Pierre Auger Observatory

studying the universe's highest energy particles

Status dell'esperimento Auger

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Dipartimento di Fisica

INFN Istituto Nazionale di Fisica Nucleare Sezione di Lecce

Summary

- Introduzione
- Produttività Scientifica
- **Il programma di upgrade**
- Finanziamenti Esterni

Il progetto Pierre Auger: range di operatività

Studio della radiazione cosmica di altissima energia

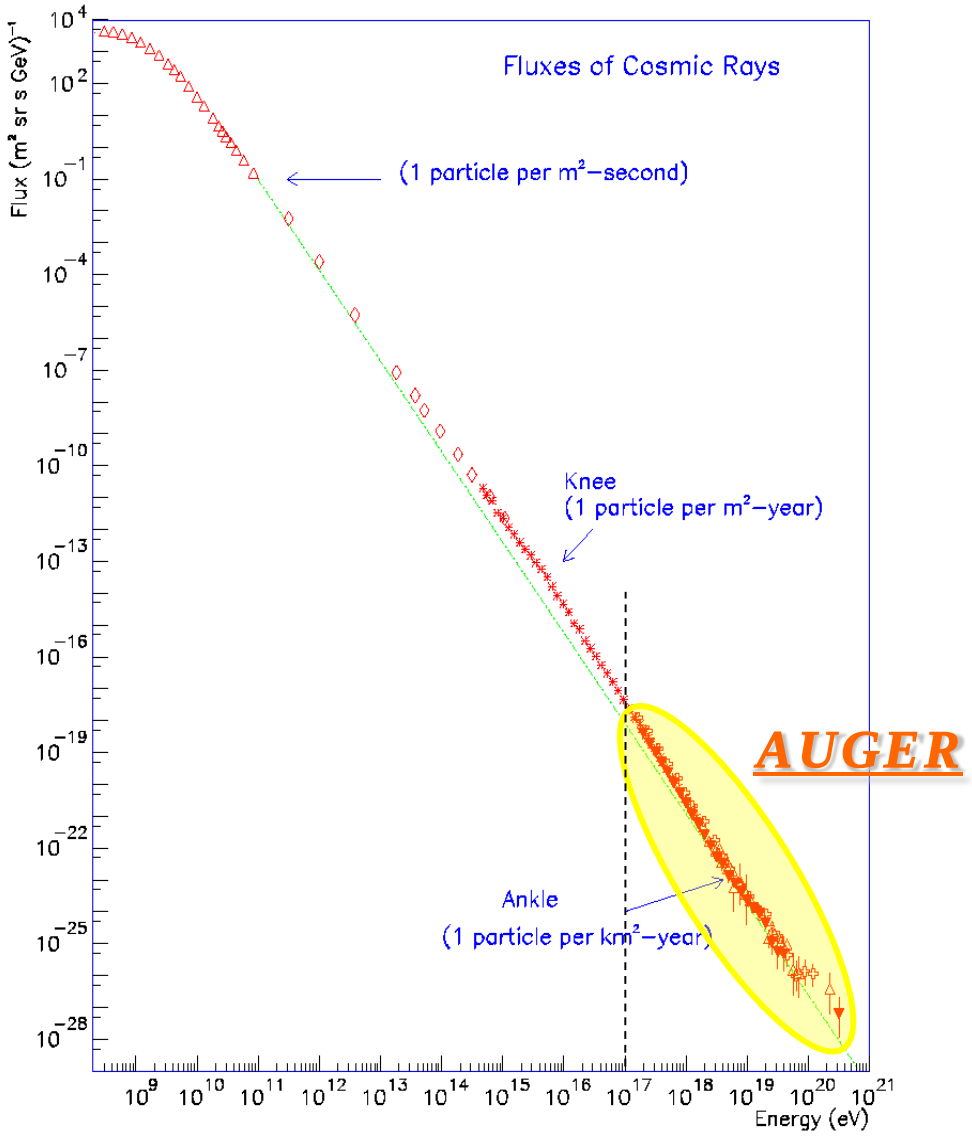
(10^{17}-10^{21}) eV

Flusso ad E>$10^{19.5}$ eV molto basso

1 particella/(km² sr secolo)

Apparato di grandi dimensioni: 3000 km² (Auger)

30 eventi/anno



La collaborazione Pierre Auger

Argentina
Australia
Bolivia
Brazil
Czech Rep.
France
Germany
Italy
Mexico
Netherlands
Poland
Portugal
Slovenia
Spain
UK
USA
Vietnam

17 Countries
63 Institutions
~ 350 members

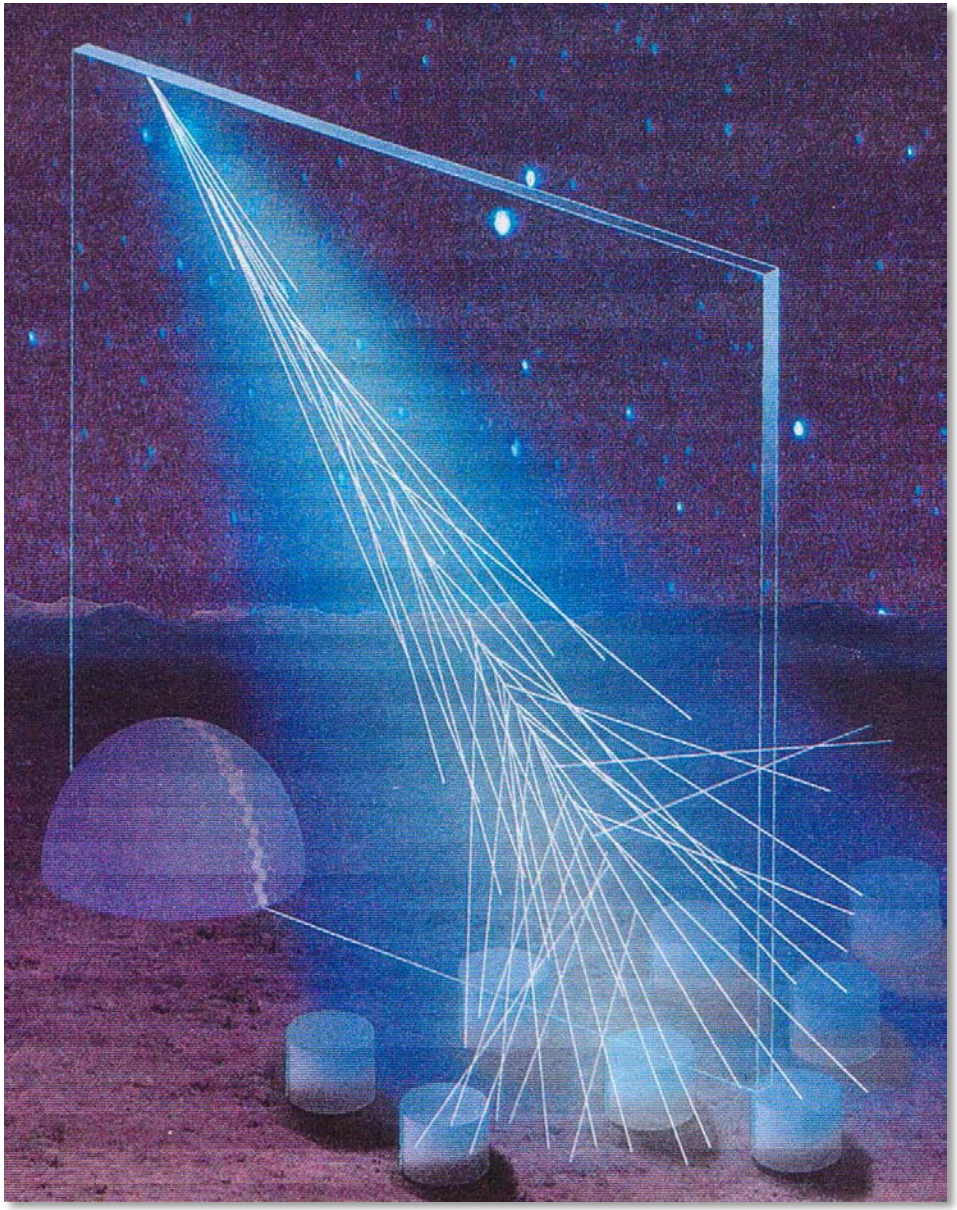
The Hybrid Concept

Hybrid Detector:

Array of 1660 water Cherenkov detectors
- **covering 3000 km²**
- **duty cycle: 100%**

Fluorescence telescopes
- **27 FDs (30ºx30º each)**
- **duty cycle: 14%**

Better geometric reconstruction, cross-calibration, control of systematic.



The Pierre Auger Observatory

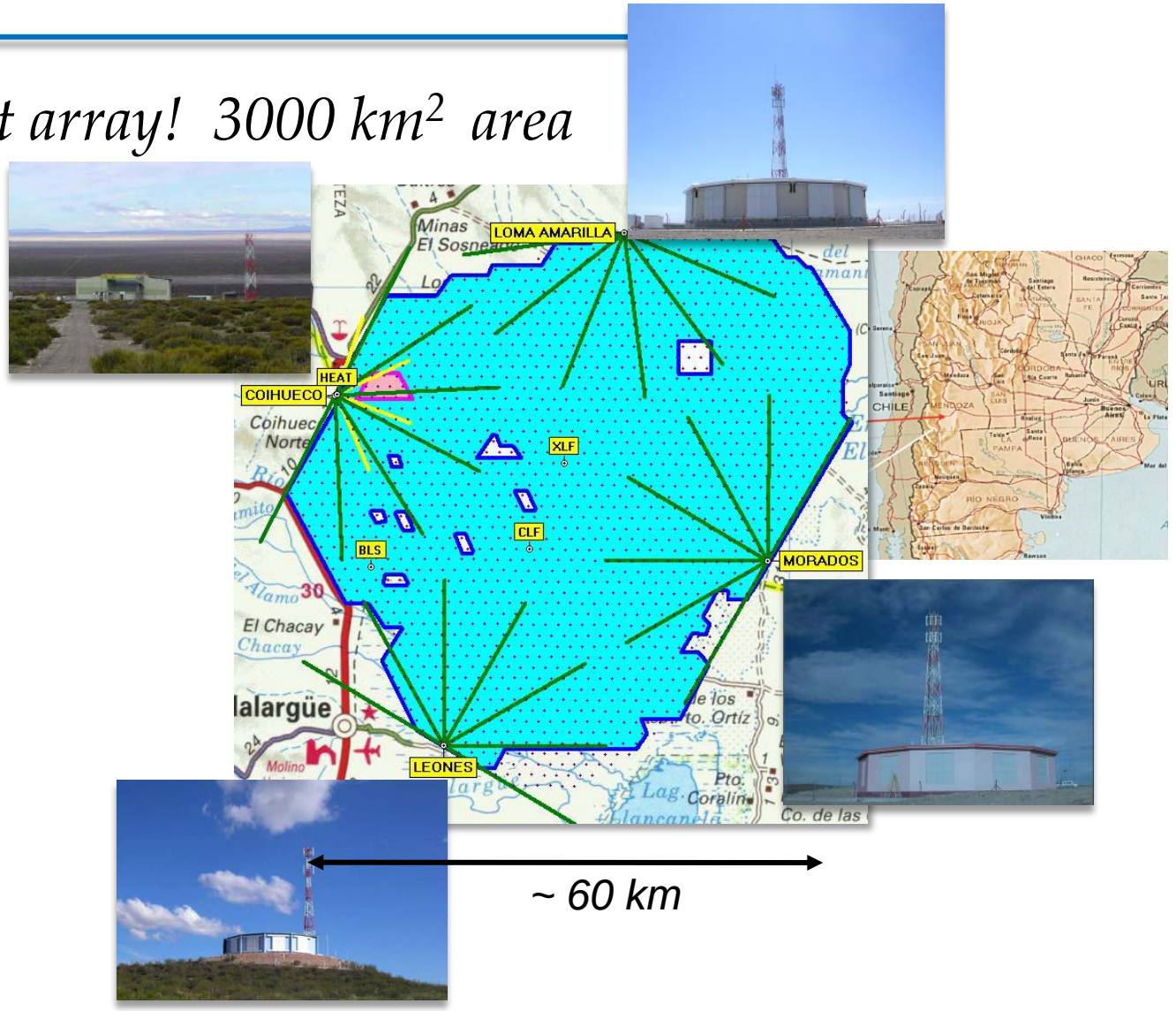
World largest array! 3000 km^2 area

1660 tanks installed!

27 FD Telescopes (4 positions)!

Completed in 2008 !

Taking data since 2004



≈ 3000 evts/yr with E > 10^{19} eV

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P.Ghia Malargue Marzo 2013

All Databases

Fonte Scopus

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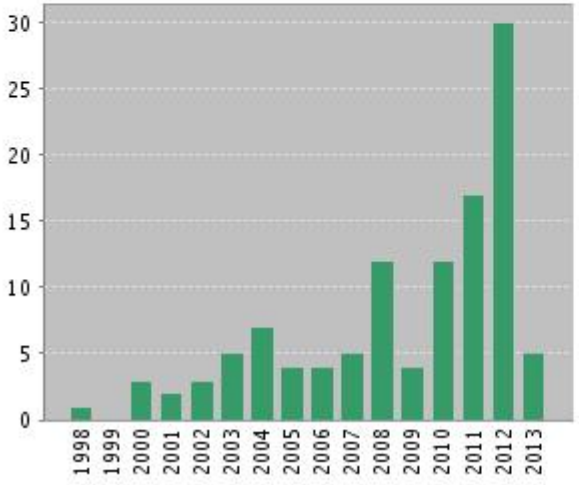
Citation Report Group Author=(auger)

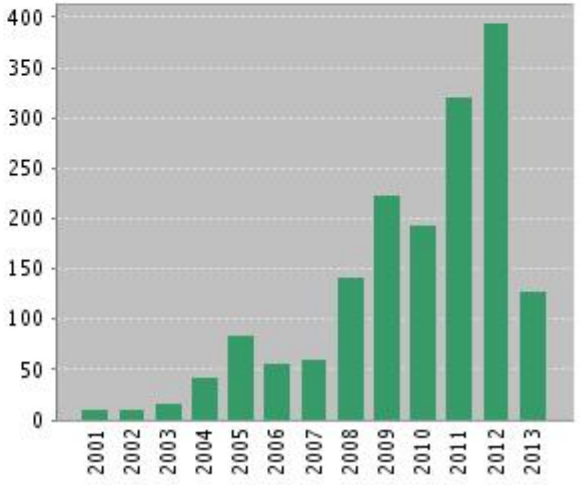
Timespan=All years.

This report reflects citations to source items indexed within All Databases.

Published Items in Each Year



Citations in Each Year



Presentazioni a Conferenze Int. 2013 (fatte o schedulate)	97
Speakers Italiani	17
Speakers Lecce	4

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Roadmap Upgrade

2) *Finance Board has appointed a SAC*

1. Francis Halzen (chair)
2. Christian Spiering
3. Tom Gaisser
4. Roberto Battiston
5. Christophe de la Taille
6. Henry Sobel
7. Felix Mirabel

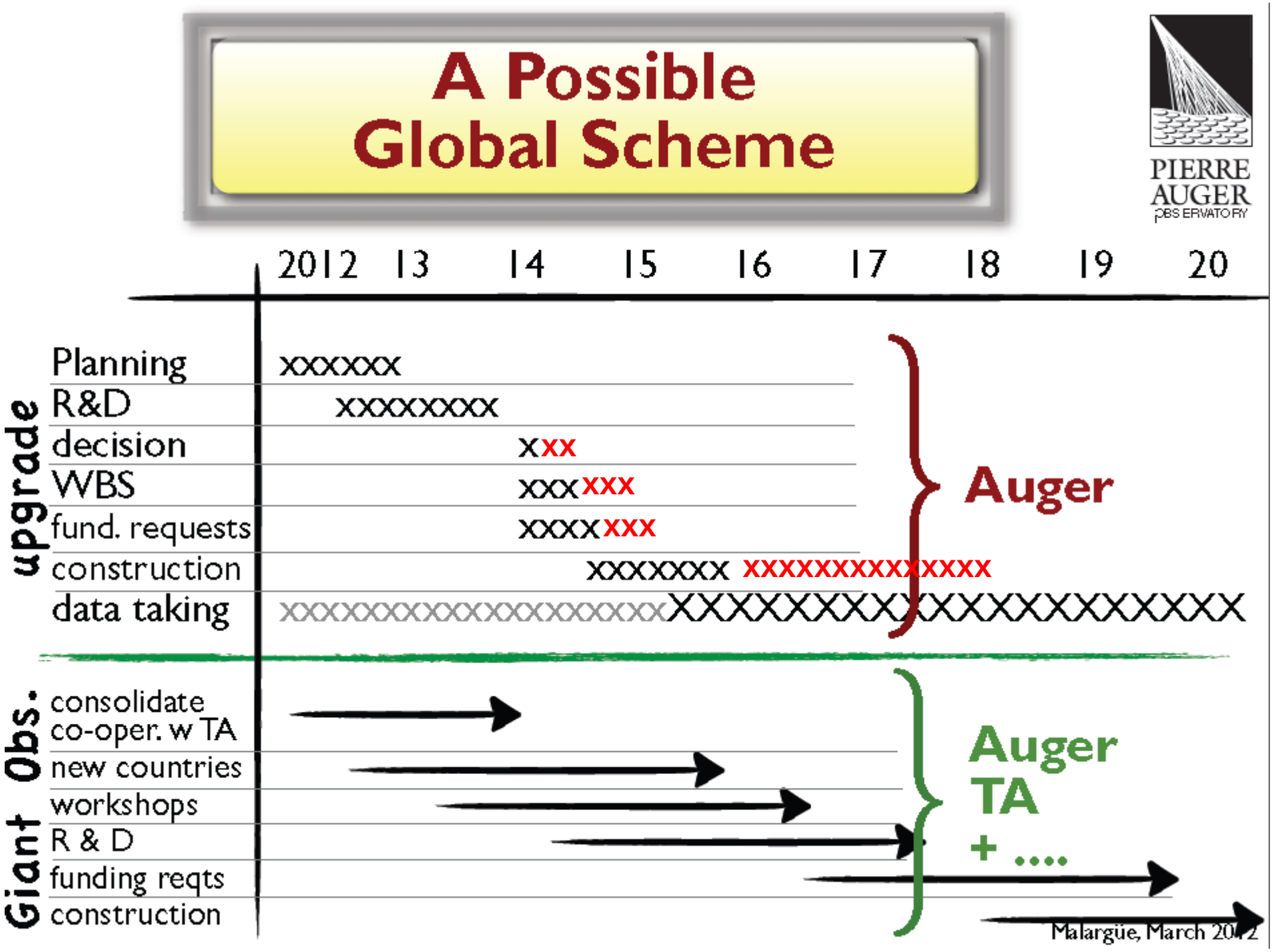
... will be at ICRC in Rio
and a first (informal) meeting
should be arranged

Roadmap Upgrade

Suggested Roadmap
to be agreed with FB and SAC

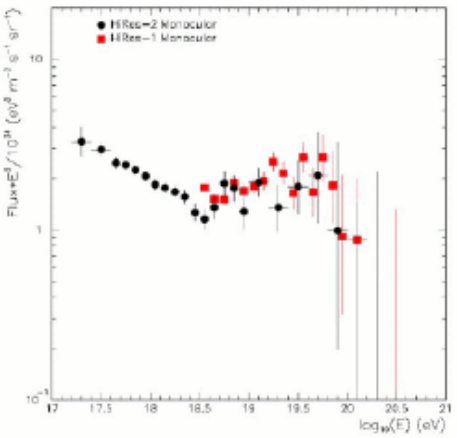
1. Informal Meeting with SAC at ICRC in July, 2.-9., 2013
2. Submission of proposal by September 23, 2013
3. Face to Face meeting with SAC in Malargüe, November 7.-8., 2013
4. Finance Board will meet in Malargüe, November 9.-10., 2013
5. Chair of SAC could stay in Malargüe for his report

A Possible Global Scheme



Alcuni risultati

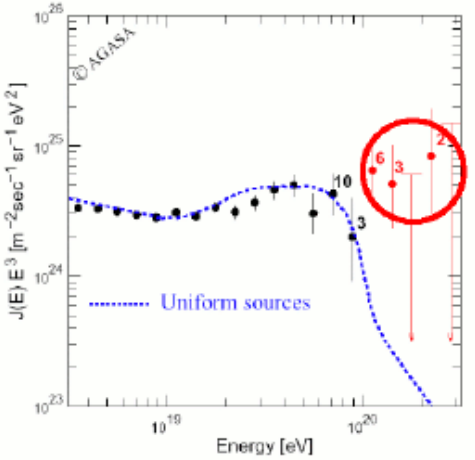
High Resolution Fly's Eye (HiRes)



Consistent w/ GZK cutoff

energy from atmospheric calorimeter - a challenge

AGASA



No GZK cutoff?

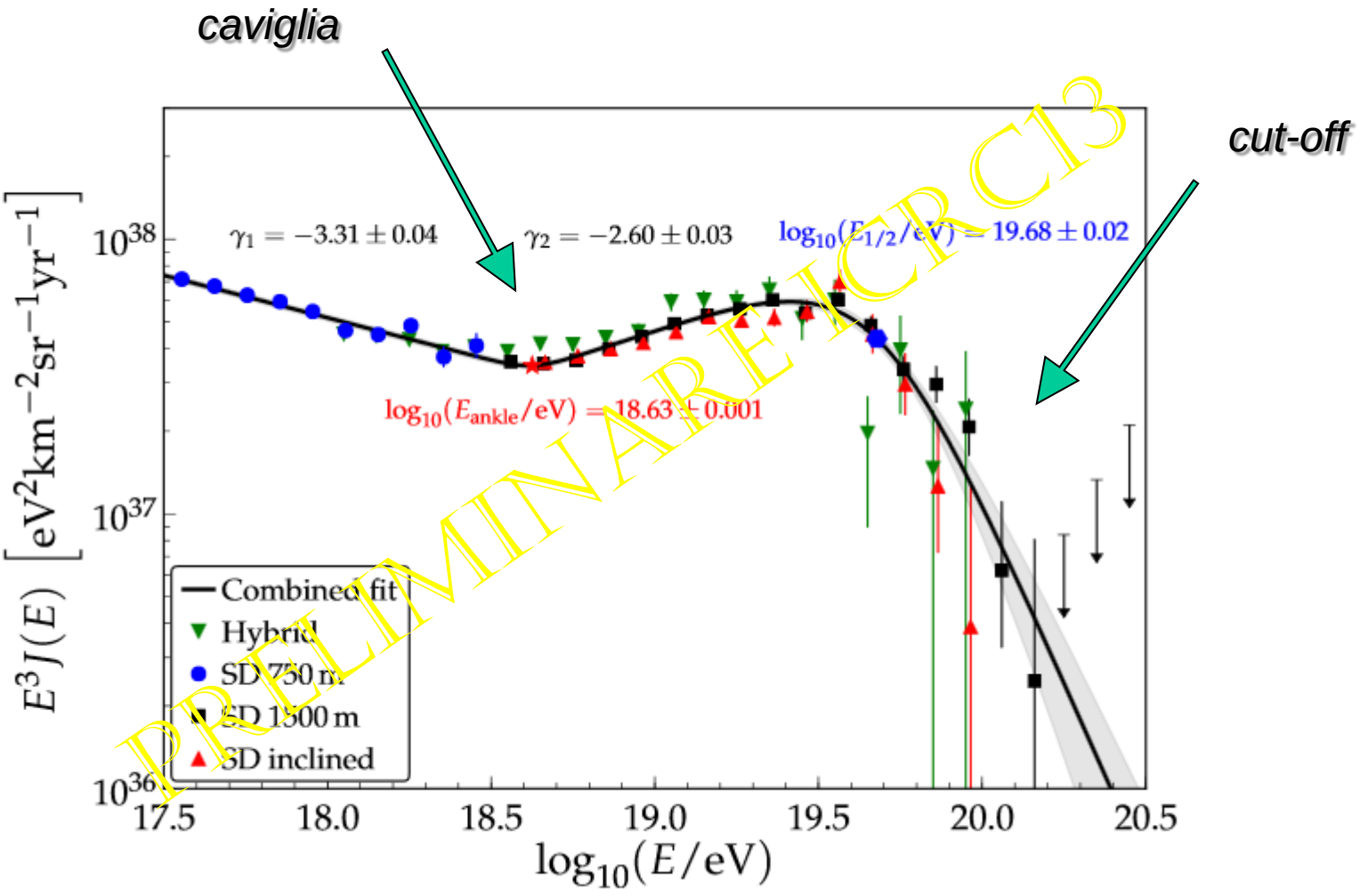
energy from shower simulations - how to check?

problem: partly statistics, probably also energy measurement systematics

Uno dei principali problemi aperti che ha spinto alla realizzazione di AUGER e' legato all'analisi della parte piu' energetica delo spettro dei raggi cosmici.

