Rapporteur OG 2.5,2.6,2.7

OG 2.5 Neutrino Dectection & issues

OG 2.6 Gravitational Waves

OG 2.7 Gamma-Ray Detection

Gavin Rowell *Uni. Adelaide*

Apologies for: (my) gamma-ray bias,
not able to cover all contributions

30th ICRC Merida, Mexico Jul 2007

OG 2.7 Gamma Rays

- Status of current/forthcoming detectors
- New detectors and ideas & simulations
- Analysis Methods

75 contributions

Current, Forthcoming Detectors & Analysis Methods

Imaging IACTs

VERITAS, MAGIC & MAGICII, CANGAROO III, GAW
ASHRA, HANLE

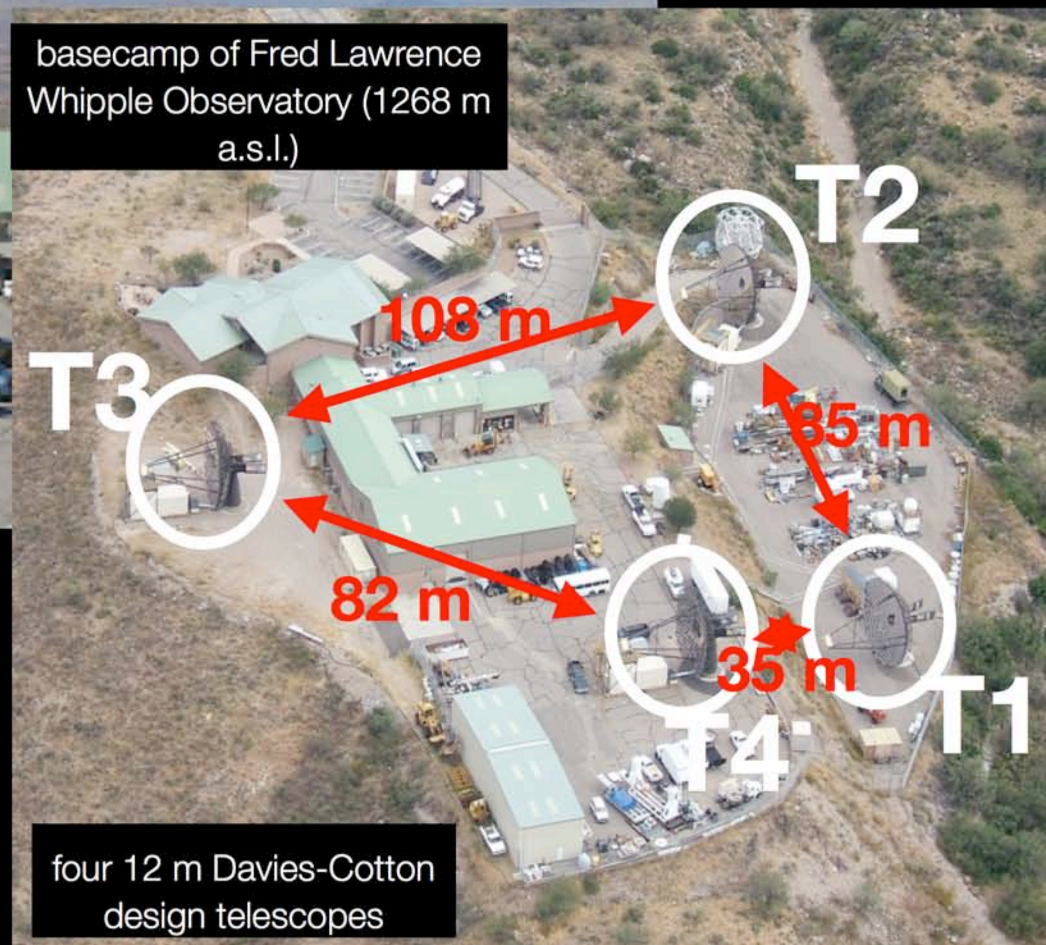
Ground Arrays/Water Cherenkov

MILAGRO, ARGO

Space

GLAST

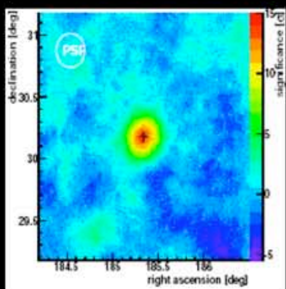
VERITAS Maier et al. OG2.7 810, 701

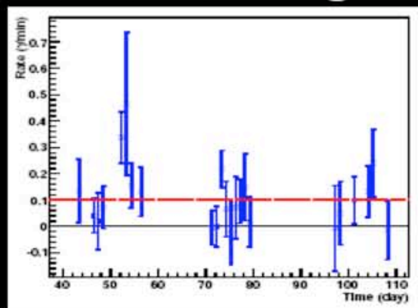


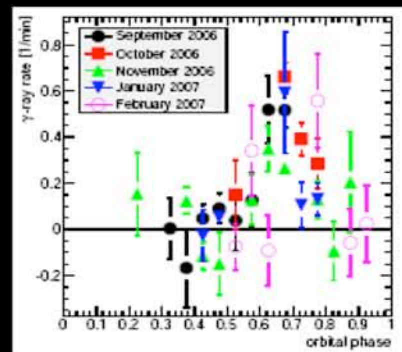
- Whipple Obs. Base Camp
  1268m a.s.l.
- 4 x 106 m^2 telescopes
- 499 pixel camera
- Angular resolution 0.14deg
  evt-by-evt
- Field of View 3.5 deg
- 10% Crab < 1 hr obs.
- March 2007 Four telescopes operating
- First light April 2007

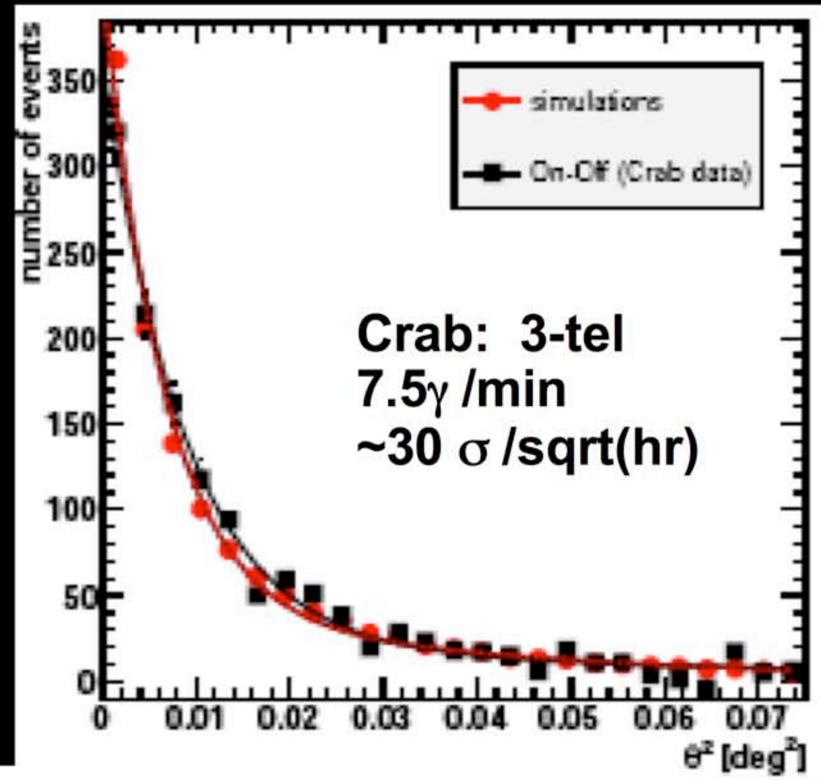
- **Checks on Crab with 3-tel data**

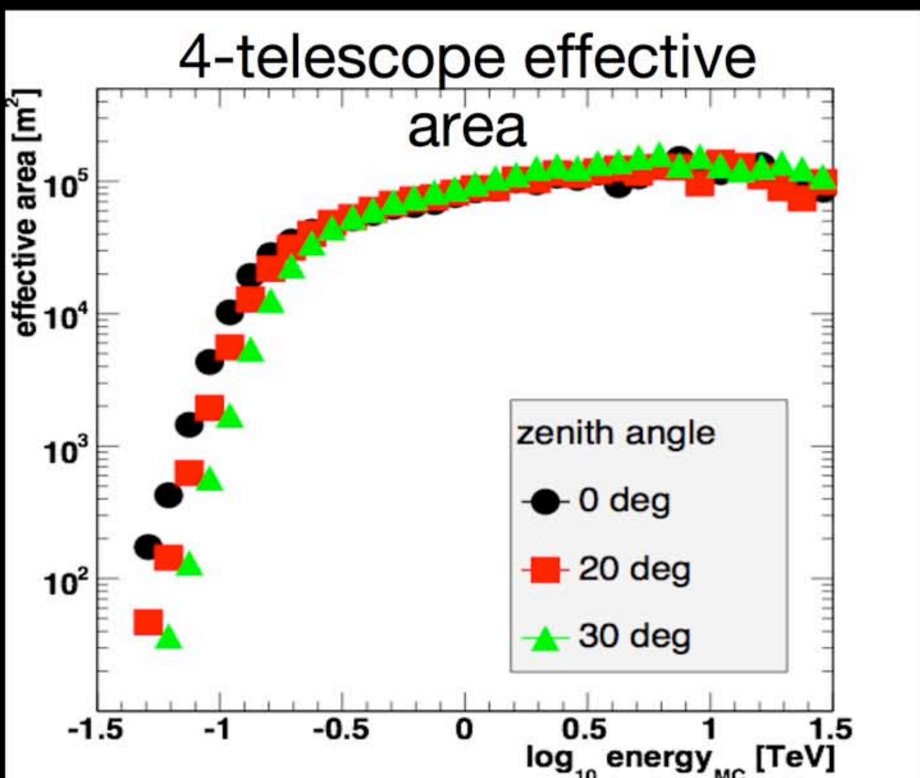
- **New results now coming.**

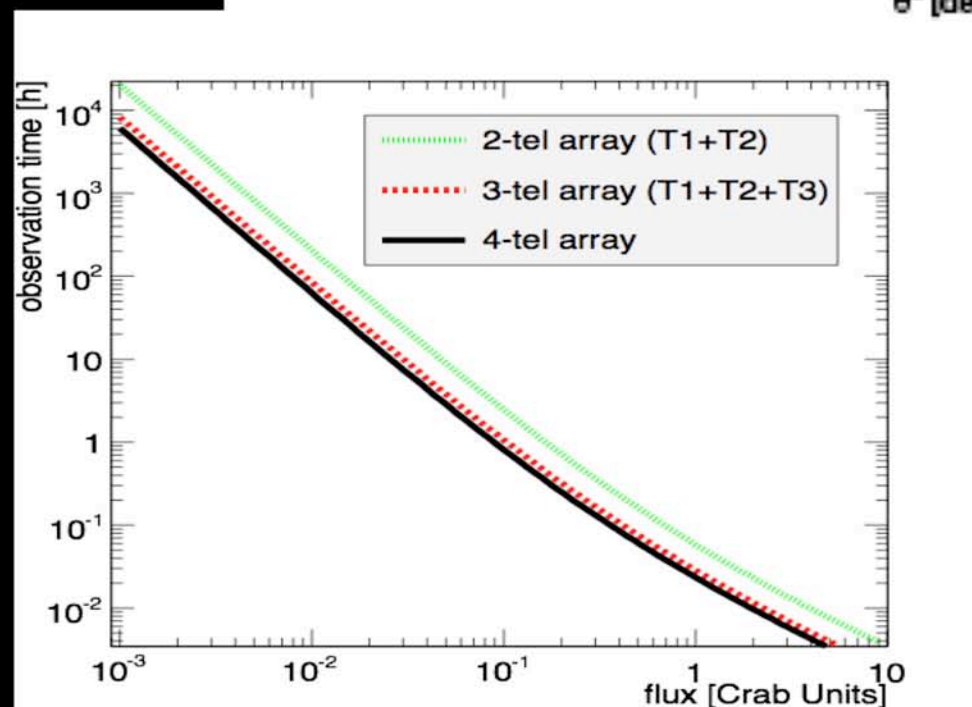








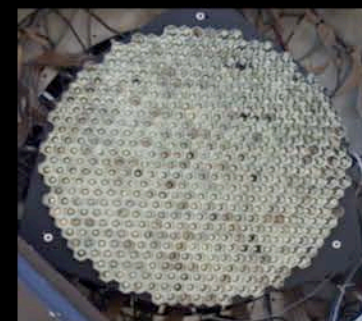




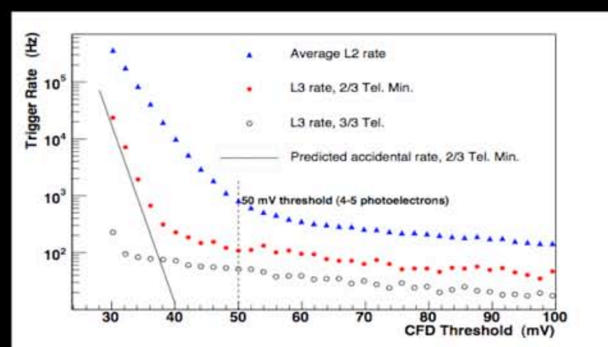
VERITAS

Standard Data Analysis **Daniel etal 2.7 283**
based on MSW, MSL etc. ***VEGAS***

Optical System
E.Roache: Poster #673
J.Toner: Poster #676



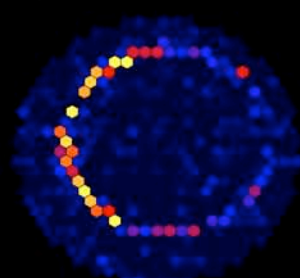
Camera/Electronics
T.Nagai: Poster #757
E.Hays: Poster #1166
P.Cogan: Poster #575



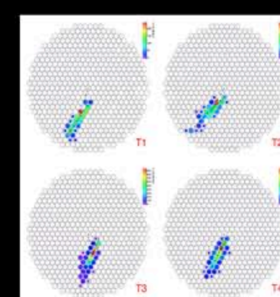
Typical array rate: 220 Hz (dead time ~10%)

Trigger System
A.Weinstein: Poster #1144
R.White: Poster #1072

Calibration
D.Hanna: Poster #702
M.Hui: Poster #794
M.Daniel: Poster #285



Stereo Reconstruction
M.Daniel: Poster #283
P.Cogan: Poster #652



Current Status of MAGIC

Goebel etal OG2.7 922

First telescope in regular observation mode since fall 2004

- 236 m^2 mirror area (17m Ø)
- Fast repositioning (40 sec) for GRB follow-up observations
- Data analysis has matured
- **Upgrade: 2GSamples/s FADCs**

- **Trigger threshold: ~ 50 GeV**
- **Sensitivity: 2 % Crab** (5σ,50h) for E>100GeV
- Using timing parameters after installation of new 2GSamples/s FADC:
  => Sensitivity improved to 1.5% Crab

See poster:
"Study of the performance of the new 2 GSamples/s FADCs of the MAGIC telescope"

but

- **Analysis below 100 GeV difficult**

MAGIC Data Analysis – some topics

Active mirror control

Biland etal ~ 10 sec to align with lookup table

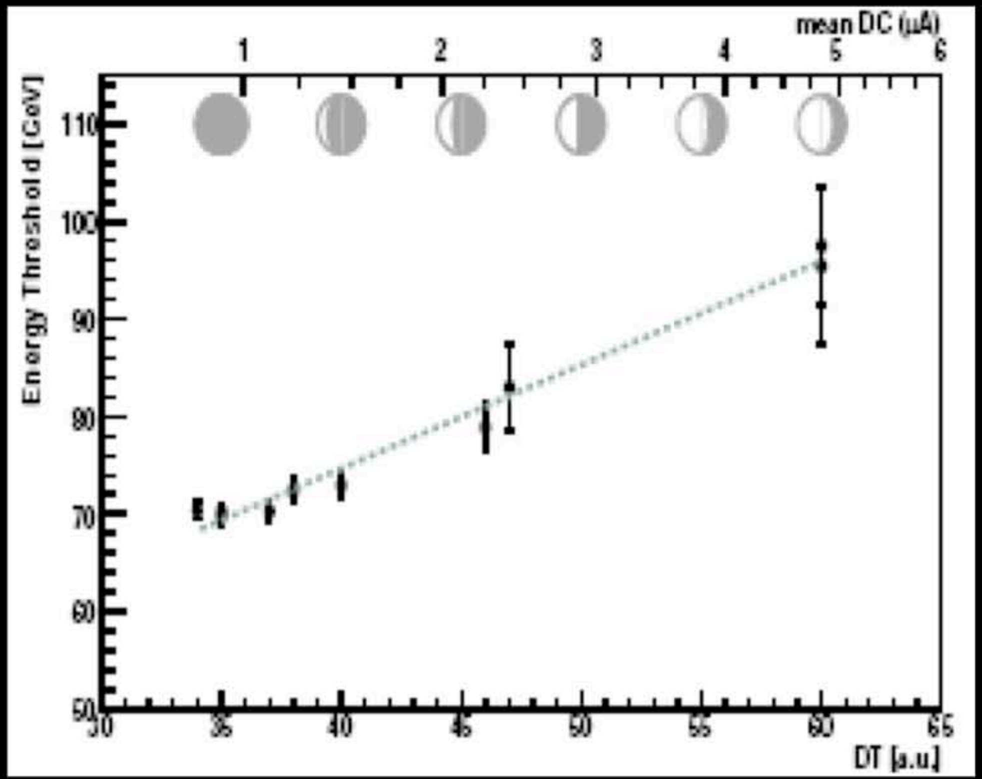
Geomagnetic Effects on EAS

Comminchau etal --> <5 TeV use distinct MC datasets vs. azimuth

Moon & twilight obs.

