

Subarray Divergent Pointing

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PhD SST
Space Science
and Technology

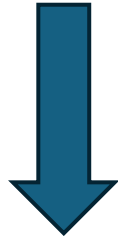


New generation of Cherenkov Telescopes

- ASTRI FoV **10.5 deg**
- SST FoV **9 deg**



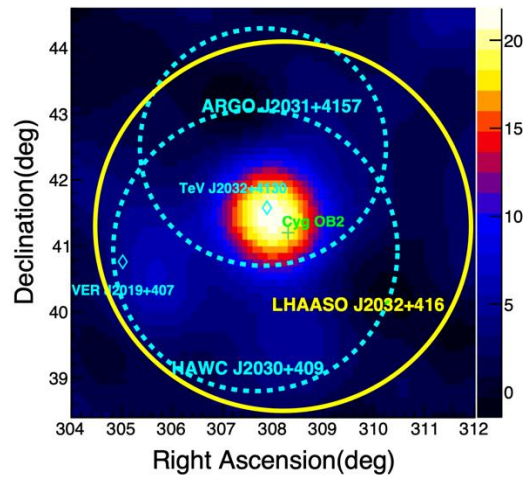
- LST FoV **4.3 deg**
- Veritas FoV **3.5 deg**
- HESS
 - CT1-CT4 FoV **5 deg**
 - CT5 FoV **3.4 deg**
- MAGIC FoV **3.5-3.8 deg**



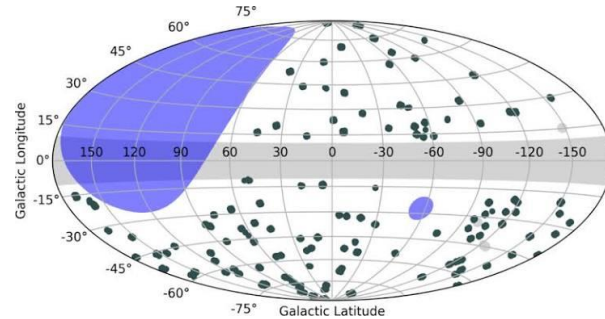
- High FoV
- Why shall we increase it even further?



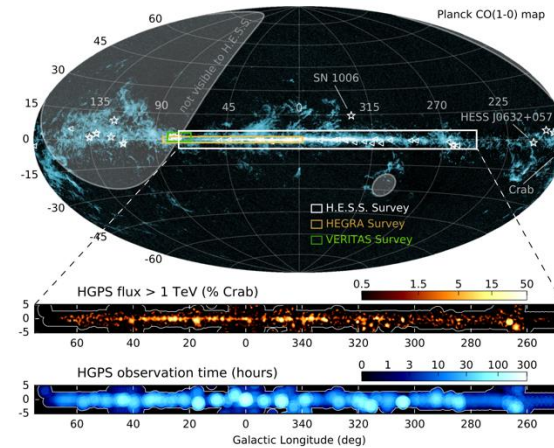
Reasons to increase the FoV



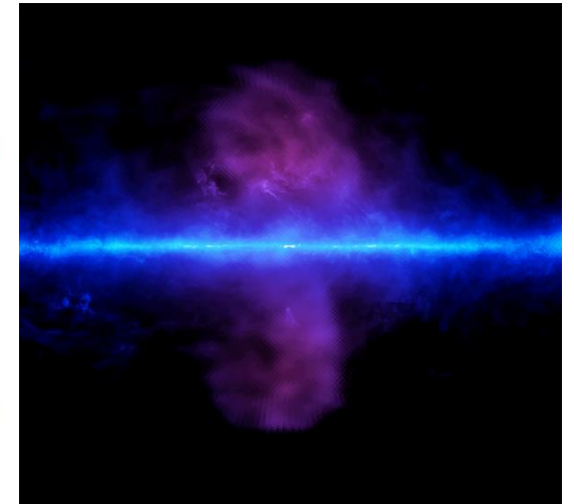
[Detection of emission from Cygnus Cocoon above 100TeV with LHAASO C. Li et. AL](#)



[The H.E.S.S. extragalactic sky survey with the first decade of observations - HESS collaboration](#)



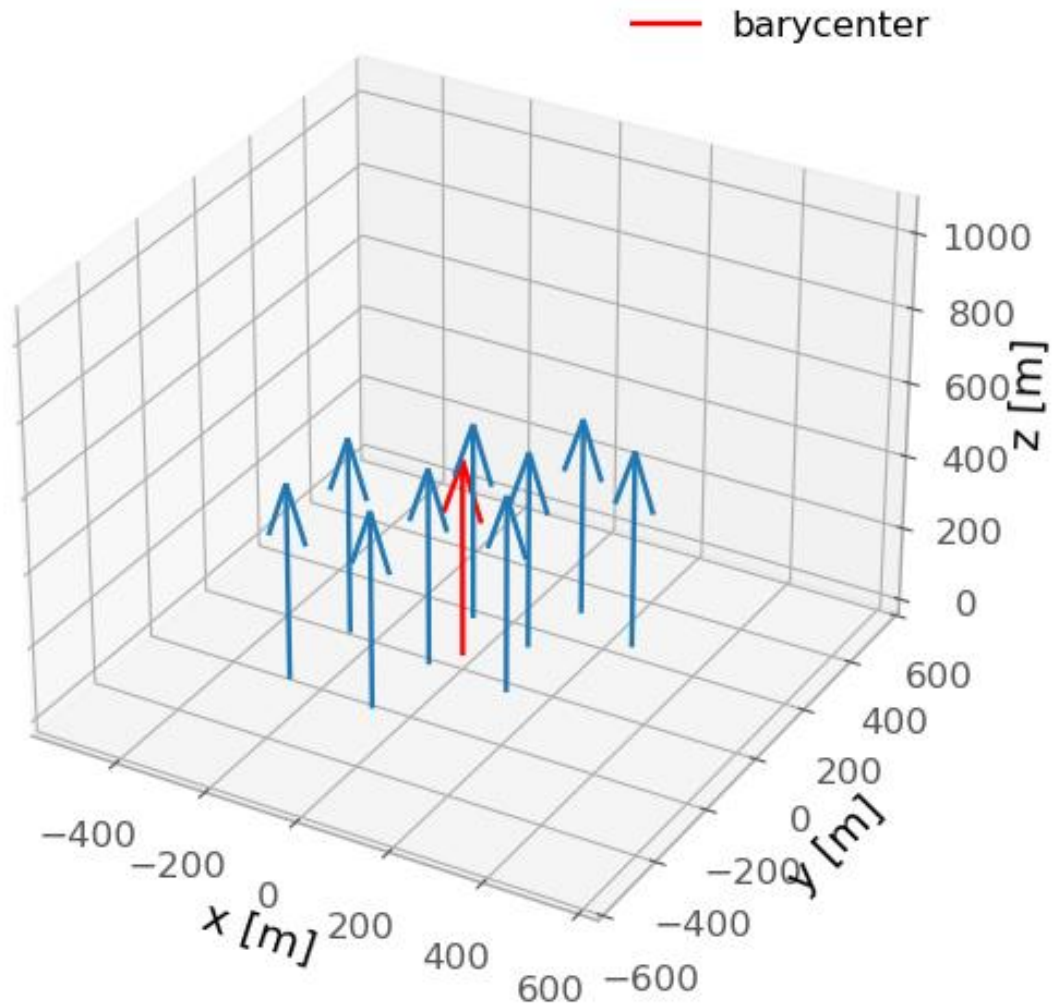
[The H.E.S.S. Galactic plane survey \(HESS collaboration\)](#)