Quarant'anni fa' Greisen Zatsepin e Kuzmin conclusero che a causa della Cosmic Microwave Background l'universo e' opaco per particelle cariche di energia superiore a 10^20 eV.
Ma i due esperimenti in grado di esplorare la regione di energia interessata precedenti ad AUGER davano risultati discordanti

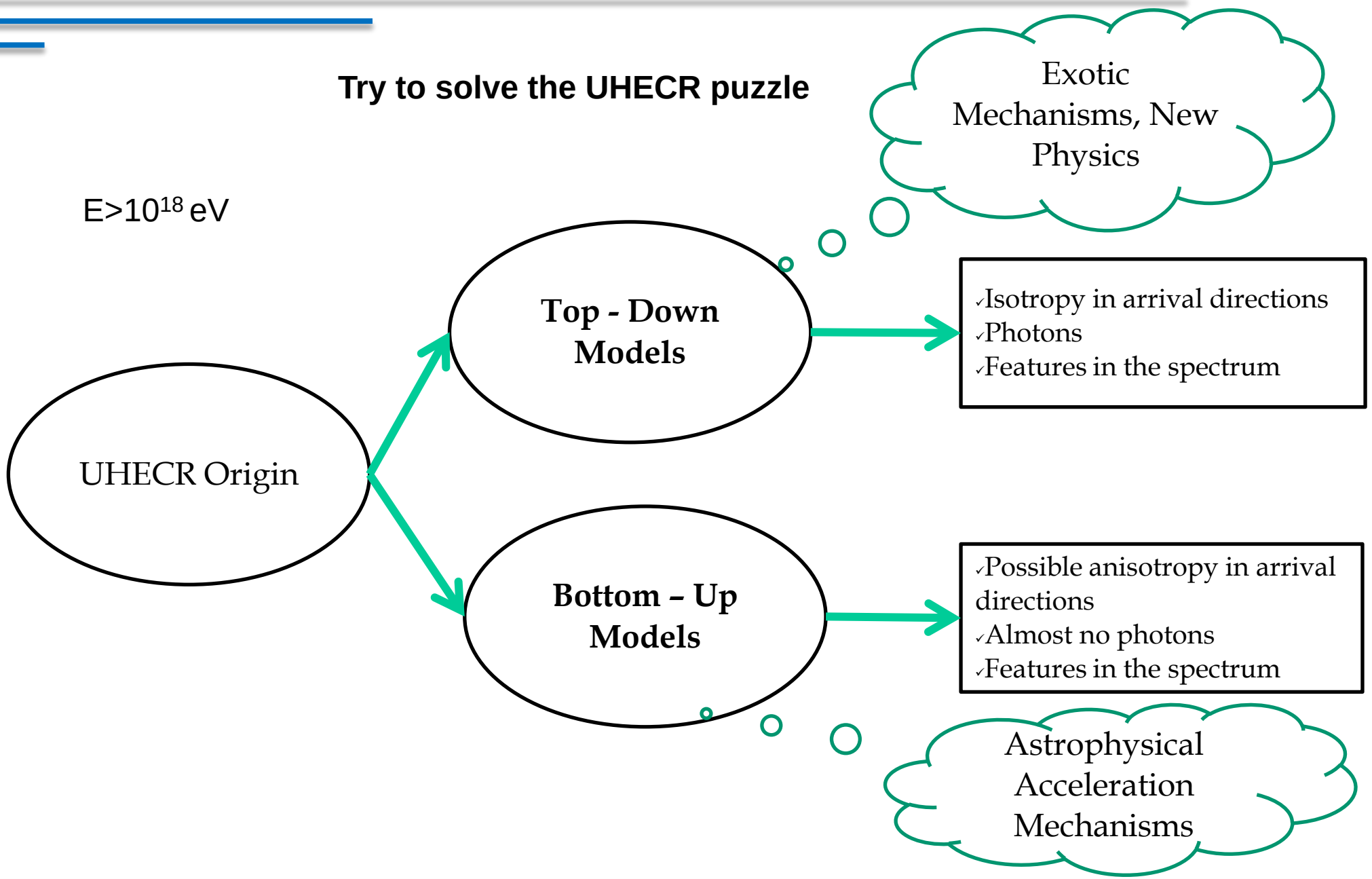
La parte più energetica dello Spettro dei Raggi Cosmici così come è misurata dall'Osservatorio Pierre Auger



Universalmente accettato che esiste un *cut-off* nel flusso dei Raggi Cosmici.
Universalmente accettato che esiste una *caviglia*.

The UHECR Physics

Try to solve the UHECR puzzle



The UHECR Physics

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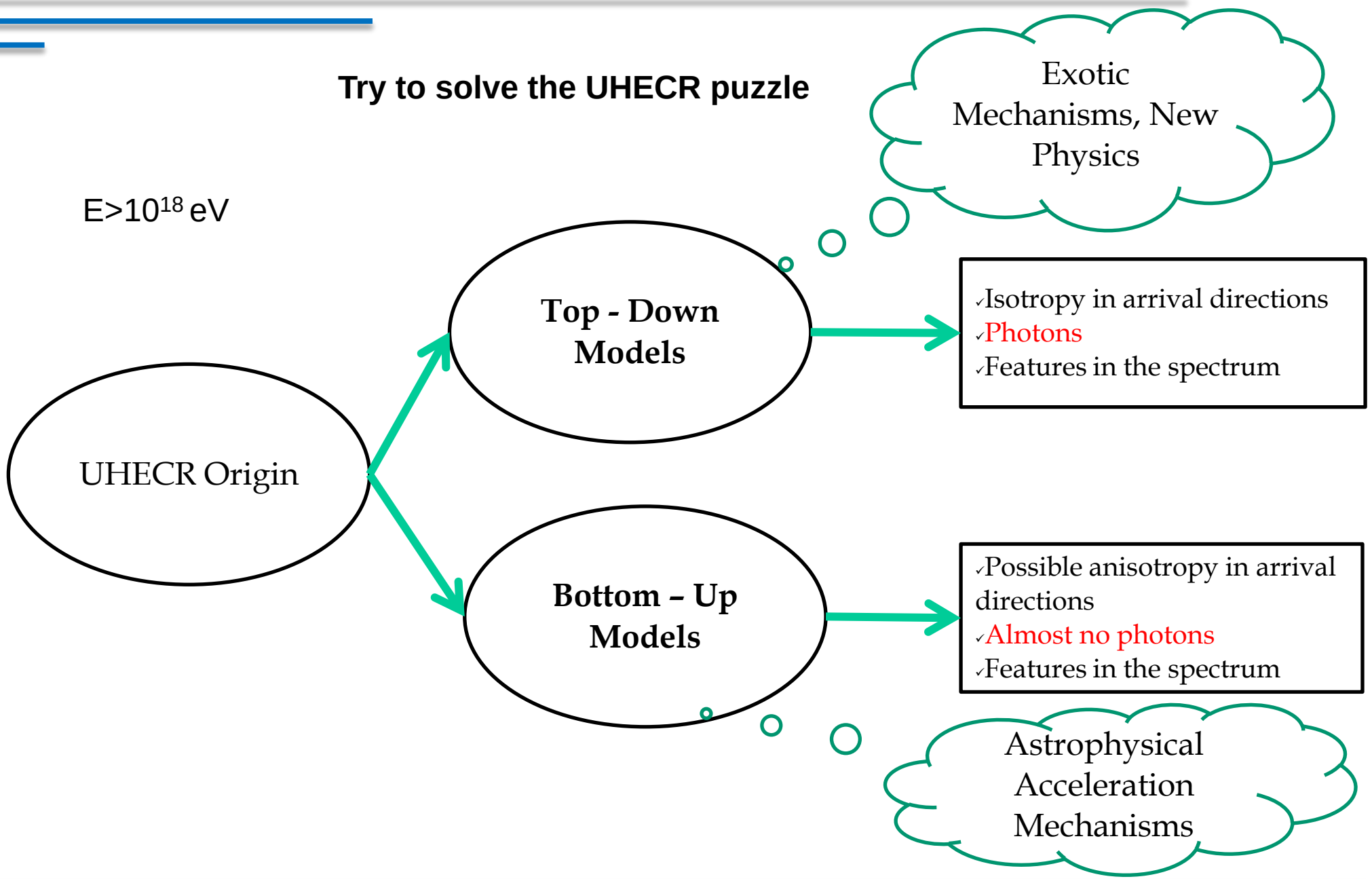
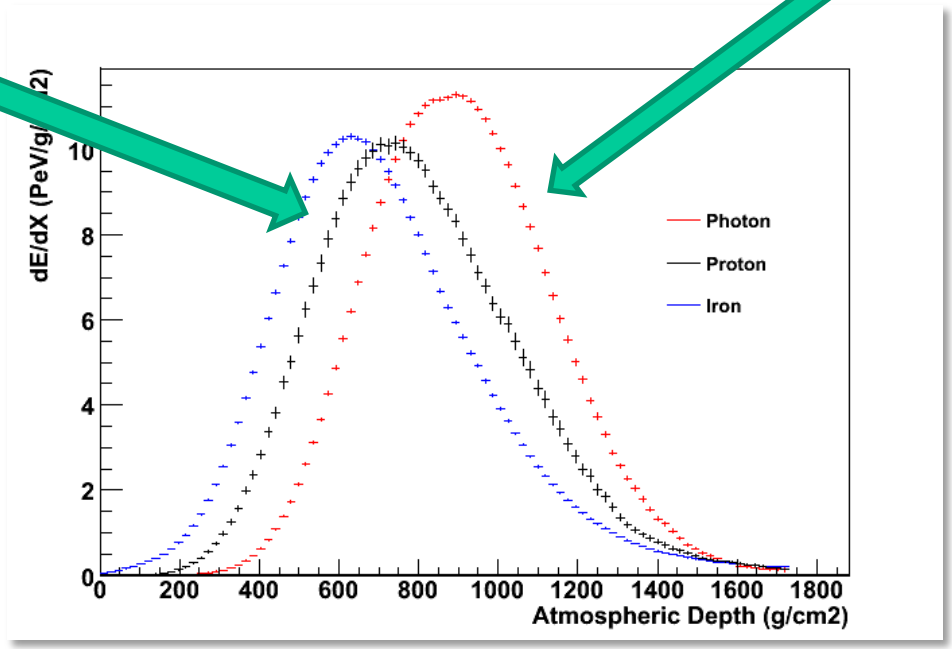


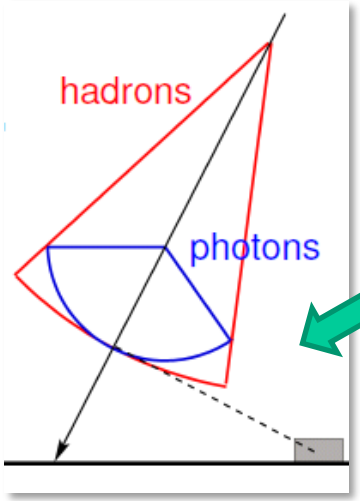
Photons

Photons

hadrons

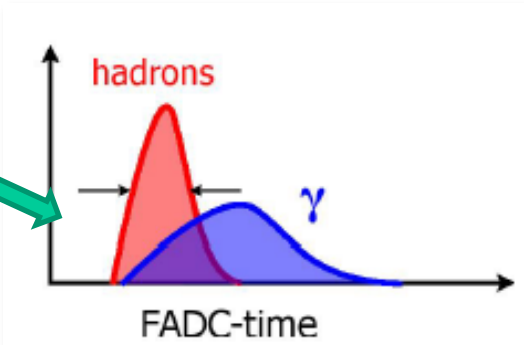


FD photons search based on X_{max} distribution



Deeper showers larger curvature

Slower signal, longer risetime

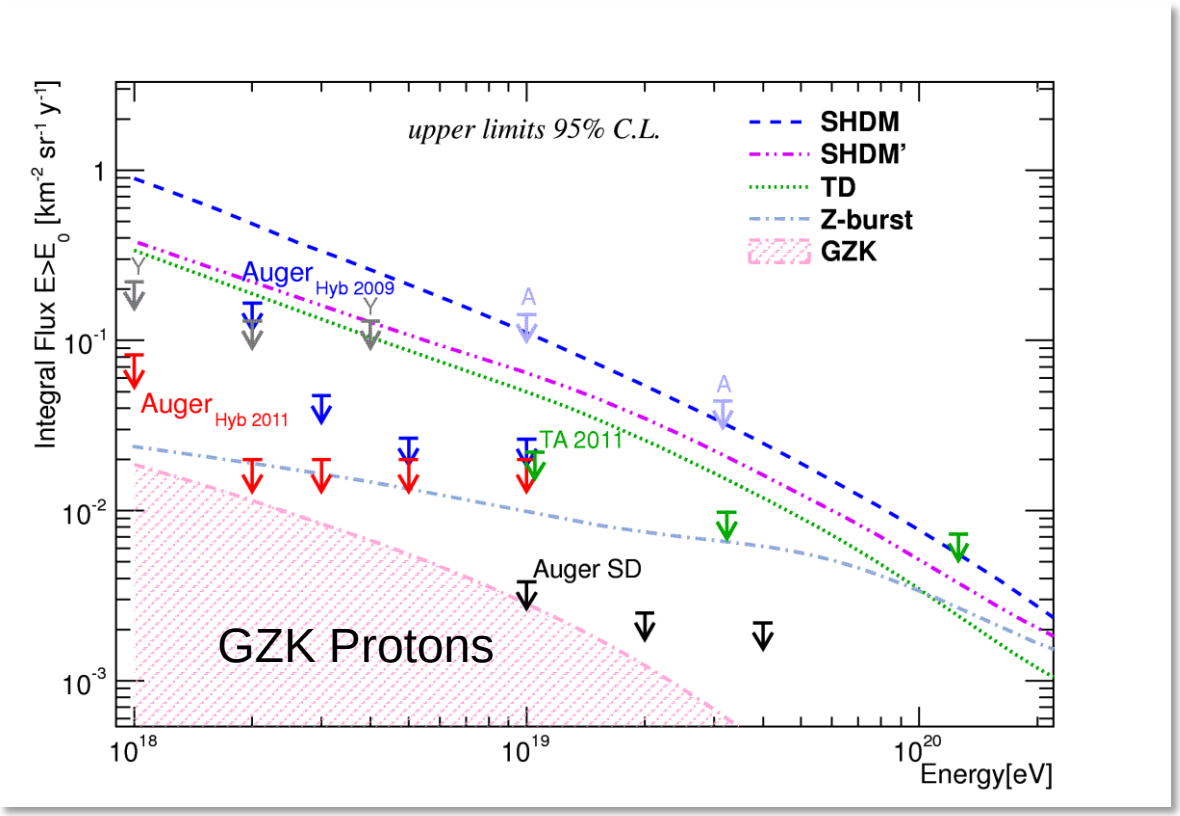


SD photons search based on signal structure

Photons

Exotic Mechanisms
- ✓ Decay of topological defects
- ✓ Relic monopoles
- ✓ Etc.

New Physics
- ✓ Supersymmetric particles
- ✓ Strongly interacting neutrinos
- ✓ Decay of massive new long lived particles
- ✓ Etc.



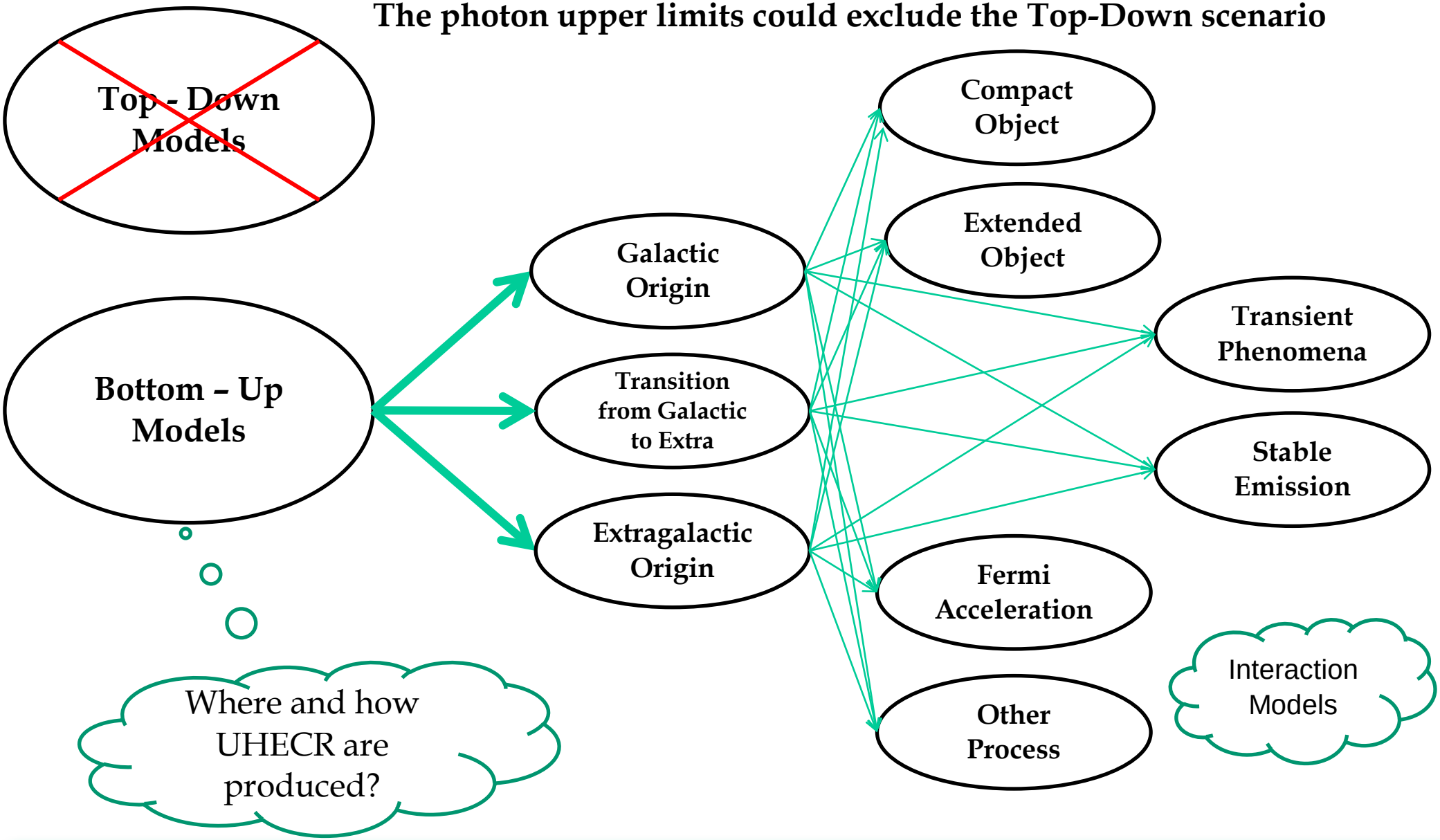
GZK region within reach in the next years

Top-down models severely constrained

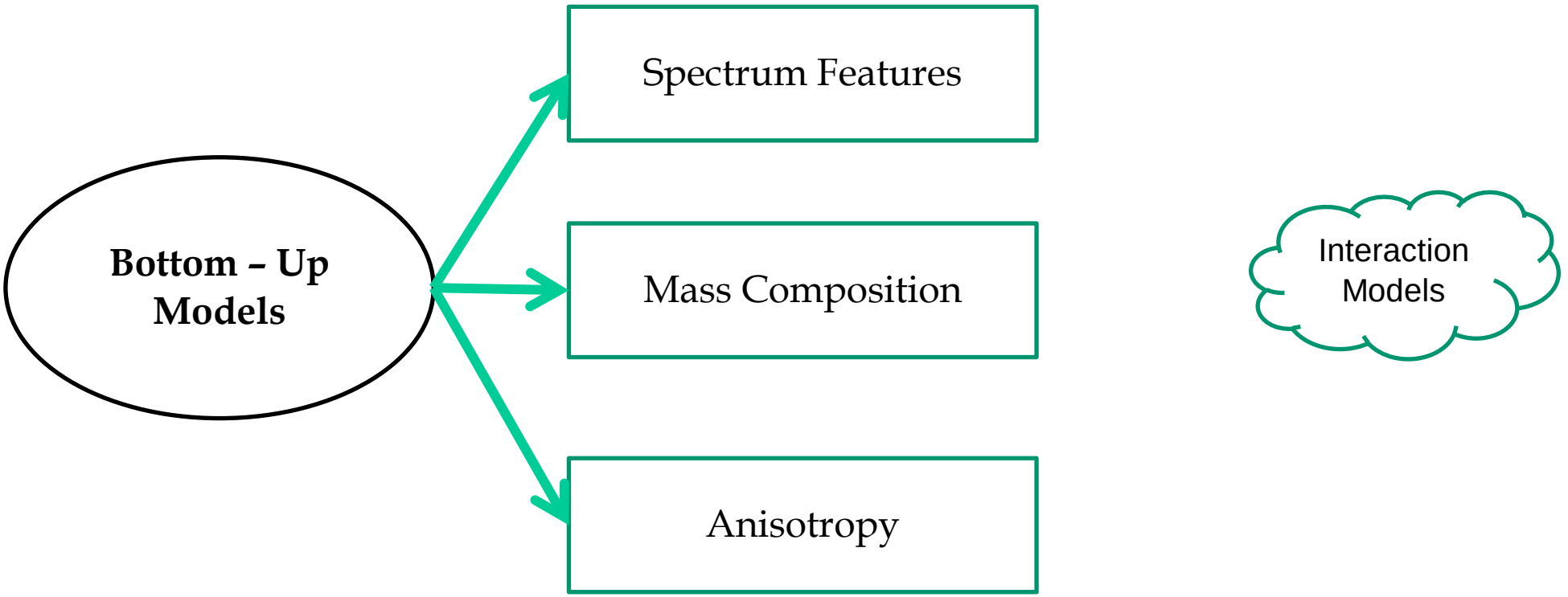
Favor astrophysical origin of UHECR

Photons: implications

The photon upper limits could exclude the Top-Down scenario

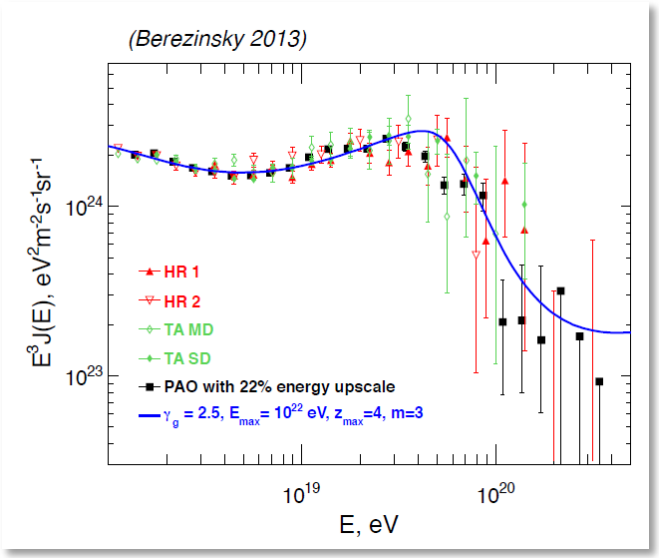


The UHECR puzzle

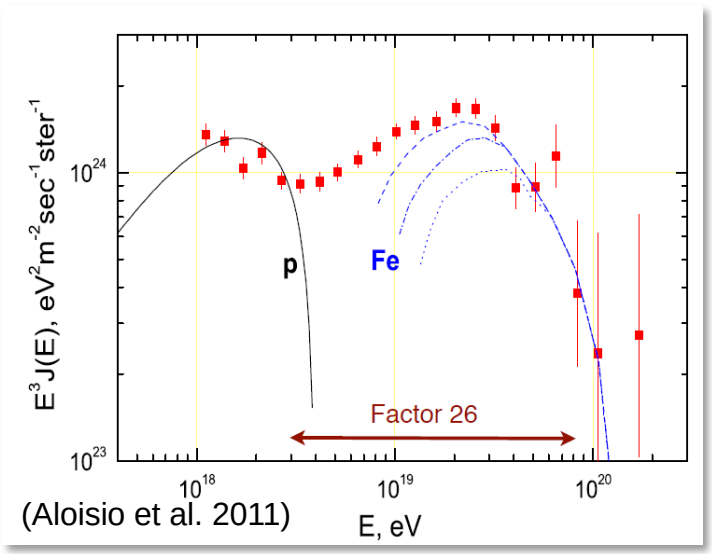


Spectrum: implications

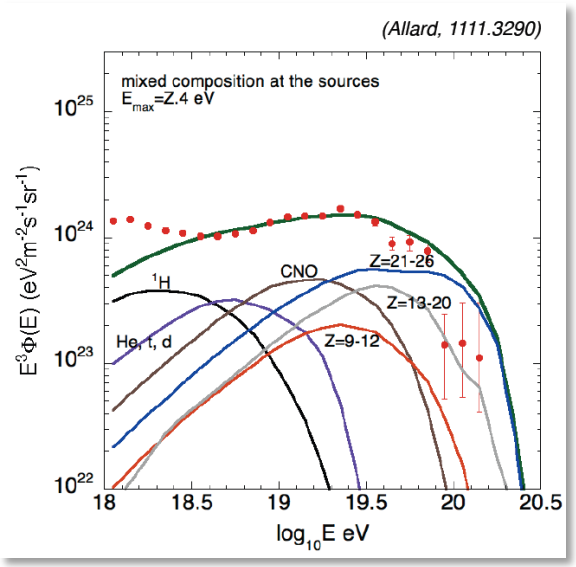
Suppression established ($E > 4 \cdot 10^{19}$ eV)
Ankle observed at about $4 \cdot 10^{18}$ eV



- ✓UHECR are Protons
- ✓GZK effect produce the cut off
- ✓Natural explanation for the ankle



- ✓UHECR Rigidity dependent composition of Extragalactic origin
- ✓GZK effect not needed
- ✓ Transition from galactic to extragalactic at lower energy (2nd knee)



- ✓UHECR Mixed composition at the sources (Extragalactic origin)
- ✓GZK effect but for Heavy Elements
- ✓ Ankle due to transition between Galactic and Extragalactic spectrum.

