VERITAS ESAC 2009 Meeting: Overview

1. Science Overview:

   Science WG's, Key Science Projects, time allocation, partnerships.

2. Tremendous Progress since last ESAC meeting (Feb 2007):
   Technical and scientific highlights.

3. Strategic plan for next two years:

   Science framework and the path to an Upgrade.

4. Help that the ESAC can give us.

Rene Ong, Jamie Holder for the VERITAS Collaboration

VERITAS 2009

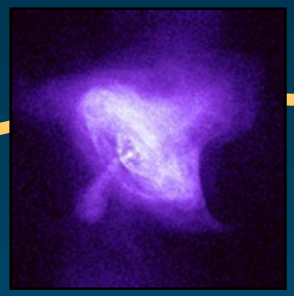
- Smithsonian Astrophysical Observatory
- Purdue University
- Iowa State University
- Washington University in St. Louis
- University of Chicago
- University of Utah
- University of California, Los Angeles
- McGill University, Montreal
- University College Dublin
- University of Leeds
- Adler Planetarium
- Argonne National Laboratory
- Barnard College
- DePauw University
- Bartol Research Institute/ University of Delaware
- Grinnell College
- University of California, Santa Cruz
- University of Iowa
- University of Massachusetts
- Cork Institute of Technology
- Galway Mayo Institute of Technology
- National University of Ireland Galway

- ~25 Associate Members

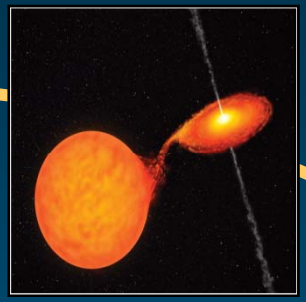
VERITAS Science

Origin of Cosmic Rays

SNRs

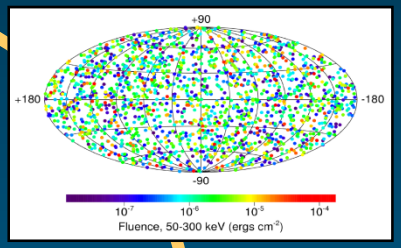


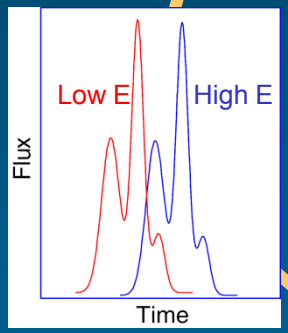
Pulsars



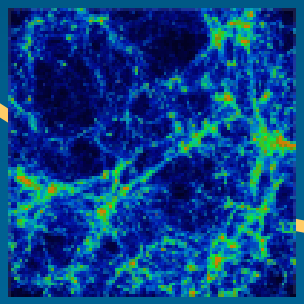
Microquasars

GRBs

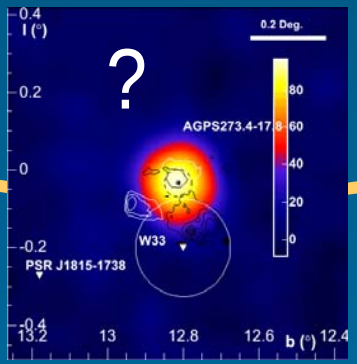




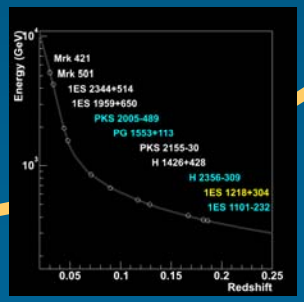
Testing Lorentz Invariance



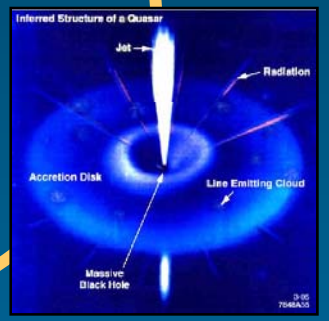
Cold Dark Matter



Something New !



cosmological γ-Ray Horizon



AGN

Science WG's

Original

- Gal. Compact Obj.
- Gal. Diffuse
- Sky Survey
- SNRs/PWN
- Un-IDs
- GRB's
- Blazars
- Extrgalactic Non-Blazar
- Astroparticle
- Dark Matter

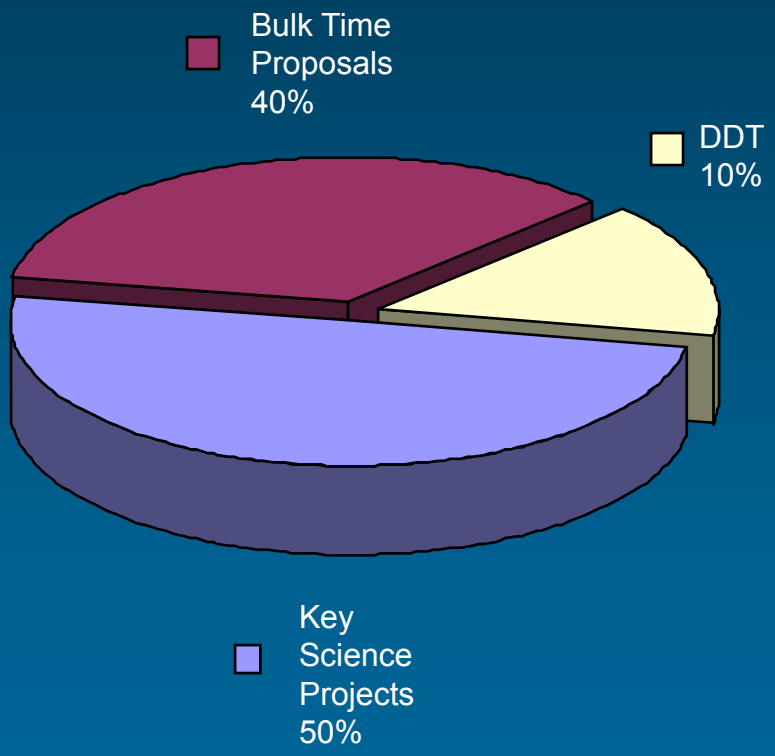
Now

- Galactic Sources
- GRB's
- Blazars
- Astro/Extragalactic
- Dark Matter

Time Division (2007-8 & 2008-9)

- **Key Science Projects:**
  - Sky Survey
  - Blazars
  - Supernova Remnants
  - Dark Matter
- **Bulk Time Proposals** administered by VERITAS Time Allocation Committee (TAC).
- **Directors's Discretionary Time (DDT)** for engineering, ToO's, etc.

Note: GRB's have highest observing priority.



TAC, Publications, Speakers

TAC (chair: J. Holder)

- Receives and rates proposals for bulk time.
- Generates and maintains observing schedule.
- Ensures that correct observations are made.

Publications (chair: D. Hanna)

- Maintains database of papers in various stages.
- Reports on progress, encouraging completion.
- Ensures that publications are of high quality.

