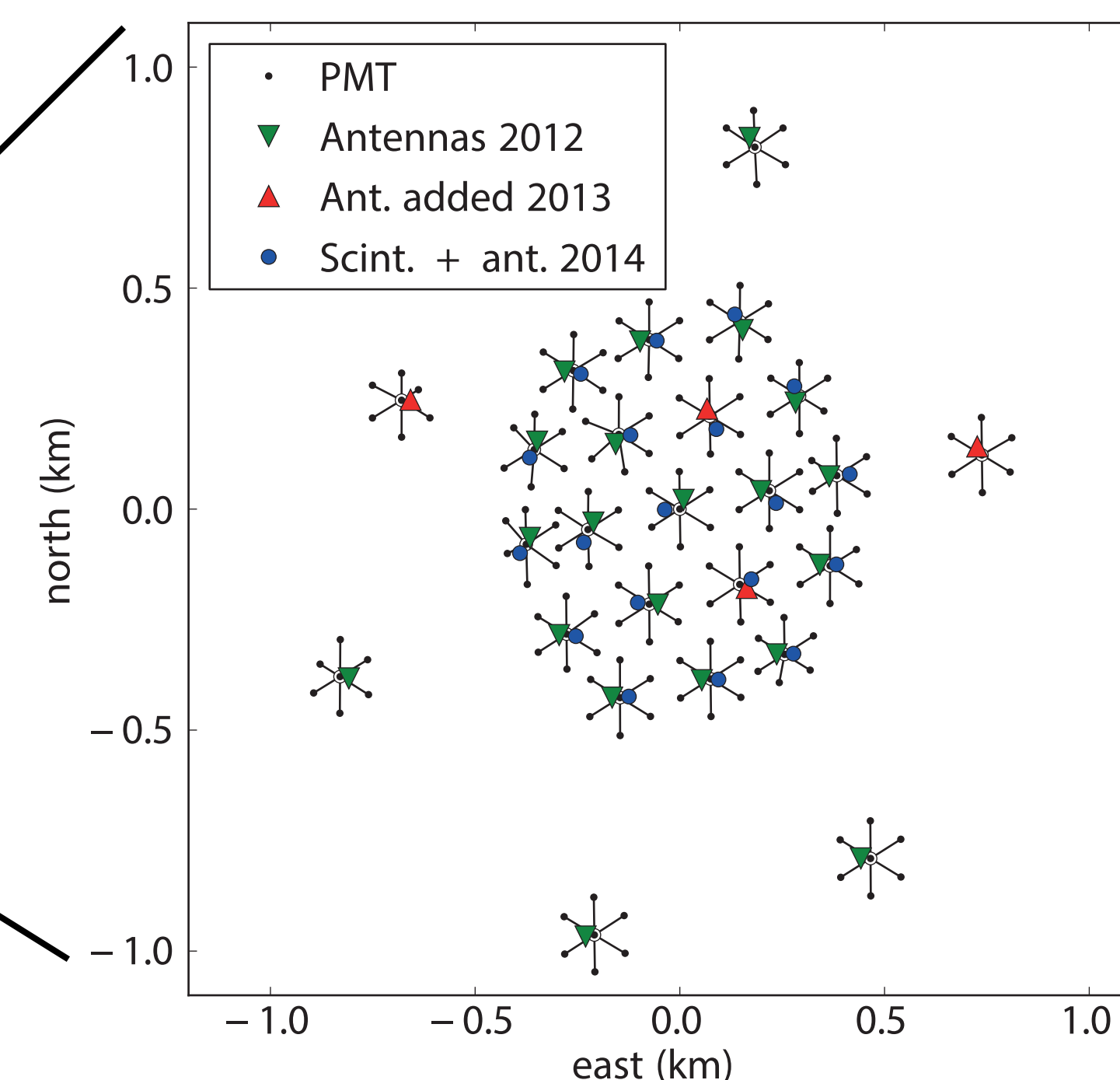