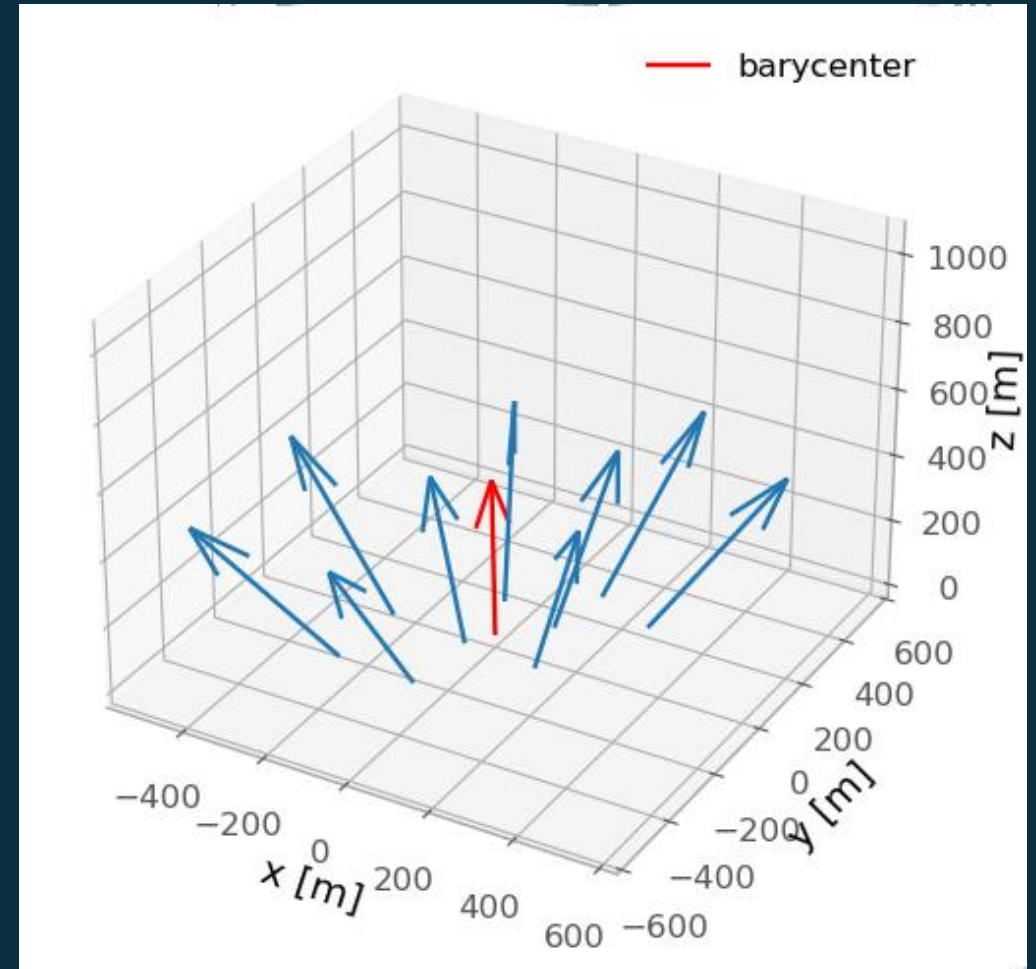
[Giant Gamma-ray Bubbles from Fermi-LAT: AGN Activity or Bipolar Galactic Wind?](#)

- Superbubbles
- TeV Halo emissions
- Surveys
 - Galactic
 - Extragalactic
- Fermi Bubbles

