The UHECR Spectrum with HiRes

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The HiRes Experiment

- **Study UHECR with Air Fluorescence**
  - **Spectrum**
  - **Composition**
  - **Sources/Anisotropy**
- **Currently has the highest exposure above 10 EeV**

HiRes Collaboration

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HiRes Location

- West Desert of Utah on Dugway Proving Grounds
- 100 miles WSW of Salt Lake City

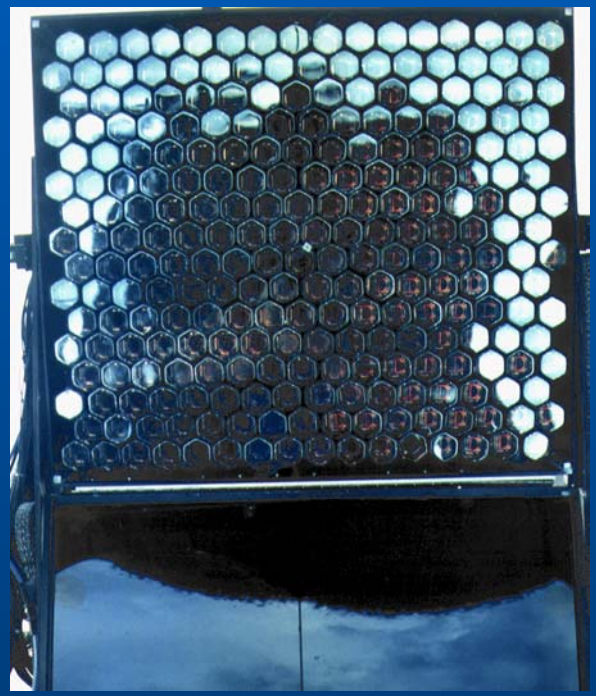
HiRes Sites

- 21 Mirrors
  - 360 deg in azimuth
  - 3-17 deg in elevation
- Sample & Hold DAQ
- Began observation: June 1997

- 42 Mirrors
  - 360 deg in azimuth
  - 3-33 deg in elevation
- FADC DAQ
- Began observation: October 1999

