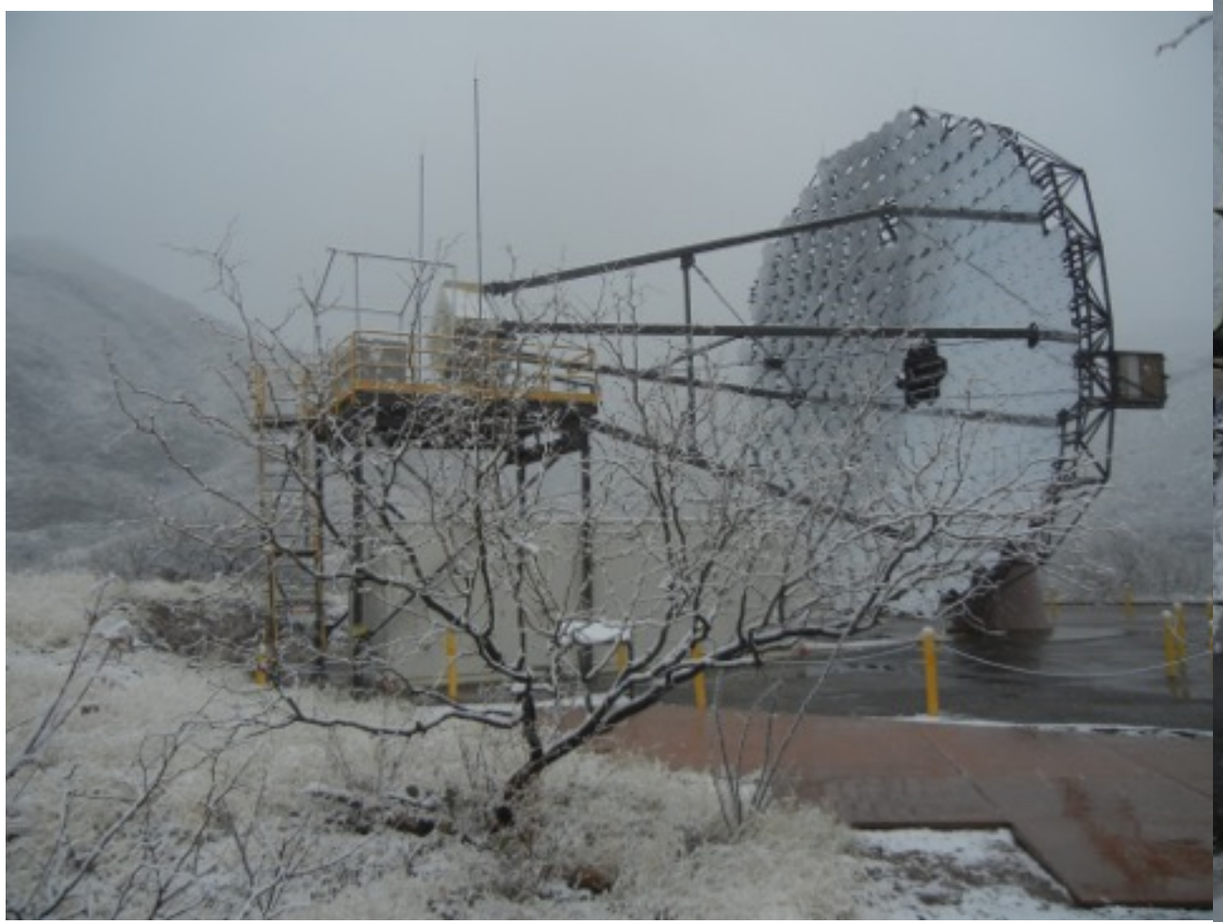
Days & Nights @VERITAS

Michael Daniel
Harvard-Smithsonian Center for Astrophysics

Smithsonian Astrophysical Observatory

“Neither snow nor rain nor heat nor gloom of night stays these couriers from the swift completion of their appointed rounds.” unofficial motto of the postal service

“Neither snow nor rain nor heat nor gloom of night stays these couriers from the swift completion of their appointed rounds.” unofficial motto of the postal service



☑ Snow

“Neither snow nor rain nor heat nor gloom of night stays these couriers from the swift completion of their appointed rounds.” unofficial motto of the postal service

☑ Rain

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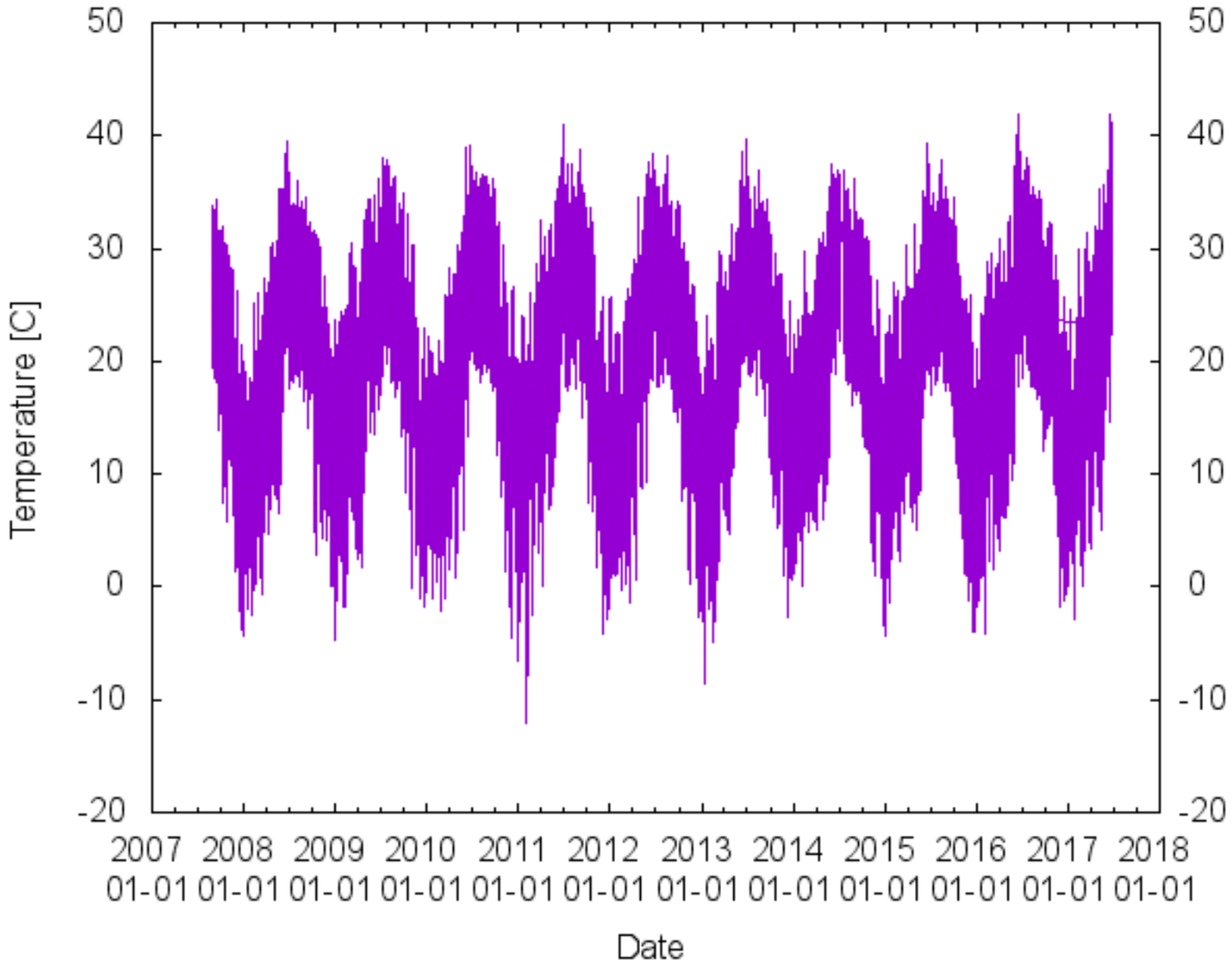

☑ Heat

“Neither snow nor rain nor heat nor gloom of night stays these couriers from the swift completion of their appointed rounds.” unofficial motto of the postal service

☑More heat

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- Any more heat?

