



TELESCOPE ARRAY: FIRST RESULTS



TELESCOPE ARRAY: FIRST RESULTS

P. Tinyakov¹
for the Telescope Array Collaboration

¹Universite Libre de Bruxelles, Bruxelles, Belgium

P. Tinyakov¹
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Array
Collaboration

Introduction

TA detector

CR spectrum

Composition and
anisotropies

Summary

UHECR: highest-energy window into Universe



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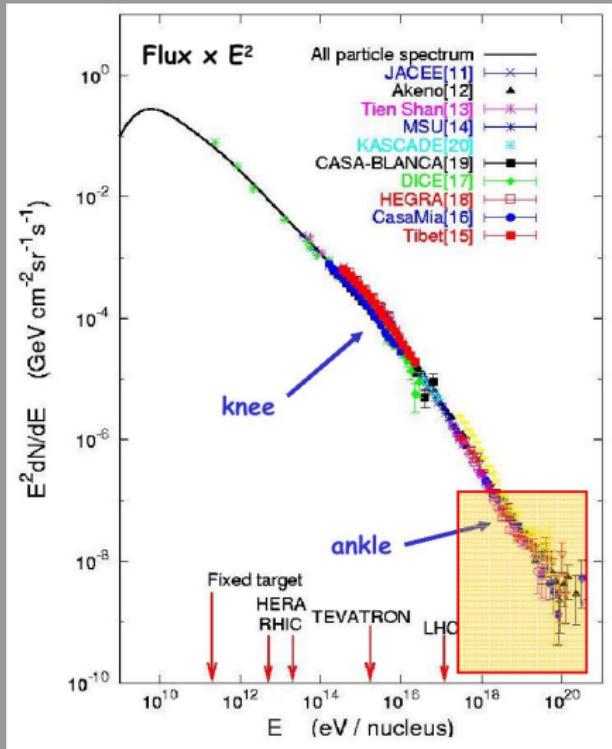
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- ▶ CR spectrum extends to 10^{20} eV
- ▶ Highest-energy particles carry ~ 50 J each
- ▶ Typical flux at high energies: 1 particle per km^2 per century