HiRes Mirror & PMT Cluster

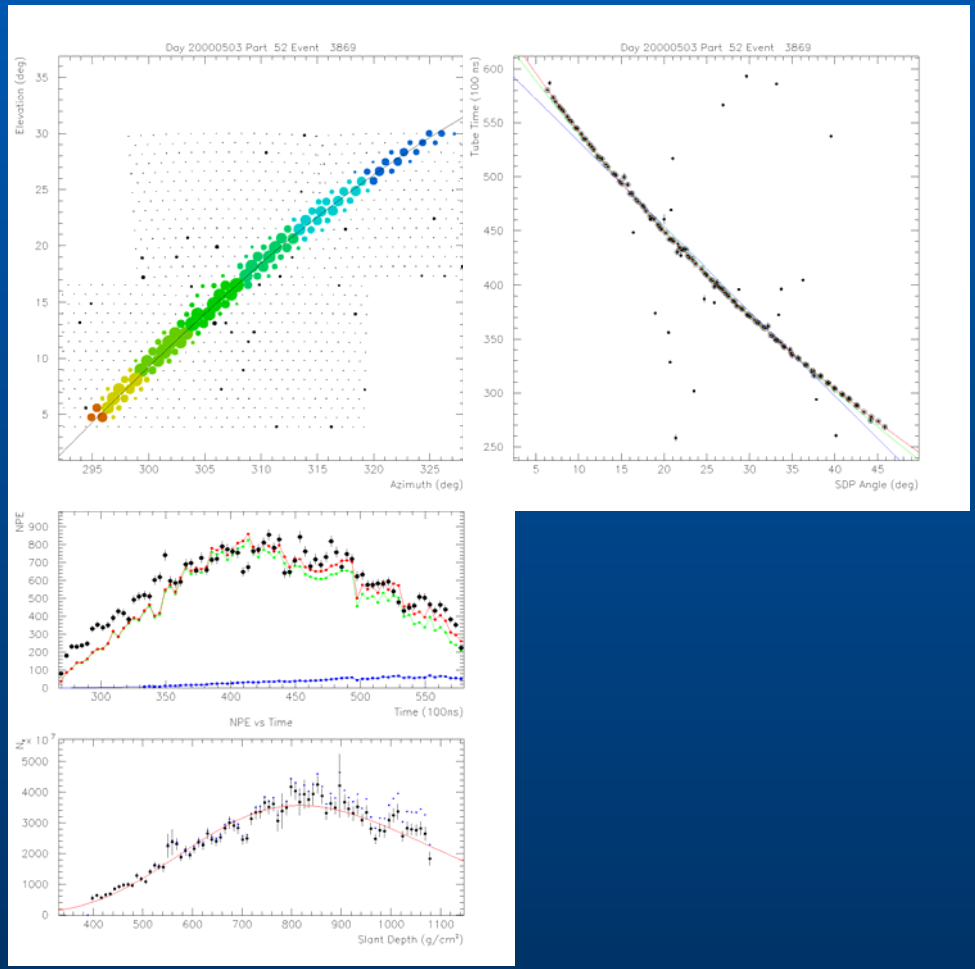
5.1 m^2 segmented mirror



256 pixel PMT array and UV filter

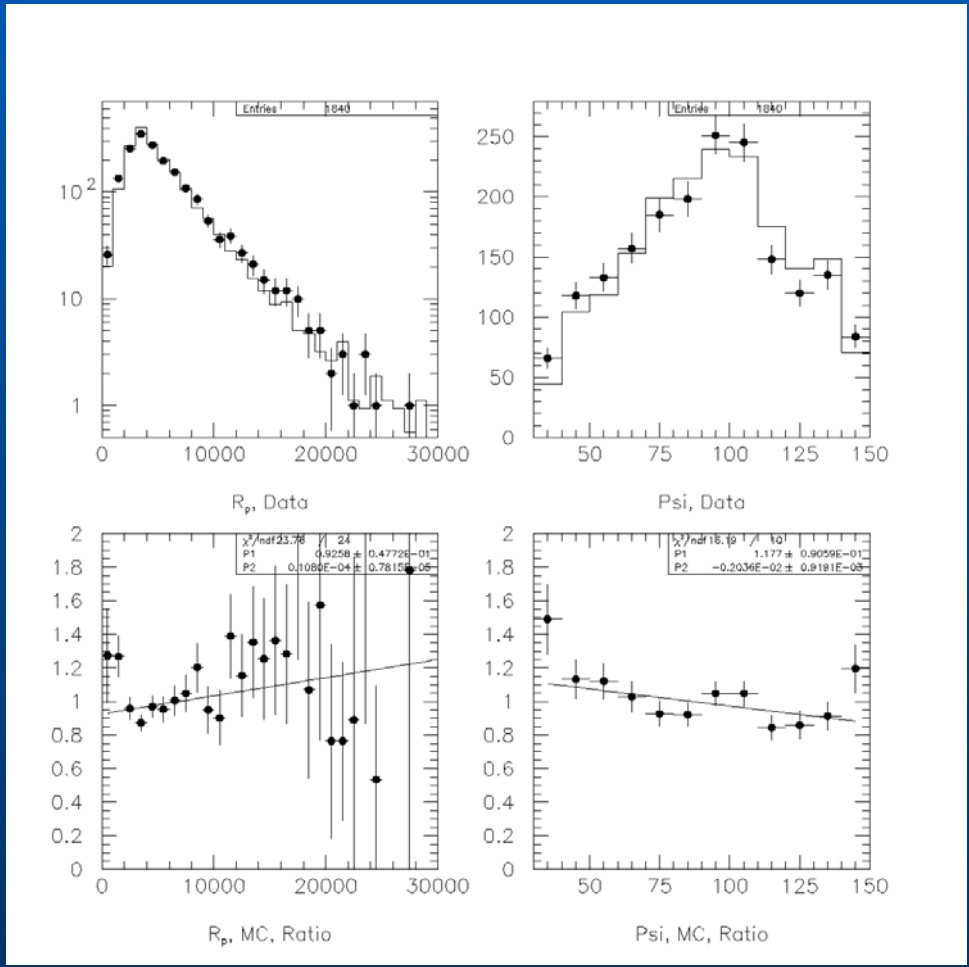
Data Reconstruction & Analysis

- Find Shower-Detector Plane
- Fit time vs angle to determine geometry
- Convert number of photoelectrons to number of particles in shower
- Integrate, using average energy loss, to find energy