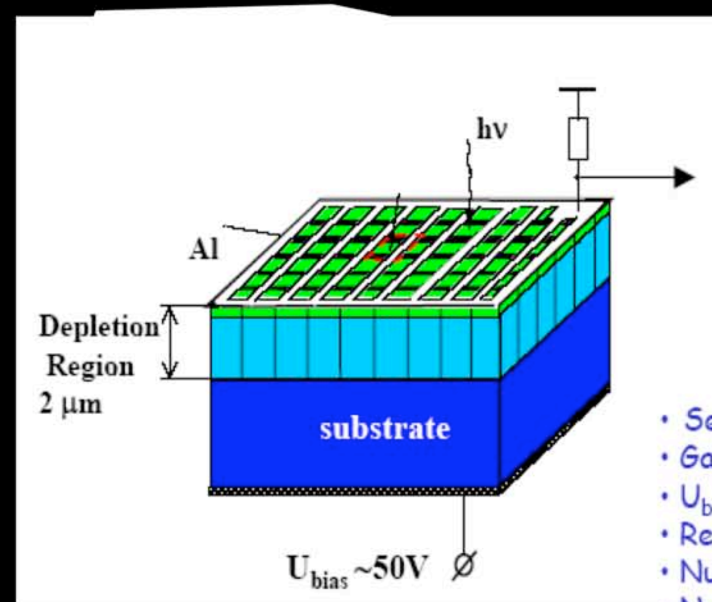
Rico etal OG2.7 557 increase trigger thres vs moon phase;

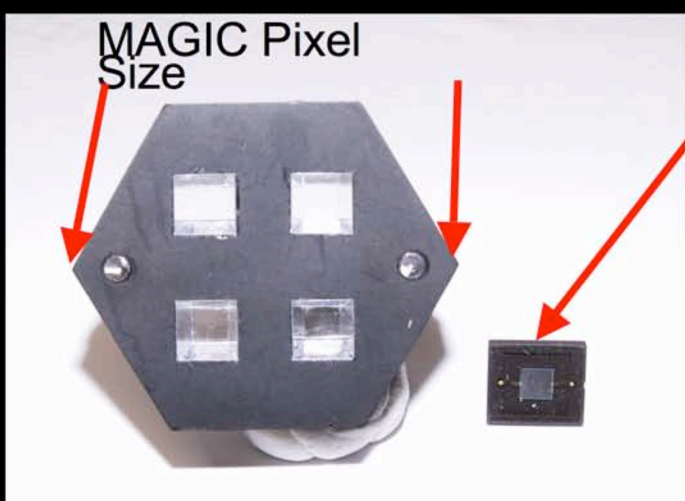
HV constant marginal increase in threshold



Cherenkov EAS Detection with Geiger-APDs   Otte et al OG2.7 1070

- Geiger Avalance Photodiodes
- High QE photon detectors extremely useful in realising low energy (E<100 GeV) thresholds
- up to 60% QE compared to <=30% for PMTs
  small voltage ~50V,
  compact & robust, gain 10^5 to 10^6
- but small size (mm) & crosstalk (10%)
- Field test of G-APDs on a solar concentrator
- Further tests on MAGIC; running for 3 nights
  --> MAGIC DAQ





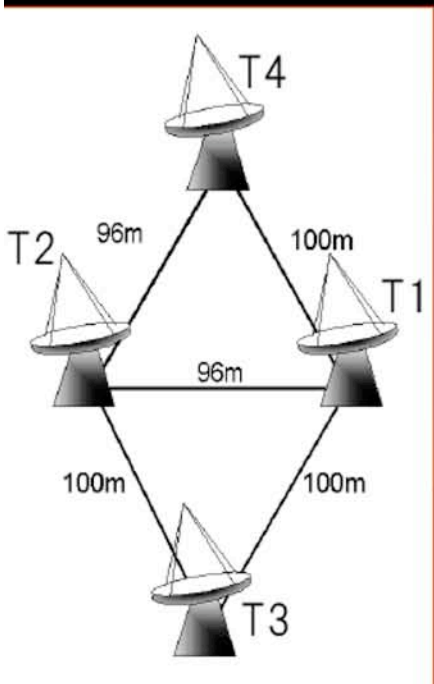
4MPPC-33-050C from Hamamatsu:
3x3mm²   each cell: 50x50µm²

- Laser runs   1,2 and ~3 pe peaks resolved
- Cherenkov signals
  ratio MPPC/(scaled)PMT ~ 1.6

Start using G-APDs !!

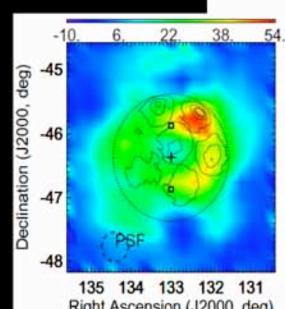
CANGAROO-III: Mori etal OG2.7 266

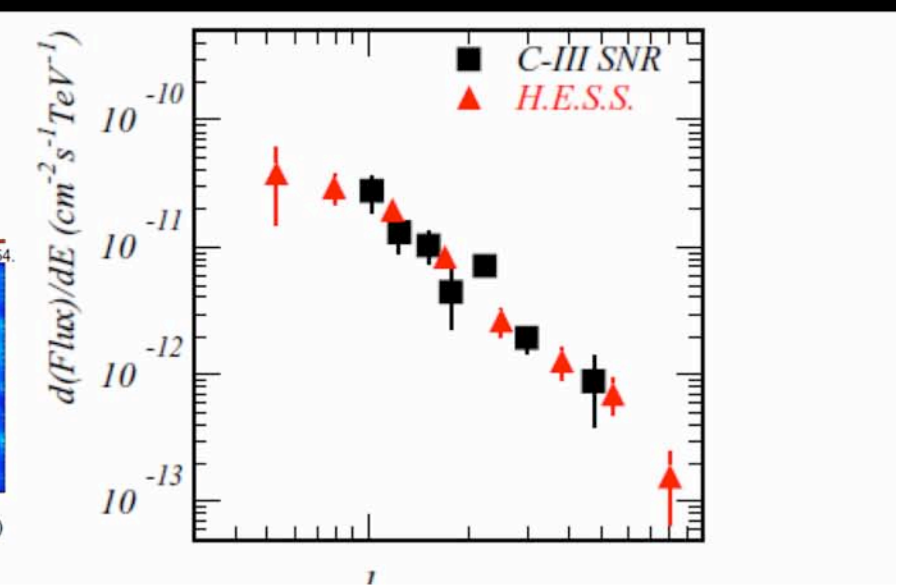
4-tels since 2004 March



- Location:
  - 31d06'S, 136d47'E, 160m a.s.l.
- Telescope:
  - 114x 80cm FRP mirrors ($57m^2$, Al surface)
  - 8m focal length
  - Alt-azimuth mount
- Camera:
  - T1: 552ch (2.7deg FOV)
  - T2,T3,T4: 427ch (4deg FOV)

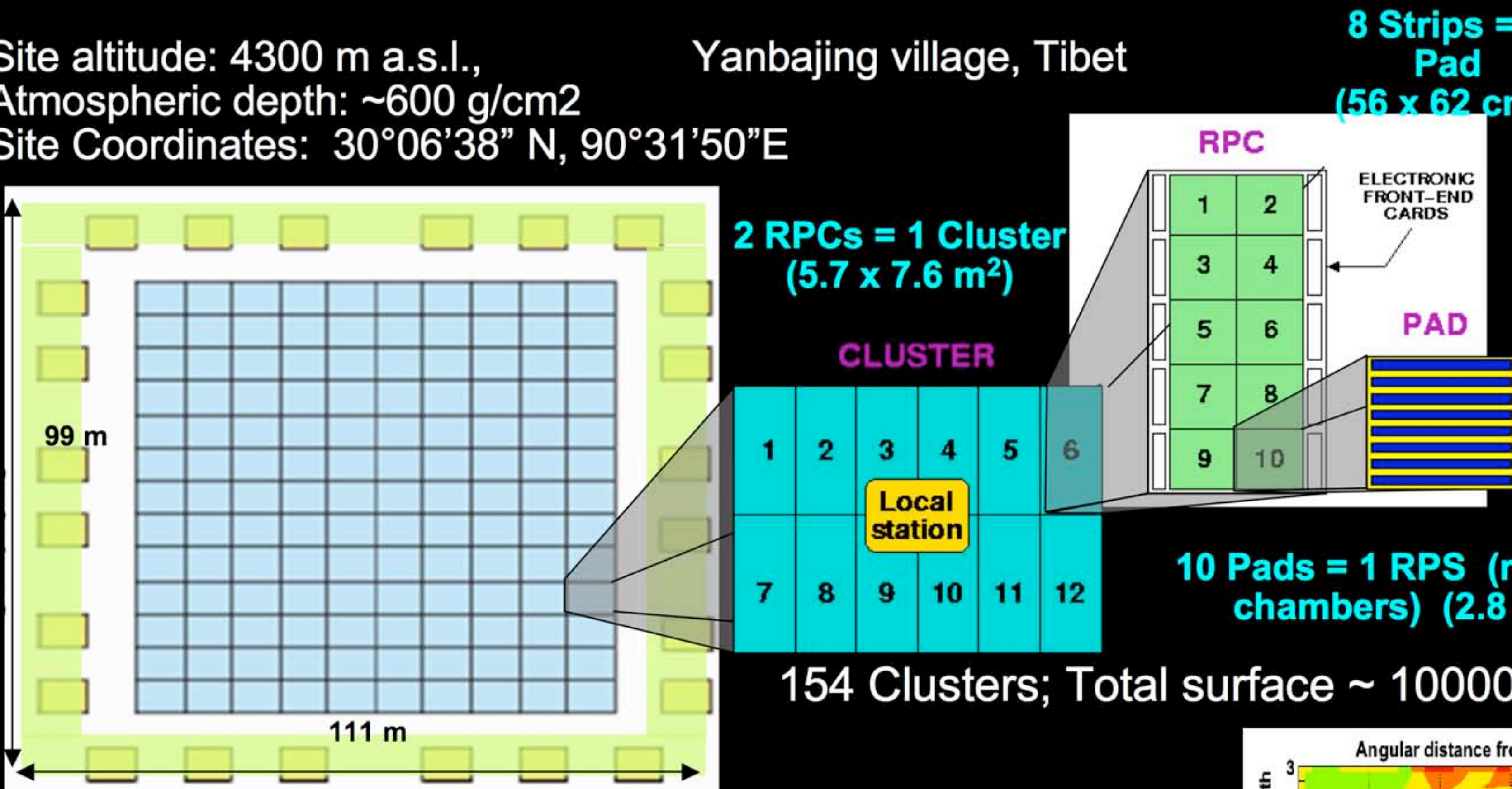
Several sources now detected eg VelaJnr, VelaX with spectra consistent to that of H.E.S.S. However, less sensitive than H.E.S.S.



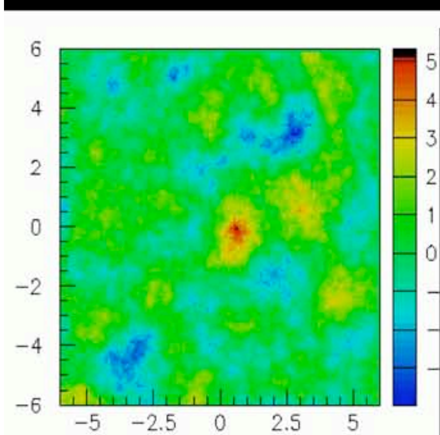


ARGO-YBJ Martello etal OG 2.7 1029

Site altitude: 4300 m a.s.l., Yanbajing village, Tibet
Atmospheric depth: ~600 g/cm2
Site Coordinates: 30°06'38" N, 90°31'50"E



154 Clusters; Total surface ~ 10000 m^2



CRAB

N_ Pad >200

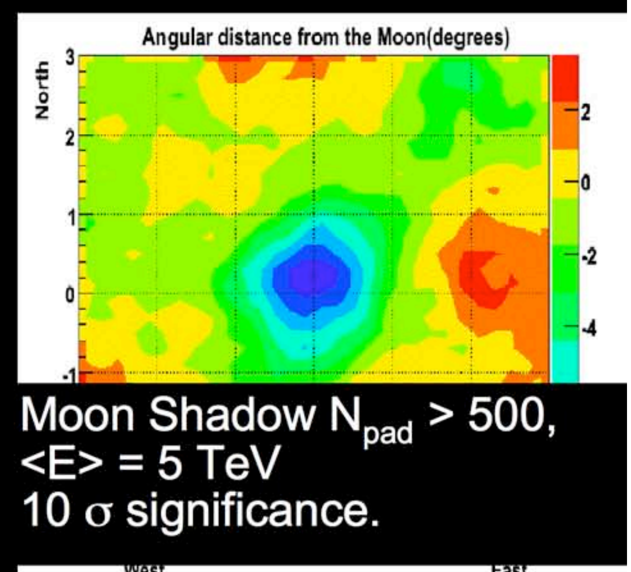
Effective time 50 days

~5 sigma

Mkn 421 5 sigma (Aug-Sept 2006

GRB search

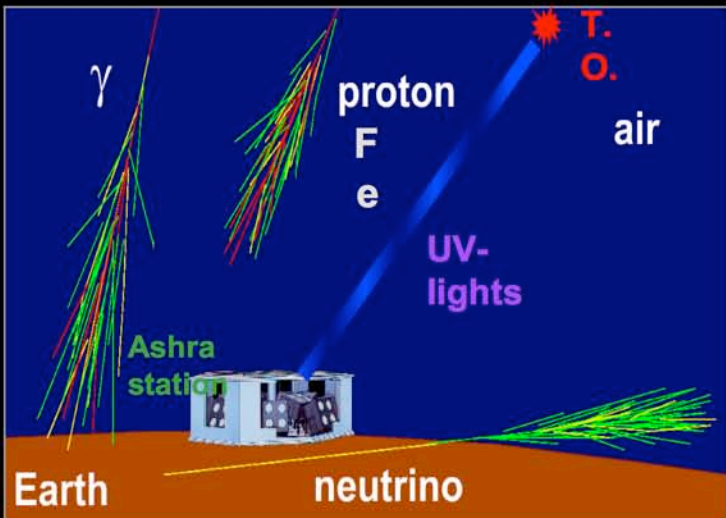
p-Air x-section studies



Moon Shadow $N_{pad} > 500$,
<E> = 5 TeV
10 σ significance.

ASHRA

***A**ll-sky **S**urvey **H**igh **R**esolution **A**ir-shower detector*



Sasaki etal   OG2.7 1232

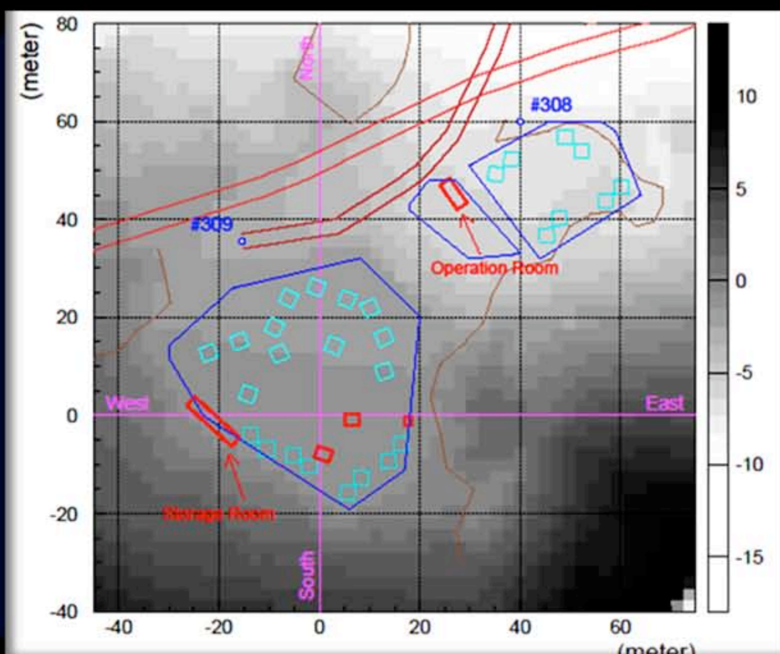
- multi-function detector

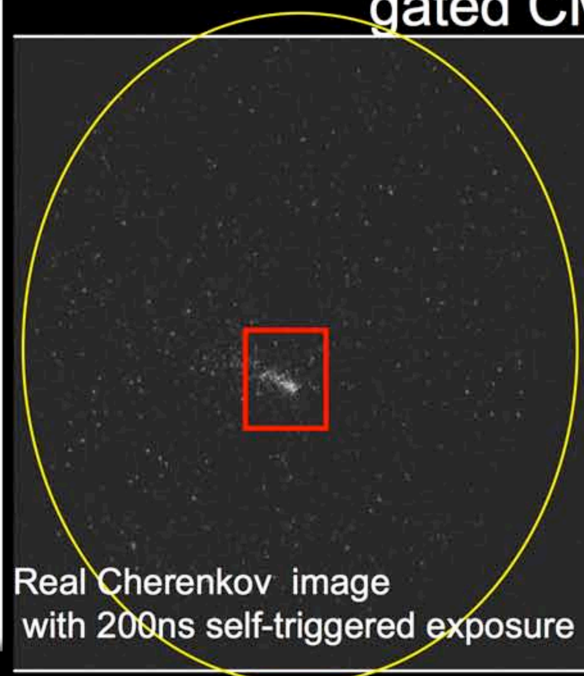
Each 'station'

- optics modified Baker-Nunn

  arcmin res over 42deg FoV

- detector image intensifier with
  gated CMOS detector
  x2048 pix 1.2 arcmin





Real Cherenkov image
with 200ns self-triggered exposure

500 hrs, 5 sigma

Int Flux [cgs] sens

10^{-12} >1 TeV

10^{-14} >100

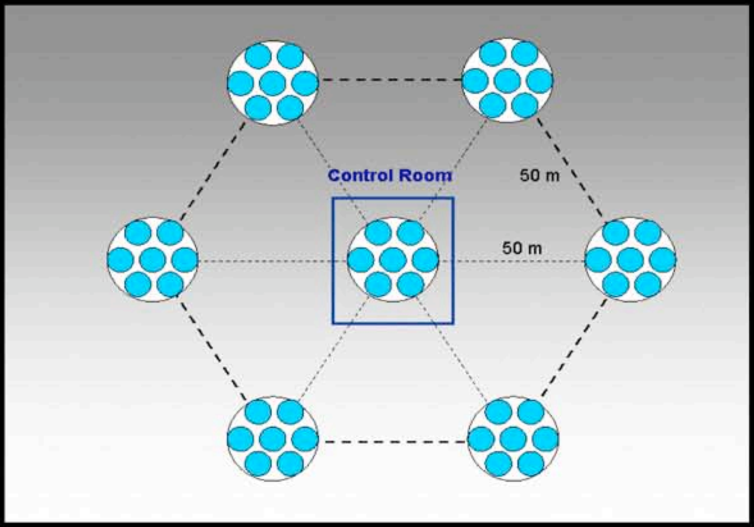
stations under
construction

Mauna Loa (3300m a.s.l.)