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⭐Gloom of night

That’s where we shine

Timelapse by Samuel Trepanier (2017)

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That’s where we shine

Timelapse by Samuel Trepanier (2017)

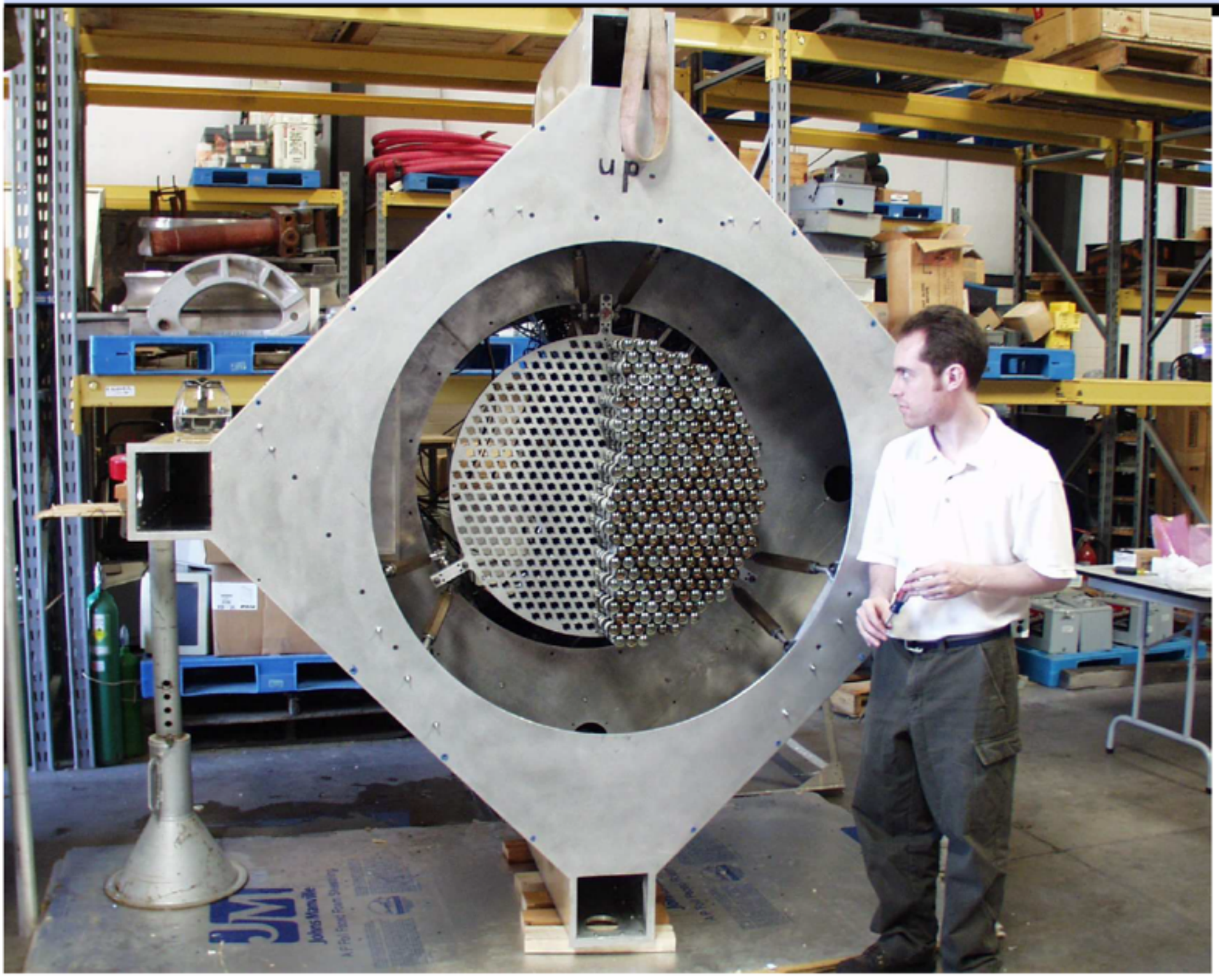
Important Dates

- October 2002: MKD starts in VERITAS
- April 2003: Installation of VERITAS prototype (V0) @ the FLWO Basecamp
- February 2004: First light of VERITAS prototype
- January 2005: VERITAS T1 (V1)
- 2006: VERITAS T2 (T1&T2 = V2)
- still 2006: VERITAS T3 (T1&T2&T3 = V3)
- January 2007: Completion of 4 telescope array at FLWO (V4)
- April 27-28 2007: First Light Fiesta 🌮🍻🍷🌶️📡
- July 2007: VERITAS staying at FLWO — full steam ahead!
- Summer 2009 (V5): moved T1 to new location for improved sensitivity (~15%)
- Summer 2012 (V6): upgrade of camera PMTs to high-QE & L2 trigger upgrade

Chicago Circa 2002/3

Perkins

Camera Installation: at Whipple



Integration by: M. Daniel, F. K. & local SAO crew

FLWO
circa 2003

DoE review, Iowa State University

FLWO circa 2003

November 2003: the first prototype observing log

172.16.0.150

Epochs and Periods for EBs | Manual Cinema | Object Visibility | Wikipedia

demo | VBC

VERITAS at Basecamp, Page 314 of 314 — ELOG

New | Find | Select | Import | Config | Last day | Help

Full | Summary | Threaded | Hide attachments — -- All entries -- | -- Type -- — 6261 Entries

Goto page Previous 1, 2, 3 ... 312, 313, 314

ID	Date	Author	Type	Category	Subject
1	Wed Nov 26 00:07:31 2003	JH			

By popular demand - here is the first log for the prototype.

1800 - 2000: Pointing measurements using Polaris (MS & KG)

2000 - 0100: Camera HVs flat-fielded using the laser and KK's "testfadc"
program.
Trigger system (L1->L2->L3) ran happily for 5 hours without crashing.
Current map now looks very flat. 10% of tubes are dead for varying
reasons.
FADC board 9 is not working. Just seems to give large noise fluctuations
on every channel.

0100 - 0200: Rate vs threshold curves with the shutter down (for single
p.e. calibration)

Should be able to take L2 bias curves tommorrow night if the weather
holds.

