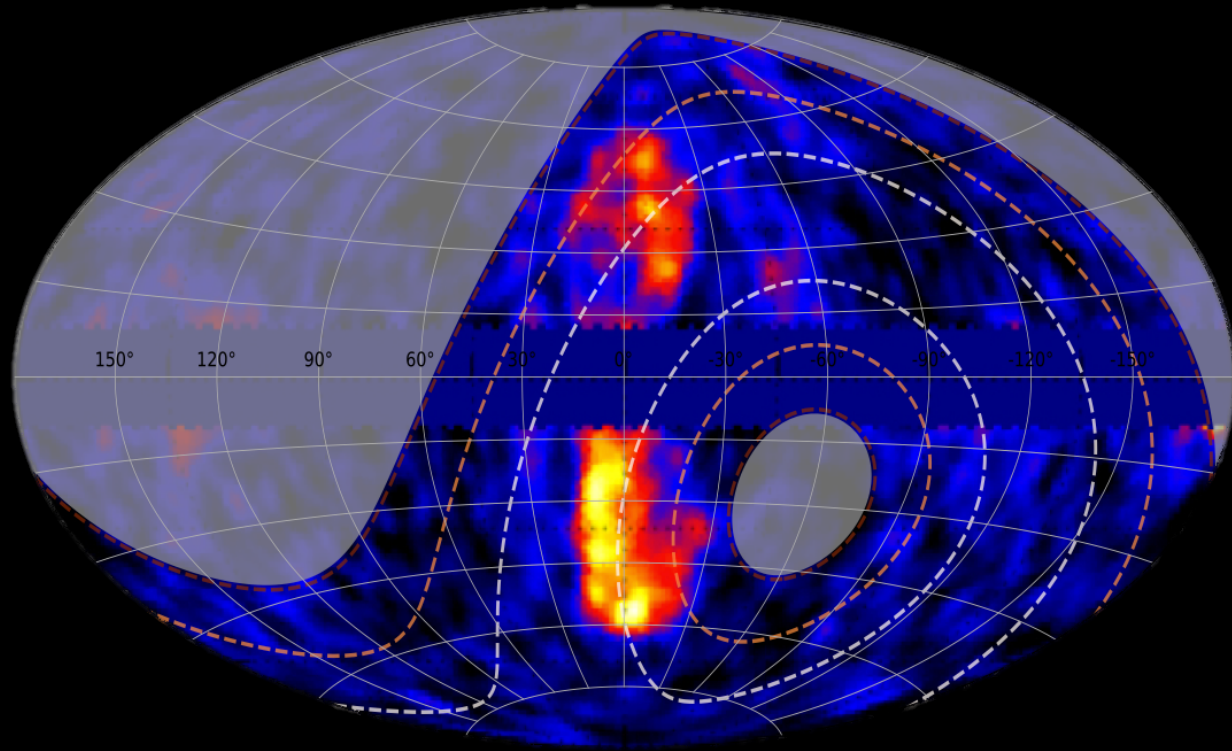


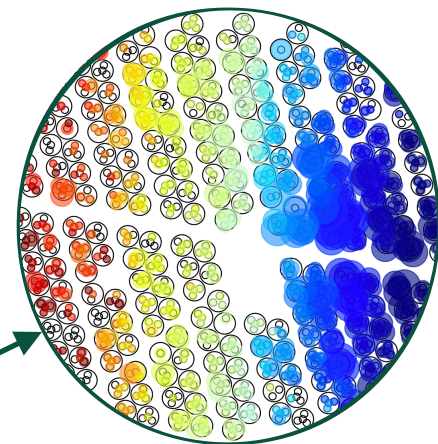
Towards a Southern Wide-field Gamma-ray Observatory



Jim Hinton

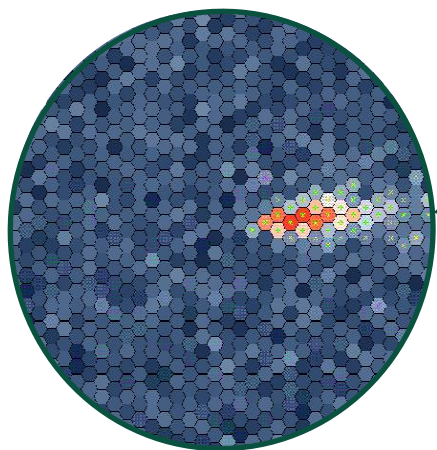
Max Planck Institute for Nuclear Physics
Lisbon, May 20th 2019

FoV $\sim 40^\circ$, Duty cycle $\sim 100\%$, tens of arcmin resolution



Few ns spread in
particle arrival at
each detector

Few ns light flash



Adapted from Armelle Jardin-Blicq

FoV $< 9^\circ$, Duty cycle $< 20\%$, few arcmin resolution

Southern wide field motivations

⊙ Large scale structures

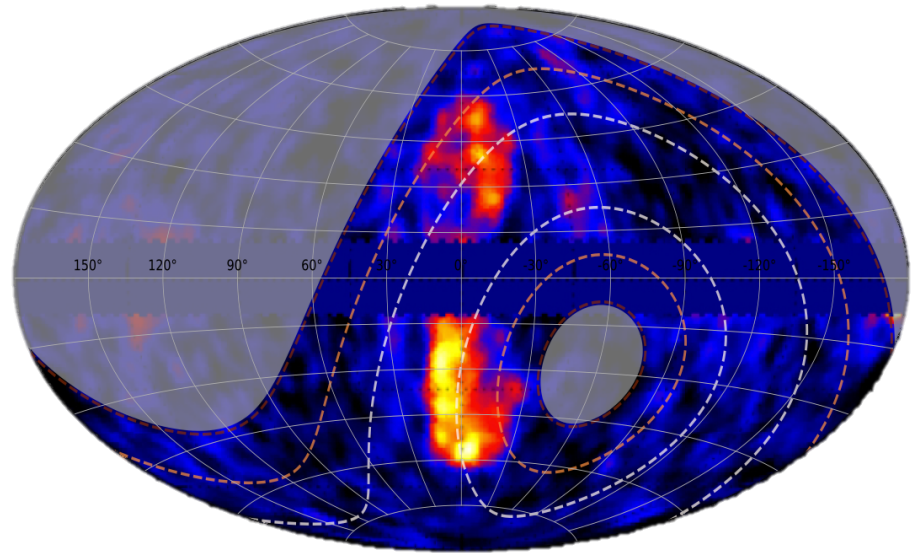
- ✦ Fermi bubbles
- ✦ Nearby accelerators
- ✦ Diffuse galactic emission
- ✦ Dark matter halo of the MW

⊙ Highest energy accelerators

- ✦ Very very deep >100 TeV observations possible in the inner galaxy

⊙ Transients – increasingly rich

- ✦ a few hundred GeV emission from two GRBs seen recently with ground based detectors
- ✦ Gravitational waves, neutrinos, +++