High-energy CR spectrum in more detail



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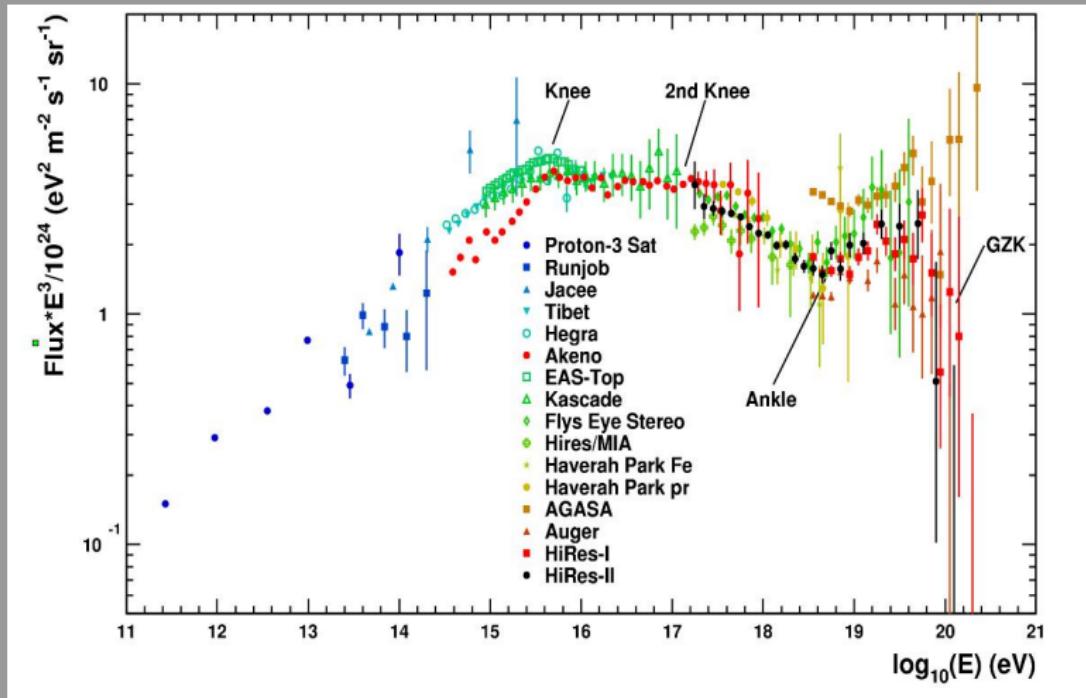
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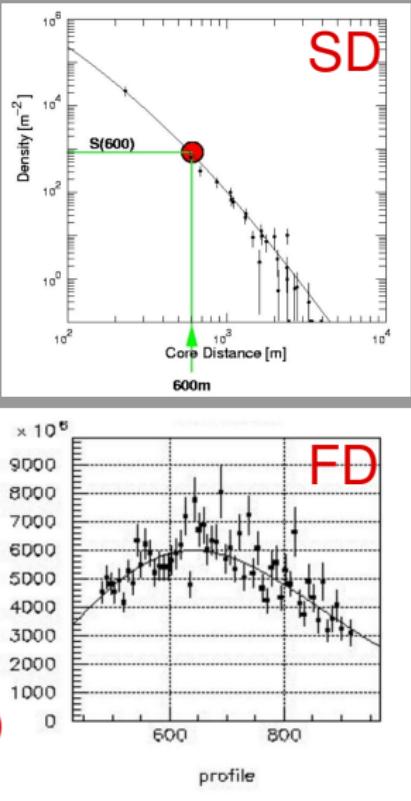
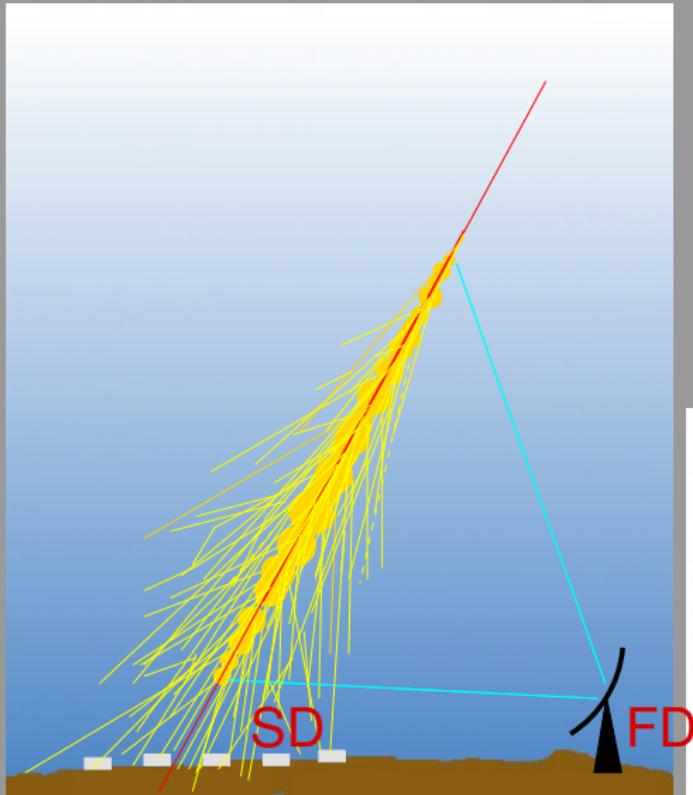
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Registration of UHECR



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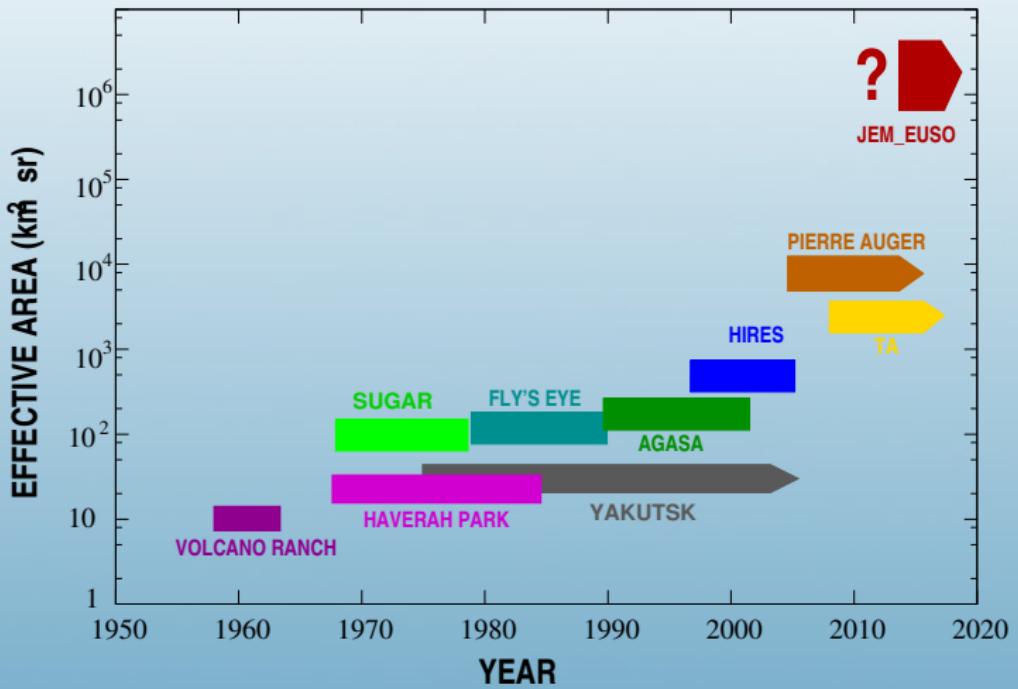
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UHECR experiments



