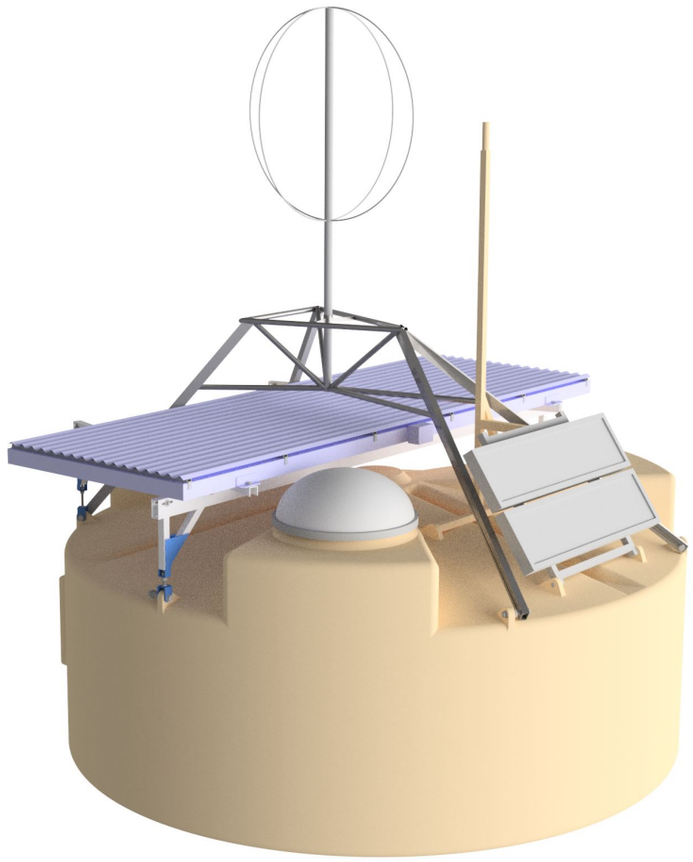
UHECR 2018 Ultra High Energy Cosmic Rays

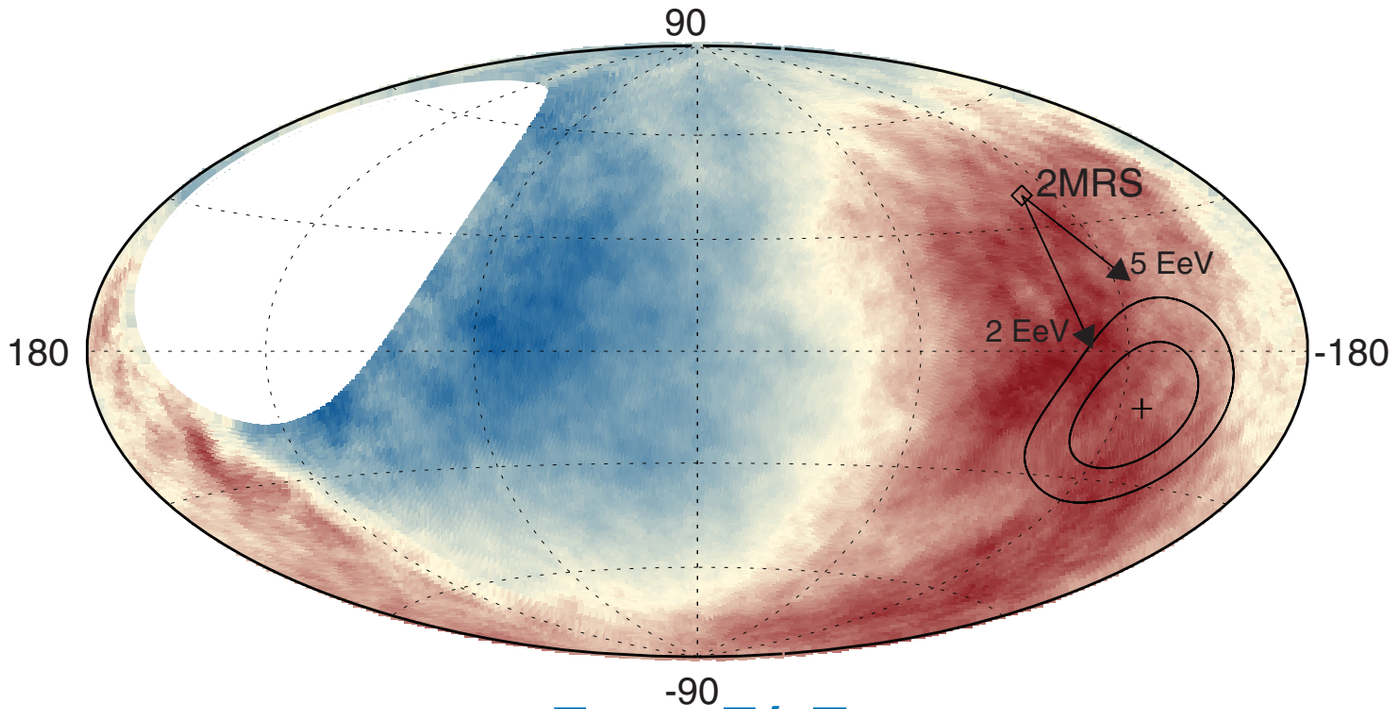
Some ideas towards a next-generation cosmic ray experiment