Do not resolve between different scenario.
Also the galactic origin is not excluded.

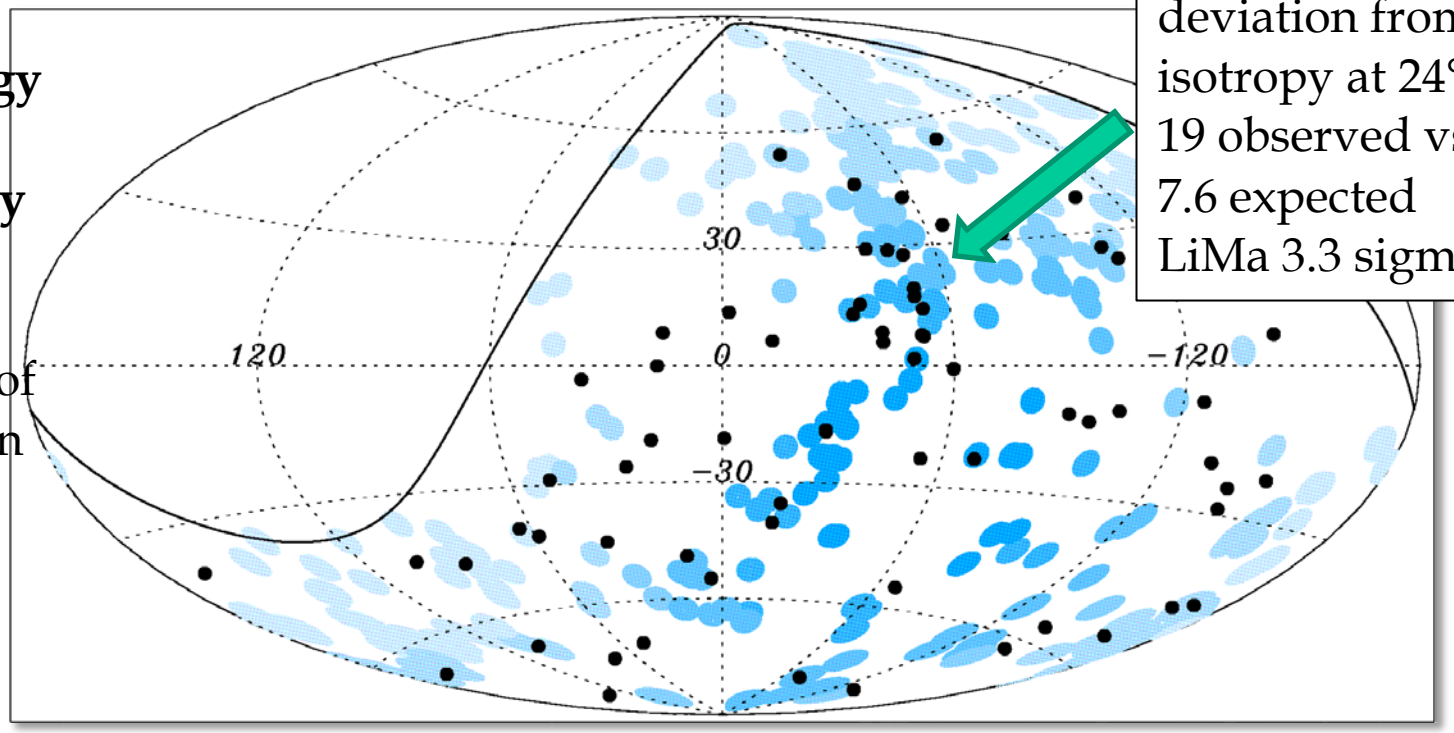
Anisotropy

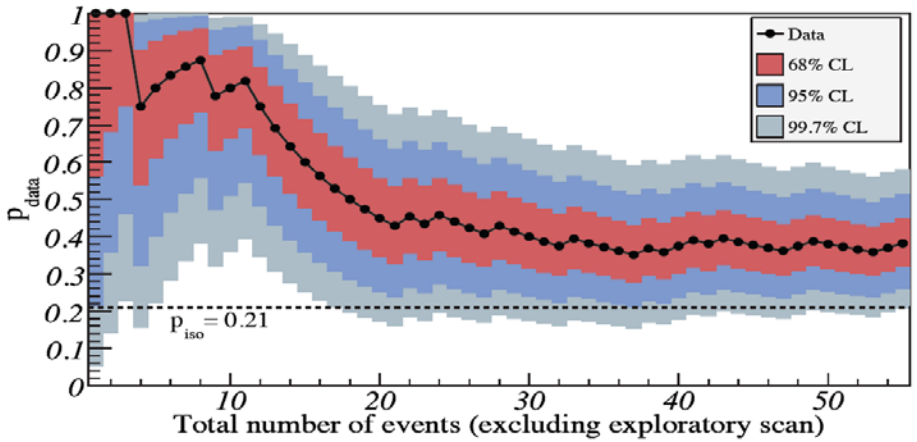
Astropart. Phys. 34 (2010) 314

CenA: Maximum deviation from isotropy at 24°
19 observed vs 7.6 expected
LiMa 3.3 sigma

The 69 events with Energy > 55 EeV detected by the Pierre Auger Observatory

Blue circles of radius 3.1° centered at the positions of the 318 AGNs < 75 Mpc in the VCV catalog.

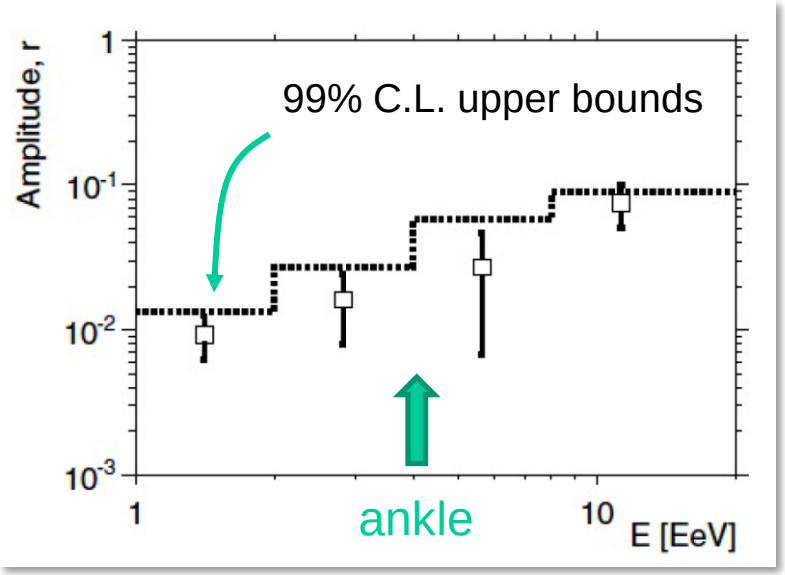




The exposure weighted fraction of the sky covered by the blue circles is 21%.
Chance probability for a isotropic source distribution < 1%

TA results can not exclude this conclusions

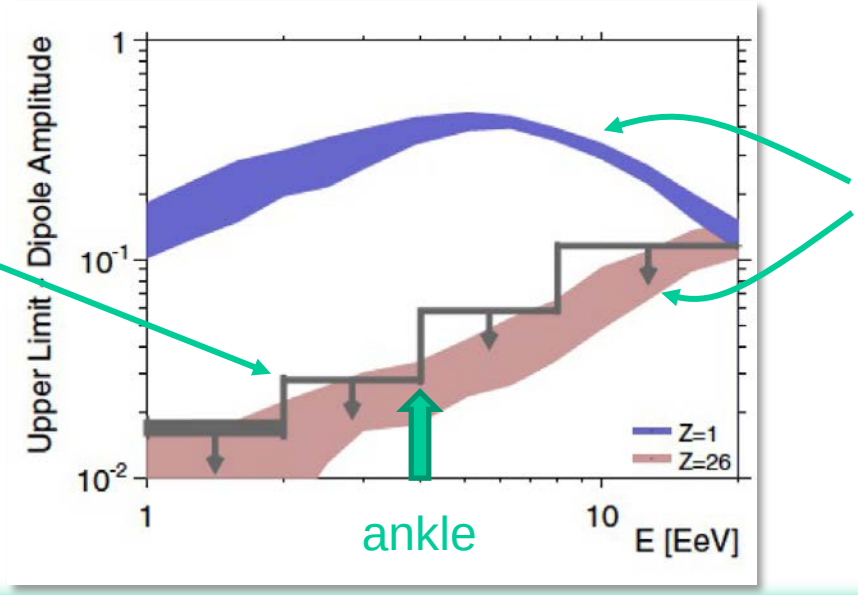
Anisotropy



Above 1 EeV anisotropies could be imprinted in the distribution of arrival directions as the result of the escape of UHECRs from the Galaxy up to the ankle energy.

If UHECRs have already a predominant extragalactic origin their angular distribution is expected to be isotropic to a high level.

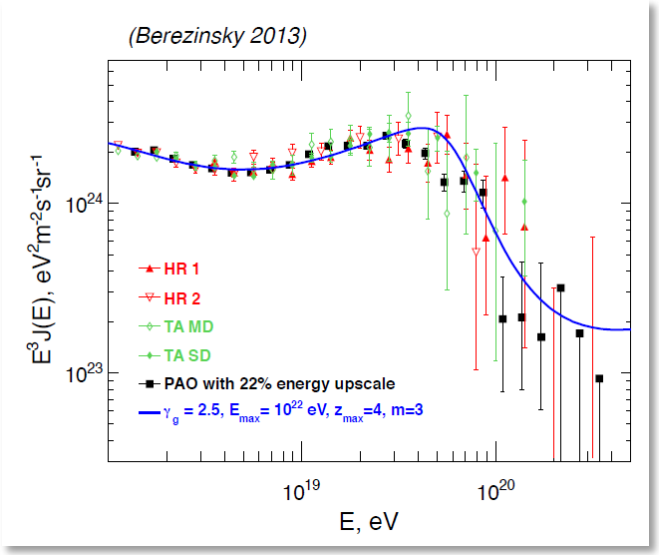
99% C.L. upper limits

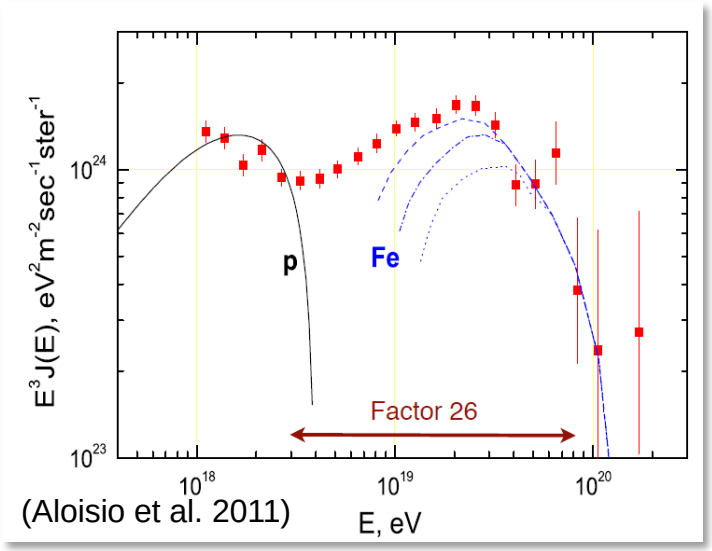


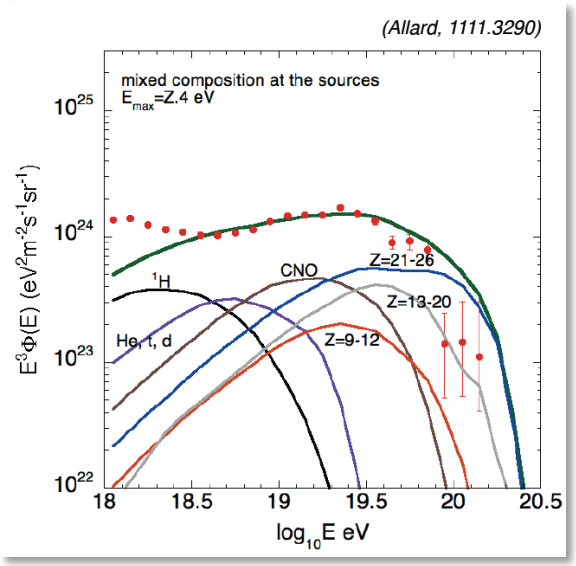
Model prediction for an uniform distribution of sources in the galaxy and different compositions

Anisotropy: implications

The degree of correlation with VCV catalog is stable (about 33%)
Definitive conclusions must await additional data
No neutron sources (constrain on galactic origin)
Lower energy events, if protons, has to be extragalactic







✓ Explain the missing anisotropy below the ankle.
✓ Require a stronger correlation with the extragalactic mass distribution.

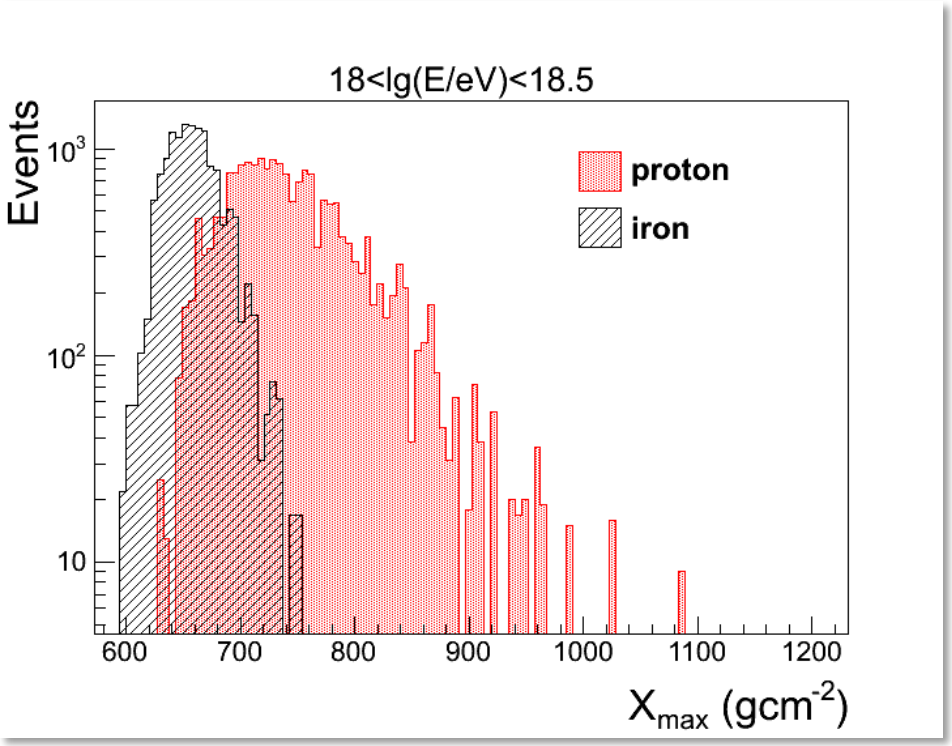
✓ Not totally explain the still present correlation with the distribution of the mass near our galaxy.
✓ Not in contradiction with the results of the other detectors.

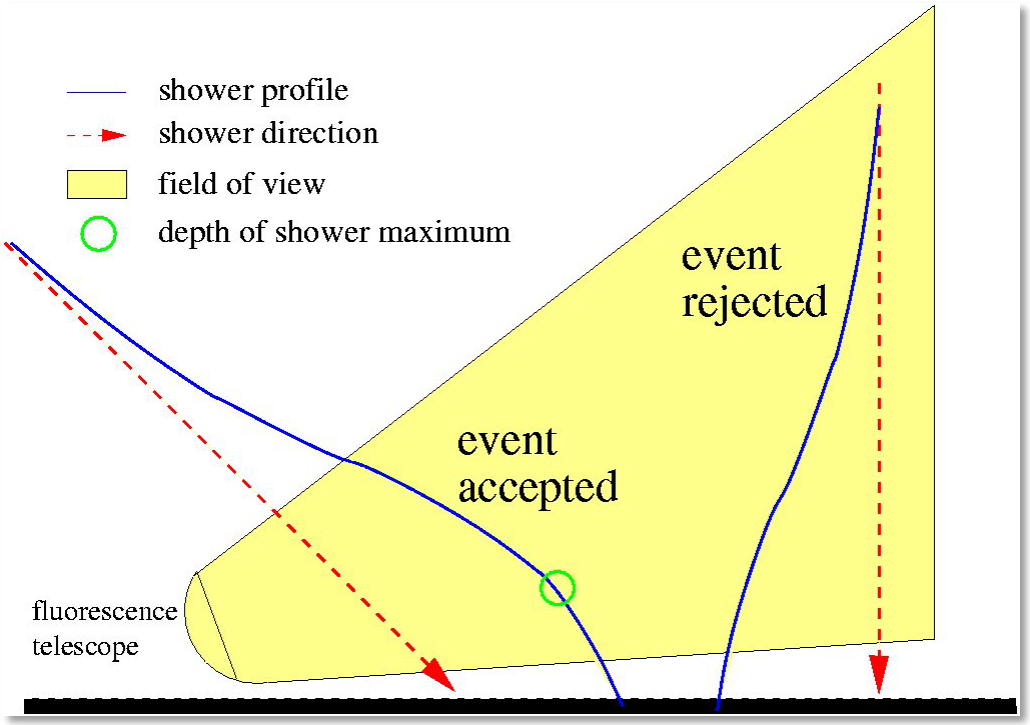
✓ Better explanation of the anisotropy at higher energy.
✓ Require a heavy galactic component at the ankle.

Mass Composition

The main instrument of analysis is the Fluorescence Detector, but also the Surface Array can be used.

See D. Boncioli next talk

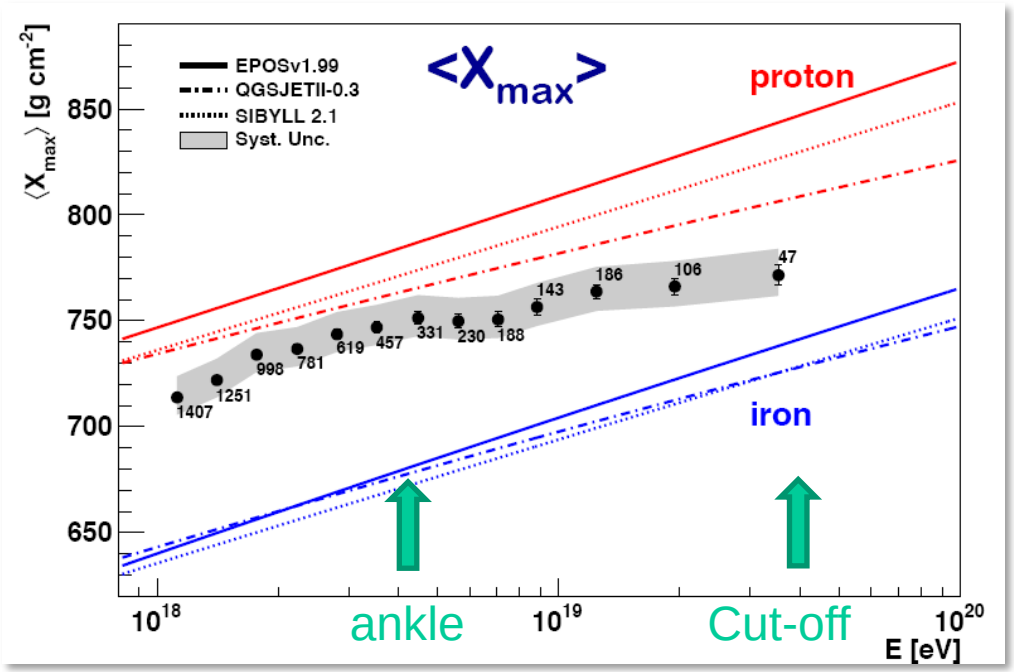


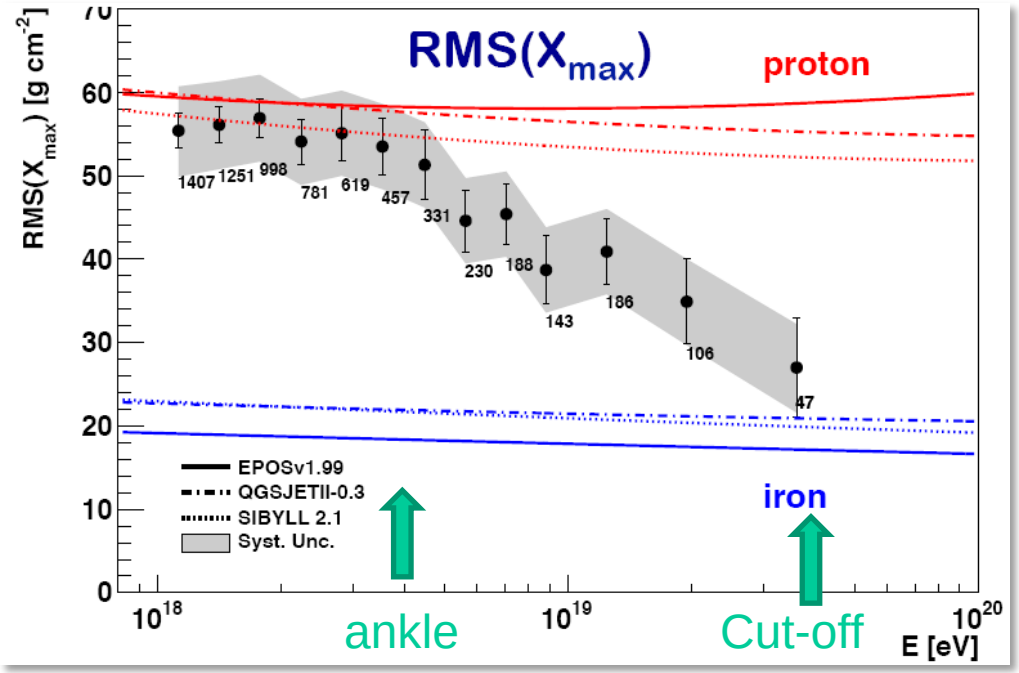


<X_{max}> and its RMS sensitive to mass composition
Key observables for composition studies

Filed of View and Anti-Bias cut used to obtain detector independent results

Mass Composition





Syst uncertainty < 13 g cm^{-2}
X_{max} resolution ~ 20 g cm^{-2}

$<X_{max}>$ became lower with energy

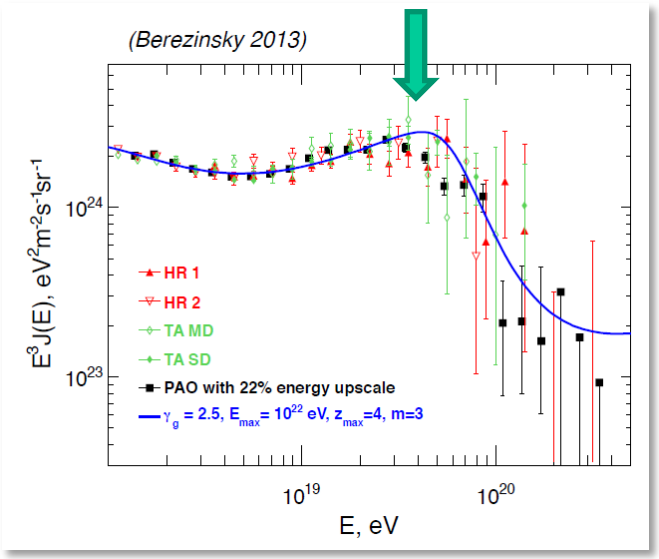
X_{max} distributions become narrower with energy

Increase of the mean mass with the energy? Inadequate interaction models?