HAGAR Acharya etal OG2.7 536

- at HANLE 4300m
- wavefront sampling technique
  (eg. Pachmari)
  single PMT at mirror focus
  threshold ~ 60 GeV

1 Crab ~30min ~ now running

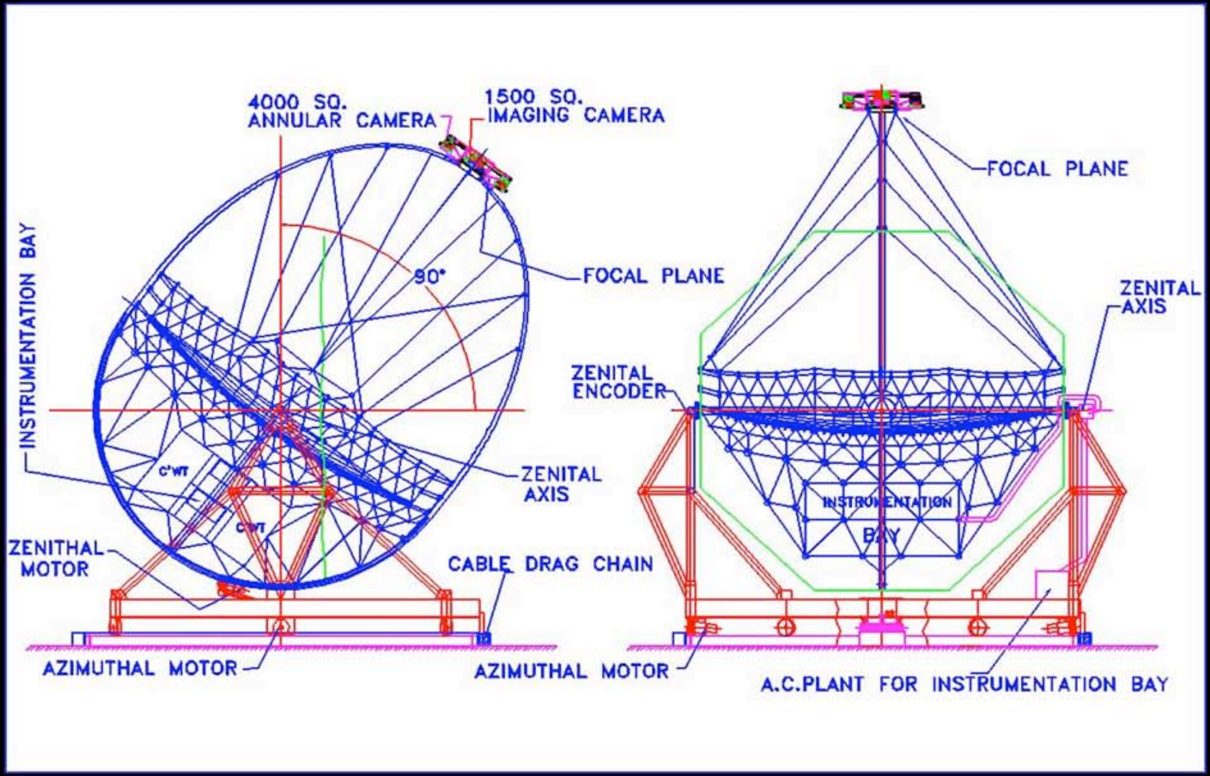


MACE (Planned)

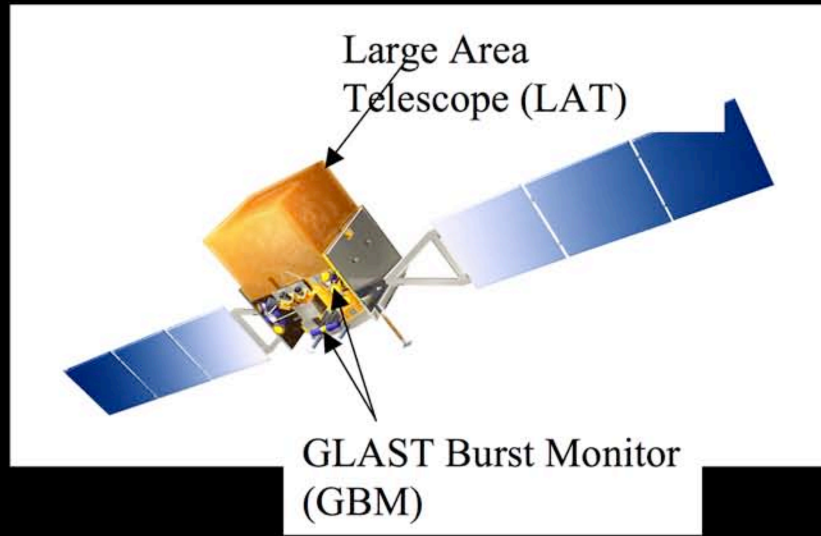
- similar to MAGIC dish
  21m diam
- 5deg FoV camera
  0.1 & 0.2 deg pixels

~20 GeV thres

design phase:
build by 2010
x2 ~ 2012 stereo...



GLAST McEnergy etal OG2.7 1306



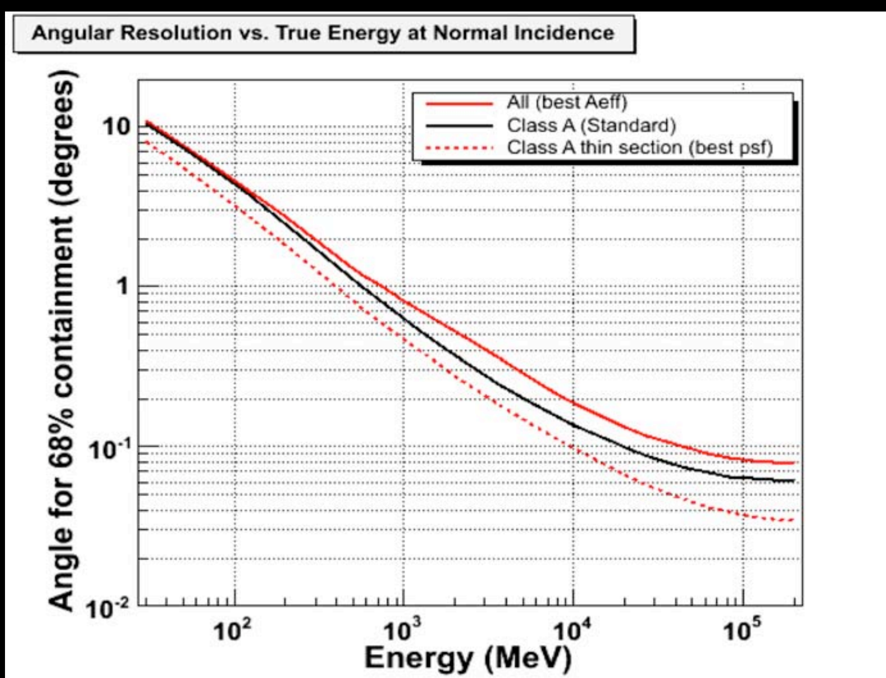
LAT – Large Area Telescope 20 MeV – 300 GeV
2.5 sr FoV

Si strip tracker, CsI calorimeter

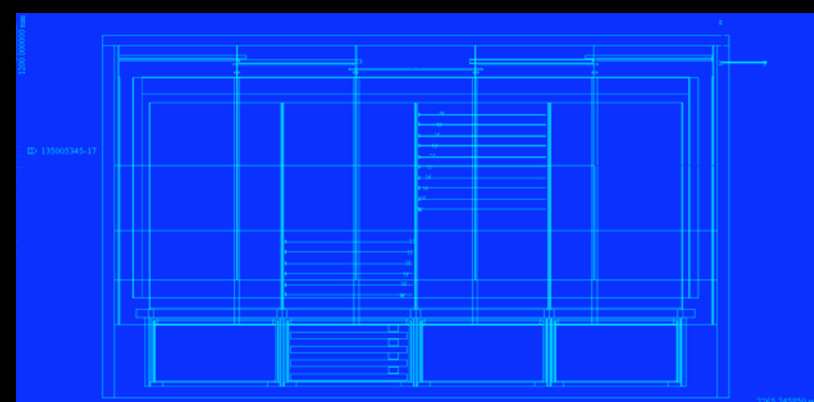
details Tanugi etal poster

GBM – Gamma Ray Burst Monitor 8 keV - 20 MeV
9.5 sr FoV

Last round of tests in lab **Launch Jan 2008**



cosmic-rays in LAT

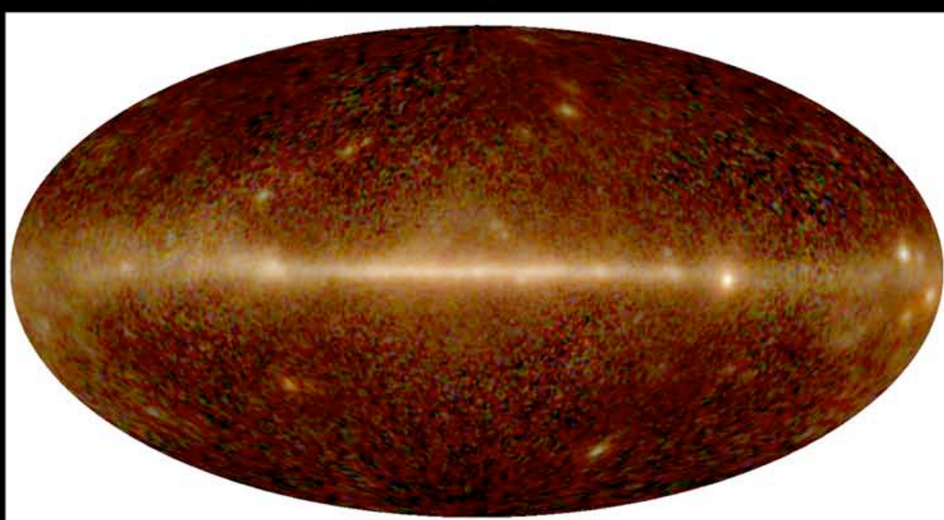


Flux Sens 1 yr < 4x10-9 ph/cm2/s > 100 MeV

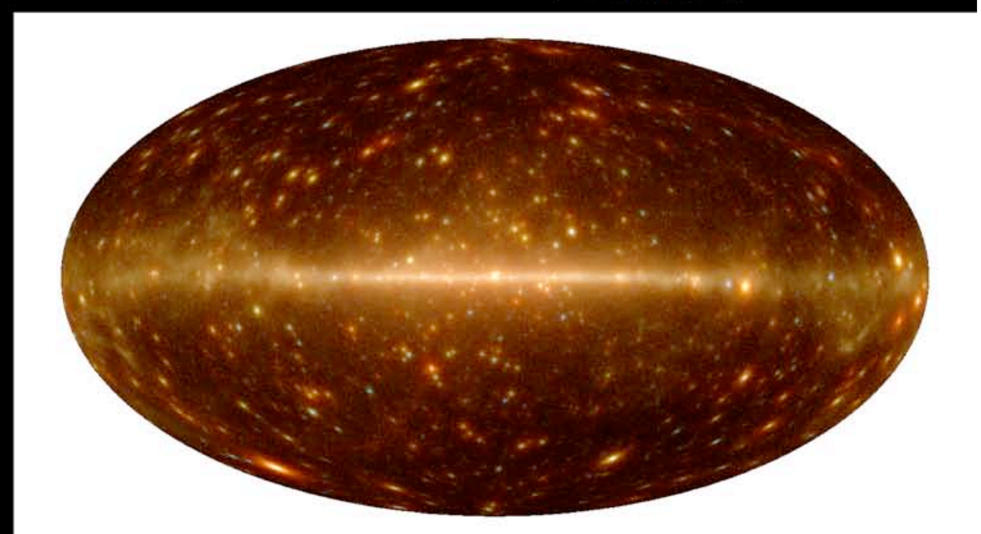
all parts of sky sampled every 3 hrs (for 30 mins)

predict
> x10 more pt sources
< arcmin localisation of bright sources, fewx10 arcmin weak sources

AIM
From this (EGRET)



To this....



GLAST welcomes collaborative efforts from observers at all wavelengths

http://glast.gsfc.nasa.gov/science/multi

mailing list contact Dave Thompson, *djt@egret.gsfc.nasa.gov*

GI Program will support correlative observations and analysis

See *http://glast.gsfc.nasa.gov/ssc/proposals*

- First Year observations - Sky Survey
  Repoints for bright bursts and burst alerts will be enabled
  Extraordinary ToOs will be supported.

- First Year Data release
  - All GBM data
  - Information on all LAT detected GRB (flux, spectra, location)
  - High level LAT data (time resolved flux/spectra) on 23 selected sources and on all sources which flare above $2x10^{-6}$, continued until the source flux drops below $2x10^{-7}$ (rate ~ 1-4 such objects per month).
  - The LAT team will produce a preliminary source list after ~6 months on a best effort basis

Subsequent years: Observing plan driven by guest observer proposal selections by peer review. Default is sky survey mode.

- All data publicly released within 72 hours through the Science Support Center (GSSC).

See http://glast.gsfc.nasa.gov/ssc/data/policy/ for more details

GAW Cusumano etal OG2.7 279, Maccarone OG2.7 144

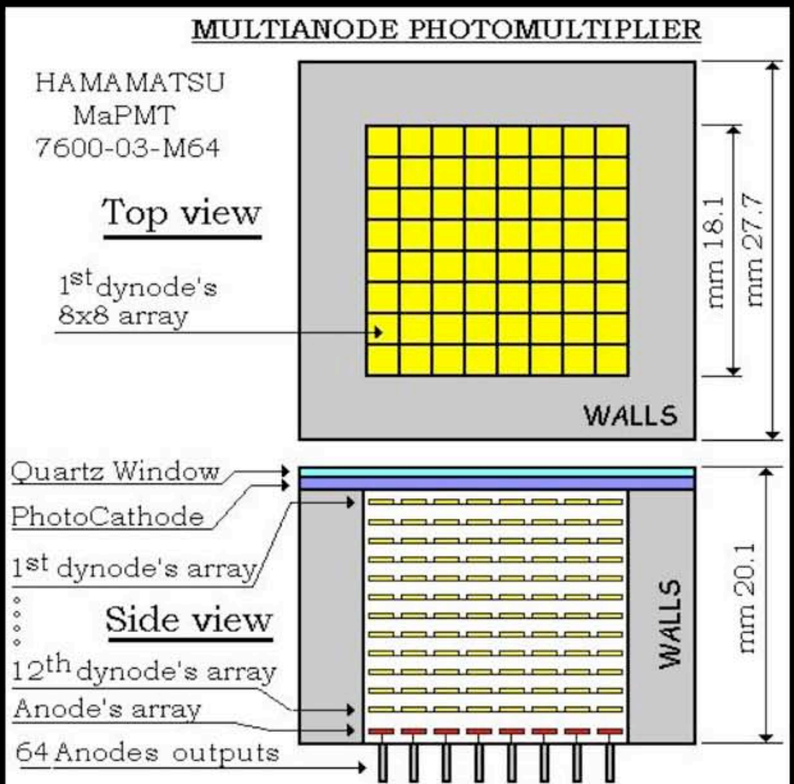
Gamma Air Watch

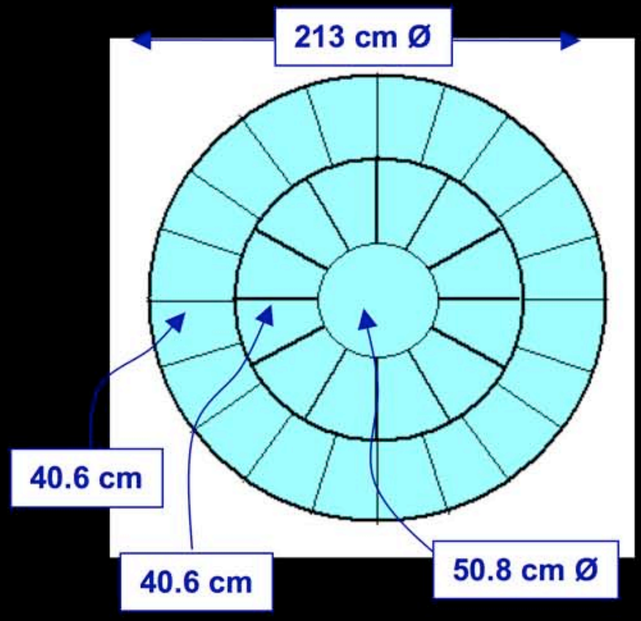
Large FoV IACT using Fresnel lens
instead of reflective optics

Focal plane array of MAPMTs
4arcmin pix size

photon detection mode (discriminators only)

Baseline Optics Module for GAW prototype	
Lens	Flat single-sided
Diameter	2.13 m
Focal Length	2.56 m
f/#	1.2
Material	**UV Transmitting Acrylic**
Refraction Index	1.517 (at λ = 350 nm)
Standard Thickness	3.2 mm
Trasmittance	~95% (330-550 nm, from UV to Near Infra Red)
Manufactured by Fresnel Technologies Inc.	