upgraded PAO will measure

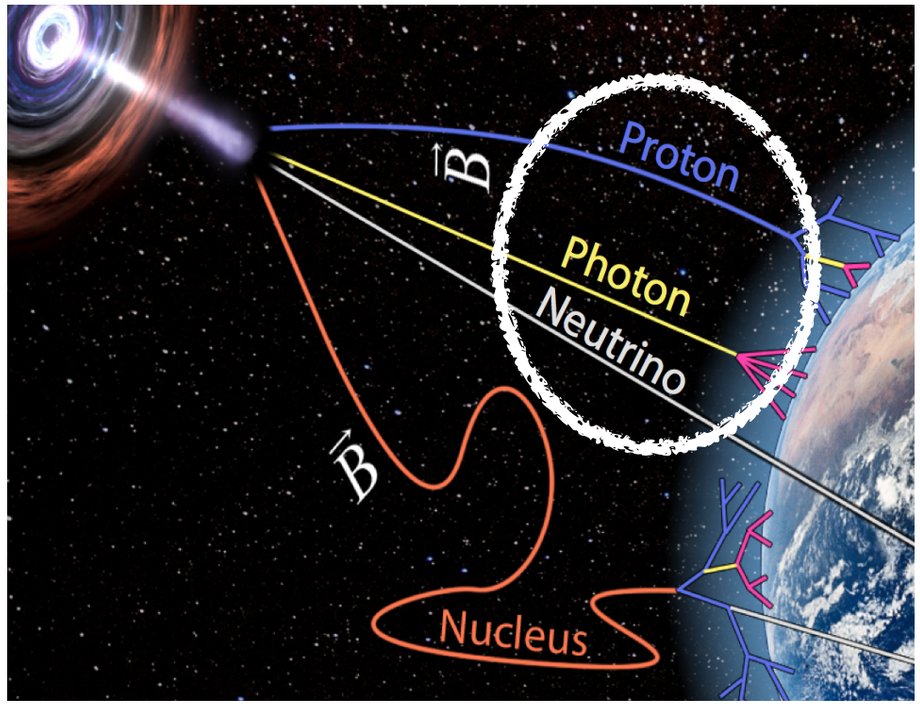
$$(E, \sim Z, \theta, \phi)$$

for each cosmic ray