Speaker's Bureau (chair: L. Fortson)

- Maintains database of conferences, figures, etc.
- Determines speakers for conferences, lobbies for talks, etc.

Partnerships

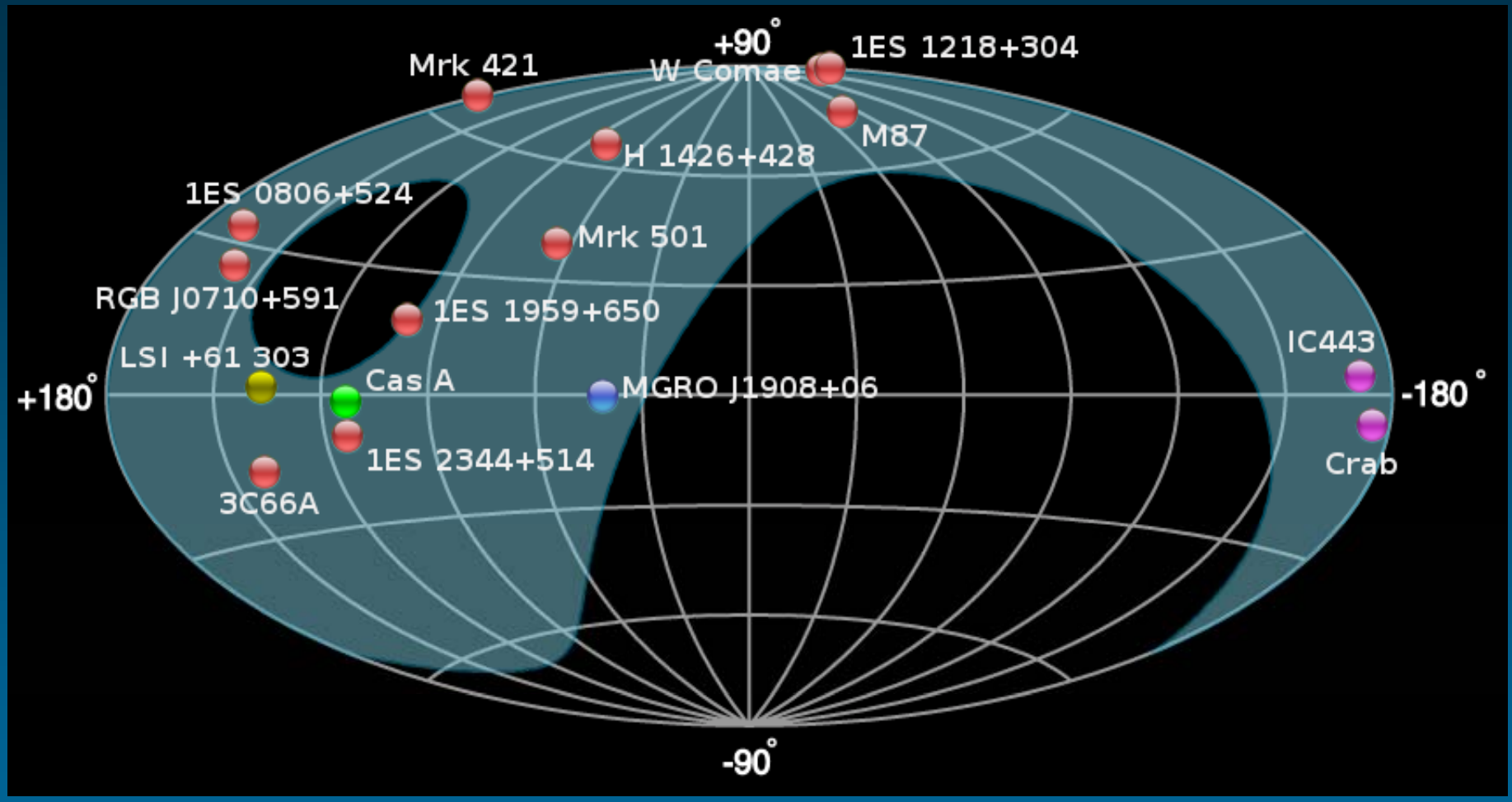
We have partnerships with the major players in the HE and broader astronomical communities:

- We are working with Fermi and AGILE on joint campaigns, ToO's, data-sharing, and papers.
- We have good working relationships with MAGIC, HESS for joint observing programs and papers.
- A MoU for collaboration with Fermi-LAT is in place and working.
- We work closely with MWL partners in radio, optical and X-ray.
- VERITAS Associates include theorists and members of other major teams (e.g. Fermi-LAT, Swift, IceCube).

You will hear more details on this in upcoming talks.

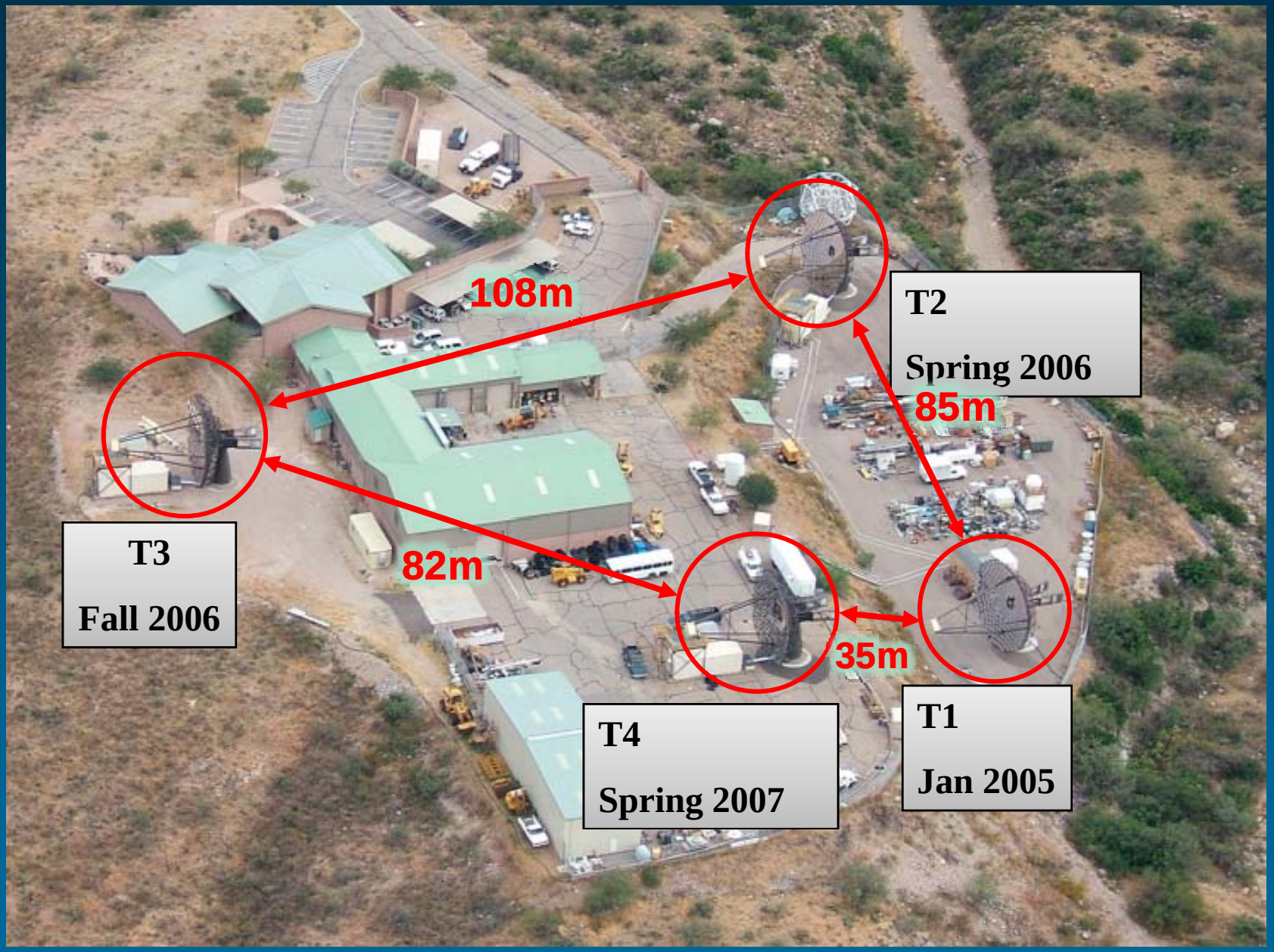
At Time of Last ESAC Mtg.
(February 2007)