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TELESCOPE ARRAY COLLABORATION

T Abu-Zayyad¹, R Aida², M Allen¹, R Azuma³, E Barcikowski¹, JW Belz¹, T Benno⁴, DR Bergman¹, SA Blake¹, O Brussova¹, R Cady¹, BG Cheon⁶, J Chiba⁷, M Chikawa⁴, EJ Cho⁶, LS Cho⁸, WR Cho⁸, F Cohen⁹, K Doura¹, C Ebeling¹, H Fujii¹⁰, T Fujii¹¹, T Fukuda³, M Fukushima^{9,2}, D Gorbunov², W Hanlon¹, K Hayashi³, Y Hayashi⁹, N Hayashida⁹, K Hibino¹¹, K Hiyama², K Honda², G Hughes⁵, T Iguchi³, D Ikeda⁸, K Ikuta², SJJ Innemee⁵, N Inoue¹¹, T Ishii², R Ishimori², D Ivanov⁵, S Iwamoto², CCH Juil¹, K Kadota⁶, F Kakimoto³, O Kalashev², T Kanbe², H Kang⁶, K Kasahara⁷, H Kawai⁸, S Kawakami¹¹, S Kawana¹¹, E Kido⁹, BG Kim⁶, HB Kim⁶, JH Kim⁶, JH Kim¹¹, A Kitsugi⁹, K Kobayashi⁷, H Koers², Y Kondo⁹, V Kuzmin², YJ Kwon⁸, JH Lim⁶, SI Lim⁹, S Machida³, K Martens², J Martineau¹, T Matsuda¹, T Matsuyama¹¹, JN Matthews¹, M Minamino¹¹, K Miyata⁷, H Miyauchi¹¹, Y Murano³, T Nakamura², SW Nam⁹, T Nonaka⁹, S Ogio¹¹, M Ohnishi⁹, H Okoha⁹, T Okuda¹¹, A Oshima¹¹, S Ozawa⁷, IH Park⁹, D Rodriguez¹, SY Roh¹⁰, G Rubtsov⁹, D Ryu², H Sagawa⁹, N Sakurai⁹, LM Scott⁵, PD Shah¹, T Shibata⁹, H Shimodaira⁹, BK Shin⁶, JD Smith¹, P Sokolsky¹, TJ Sonley¹, RW Springer¹, BT Stokes⁵, SR Stratton⁵, S Suzuki⁹, Y Takahashi⁹, M Takeda⁹, A Taketa⁹, M Takita⁹, Y Tameda³, H Tanaka¹¹, K Tanaka², M Tanaka¹¹, JR Thomas¹, SB Thomas¹, GB Thomson¹, P Tinyakov¹², I Tkachev², H Tokuno⁹, T Tomida², R Torii⁹, S Troitsky⁹, Y Tsunesada³, Y Tsuyuguchi², Y Uchihori², S Udo⁹, H Ukai², B Van Klaveren¹, Y Wada¹¹, M Wood¹, T Yamakawa⁹, Y Yamakawa⁹, H Yamaoka⁹, J Yang⁹, S Yoshida⁸, H Yoshii², Z Zundel¹

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¹³Kanagawa University, ¹⁴Saitama University, ¹⁵Tokyo City University, ¹⁶Pusan National University,
¹⁷Waseda University, ¹⁸Chiba University ¹⁹Ewha Womans University, ²⁰Chungnam National University,
²¹University Libre de Bruxelles, ²²University of Tokyo, ²³Kochi University, ²⁴Hiroshima City University,
²⁵National Institute of Radiological Science, Japan, ²⁶Ehime University

