High Energy Physics Division
Gamma-ray Physics Program

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Argonne Gamma-ray Physics Program

- VERITAS IACT Array
  - Observing Shifts
  - Scientific Data Analysis
    - Indirect Dark Matter Program
    - LS I +61 303
    - Blazar Monitoring
  - Trigger Upgrade
    - Collaboration with Iowa State University -- F. Krennrich, M. Schröeder (now at SAO)
- AGIS/CTA
  - Schwarzschild-Couder Telescope design
    - Collaboration with UCLA (V. Vassiliev), McGill Univ., Univ. of Chicago, SAO, Marshall Space Flight Center
    - Argonne designing optical support structure
  - Davies-Cotton 12m design
    - Collaboration with DESY (Zeuthen & Hamburg) and CEA, France
  - Trigger - Iowa State, Washington University
  - Photodetectors - UC/Santa Cruz, Barnard College

VERITAS Array Specs

VERITAS:

Sensitivity ~ **5σ detection at 1% Crab** (2×10^{-13} erg $cm^{-2}s^{-1}$ @ 1 TeV in **28hrs**

Energy range ~ 150 GeV – 30 TeV, 15% resolution (for spectral measurements)

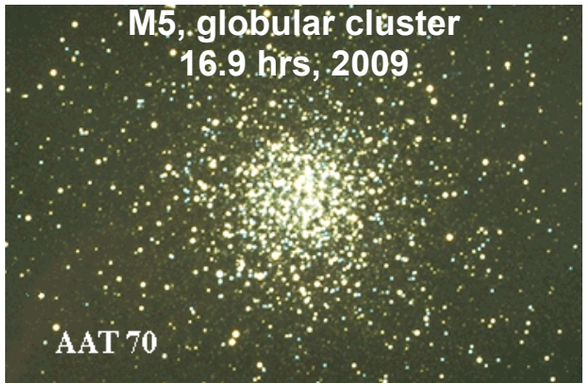
Effective area ~ 10^5 m^2 above 500 GeV

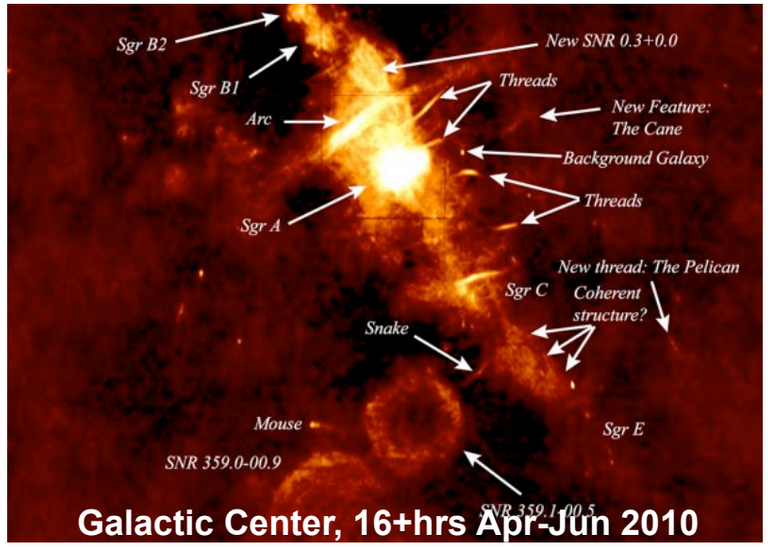
Angular resolution < 0.1^o

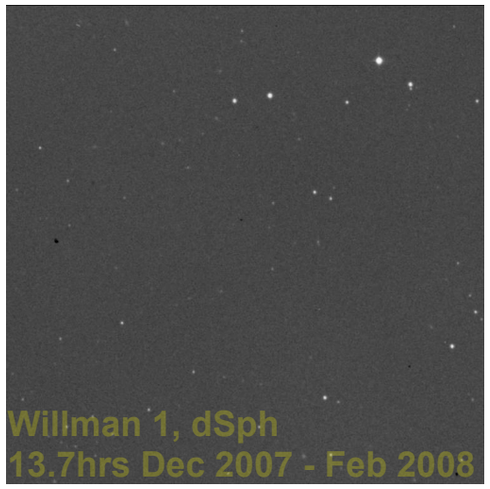
VERITAS is currently the most sensitive TeV Observatory in the World!

