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LOFAR Cosmic Ray Comissioning

Andreas Horneffers

view of the LOFAR-CR Effort

LOFAR-CR Observation Modes

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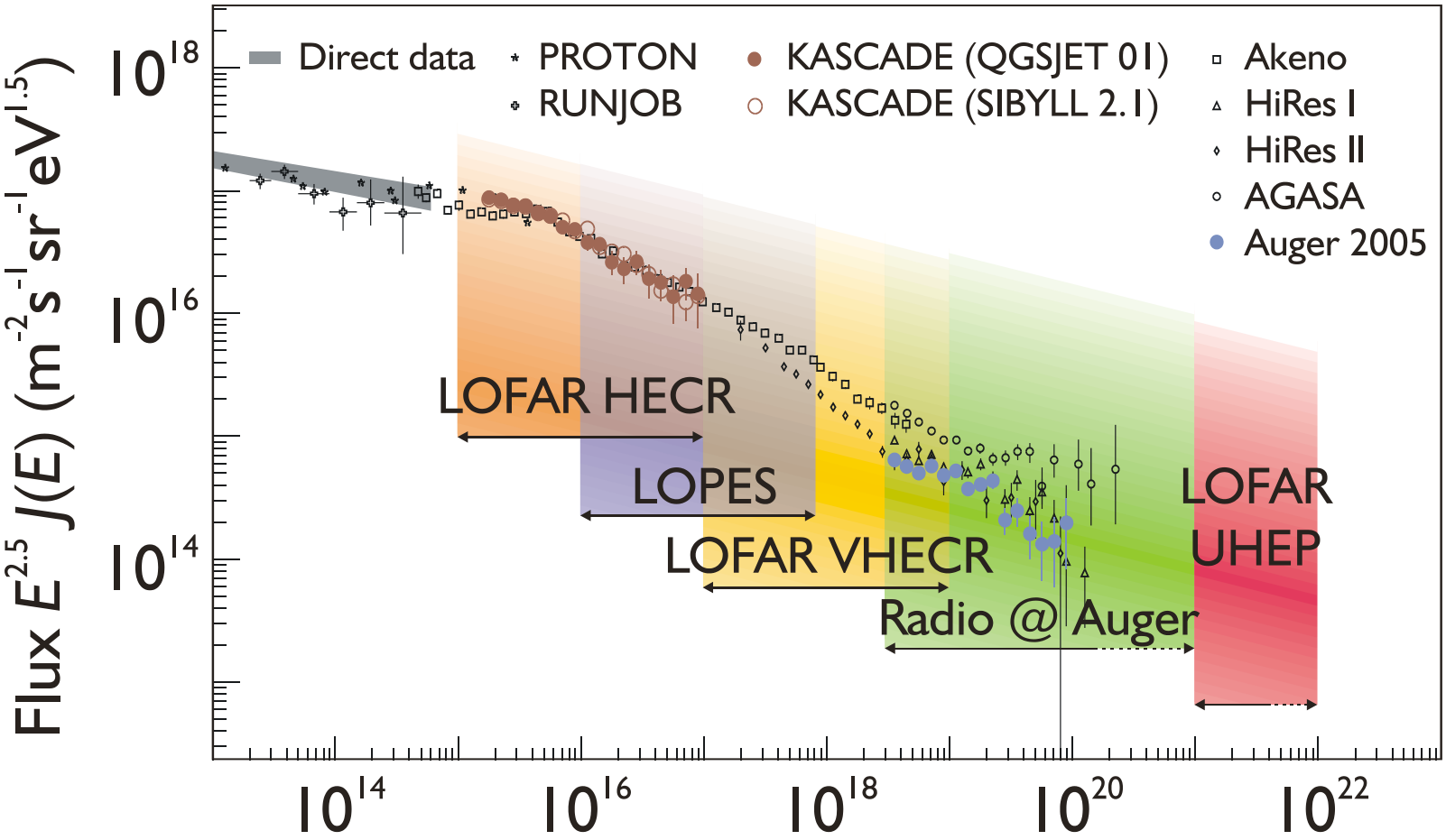