Parallel

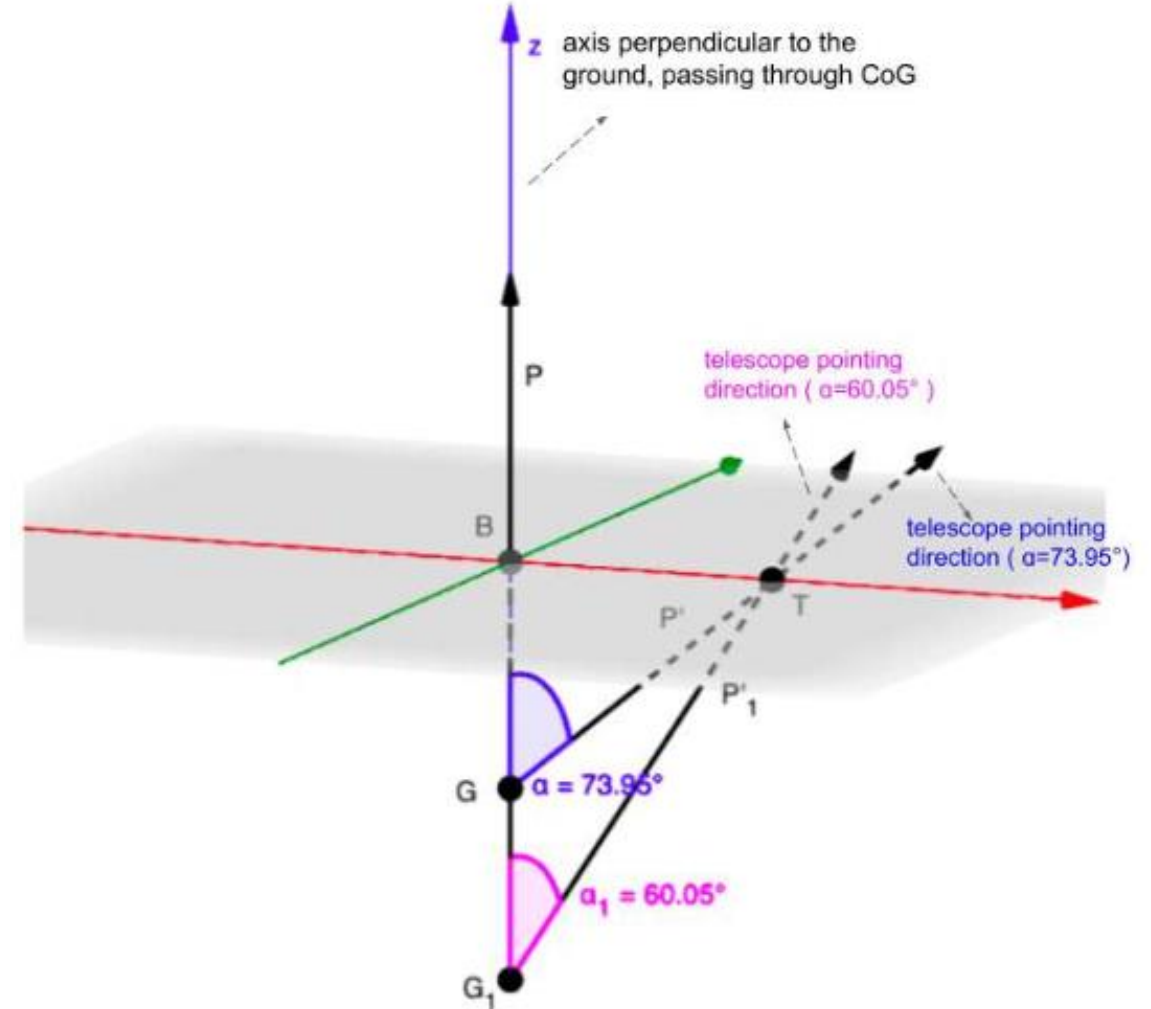


Divergent



Some terminology

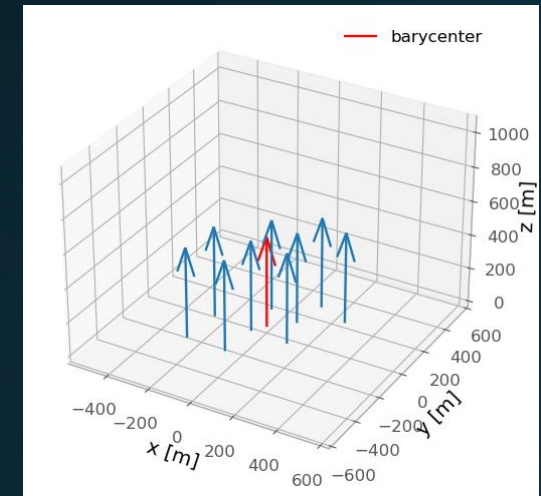
- [Umbrella method](#) – Original idea for CTAO
 - Telescopes point away from a common reference direction.
 - Donini A. PhD thesis (Università degli studi di Udine 2020)
 - Burelli I. PhD thesis (Università degli studi di Udine 2023)
 - $\text{Div} = \sin(\alpha)$
- Div parameter
 - $\text{Div} = 0$ (parallel pointing)
 - $\text{Div} = 1$ (widest pointing spread)



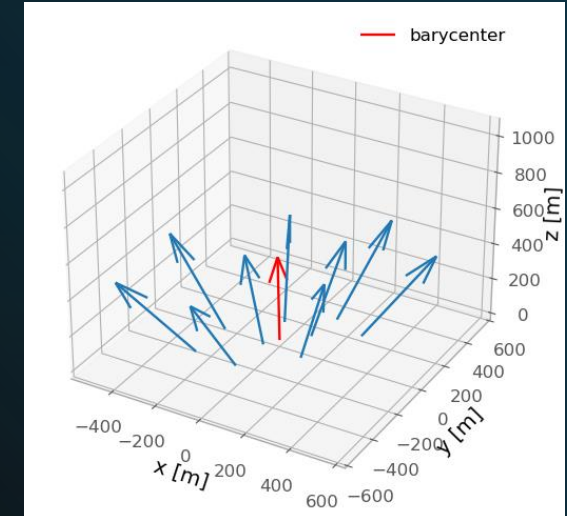
Some terminology

- Divergence /Umbrella method
 - Telescopes point away from a common reference direction
- Subarrays
 - A subset of telescopes selected from the full array.
- **Multiplicity cut**
 - The minimum amount of telescopes looking at a certain area of the sky.