Three agreements signed in December 2019 in Santiago de Chile

- CTA South will be built in Chile!
- ✦ Site infrastructure work starting 2019



Chilean Ministry of Foreign Relations – ESO



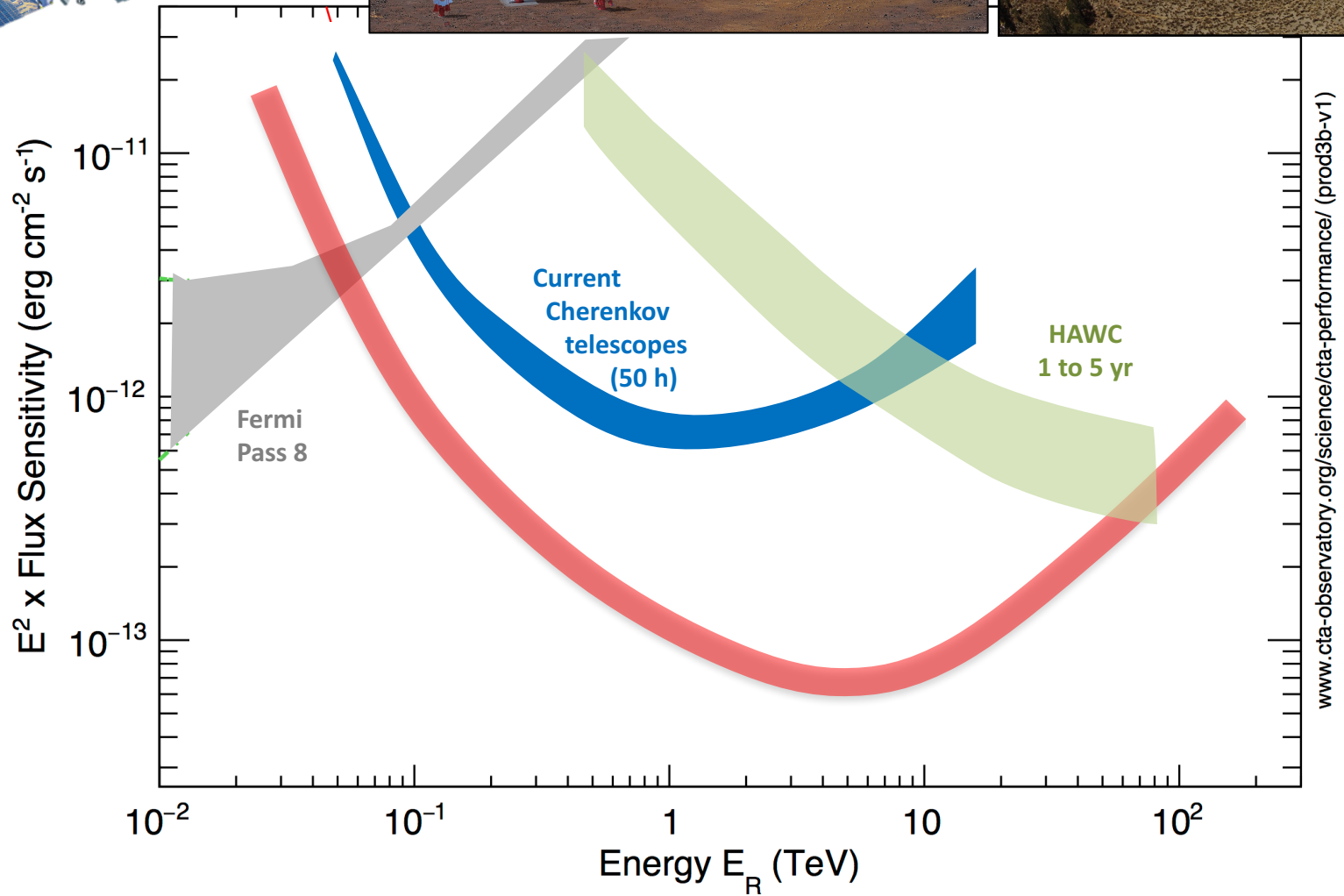
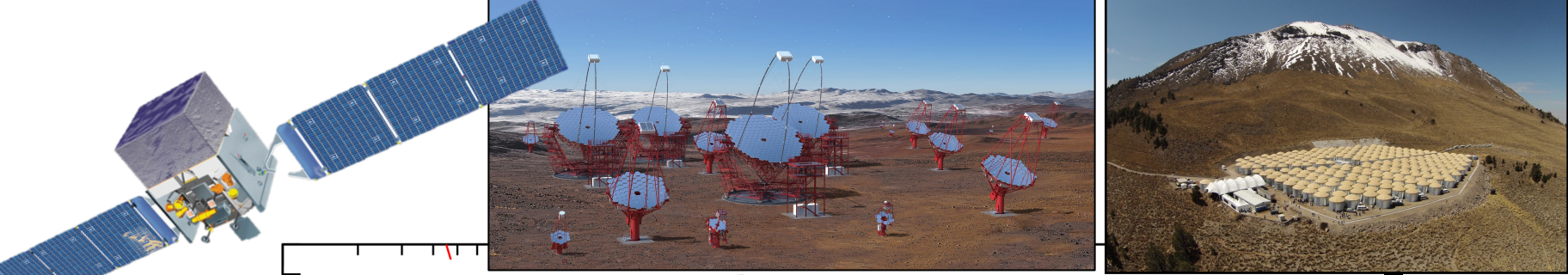
ESO – CTAO