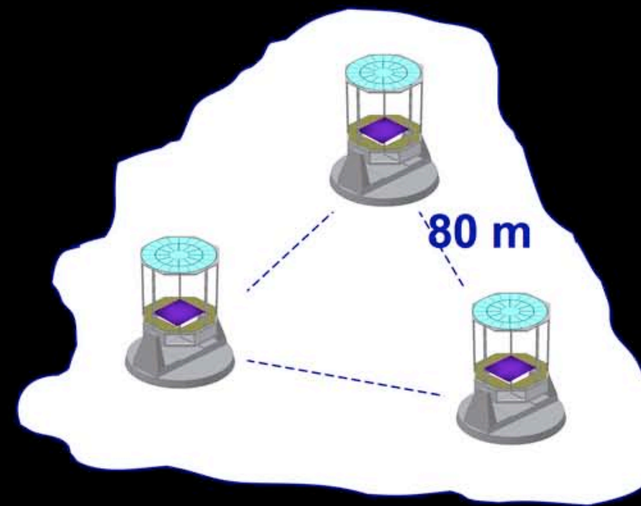


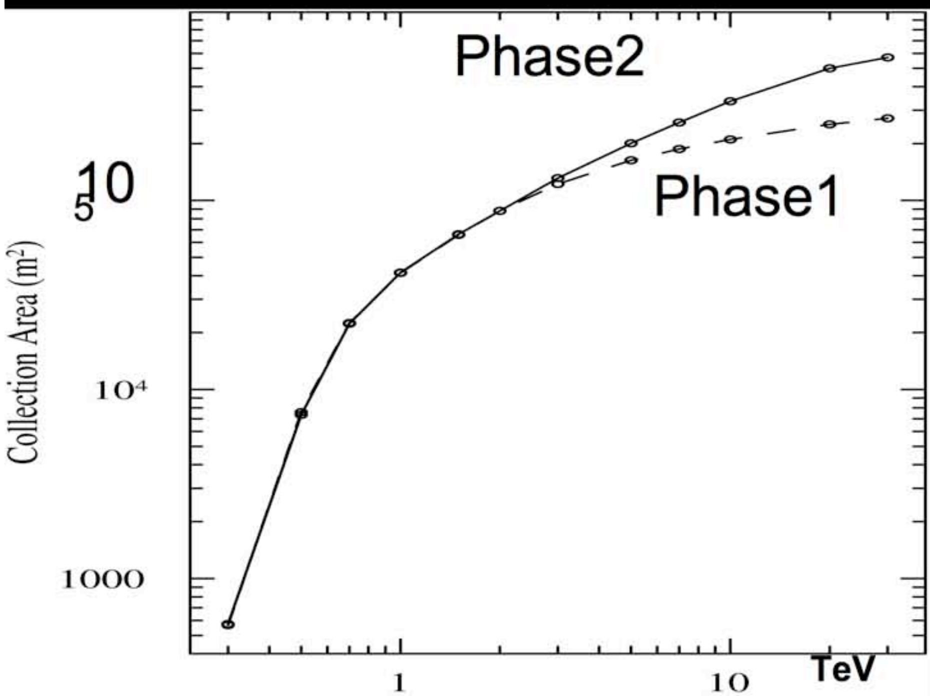


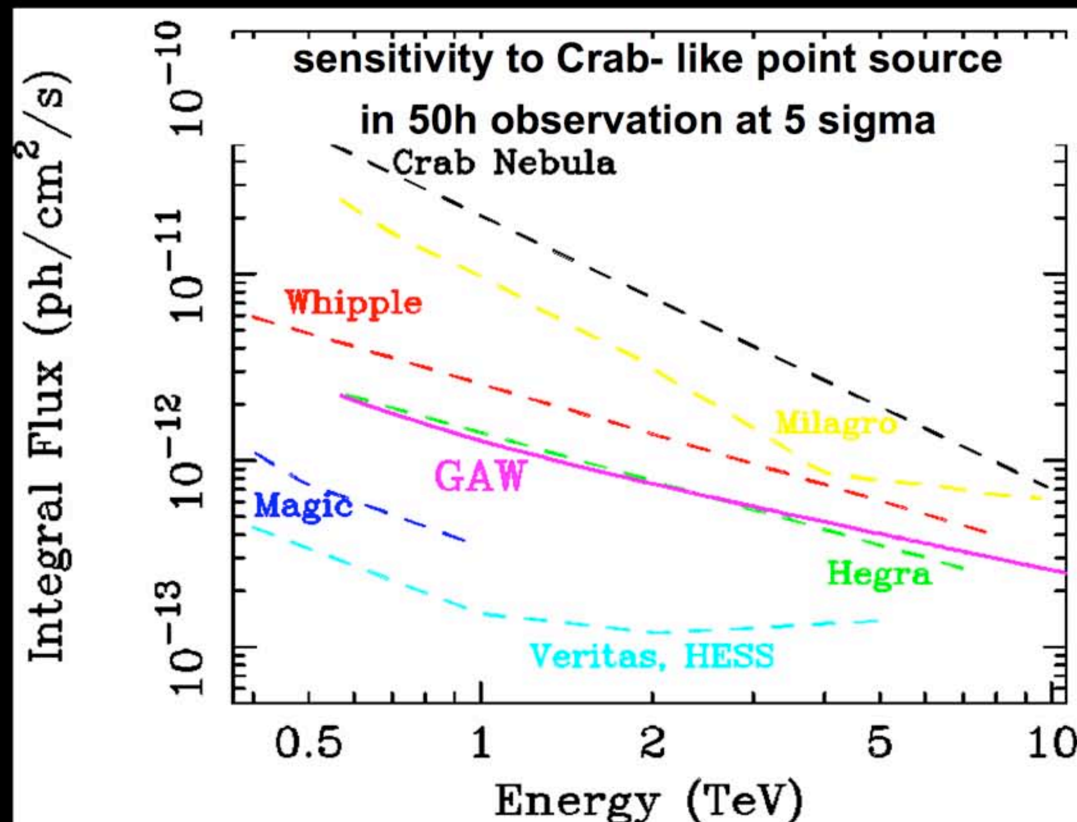
Site – Calar Alto 2150m a.s.l.

Phase 1
3 telescopes (alt-az mounts)
5x5 deg FoV

Phase 2
24x24 deg







-ang res 20 to 6 arcmin
(0.3-20 TeV)
- image shape to reject CR bkg

-2007 phase 1 install & testing

-2009 phase 2

New Proposals/Ideas

Imaging IACTs
- CTA
- White Paper (USA) Discussion of options
- 1km^2 array of telescopes --> AGIS
- TenTen
- Additional simulation studies

Ground Arrays/Water Cherenkov
- HAWC

CTA   Drury etal OG2.7 149, Schweizer etal OG.2.7 196, Bernloehr etal

Cherenkov Telescope Array

Science case outlined by Drury.

- Results from H.E.S.S. and others show that we are now doing TeV *astronomy!* *images, spatially-resolved spectra......*

- Need to make other astronomers aware of this......the MWL connection is crucial

- Clear need for better sensitivity by factor x10 and expand energy coverage improved angular resolution....a factor ~5

- key drivers "Usual suspects" SNRs, PWNe, binary systems, AGN........ still many questions

- additional topics, Pulsars (if low threshold), GRBs, Gal-Clusters, UHECR srcs dark matter

- synergies with GLAST, MILAGRO/HAWC, future radio telescopes, X-ray missions

- operated as an open/public observatory

CTA – More Details

Current simulations

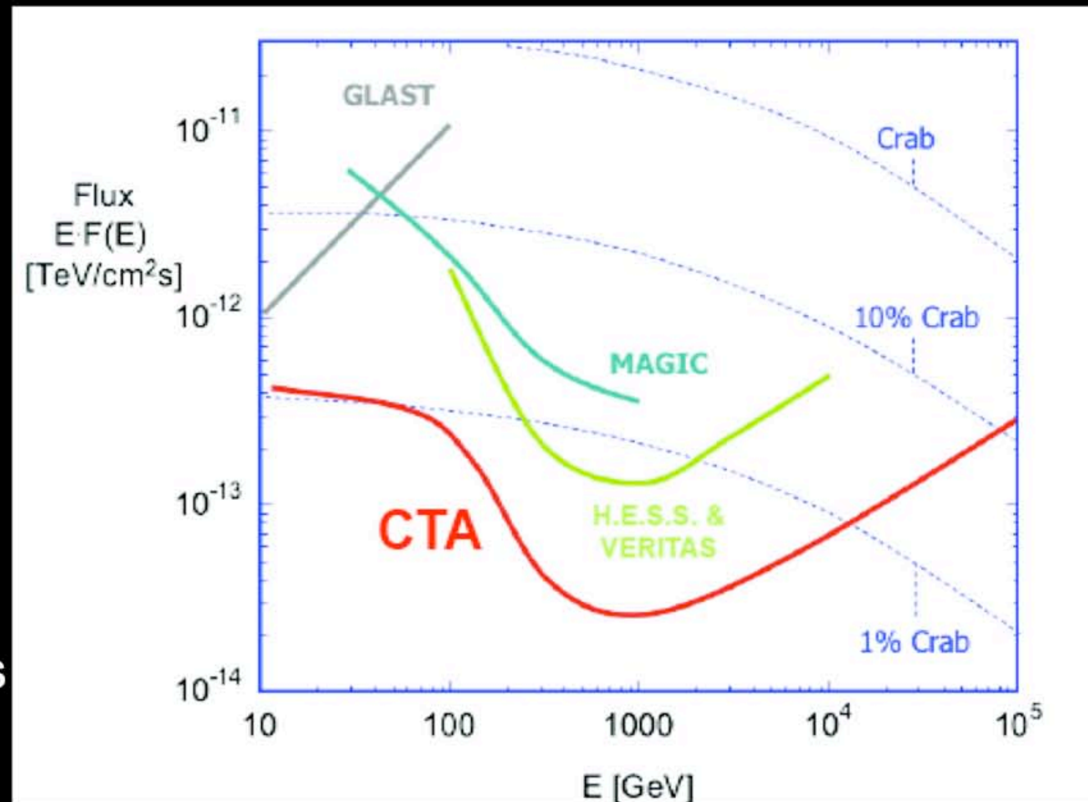
see also poster Bernlohr etal

23m tel 5deg fov 0.1 deg pixels

10m tel 7deg fov 0.16deg pixels

using available technology

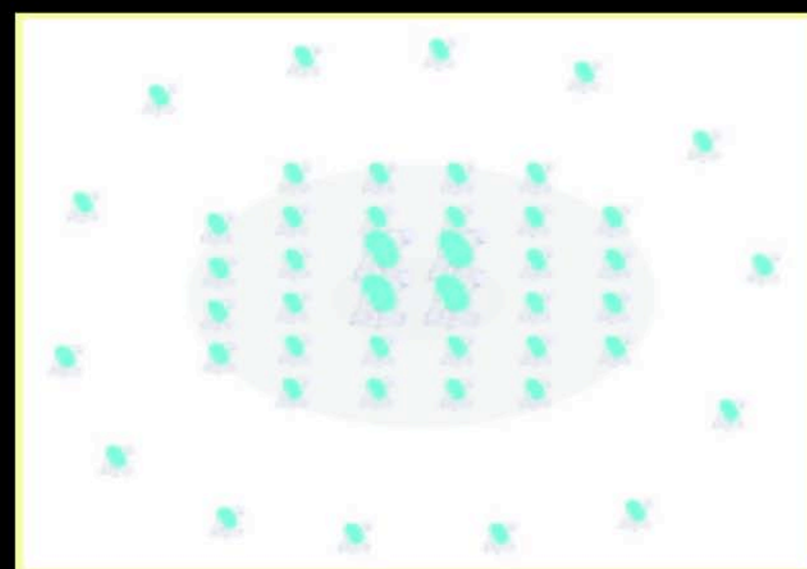
possibly wide fov 12deg telescopes



but options still open

North array 50 MEuro

South array 100 MEuro



FP7 design study 34 institutes 15 countries

design study 5MEuro 2008-2010

CTA – listed in ESFRI 2006 report

Krawczynski etal OG2.7 783 **White Paper on Gamma-Ray Astronomy**

- Current generation instruments.... exceed expecations--> motivates the next step
(TeV catalogue http://tevcat.uchicago.edu Wakeley, Horan)

Agenda: *Future of TeV Gamma-Ray Astronomy in the USA*

several meetings already Oct 2005, May 2006, May 2007

- analyse emerging science opportunities
- increase involvement of astrophysics and physics community
- experience exchange with international community

Initiatives:

1. White Paper
2. R&D Proposal
3. AGIS Collaboration

Commissioned by Div. of Astrophysics of the American Physical Society Sept 2006

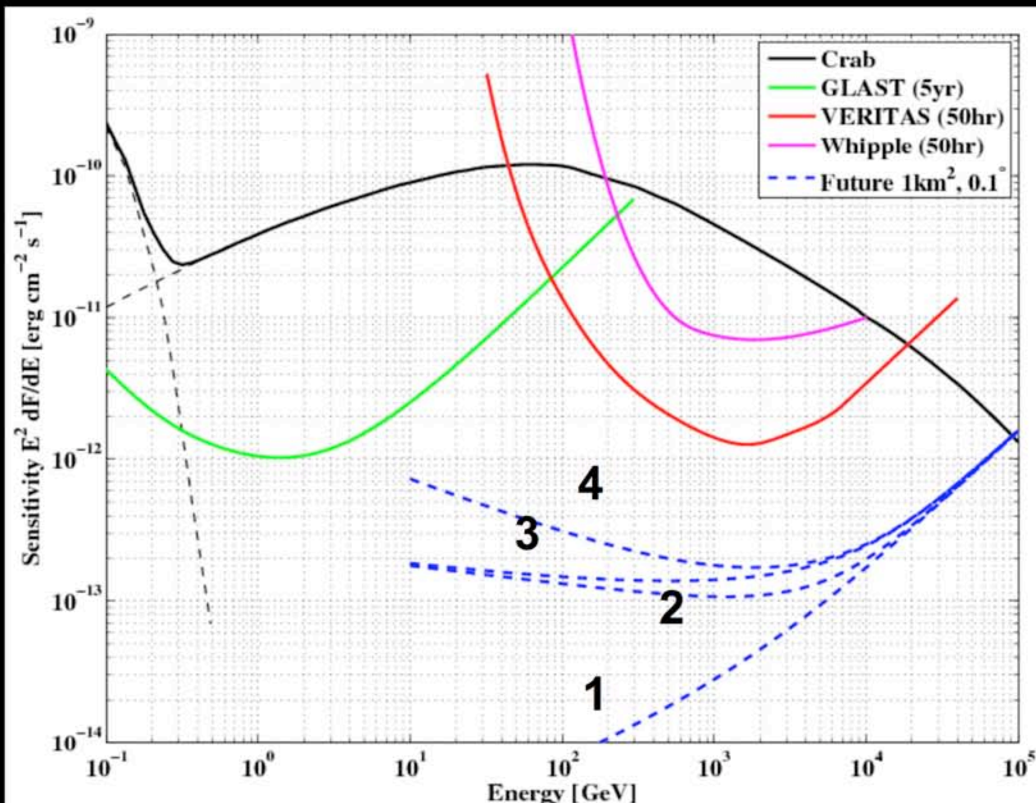
Editorial Board: B. Dingus, H. Krawczynski, M. Pohl, V. Vassiliev,
F. Halzen, W. Hofmann, S. Ritz, T. Weekes

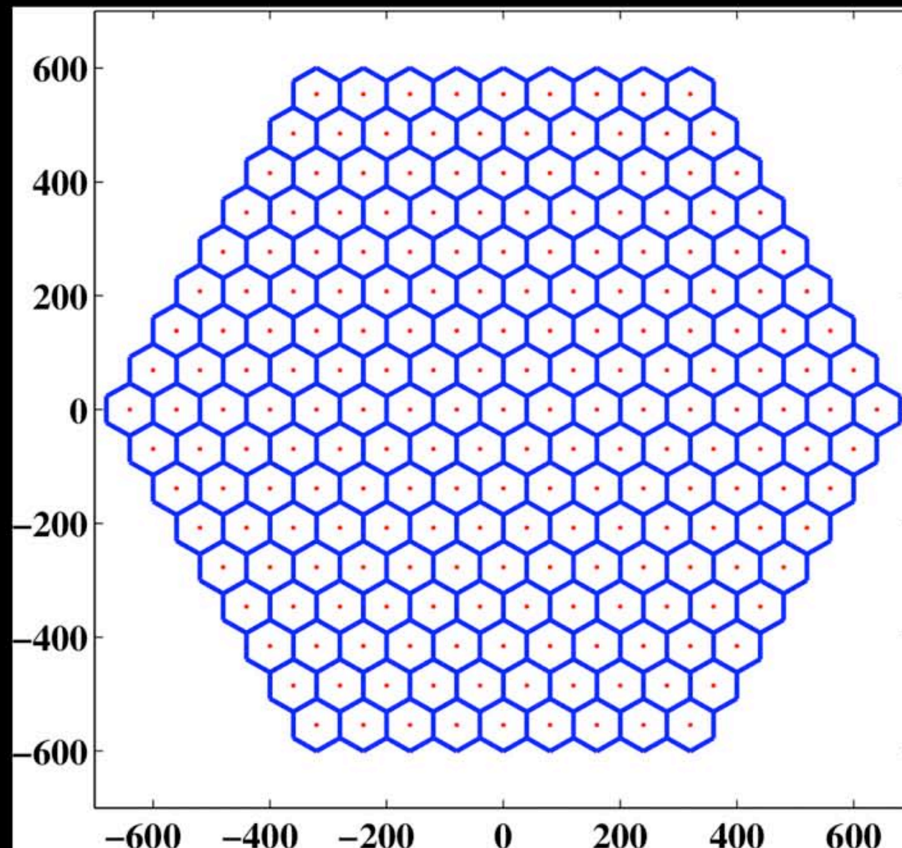
White Paper – Fall 2007 R&D Proposal Fall 2007