~ 130 scientists from Belgium, China, Japan, Korea, Russia, USA



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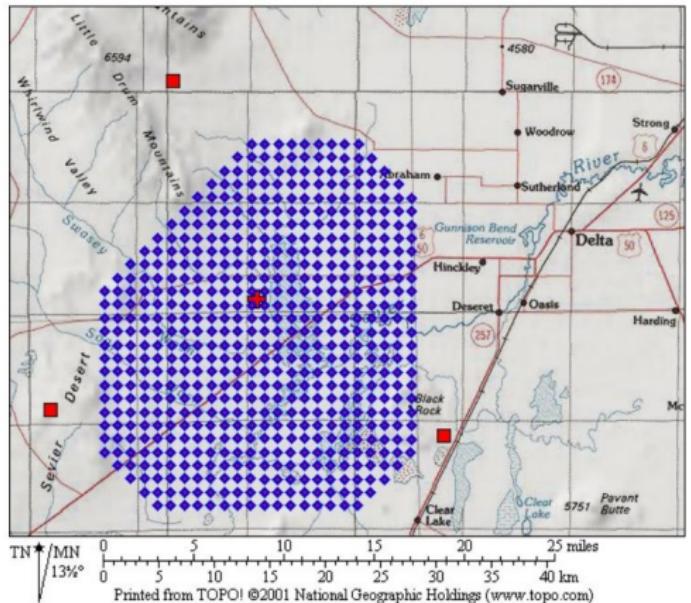
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TELESCOPE ARRAY HYBRID DETECTOR



SD relative size: TA $\sim 9 \times$ AGASA \sim PAO/4

- ▶ Situated in Utah, USA
- ▶ 507 scintillator detectors over 680 km²
- ▶ 3 towers, 38 telescopes
- ▶ Complete and operational as of 1/2008

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FLUORESCENCE DETECTOR



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SURFACE DETECTOR



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TRIPLE EVENT (2008-10-26)



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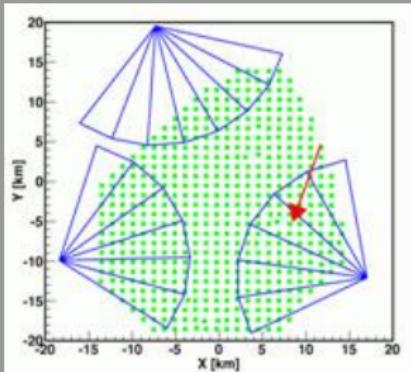
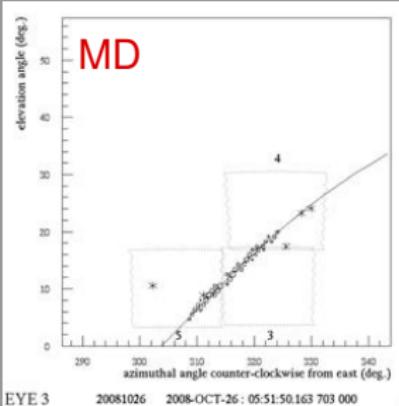
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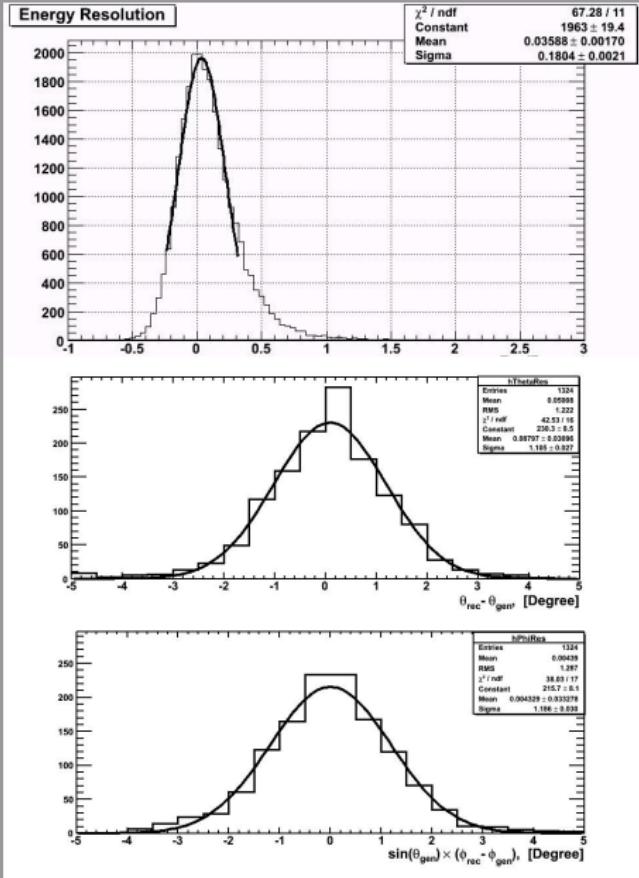
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binary