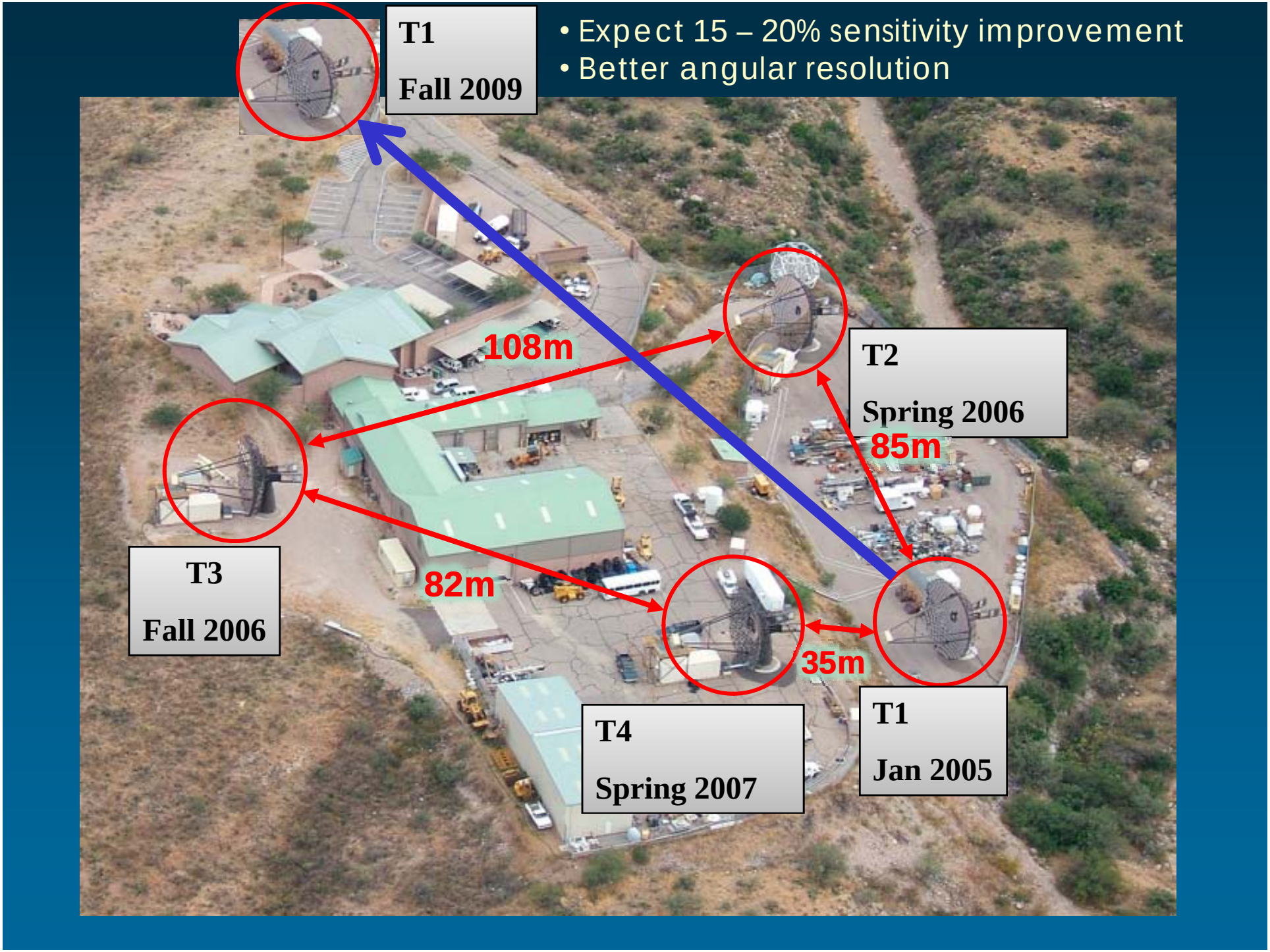
1. We were planning for an eventual move to Kitt Peak.
2. We had not yet started 4-telescope operation; we did not know the reliability of the 4-telescope array.
3. We were not taking data in moonlight.
4. The KSP's were getting refined and we were just starting initial observations.
5. Fermi had not been launched.
6. We were exploring ideas for an upgrade, but these were not well determined.
7. AGIS was at an early stage.



