



R&D studies at the Pierre Auger Observatory for a next generation ground-based ultra-high energy cosmic-ray experiment

Andreas Haungs for the Pierre Auger Collaboration

The AugerNext Project

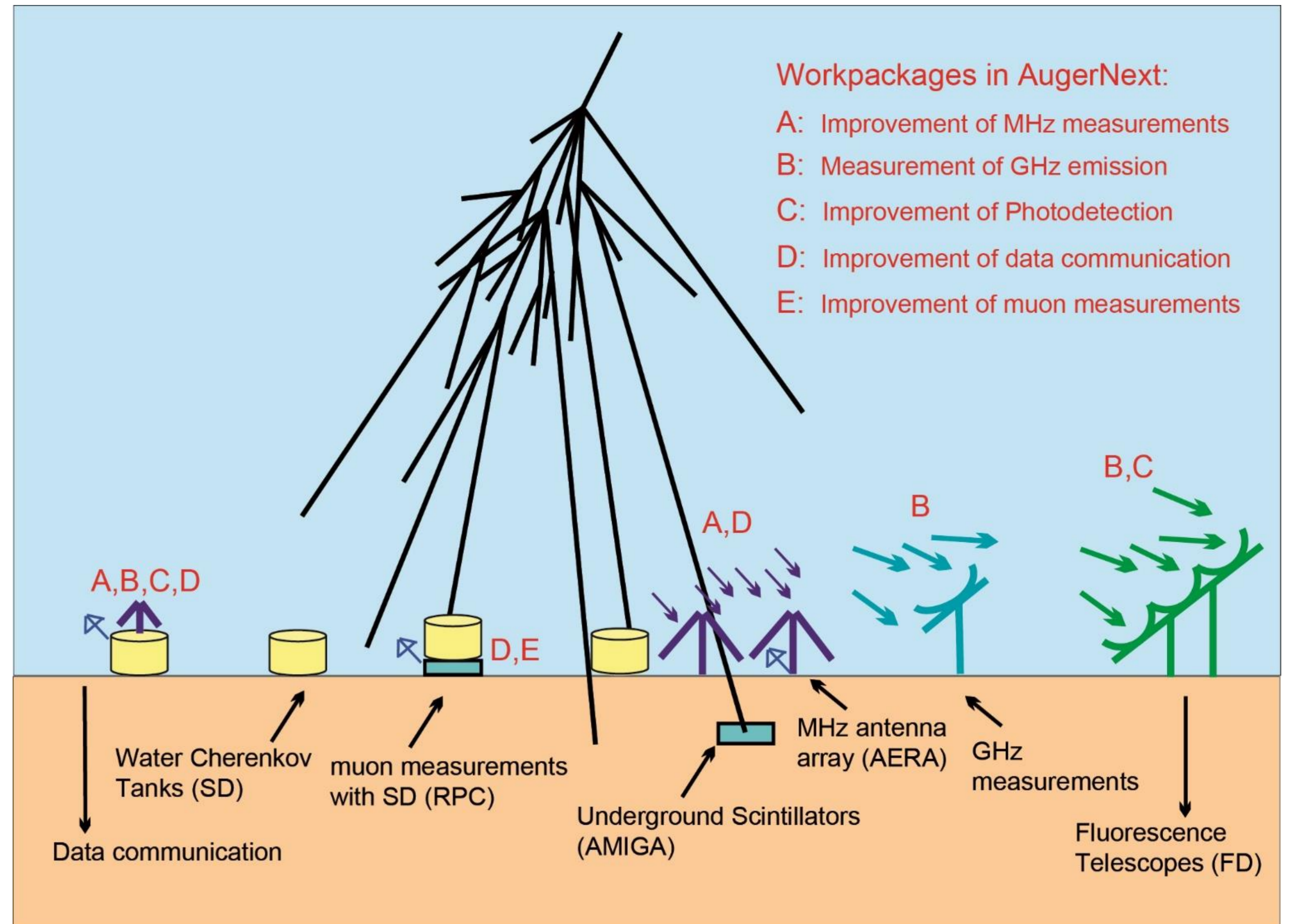
ASPERA/APPEC project (second call) for the years 2011-2014 funded by 9 European funding agencies to support design studies in view of realization of future large infrastructures in Astroparticle Physics