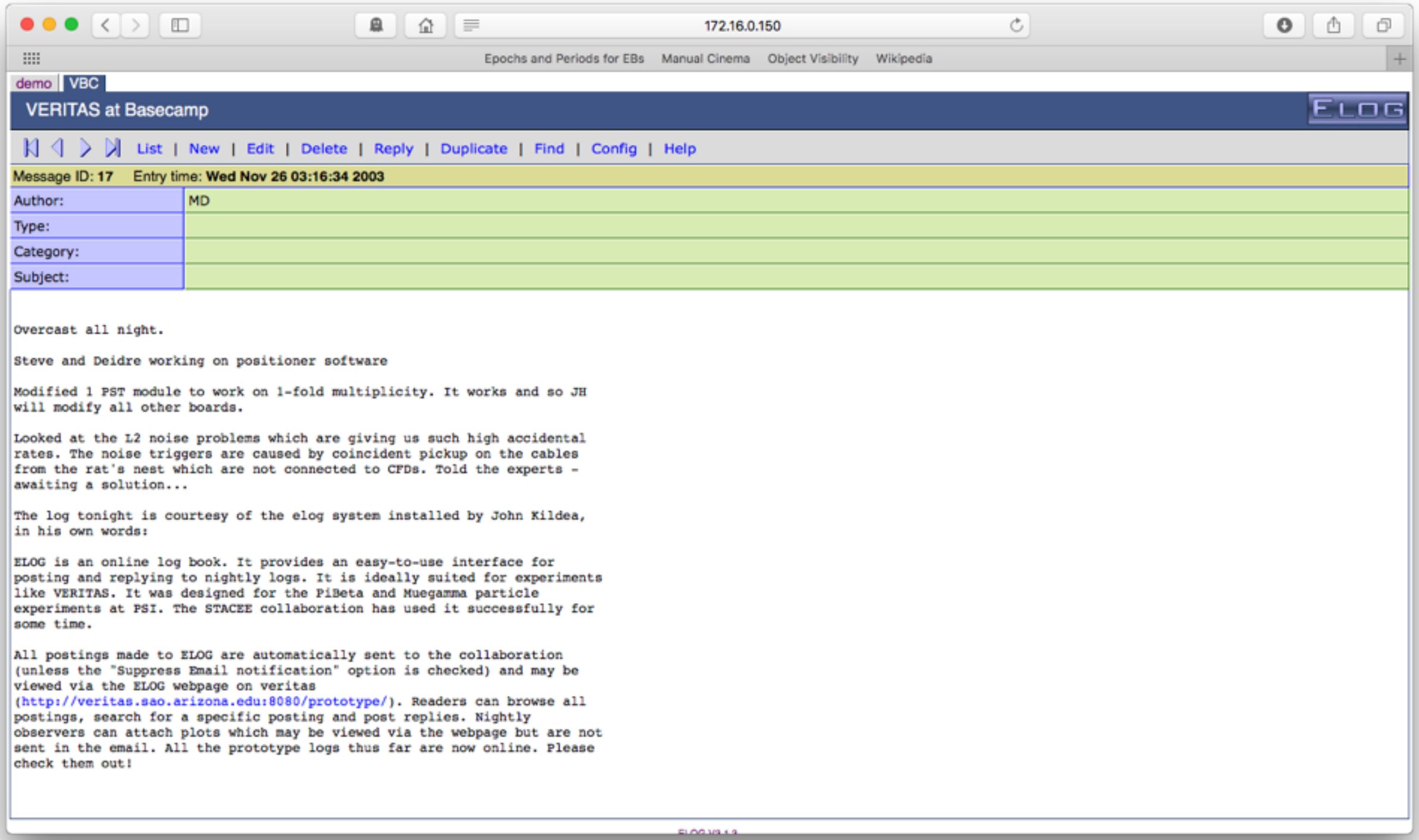
The battery is dead on the bucket lift.

No problems with the chiller since Saturday.

Goto page Previous 1, 2, 3 ... 312, 313, 314

ELOG V3.1.3-

A little later in Nov. 2003: the first prototype observing **e-log**



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Epochs and Periods for EBs | Manual Cinema | Object Visibility | Wikipedia

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VERITAS at Basecamp

ELOG

List | New | Edit | Delete | Reply | Duplicate | Find | Config | Help

Message ID: **17** Entry time: **Wed Nov 26 03:16:34 2003**

Author:	MD
Type:	
Category:	
Subject:	

Overcast all night.

Steve and Deidre working on positioner software

Modified 1 PST module to work on 1-fold multiplicity. It works and so JH will modify all other boards.

Looked at the L2 noise problems which are giving us such high accidental rates. The noise triggers are caused by coincident pickup on the cables from the rat's nest which are not connected to CFDs. Told the experts - awaiting a solution...

The log tonight is courtesy of the elog system installed by John Kildea, in his own words:

ELOG is an online log book. It provides an easy-to-use interface for posting and replying to nightly logs. It is ideally suited for experiments like VERITAS. It was designed for the PiBeta and Muegamma particle experiments at PSI. The STACEE collaboration has used it successfully for some time.

All postings made to ELOG are automatically sent to the collaboration (unless the "Suppress Email notification" option is checked) and may be viewed via the ELOG webpage on veritas (http://veritas.sao.arizona.edu:8080/prototype/). Readers can browse all postings, search for a specific posting and post replies. Nightly observers can attach plots which may be viewed via the webpage but are not sent in the email. All the prototype logs thus far are now online. Please check them out!

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VERITAS at Basecamp

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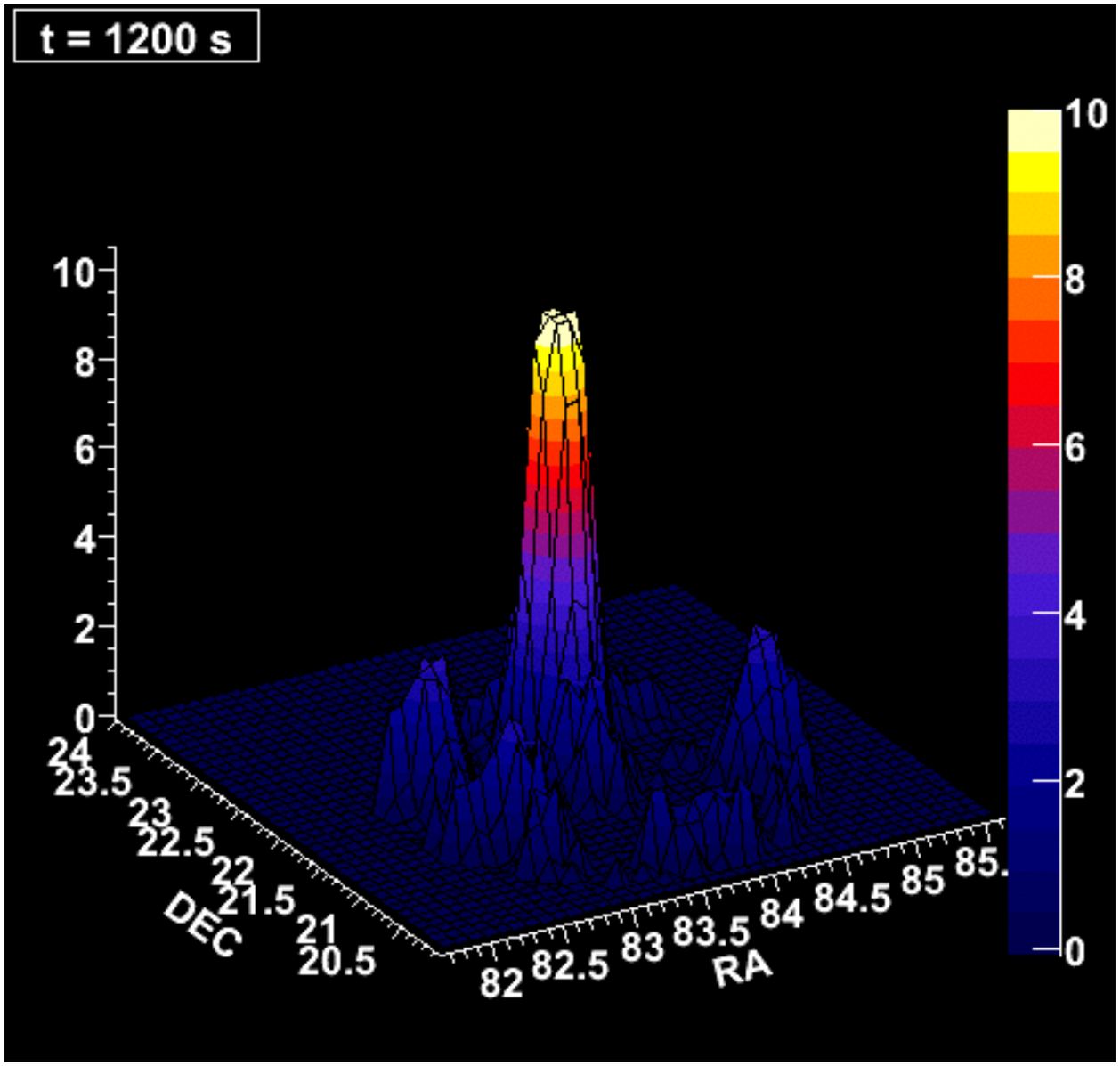
Observation of TeV Gamma Rays from the Crab Nebula using the Atmospheric Cerenkov Imaging Technique

The existence of a steady source of TeV gamma rays has important consequences for the development of the field. For years significant improvements have been hampered by the absence of a standard candle which would act as a means to calibrate and test new techniques. Although weak, the Crab Nebula appears to have the stability necessary for this role. It will be of interest therefore to compare the results from other experiments when they devote time to the study of the steady emission from this source.