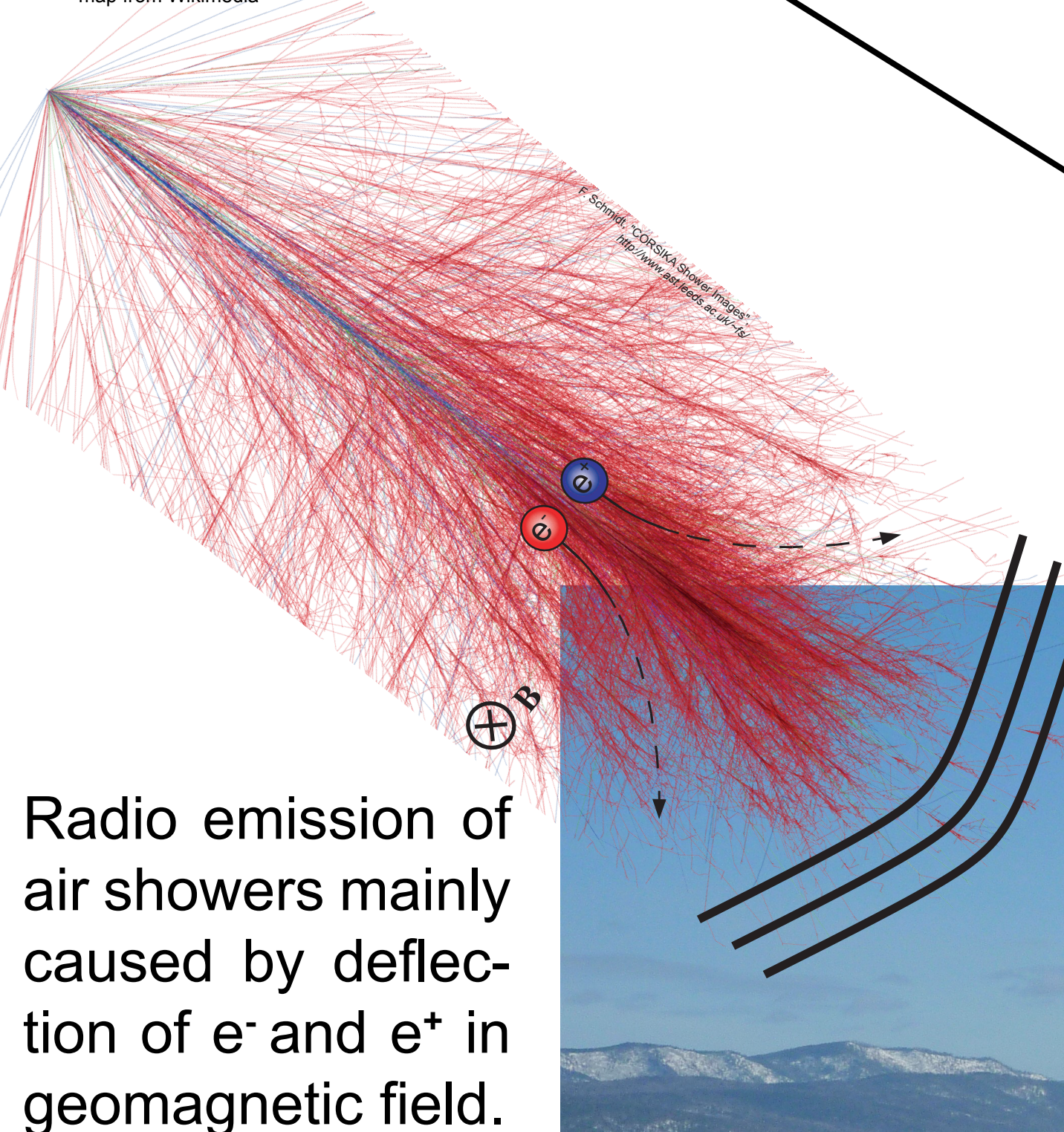