16 VERITAS sources and counting ...

Construction Timeline


108m
T2
Spring 2006
85m
T3
Fall 2006
82m
35m
T4
Spring 2007
T1
Jan 2005

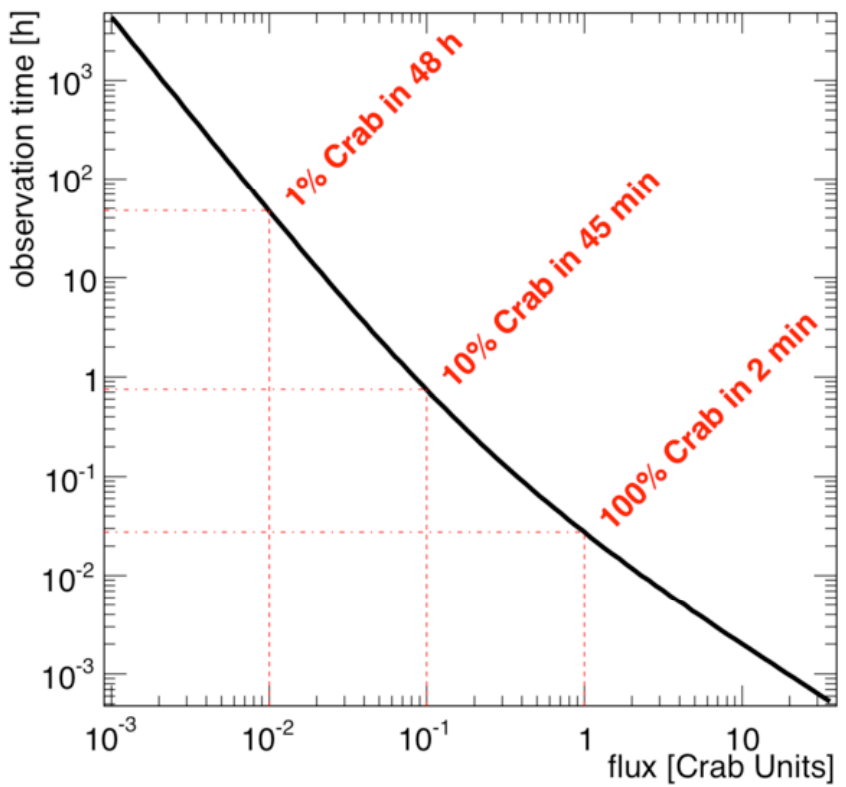

T1
Fall 2009
• Expect 15 – 20% sensitivity improvement
• Better angular resolution
108m
T2
Spring 2006
85m
T3
Fall 2006
82m
35m
T4
Spring 2007
T1
Jan 2005

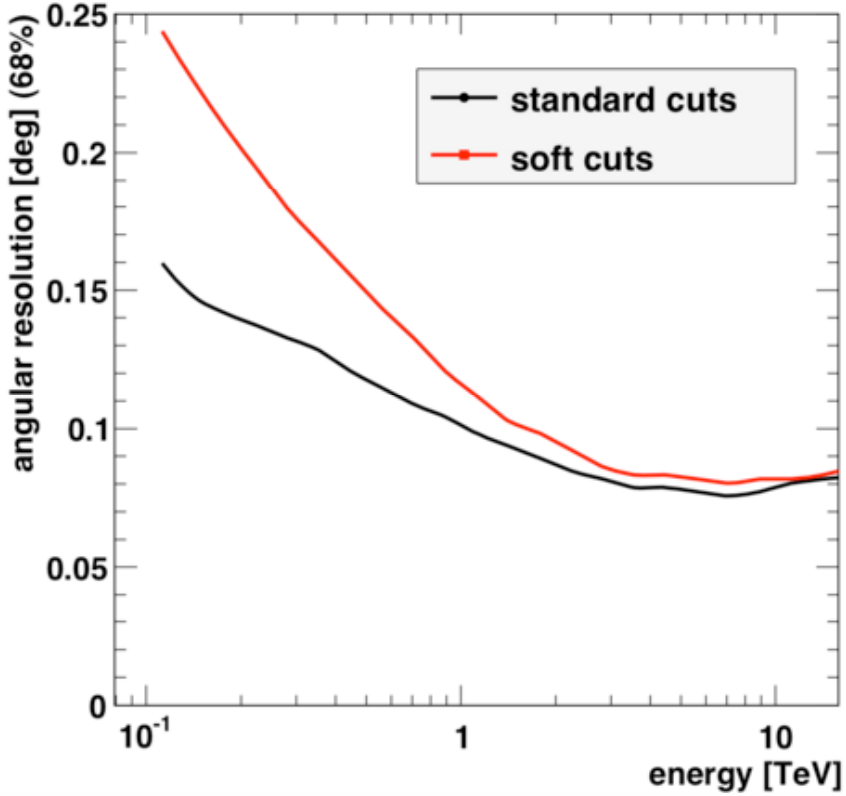
• 10m provides long term monitoring of bright blazars

VERITAS Technical Performance

- VERITAS is currently the most sensitive TeV Observatory in the world
  - Conservative sensitivity of 1% Crab in <50 hours.
  - Further improvements from refined analysis in the works.
  - Angular resolution ~0.1° (68% containment).

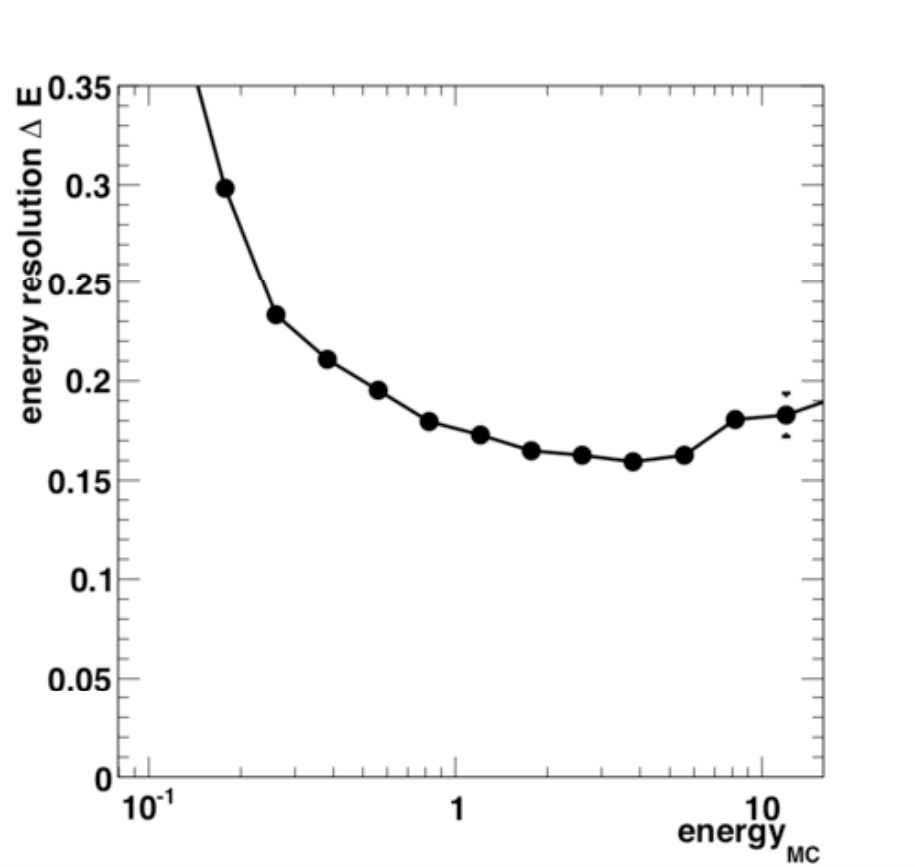
(MAGIC ~1.6% Crab in 50 hours. H.E.S.S., originally 1% Crab in 25 hours, currently significantly degraded due to poor mirror reflectivity).

