What’s Next?
From Milagro to HAWC
Why are High Energies Important?

- Do spectra continue or break at high energies?
  - Hard to accelerate electrons beyond 50-100 TeV
More on 1908+06 - Preliminary

Median energy for this angle and $\alpha=-2.0$ is 50 TeV
Cut on $A4>4$ & 9 gives median $E$ of 60 and 90 TeV

E. Ona-Wilhelmi, et al., ICRC 2007
Why are High Energies Important?

• Do spectra continue or break at high energies?
  – Hard to accelerate electrons beyond 50-100 TeV
• Photons from hadronic interactions probe the knee region (~10x higher E)
• Need a high energy picture of the Galaxy, for example diffuse emission:
Why are High Energies Important?

Strong & Moskalenko

GALPROP model of Cygnus Region

standard

optimized

Inverse Compton

Pion

bremsstrahlung

\[ E \text{ intensity, cm}^{-2} \text{s}^{-1} \text{sr}^{-1} \text{MeV} \]

\[ \text{dN/dE (TeV/cm}^2\text{sr)} \]

\[ 30 \leq \theta \leq 65 \]

\[ 65 \leq \theta \leq 85 \]
Why are High Energies Important?

Strong & Moskalenko
GALPROP model of Cygnus Region

GLAST

???
HAWC - A Wide-Field Gamma-Ray Telescope
- Build detector at extreme altitude
  - Sierra Negra, Mexico 4100m
- Incorporate new design
  - PMTs in isolated tanks
  - Larger PMT spacing
  - Single PMT layer (4m deep)

HAWC: High Altitude Water Cherenkov

~$6M for complete detector
From Milagro to HAWC

- Increase Altitude to 4100 m from 2650 m
- Increase Area to 22,000 m² from 4,000 m² (2,200 m²)
- Reuse Milagro PMTs and front end electronics - upgrade later?
- HAWC ~10x-15x Sensitivity of Milagro:
- Better Sensitivity at Low Energy
  - ~100 m² at 100-200 GeV
900 5m dia. tanks 4.3m deep

150m x 150m (78% cov.)

Reuse Milagro PMTs & FE elec.
Higher Altitude is Closer to Shower Max.

Difference between 2600m (Milagro) and 4300m (HAWC):
~ 6x number of particles
HAWC’s median trigger energy ~ 1 TeV vs Milagro’s ~ 4 TeV
Gamma/Hadron Separation

Energy Distribution at ground level

Petra Hüntemeyer
BNL Seminar, November 2007
Gamma-Ray Sensitivity to Crab-like Point Source

- **HESS/VERITAS, MAGIC, Whipple, CTA** sensitivity in 50 hours, (~0.2 sr/year)
- **GLAST** sensitivity in 1 year (4π sr)
- **HAWC, Milagro** sensitivity in 1(5) year 2π sr
- **HAWC** will do better for hard & diffuse sources
HAWC Complementary Science

- Complements TeV atmospheric Cherenkov telescopes
  - Identifies new and flaring sources for follow up observation of morphology and sub TeV spectra
  - Extends TeV spectra to higher energies
- Complements TeV neutrino observations
  - Identifies new and flaring TeV sources to improve the sensitivity and interpretation of blind searches
- Complements GeV All Sky Survey
  - Determines which of GLAST’s 1000s of sources extend to high energies
Conclusion

• Milagro has demonstrated the power of the water Cherenkov technique
  • Detection of Crab Nebula and Mrk 421, known TeV sources
  • Discovery of 7 new TeV sources
  • 1st detection of TeV diffuse emission from the Galactic plane

• Future: HAWC
  • Building on expertise with Milagro
  • Design improvements in Size, Altitude, Water tanks
  • 15x Milagro sensitivity

• Milagro /HAWC complementary to other particle astrophysics observatories
TeV $\gamma$-rays: A New Window on the Sky

Petra Hüntemeyer
BNL Seminar, November 2007