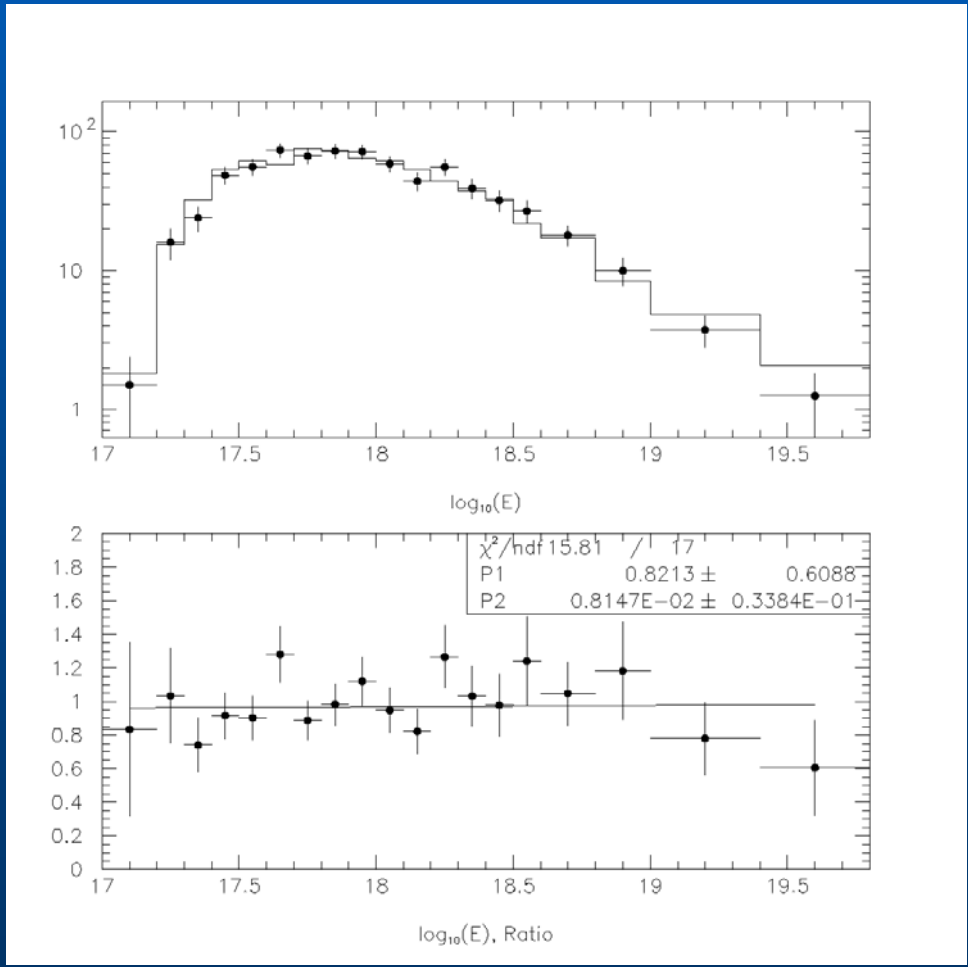
Data/MC Comparison: Geometry

- Data/MC comparisons constrain possible errors in aperture calculation
- Note that Psi and Rp are correlated