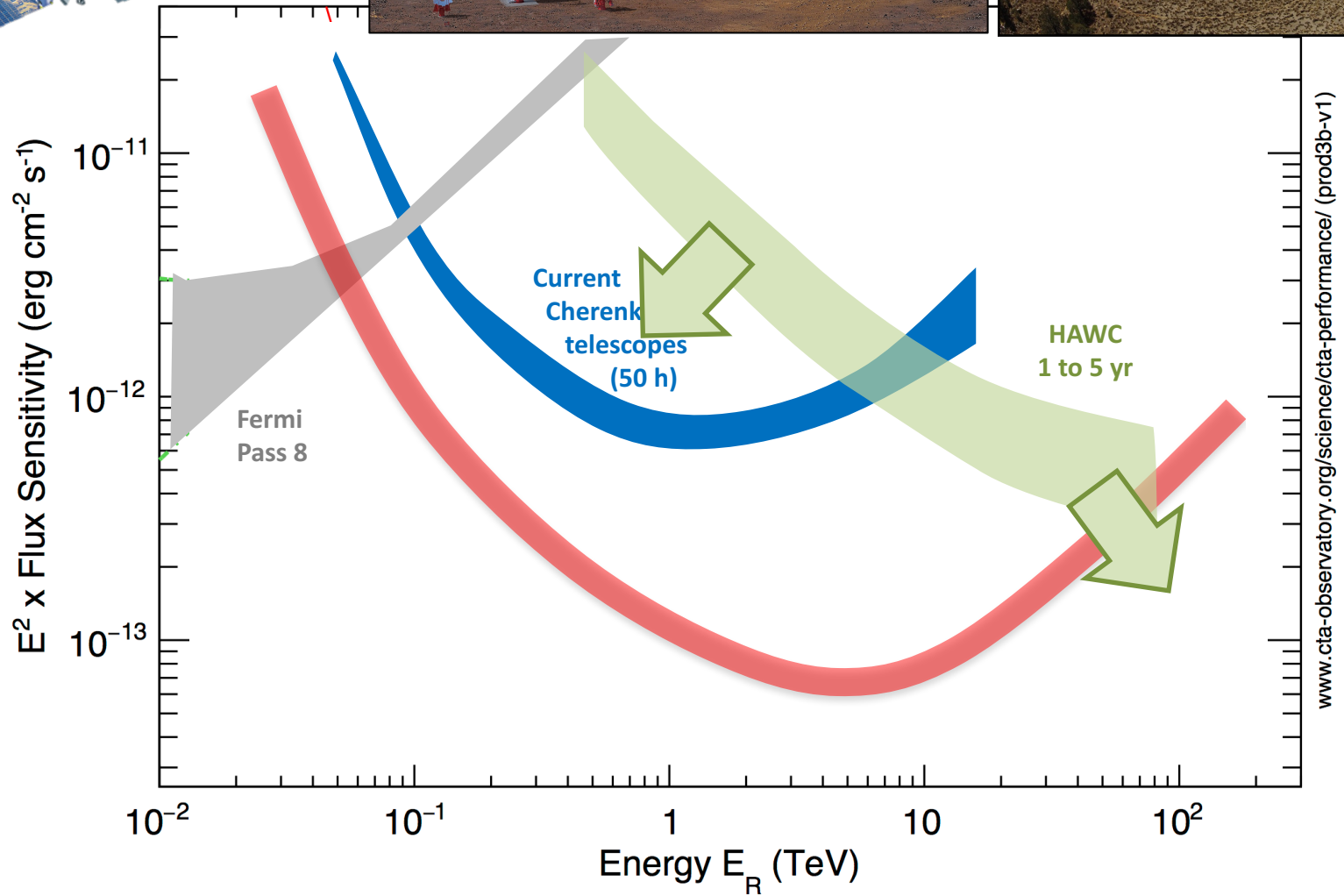
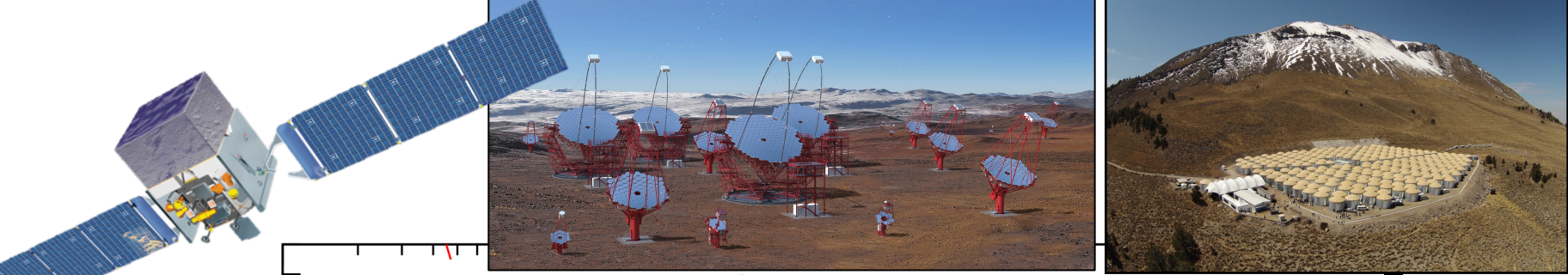