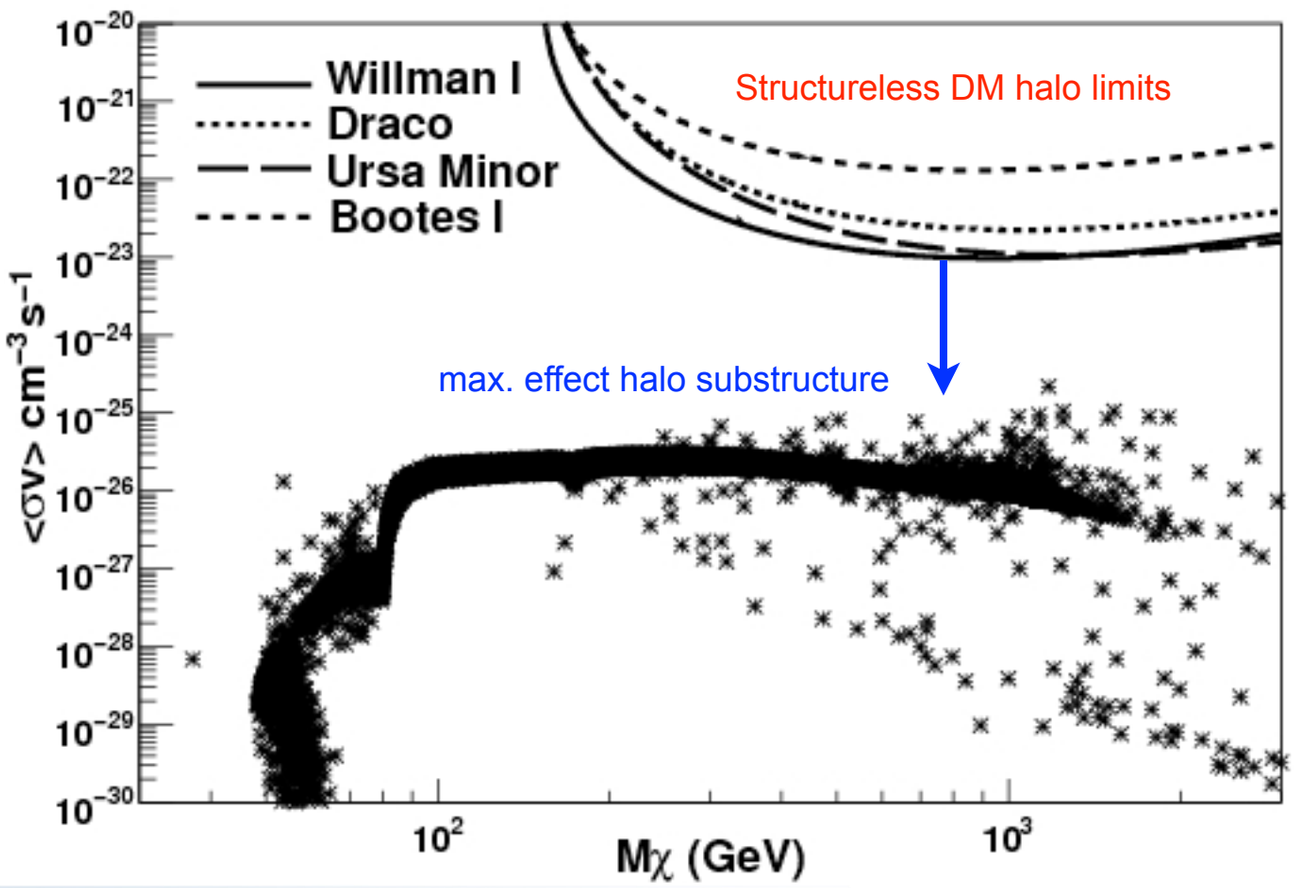
VERITAS Indirect Dark Matter Search

Indirect Dark Matter Search
Target variety of possible sources









Emphasis on Dwarf Spheroidal Galaxies

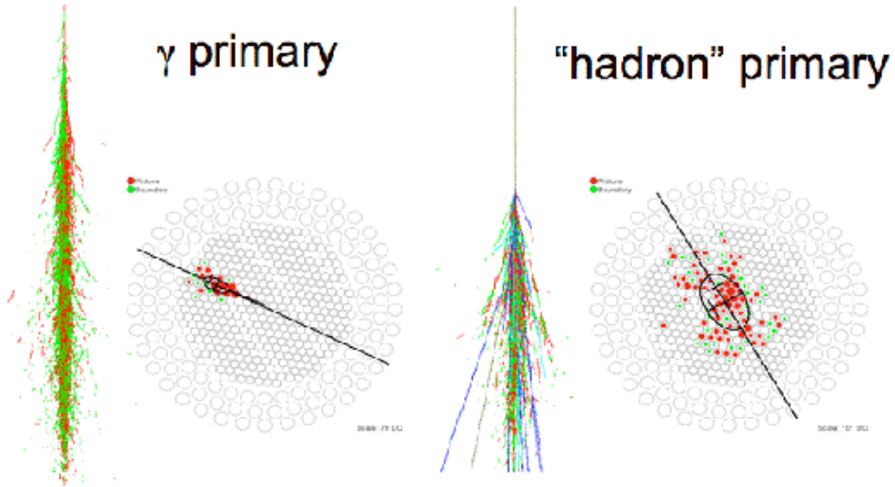
- Milky Way satellites (proximity)
- No active star formation
  ⇒ No bkgd from known VHE sources
- Dark Matter dominated -- $M_\odot / L_\odot \sim$ 200-1000