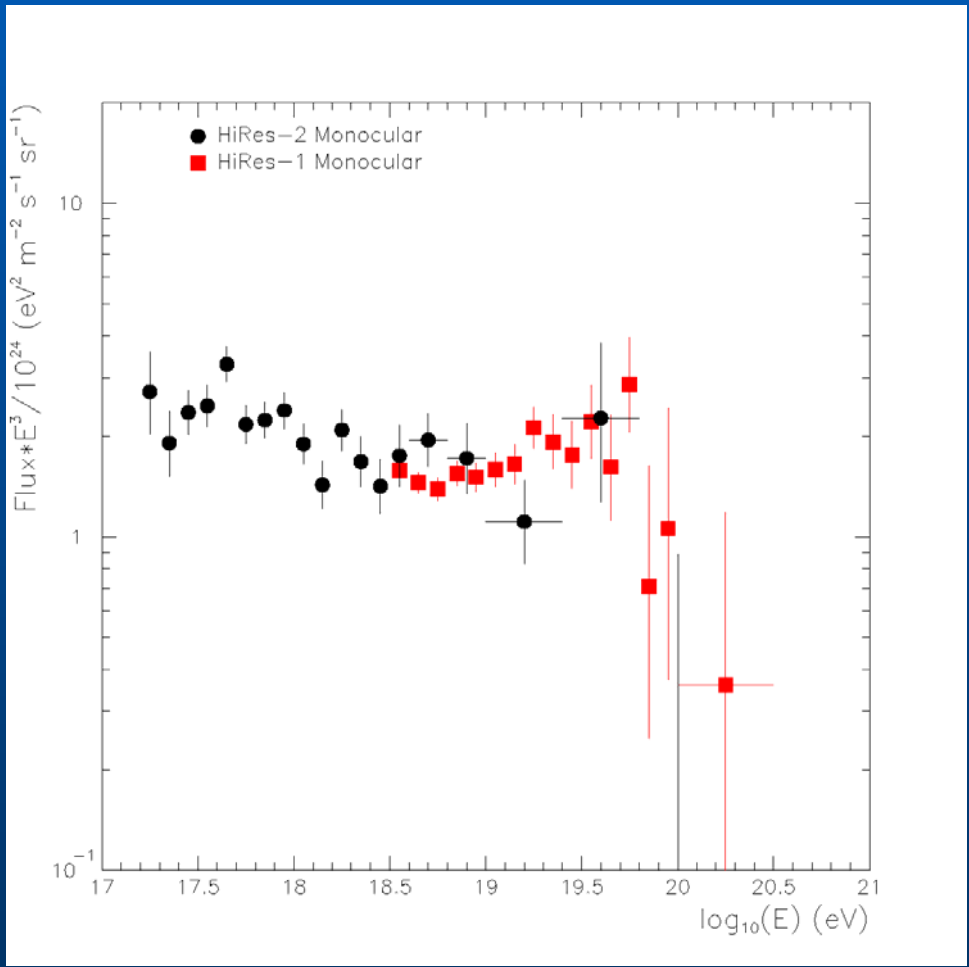
Data/MC Comparison: Energy

- **Energy distributions also match**
  - **Depends on spectrum and composition in MC**
  - **Input spectrum divides out of aperture**