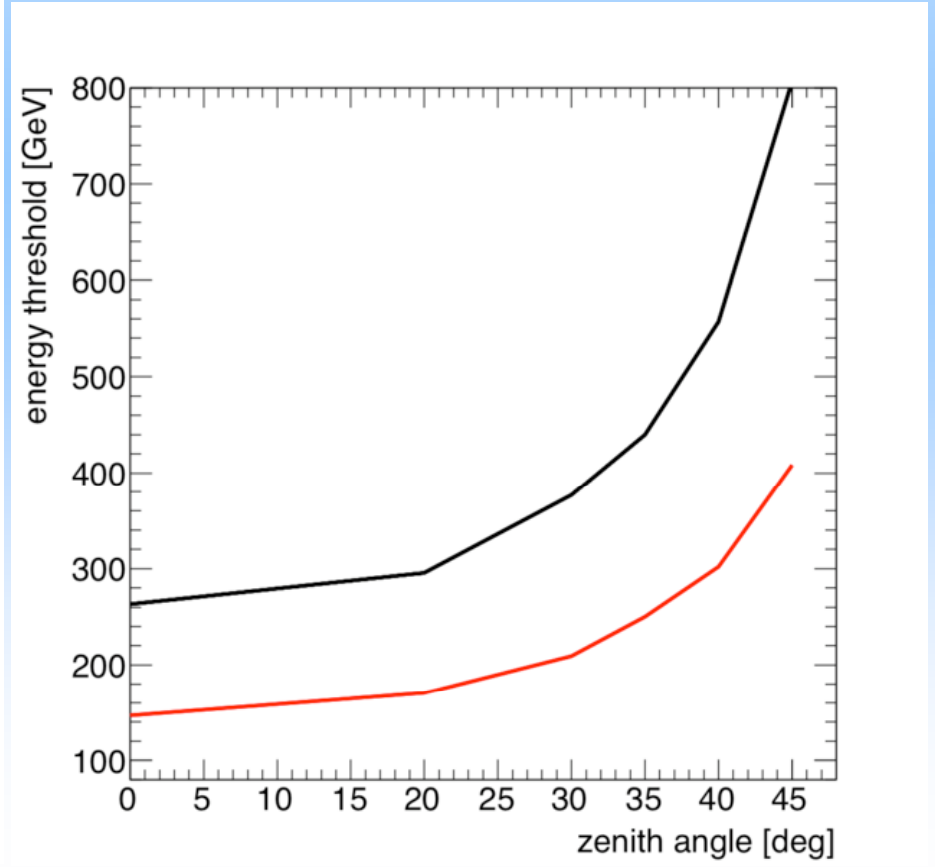




VERITAS Technical Performance

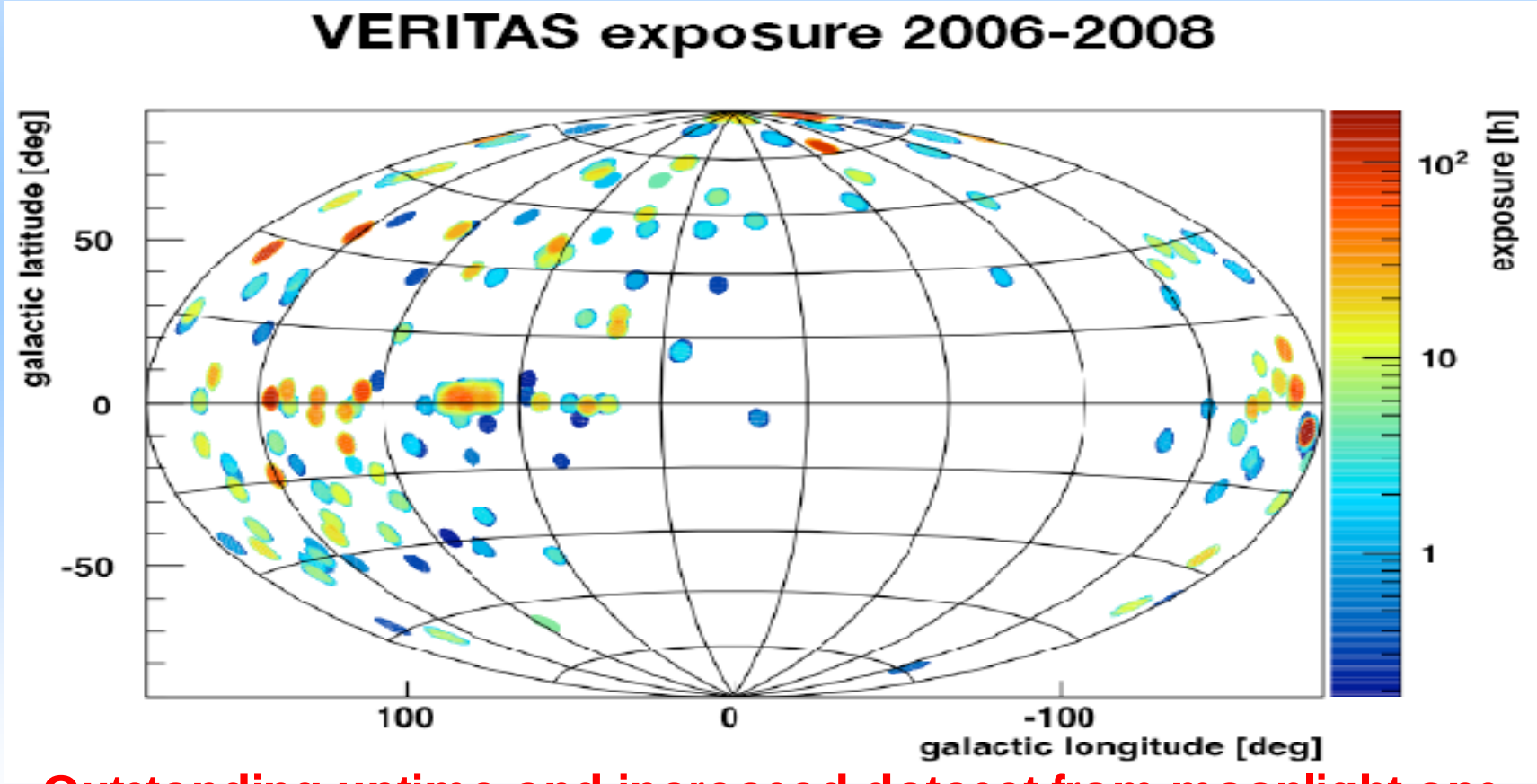
- VERITAS is currently the most sensitive TeV Observatory in the world
  - Energy resolution ~15-20% >300GeV
  - Energy threshold ~150 GeV with 'soft' cuts, expected to go lower with optimized trigger settings and refined analysis.