- SEGUE 1 Observed Dec, 2009 - Mar, 2010

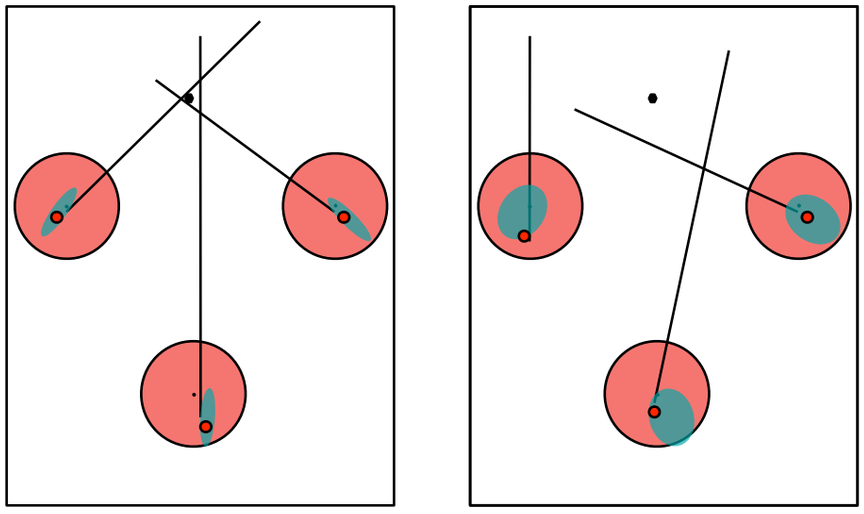
Topological Trigger Development

Collaborative effort between Argonne HEP and Iowa State Univ.

Motivation: Lower Energy Threshold/ Bkgd CR Rejection

- GRB detection
- Dark Matter Search
- High z Blazars & EBL measure
- Pulsars

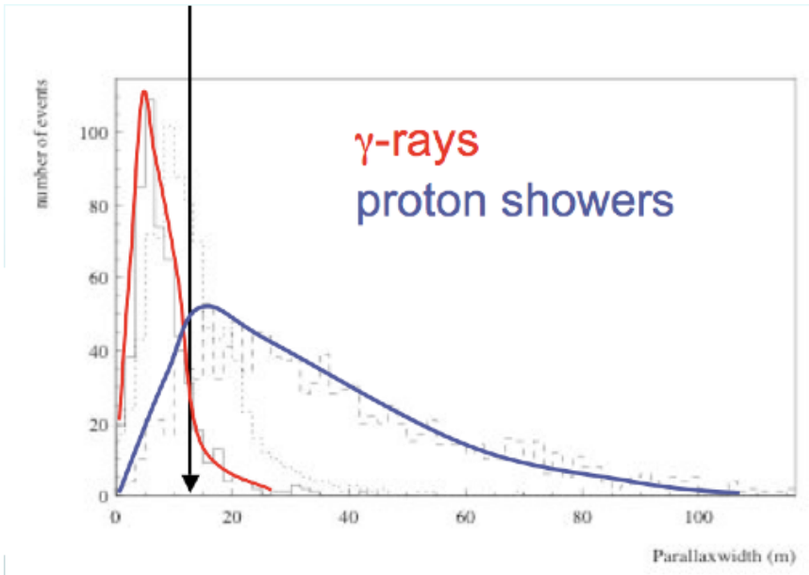




Overview:

Use calculation of major axis of ellipse in lowest level trigger

Intersection of axes at array level -- parallactic displacement

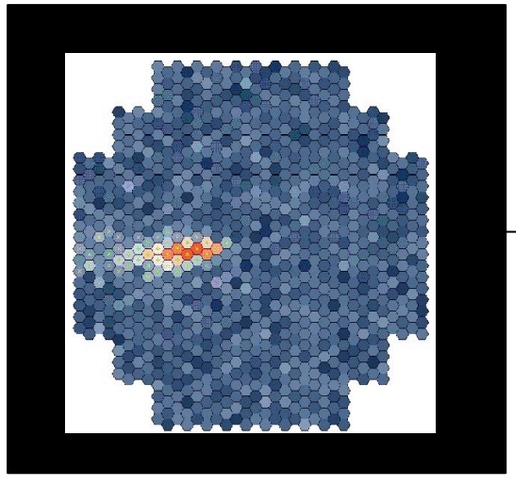


Monte Carlo simulation of γ/hadron separation with ParallaxWidth.

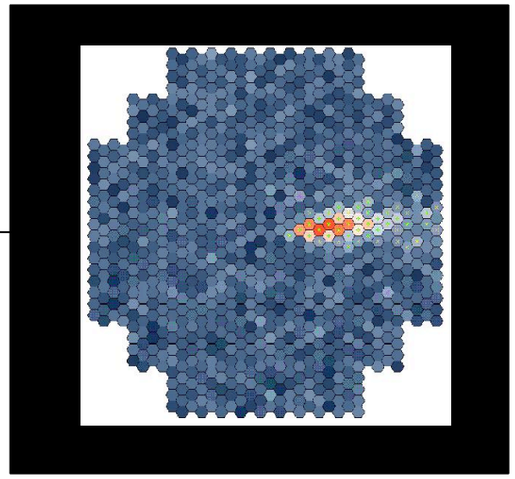
Simulation with array of 19 10m telescopes spaced at 60m

VERITAS Trigger System (Old vs New)

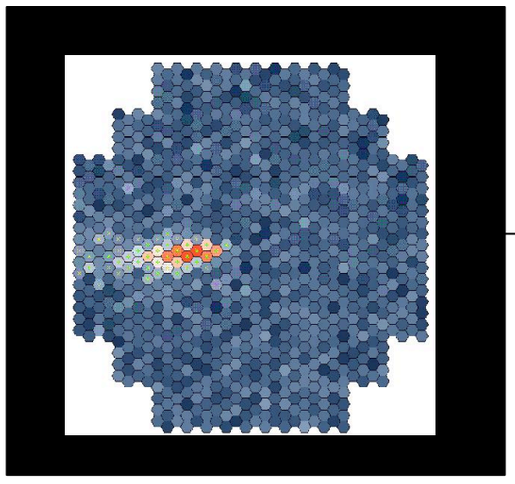
- Shorter coincidence gate (8➛3ns) reduces NSB allowing lower Trigger thr.
- Lower thr. ⇒ higher CR rate ⇒ higher deadtime
  - Remedies: zero suppress, QADC mode, 2➛3 telescope multiplicity, topological trigger mode (L4)
- L4 enabled by new L2. Being pursued but **not** part of base