DETECTOR RESOLUTION



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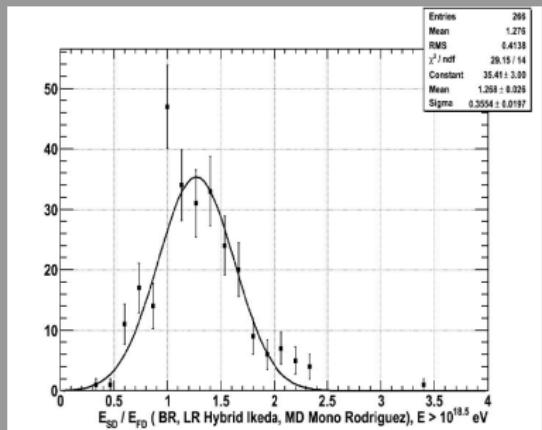
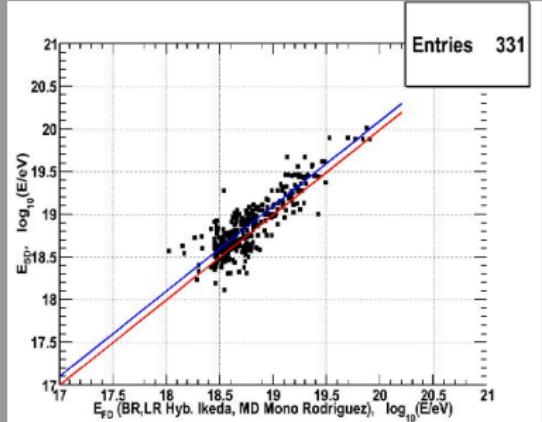
CR spectrum

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Summary

- ▶ Energy: 20%
- ▶ Zenith: 1.1°
- ▶ Azimuth: 1.2°

ENERGY SCALE



- ▶ Energy scale of SD is set to that of FD
- ▶ This amounts to ~ 27% shift downward
(note: without shift, SD is compatible with AGASA)



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TA SD vs Middle Drum spectrum



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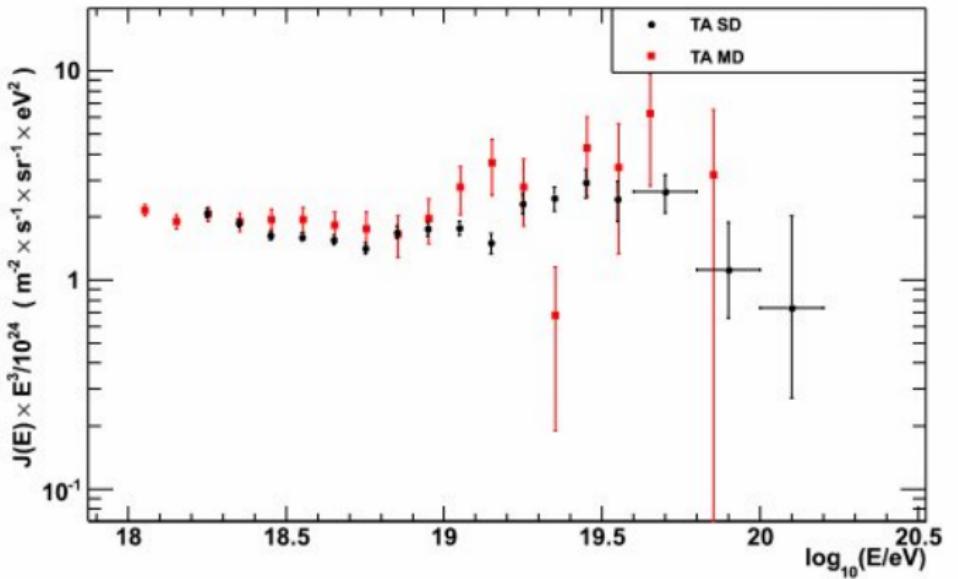
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TA SD vs TA Hybrid spectrum