Weekes et al. *ApJ* **342**, 379 (1989).



Crab significance vs time animation by Scott Wakely (2007).

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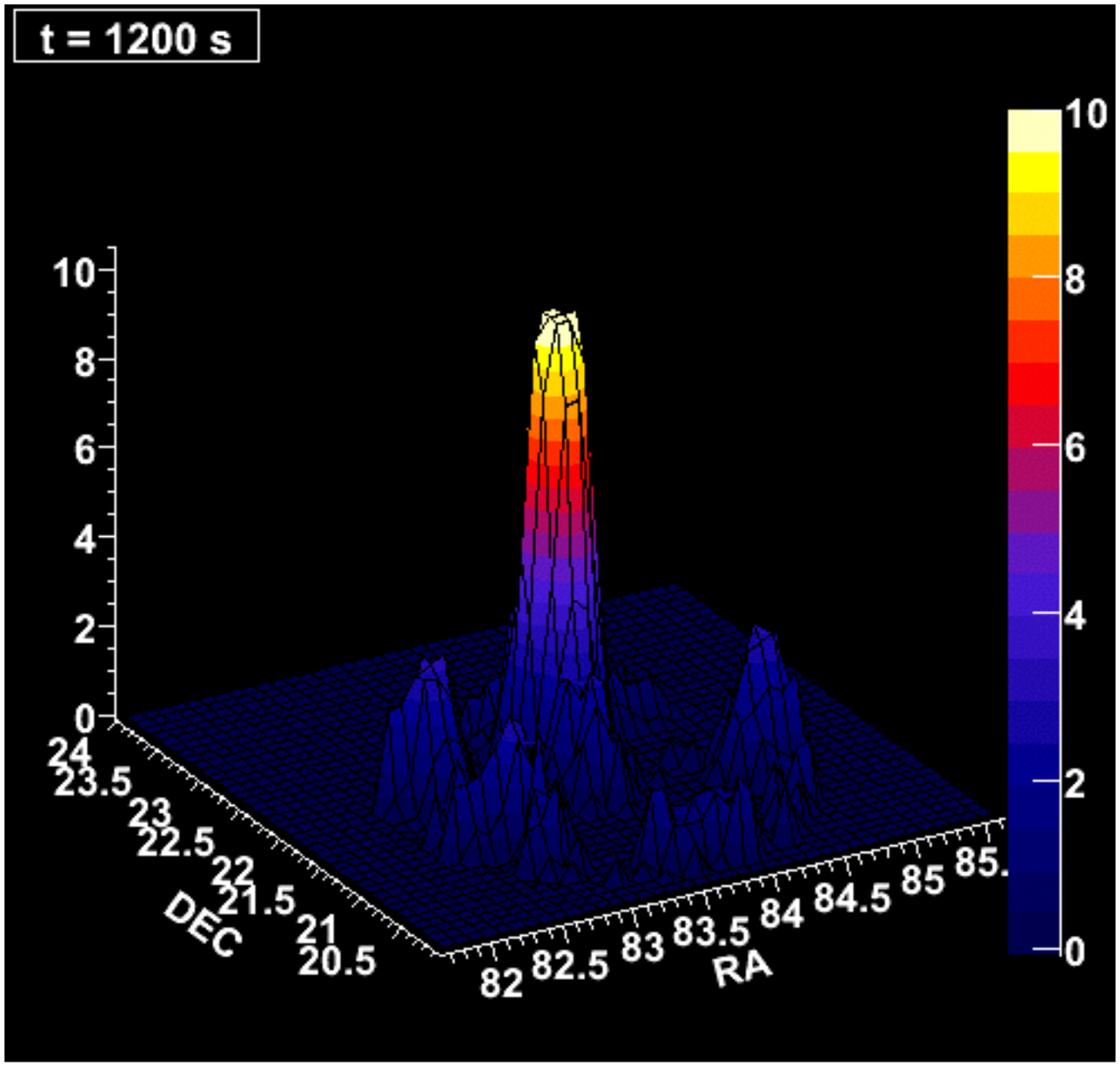
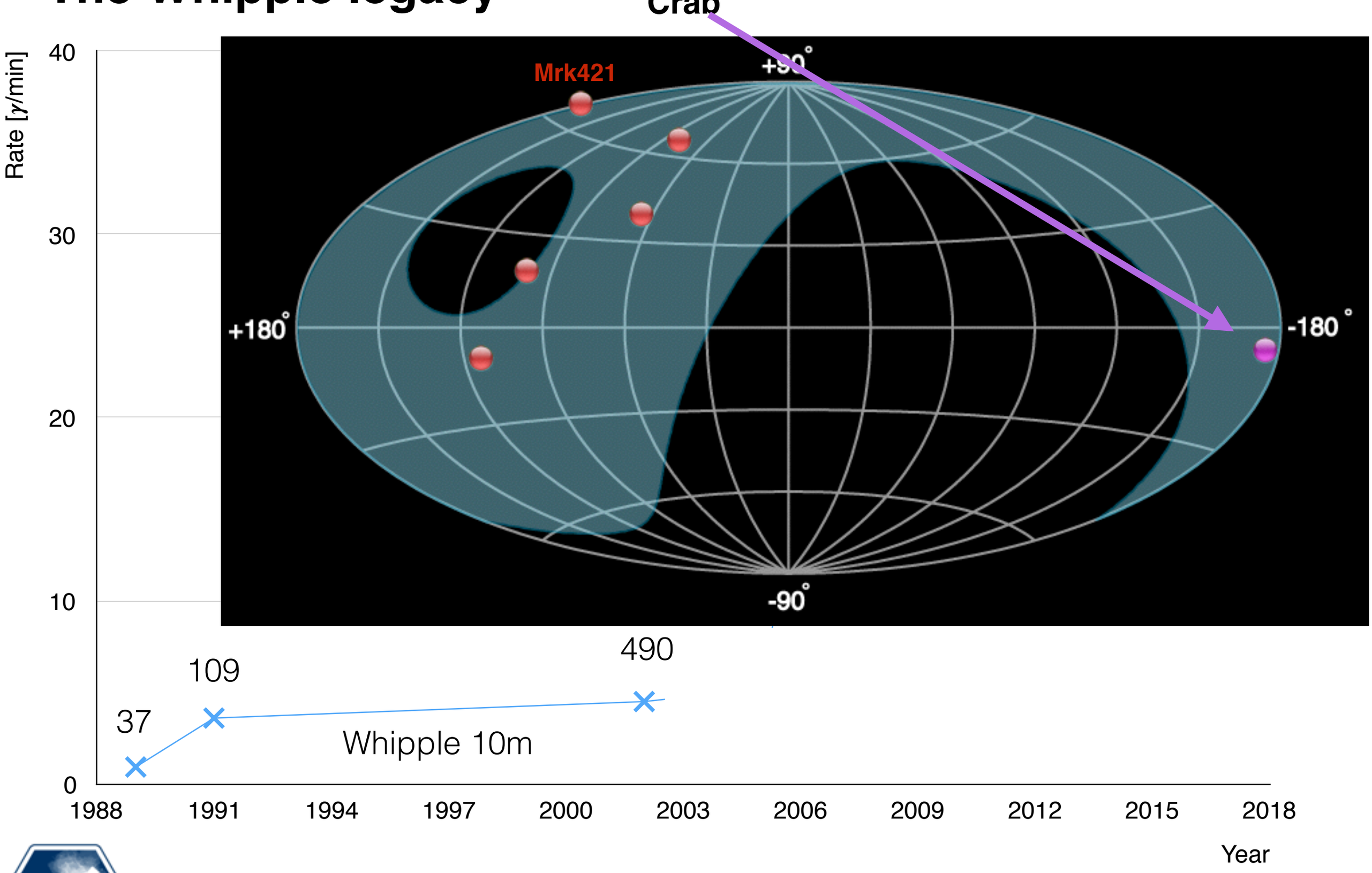
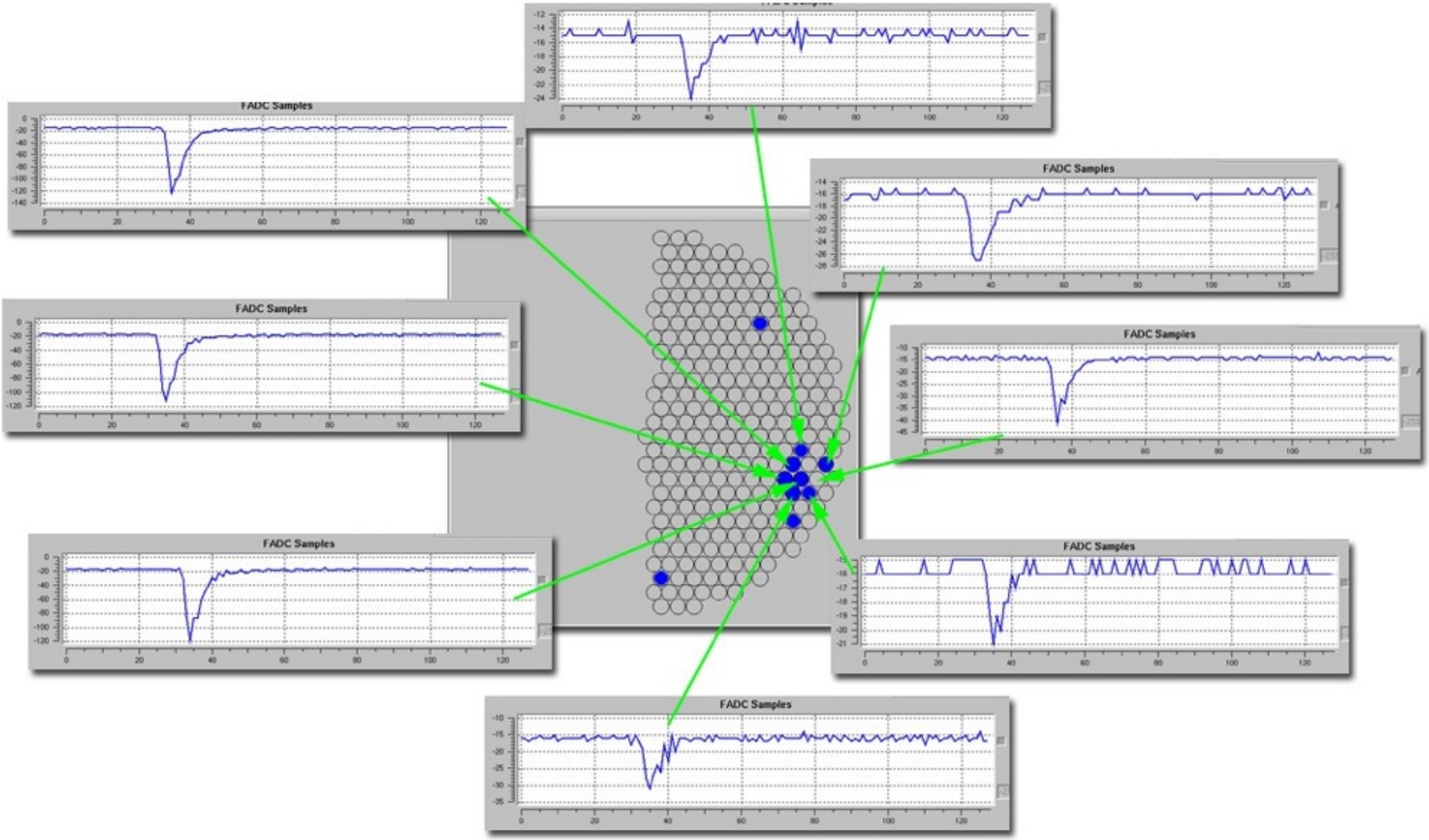
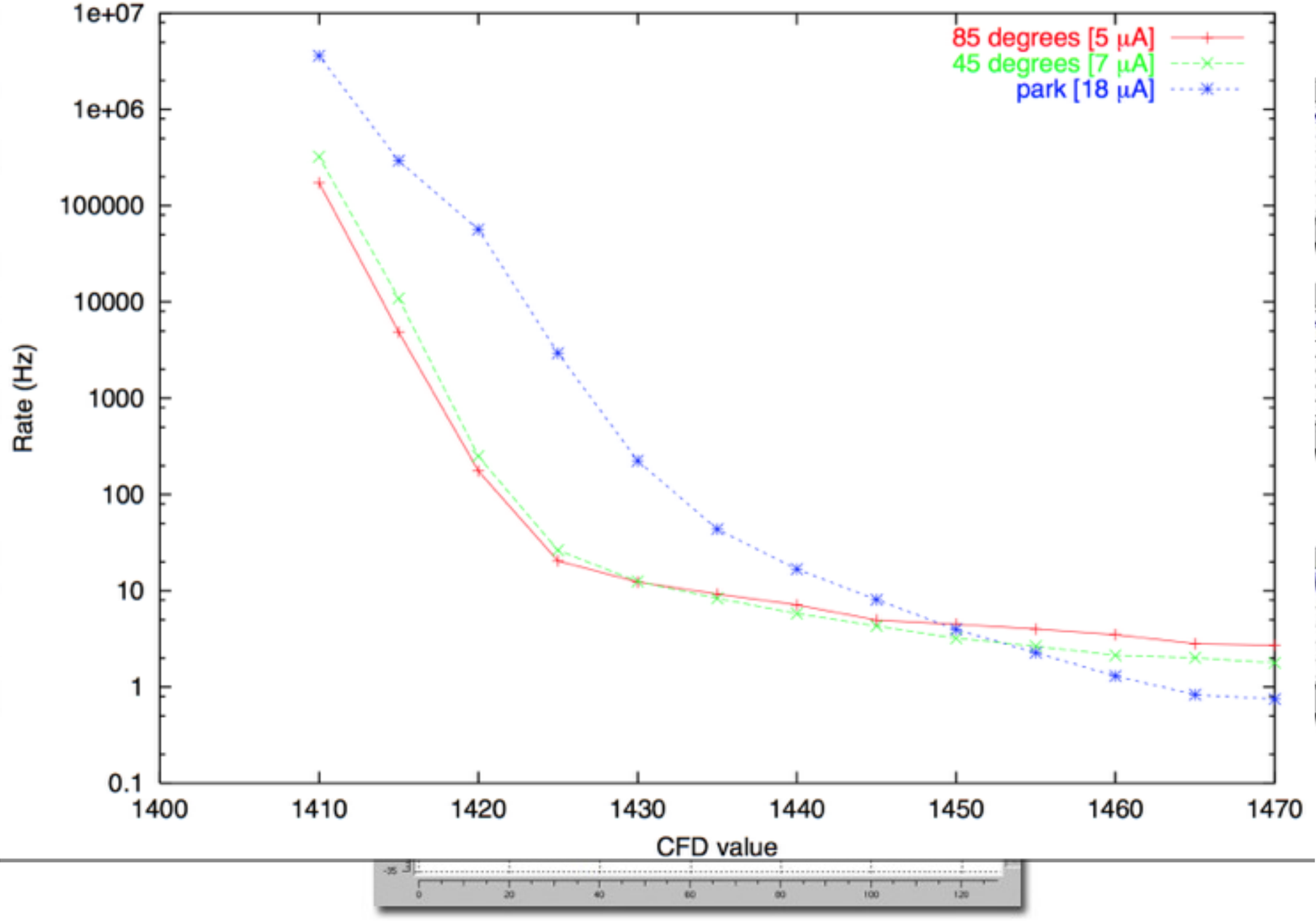