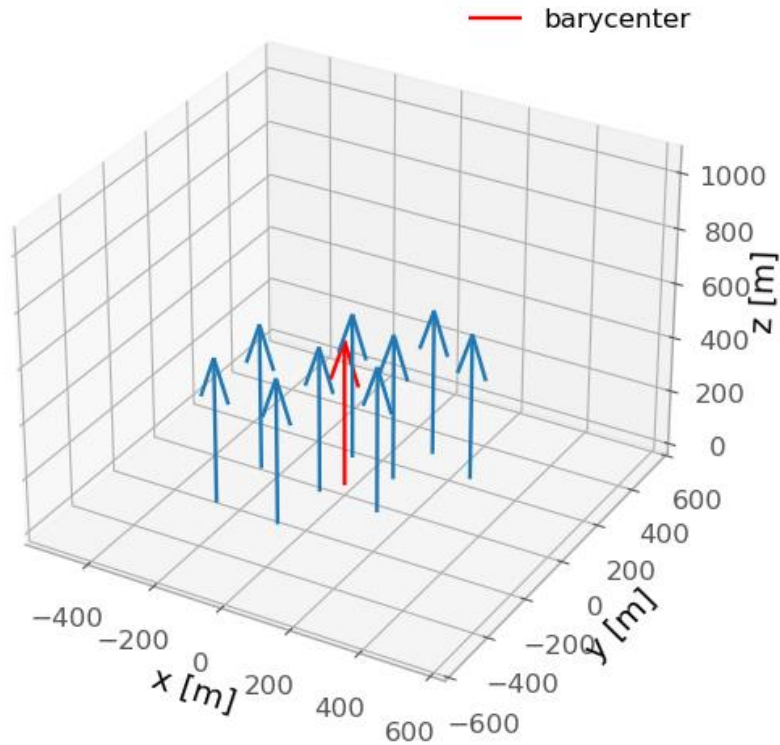
Div=0



Div=0.2

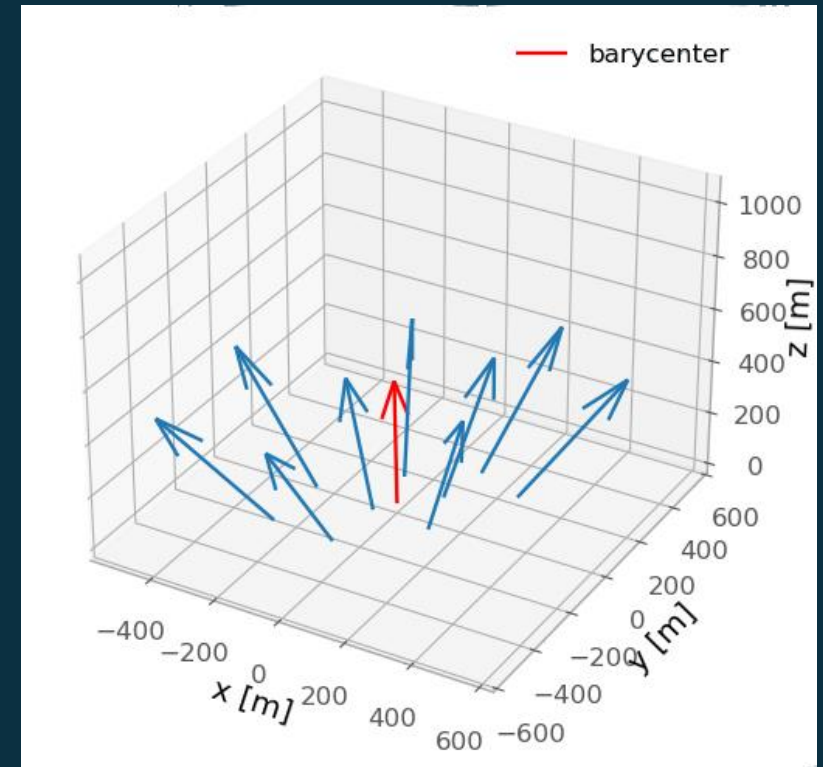


Parallel



- Best sensitivity possible.
- Limited FoV.