CTAO – CONICYT



cherenkov
telescope
array

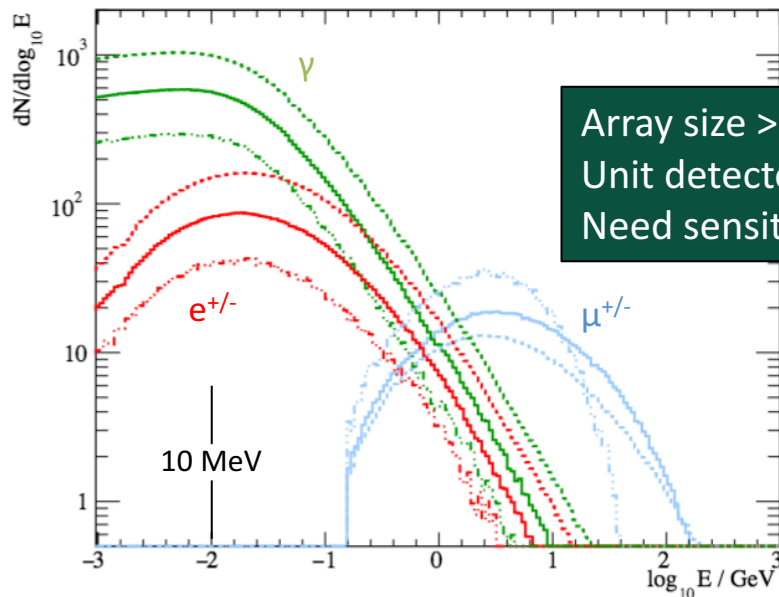




Detector Considerations

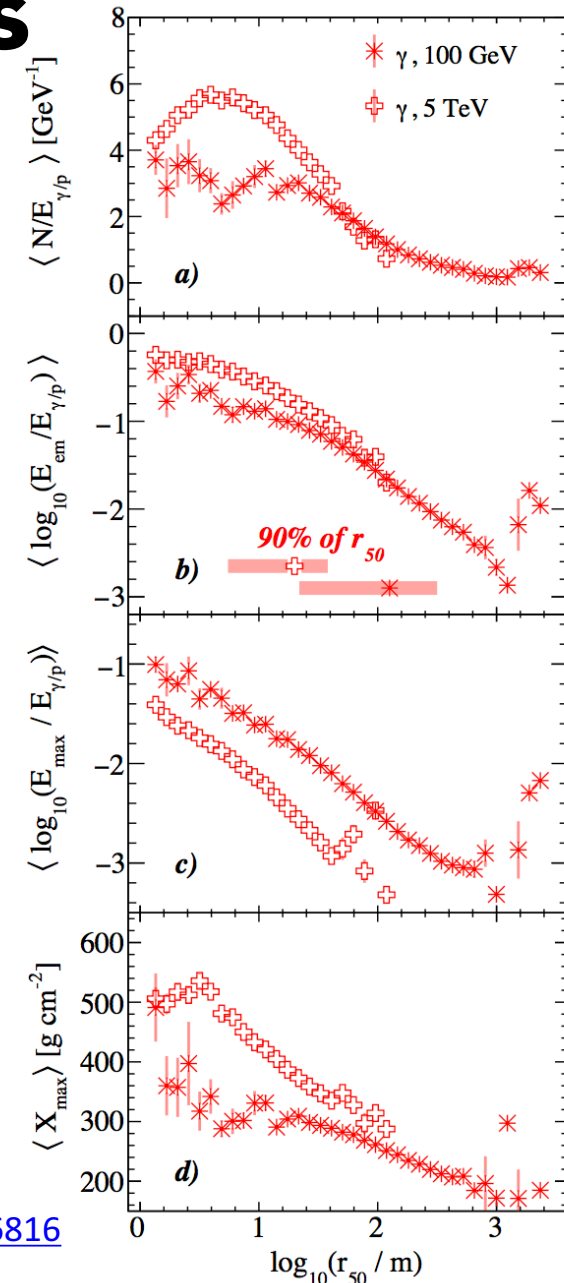
Typical 100 GeV gamma-ray shower at 5 km altitude (vertical)

- ✦ 50% of energy contained within 200m diameter
- ✦ A few GeV total energy arriving at the ground
- ✦ Highest energy particle: ~200 MeV
- ✦ Most particles are 10 MeV gammas (universal)

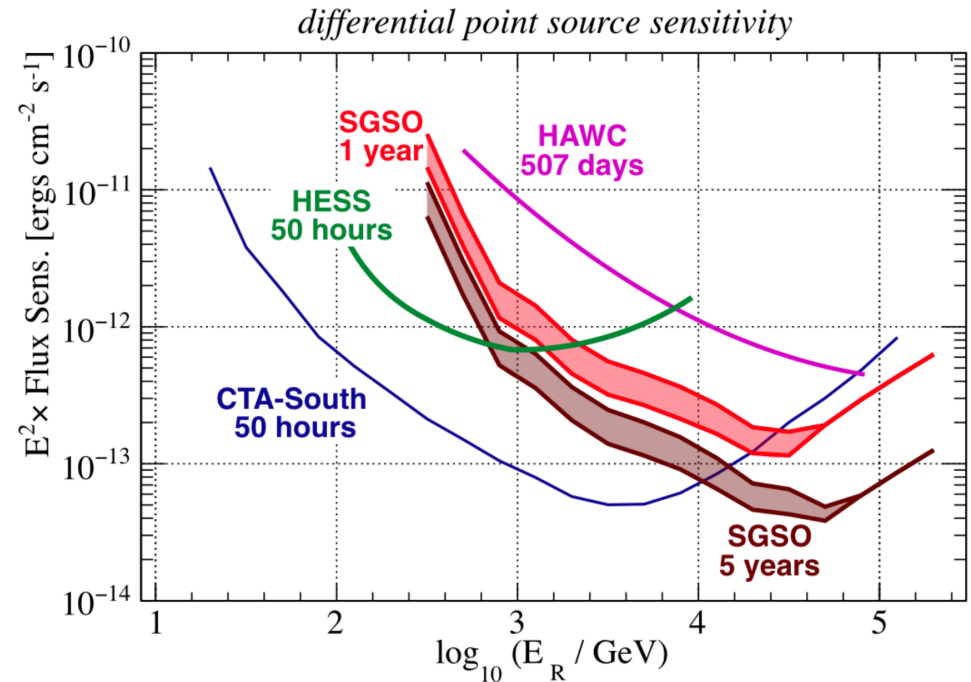
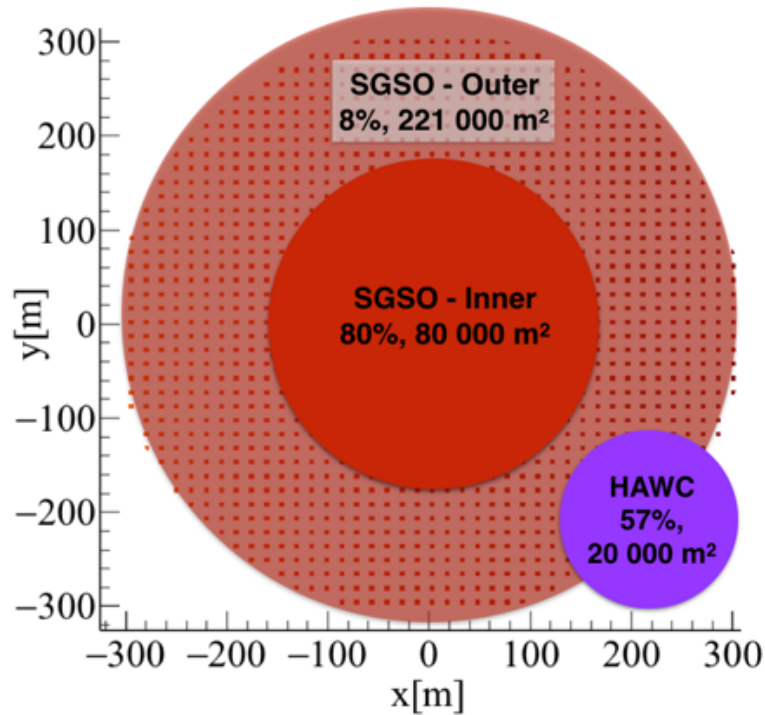


Array size $\gg 100$ m
Unit detector threshold ~ 10 MeV
Need sensitivity to photons