Mass Composition: implications

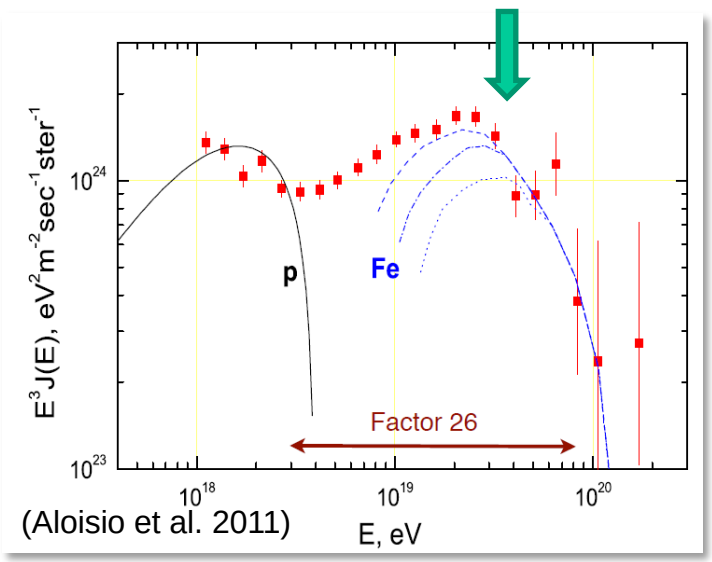
AUGER results:
Light dominated at low energies, heavier with increasing energy

E_{max} FD



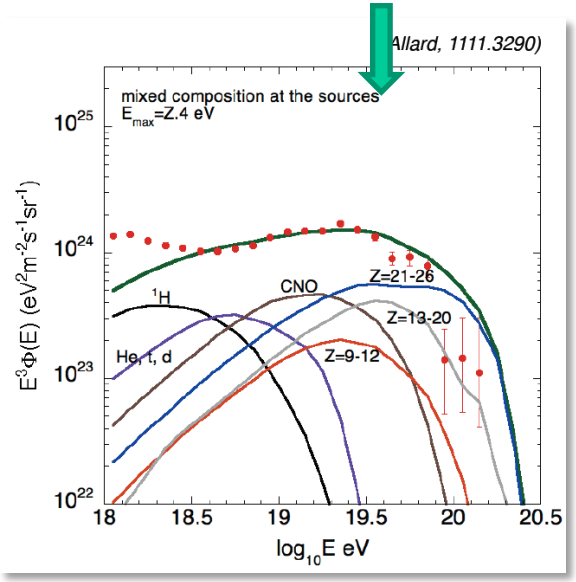
✓ AUGER Excluded? Still possible if new physics is responsible of the change in the $<X_{max}>$ and RMS(X_{max}) distributions.

E_{max} FD



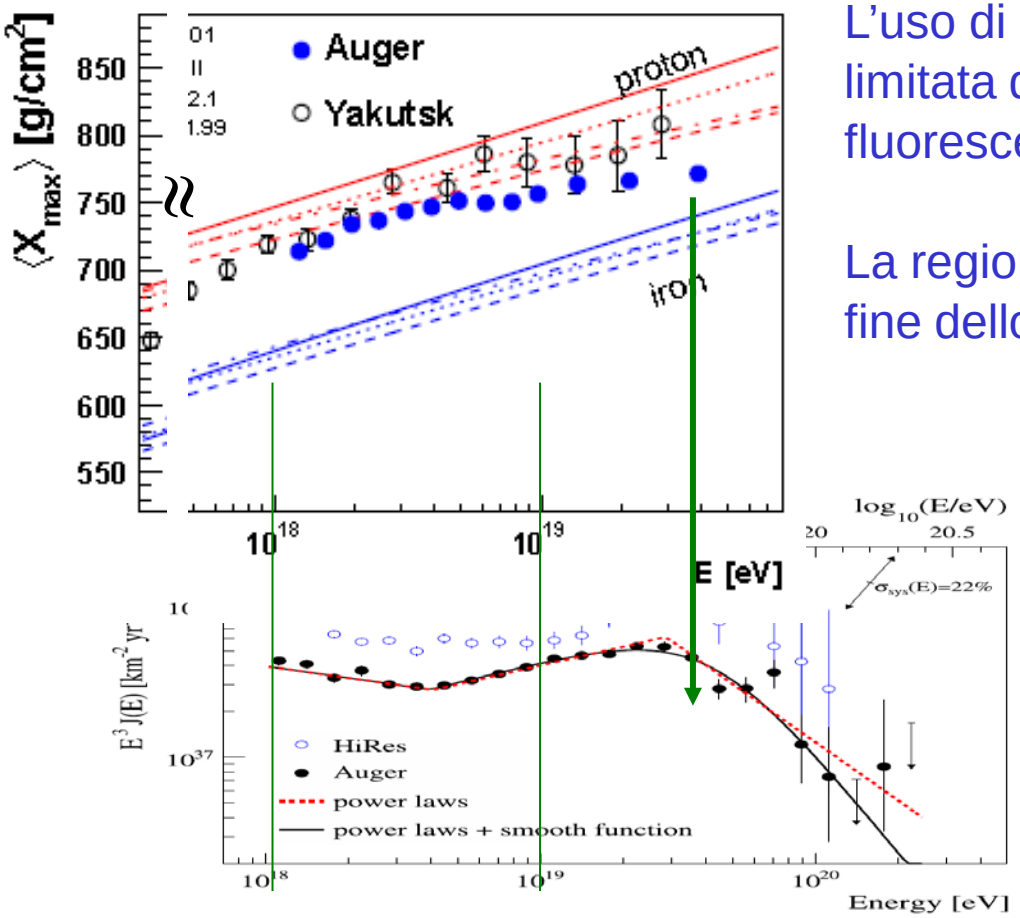
✓ Not in contradiction with Auger Mass Composition Data.

E_{max} FD



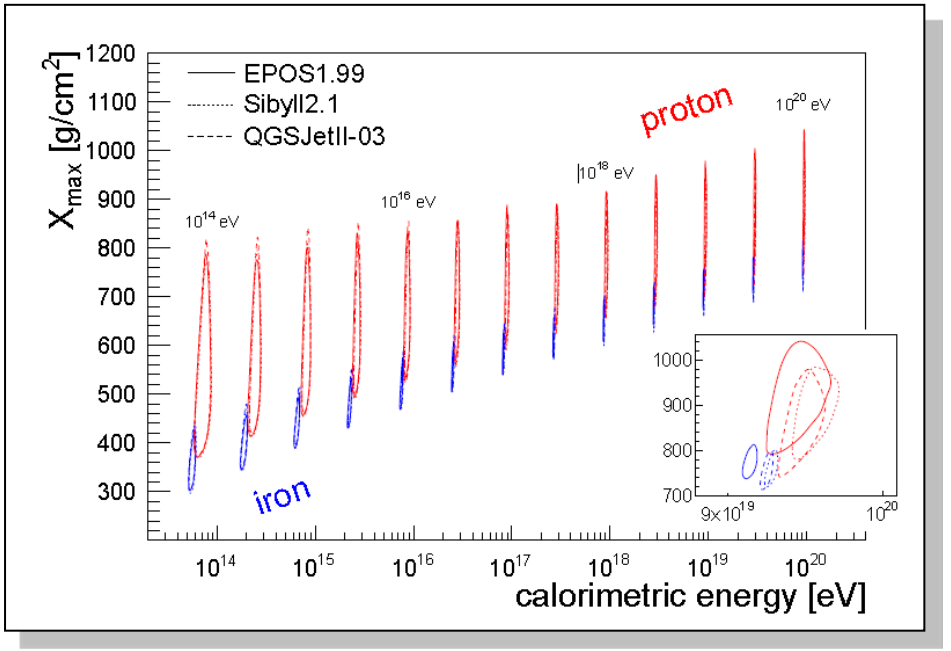
✓ Not in contradiction with Auger Mass Composition Data.

Determinazione della Composizione



L'uso di X_{max} per la discriminazione di massa è limitata dal Duty Cicle del rivelatore di fluorescenza (12-15%).

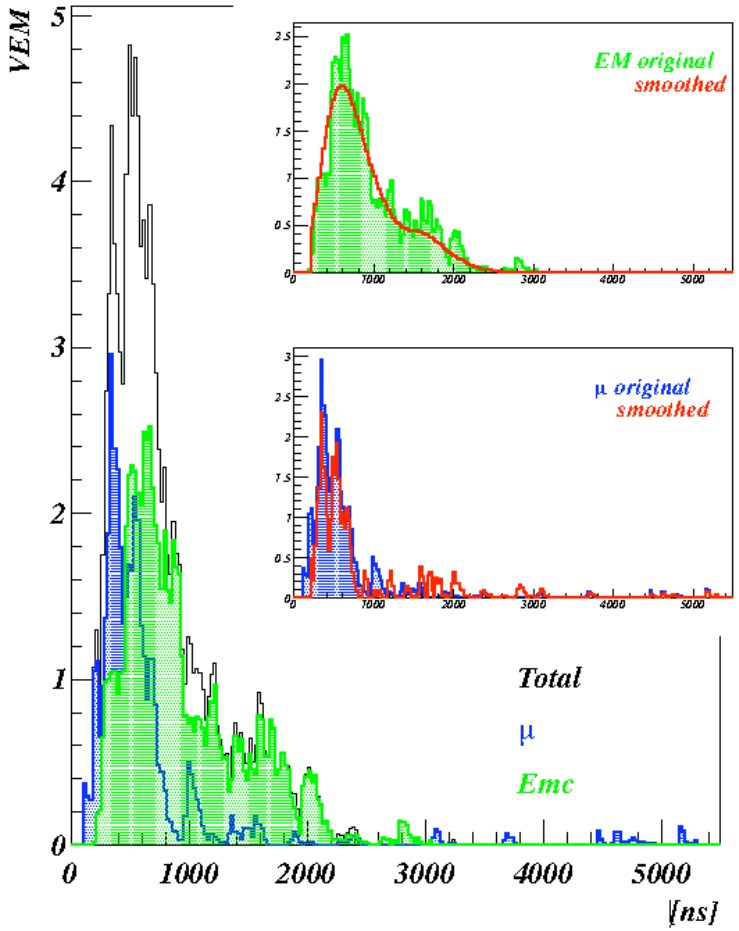
La regione interessante si estende sino alla fine dello spettro.



Il parametro X_{max} da solo "soffre" a causa delle significative fluttuazioni dovute prevalentemente alla fluttuazione del punto di prima interazione del primario che rendono più incerto lo studio della composizione sulla base del singolo evento.

Determinazione della Composizione

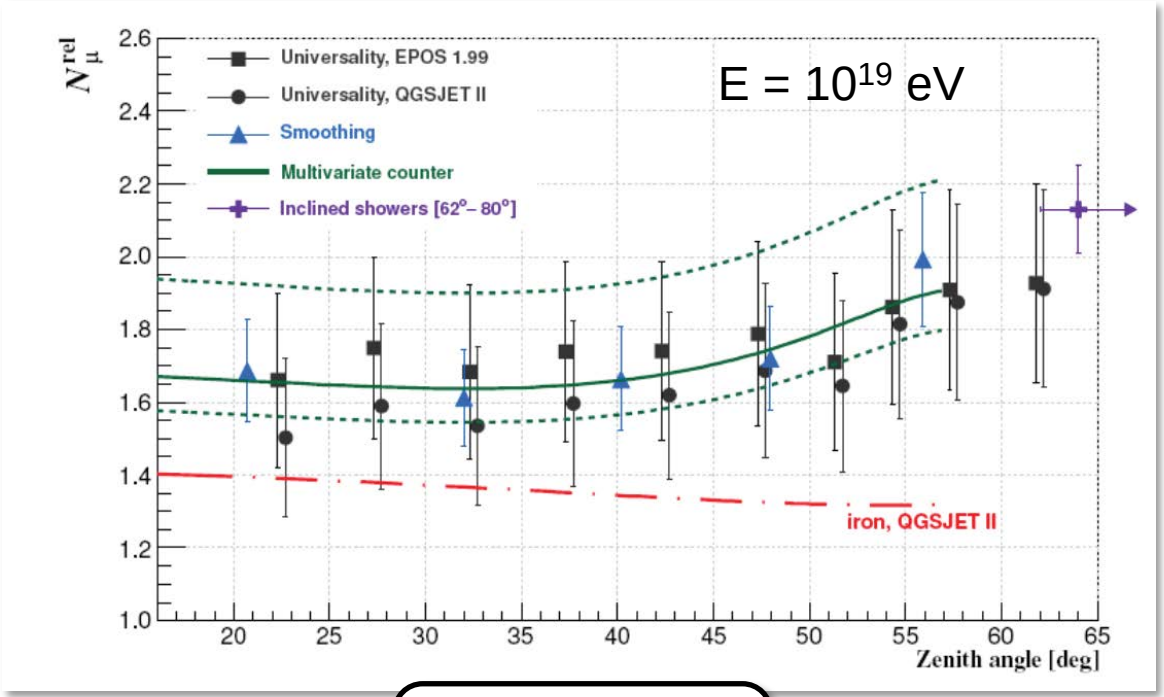
Cosa è in grado di fare AUGER SD



Gli attuali algoritmi di separazione della componente elettromagnetica dalla componente muonica negli sciami si basano sull'analisi della struttura del segnale nelle tank.

Sono state sviluppate differenti tecniche da gruppi indipendenti con risultati simili.

The muons puzzle



$$N_\mu^{rel} = \frac{N_\mu^{Data}}{N_\mu^{QGSJET_{proton}}}$$

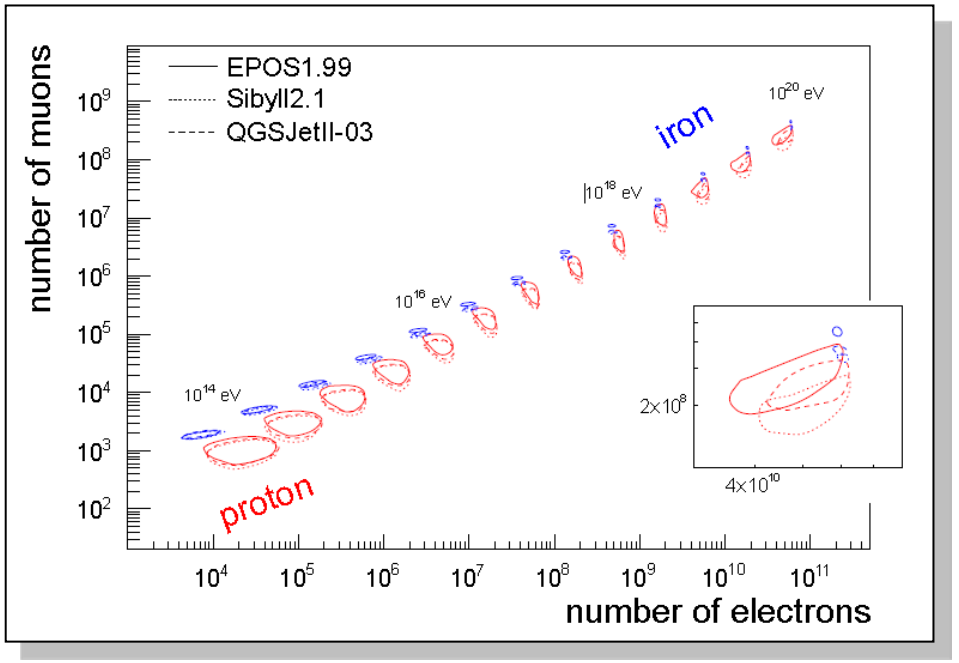
Measure Muon shower content by four methods

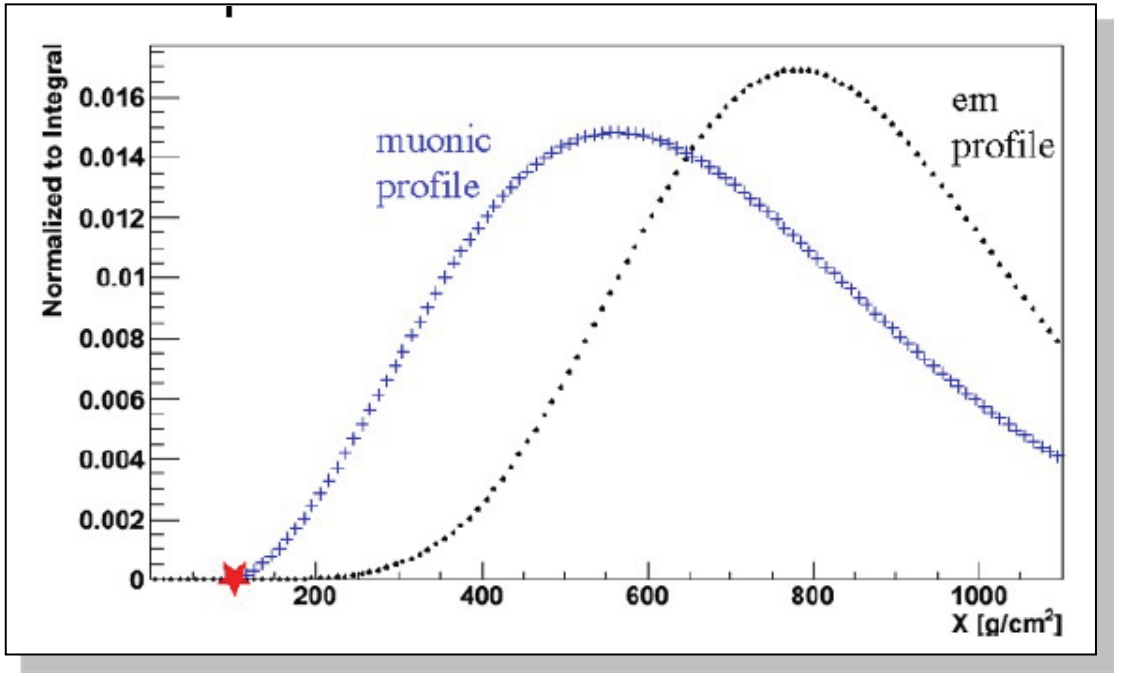
- ✓Smoothing
  - Smoothing filter over traces
  - $S_\mu = S_{tot} - S_{em}$
- ✓Multivariate muon counter
  - Neural Network prediction of N_μ at each tank
- ✓Inclined showers
  - Shower size N_{19} α N_μ
- ✓Shower Universality

The determination of the muons signal in Auger detector is indirect. Current results show a disagreement between the data and the Monte Carlo predictions.

Inadequate interaction models? New Physics?

Determinazione della Composizione





La determinazione del contenuto di muoni in uno sciame può migliorare la capacità di identificare la massa del primario sulla base del singolo evento. Ma può anche:

1) Identificare il punto di prima interazione (sezione d'urto)
2) Migliorare la capacità di identificare sciami da neutrino e da fotone
3) Studiare i processi di interazione

UHECR: What next?

AUGER and ground based detectors

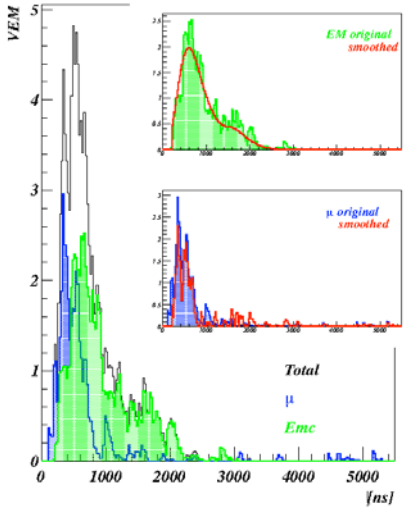
Goal: identify the primary cosmic ray nature at the highest energy
→ investigate the interaction properties more deeply

Upgrade: Muons identification with SD detectors

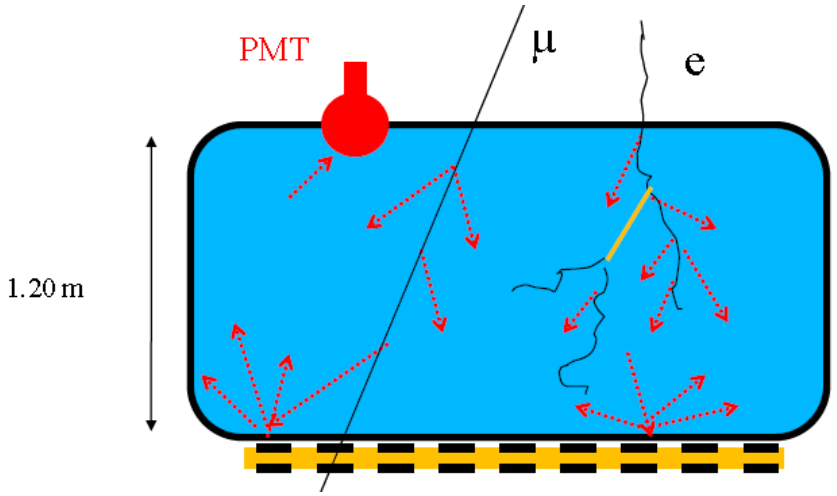
JEM-EUSO

Goal: identify sources and/or help in anisotropy analysis

The AUGER upgrade Proposal

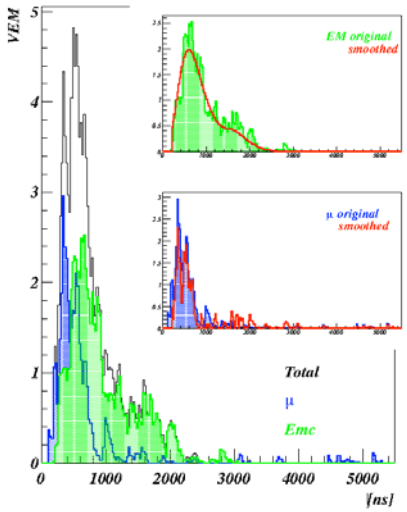


Migliorare quello che si è già sviluppato.

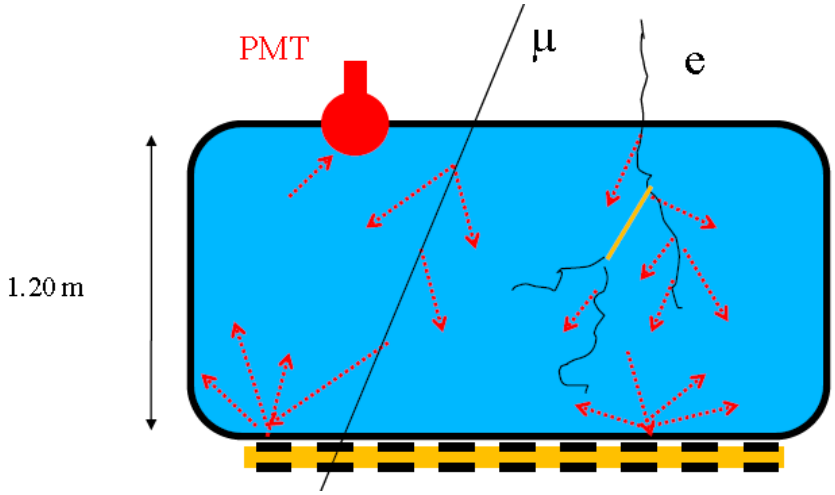


Modificare il rivelatore o aggiungerne un altro per separare la componente muonica da quella elettromagnetica.

The AUGER upgrade Proposal



Migliorare quello che si è già sviluppato.



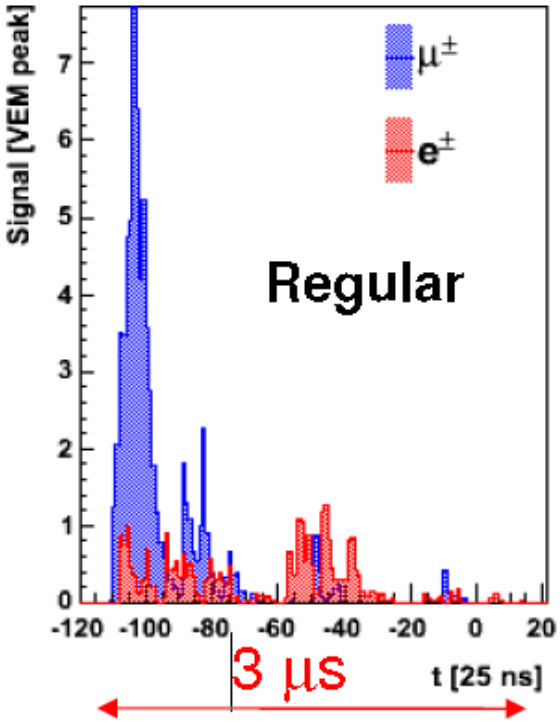
Modificare il rivelatore o aggiungerne un altro per separare la componente muonica da quella elettromagnetica.