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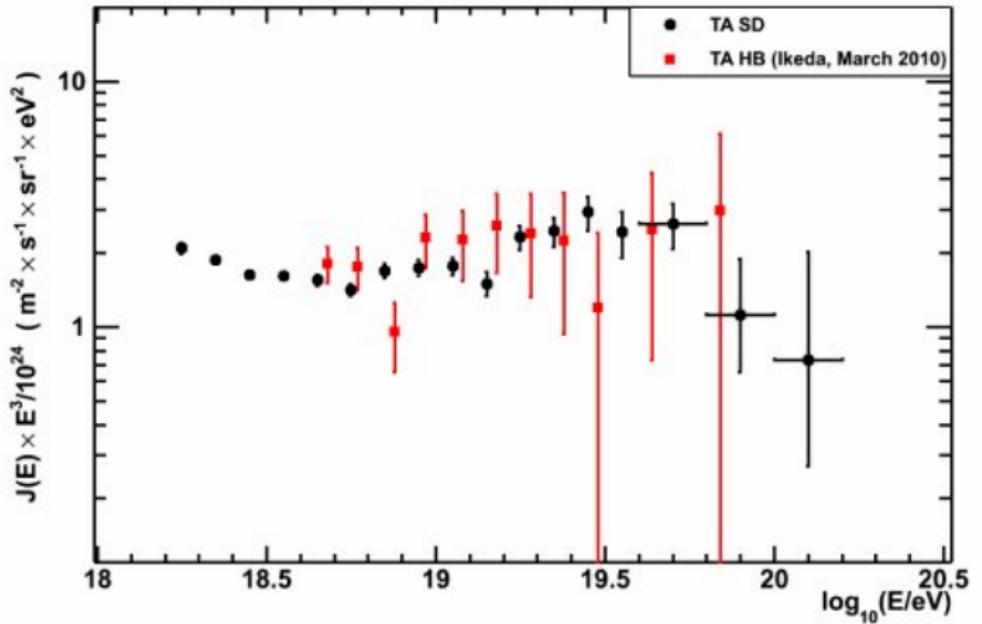
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TA SD vs HiRes spectrum



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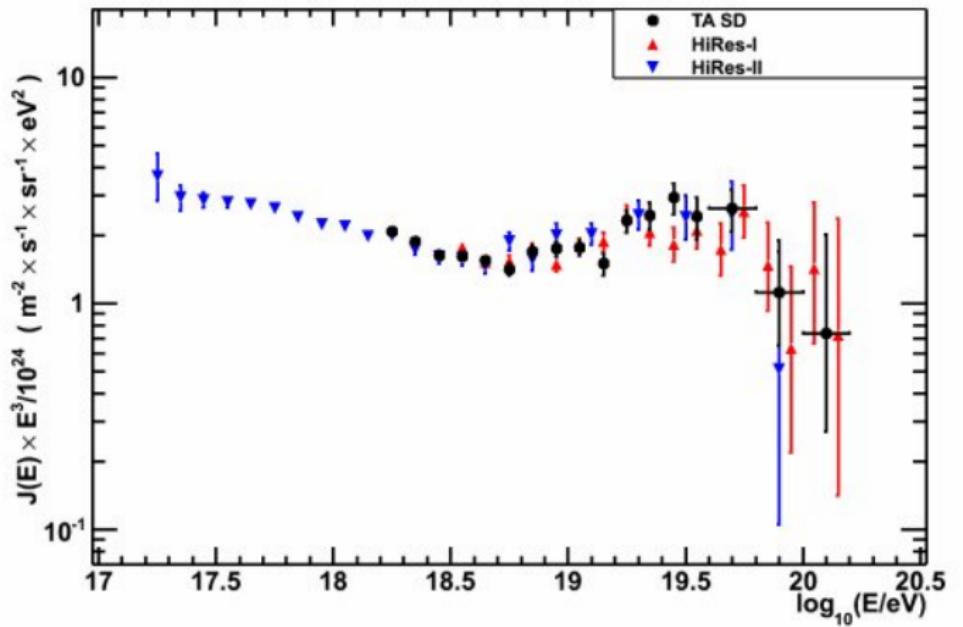
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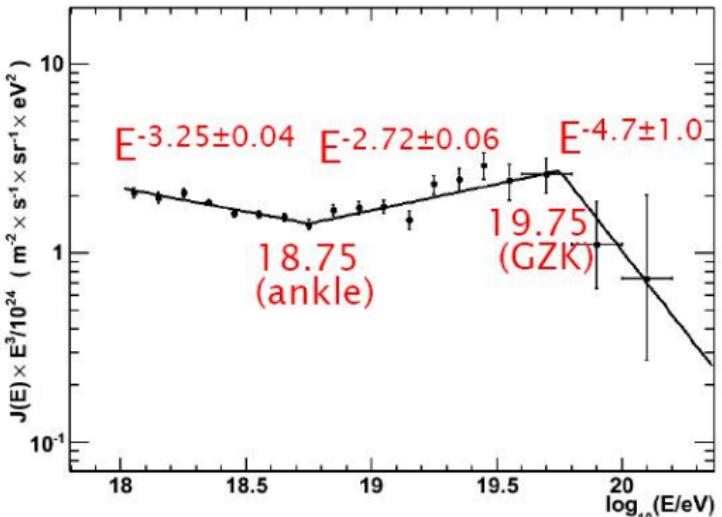
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(Solid line is a simple 0.1 logE-bin chi2 fit)