LOPES and Radio@Auger

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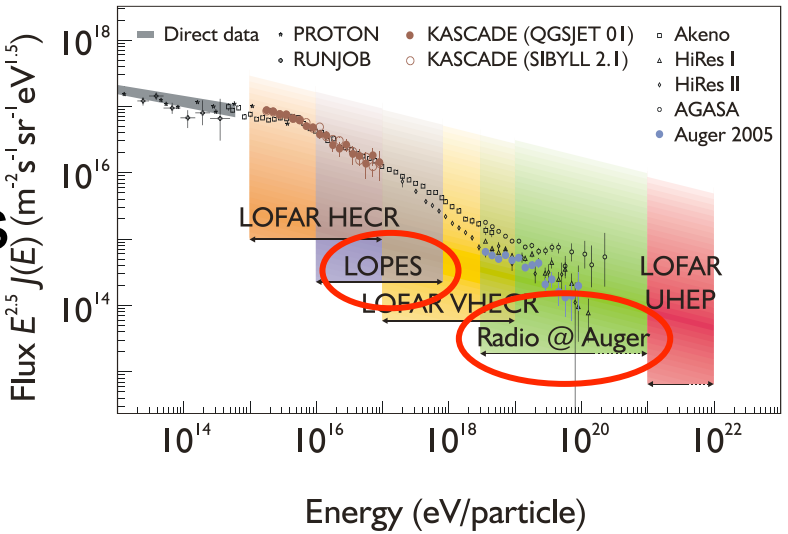
- measure radio pulses from air showers together with an existing air shower experiment:
  - LOPES: together with KASCADE-Grande
  - Radio@Auger: with the Pierre-Auger-Observatory
- LOPES: experiment is running, some data analysis remains
- Auger: mostly hardware development for autonomous antennas



VHECR

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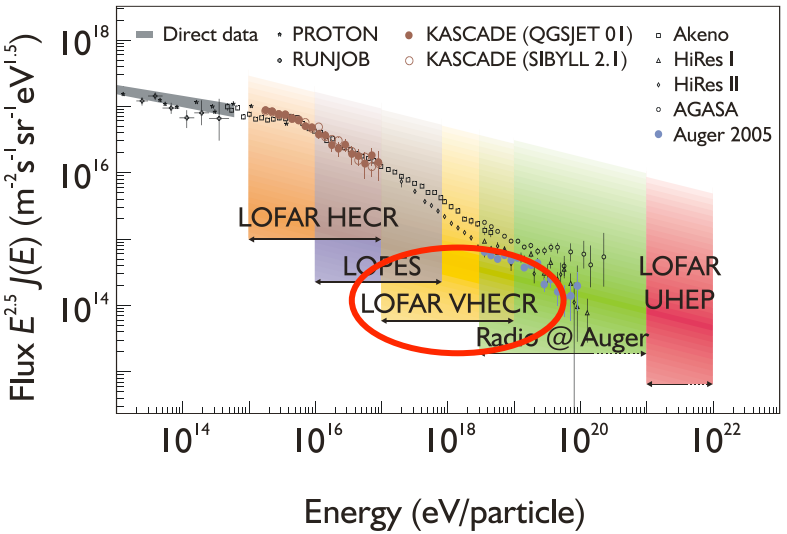
- **V**ery **H**igh **E**nergy **C**osmic **R**ays
- measure air showers in by triggering on single dipoles
  - frequency range: 10-88 MHz
  - triggering in several stages
- main goals:
  - study single air showers in great detail
  - measure the transition from galactic to extragalactic CRs



HECR

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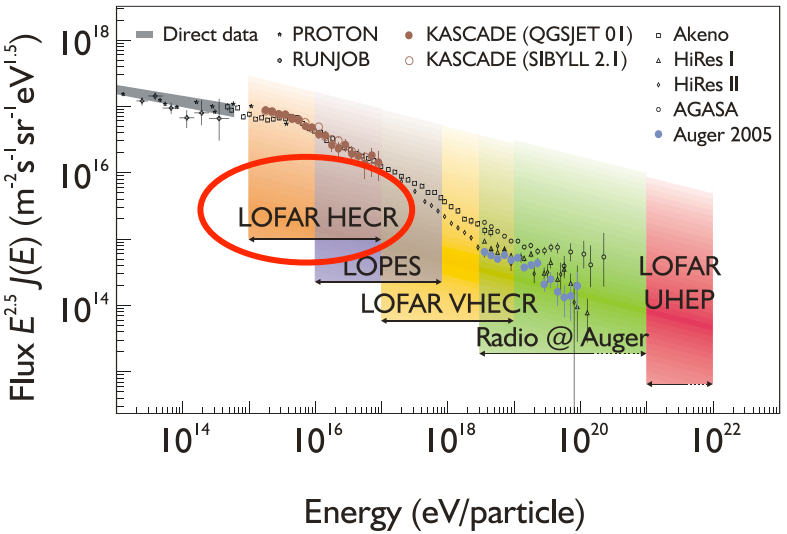
- **H**igh **E**nergy **C**osmic **R**ays
- measure air showers in by triggering beam-formed data
  - frequency range: 10-88 MHz
  - triggering on station beams at CEP
- main goal:
  - extend measured spectrum to lower energies