E —> E/~Z

sky maps in energy —> sky maps in rigidity



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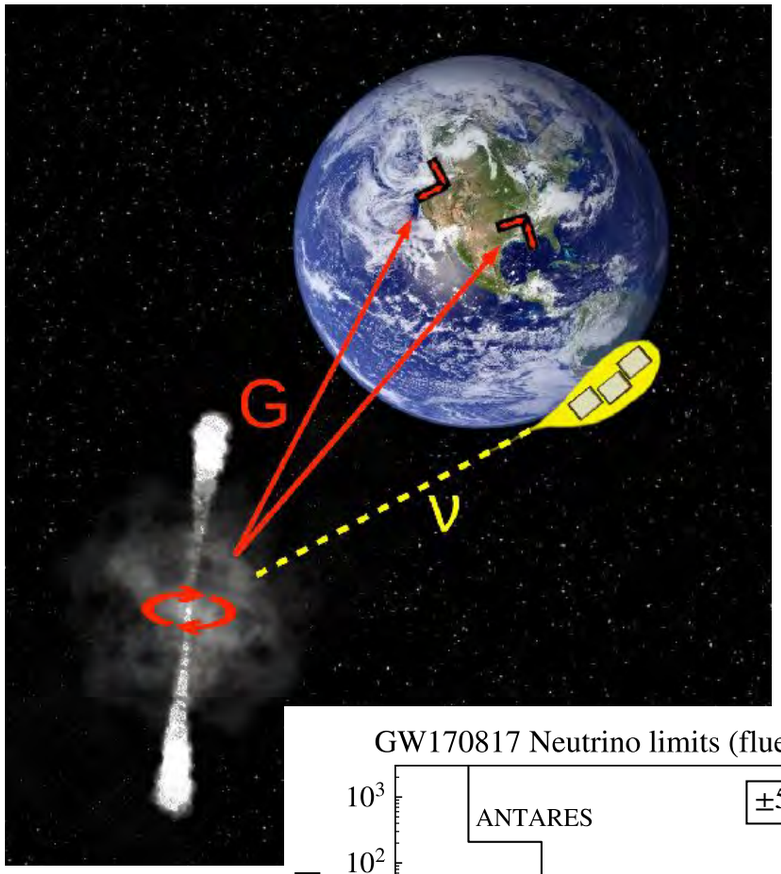
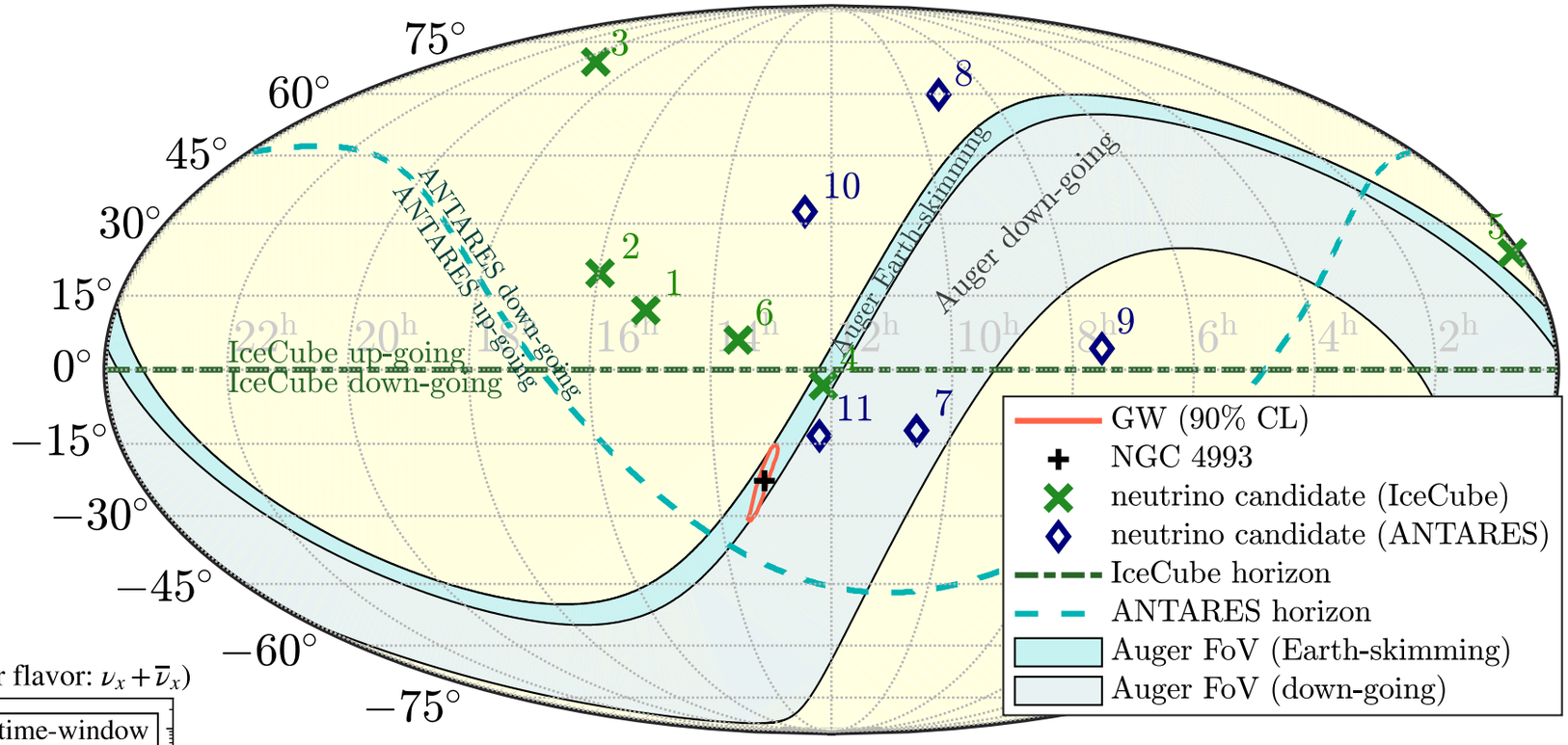
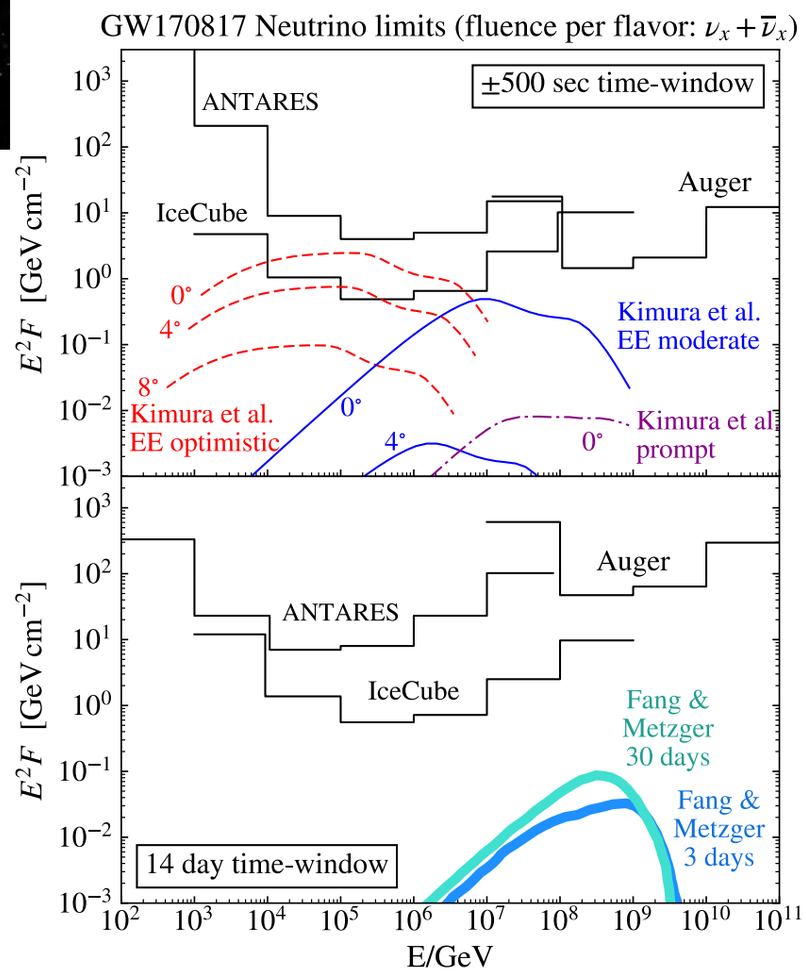