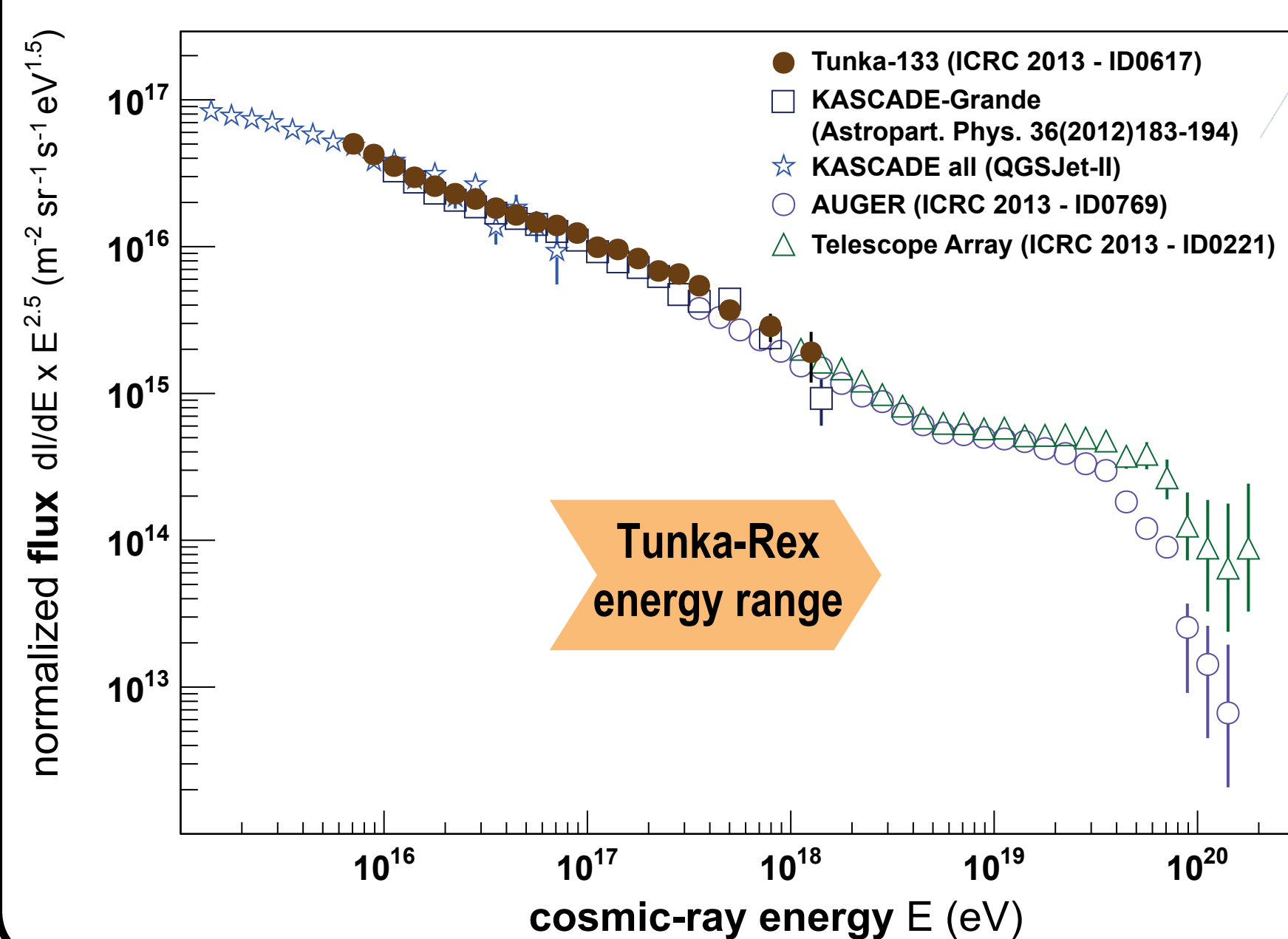
## Take home message