UHEP

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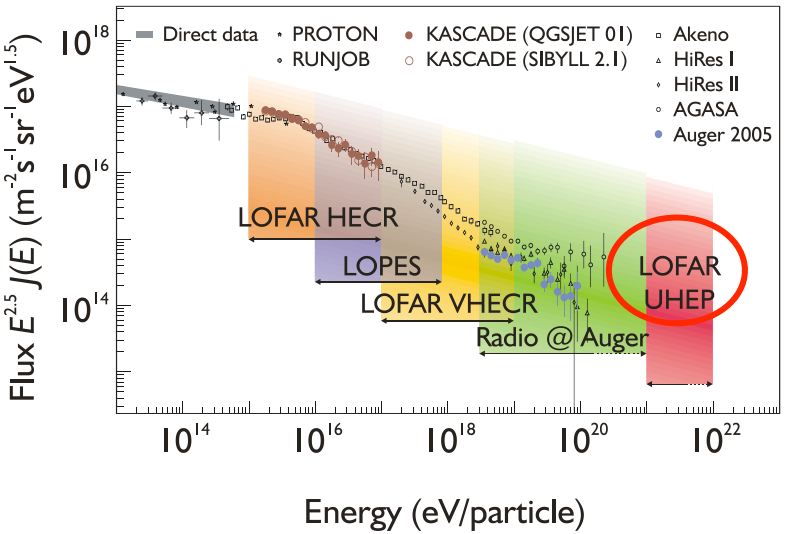
- **U**ltra **H**igh **E**nergy **P**aricles
- observe radio flashes from the moon
  - frequency range: 115-190 MHz
  - form several tied-array beams on the moon and trigger on the beam-formed data stream
- main goal: observe for the first time particles > 10^{21} eV



LOFAR

OSASS

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- **O**ne **S**econd **A**ll **S**ky **S**urvey
- General TBB-imaging
  - Includes imaging of lightning
- Search for transients on time-scales << 1 sec
  - frequency-range: ? (same as surveys?)

Commissioning
(aka ToDo-List)

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IN·DEI·NOMINE·FELICITER

1. Technical issues
2. Commissioning-data

Technical Commissioning

LOFAR

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- TBB read-out
- MAC/SAS integration
  - Control of TBBs
  - Trigger interface
- Metadata interface
- General TBB imaging
  - Imaging of **large** datasets
- VHECR trigger
  - TBB trigger
  - LCU trigger-frame
  - CEP trigger-frame
- UHEP/HECR trigger
  - CEP-latency (TBB buffer size!!!)
  - Moon tracking
  - Ionosphere de-dispersion
  - PPF inversion implementation

LOFAR Commissioning Data

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- VHECR
  - Figure out the correct parameters for the trigger
    - Survey of single-dipole pulse parameters
      - Piggy-backed(?) runs of ~1day with one channel
    - Iterative LCU trigger-algorithm development
      - Piggy-backed(?) runs of ~1day with the superterp
      - Run together with the particle array
  - Correct parameters for the offline pipeline
    - Tune the reconstruction algorithm
    - Parameters for event-selection
    - Piggy-backed runs
- UHEP
  - Study noise level and effect of PPF/PPF-inversion
  - Iterative trigger-algorithm development
    - “short measurements” (~15min)

Triggering

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- for VHECR mode
  1. TBB stage
     - essentially done, need final testing
  2. LCU stage
     - first version done, needs testing and refinement
  3. CEP stage
- for UHEP/HECR mode
  1. de-dispersion (only UHEP)
     - hope we can borrow this from other KSPs
  2. PPF inversion
     - algorithm defined, needs implementation on Blue Gene
  3. peak finding
  4. UHEP peak evaluation
  5. HECR peak evaluation
- Particle array
  - general design and layout planned
  - need to build and test detectors

CR-KSP Tasks

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- tasks are grouped into four tasks:

1. Triggering
   - "Algorithms to decide when to dump the TBB data"
2. Software
   - implement analysis software
   - batch and interactive mode
   - have to write basically everything on our own
3. Simulations
   - lots of work done by loosely associated people
4. Data analysis