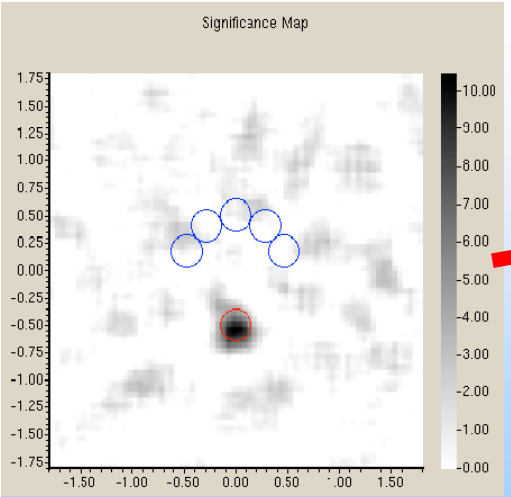
VERITAS Observations

- 2007-8: 707 hours under clear skies, plus 89 hours moonlight.
- 2008-9: 548 hours under clear skies, plus 132 hours moonlight.
- >95% Taken with all four telescopes operating.

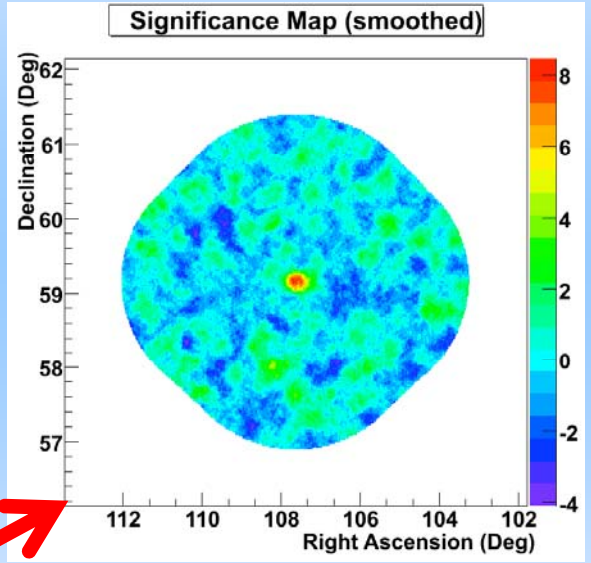


Outstanding uptime and increased dataset from moonlight ops.

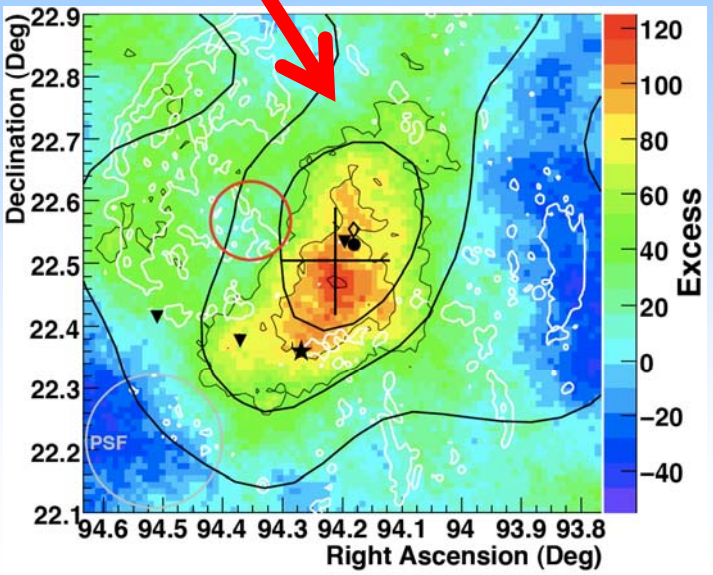
Rapid Feedback and Reliable Results



"Quicklook" provides immediate feedback to observers (seconds).



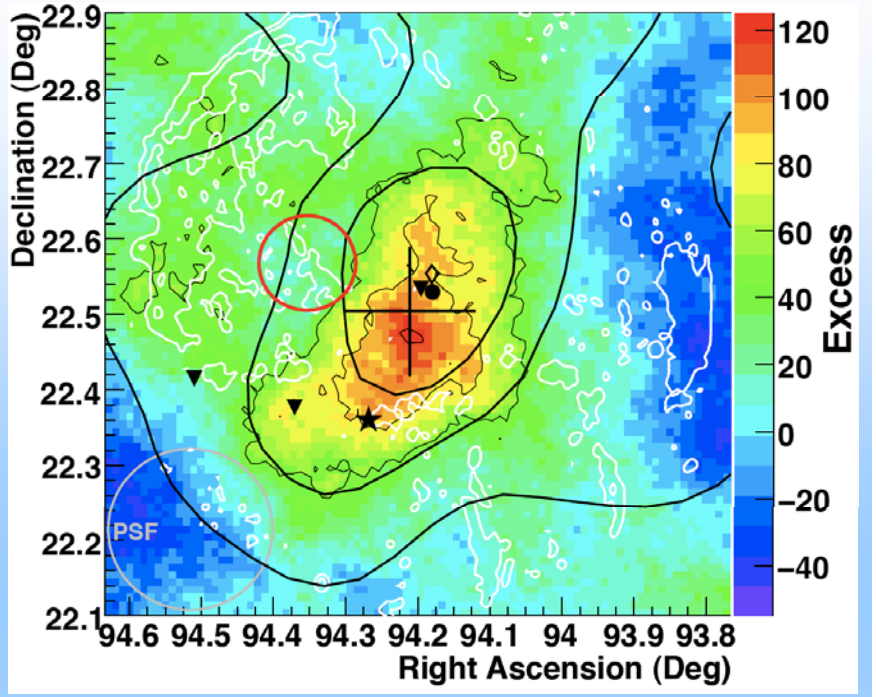
- All data is stored in raw and pre-processed format at UCLA.
- Publication requires two independent analyses >5σ.

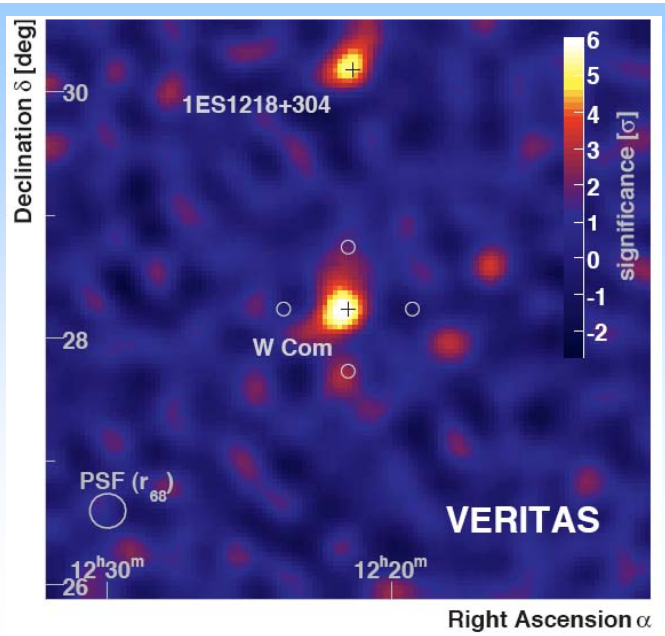


- Automatic "Next day" analysis provides more sensitive and stable confirmation (24 hours).
- Used for e.g. Astronomers Telegrams.