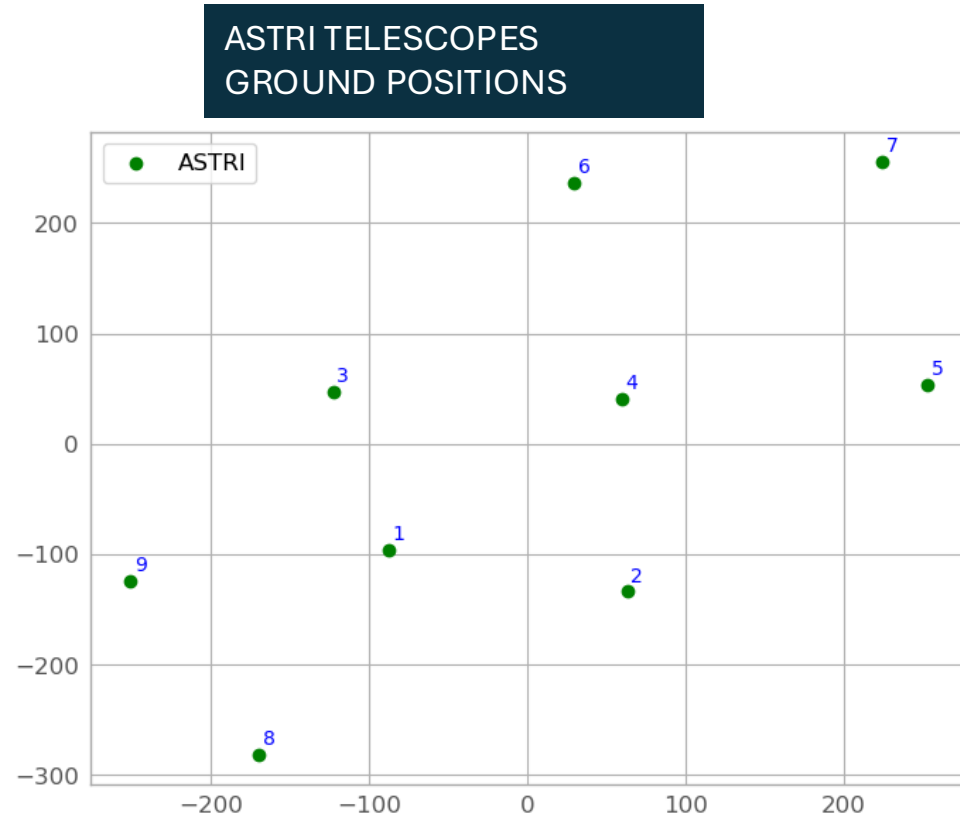
Divergent



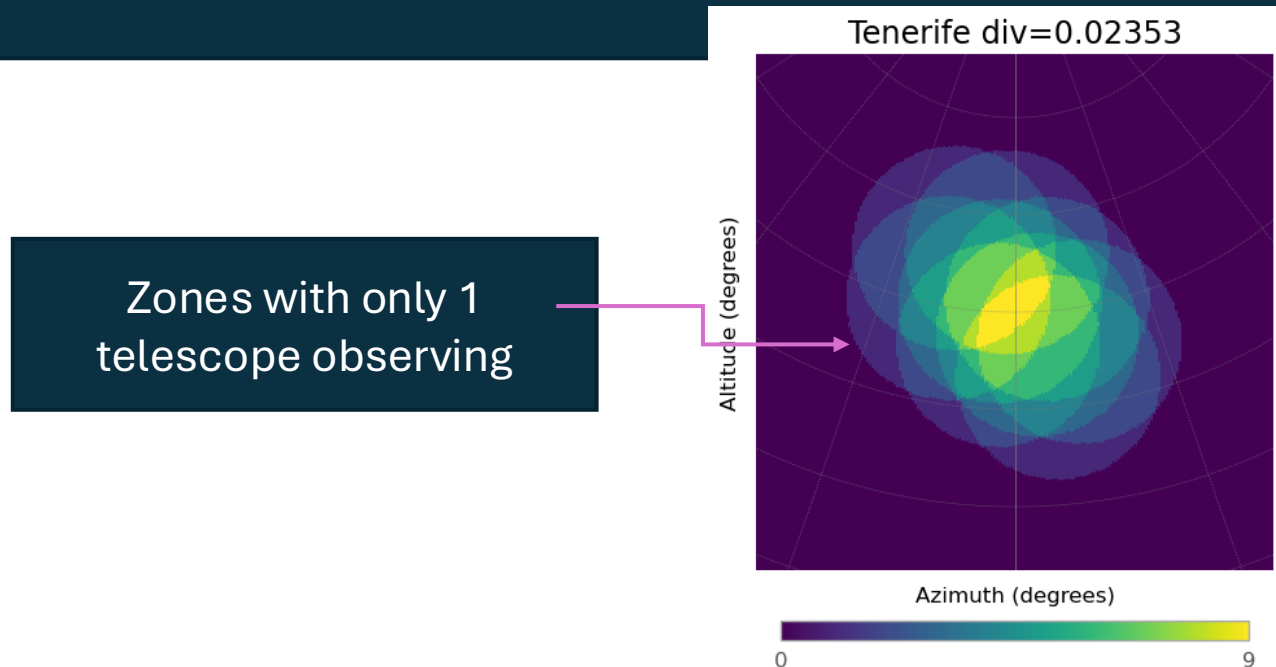
- Limited Sensitivity.
- Higher FoV.

ASTRI implementation of Divergent Pointing

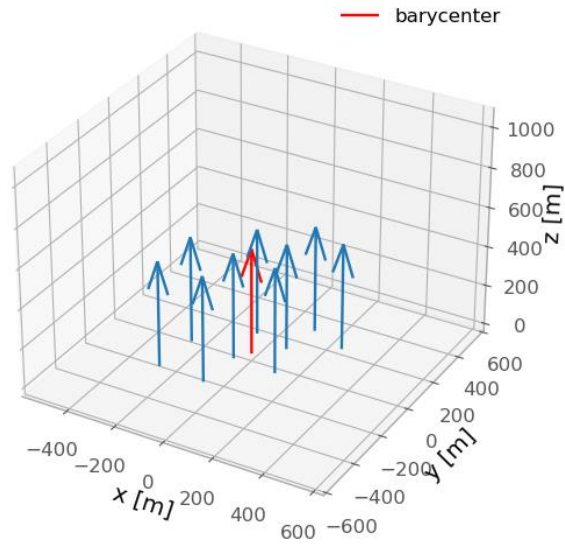
- A question persists can divergent pointing work for ASTRI?
- If we implement the umbrella method could this be tried here and could we then use it for SST?



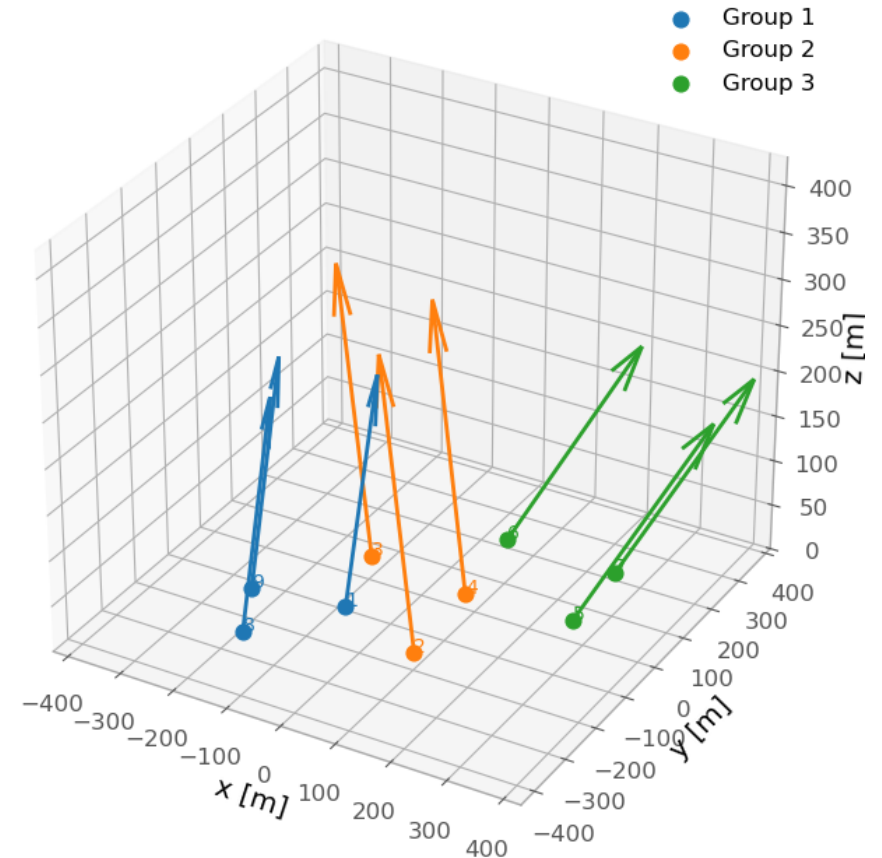
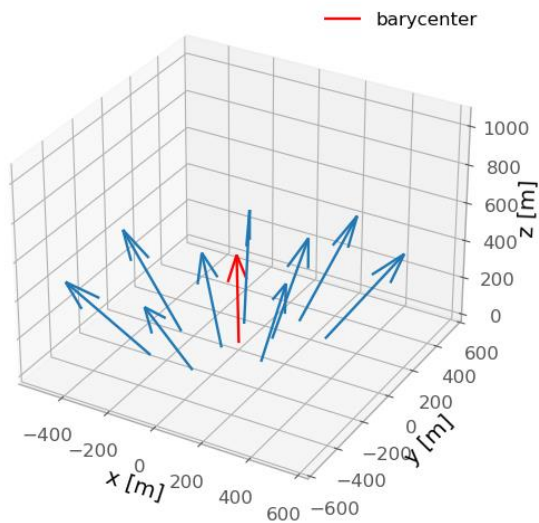
What about the stereo reconstruction for Divergent?