- Cross-calibration of air-Cherenkov and radio measurements of the same air showers
- Both have similar energy precision:  $\sim 15\%$
- 24/7 operation possible due to trigger by new scintillator extension Tunka-Grande

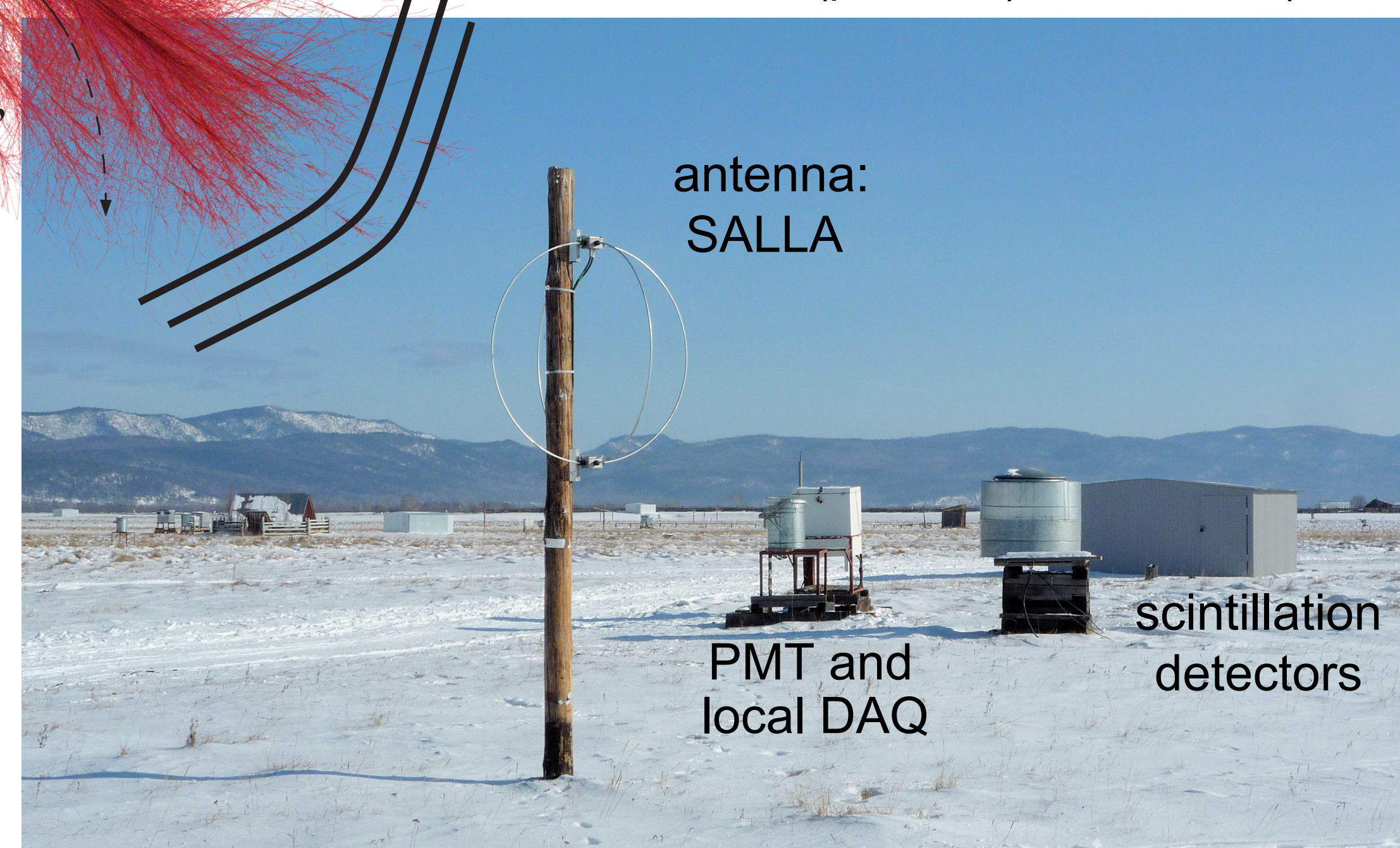


Map of the Tunka experiments: Tunka-133 (air-Cherenkov), Tunka-Grande (particles), Tunka-Rex (radio)