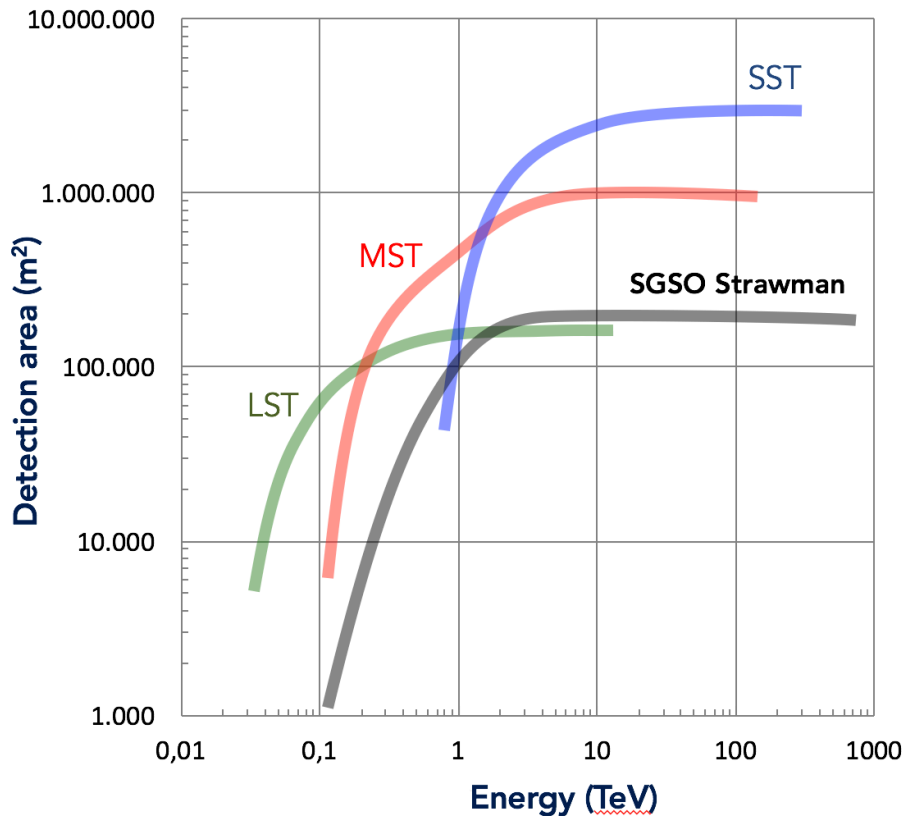
[Harm Schoorlemmer et al.
https://arxiv.org/abs/1905.06816](https://arxiv.org/abs/1905.06816)



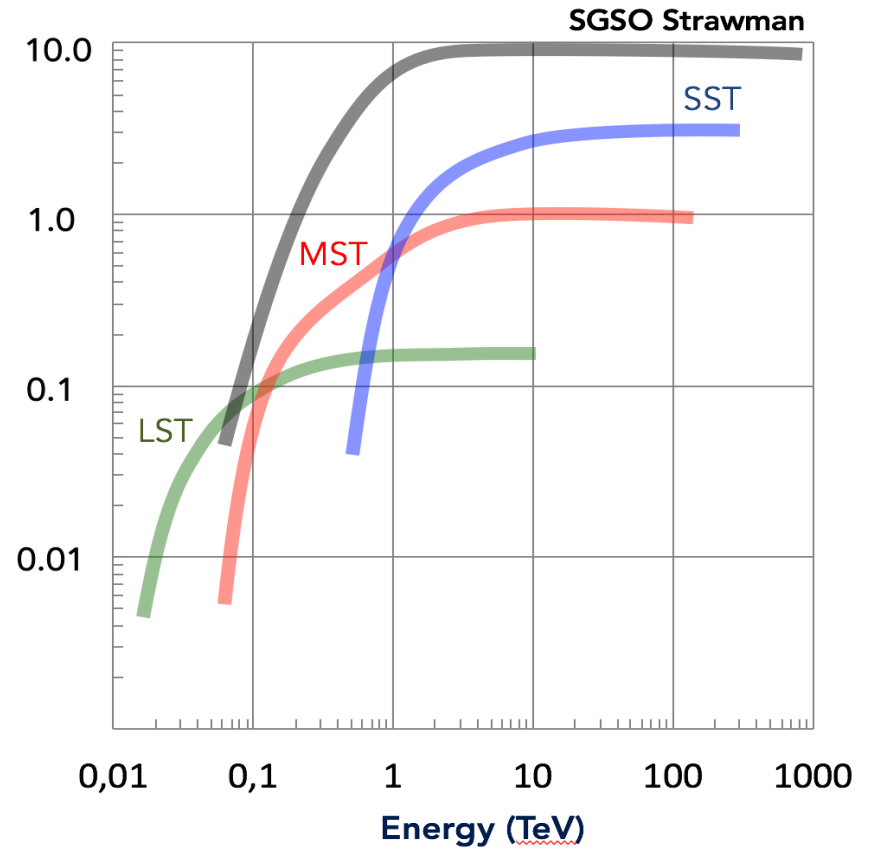
"Strawman Design"



Science Case - <https://arxiv.org/abs/1902.08429>

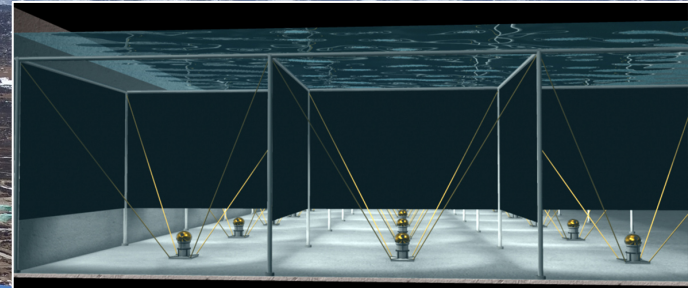


Detection Area



Annual Exposure

- ⊙ Transients: If CTA can get there → it is much better
- ⊙ Steady sources: If background can be suppressed → can do much better than CTA over several years



- ⊙ Rapid progress on construction
 - ✦ Operation of first WCD unit has begun (area=HAWC)!

Water Volumes

- ⦿ Recognition that water volumes are an essential ingredient of a large area low threshold detector, but how?

- ⦿ Tanks

- ✦ Was cost-effective for HAWC
- ✦ Being explored for ALTO
- ✦ Can be relatively easy to deploy