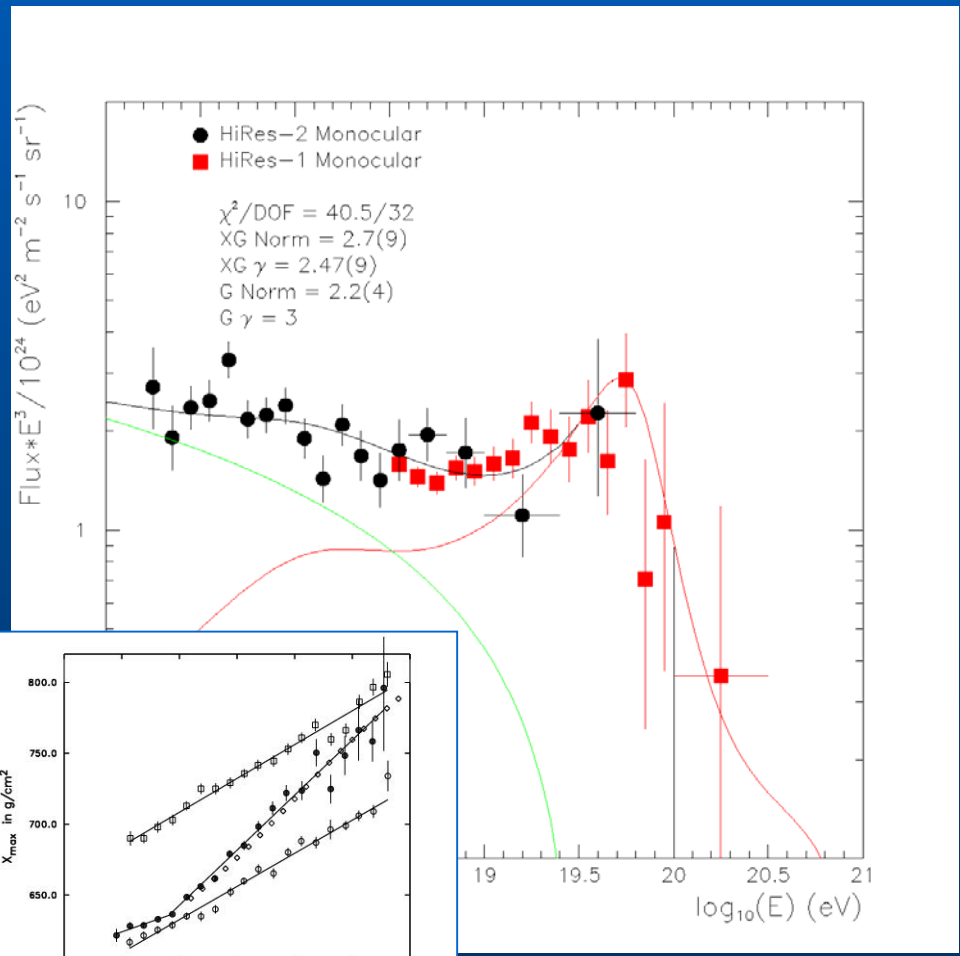
HiRes Spectra

- **Excellent agreement between HR-1 and HR-2**



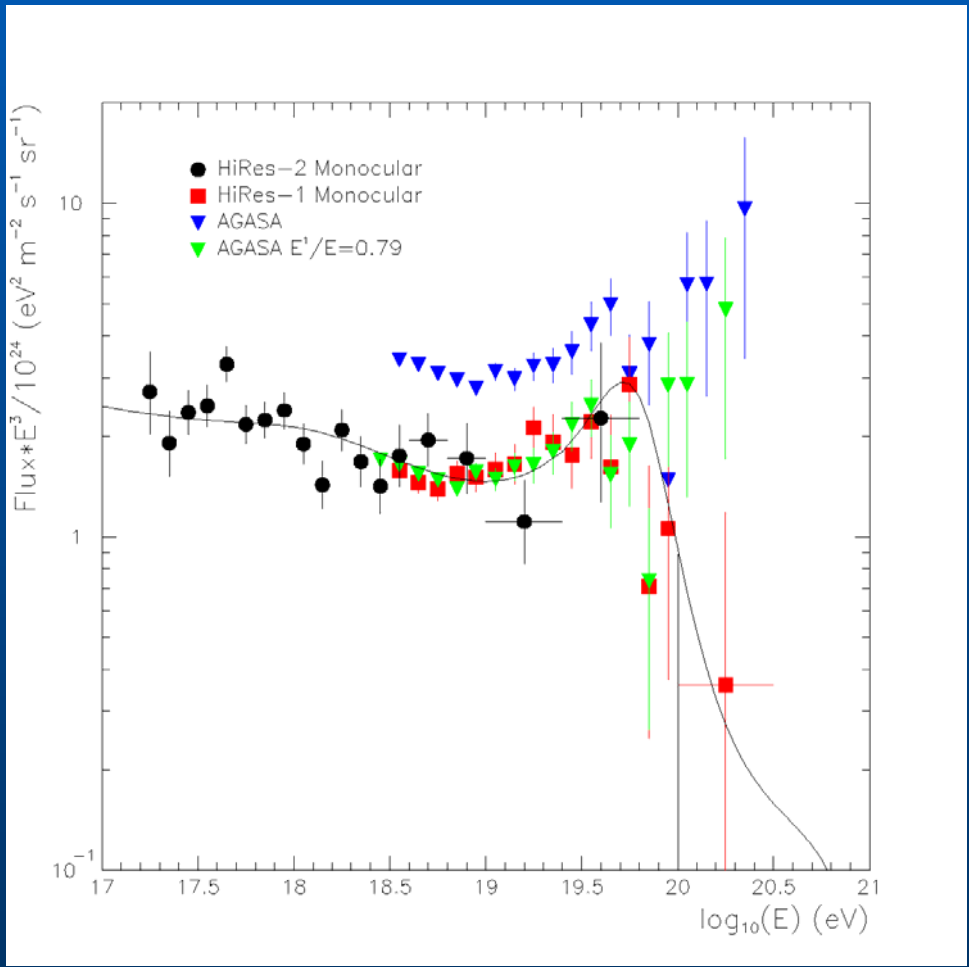
Uniform Source Model Fit

- Fly's Eye composition suggests heavy-to-light change in ankle region
- Use this to motivate a two component spectrum
  - Galactic component, power law with linear factor from composition measurement
  - Extragalactic component assuming uniform source density as in Berezinsky et al., hep-ph/0204357