SLAC : “Toward the Future of Very High Energy Gam Astronomy” Nov 8-9 2007

Fegan etal OG2.7 775 **Performance of a $1km^2$ Array**

- increase sens by increase effective area
- thought experiment: Assume we have $1km^2$ & 0.1 deg ang res at ALL energies

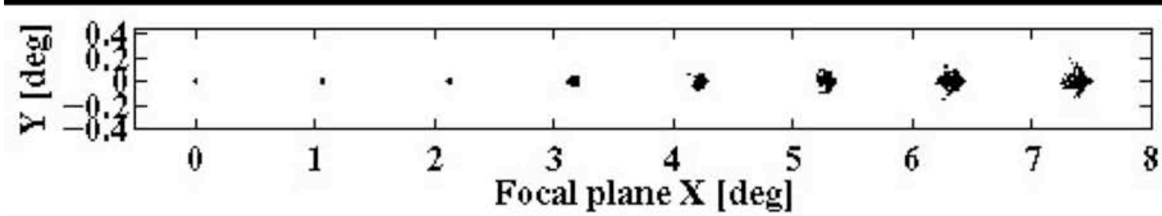


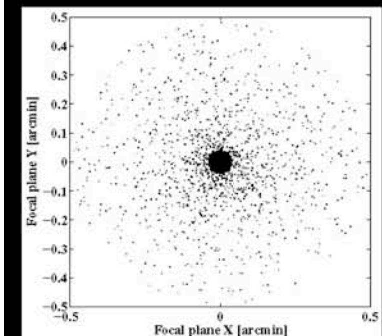


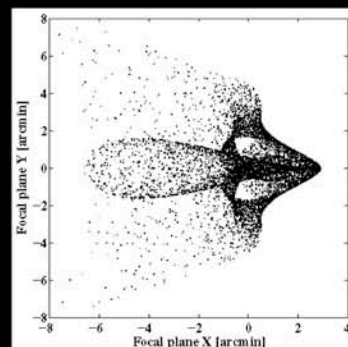
possible config 217 tels, 80m spacing

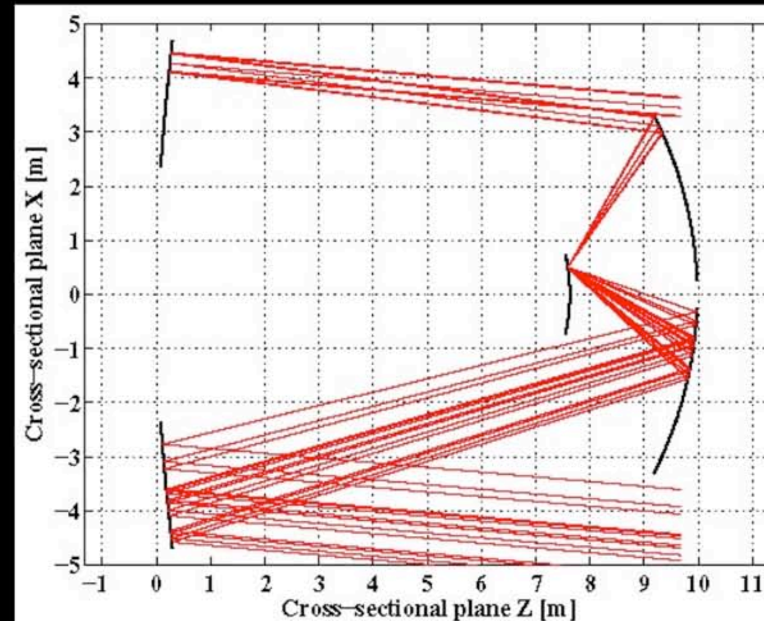
- Aim: high density sampling at E<1 TeV, EAS almost always within one cell
  low threshold possible (<50 GeV) with 10 metre dishes
  Optimal pixel size 2 to 4 arcmin at 40 – 100 GeV..

Schwarzschild-Couder optics Fegan etal.



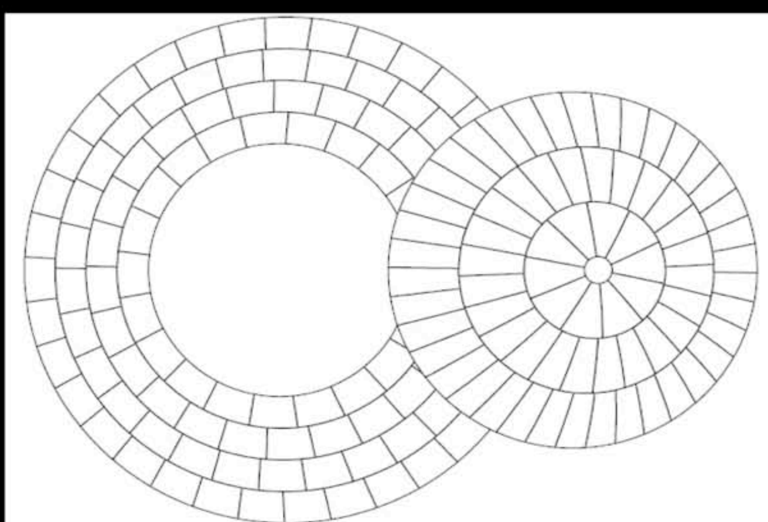


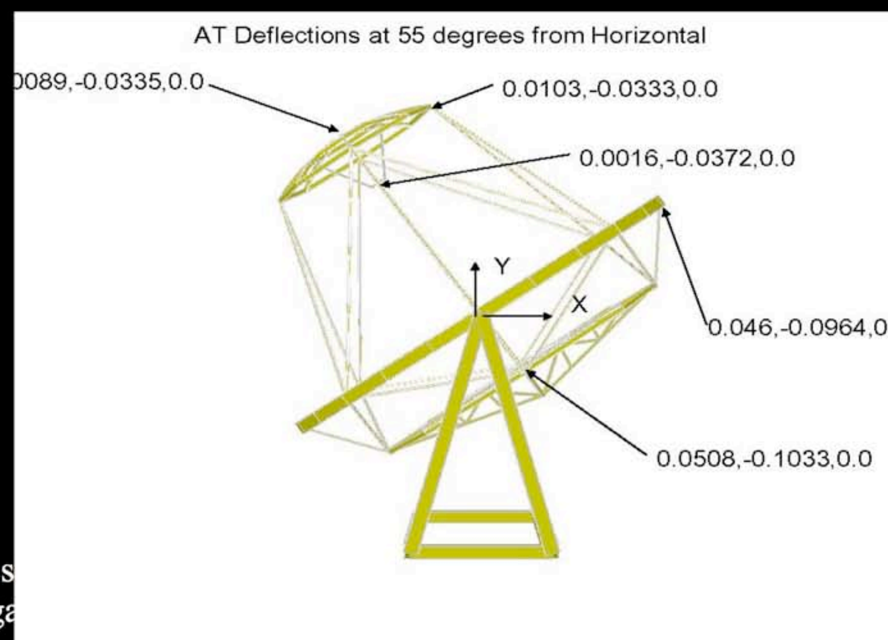




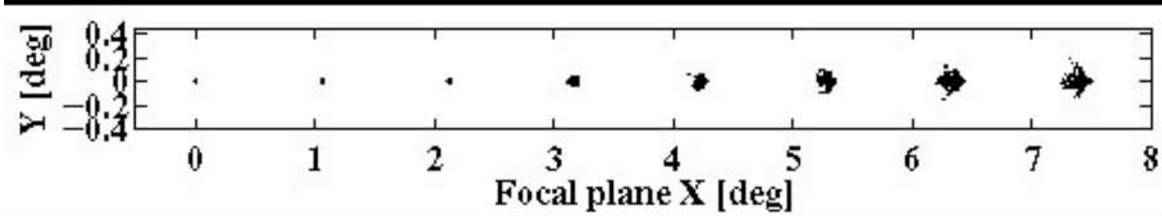
2RMS < 3' over full 15 deg FoV can be achieved

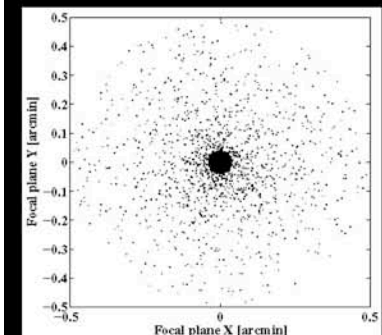
(V. Vassiliev, S. Fegan, astro-ph/0612718)

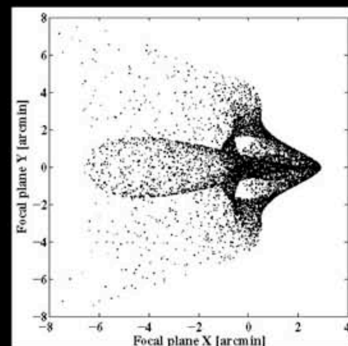


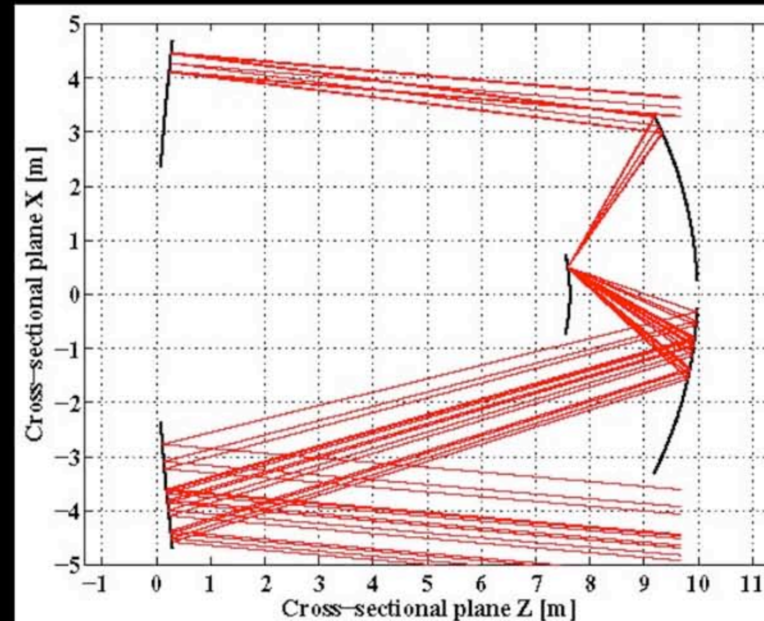


Schwarzschild-Couder optics   Fegan etal.



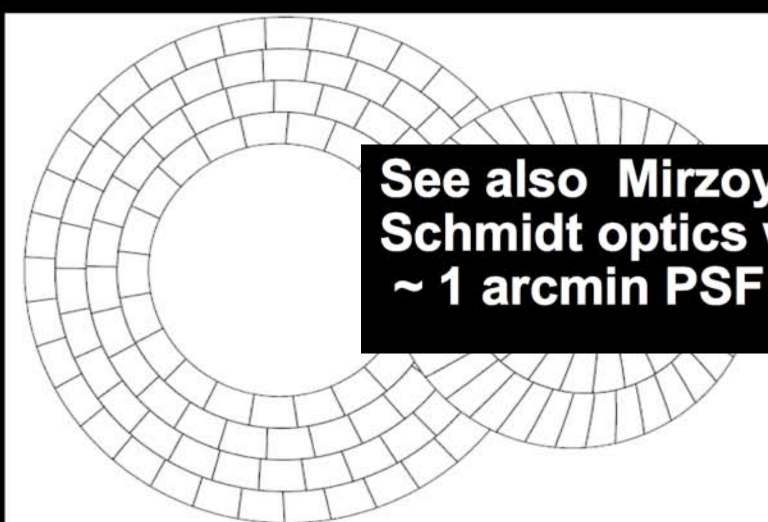


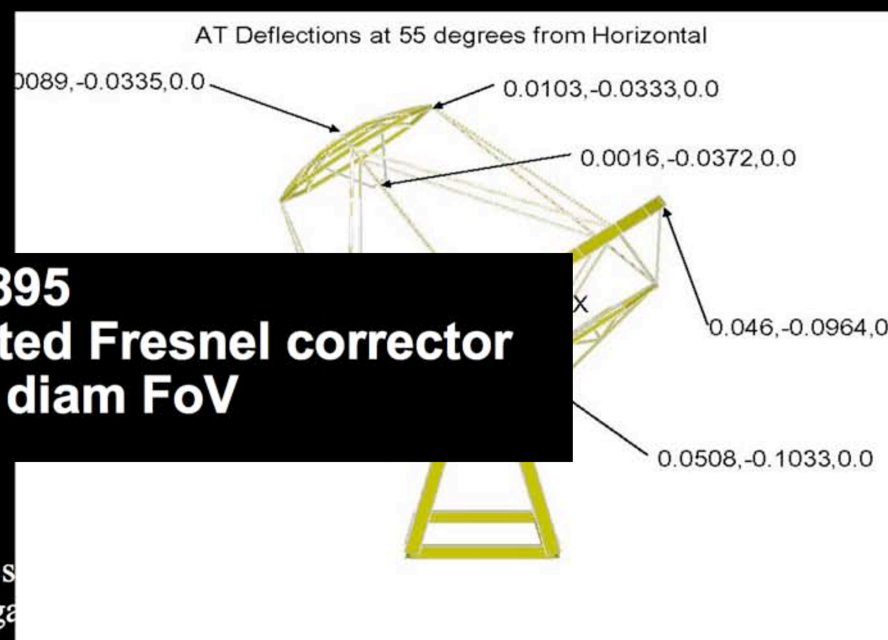




2RMS < 3' over full 15 deg FoV can be achieved

(V. Vassiliev, S. Fegan, astro-ph/0612718)





See also Mirzoyan etal HE 895
Schmidt optics with tesselated Fresnel corrector
~ 1 arcmin PSF over 15deg diam FoV

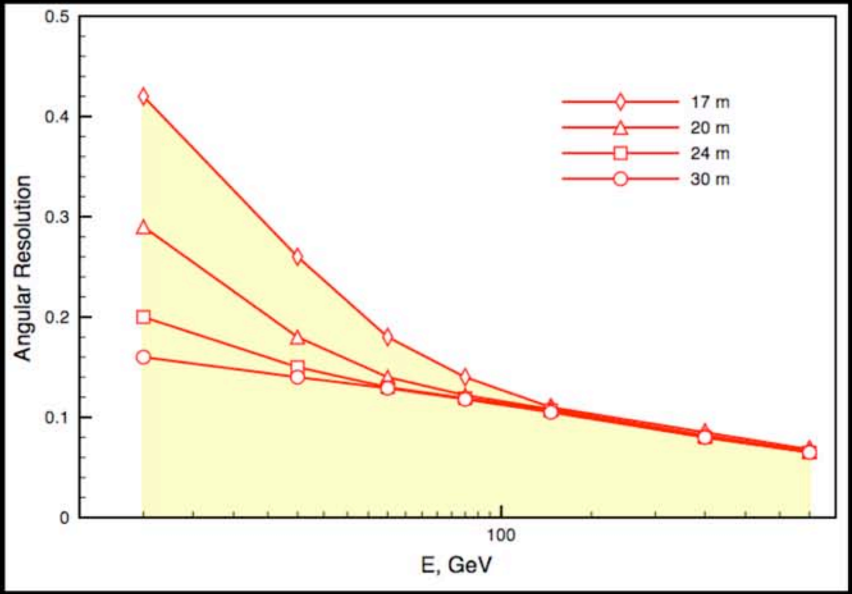
Konopelko etal OG2.7 **Design Study of a Future Low Energy Array**

- Performance of 3 telescopes with diameter 17 to 28 m, various spacings
- 3 deg FoV cameras, up to ~1900 pixels with 0.07deg pixel sizes

Threshold (peak rate) 17m ~50 GeV
28m ~25 GeV

- Bkg rejection better at E>100 GeV.

For 10-100 GeV CR rejection factor using scaled width, length is ~7(E/20GeV)$^{2/3}$ with 60% gamma acceptance.



Bugaev etal OG2.7 **Design Considerations for Next Gen Tel. Arrays.**

- assume perfect optics, infinite camera (indiv. photon positions) 4-8deg FoVs
- 18m diam dish, 2700m asl.
- E< 500 GeV
- optimise S/sqrt(B) S – gamma rate from Crab like spec., B- Crs

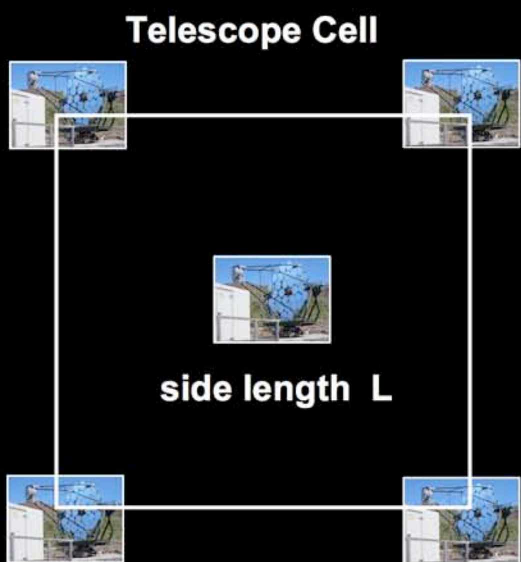
--> for these low energies 8 deg FoV marginally better than 4 deg.
--> 0.15deg pixels provide similar ang res compared to inifite camera.