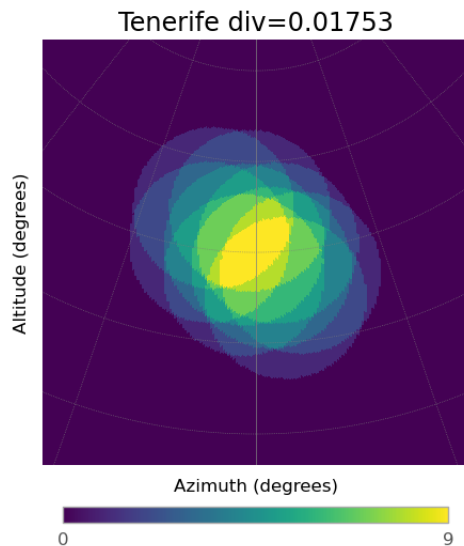
The best of Both!



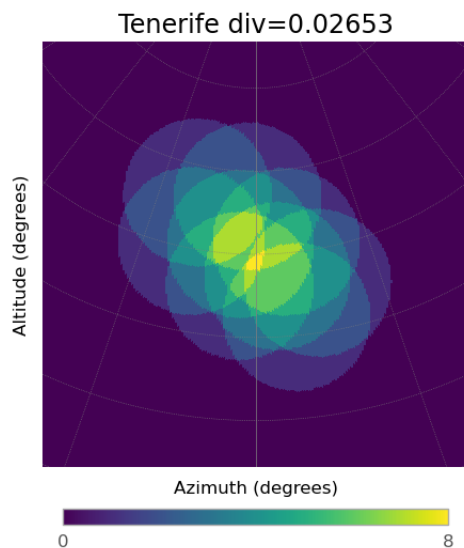
+



Normal Div.



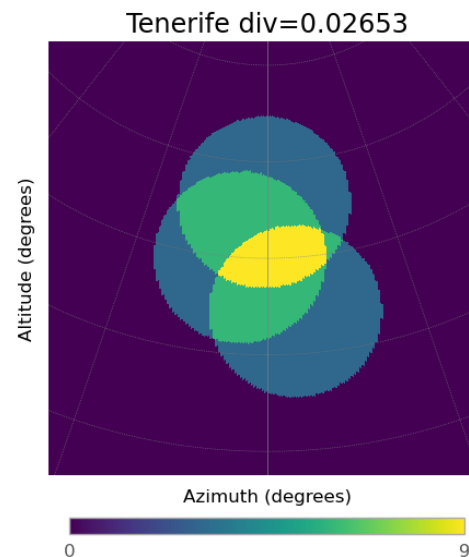
FoV mult cut:
112.91 deg²
Average mult.
cut: 6.01



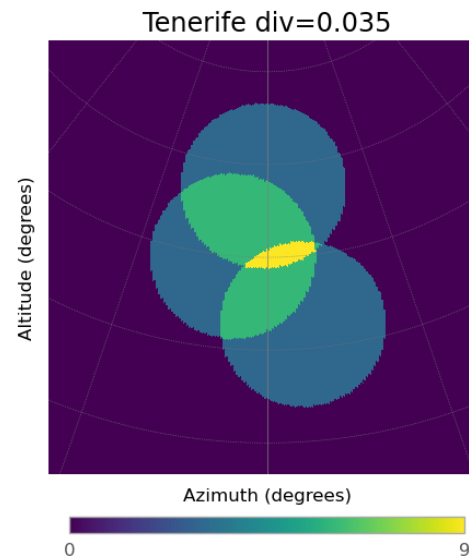
FoV mult cut:
122.08 deg²
Average mult.
cut: 5.03

VS

Subarray Div.