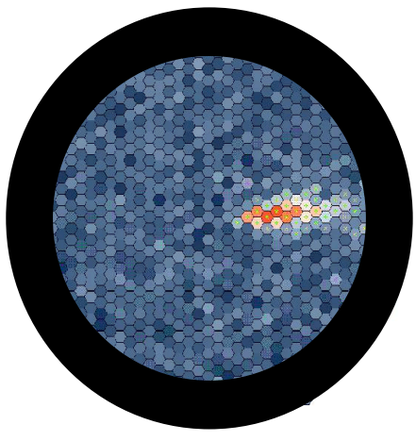
3 neighbor pixel
~ 8 ns



Array coincidence
~ 100 ns

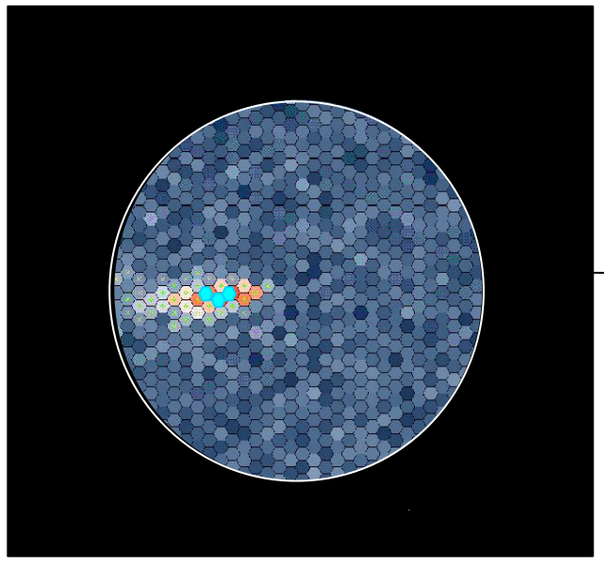


3(4) neighbor pixel
~ 3 ns



Array coincidence
~ 30 ns

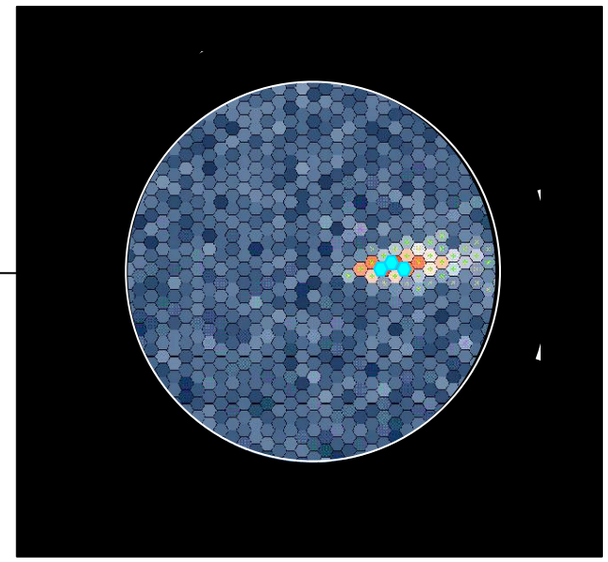
Advanced Trigger System -- L4 implemented

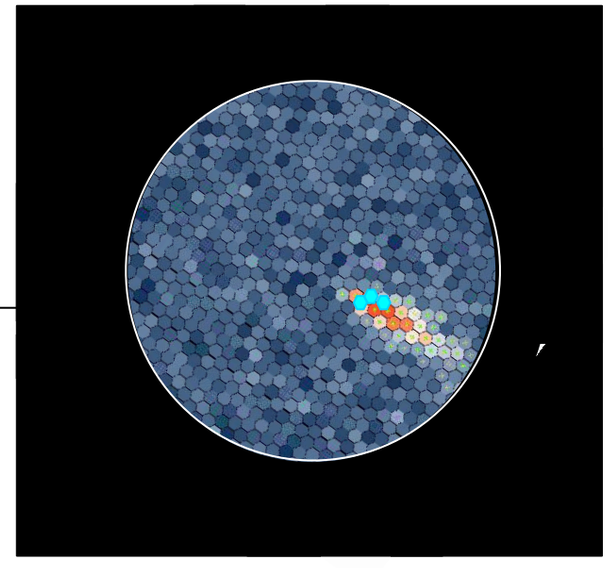


3(4) neighbor pixel
~ 3 ns

Real time image (centroid) analysis + wavefront fitting

Array coincidence
~ 30 ns





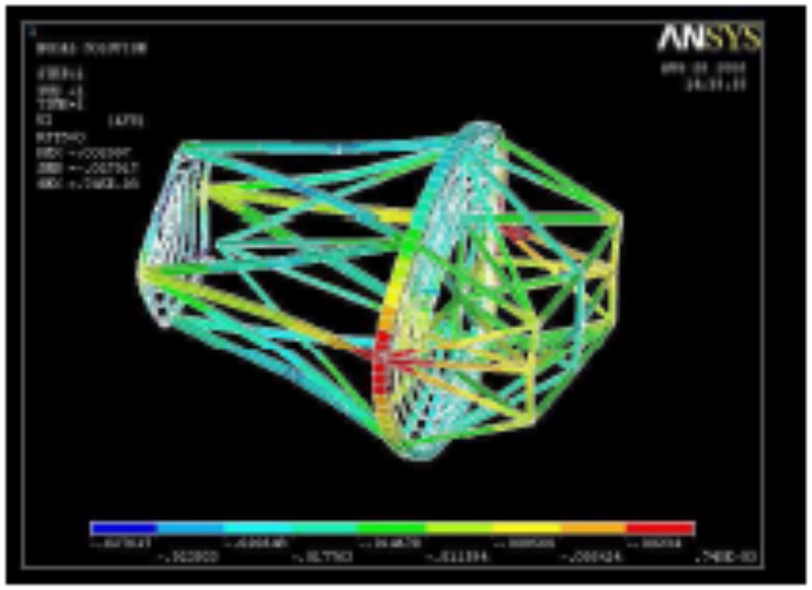
Note: pursuing design but not part of VERITAS baseline upgrade