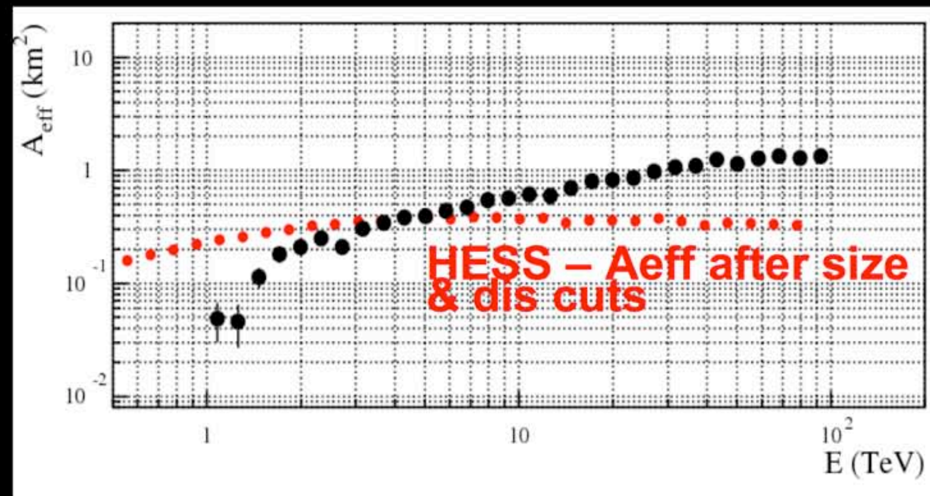
See also poster Colin etal OG2.7 array designs up to 100 TeV

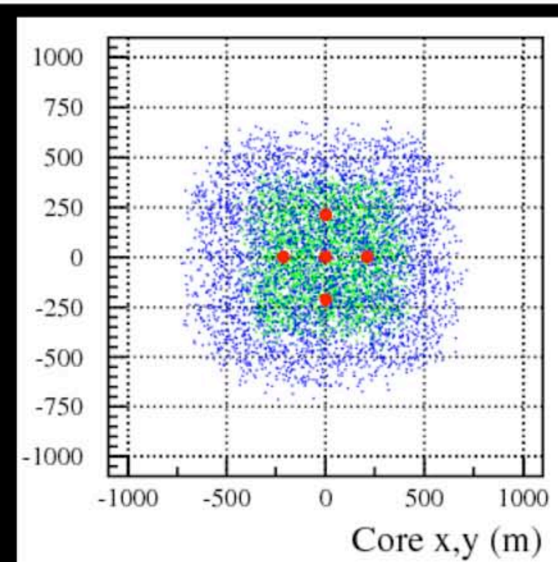
TenTen   Rowell etal OG2.7 128, Stamatesu etal OG2.7 165

- Focus on multi-TeV energies – maximise effective collection area
- Simulations of a large array of small (~6m diam) telescopes
- 8 deg FoV, 1024 pixels, 0.25deg pixel

- 5 telescope cell, 300m
  side spacing







1-10 TeV
10-100 TeV

- Aeff x 5 better than HESS E >~ 30 TeV
- Ang res ~0.1 deg, Cosmic ray bkg rejection
  similar to HEGRA (& ~HESS)

- Extend to 10 x cells (independent)
  --> 10 km^2 for E> 10 TeV --> TenTen concept

Possible Cherenkov Telescope Array Performance   Sajjad   OG2.7 1135

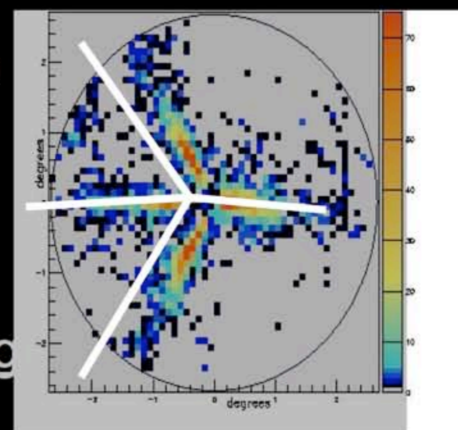
- focus on gamma EAS recons, not yet on gamma/hadron separation, nor cleaning or NSB

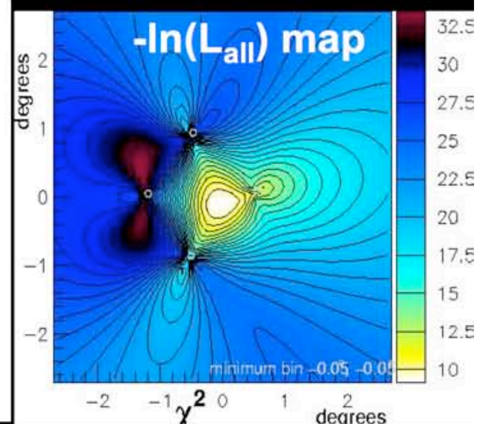
CORSIKA 6.020   up to 100 telescopes

$$\ln(L_{all}) = -\sum_{j=1}^{N_{tel}} \sum_{i=1}^{N_{pix}} \frac{N_{ij} t_{ij}^2}{2\sigma_t^2}$$

- 5deg FoV cameras

- Use likelihood function for reconstruction Images – transverse assumed to be Gaussian use likeihood & sum over all telescopes





Focus on ~10s GeV to few 10s TeV energ

>300 GeV 12.5m tels   1800m asl
<300 GeV 30m tels   3000m asl

Conclusions: optimal tel separation for angular & Eresolution   ~100-200 metres

Mixed grid of large 4tels & medium 33tels arrays --> ang res 1TeV ~ 0.05deg
50GeV ~0.17deg

Higher altitude gives smaller collection area (1800m/3000m)
Area ratio ~ 1.2 (1 TeV)

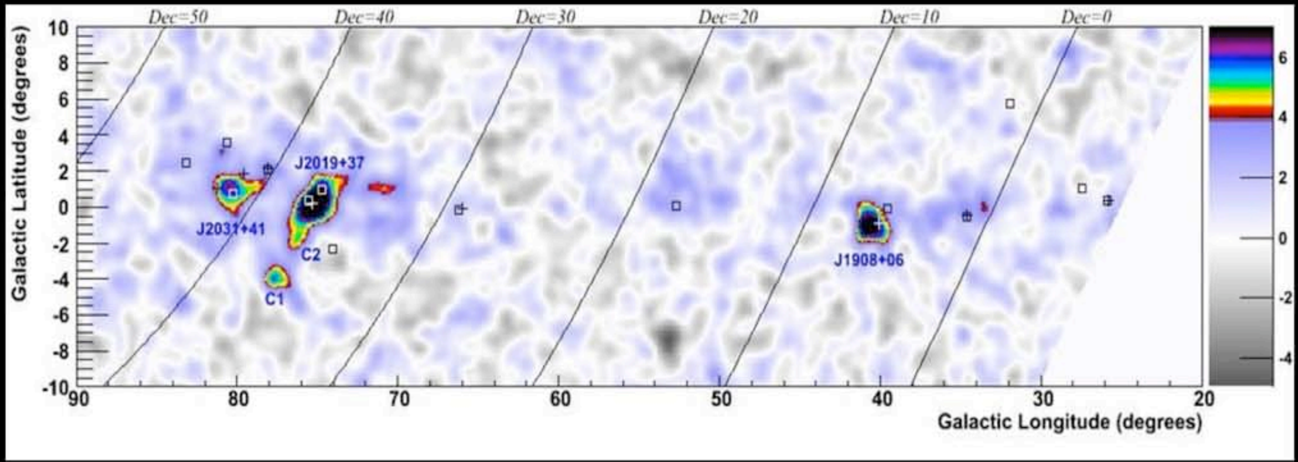
HAWC Gonzalez etal OG2.7 1238

High Altitude Water Cherenkov Telescope

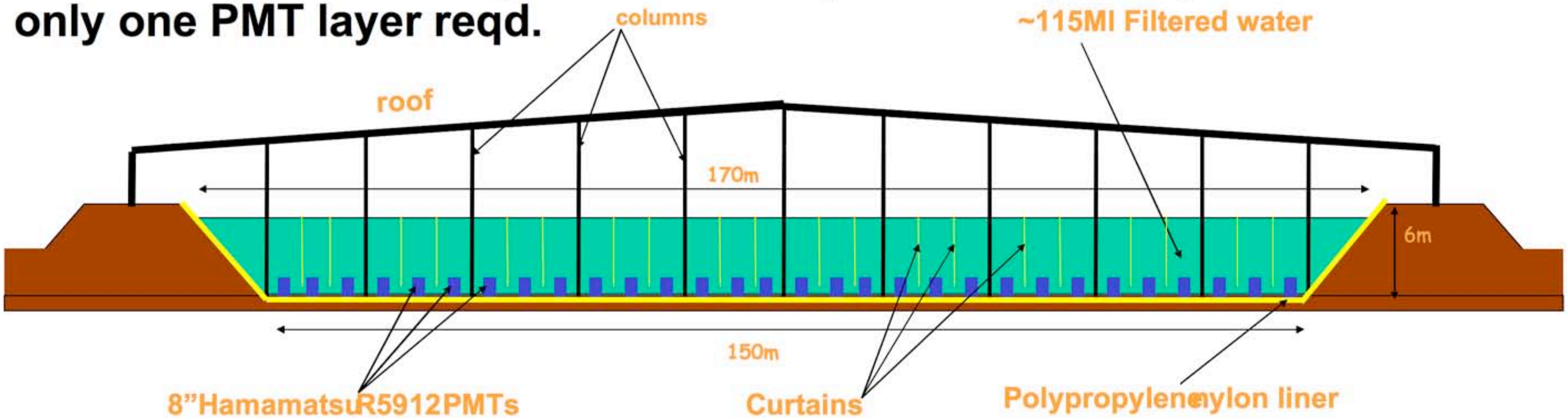
2nd generation of water Cherenkov Telescopes (WCT) water Cherenkov telescope:

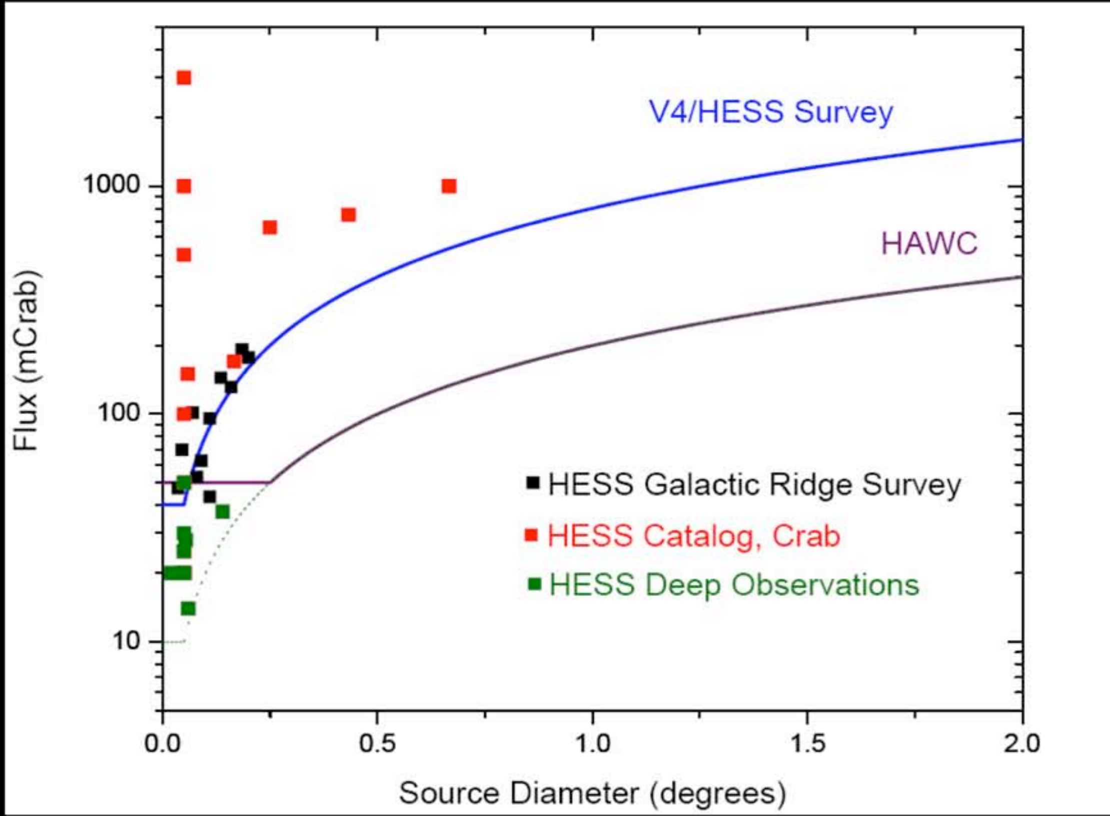
Milagro has proven the technique and capabilities of WCT

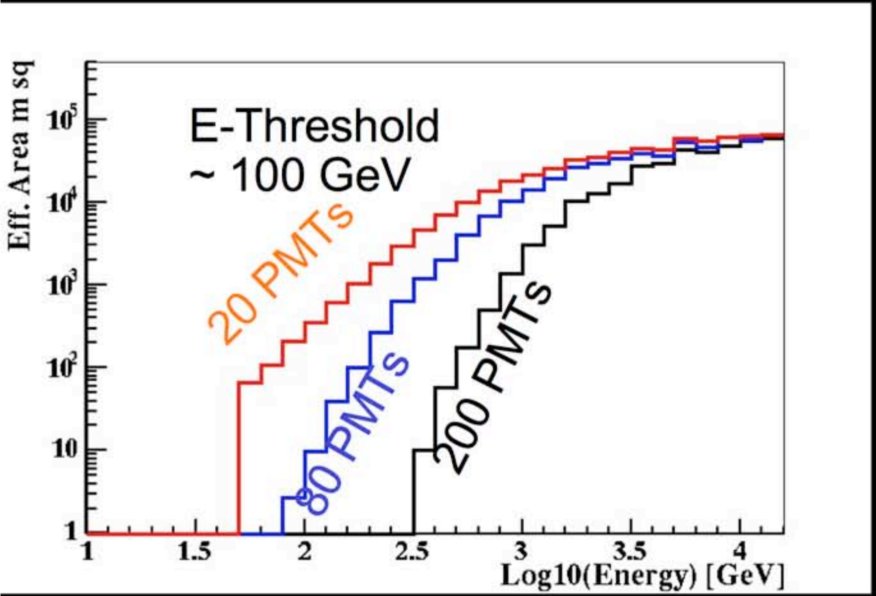
- at least one source confirmed by HESS (MGRO1909+06)



HAWC: key points – high altitude- deep water - optically isolate PMTs --> only one PMT layer reqd.