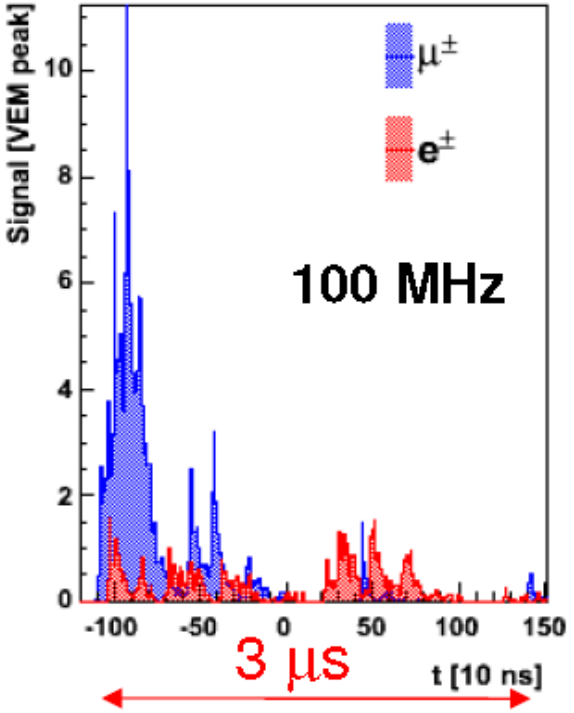
Determinazione della Composizione

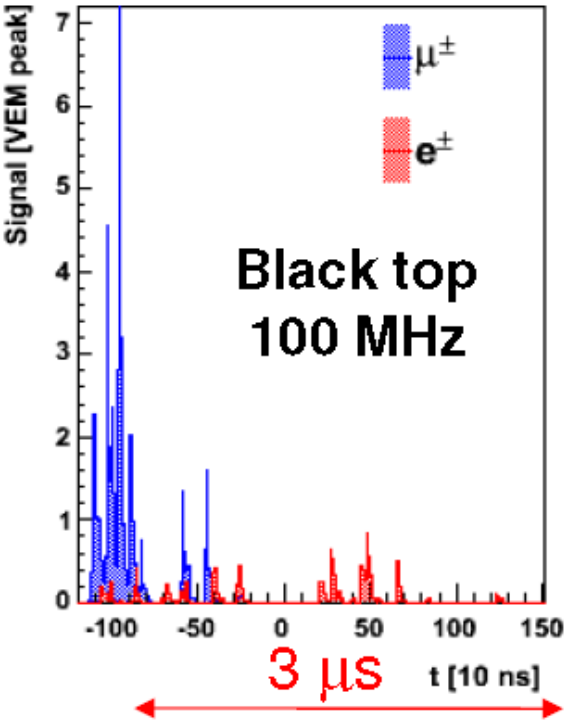
Come migliorare

45°, 12 EeV, 900 m from axis

L. Perrone





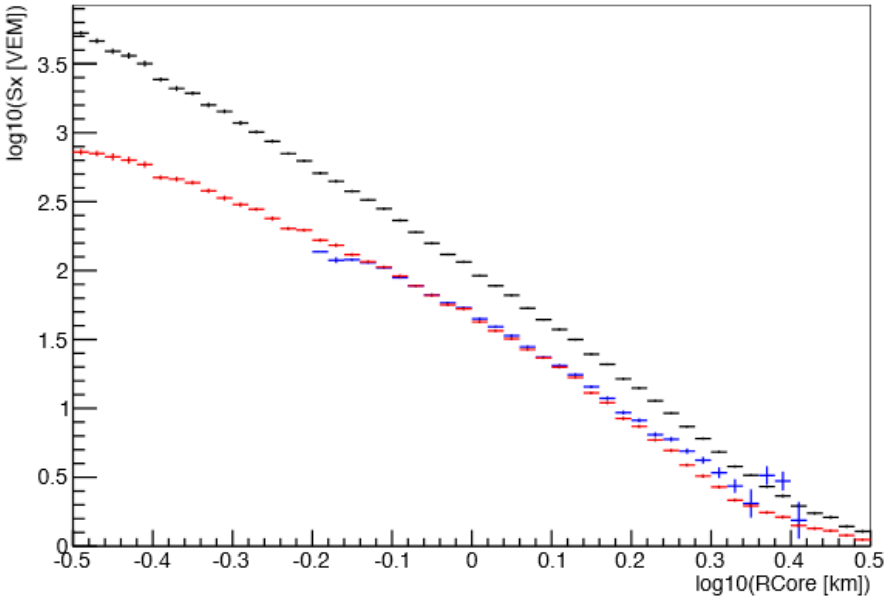


L'aumento della frequenza di campionamento migliora la capacità di identificare strutture nel segnale.

La riduzione della riflettività della parete superiore mette in evidenza il segnale dovuto alla componente muonica.

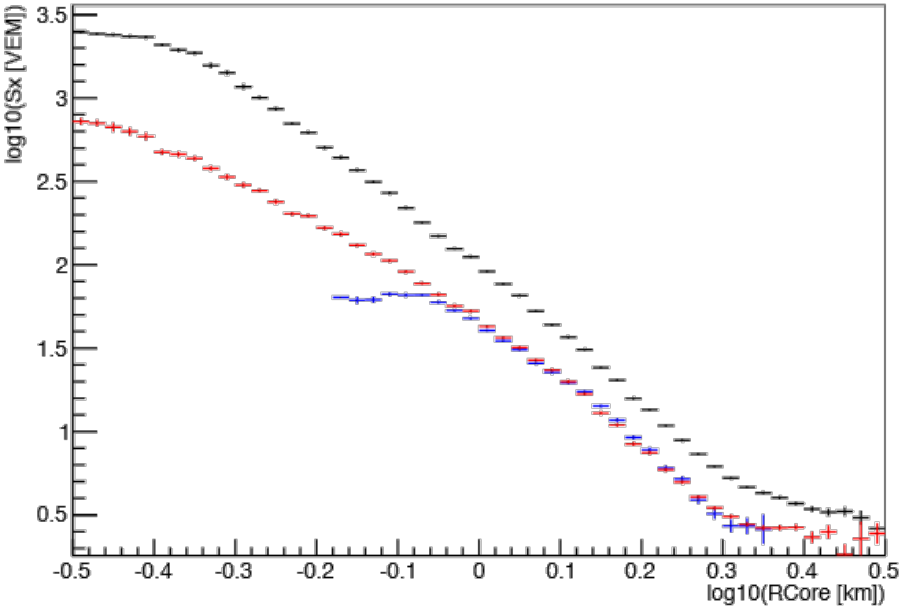
Determinazione della Composizione

Come migliorare



Zenith = 23°
Energy = 1019.5 eV
Primary = proton
Red S_μ^{simu}
Blue S_μ^{rec}
Black S_{tot}

120 MHz FADC

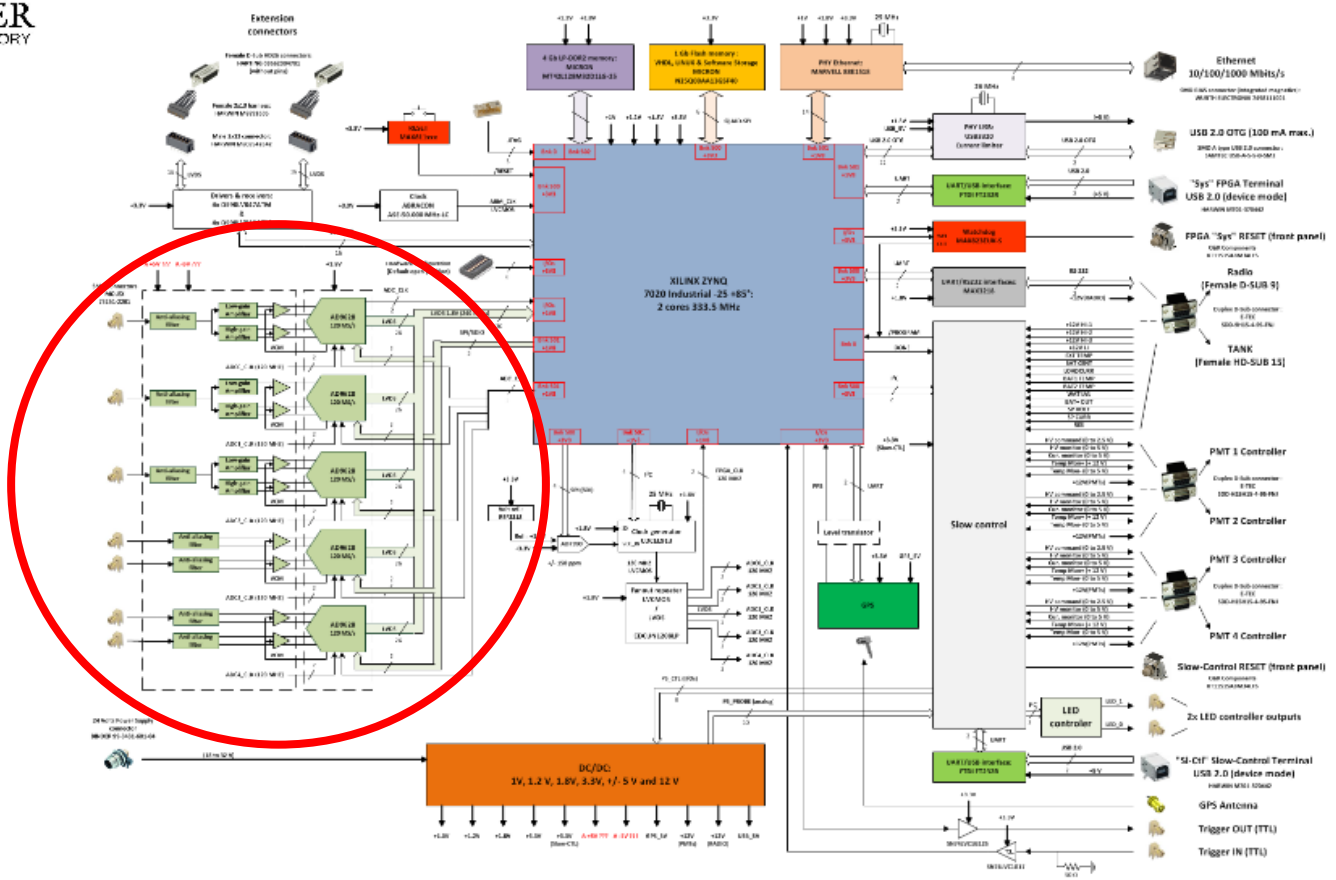


40 MHz FADC

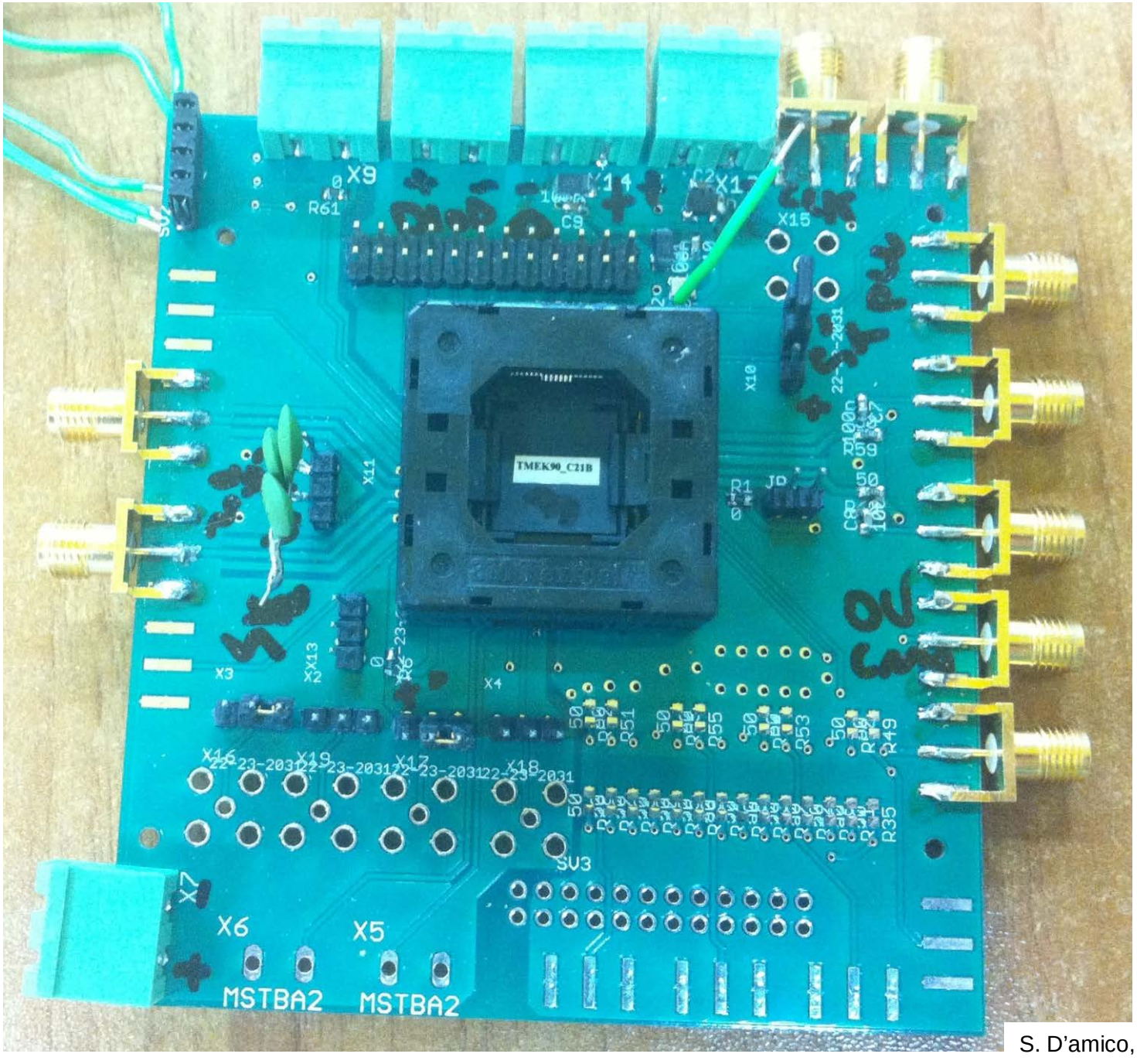
Faster electronics and extended dynamic range

