



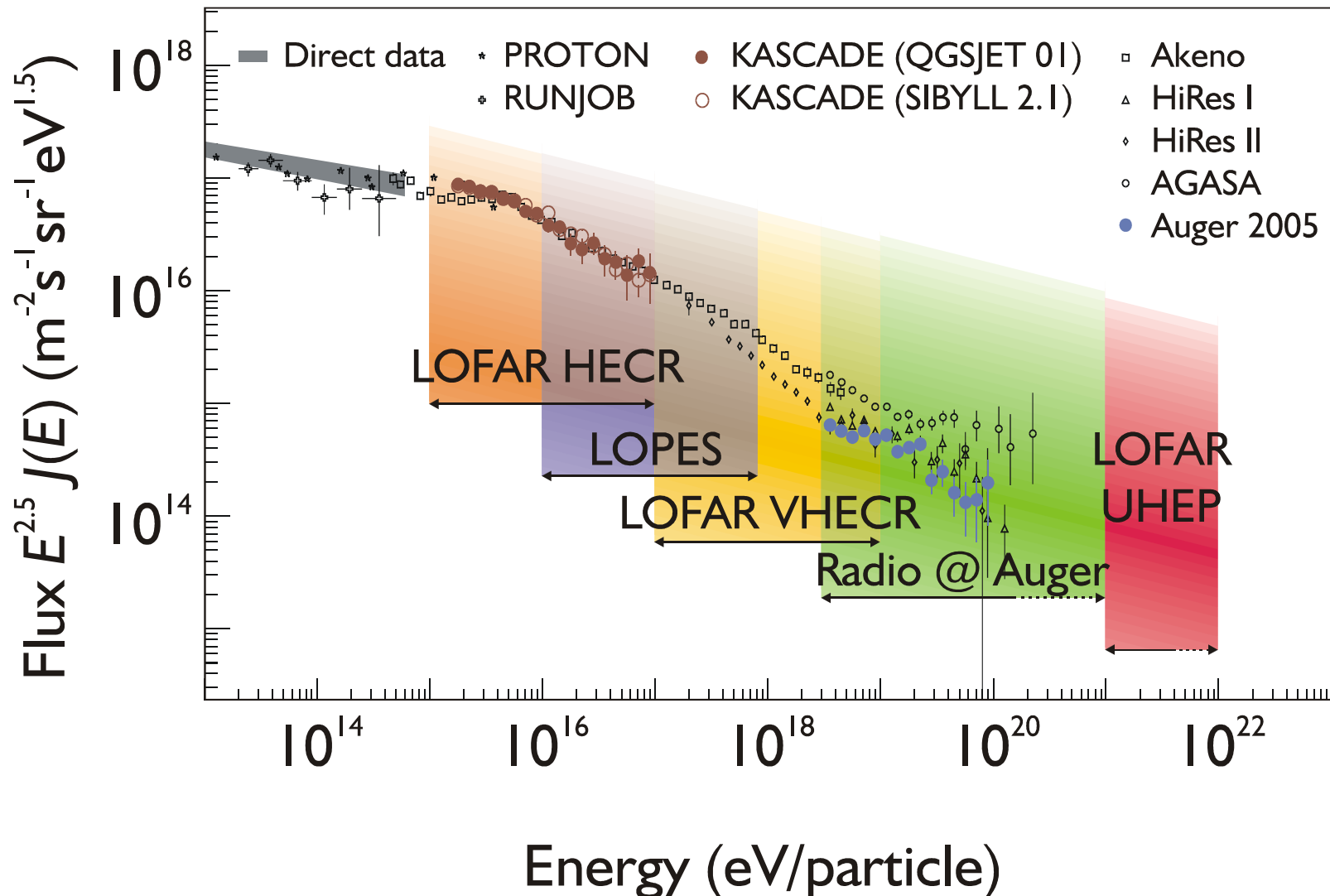
**Radboud
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Calibration Requirements of Cosmic Ray Measurements