Some Key VERITAS Achievements

- 6 new detections: IC443, 1ES0806+524, RGB J0710+591, WComae, 3C66A, SNR G106.3+2.7. (4 ATELs issued).
- 5 promising candidate sources (3 new).
- Extended extragalactic TeV source classes (both WComae and 3C66A are *IBLs*).
- Ongoing contributions to *EBL density* studies (with 1ES1218+304).
- Unparalleled morphological and spectral studies of *IC443*, *Cas A*.
- First evidence of TeV emission associated with activity at the ***core*** of M87.
- Completed a 120 hour *survey* of the Cygnus region.
- Bright *flare* studies of Mrk421, 1ES2344+514, WComae, 3C66A.
- Detailed time-resolved studies of the gamma-ray binary *LSI+61°303*.
- GRB observations with 2-3 minute response.
- Excellent coordination with RXTE, Swift, Fermi, HESS, MAGIC and numerous optical/radio observatories.





VERITAS Refereed Publications 2008-

- "VERITAS observations of the BL Lac 1ES 1218+304 "Acciari et al., ApJ 695, 1370, 2009.
- "Multiwavelength Observations of Markarian 421 in 2005 – 2006", Horan et al., ApJ 695, 596, 2009.
- "VERITAS Observations of a Very High Energy Gamma-ray Flare from the Blazar 3C 66A", Acciari et al., ApJ 693, L104, 2009.
- "The June 2008 Flare of Markarian 421 from Optical to TeV Energies", (w. AGILE,GASP-WEBT,MAGIC) Donnarumma et al., ApJ, 691, L13, 2009.
- "Discovery of Very High Energy Gamma-ray Radiation from the BL Lac 1ES 0806+524", Acciari et al., ApJ, 690, L126, 2009.
- "VERITAS Discovery of >200 GeV Gamma-Ray Emission from the Intermediate-Frequency-Peaked BL Lacertae Object W Comae", Acciari et al., ApJ, 684, L73, 2008.
- "VERITAS Observations of the γ-Ray Binary LS I +61 303", Acciari et al., ApJ, 679, 1427, 2008.
- "Observation of Gamma-Ray Emission from the Galaxy M87 above 250 GeV with VERITAS", Acciari et al., ApJ, 679, 397, 2008.
- "A search for Dark Matter Annihilations with the Whipple 10m Telescope", M. Wood et al., ApJ 678, 594, 2008.

VERITAS Publications: Soon (7)

- "Multiwavelength Observations of LS I +61 303 with VERITAS, Swift and RXTE" Acciari et al., submitted to ApJ.
- "Observation of Extended VHE Emission from the Supernova Remnant IC 443 with VERITAS" submitted to ApJ.

The following will be submitted within <1 month

- "Evidence for long-term gamma-ray and X-ray variability from the unidentified TeV source HESS J0632+057" ApJ.
- "Radio Imaging of the Tera-electron Volt emission region in the central engine of a radio galaxy " (w. HESS,MAGIC,Radio), Science.
- "Simultaneous Multiwavelength Observations of Markarian 421 During Outburst" (w. MAGIC) ApJ.
- "Observations of the Crab Nebula at Very High Energies with VERITAS" ApJ.
- "Multiwavelength Observations of the VHE Blazar 1ES 2344+514" ApJ.

In the Pipeline Now (14)

These topics have a draft under review by internal paper committees:

- SNR G106.3+2.7.
- Cassiopeia A.
- WComae flare (with AGILE).

- These topics (and others) are in preparation:
- NGC1275.
- 3C66A (wi.Fermi).
- RGBJ0710+591 (w. Fermi).
- Blazar survey limits (42 sources).
- Extended VERITAS Observations of Markarian 421.
- 1ES1218+304 high state.
- Sky Survey.
- Markarian 501 (w. MAGIC and Fermi).
- CR composition – Direct Cherenkov light.
- Coma Cluster.
- Dwarf Galaxies (Dark Matter).

Strategic Plan (2009-2011)

Science Framework

- We have streamlined the Science WG's to increase efficiency and communication.
- We will continue the basic framework with 3 KSP's:

Galactic Sources	(125 hrs/yr)
Blazars	(125 hrs/yr)
Dark Matter	(50 hrs/yr)
Bulk Program	(400 hrs/yr)
DDT	(75 hrs/yr)

- TAC will determine program, with revisiting in early 2010.

Upgrade Plans

- T1 will be move in summer 2009 as first step in upgrade.
- Considering a baseline/enhanced program with a proposal submission in September 2009.

Revisting the 2007 ESAC Report

1. Whipple 10: value in continuing to run 10m Telescope.
2. Observing Plan: KSP's important, balance is good. Advertise procedure to participate in MWL campaigns.
3. FERMI: crucial to run through first two years.
4. Site: explore staying at basecamp for first two years of Fermi.
5. Upgrades: few $M could be useful. Encourage team to inform ESAC of ideas.
6. Theory/modeling: propose for AAS,HEAD session. Add theorists to be involved in interpretation.
7. Consider moonlight operations.

These have all been largely addressed.

ESAC 2009

From Roger R:

- Recommend ways to maximize community impact.
- Suggest broad-brush strategies for continued observing programs.
- Evaluate multi-wavelength contacts and recommend enhancements, if appropriate.
- Hear about upgrade/extension plans and comment on strategies in the context of the wider HE community.

ESAC 2009

VERITAS Perspective:

- Comment on any items that you see fit – all criticism is greatly valued – but especially on science impact and balance, partnerships, missing areas, and the upgrade.
- Note that in October 2009, the VERITAS operations funding runs out. We need to renew this funding and are working on it. A positive ESAC report could safeguard against a real slip-up.

(Please note that some of the results presented here are preliminary and should be kept confidential).