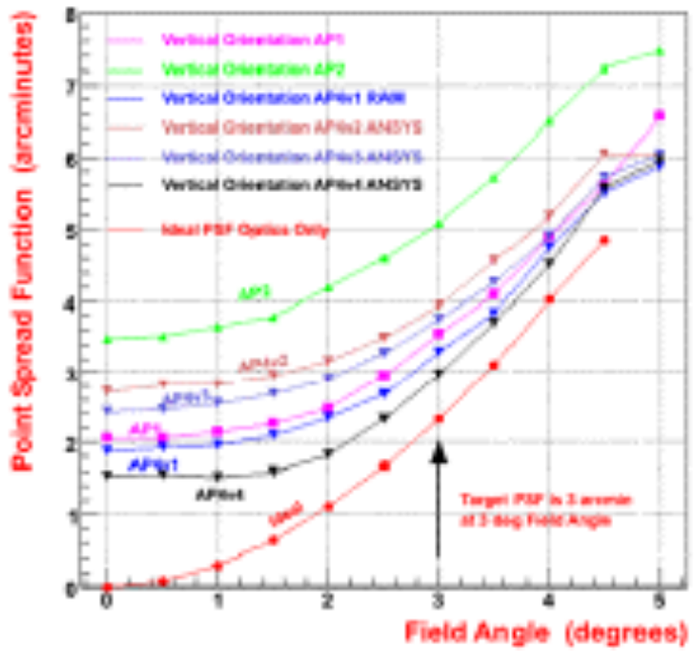
Advanced system implements L2 selection at telescope level based on Hillas parameters
L4 implements ParallaxWidth selection

Telescope Mechanical Structure Challenges

- Positioning aspherical mirror segments imposes tight specifications for allowable gravity and thermal deformation for Schwarzschild-Couder design
- Support moments from camera and secondary mirror structure
- Minimize deflections of mirror support points to <0.1mm
- Slew at high rate -- sets scale on deflections & required stiffness
- Robust design driven by low cost fabrication & assembly

Future Gamma-ray Telescope Array Mechanical Structure Development (I)