The ASPERA AugerNext Pierre-Auger-Consortium:

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Acknowledgement:

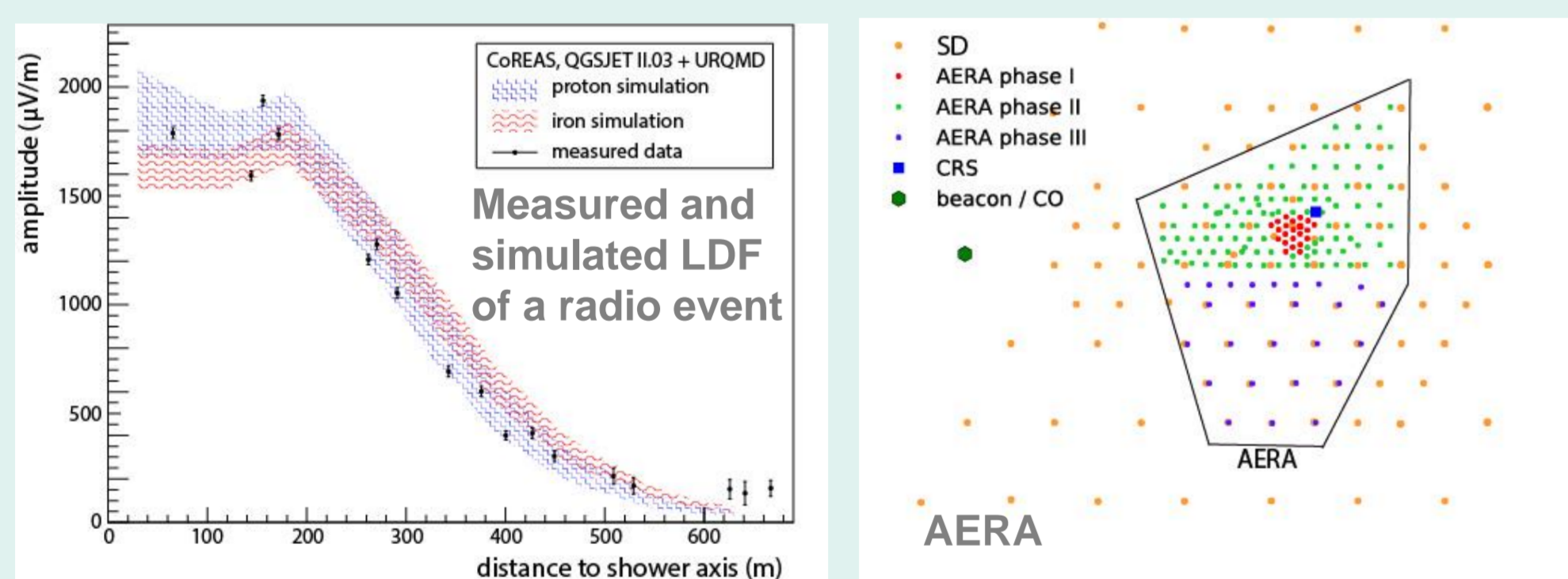
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A Investigation of MHz radio emission in air showers

Goal: establish the detection method & estimate resolution for primary energy, mass and direction

