one and ring 5 has 16 cells. 48 cells

Configuration 3. It has rings 1 to 3 with 8 cells per ring and rings 4 and 5 with 16 cells each one. 56 cells

Configuration 4. This is the original AliFITv5 and has 5 rings, with 8 cells per ring. 40 cells

Layout	Event plane resolution						
	0-10%	10-20%	20-30%	30-40%	40-50%	50-60%	
Config. 1	0.376	0.395	0.333	0.265	0.216	0.169	80 cells
Config. 2	0.294	0.323	0.269	0.212	0.161	0.131	48 cells
Config. 3	0.339	0.375	0.304	0.233	0.173	0.153	56 cells
Config. 4	0.246	0.245	0.204	0.171	0.121	0.082	40 cells

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More details on Varlen and Ruben's slides

A more realistic analysis is a future work. (MSc. thesis of Valeria Zelina Reyna Ortiz)

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EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

ALICE-ANA-2017-xxx
November 15, 2017

More details on Varlen and Ruben’s slides

Event plane resolution for higher order harmonics flow with the V0+ detector

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A more realistic analysis is a future work. (MSc. thesis of Valeria Zelina Reyna Ortiz)

Abstract

The azimuthal anisotropy is a very important observable to study the Quark-Gluon Plasma in non-central heavy-ion collisions. An experimental approach to the azimuthal anisotropy relies on the determination of the event plane. For this reason, the event plane resolution is a key measurement for some of the detectors that will be installed in ALICE during Long Shutdown 2. Among these, the V0+ that will replace the actual V0 system. In the present analysis note we report on the expected performance of the V0+ detector for the event plane resolution for higher order harmonics. All the results were obtained at the hits level. reason the resolution of the event plane

Final comments

Topic	Product	People involved	to be ready for	thesis	level
Ratio mu+/mu- for single muon events and multimuons	regular ALICE paper	B. Alessandro, **E. Gonzalez**, A. Fernández, M. Rodríguez Cahuantzi, M. Sitta	Dec. 2019	**1**	**PhD**
Detailed study of high muon multiplicity events		B. Alessandro, **E. Gonzalez**, A. Fernández, M. Rodríguez Cahuantzi, M. Sitta	Dec. 2019		
Sensitive studies for an RPC detector with 2 gas mixtures	paper	**D. Blanco**, M. Rodríguez Cahuantzi, M. A. Subieta	Nov. 2018	**1**	**MSc.**
Measurement of double diffractive cross section	regular ALICE paper	**A. Villatoro Tello**, A. Fernández Tellez, M. Rodríguez Cahuantzi, I. León, R. Orava	Nov. 2019	**1**	**PhD.**
Analysis of central production of pi+pi- in diffractive events	Analysis note	**S. Paisano**, M. Rodríguez Cahuantzi	April 2019	**1**	**BSc.**
Performance of the ALICE cosmic ray detector, ACORDE	regular ALICE paper	A. Fernández, M.I. Martínez Hernández, M. Rodríguez CAhuantzi, L.A.P. Moreno, Abraham Villatoro	Sept. 2019		
Upgrade of the ALICE cosmic ray detector	NIM paper	A. Fernández, M.I. Martínez Hernández, M. Rodríguez CAhuantzi, L.A.P. Moreno, Abraham Villatoro	Dec. 2018		
LHC forward physics	paper	M.I. Martínez Hernández, L.A.P. Moreno, JC Cabanillas, M. Rodríguez Cahuantzi, A. Villatoro Tello, I. Leon Monzon	published		
Physics performance of FIT	analysis note	V. Z. Reyna Ortiz, M. Rodríguez Cahuantzi	XXX?	**1**	**MSc.**