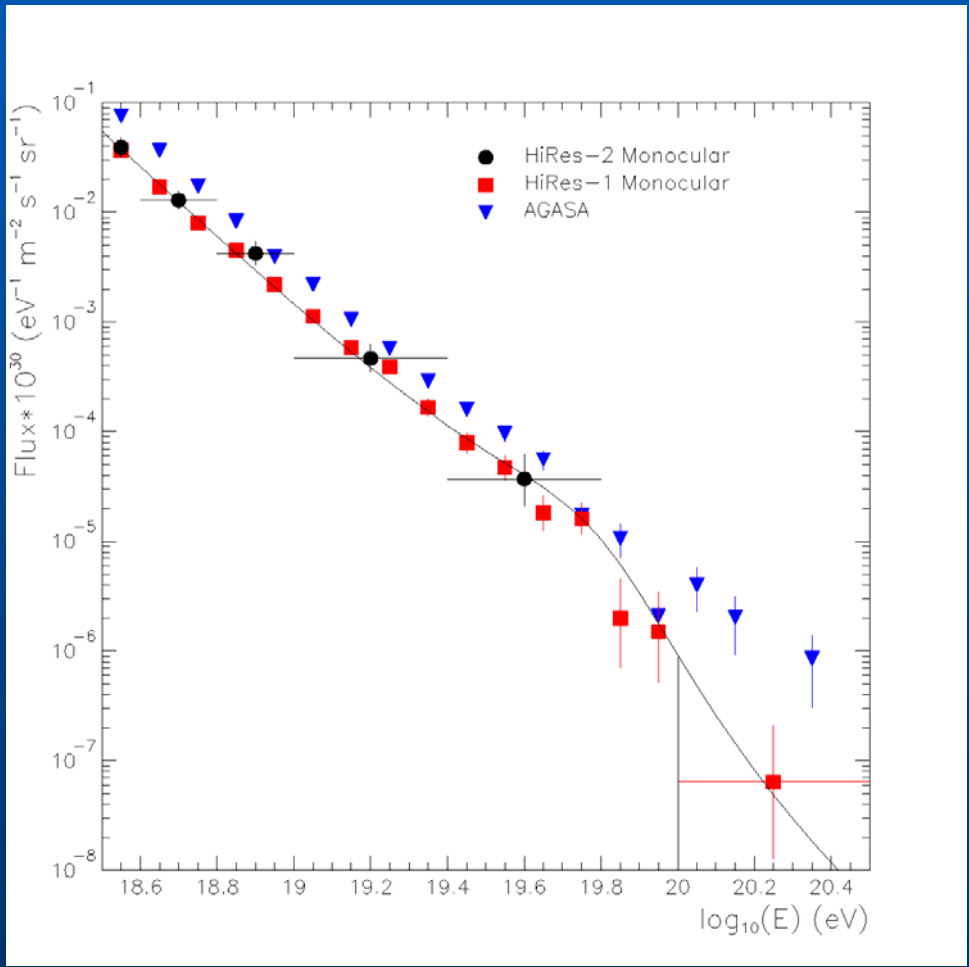
HiRes vs AGASA

- Disagreement between HiRes and AGASA reduced:
  - Factor of 2 in flux
  - A few points over 100 EeV
- Scaling AGASA energies down by 20% makes apparent the nice agreement in ankle region



HiRes vs AGASA

- **Agreement below 60 EeV and disagreement above quite visible in unmodified flux comparison**



Conclusion

- HiRes has measured the spectrum of Cosmic Rays at the highest energies and with the highest sensitivity at these energies
- We observe a feature consistent with what's expected from the GZK process
- HiRes has observed several strong candidates at energies above the the GZK energy