PIERRE AUGER OBSERVATORY

UUB Block Diagram

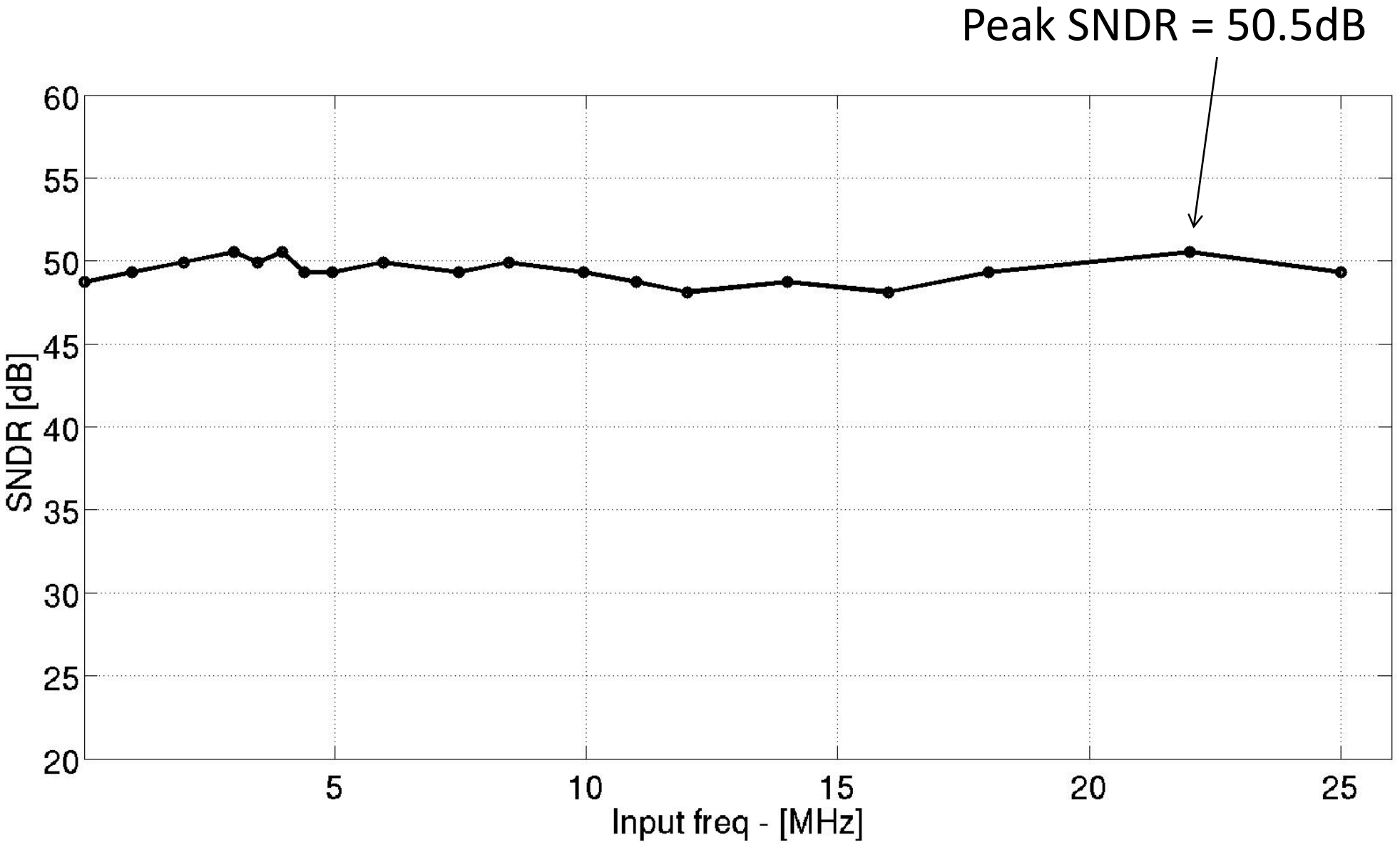


Chip measurement setup: details



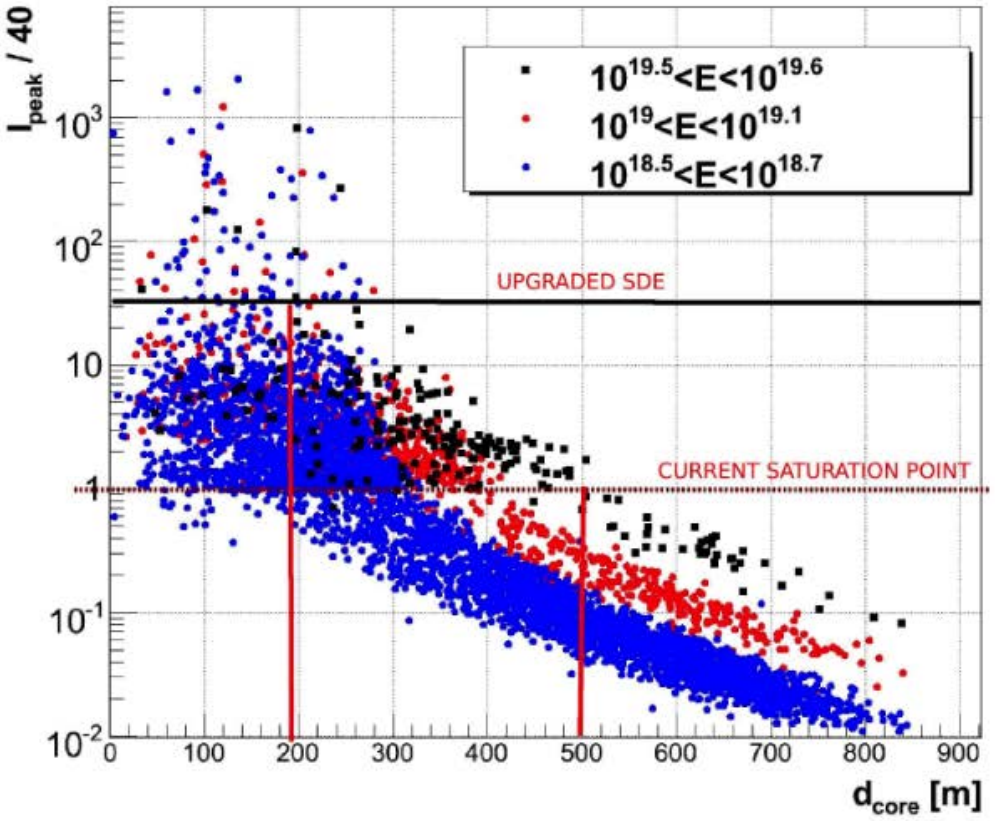
S. D'amico, G. Cocciolo, A. Donno

SNDR vs Input Frequency

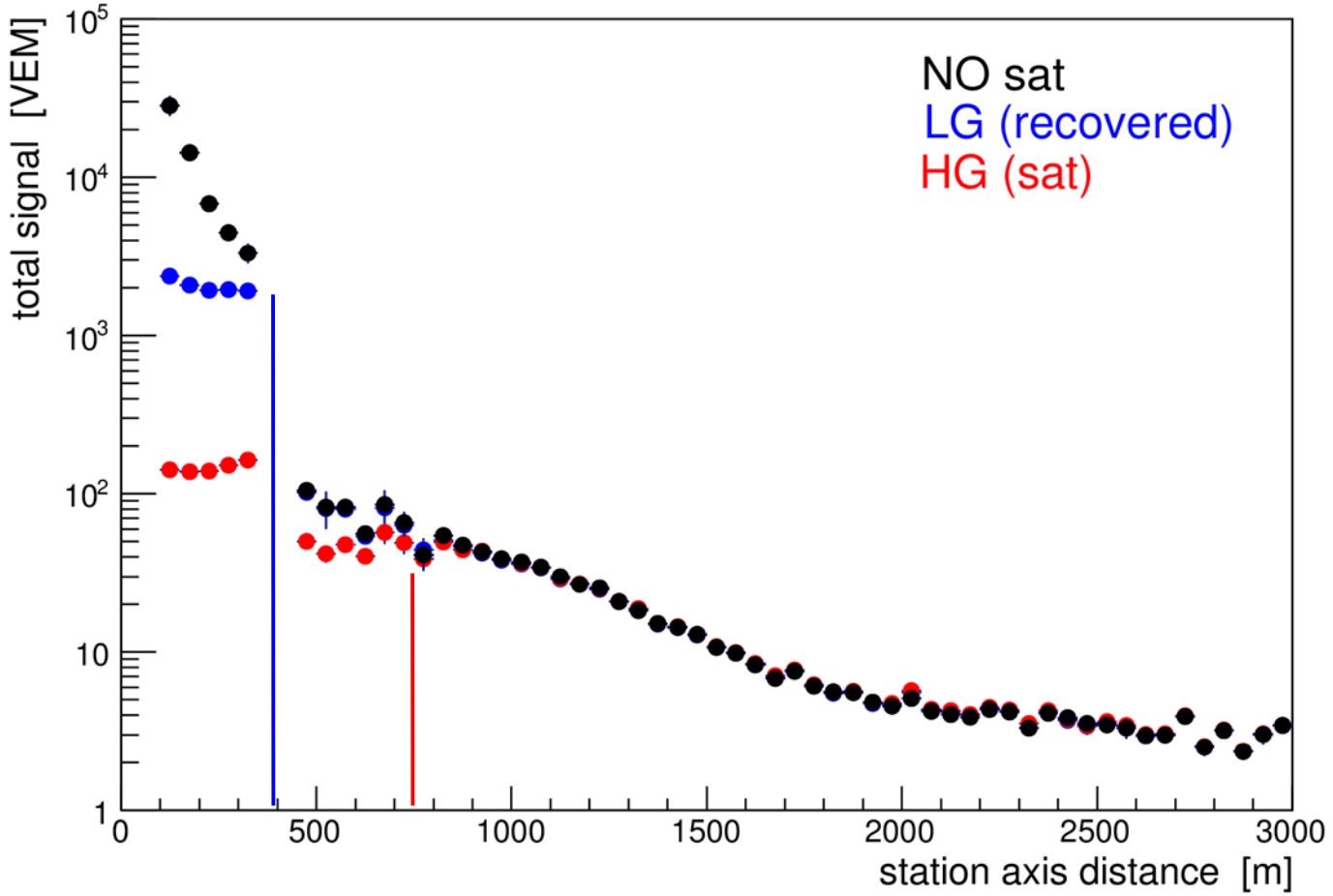


Faster electronics and extended dynamic range

Saturation & Dynamic Range



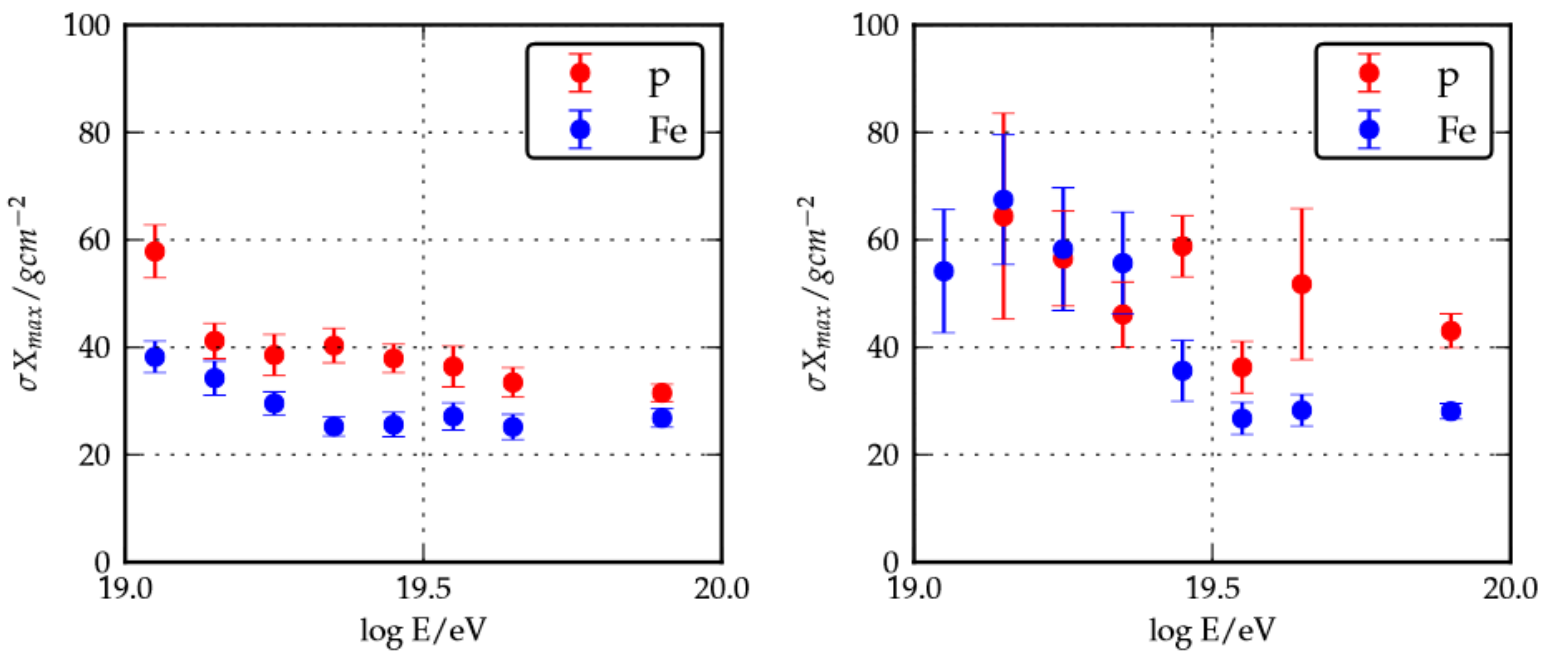
Total signal as a function of distance



Factor 10 in signal moving from 300 to 100 meters from axis

Faster electronics and extended dynamic range

Universality: Xmax Resolution



Without saturated stations

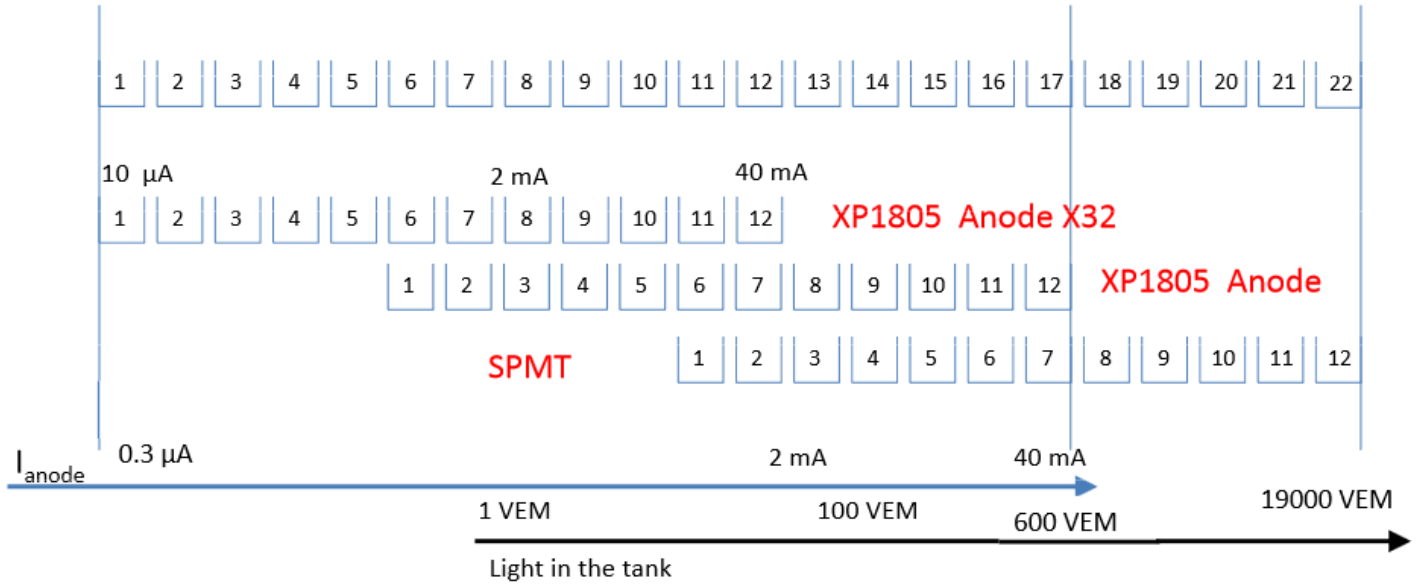
With saturated stations

- $\approx 30\%$ improvement in X_{max} resolution in universality analysis from increased dynamic range

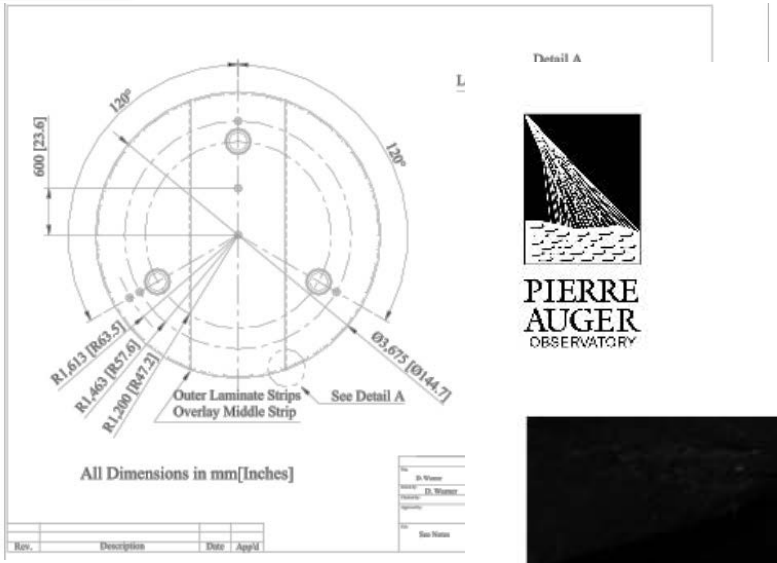
Faster electronics and extended dynamic range

PIERRE AUGER OBSERVATORY

Gain Scheme including Small PMT



Faster electronics and extended dynamic range



PIERRE AUGER OBSERVATORY

Small PMT test @ Malargue

- Hamamatzu R9065
28mm diameter
2% non linearity up to 80mA

- installed in the spare LED window (Didi Tank)

- photocatode area ratio

$$\frac{S^{XP1805}}{S^{R6095}} \sim 75$$

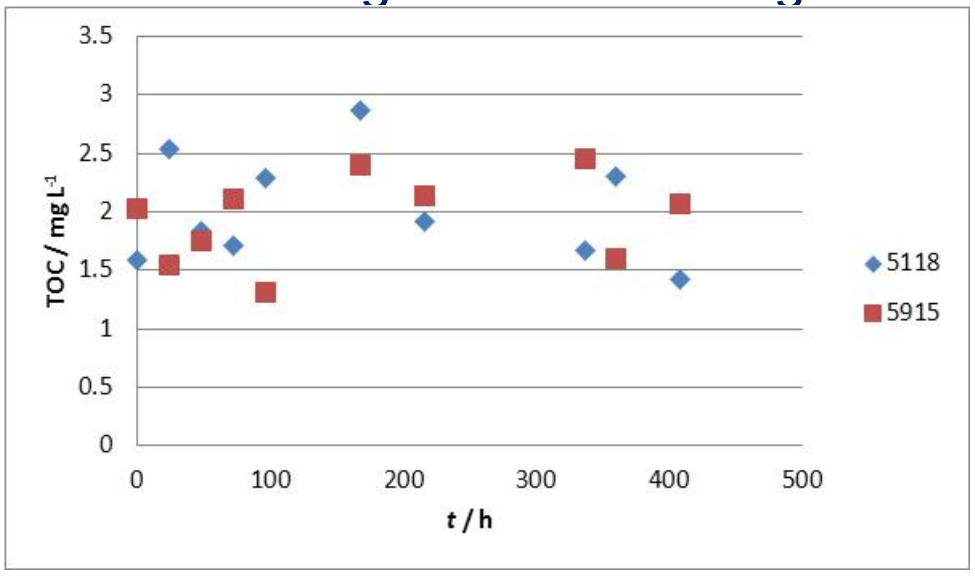
- High voltage from a separate module

- acquired by UB in place of dynode of PMT 3

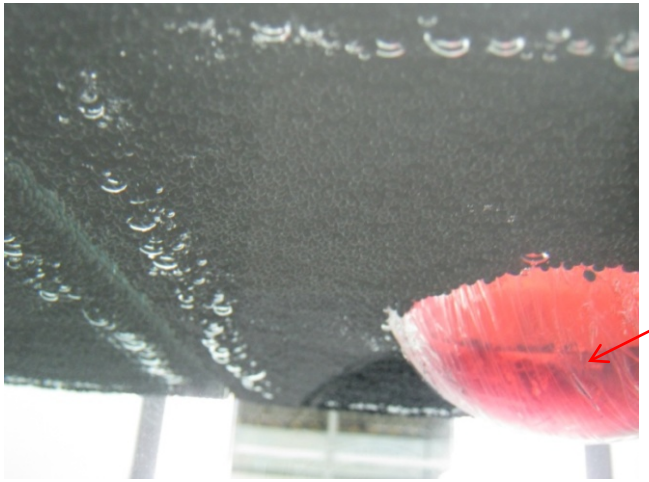
Auger Tank Black-Top

Test effettuati con sferette di Polipropilene (JSP-ARPRO

- Test su diversi campioni (≠ densità, ≠ dimensione
- Test di stabilità elettrostatica **LECCE**
- Test chimici
- Test di aging
- Test congelamento/scongelamento **LECCE**



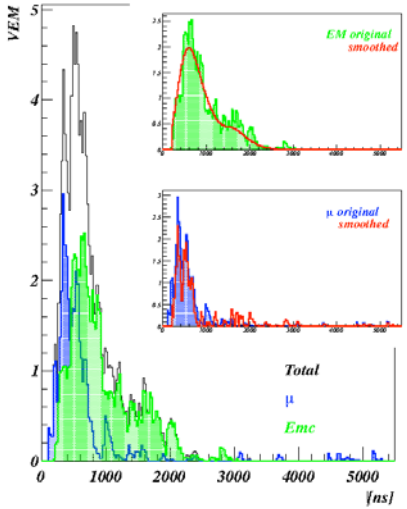
Aging test @ 80 oC per 2 campioni con densitàdiverse



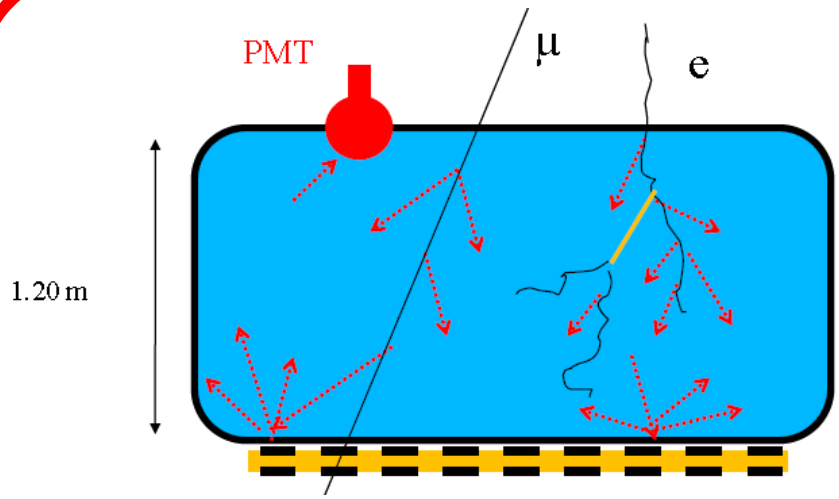
Emulazione punto di calore

G. Cataldi R. Coluccia

The AUGER upgrade Proposal

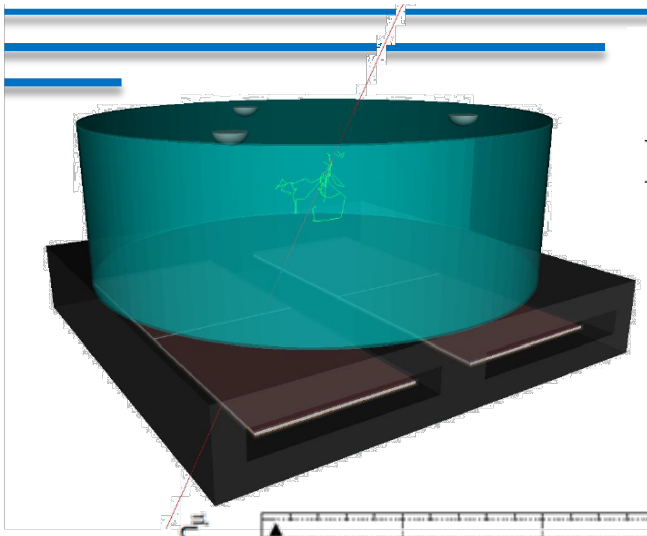


Migliorare quello che si è già sviluppato.

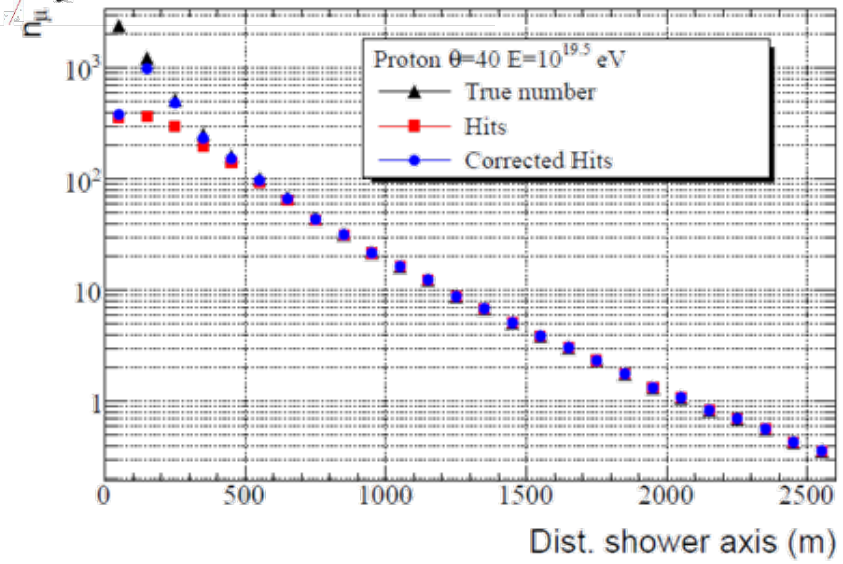


Modificare il rivelatore o aggiungerne un altro per separare la componente muonica da quella elettromagnetica.

New detectors



MARTA
Muon Auger RPC for the Tank Array
Design Report



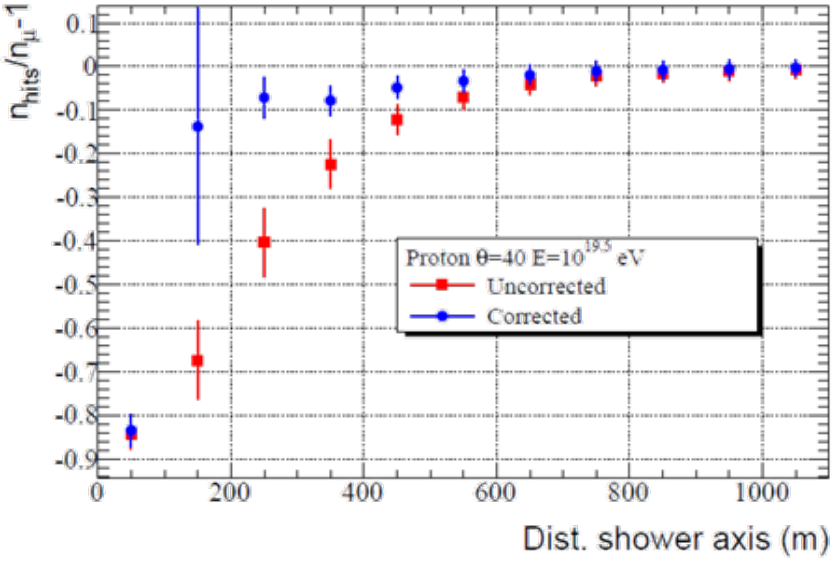
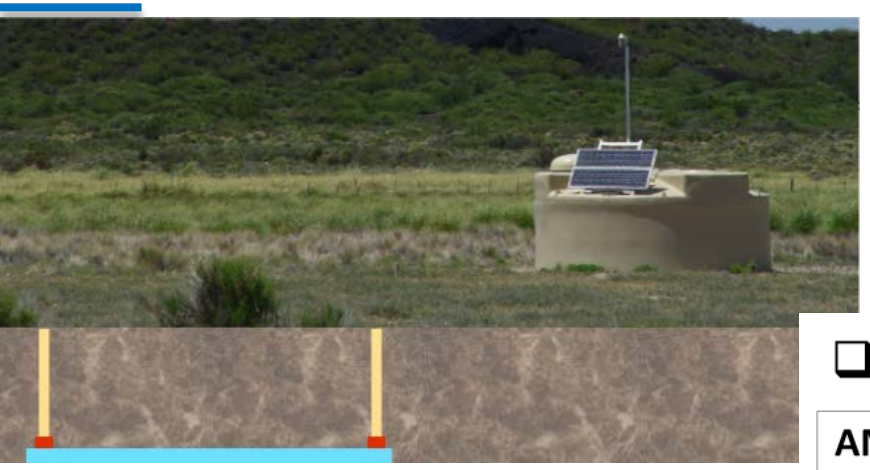


Figure 6: Left: Average true, uncorrected and corrected number of muons as a function of the distance to the shower axis for the MARTA baseline configuration (256 pads of 15×20 cm^2), for a $10^{19.5}$ eV proton at 40°. Right: The corresponding bias and RMS (given by the error bars).

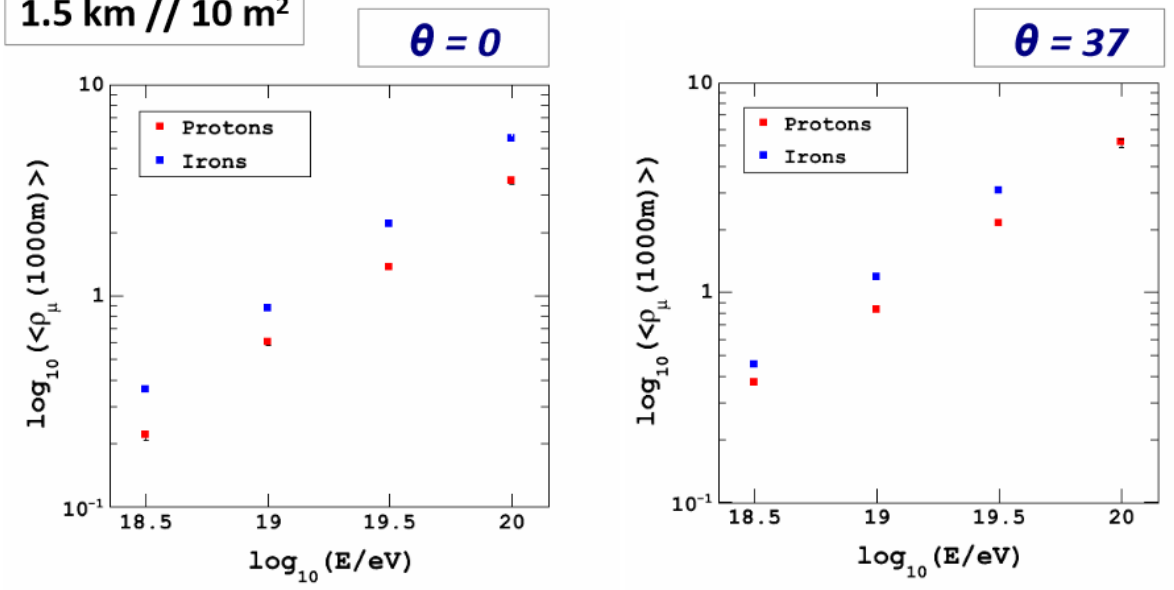
New detectors



AMIGA GRANDE

❑ **COMPOSITION SENSITIVITY, $<\rho_\mu>$ vs *E* for *p* and *Fe***

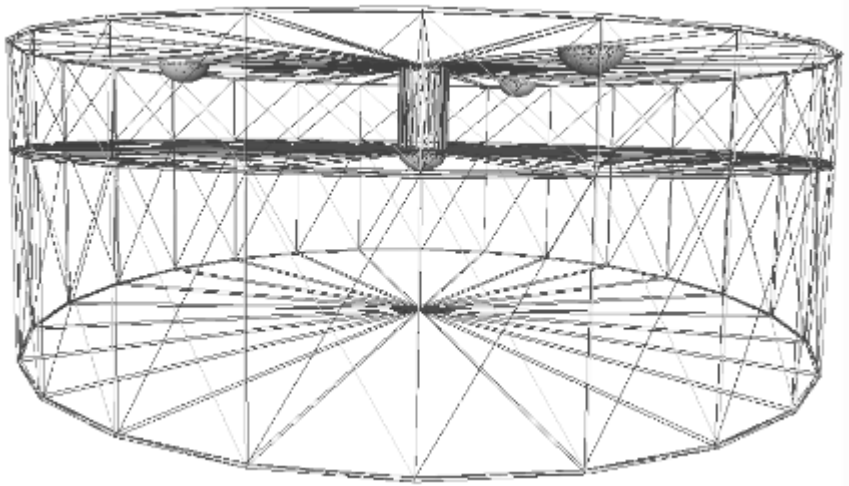
AMIGA-Grande
1.5 km // 10 m²



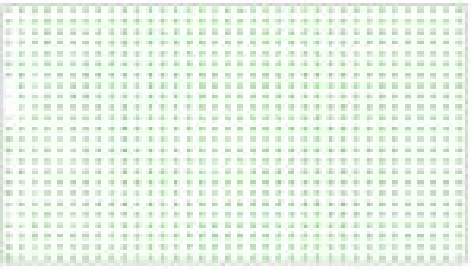
The MD array with spacing of 1.5 km provides an observable, $\rho_\mu(1000)$ which, as shown here, is sensitive to composition.

New detectors

PROPOSAL FOR A SEGMENTED WATER CHERENKOV ARRAY



Luce emessa da e.m.