~15 times the sensitivity of Milagro
~5 sigma/day on the Crab everyday
30mCrab survey of the N-Sky in 2yr

- sensitive to GRBs

E-resolution~30% above median energy

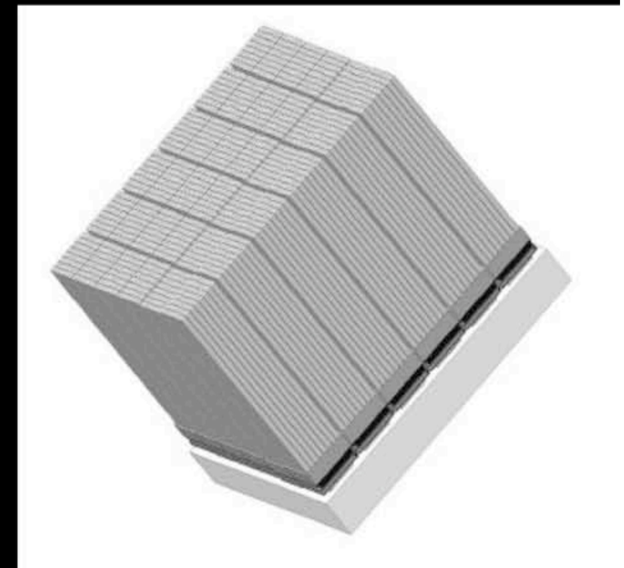
Ang res 0.25 to 0.4 deg

POLAR

AN INSTRUMENT TO MEASURE GRB POLARIZATION

G. LAMANNA ETAL OG 2.7 159

- NEED FOR GAMMA-RAY POLARISATION
- STUDIES (INITIAL RESULTS FROM RHESSI
- PROVIDE IMPETUS)

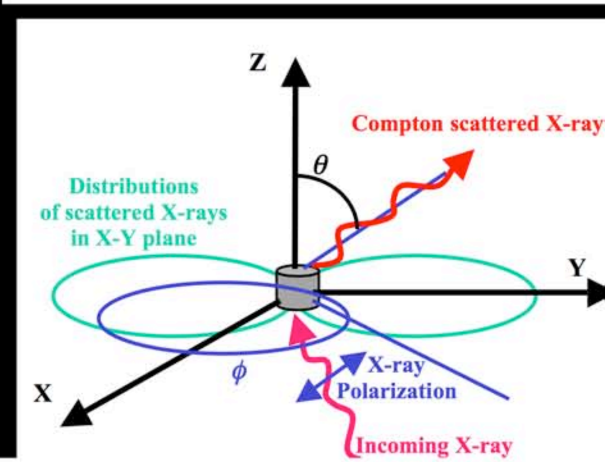


- CAN BETTER PIN DOWN GRB MODELS EG:

FIREBALL P_{LIN} ~ 10-20 %

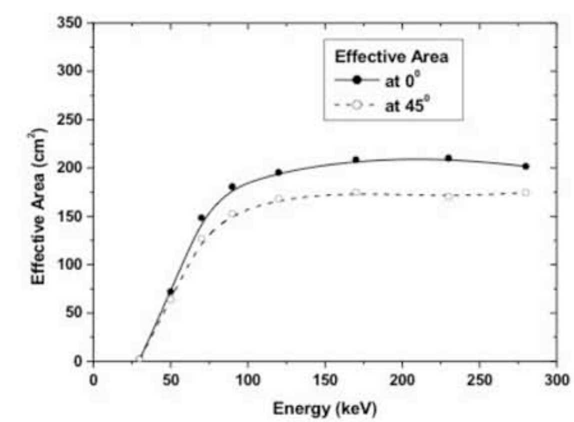
CANNONBALL P_{LIN} = 0 – 100%

ELECTROMAGNETIC P_{LIN} ~ 50 %



40X40 SCINTILLATOR ARRAY, LOW Z PLASTIC

6X6X200 M² CURRENT VERSION



MIN DETECTABLE POLARISATION

$MDP_{3\sigma} \approx 10\%$ for GRB total energy of 10^{-5} erg/cm²; tens of detections/year

(also see POGOlite OG1.5,1177)

0.3-50 MeV Gamma-Rays Imaging: Three-Dimensional Track Imager (3-DTI) Link et al OG2.7 369

- Followup to CGRO/COMPTEL
  Intermediate mission prior to ACT (NASA)
  x10 better sens than COMPTEL

Science outlined by Hunter etal OG2.7 655

- Type Ia SN ^{56}Co ; Galactic
  Nucleosynthesis, AGN, XRB, pulsars

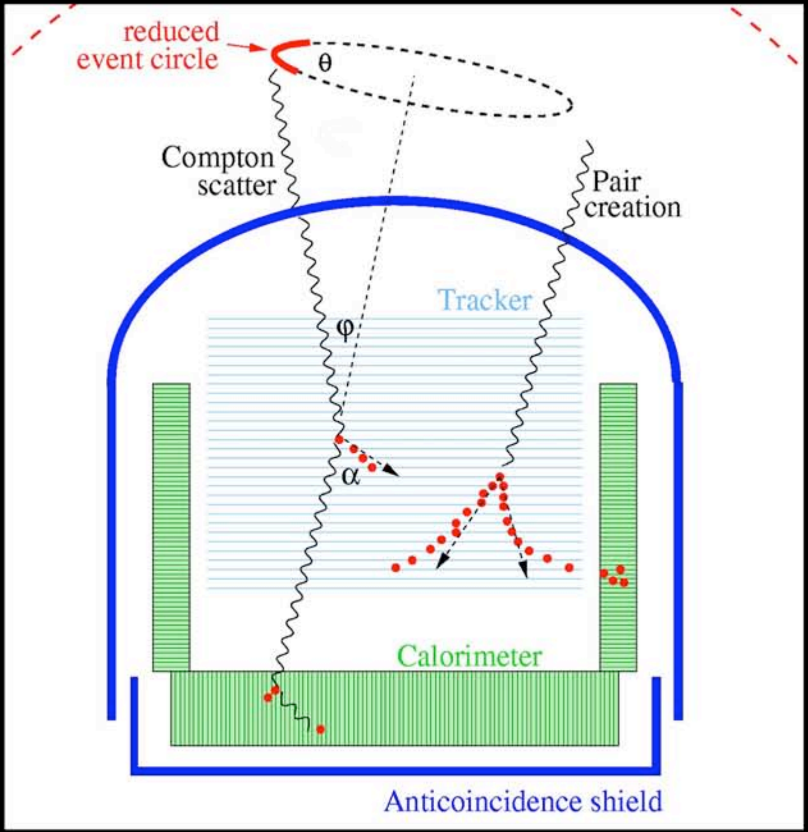
<u>3-DTI</u>

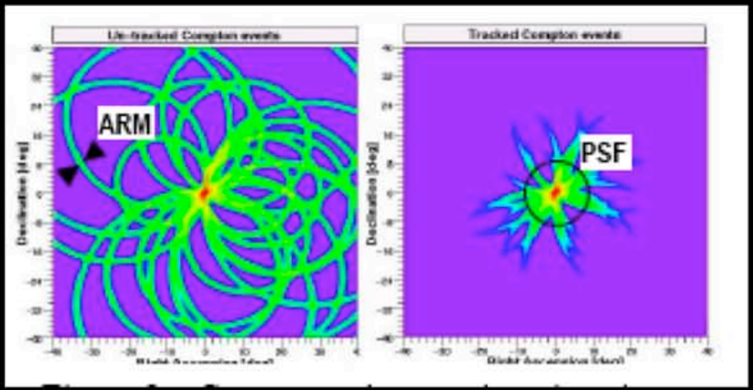
- Measure momentum & direction
  of Compton recoil electron
  --> track arcs instead of circles
  --> better angular resolution

Tracker -ve ion drift to microwell r/o

Prototype 10cm 3-DTI running
see Son etal OG2.7 634

Space/ballon borne version planned





Grasso etal OG2.7 348 **Diffuse Gamma-Ray & Neutrino emission**

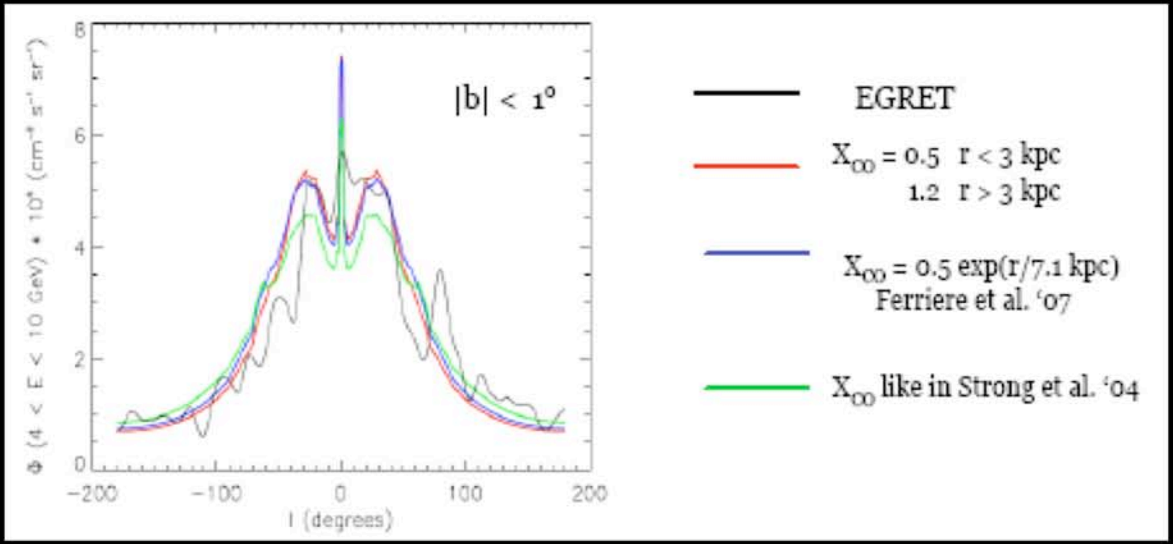
Predict Diffuse Gamma & neutrino emission from the Galactic Plane

- consider distribution of CR (SNRs) sources (Ferriere 2001), CR diffusion, gas distribution

Adopt Diffusion coeff D(E,sigma) from MC simulations of particle propagation in turbulent B's (Candin & Roulet 2004)

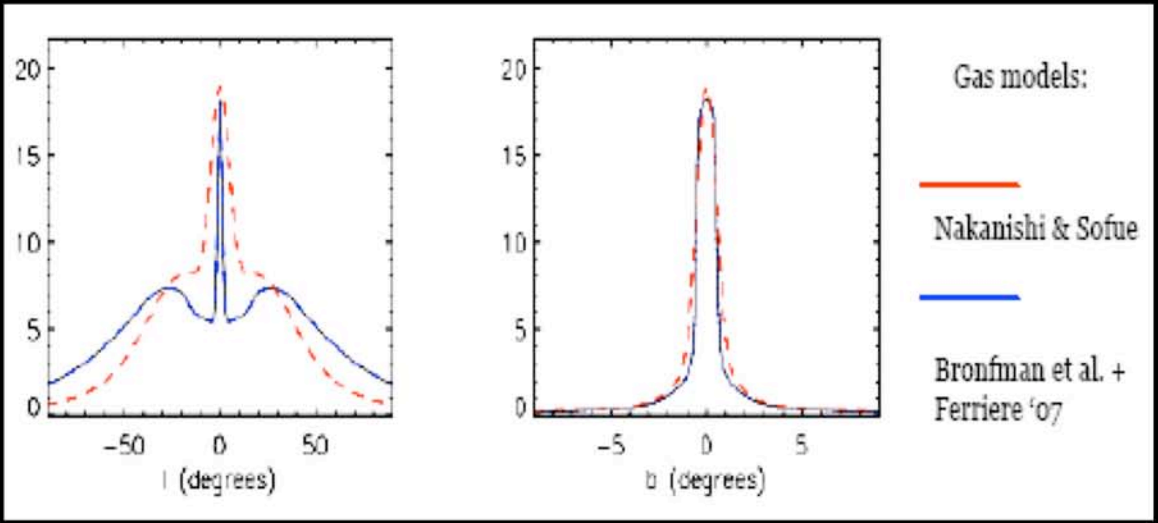
able to match EGRET measurement

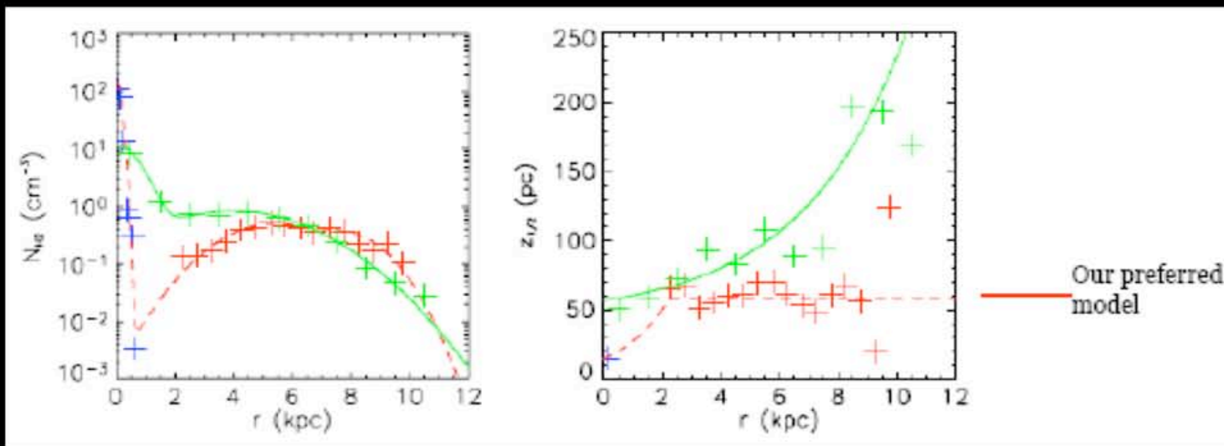
4<E<10 GeV



E>1 TeV

TeV regime: x2-3 large and more narrow than Berezinsky etal '93





N_H (cm^-3)
r (kpc)
z_1/2 (pc)
r (kpc)
Our preferred model

OG 2.5 Neutrinos

- Status of some detectors
- Flux predictions
- Coordination with Gamma-Ray
  Observatories

19 contributions

Radiofrequency Ice Properties at Taylor Dome Besson OG2.7 809

- Askaryan effect (Radio freq Cherenkov emission)

Key parameters to measure:

Attenuation length --> for energy reconstruction

Density profile of ice --> for direction reconstruction

Birefringence --> Cherenkov is verticall polarised along propagation direction

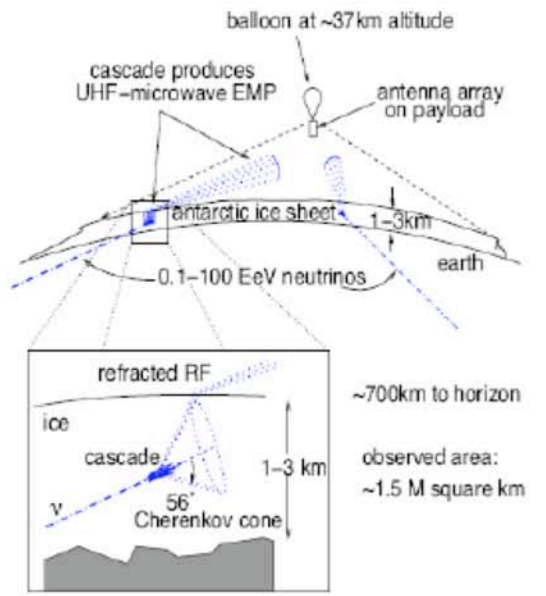
For the ANITA experiment

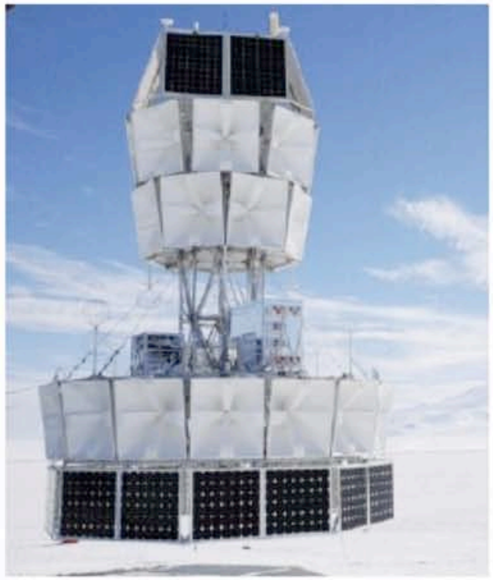
Taylor Dome site Antarctica

--> at edge of Ross Ice Shelf

Method

radio pulse sent through ice to bedrock. Pulse reflection is received by detector 70m away from transmitter.





ANITA gondola

Conclusions: Atten length & biregringence similar to South Pole measurements. not expected to be a problem for ANITA.

Status of RICE

Rezzaque OG2.7 659

Effective Volume for neutrino detection increases 1 to 10km^3 from 1 to 1000 EeV

Ang resolution few 10's of degrees

Currently operational and taking data

Limits on GRBs

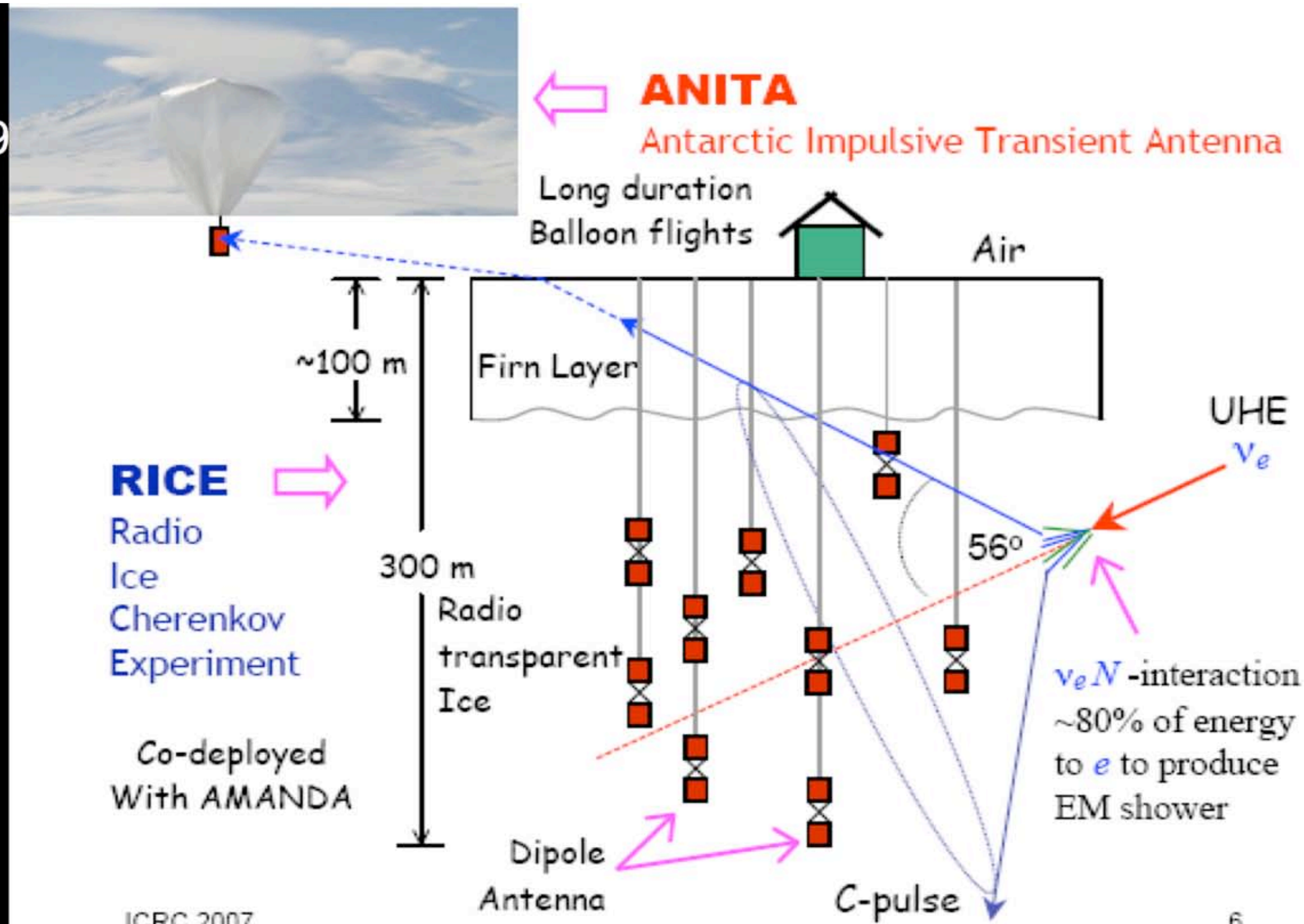
2000-2005 data

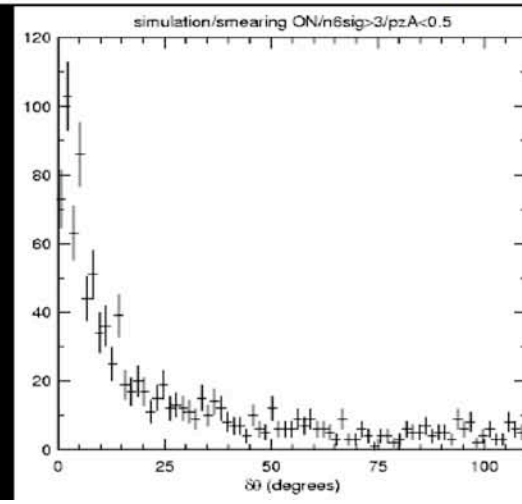
1000s window around GRB time

5 GRBS with sufficient info (redshift..)

Limits unconstraining --> further investigation with larger data sample.