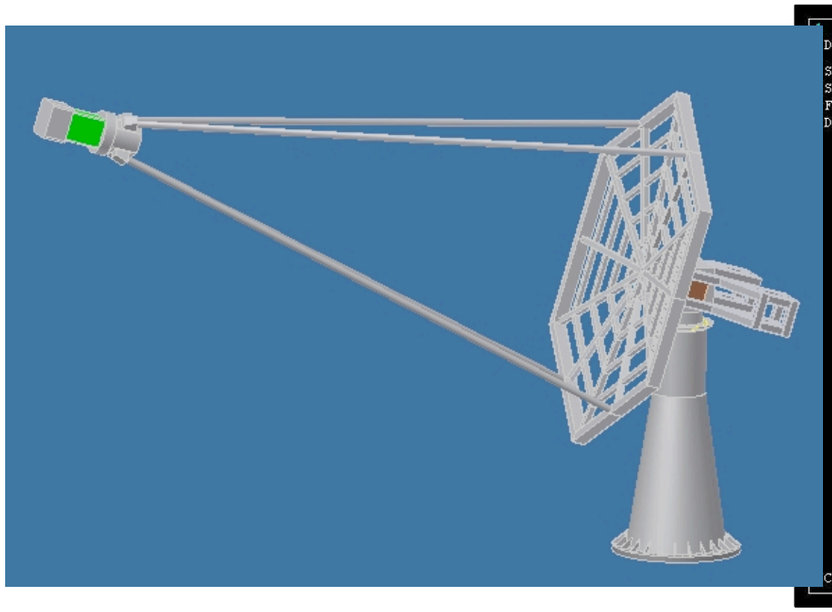


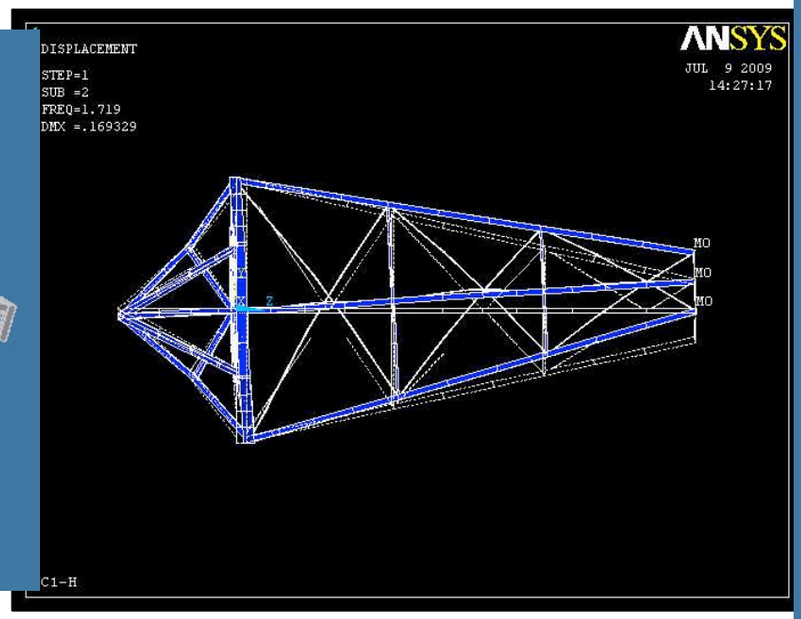
Completed a preliminary 9-meter SC OSS Design and Motion Control System

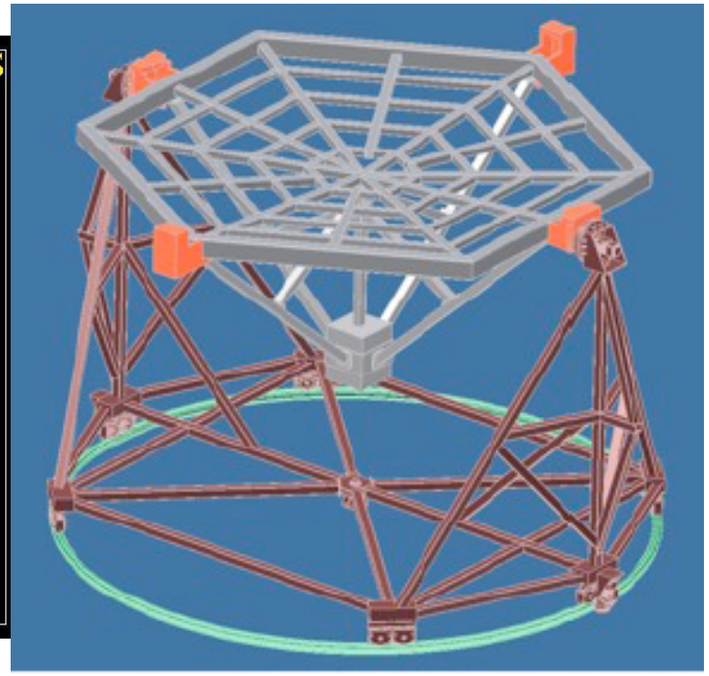
- **OSS design includes structure deformation under rotation, thermal expansion and contraction, and modal analysis to meet design spec of 3 arcmin to field angle of 3 deg.**
- **Drive System Design included wind and inertial loads.**