Luce emessa da μ

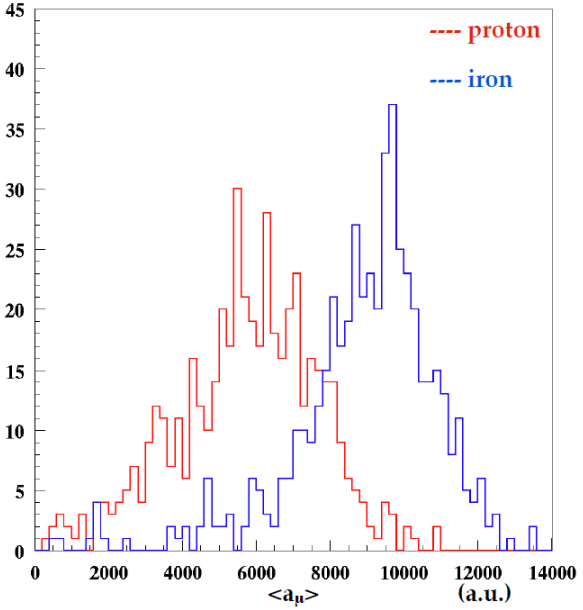
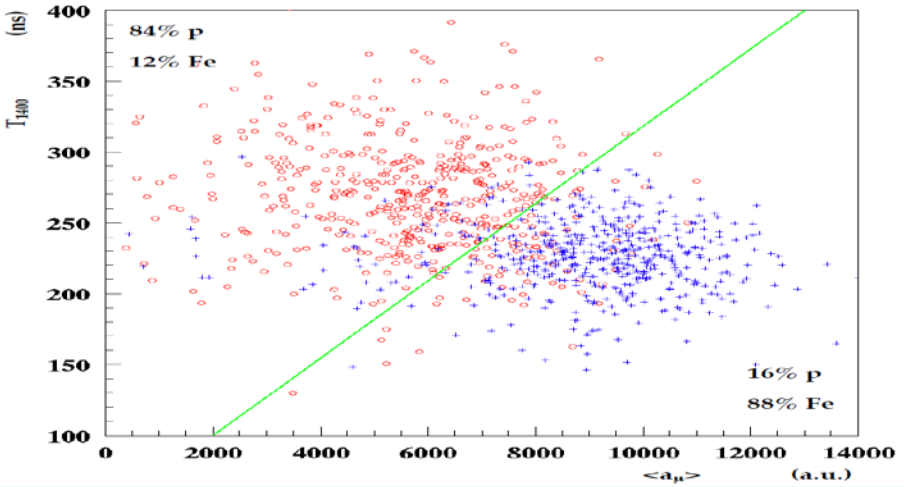
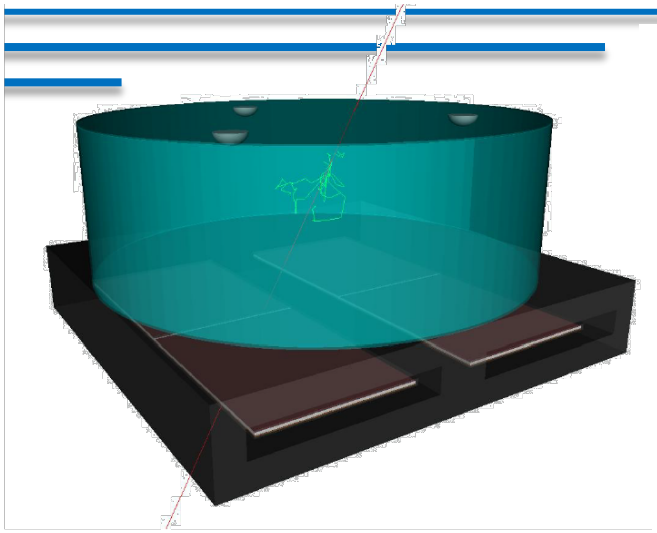


Figure 4: Reconstructed muon size (arbitrary units) for proton (red curve) and iron (blue curve). The resolution is about 30 and 15% respectively.

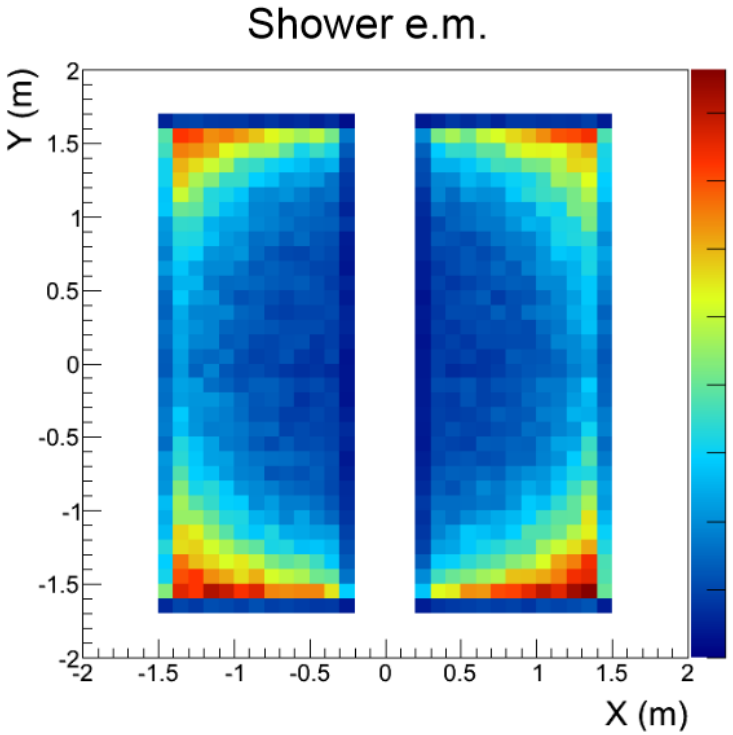
$$\begin{pmatrix} S_{top} \\ S_{bot} \end{pmatrix} = \begin{pmatrix} a & b \\ 1-a & 1-b \end{pmatrix} \begin{pmatrix} S_{em} \\ S_{\mu} \end{pmatrix}$$

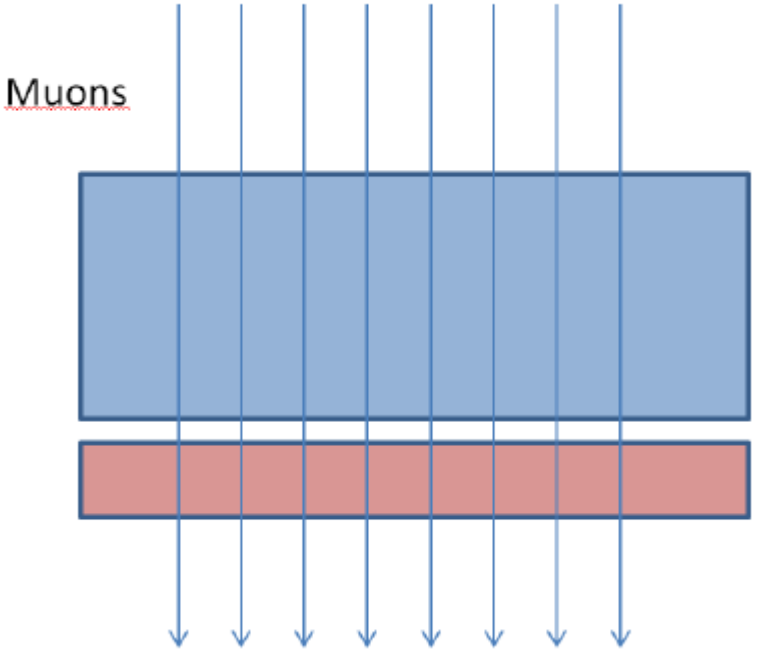


New detectors



A Plastic Muon Detector for Auger Beyond 2015 (the backup solution)

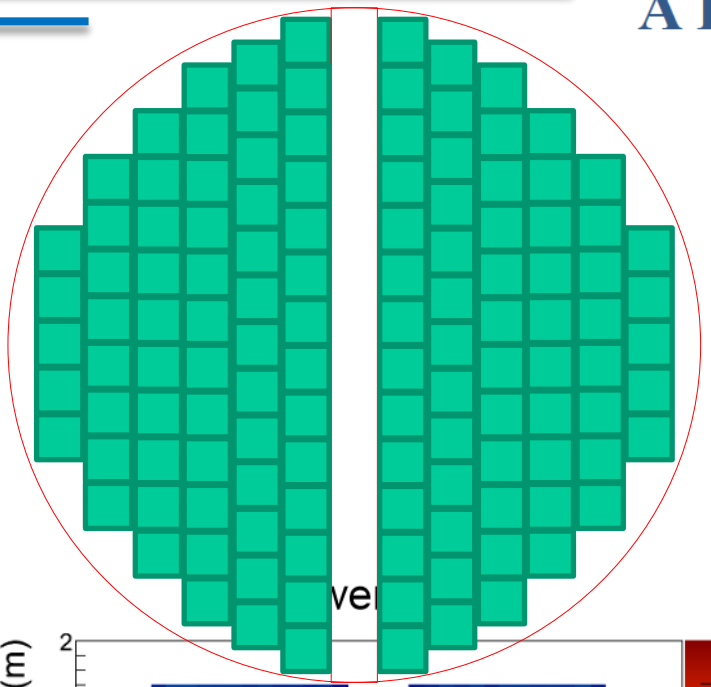


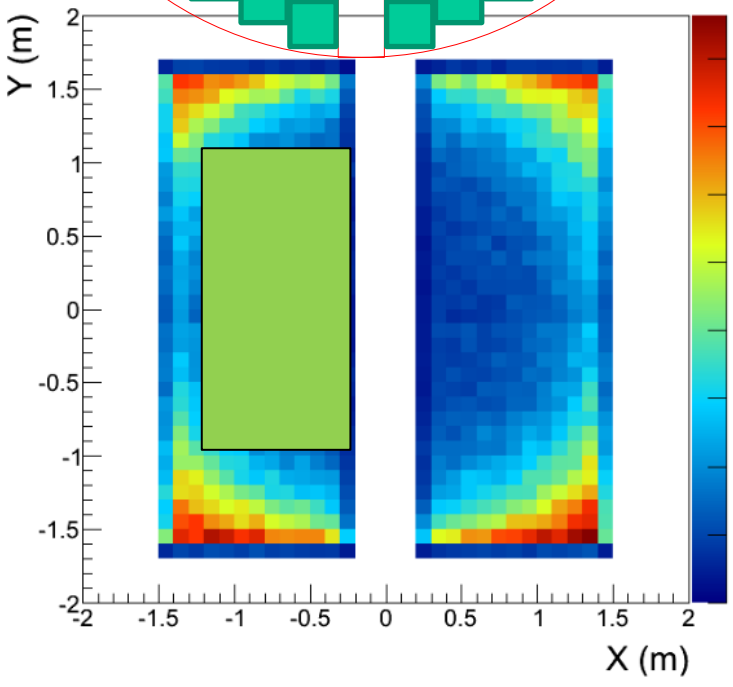


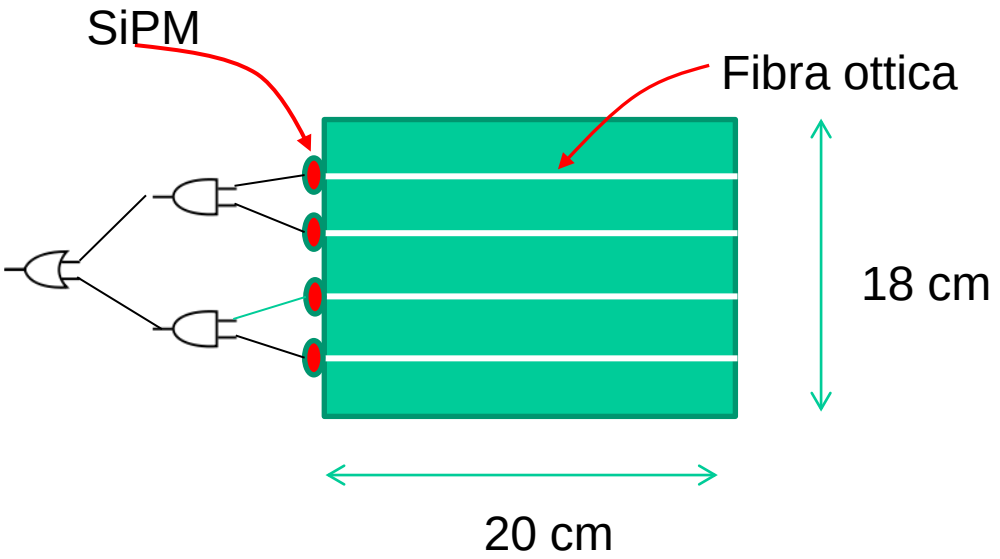
$$\begin{pmatrix} S_{top} \\ S_{bot} \end{pmatrix} = \begin{pmatrix} a & b \\ 1-a & 1-b \end{pmatrix} \begin{pmatrix} S_{em} \\ S_{\mu} \end{pmatrix}$$

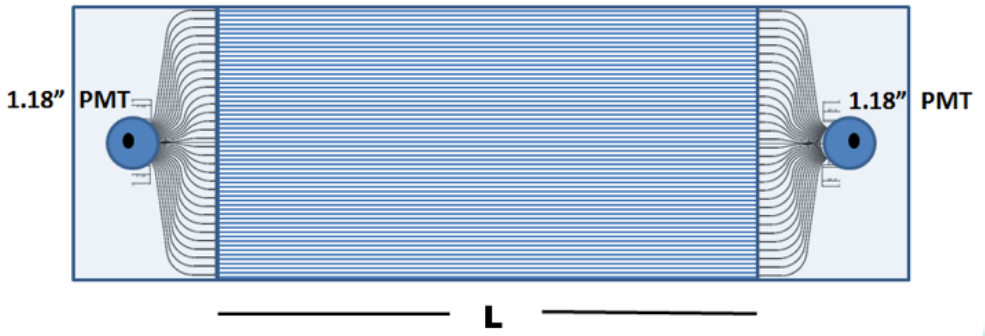
New detectors

A Plastic Muon Detector for Auger Beyond 2015 (the backup solution)



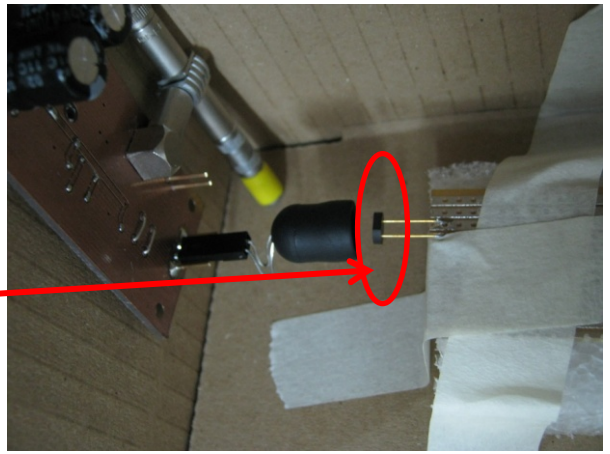




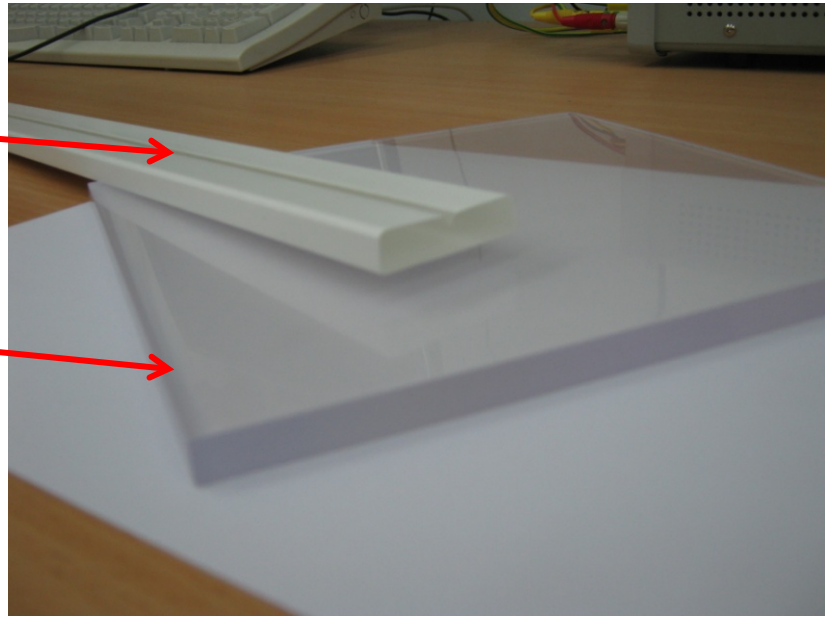


R&D: SiPM/Scintillatori

- SiPM:
  - 2 Hamamatsu
  - 2 Trieste



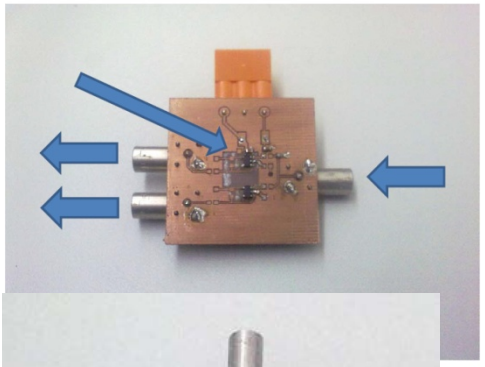
- Scintillatori
  - FNAL-NICADD (estruso)
  - Epic-Crystal (Cast) (China)

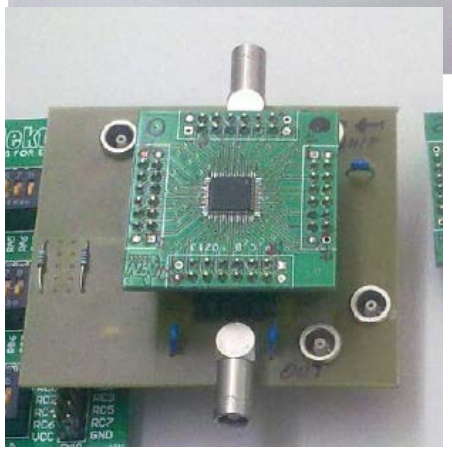


Attività 2014 Lecce: Nuova Elettronica

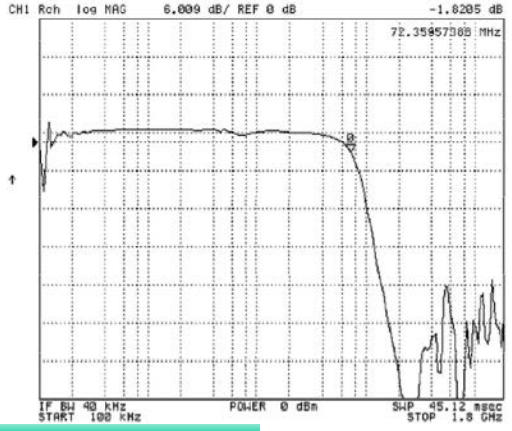
Sviluppo prototipo front-end

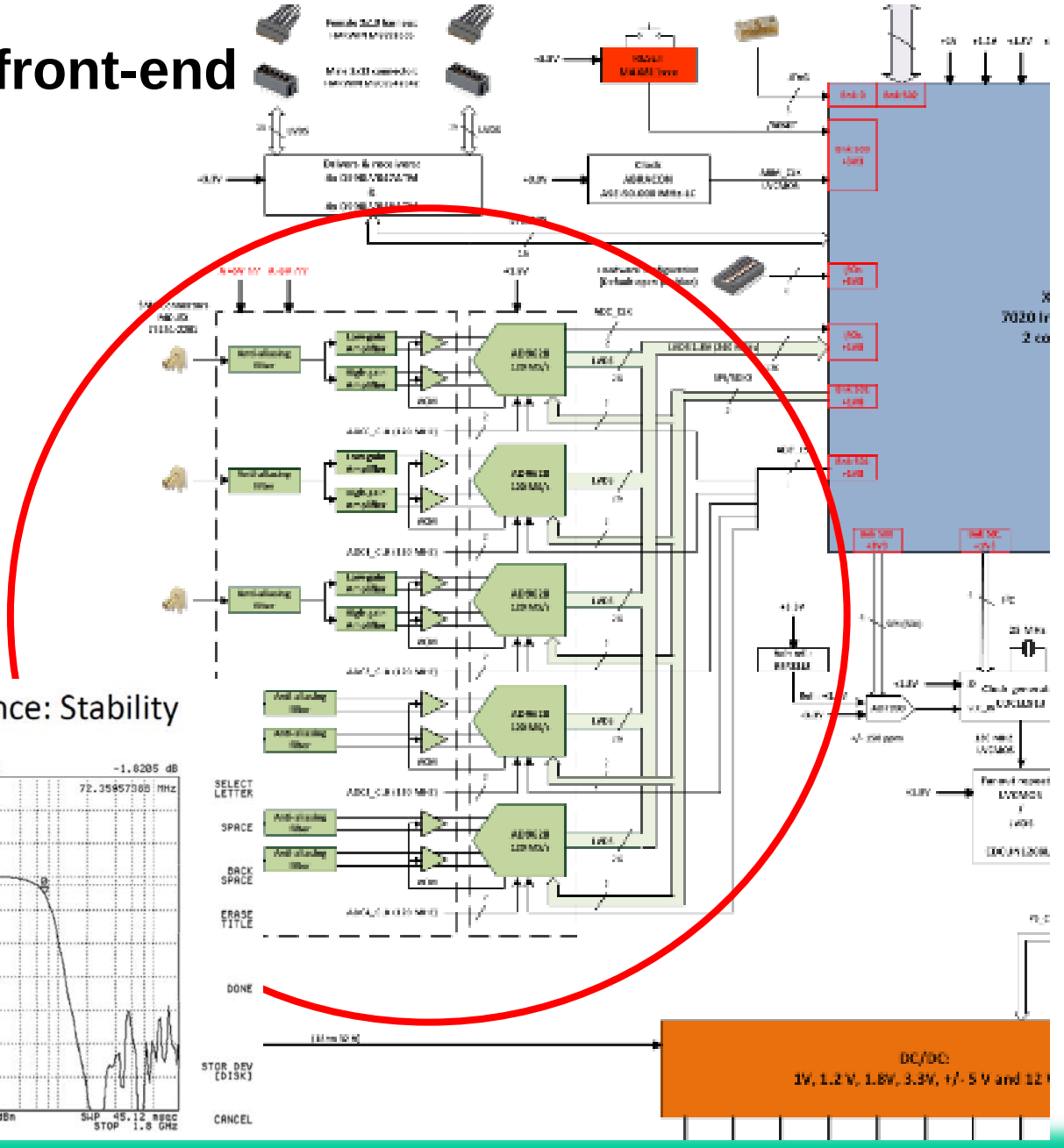
The LMH6629 as splitter





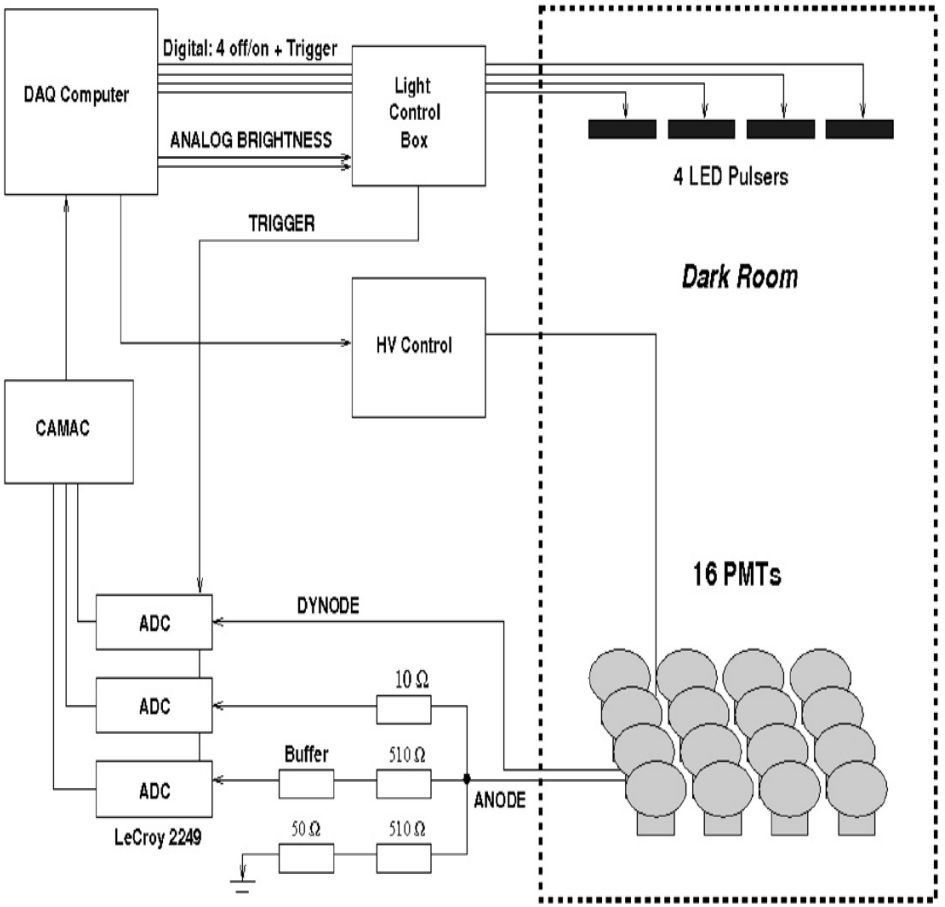
Performance: Stability





Attività 2014 Lecce: Nuova Elettronica

Modifica e potenziamento stazione SDECO a Malargue



- Test 16 PMTs
  - Single PE
  - Dark current
  - After pulses
  - Linearity
  - Saturation
- AUGER PMTs maintenance