The Astrophysical Journal Letters, 848:L12 (59pp), 2017 October 20 https://doi.org/10.3847/2041-8213/aa91c9

OPEN ACCESS

Multi-messenger Observations of a Binary Neutron Star Merger

LIGO Scientific Collaboration and Virgo Collaboration, Fermi GBM, INTEGRAL, IceCube Collaboration, AstroSat Cadmium Zinc Telluride Imager Team, IPN Collaboration, The Insight-Hxmt Collaboration, ANTARES Collaboration, The Swift Collaboration, AGILE Team, The 1M2H Team, The Dark Energy Camera GW-EM Collaboration and the DES Collaboration, The DLT40 Collaboration, GRAWITA: GRAvitational Wave Inaf TeAm, The Fermi Large Area Telescope Collaboration, ATCA: Australia Telescope Compact Array, ASKAP: Australian SKA Pathfinder, Las Cumbres Observatory Group, OzGrav, DWF (Deeper, Wider, Faster Program), AST3, and CAASTRO Collaborations, The VINROUGE Collaboration, MASTER Collaboration, J-GEM, GROWTH, JAGWAR, Caltech-NRAO, TTU-NRAO, and NuSTAR Collaborations, Pan-STARRS, The MAXI Team, TZAC Consortium, KU Collaboration, Nordic Optical Telescope, ePESSTO, GROND, Texas Tech University, SALT Group, TOROS: Transient Robotic Observatory of the South Collaboration, The BOOTES Collaboration, MWA: Murchison Widefield Array, The CALET Collaboration, IKI-GW Follow-up Collaboration, H.E.S.S. Collaboration, LOFAR Collaboration, LWA: Long Wavelength Array, HAWC Collaboration, The Pierre Auger Collaboration, ALMA Collaboration, Euro VLBI Team, Pi of the Sky Collaboration, The Chandra Team at McGill University, DFN: Desert Fireball Network, ATLAS, High Time Resolution Universe Survey, RIMAS and RATIR, and SKA South Africa/MeerKAT

