





































### The Radio Detector of the Pierre Auger Observatory







#### **Key science questions** •What are the sources and acceleration mechanisms of ultra-high-energy cosmic rays (UHECRs)?

- Do we understand particle acceleration and physics at energies well beyond the LHC (Large Hadron Collider) scale?
- •What is the fraction of protons, photons, and neutrinos in cosmic rays at the highest energies?











### The Radio Detector of the Pierre Auger Observatory







 dual polarized radio antenna (30-80 MHz) on each SD station

1661 positions over 3000 km<sup>2</sup>

 mass sensitivity for inclined air showers radio: e/m WCD: muons

complementary to SSD/WCD







### Expected number of cosmic rays in 10 years Karlsruhe Institute of Technology



#### **T. Huege, UHECR symposium 2022**



- integral spectrum from folding flux with aperture
- expect ~4000 cosmic rays above 10<sup>19</sup> eV









# **Expected mass composition sensitivity**







#### see also proof of principle study with AERA, PoS(ARENA2022)





# Precision measurement of muon number







 very precise measurement of muon number with WCD & RD at highest energies

 especially measurement of the variation of the muon number will be very powerful



### Serious logistics effort to get all components to the Observatory

- solar panels 2000 units
- antenna arms 6800 parts
- ropes (6 km) and tensioners for the mast
- Al tubes for frame 13600 parts
- Al plates and antenna foot 8500 parts
- small parts, u-bolts, nuts, screws, ... ~400000 pieces
- housings for digitizers 2000
- pigtail cables for the LNA 4000
- housings for LNAs and bottom loads 12000 parts
- glass fiber antenna masts 1700
- ferrites 8500
- mounting brackets for solar panels 3400 pieces
- L-ground bracket inside the dome 1700 pieces
- bottom load PCBs 2000 pieces
- LNAs 2000 units
- signal cables from LNA to digitizer 10200 cables
- digital cable from digitizers to UUB 1700 cables
- fixtures to assemble ferrites 24 units
- digitizers 2000 units

### > 6 sea containers, 75 m<sup>3</sup> each & several (~5-10) air freight cargos hef VUB





27th Symposium on Astroparticle Physics in the Netherlands, Soesterberg - June 2023





# Deployment in field ongoing





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# **Calibration with Galactic signal**

### Simulated galactic signal in the EW loop



- EW calibration constant: 1.03 ± 9.6% ± 2%
- NS calibration constant: 0.96 ± 9.7% ± 2%
- <u>Uncertainty caused by the Antenna model: max 1.5%</u>

T. Fodran, ICRC 2022 T. Fodran, ARENA 2022



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### A measured air shower







- [max = 52 (-6), 51 (-10)]
- [max = 53 (-2), 46 (-2)]



### Measured air showers

### sky map







#### distribution of shower cores















strong NL contribution to Pierre Auger Observatory significant enhancement of performance of Observatory

#### deployment in field ongoing expect to be completed in early 2024 stay tuned for first results