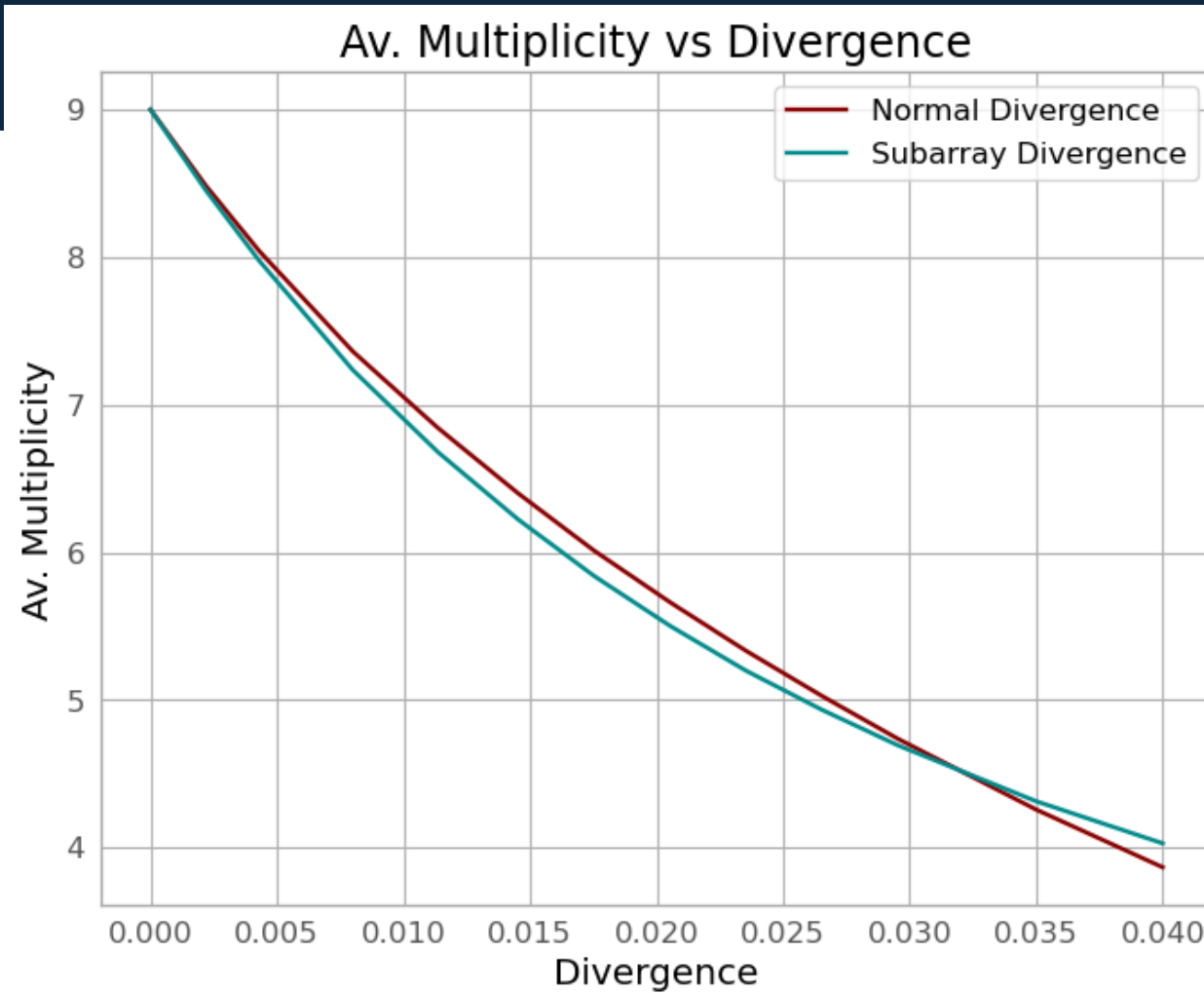


FoV : 157.92
deg²
Average mult.
cut: 4.93



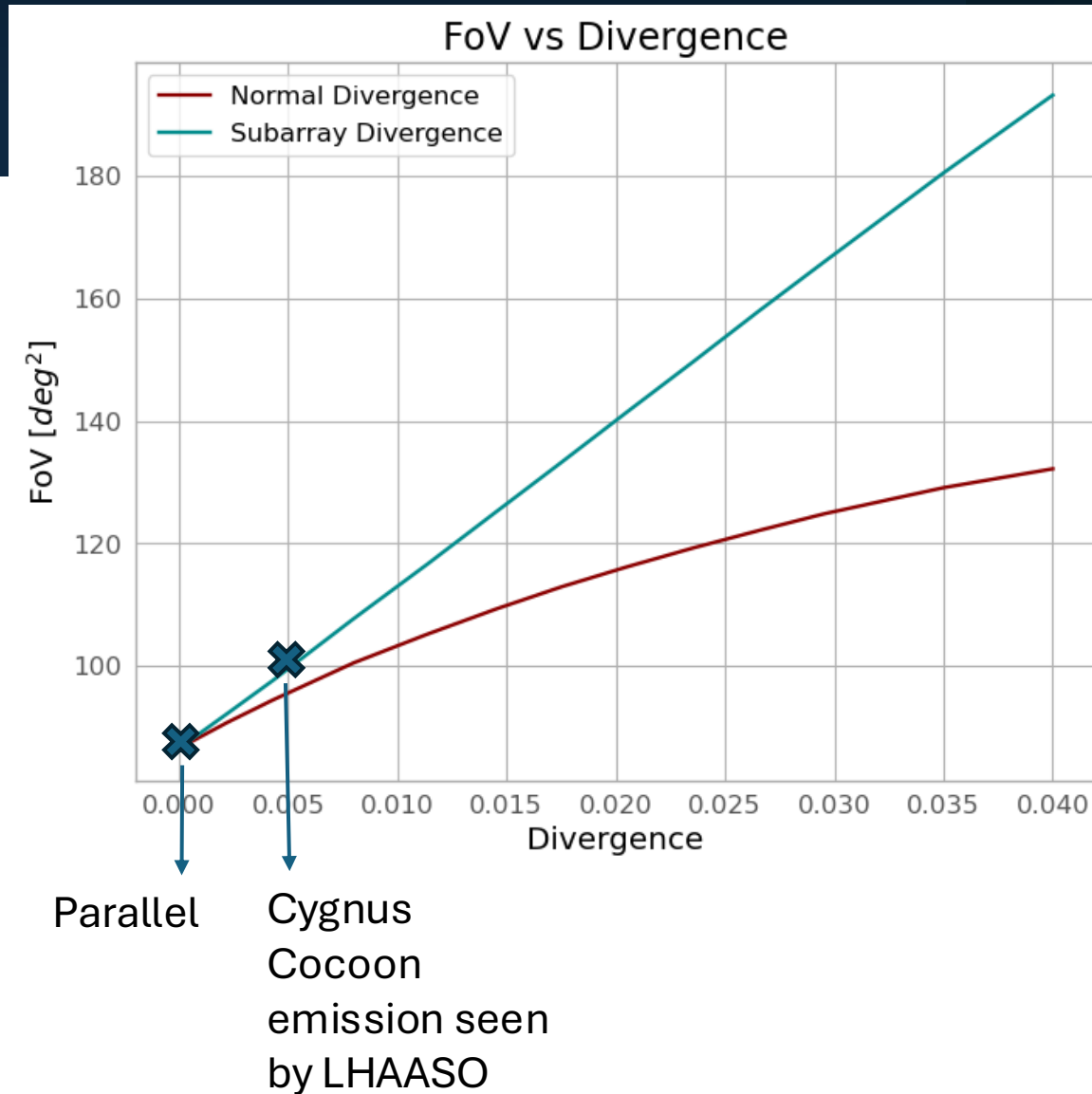
FoV : 180.54
deg²
Average mult.
cut: 4.31