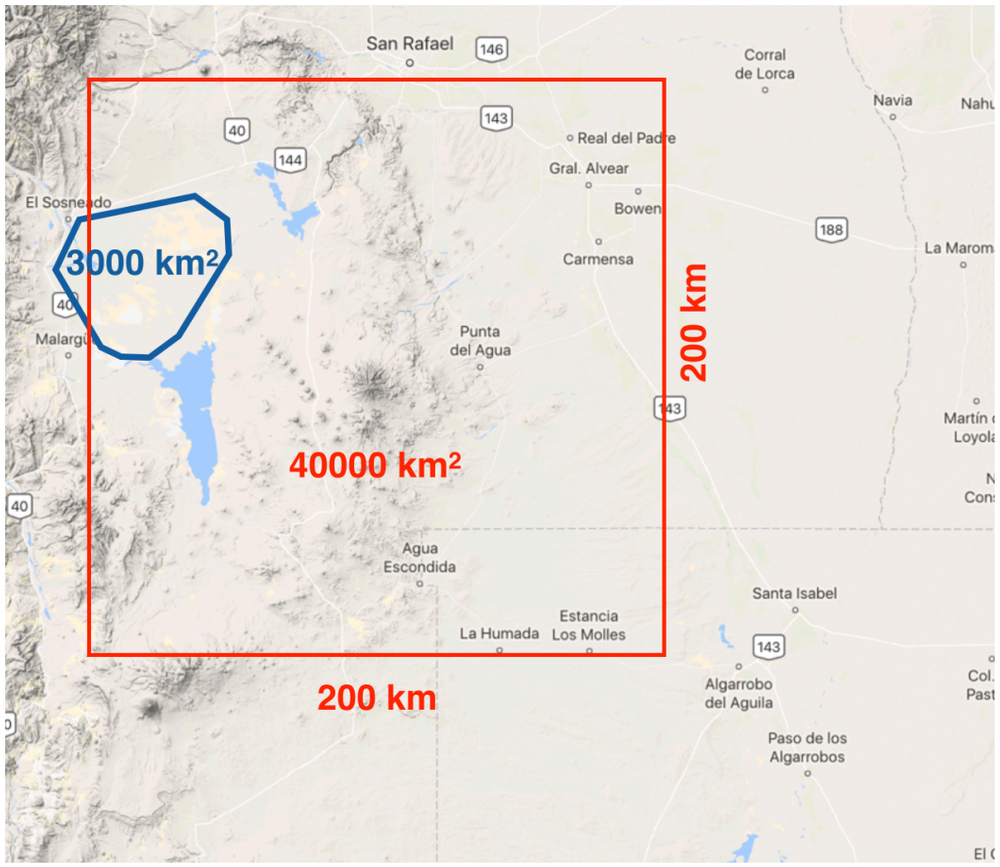
Next-generation cosmic-ray experiment

if upgraded PAO finds p-fraction >10%

--> source hunting *see talk by Arjen van Vliet*

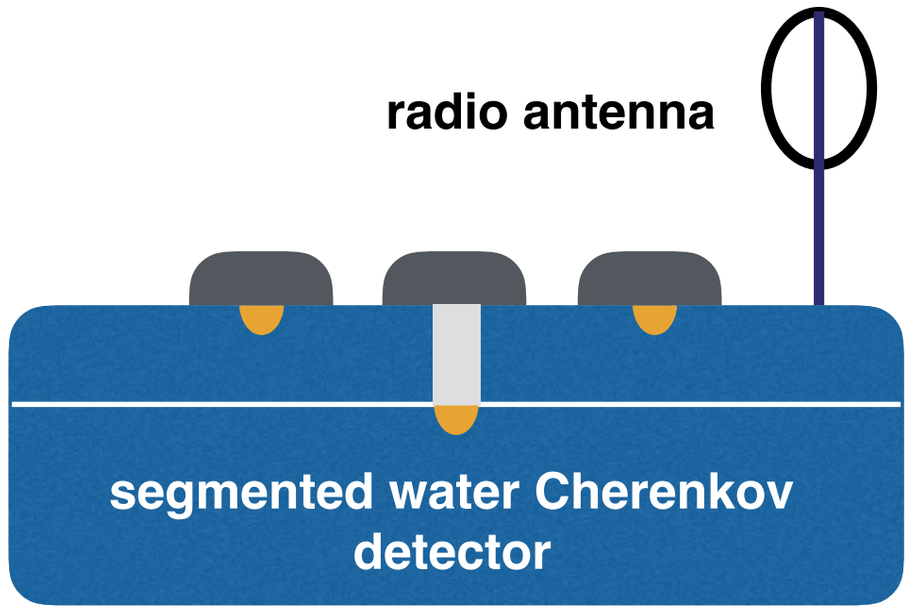
Key science questions

- **isolate protons, photons, neutrinos**
- **—> astronomy**
- **identify sources of CRs**
- **particle physics at extreme energies**



40000 km² (>10 times PAO)
2 km spacing
--> 10000 detectors
~120 M€

e/m to muon ration
—> mass sensitivity
for vertical and horizontal EAS



Antoine Letessier-Selvon et al.,
Nucl. Instr. Meth. A 767 (2014) 41–49

see also K.-H. Kampert at

High-energy neutrino and cosmic-ray astrophysics - The way forward

January 2-15, 2017 | Weizmann Institute of Science, Israel