Crab significance vs time animation by Scott Wakely (2007).

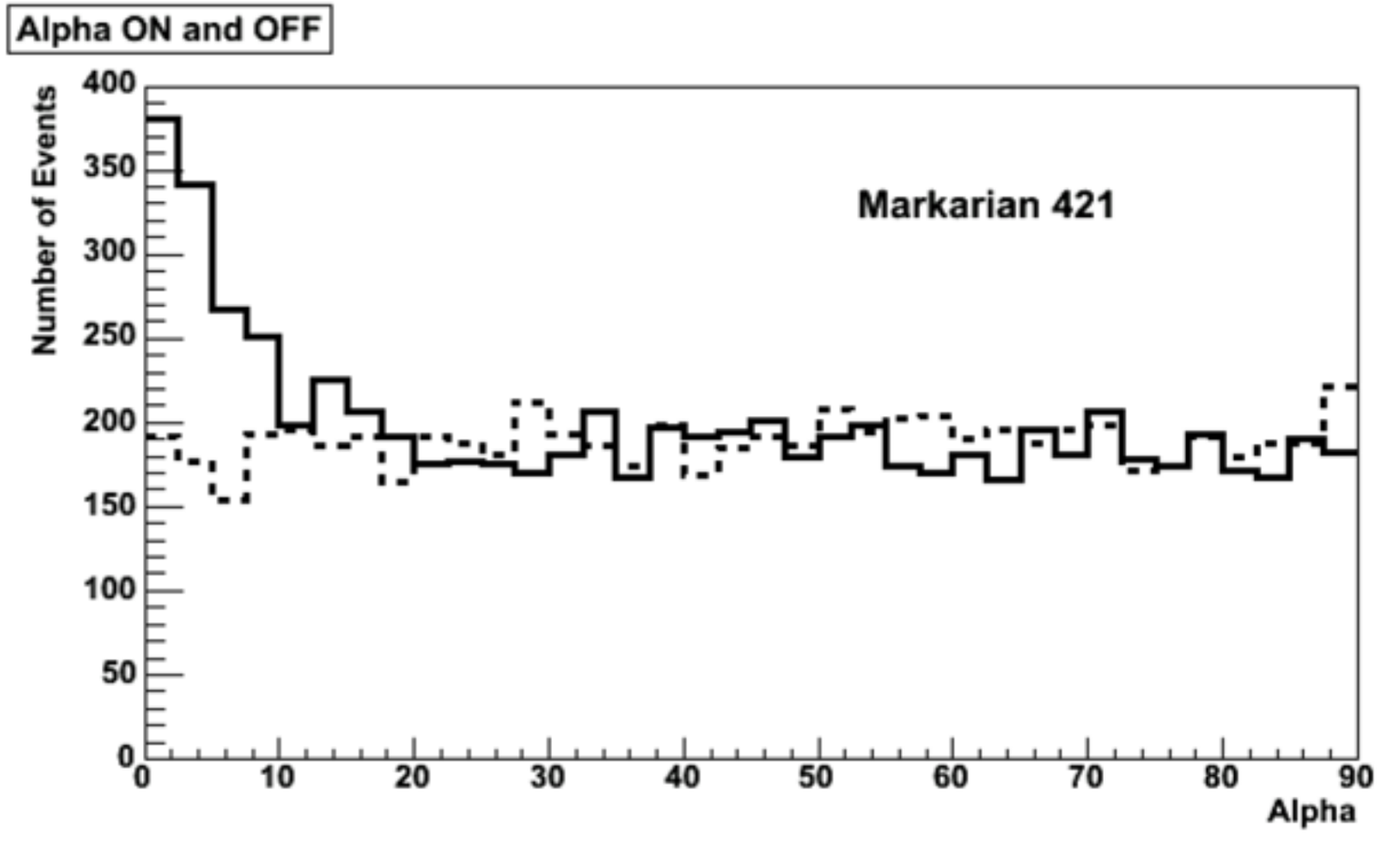
The Whipple legacy




FADC Samples
FADC Samples
FADC Samples
FADC Samples
FADC Samples
FADC Samples
FADC Samples