Andreas Horneffer
for the Cosmic Ray KSP

LOFAR-CR Energy Ranges

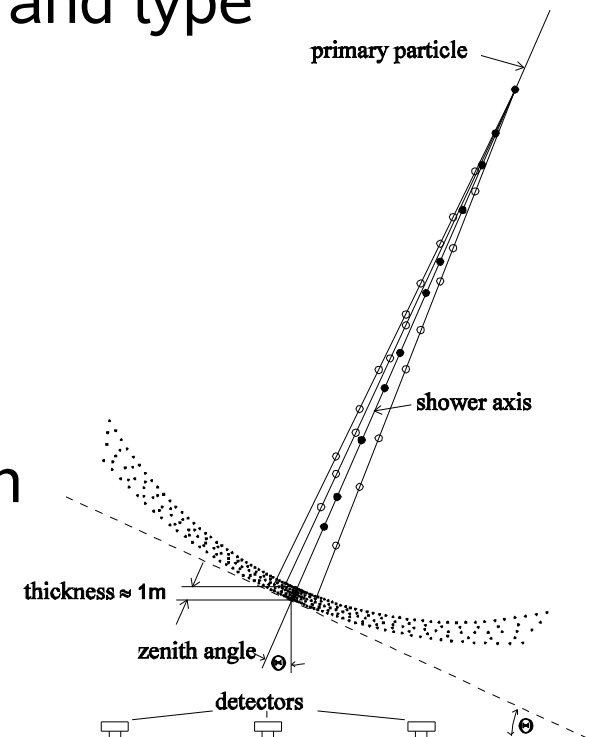


■ Air shower physics

- Understanding the emission process
- Determination of the particle energy and type
- Direction reconstruction
- Search for isotropic radiation

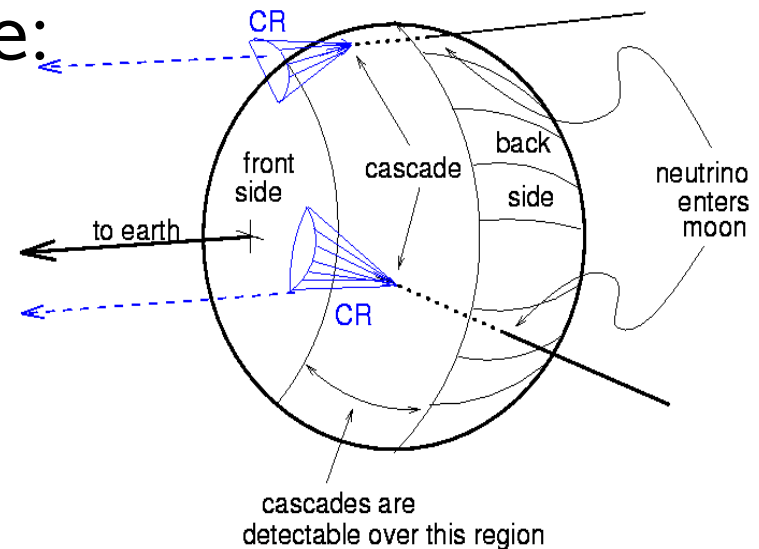
■ Cosmic ray physics

- Determination of the CR spectrum
- Determination of the CR composition
- (Arrival directions)



- Triggering (online) requirements:
 - Well ... (Know which antennas work.)
- Determine the pulse height (offline)
 - Calculate field strength from ADC values
 - Field strength error for one station: $\Delta E/E < \sim 2\%$
 - $\rightarrow \Delta E/E < \sim 20\%$ for a single antenna
- Measurement of the shower disc shape (offline)
 - Measure the pulse arrival time in different antennas
 - Relative timing error: $\Delta t < \sim 0.1$ ns
 - at least inside a station, preferably also inside the core
 - not needed to remote stations

- Measure radio pulse and identify it as an UHEP radio pulse (for the first time)!
 - Bandwidth limited pulse
 - From the Moon (i.e. outside the ionosphere)
 - From one spot on the Moon
- Measure features of the pulse:
 - Position on the Moon
 - Pulse strength at the Moon
 - Polarisation





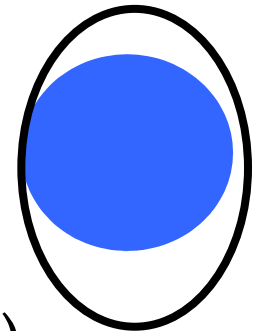
LOFAR UHEP Requirements

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■ Triggering requirements (online):

- The formed beam should stay on the moon
- Pulse widening due to uncorrected dispersion in the order of the pulse width: ($\Delta_{\text{STEC}} < 1\text{TECU}$?)



■ Analysis requirements:

- The position on the Moon determined with full LOFAR resolution
- Pulse widening due to uncorrected dispersion less than the pulse width: ($\Delta_{\text{STEC}} \ll 1\text{TECU}$?)