Comparison

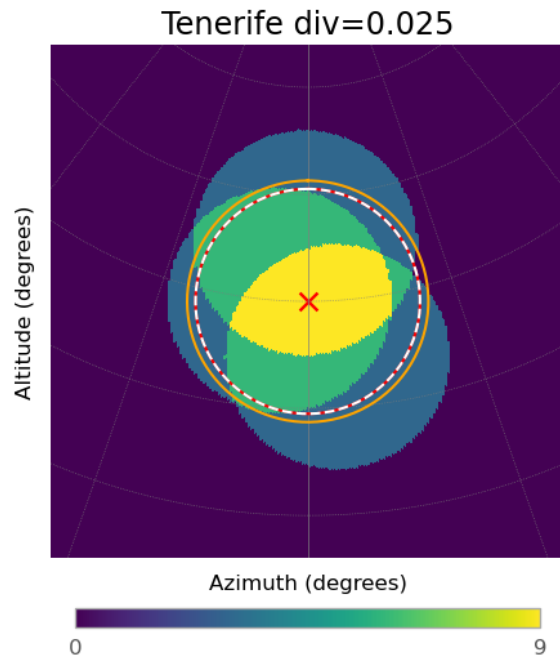


From 9 to 40: the SST Telescopes and Gamma-Ray Science
with ASTRI and CTAO

Comparison



Some Example to what in principle could be studied



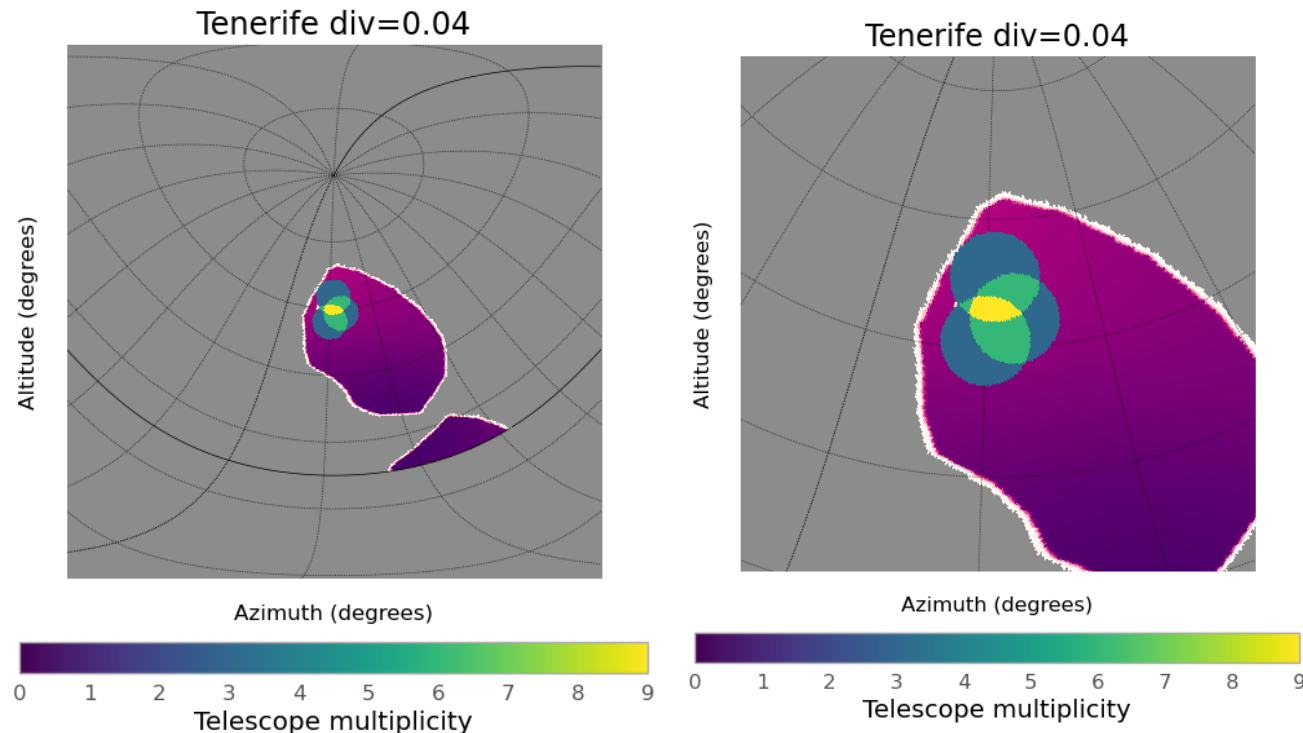
Subarray divergent pointing Fov:
153.84 deg² and Av. Mult =5.06

- Cygnus Cocoon in one shot we could get the whole LHAASO FoV.
 - [Taken from Detection of emission from Cygnus Cocoon above 100 TeV with LHAASO – LHAASO collaboration.](#)

Some Example to what in principle could be studied

Template of Fermi Bubbles
taken from [Fermi bubbles
template from 2 - 20 GeV](#)

July 29
visibility



- Fermi Bubbles
Div 0.04 we get a FoV:
193.25 deg²
with 7 pointings we could
cover it all.
While for the normal
pointing we would need at
least 16 Pointings.

Conclusion

- Taking into consideration the FoV, the average multiplicity and the multiplicity plots: subarray divergent pointing seems to be a valid option when we have enough telescopes to group and might be of most interest for cherenkov telescopes arrays such as ASTRI and SST.
- What about the simulations? Would it be feasible to do simulations with ASTRI Mini-Array?
- Is someone of you willing to join?
- What about CTAO SST? Is it interesting?

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- Taking into consideration the FoV, the average multiplicity and the multiplicity plots: subarray divergent pointing seems to be a valid option when we have enough telescopes to group and might be of most interest for cherenkov telescopes arrays such as ASTRI and SST.
- What about the simulations? Would it be feasible to do simulations with ASTRI Mini-Array?
- Is someone of you willing to join?
- What about CTAO SST? Is it interesting for you?

Thank you for your attention!

BACK UP

SSTs

- Convergence and Divergence
- Maximum
 - Convergence -0.0082
 - Divergence 0.013
 - 229.65 deg^2
 - Av mult. 10.01

MapCombination1and2-0.0082a