- ⦿ Buildings/Pools

- ✦ Was cost-effective for LHAASO
- ✦ Can be more easily insulated

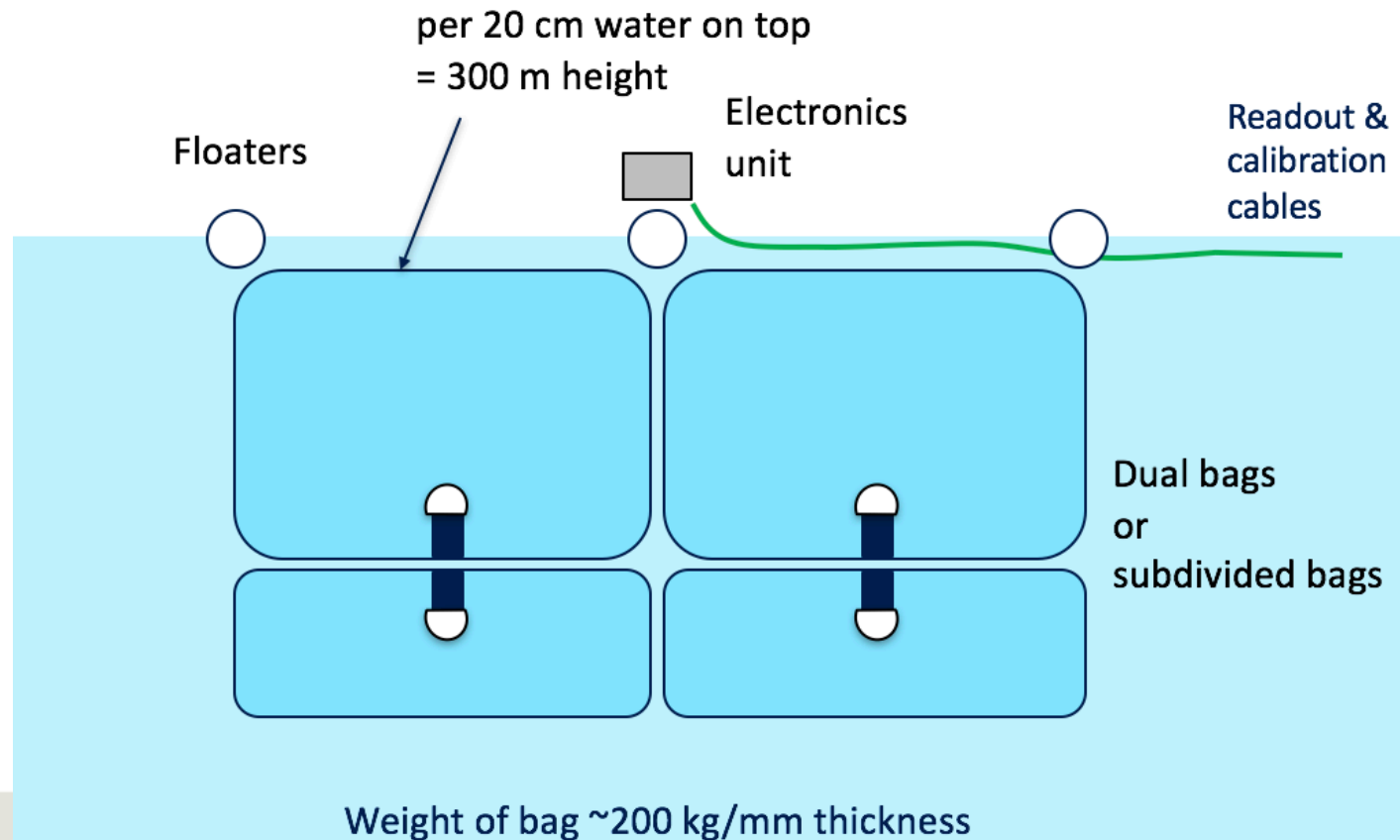
- ⦿ Choice likely depends on site constraints/costs



Or perhaps...

🕒 Lakes!

BASICS

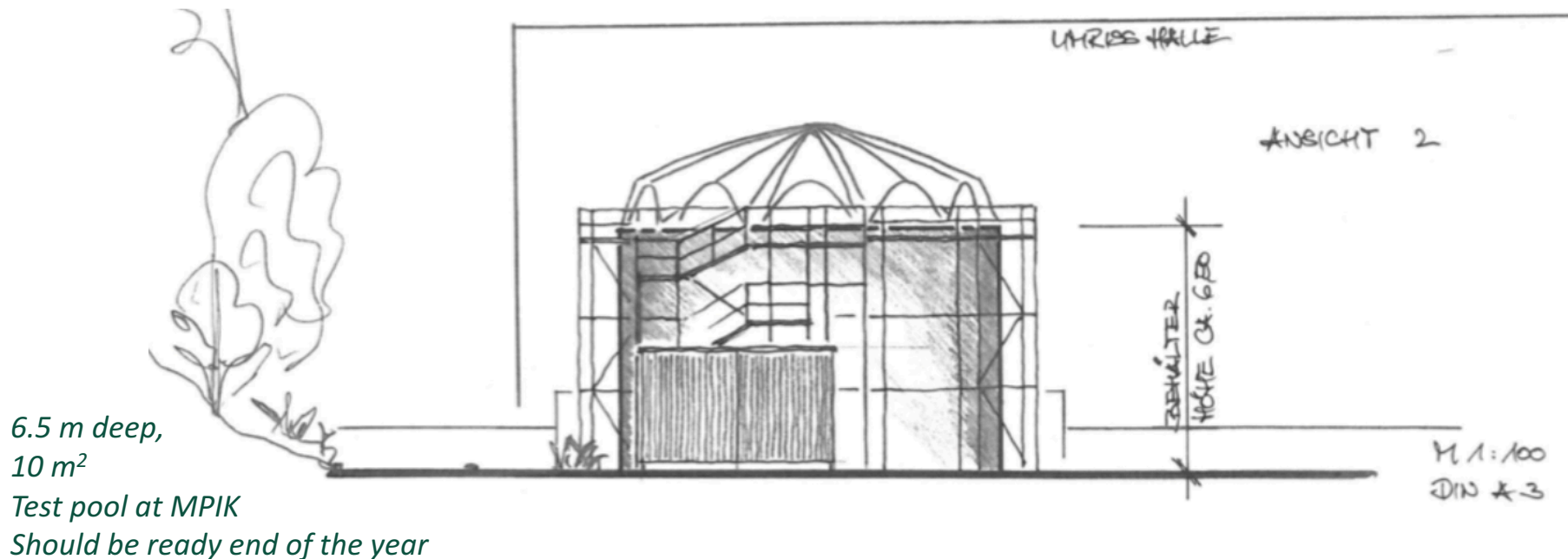


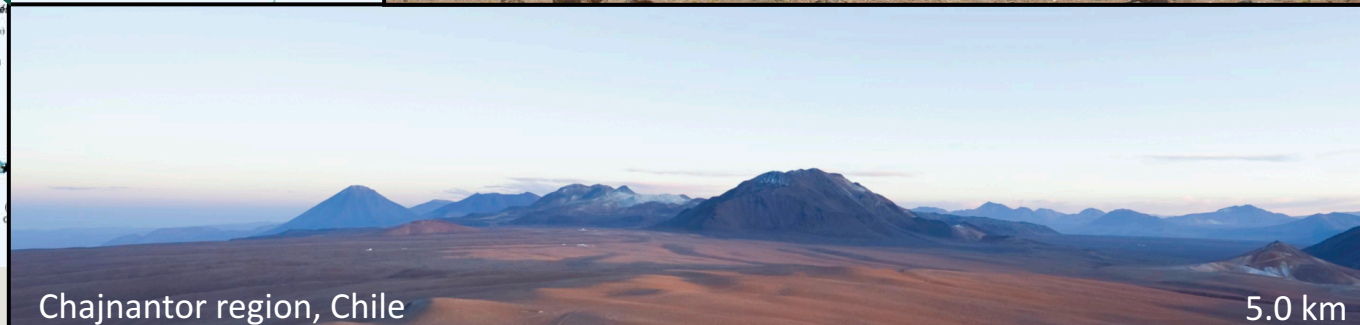
Werner Hofmann
– Heidelberg
Meeting 2018