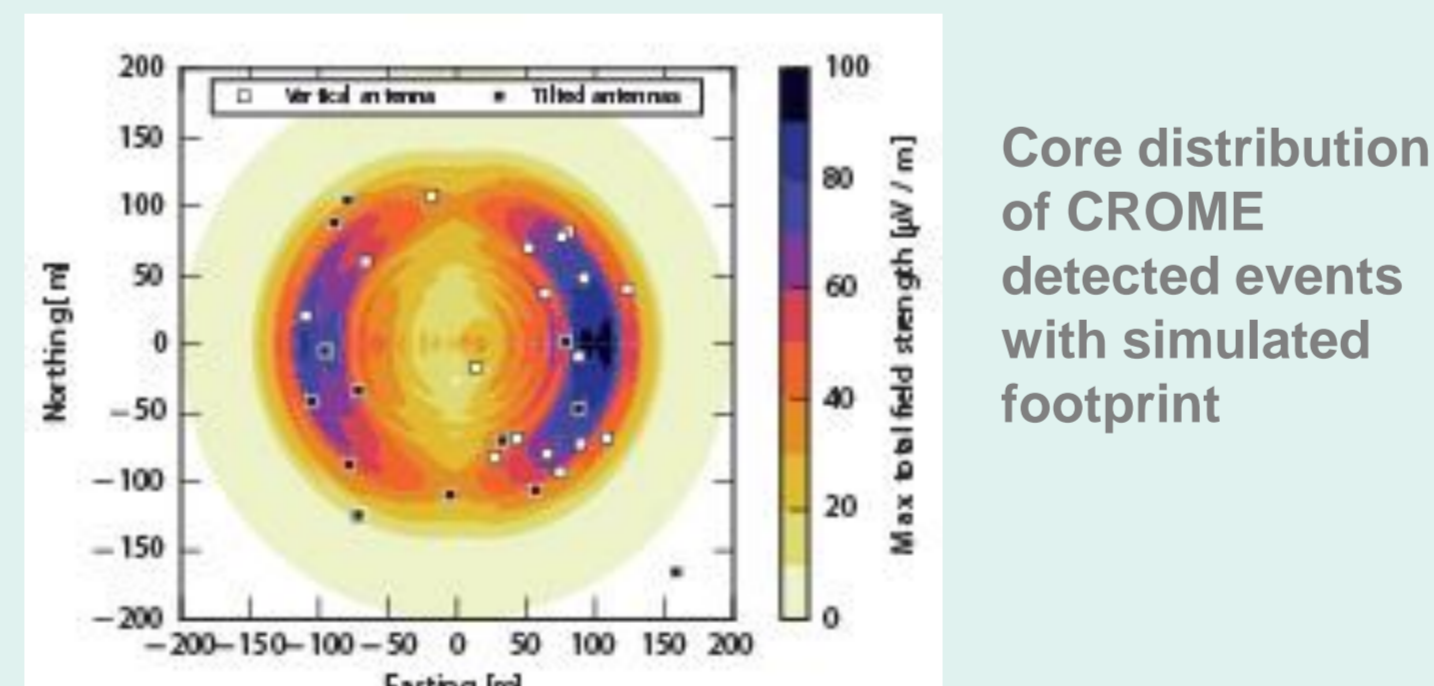
- **demonstrator for hybrid detection (EASIER)**
 - radio + SD hybrid detector: proof-of-principle
 - lateral distributions in radio for large distances
- **Auger Engineering Radio Array AERA**
 - external- and self-trigger option
 - understanding of the emission processes
 - hardware optimization for large-scale arrays
- **Horizontal air shower detection with radio**
 - sensitivity of radio the electromagnetic part of HAS