## Cosmic-Ray energy range



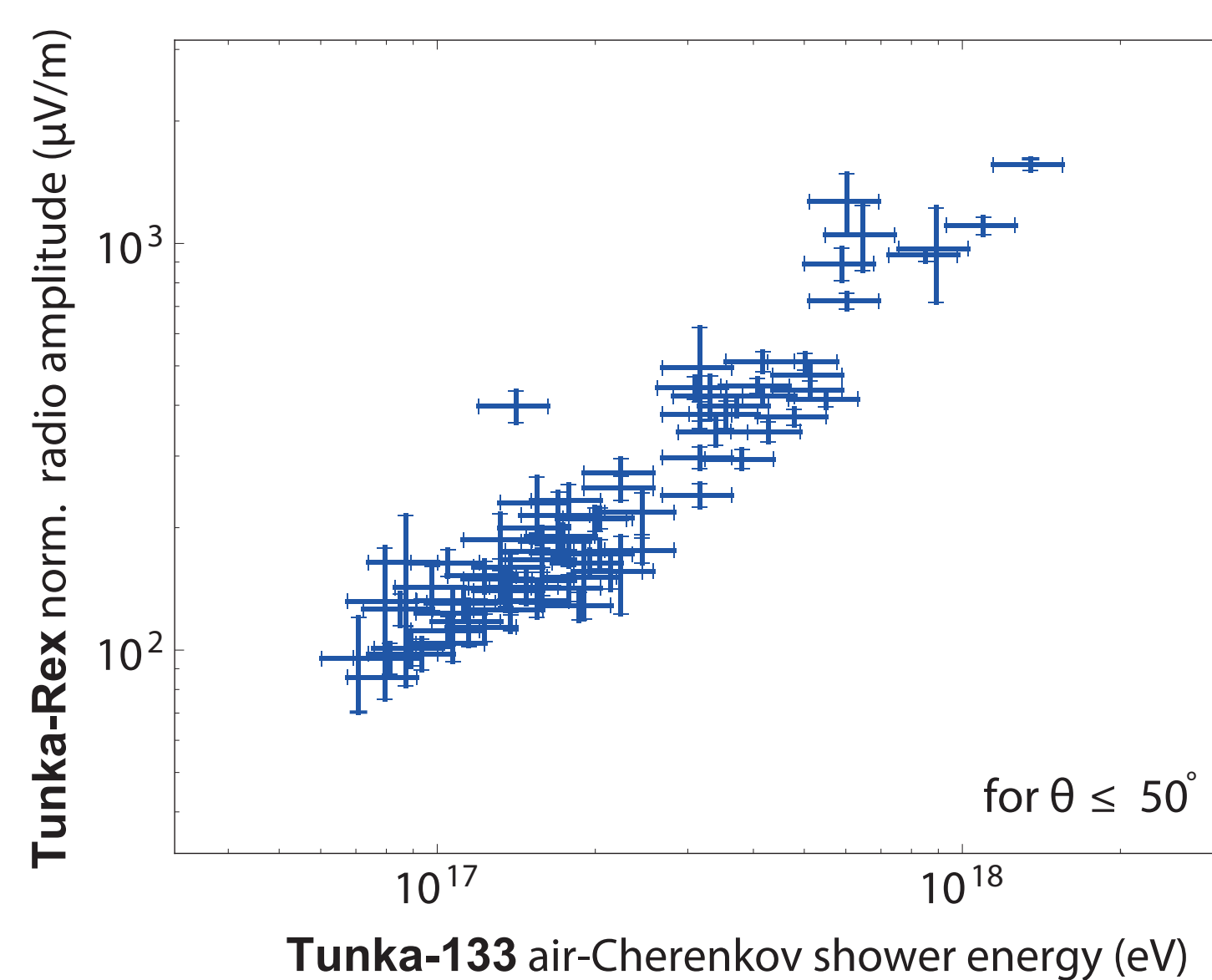
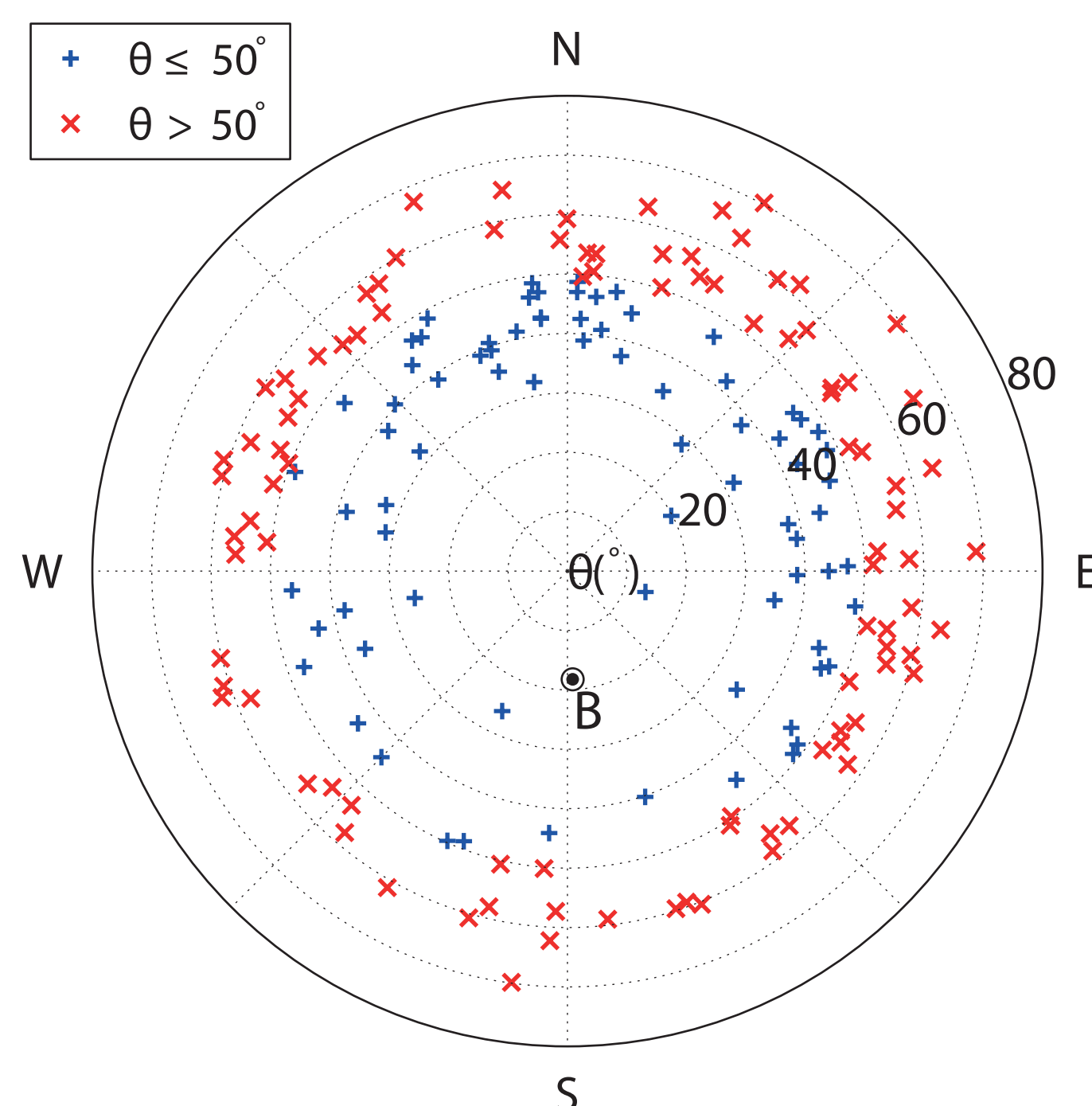
Radio emission of air showers mainly caused by deflection of  $e^-$  and  $e^+$  in geomagnetic field.



## First results

### Sky map of events of first season (2012/2013):

- North-South asymmetry due to dominant geomagnetic effect
- In contrast to air-Cherenkov method, radio more efficient for inclined events



### Energy correlation:

Radio amplitude at 100 meter distance from shower axis, normalized for geomagnetic effect vs. air-shower energy obtained from Tunka-133 air-Cherenkov measurement

## Technical data

- Trigger and DAQ: by PMTs and scintillators
- Effective freq. band: 35-76 MHz
- Antenna type: SALLA (2 channels)
- Alignment: 45° and 135° (like LOFAR)
- Array size: 44 antennas on approx. 3 km<sup>2</sup>
- Approx. cost:  $\sim 400$  € per antenna
- Event rate: approx. one event per hour

## Blind strategy for cross-calibration

- Develop methods for reconstruction of Tunka-Rex radio measurements by cross-calibration to the Tunka-133 air-Cherenkov data of 2012/13
- Test of the **precision for energy and composition** by comparison with yet blind Tunka-133 data of 2013/14



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## Tunka-Rex Collaboration

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