Flux UL on Dirac monopoles (mass 10^5 – 10^{12} GeV) competitive





MC simulations: Angular Resolution

Energy resolution ~50% for r<1 km

Stegmann OG2.7 777

Potential Neutrino Signals from Galactic Gamma-Ray Sources

- Use HESS observations of southern Galactic Gamma-Ray sources to predict the neutrino rates in a northern hemisphere neutrino detector eg KM3NeT.

From γ-ray to neutrino flux (I)

- Hadronic γ-ray and neutrino production

$$p+p \rightarrow \pi^0 + X,\quad \pi^0 \rightarrow \gamma\gamma$$

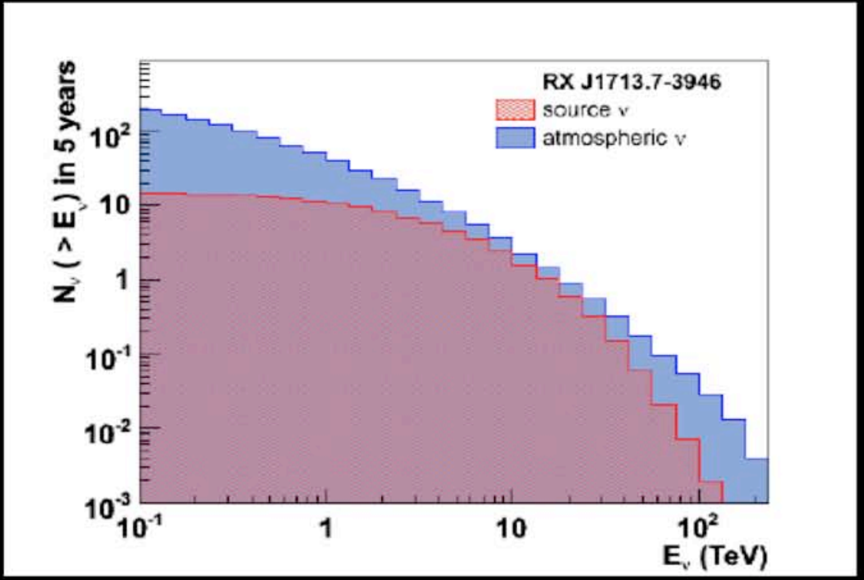
$$p+p \rightarrow \pi^\pm + X,\quad \pi^\pm \rightarrow \mu^\pm + \overset{(-)}{\nu}_\mu,\quad \mu^\pm \rightarrow e^\pm + \overset{(-)}{\nu}_\mu + \overset{(-)}{\nu}_e$$

  - Strong isospin symmetry $(\gamma, \nu_e, \nu_\mu, \nu_\tau) = (1,2,1,0)$
- Parametrization of pion and secondary particle production (Sybill) (Kelner et al., astro-ph/0606058)
  - primary proton spectrum $\left(\frac{dN}{dE}\right)_p = k_p E^{-\alpha_p} \exp\left(\frac{E}{\epsilon_p}\right)$
  - gamma/neutrino spectrum $\left(\frac{dN}{dE}\right)_{\gamma/\nu} = k_{\gamma/\nu} E^{-\Gamma_{\gamma/\nu}} \exp\left(\sqrt{\frac{E}{\epsilon_{\gamma/\nu}}}\right)$

Christian Stegmann, Galactic Neutrinos, ICRC 2007

Assume

- Full neutrino mixing, source size large
- No non-hadronic contributions
- Radiation density at source low
- Low magnetic field



KM3NeT 5yrs exposure E> 5 TeV

Best S/N RXJ1713 2.6 to 6.7 evts over 8.2 bkg
VelaX 5 to 15 evt over 4.6 bkg

ie. ~ 1 neutrino per year from the brightest sources..

High Energy Neutrinos from Astrophysical Sources Tomas etal OG2.7288

WB limit $E^2F < 10^{-8}$ GeV/sr/cm^2/s applies to transparent sources

τ = Radius/InteractionLength << 1.0

what if $\tau > 1.0$ thick source
$\tau < 1.0$ but diffusion in strong magnetic field τeff > 1.0

- Monte Carlo Simulation of neutrino fluxes from pp collisions & sec. mesons (extended version of SOPHIA) where dN/dE ~E^{-2} for protons Emax = 10^{24} eV

--> neutrino fluxes 10^{12} to ~10^{22} eV

Results: Thick sources

neutrino flux increased, but at higher energies mesons scatter --> suppessed neutrino fluxes

neutrino flavour ratio strongly dependent on energy

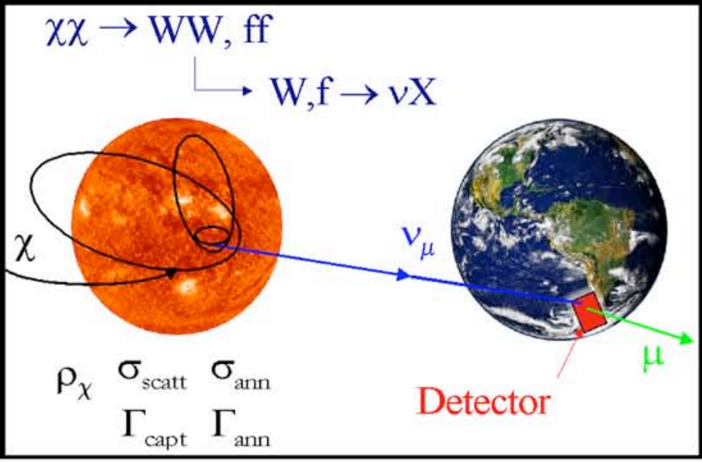
Results: Thin sources with high B field

synchrotron cooling suppresses high energy(>10^{20}) neutrino flux.
At low energies charged particles diffuse τeff > 1.0

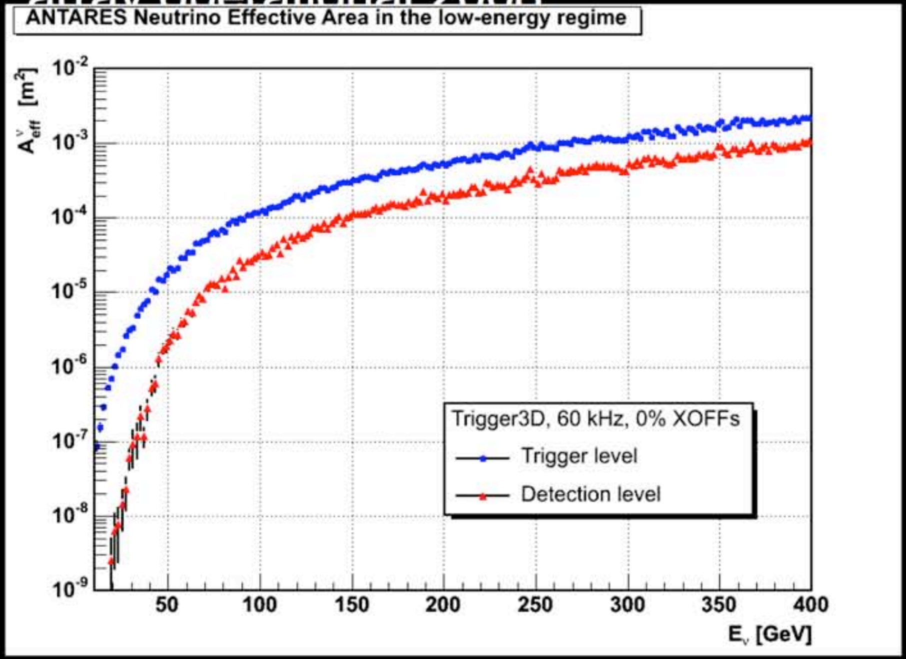
Sensitivity of ANTARES to Dark Matter Candidates   Falcini OG2.7 355

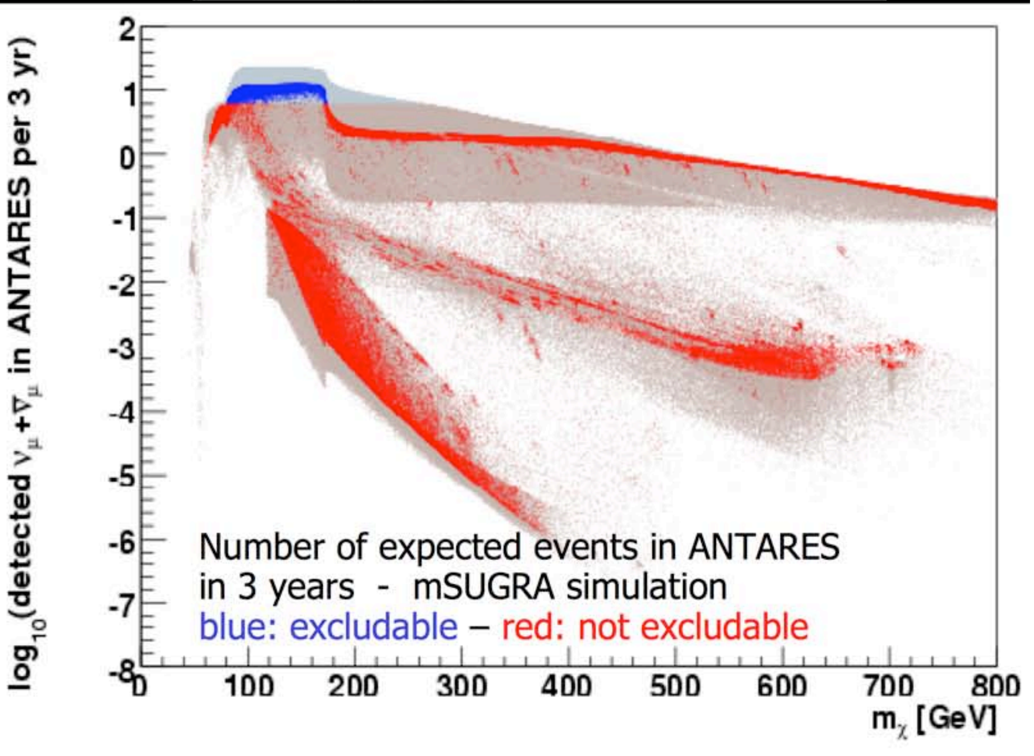
- Favoured candidate ***neutralino*** χ annihilation. Neutrinos take 0.1 to 0.5 of the χ energy, ie GeV to TeV energies.

- Models neutralinos from the Sun, Galactic Centre --> Northern location of ANTARES is advantage



Eff area for upgoing neutrinos – full array operational 2008





fold detector response & compare with models

Bernardini etal OG2.7 1049 **Neutrino ToO with AMANDA-II & MAGIC**

Idea: Trigger MAGIC obs. with neutrino evts from known sources.
Might expect gamma/neutrino correlations (eg. proton blazar models)

Considerations: MAGIC Obs. schedule --> use targets of interest to MAGIC
Make sure alert probability not too high

AMANDA – predefind analysis scheme

Neutrinos (N_{obs} / N_{bck})	# coincident gamma-ray flares	significance (σ)
3 / 1	?	1.4
3 / 1	2	4.0
3 / 1	3	5.1

$$P = \sum_{m=n_{obs}}^{+\infty} \frac{(n_{bck})^m}{m!} e^{-n_{bck}} \sum_{c=n\gamma_{coinc}}^{m} \frac{m!}{c!(m-c)!} (p^{\gamma}{}_{\Delta t})^c (1-p^{\gamma}{}_{\Delta t})^{m-c}$$

Test Run 2006
estimate probability to observe
gamma-ray flare given neutrino evts
Δt = 1 day

Several alerts given:

No coincidence gamma-ray events found.

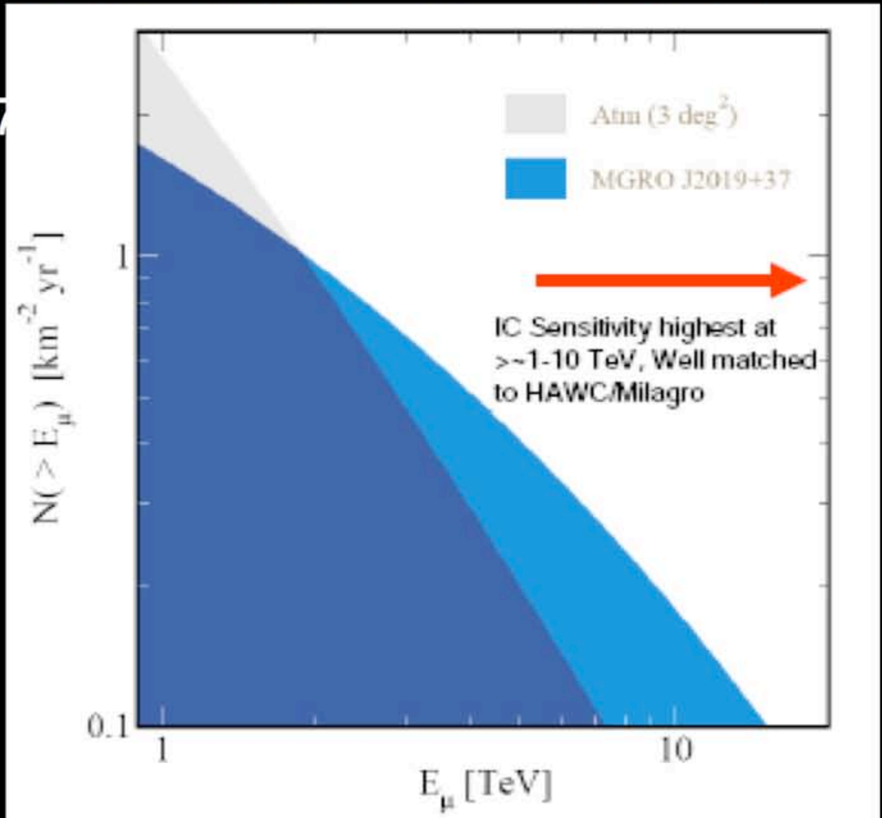
- Further work on neutrino alert design based on pre-defined significances.

	Neutrino				γ-ray		
Source	Bin (deg)	obs	bck	P (%) N ≥ obs	Follow up obs.	Threshold (Crab Units)	Flux or U.L. (Crab Units)
Markarian 421	6.5	3	1.5	19	1	4	(30 ± 10) %
1ES 2344+514	5.0	1	1.0	63	1	0.5	< 16 %
1ES 1959+615	4.5	0	0.9	100	—	1	—
LSI +61 303	4.5	0	0.9	100	—	0.2	—
GRS 1915+105	7.0	1	1.3	73	0	0.2	Not obs.

Goodman etal OG2.7 622 **Coincident Neutrino/Gamma-Ray Measurements with IceCube and HAWC**

- Expected neutrinos from MGROJ2039+37

  < few evts per year



Beacom & Kistler 07

For flaring sources such as blazars and GRBs.....

HAWC 5-15 Crab in detectable in 10 minutes from v.strong Mkn421 flares.

Main point – can use TeV flares to constrain time window for neutrino detectors

Does one expect >=1 neutrino detected in such short timescales (say <hr)?

OG 2.6 Gravitational Waves

- Cosmic Ray backgrounds in GW detectors

2 contributions

Ugolini #1092 Charging issues in LIGO
Excess charge on LIGO optics (from cosmic-rays) could be a dominant noise source at low frequencies.

Choudhury #220 Studies on Curvature Tensor and Geodesic Deviation Eqn

Summary - Gamma-Ray Detection

- TeV detection and analysis techniques robust and reliable. Both imaging Cherenkov and Water Cherenkov methods are the future & complementary.

  We are definitely doing TeV Astronomy now

- MeV/GeV detection: Looking forward to GLAST early next yr

- <MeV : x10 better sensitivity missions planned.
  Polarimetry now a serious activity.

Summary – Neutrino Detection

- Expect <few evts per year from strongest TeV gamma sources in km^3 detectors. This could give them a chance.

- Coordinated gamma/neutrino ToOs now underway.