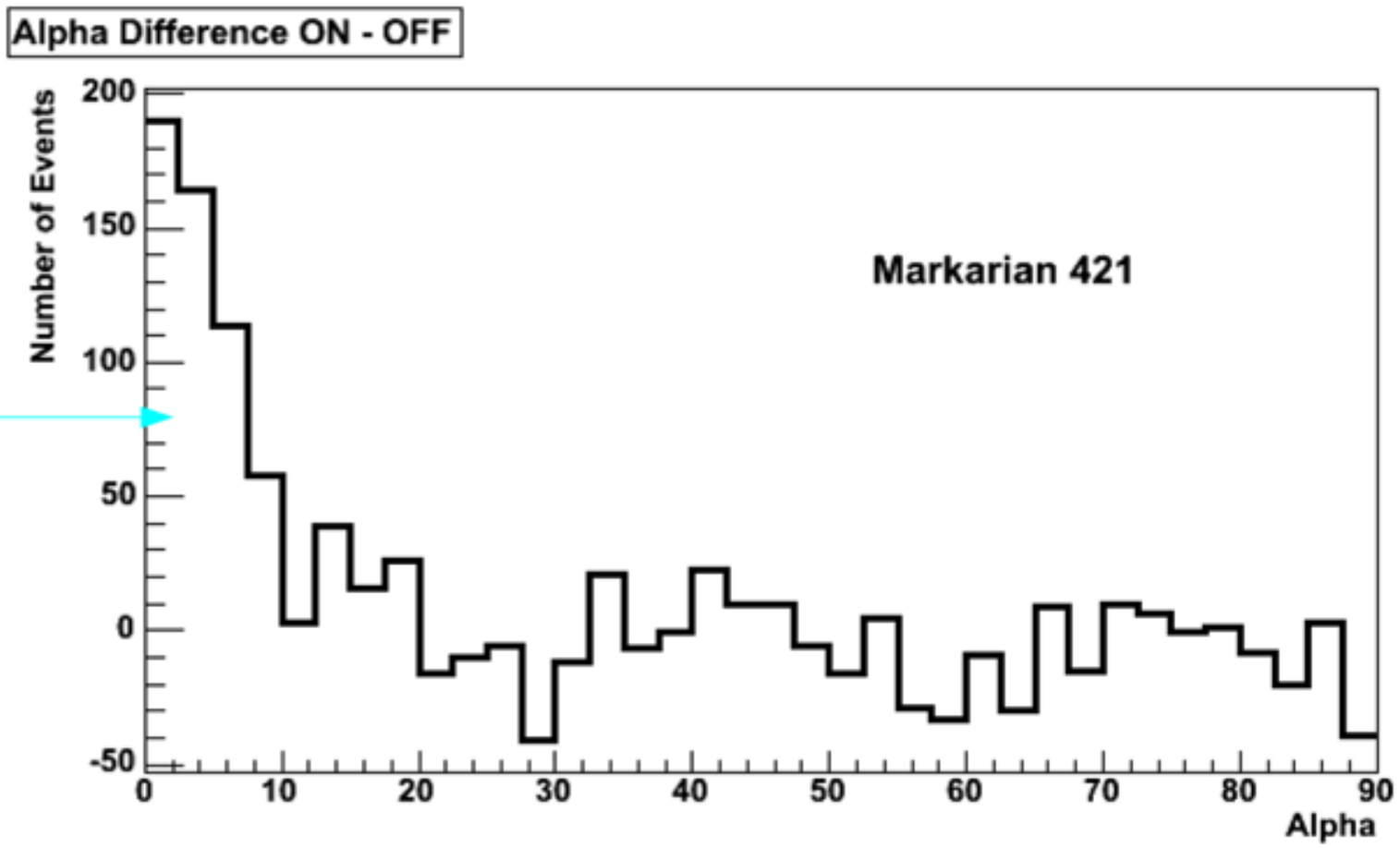

Threshold mode
85 degrees [5 μA]
45 degrees [7 μA]
park [18 μA]
Rate (Hz)
1e+07
1e+06
100000
10000
1000
100
10
1
0.1
1400
1410
1420
1430
1440
1450
1460
1470
CFD value

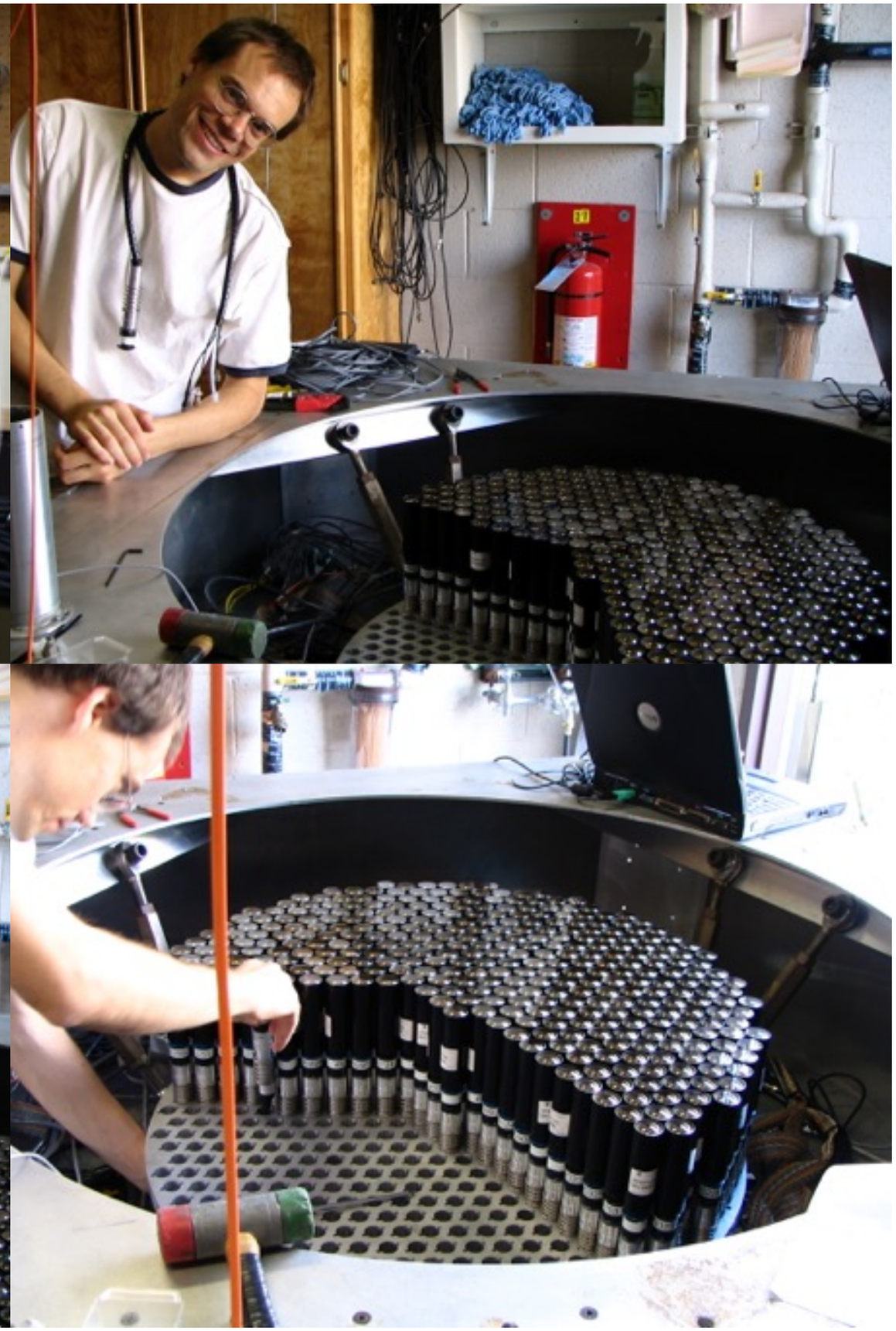
Even this basic engineering set-up yielded good results of the Mrk421 flares.