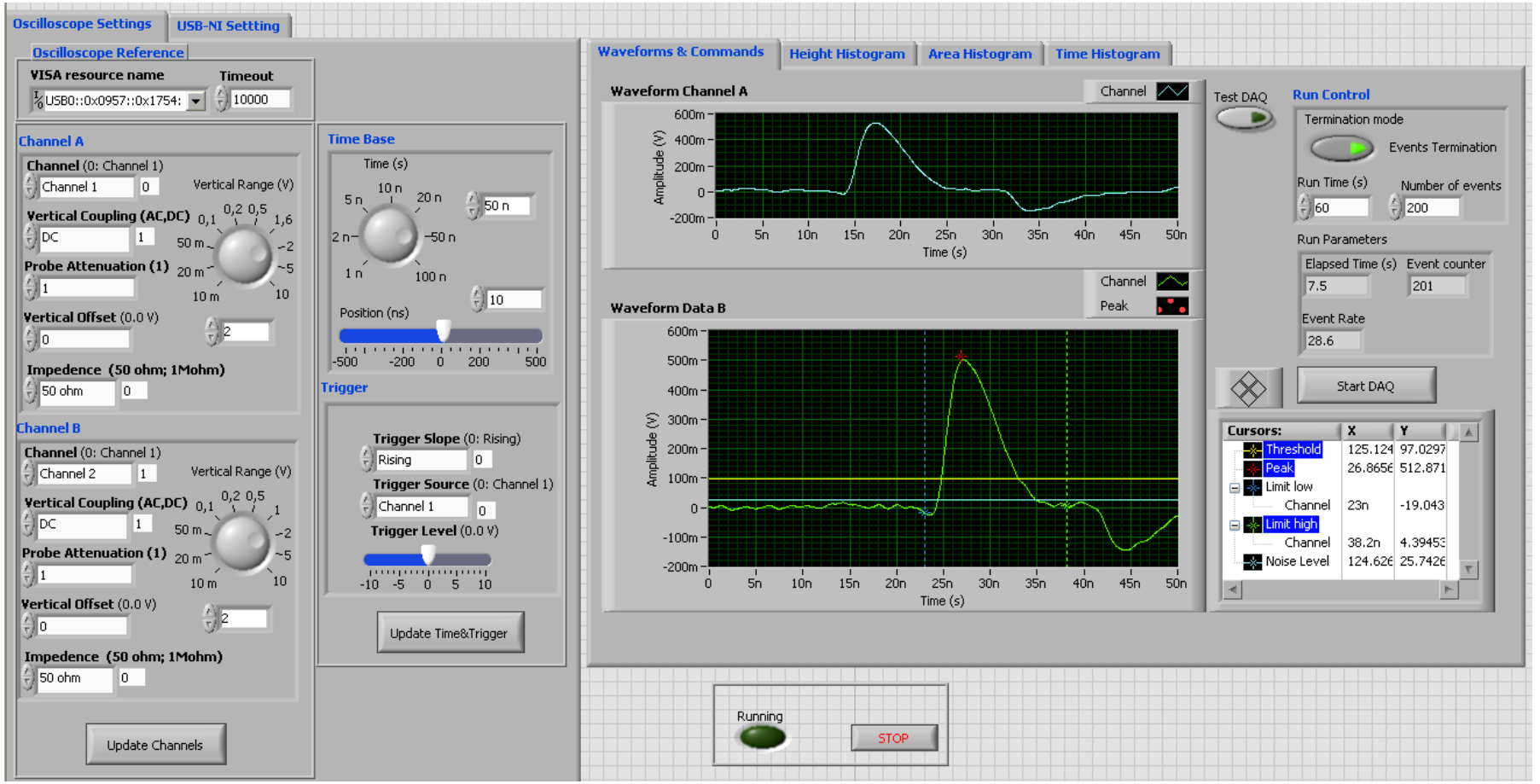
  New proposal

- PMT test: saturation recovery
  - Super Led linearity curves
  - Effect on SD reconstruction
- New PMT test and characterization

Attività 2014 Lecce: Nuova Elettronica

Sviluppo di sistema di acquisizione e test PMT in LabView2012 per :

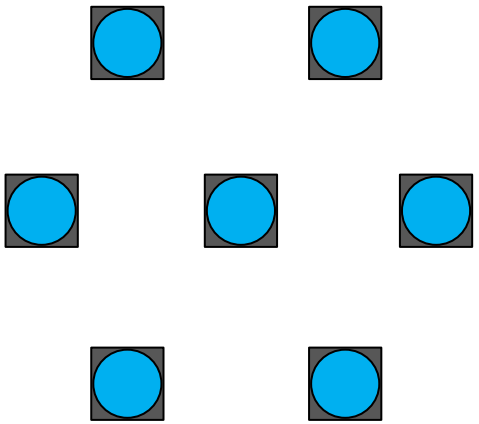
- Stazione test Laboratorio ASTROPARTICELLE
- Possibile estensione SDECO (Argentina)



Attività 2014 Lecce: New detectors

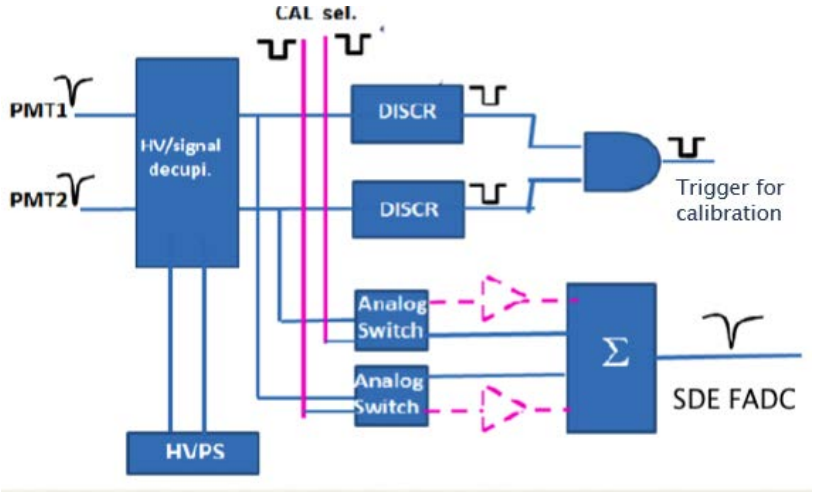
Realizzazione di due moduli da installare sotto una tank entro la fine dell'anno.

Realizzazione di una engineering array di 7 tanks entro la fine del prossimo anno se la soluzione verrà scelta dalla collaborazione.



Contributo Lecce

1) R&D soluzione segmentata con SiPM (coll. MI e NA)
2) Meccanica per inserimento ed estrazione moduli da sotto le tanks. (resp. LE)
3) Collaborazione in sviluppo elettronica (resp. NA)



4) Si potrebbero costruire 3-4 stazioni a Lecce

Attività 2014 Lecce: Servizi

Per upgrade SDE (elettronica e SDECO)

Lab. Elettronica	6 mesi uomo
Off. Meccanica Prog. e Costr.	2 mesi uomo

Per rivelatore a scintillazione (se scelto)

Lab. Elettronica	3 mesi uomo
Off. Meccanica Progettazione	3 mesi uomo
Off. Meccanica costruzione	3 mesi uomo

Per rivelatore a scintillazione (se mezzi moduli a Lecce)

Off. Meccanica Progettazione	3 mesi uomo
Off. Meccanica costruzione	12 mesi uomo
Spazio in capannone per tavolo	6x4 m^2
Spazio in capannone per stoccaggio	~ 20 m^2

LECCE Activity

Analisi, Detector Performance e attività di supporto

- **Esposizone ibrida (spettro standard) L. Perrone V. Scherini**
- **Detector performance per FD L. Perrone**
- **Saturazioni I. De Mitri**
- **Worker Node on Demand G. Cataldi**

Maintenance & R&D correlati

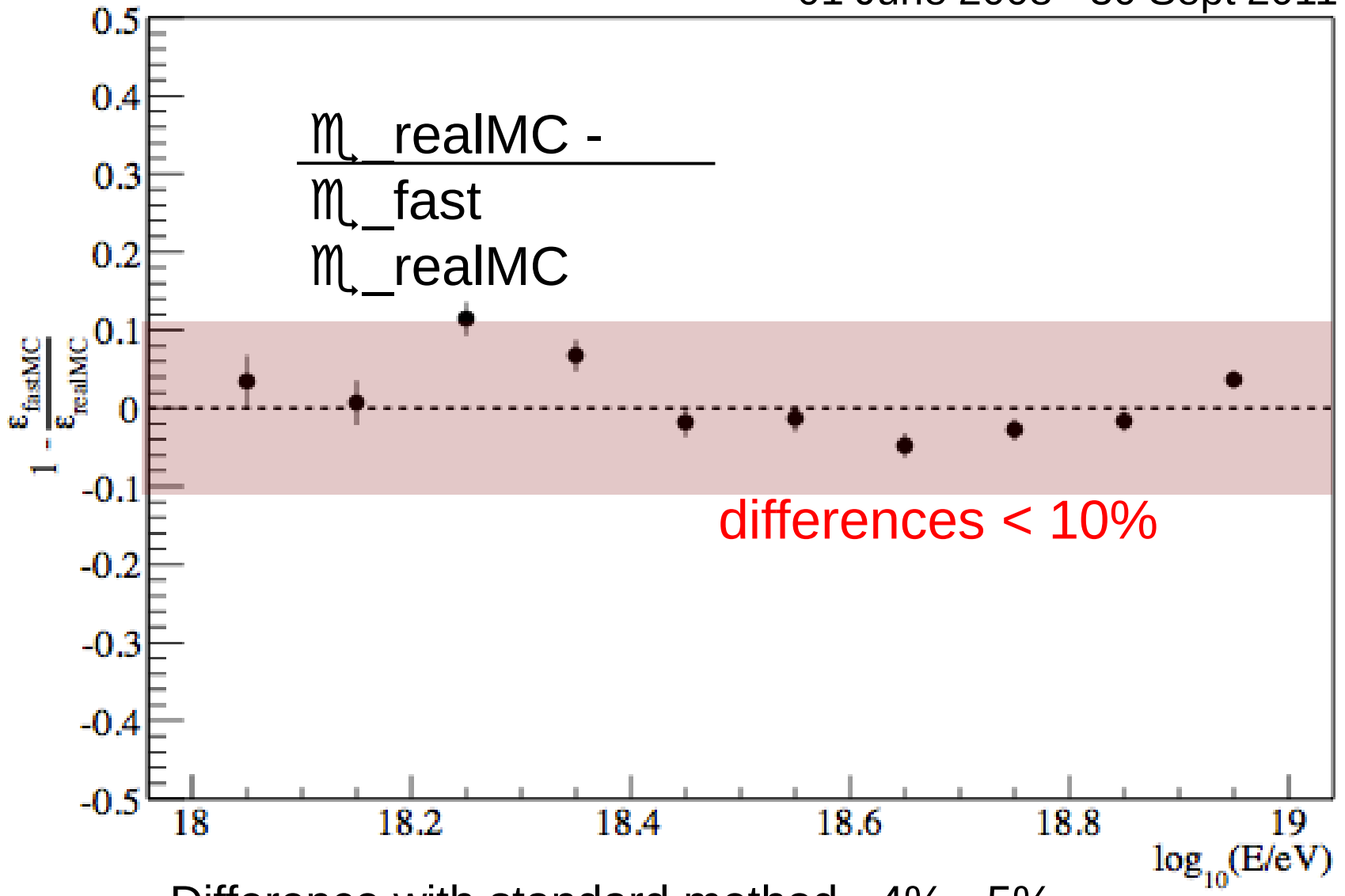
- **Simulazioni upgrade L. Perrone, V. Scherini**
- **Status SDECO G. Marsella, M. Nestola**
- **Maintenance PMT sul Campo R. Coluccia G. Cataldi L. Perrone**
- **Test PMT G. Cataldi R. Coluccia I. De Mitri**
- **Sviluppo ADC S. D'Amico G. Cocciolo, A. Donno**
- **Sviluppo elettronica P. Creti, R. Assiro, A. Corvaglia, G. Marsella,M. Nestola,**
- **CNAF-AUGER Ref. Person G. Cataldi**
- **AMY P. Creti G. Cataldi R. Coluccia**
- **NIRFE supporto esterno**

A fast method for deriving the hybrid exposure

L. Perrone, F. Salamida, V. Scherini

Fast VS standard method

01 June 2008 - 30 Sept 2011



Difference with standard method ~4% - 5%
few points have a difference ~ 10%

Conclusions

we have developed a new method for deriving the hybrid exposure

faster: months → weeks

the first reliability tests are very promising
difference w.r.t the standard method within systematic unc.

→ the method can easily provide the hybrid exposure calculation in desired time slices (as the on-line SD exposure)
→ flexible tool for realistic estimate of the exposure of a detector upgraded design

Summary

- Introduzione
- Produttività Scientifica
- Il programma di upgrade
- Highlight delle attività a Lecce
- Finanziamenti Esterni

Fondi esterni: Status
EPLANET

CERN Document Server

EPLANET: the Europe-Latin America alliance for physics research and education

Twenty-nine partner institutions participate in EPLANET – the EU-funded project aimed at strengthening the links between the physics communities in Europe and Latin America. The project will help the Latin-American scientific community to reach and consolidate the critical scientific mass, and profit from the educational, technological and industrial impact of high-energy physics.

Auger inserito nel progetto. (WP9)
Referente Nazionale G. Matthiae
Referente Locale D. Martello

Risorse in corso di trasferimento
Durata del finanziamento 4 anni (2011-2014)

Fondi esterni: Status

CUIA

Consorzio Internuniversitario Italiano per l'Argentina

Cos'è il CUIA

Il CUIA (Consorzio Interuniversitario Italiano per l'Argentina) promosso dall'Università di Camerino, sulla base di un accordo di rete con il Consejo Interuniversitario Nacional dell'Argentina e fortemente sostenuto dalla Direzione Generale per l'Università del MIUR, nasce nel 2004 tra 14 Università Italiane (successivamente esteso molte altre).

Titolo del progetto: **Studio delle anisotropie dei raggi cosmici per gruppo di massa con l'Osservatorio Pierre Auger**

Istituzioni Partecipanti

P.I. D. Martello Università del Salento
F. Guarino Università di Napoli
A. Chiavassa Università di Torino
D. Harari Centro Atómico Bariloche (CNEA)
I. Allekotte Centro Atómico Bariloche (ITeDA)

Camerino, lì 10 febbraio 2012

Caro Prof. Martello,

è con vivo piacere che Le comunichiamo, nella sua qualità di responsabile scientifico dell'università proponente, l'avvenuta approvazione da parte del CUIA del cofinanziamento di € 12000 al progetto di ricerca dal titolo "Studio delle anisotropie dei raggi cosmici per gruppo di massa con l'Osservatorio Pierre Auger" da Lei presentato in collaborazione con altre Università italiane ed argentine.

Fondi già assegnati e in fase di utilizzo.
Finanziamento avuto attraverso l'Università

Fondi esterni: Status

MAE

Ministero Affari Esteri

Farnesina
Ministero degli Affari Esteri

PROGETTI DI GRANDE RILEVANZA

Progetti di grande rilevanza previsti nei Programmi Esecutivi di Collaborazione Scientifica e Tecnologica

Progetti di ricerca scientifica e tecnologica bilaterale di "Grande Rilevanza" co-finanziati per l'anno 2011 dal Ministero degli Affari Esteri

ARGENTINA	Sensori complementari di radiazione ionizzante basati su film di diamante e recettori biologici fotosintetici per la sicurezza dell'uomo e dell'ambiente	CNR	Istituto di Cristallografia	GIARDI	Maria Teresa
ARGENTINA	Costruzione di un sistema congiunto di risk assessment Italia-Argentina per il controllo del rischio di incidente da corpo estraneo nei bambini	Università di Padova	Dipartimento di Medicina ambientale e Sanità Pubblica	GREGORI	DARIO
ARGENTINA	Caratterizzione durante e post-irraggiamento di dispositivi microelettronici per applicazioni avioniche o spaziali	CNR	Istituto per la microelettronica e microsistemi (IMM)	LIBERTINO	Sebania
ARGENTINA	Studio dei raggi cosmici di alta energia con l'Osservatorio Auger	Istituto Nazionale di Fisica Nucleare (INFN)	Sezione INFN di Roma Tor Vergata	MATTHIAE	Giorgio
ARGENTINA	SPACEBOND - Sviluppo di una procedura teorico-sperimentale per la messa a punto di giunzioni incollate per impiego aerospaziale	Università di Bologna	DIEM, Dipartimento di Ingegneria delle Costruzioni Meccaniche, Nucleari Aeronautiche e di Metallurgia	MINAK	Giangiacomo
ARGENTINA	Il ruolo delle emoglobine nella rimozione delle specie reattive dell'ossigeno e dell'azoto	Università di Parma	Dip. di Fisica	VIAPPIANI	Cristiano

2012: un annualità per un assegno di ricerca assegnata a Lecce attraverso INFN.

Fondi esterni: Status
CosMic

- CosMic -
rivelazione dei raggi cosmici nelle microonde

P.I. Lorenzo Perrone

1 Settori Scientifico Disciplinari Interessati

PE Physical Sciences and Engineering

- PE9 Universe sciences: astro-physics/chemistry/biology; solar system; stellar, galactic and extragalactic astronomy, planetary systems, cosmology; space science, instrumentation
- PE9_10 High energy and particles astronomy: X-rays, cosmic rays, gamma rays, neutrinos
- PE9_17 Instrumentation: telescopes, detectors and techniques
- PE2 Fundamental constituents of matter: particle, nuclear, plasma, atomic, molecular, gas, and optical physics
- PE2_2 Particle physics

2 Responsabile del progetto

Lorenzo Perrone, nato a Firenze il 10/08/1971, c.f PRRLNZ71M10D612Q, ricercatore confermato FIS/01, Università degli Studi del Salento, Dipartimento di Ingegneria dell'Innovazione. Tel.: 0832-297368, email: lorenzo.perrone@le.infn.it

CosMic

Finanziato su fondi 5X1000 dell'Università del Salento

Derivato dal FIRB presentato nel 2010

Partecipanti al progetto

Dipartimento di Matematica e Fisica LECCE
R.Coluccia, G.Marsella, M.Panareo, L.Perrone

Dipartimento di Fisica MILANO
V.Scherini

INFN LECCE
G.Cataldi, P. Creti

Dipartimento di Ingeneria dell'Innovazione LECCE
L.Corchia, F.Congedo, R. De Paolis

Fondi esterni: Status
Prin

1 - Titolo del Progetto di Ricerca

Ha superato la Selezione a Catania ed è stato inviato al Ministero.

Testo italiano
Raggi cosmici di altissima energia: oltre i presenti limiti delle tecniche di rivelazione

Testo inglese
Ultra High Energy Cosmic Rays: beyond the present limits of the detection tecniques

6 - Coordinatore Scientifico

INSOLIA
(Cognome)

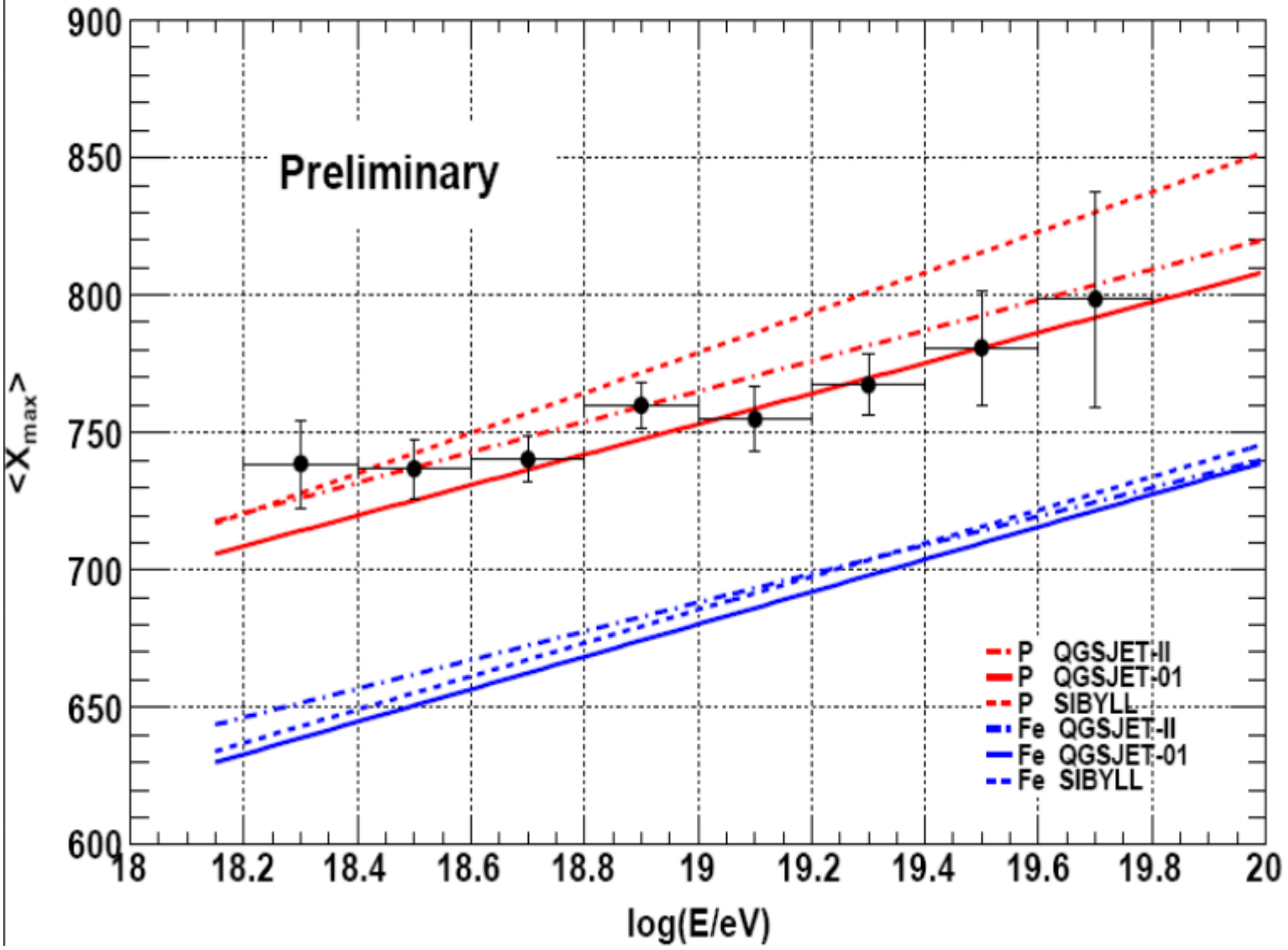
ANTONIO
(Nome)

7 - Elenco delle Unità operative

n°	Responsabile dell'Unità di Ricerca	Qualifica	Università/Enti	E-mail	Titolo e Data di conseguimento (primo dottorato o prima specializzazione, in assenza, prima laurea) solo per linea A o linea B
1.	INSOLIA Antonio	Professore Ordinario	Università degli Studi di CATANIA	antonio.insolia@ct.infn.it	Laurea: 20/07/1975 Linea d'intervento: C
2.	MARTELLO Daniele	Professore Associato non confermato	Università degli Studi del SALENTO	daniele.martello@le.infn.it	Dottorato: 19/10/1994 Linea d'intervento: C
3.	CHIAVASSA Andrea	Professore Straordinario	Università degli Studi di TORINO	achiavas@to.infn.it	Dottorato: 17/10/1994 Linea d'intervento: C
4.	GUARINO Fausto	Ricercatore confermato	Università degli Studi di NAPOLI "Federico II"	guarino@na.infn.it	Laurea: 26/01/1989 Linea d'intervento: C
5.	MIRAMONTI Lino	Ricercatore confermato	Università degli Studi di MILANO	lino.miramonti@mi.infn.it	Dottorato: 09/11/1999 Linea d'intervento: C
6.	PETRERA Sergio	Professore Ordinario	Università degli Studi de L'AQUILA	sergio.petrera@aquila.infn.it	Laurea: 21/07/1970 Linea d'intervento: C
7.	VERZI Valerio	Ricercatore	Istituto Nazionale di Fisica Nucleare	valerio.verzi@roma2.infn.it	Dottorato: 20/12/2000 Linea d'intervento: B

backup

Mean X_{max} as a function of energy



TELESCOPE ARRAY: LATEST RESULTS

P. Tinyakov for the Telescope Array Collaboration