END

ToOs and DDTs (2008-09)

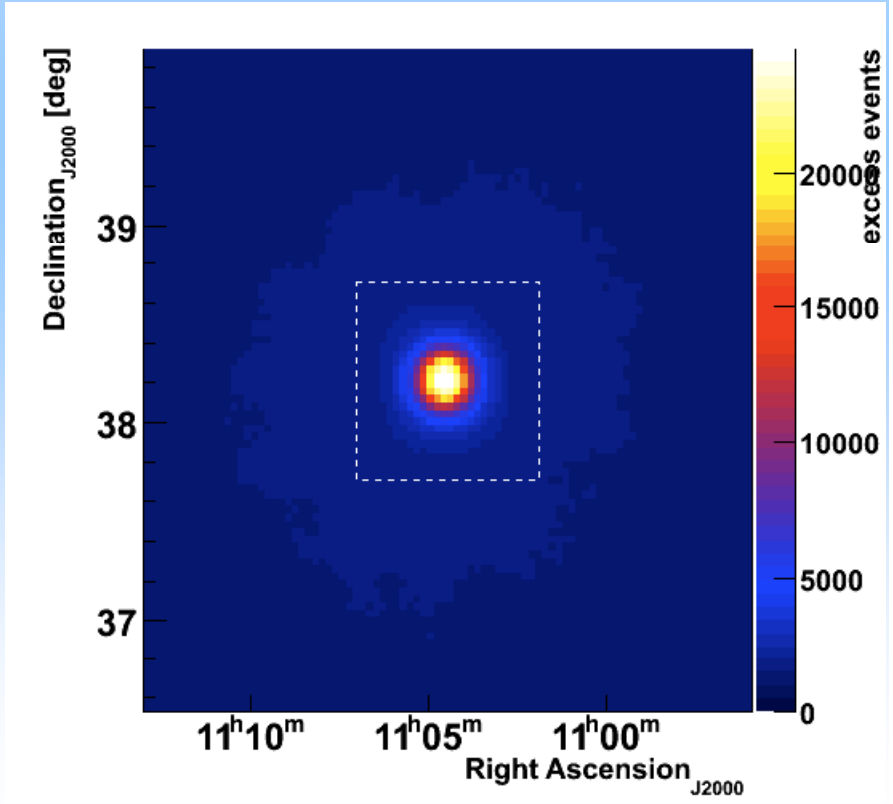
- 3C66A – 19 hours extended observations
- AO 0235+16: 5 hours – Fermi ToO
- 1ES0033+595: 80 mins ToO
- GRBs
- HESS J0632+057 (DDT)
- NGC1275 (DDT – Fermi driven)
- IC443 (DDT)
- PKS1424+240 and PKS1717+177 (DDT - Fermi driven)
- 2E 1050.7+4946 –Fermi ToO
- RGBJ0710 – moonlight hint, ToO led to detection
- GB6 J1700+6830 – Fermi ToO
- PKS1510 – 089 – Fermi ToO

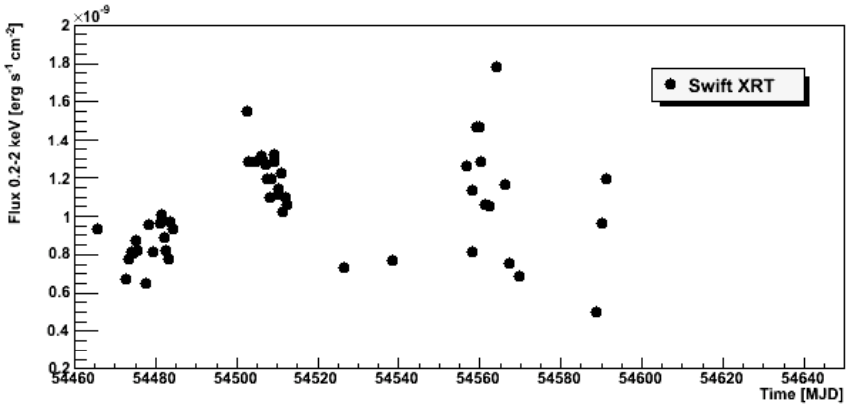
The 2008-9 Highlights

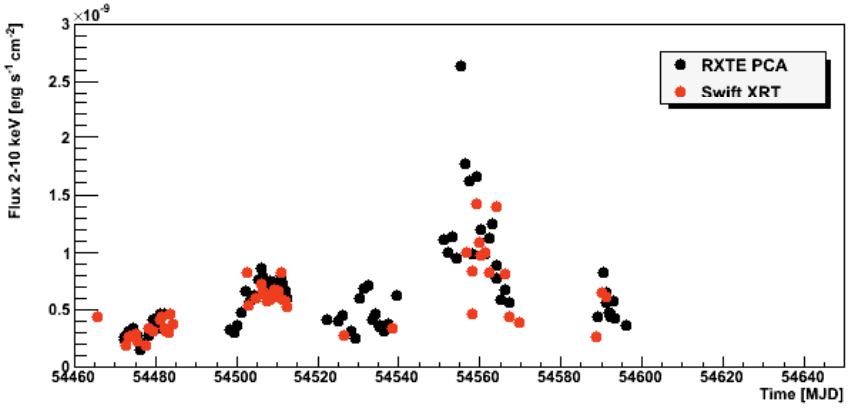
- Detection of G106.3+2.7.
- Detection of 3C66A.
- Detection of RGB J0710+591.
- Completion of first half of Survey: 2 candidate sources.
- HESS J0632+057 variability.
- LSI+61303 'anti-correlation' with Fermi.
- Huge M82 dataset.
- 1ES1218 high state.
- Fermi followups.

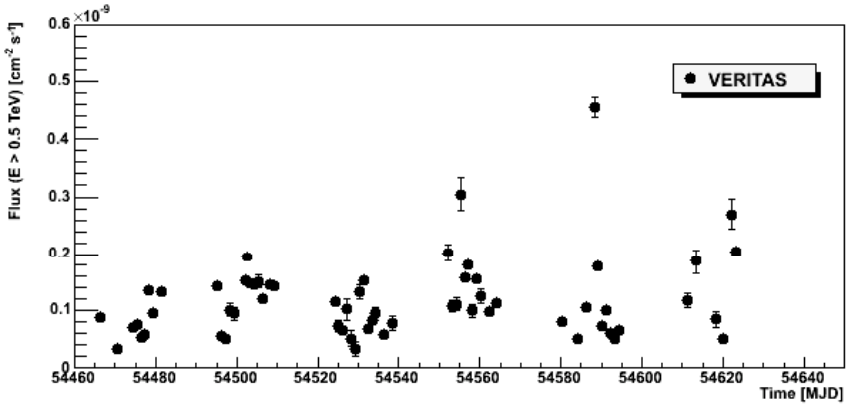
Markarian 421

- 44 hour exposure in 2007-8
- Contemporaneous Swift, RXTE
- 30,000 gamma-rays (277 sigma !)









Associates I

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Margo F. Aller	University of Michigan
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Yousaf Butt	Harvard Smithsonian CfA
Mike Carini	Western Kentucky University
Paolo Coppi	Yale University Department of Astronomy
Ignacio de la Calle Perez	European Space Astronomy Centre (ESAC)
Jodi Christiansen	Cal Poly State University, San Luis Obispo
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Julie McEnery	NASA, Goddard SFC
Teresa Montaruli	University of Wisconsin
Michelle Ouellette	Cal Poly State University, San Luis Obispo
George Pavlov	Penn State University
Dirk Petry	ALMA Project, ESO
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Alberto C. Sadun	University of Colorado at Denver
Patrick Slane	Harvard Smithsonian CfA
Merja Tornikoski	Metsähovi Radio Observatory