Lake Questions

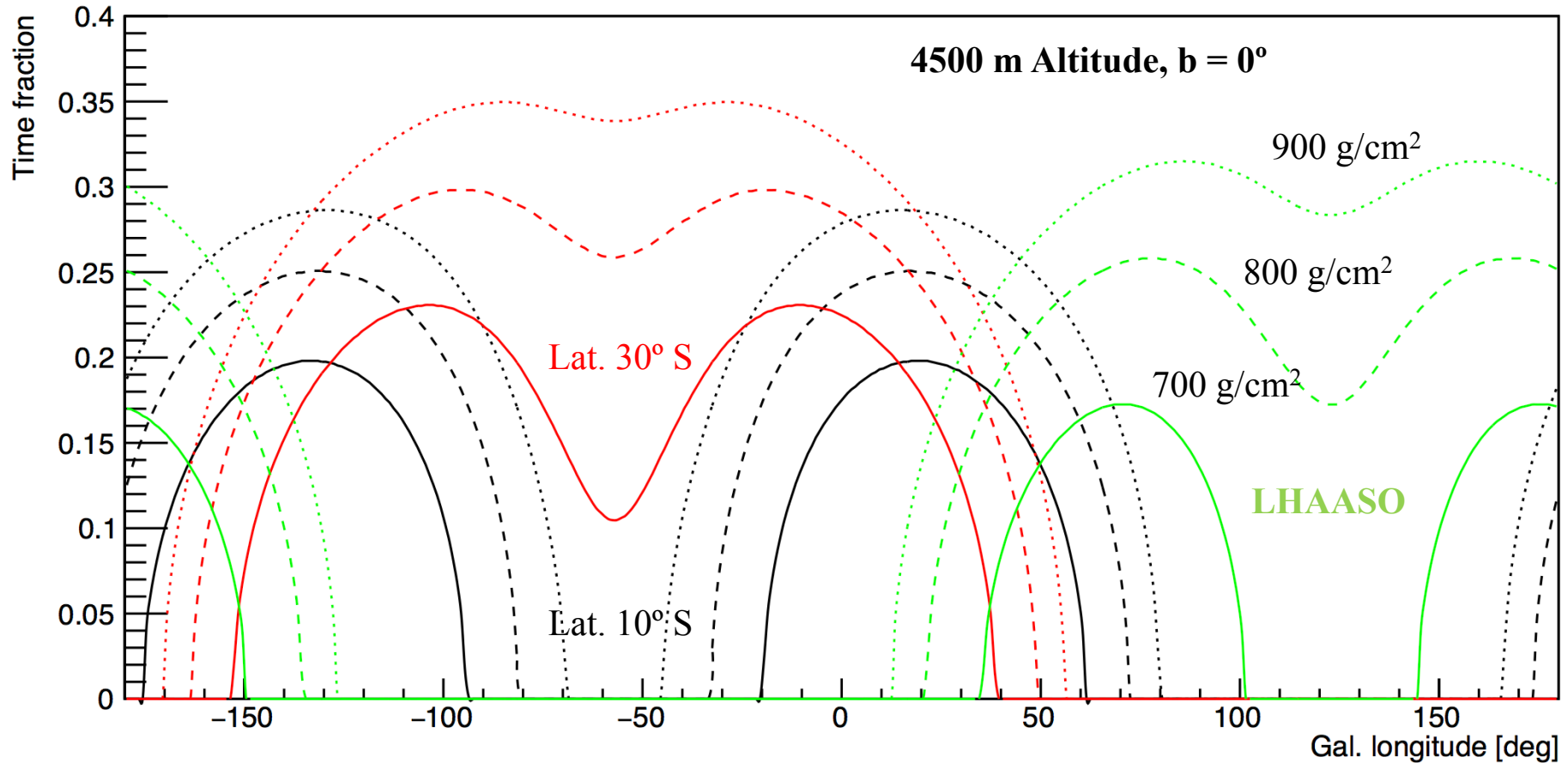
- ⊙ Does a suitable lake exit?
 - + Access, infrastructure, waves, ...
- ⊙ Can a practical detector unit / array concept be developed?
 - + Deployment, stability, ...





Site Latitude

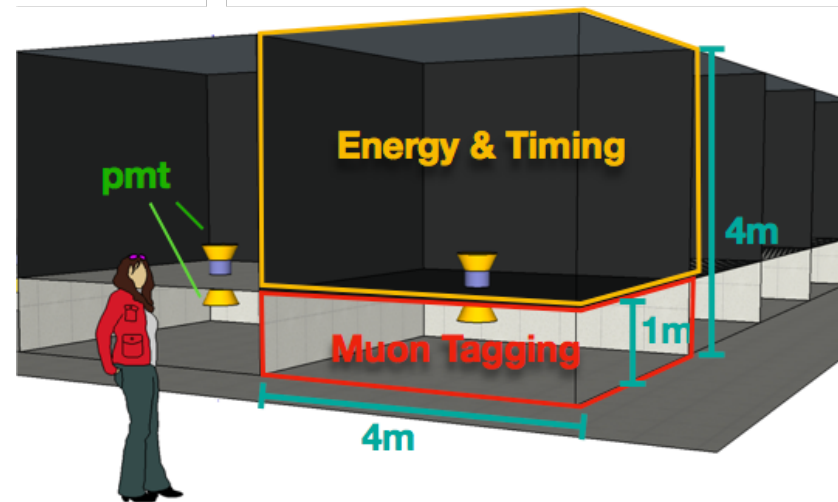
(from Heidelberg Meeting in October 2018)



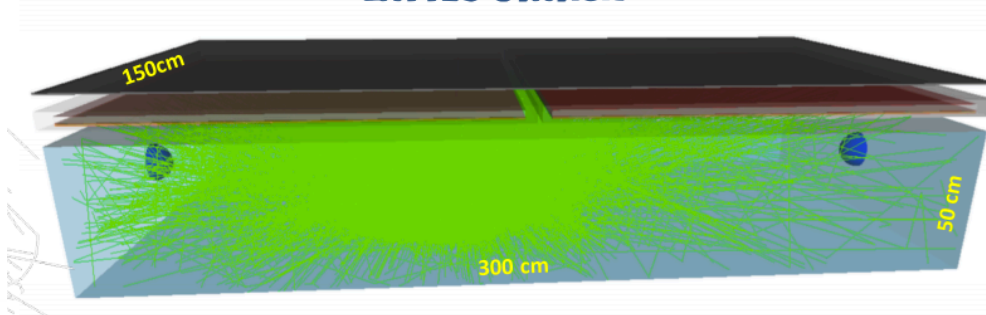
- ⊙ Fraction of time visible through $<$ given airmass on Galactic plane – from Werner Hofmann

Convergence?