TA spectrum vs other experiments



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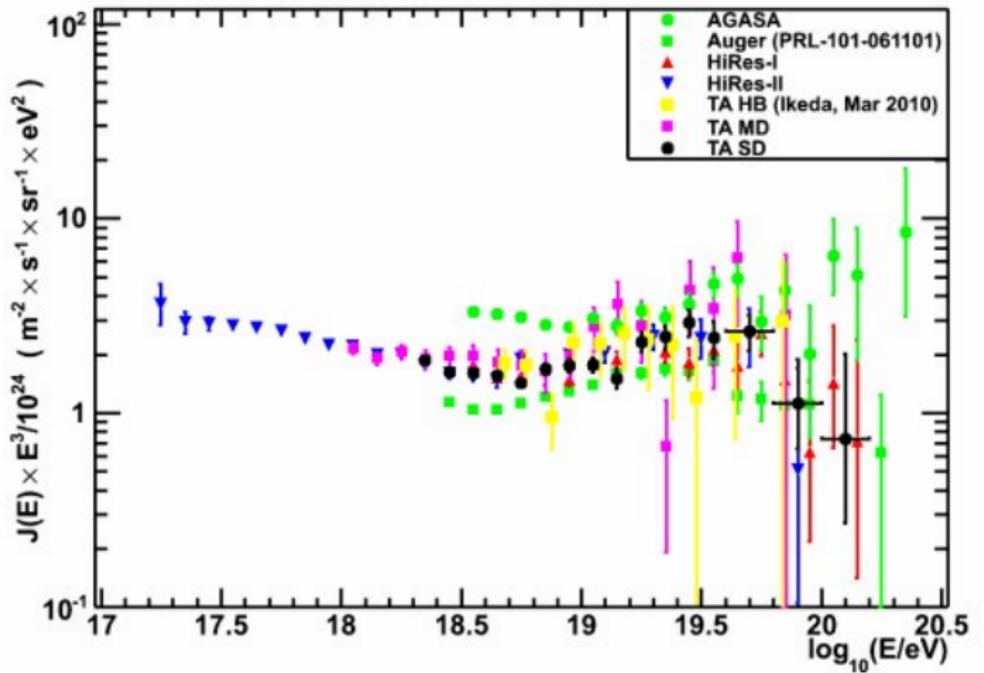
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COMPOSITION: compatible with protons



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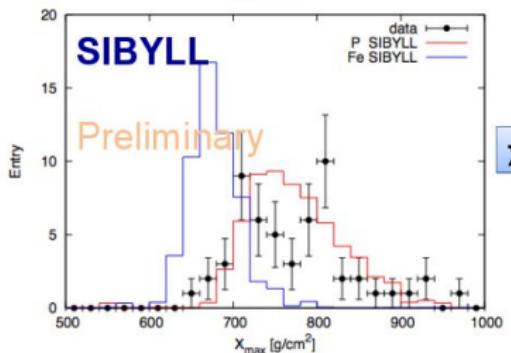
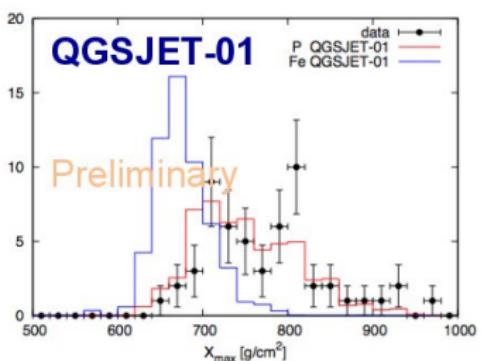
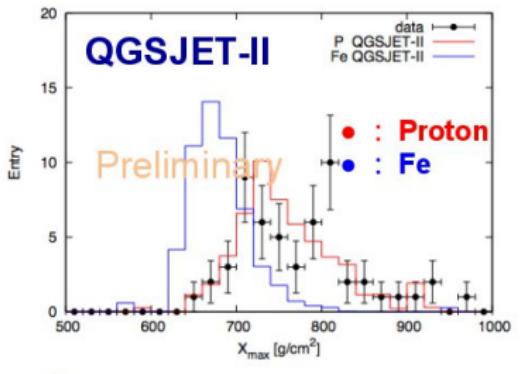
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x_{max} Data/MC comparison