There is significant interest from DESY and SACLAY to participate

12m Davies-Cotton Design







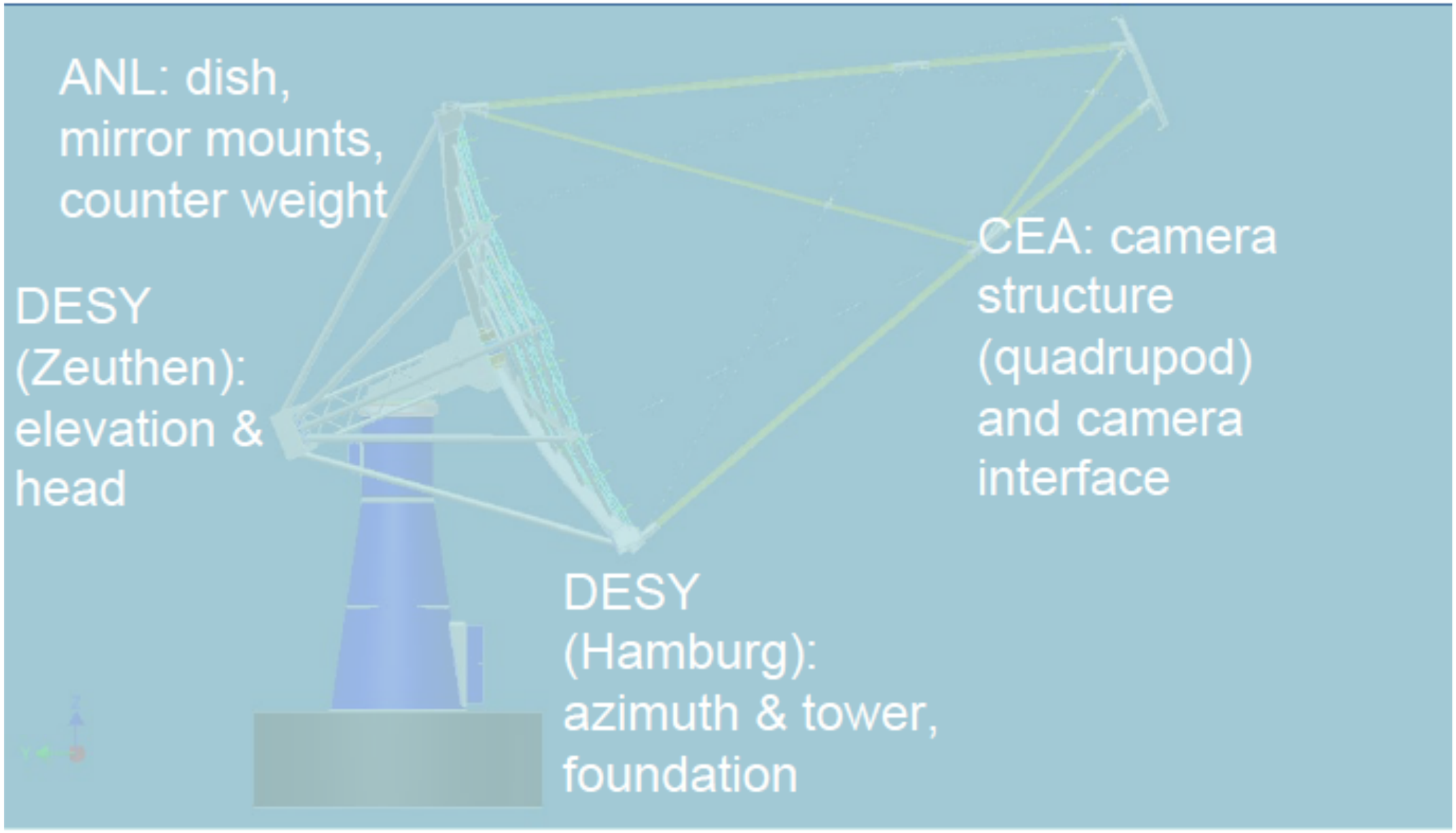
Completed Davies-Cotton 12m design with DESY providing Motion Drive design (LDRD + DESY Funding)

- Steel design for easy construction in the field using industrial parts
- Optimize location of camera truss members & counterweight structure
  - 3, 6, 9, 12 o'clock positions
  - Load transfer direct to support points with increasing elevation angle
- Counterweight balances camera load on dish minimizing deflections

Schedule has construction start ~ 1year from now in Berlin

Future Gamma-ray Telescope Array
Mechanical Structure Development (II)

ANL-CEA-DESY MST conceptual design



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ANL-CEA-DESY MST, TEL-MIR, Heidelberg March 16, 2010

Summary of Argonne Gamma-ray Astrophysics

- Scientific involvement
  - Dark Matter Search program with VERITAS
  - Would continue with AGIS/CTA
- Trigger Development
  - Implementing in VERITAS upgrade
  - Planning for incorporation into AGIS
- Telescope Optical Support Structure Design
  - 11m Schwarzschild-Couder design for AGIS
  - Collaborative design of 12m Davies-Cotton for CTA with DESY & CEA