B Detection of the microwave emission in air showers

Goal: proof if this technique provides capabilities for future experiments

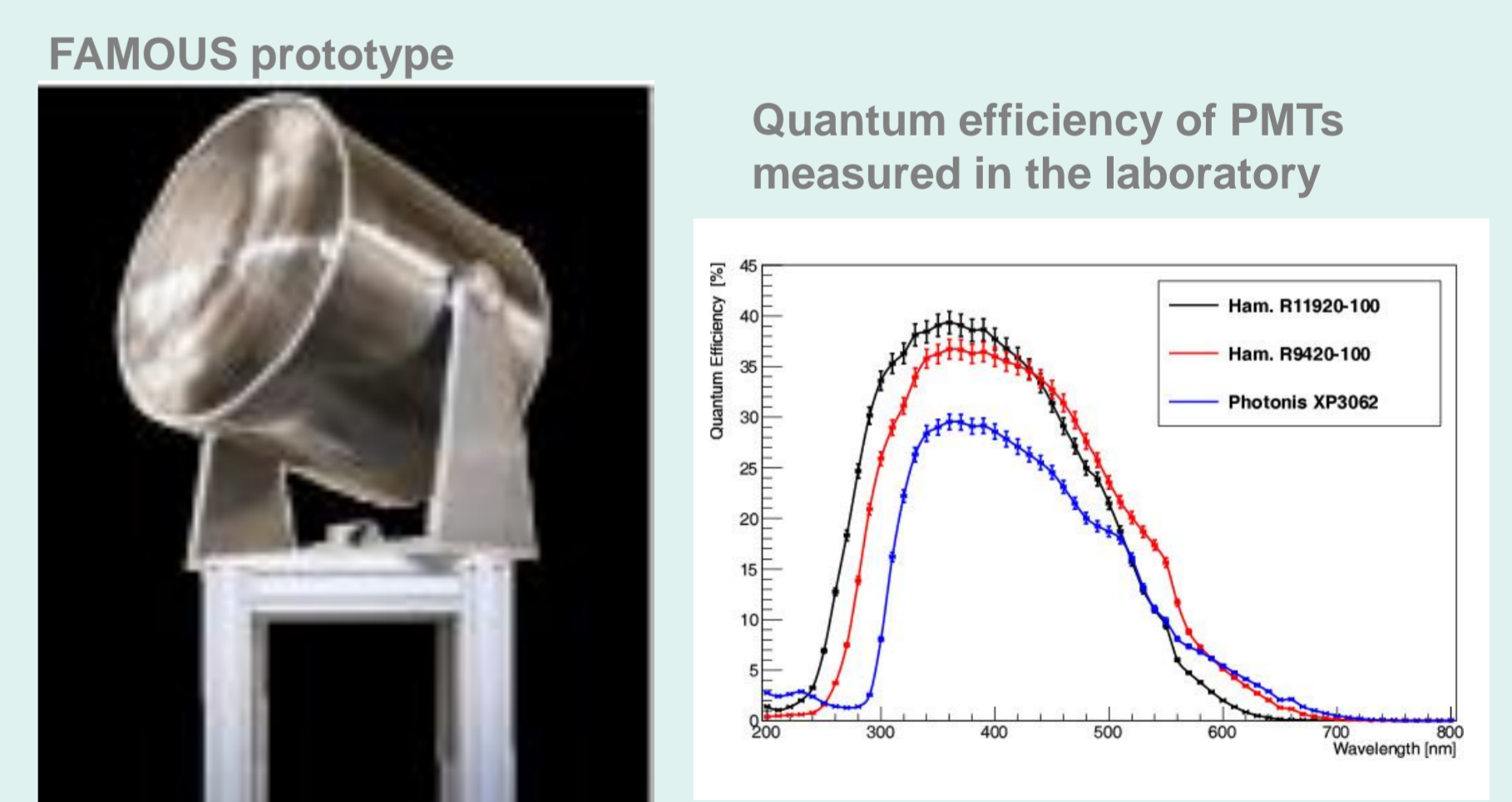
- **hybrid demonstrator (EASIER)**
 - few events detected
- **CROME**
 - triggered by KASCADE-Grande: >30 events
 - emission in forward direction (ring structure)
 - isotropic, unpolarized emission disfavored
 - radar technique seems to be unfeasible
- **FDWave and AMY**
 - concept of a microwave telescope
 - tests by accelerator measurements



C Improvement of photo sensors

Goal: capabilities of improved high-QE PMTs and SiPMs and system light collectors

- **high quantum efficiency PMTs**
 - improved QE from 35% to >45%
 - tests in Auger SD and FD as well as in labs
- **SiPM**
 - setup of first fluorescence focal-plane element based on SiPM (FAMOUS)
 - tests of SiPM readout of scintillation detectors



D Generalization of the data communication system

Goal: developing new strategies for flexible large-scale applications

- **commercial system at AERA**
 - cheap and scalable system applied
- **simulations**
 - develop suitable network topologies
 - high data rate, redundancy, failure rate, reliability
 - comparisons with measurements
- **custom-made communication**
 - proven to work at AERA
 - expensive compared to commercial systems

E Studies for a hybrid muon detector

Goal: show that RPC muon detectors can operate under harsh field conditions

- **RPC muon detector below SD**
 - prototype in hybrid operation with SD
 - optimized for low energy budget, mechanical toughness, and robust operation
 - good time resolution allows muon track reconstruction

Prototype RPC chamber and position below the SD tank



GCOS = Global COSmic ray observatory

AugerNext experience went already into AugerPRIME; possible future application in a next generation ground-based large-scale ultra-high energy cosmic-ray experiment, e.g. GCOS

- **proton astronomy with sources**
 - global, few sites, N+S; ca. 90,000 km² (x30 Auger)
 - optimized detector for composition sensitivity
 - design in 2020-25, operation 2025-??



Included in German Helmholtz large infrastructure Roadmap

Note: the references are given in the proceedings: PoS(ICRC2015)593