χ^2 / dof

	QGSJET-II	QGSJET-01	SIBYLL
P	1.44	1.046	1.63
Fe	55.54	56.67	85.71

COMPOSITION: compatible with protons



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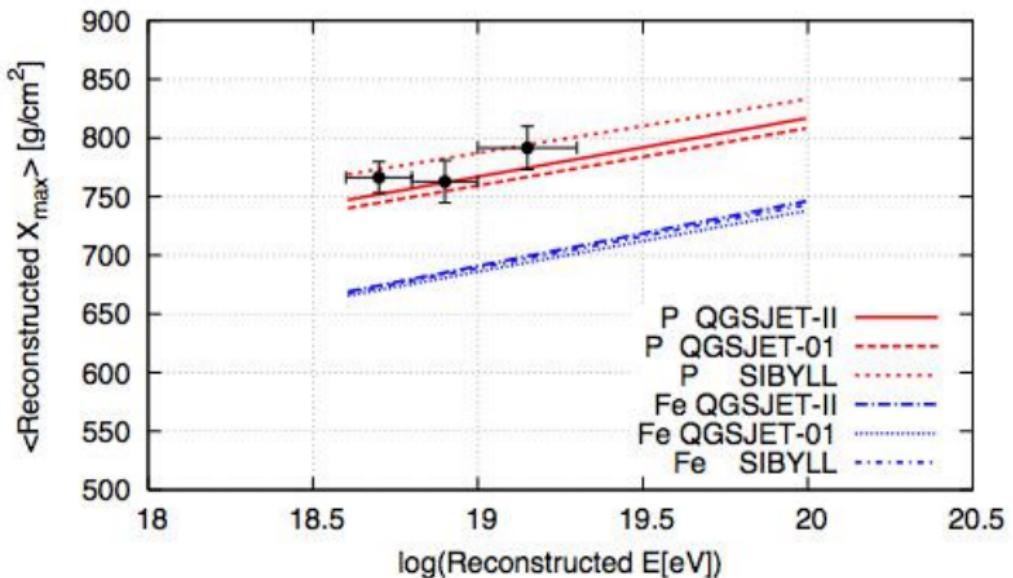
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ANISOTROPIES: no correlations with AGN



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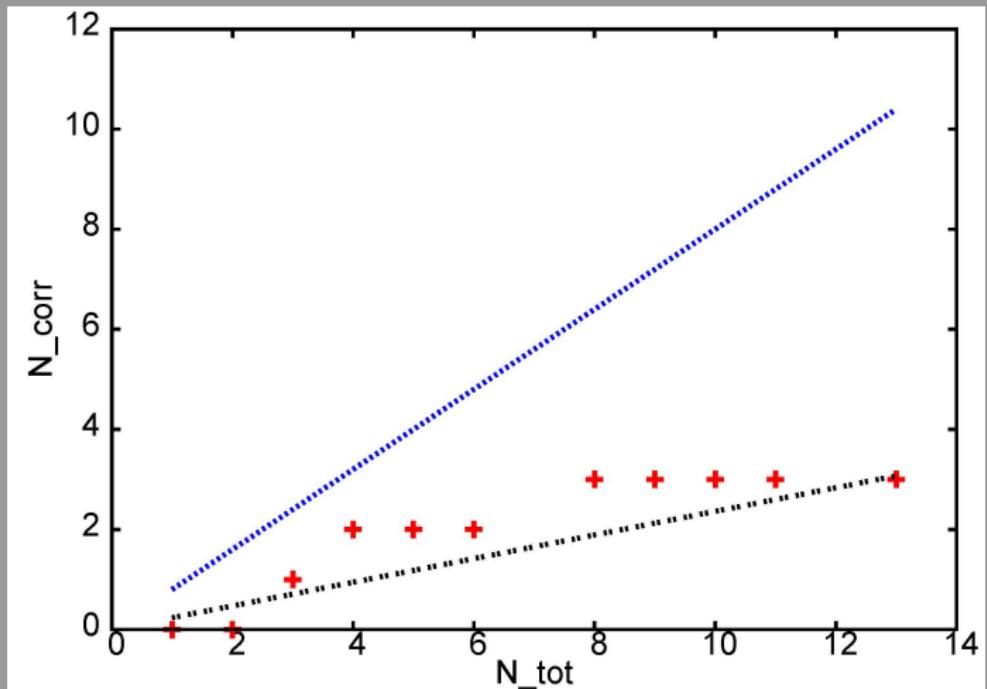
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Total events: 13; correlated: 3; expected by chance: 3.0

⇒ no effect

SUMMARY



TELESCOPE ARRAY: FIRST RESULTS

- ▶ TA is the LARGEST ultra-high energy cosmic ray detector in the Northern hemisphere
- ▶ TA CR spectrum is compatible with that observed by HiRes; in particular, TA confirms the cut off
- ▶ Complete composition and anisotropy analyses are on the way

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**Composition and
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