The VHE sky 2006–2010

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- VHE Catalog: AGN Observations above 50 GeV
- Future Experiments on the ground
- Importance for GLAST
  - Sensitivity
  - Overlap in sky, time
  - Unique capabilities on the ground
All sources discovered with atmospheric Cherenkov technique
AGN Catalog (including weak detections)

<table>
<thead>
<tr>
<th>Name</th>
<th>Type</th>
<th>Z</th>
<th>EGRET ?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mrk 421</td>
<td>XBL</td>
<td>0.031</td>
<td>Y</td>
</tr>
<tr>
<td>Mrk 501</td>
<td>XBL</td>
<td>0.034</td>
<td>Y</td>
</tr>
<tr>
<td>1ES2344+51</td>
<td>XBL</td>
<td>0.044</td>
<td>N</td>
</tr>
<tr>
<td>?? 1ES1959+650</td>
<td>XBL</td>
<td>0.048</td>
<td>N</td>
</tr>
<tr>
<td>PKS2155–304</td>
<td>XBL</td>
<td>0.116</td>
<td>Y</td>
</tr>
<tr>
<td>1H1426+428</td>
<td>XBL</td>
<td>0.129</td>
<td>N</td>
</tr>
</tbody>
</table>

- All XBL’s – different population from EGRET
- Nearby
MRK 501 – 1997

- **Light curve**

- **Spectrum**
MRK 421 – 2001

- Detection > 200 $\sigma$
- Correlation with X-rays (Holder et al, ICRC Hamburg)
- Short term variability minimum $\tau \sim 30$ min rise ~ fall
Difficult to measure "cutoff"

Universal feature?

Absorption at Source?

Note: HEGRA sees somewhat different spectral shapes – Mrk 421 appears different than Mrk 501 (ICRC Hamburg)
1H1426+428  (Horan et al., ICRC Hamburg)
Whipple/VERITAS  (also seen by HEGRA at similar significance)

- 2000  4.19 $\sigma$
- Weak signal $\sim < 100$ mCrab
- 2001  4.94 $\sigma$
2005 All four new telescopes should be operational 2 N, 2 S

Do not consider air shower arrays

For review, see Weekes, astro-ph/0010431
Both in space and on ground, sensitivities ~ 10 mCrab

- Limitation space− HE photon counting  ground− LE threshold
- Comparing "apples" and "oranges"
Most important strength for Ground–Based
– short term sensitivity
## Comparison with GLAST

<table>
<thead>
<tr>
<th>Parameter</th>
<th>GLAST</th>
<th>NGACT (e.g. VERITAS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angular resolution</td>
<td>0.10° (1 GeV)</td>
<td>0.14° (50 GeV)</td>
</tr>
<tr>
<td>(single photon)</td>
<td>0.04° (50 GeV)</td>
<td>0.05° (300 GeV)</td>
</tr>
<tr>
<td>Energy resolution</td>
<td>7–10 % (1–50 GeV)</td>
<td>15–10 % (50–500 GeV)</td>
</tr>
<tr>
<td>FOV</td>
<td>2.5 sr</td>
<td>2 x 10^{-3} sr</td>
</tr>
<tr>
<td>Duty Cycle</td>
<td>100 %</td>
<td>16%</td>
</tr>
<tr>
<td>Area (m²)</td>
<td>1.3</td>
<td>10^4 – 10^5</td>
</tr>
<tr>
<td>Instant. Crab Rate</td>
<td>&lt; 0.5 / min</td>
<td>~ 50 /min</td>
</tr>
</tbody>
</table>
Overlap with GLAST

Assumptions (optimistic):

- Two HESS/VERITAS ACTs in each hemisphere
- Duty cycle of 10% for each telescope
- Yearly operation of 10 months/telescope
- Telescopes formulate independent observing plans
- Have not folded in GLAST observing constraints

**Fraction of Time Covered by 1 or more ACTs**

(for sources that transit near zenith)

- Average (year) \( \sim 13\% \)
- Average (month) \( \sim 20\% \) winter
  \( \sim 8\% \) summer
- Peak (day) \( \sim 80\% \) winter
- Peak (day) \( \sim 45\% \) summer
Fraction of Sky covered (observations down to zenith=45°)

- Northern Hemisphere ~ 82%
- Southern Hemisphere ~ 65%
- Good overlap for $\delta = -10^\circ$ to $10^\circ$

# Sources / ACT in a year

- Include additional 80% source efficiency
- 14 sources @ 25 hr/source

Total sources (both hemispheres) seen on ground in a year

- Minimum ~ 28 (expts in each hemis. have identical obs plans!)
- Typical ~ 40
- ~ 40–50% will be extragalactic
Comments

- Have not considered "survey" modes for ACTs
  - VERITAS increase numbers of sources by 4–5
  - decrease sens. by 4 @ 100 GeV, by 8 @ 1 TeV
- For particular sources, monitoring can continue for months
- Coordination among ground–based community will help
- GLAST will strongly affect ground–based observing plans

Summary

- NGACTs will be an important complement to GLAST
- Key strength – follow ~25 AGN with great sensitivity at VHE
- Without coordination, capabilities will greatly surpass those today
- Coordination would substantially improve the science