(from Heidelberg Meeting in October 2018)



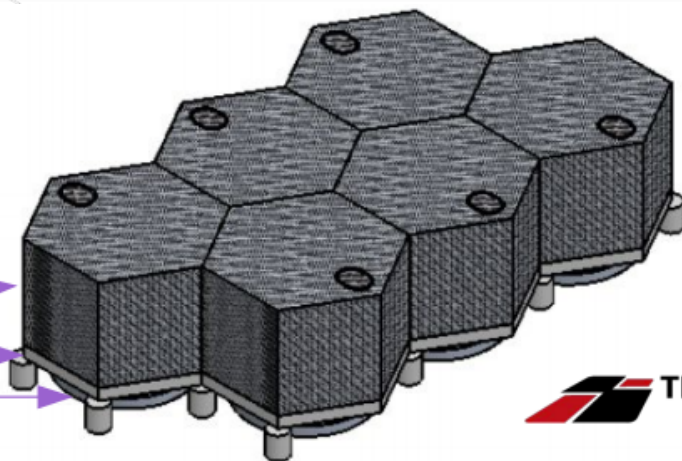
LATTES STATION



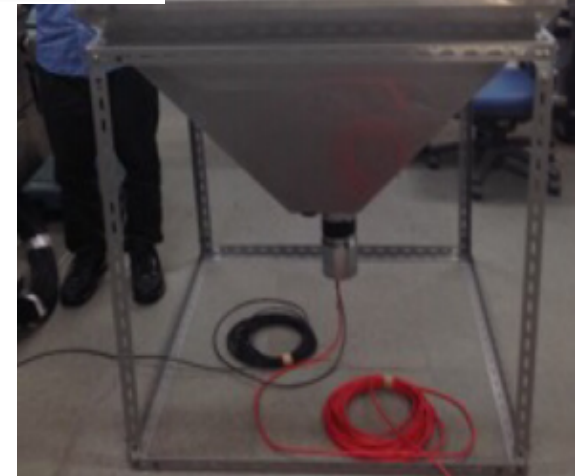
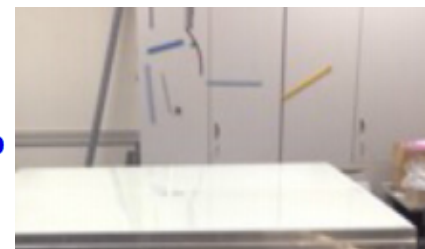
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ALTO Cluster

- WCD tank
- Concrete table
- SLD box



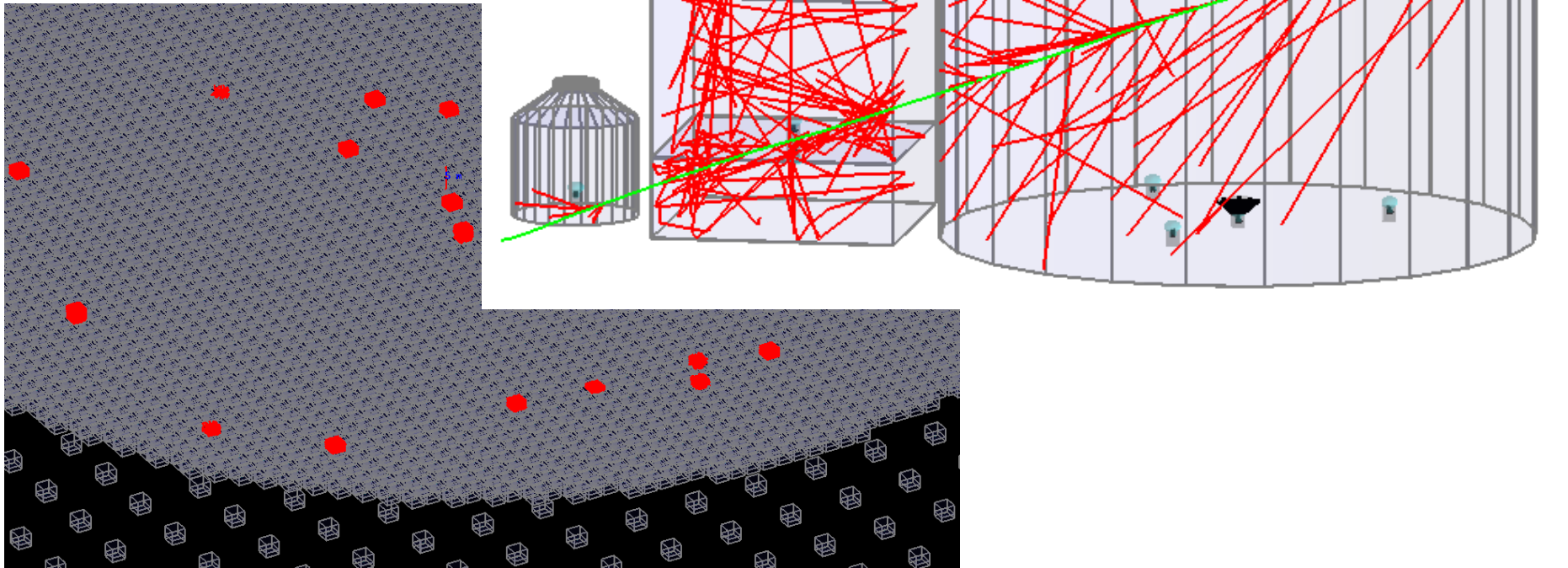
Pb
RPC
WCD



Simulations Convergence

⦿ Agreement on common toolkit:

- ✦ HAWC simulations package
generalised to allow arbitrary water
volumes – now working (!)



What Next ?

From Alliance to Collaboration?

- ⊙ “Southern Wide-field Gamma-ray Observatory R&D”
- ⊙ 3 year programme to come to a recommendation on the design and site of a wide field gamma-ray observatory in the southern hemisphere
- ⊙ Observatory concept
 - + Ground-particle detection based high altitude gamma-ray observatory – 100% duty cycle, steradian FoV, latitude -15° to -30°
 - + Wide energy range 100s of GeV to 100s of TeV
 - + High fill-factor core detector with area considerably larger than HAWC and significantly better sensitivity, with a low density outer array
 - + With possibility of extensions or enhancements
 - + Based primarily on water Cherenkov detector units
 - + Modular and scalable

"Southern Wide-field Gamma-ray Observatory R&D"

- ⊙ R&D to reach recommendations on
 - + Site
 - + Base concept: lake, hall, tank or hybrid
 - + Detector unit design / array layout
 - + Photosensor and electronics choices, array level trigger and readout, calibration concept, ...
- ⊙ Ends with a concrete proposal
 - + Next phase with construction funds and final collaboration
- ⊙ Commitment of institutes/labs/university
 - + Rather than individuals (current alliance) or agencies (too soon)
- ⊙ "Statement of interest" or similar to get going
 - + Working groups for topics above + some kind of steering com.
- ⊙ Support for the idea so far from some groups in
 - + Portugal, Italy, Brazil, Germany, USA

Questions?