12 σ in 728 mins on-source

~0.7 γ/min





January 2005: first light for a full camera

172.16.0.150

Epochs and Periods for EBs | Manual Cinema | Object Visibility | Wikipedia

demo | VBC

VERITAS at Basecamp — ELOG

List | New | Edit | Delete | Reply | Duplicate | Find | Config | Help

Thu Jan 13 02:06:44 2005, SPW, , , T1 First Light, Crab Runs

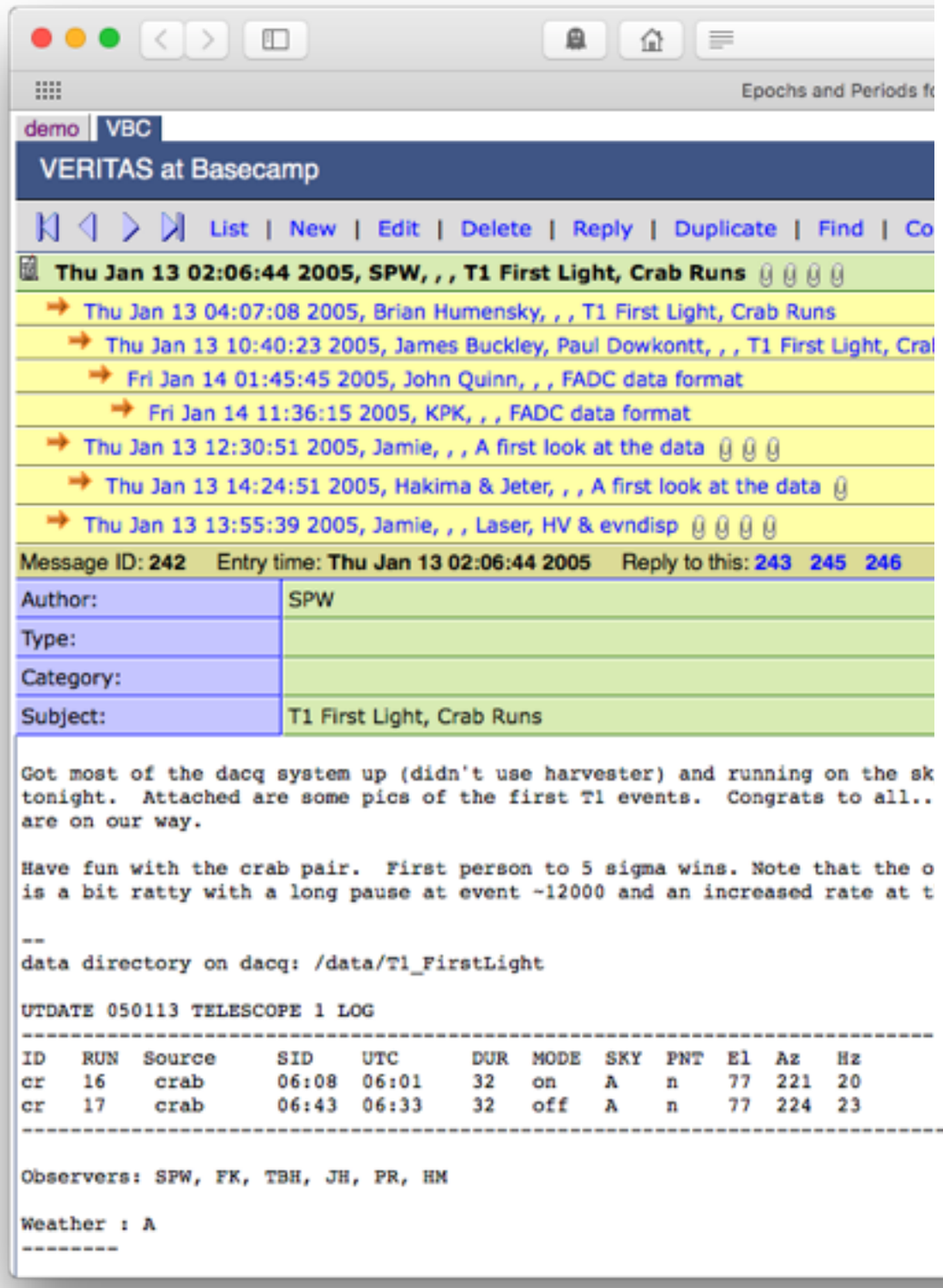
- Thu Jan 13 04:07:08 2005, Brian Humensky, , , T1 First Light, Crab Runs
  - Thu Jan 13 10:40:23 2005, James Buckley, Paul Dowkontt, , , T1 First Light, Crab Runs
    - Fri Jan 14 01:45:45 2005, John Quinn, , , FADC data format
      - Fri Jan 14 11:36:15 2005, KPK, , , FADC data format
  - Thu Jan 13 12:30:51 2005, Jamie, , , A first look at the data
  - Thu Jan 13 14:24:51 2005, Hakima & Jeter, , , A first look at the data
  - Thu Jan 13 13:55:39 2005, Jamie, , , Laser, HV & evndisp

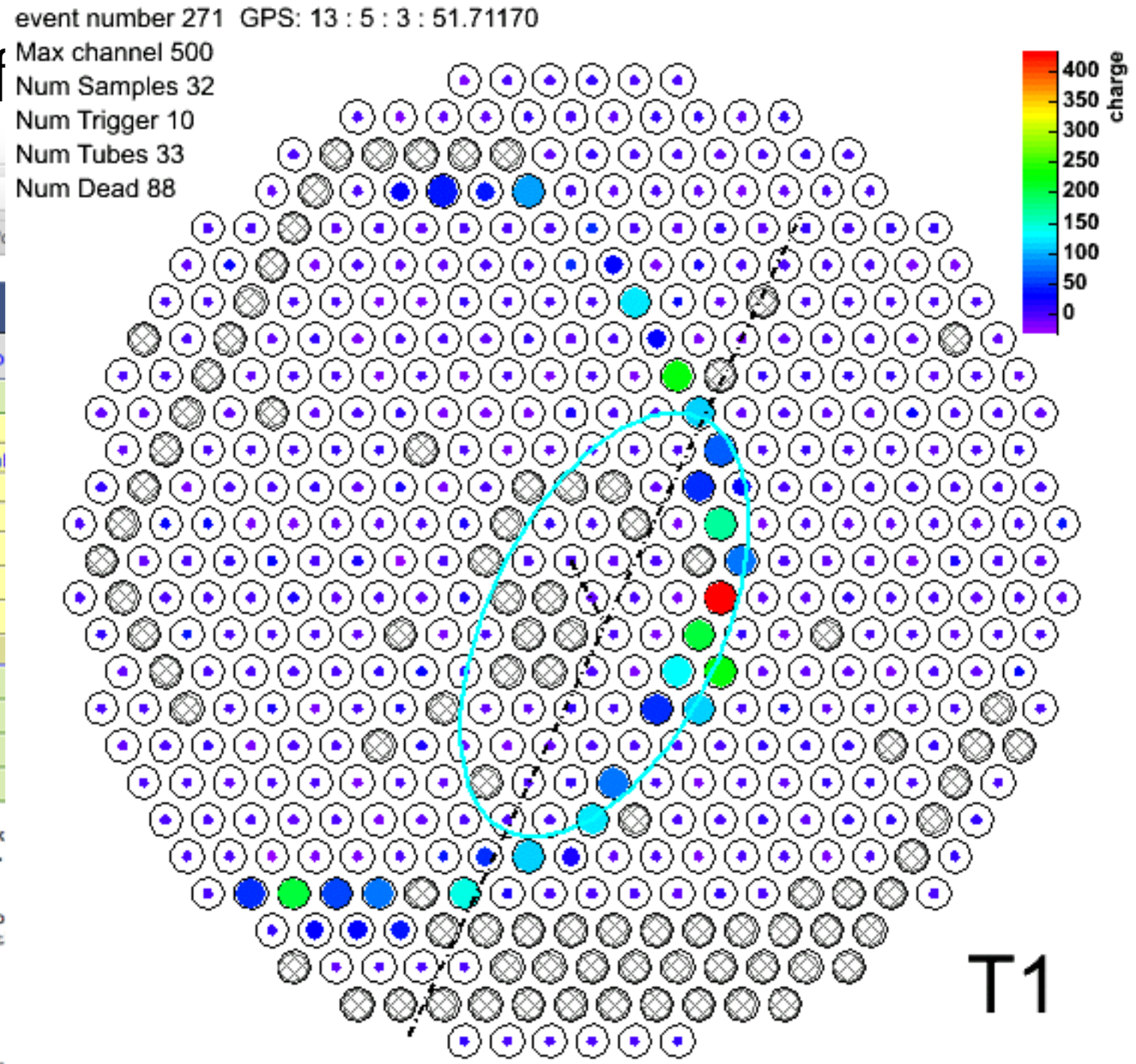
Message ID: **242** Entry time: **Thu Jan 13 02:06:44 2005** Reply to this: **243** **245** **246**

Author:	SPW
Type:	
Category:	
Subject:	T1 First Light, Crab Runs

```
Got most of the dacq system up (didn't use harvester) and running on the sky
tonight.  Attached are some pics of the first T1 events.  Congrats to all.... we
are on our way.

Have fun with the crab pair.  First person to 5 sigma wins. Note that the off run
is a bit ratty with a long pause at event ~12000 and an increased rate at the end.

--
data directory on dacq: /data/T1_FirstLight

UTDATE 050113 TELESCOPE 1 LOG
-------------------------------------------------------------------------------
ID   RUN  Source     SID    UTC      DUR  MODE  SKY  PNT  El  Az   Hz
cr   16    crab      06:08  06:01    32   on    A    n    77  221  20
cr   17    crab      06:43  06:33    32   off   A    n    77  224  23
-------------------------------------------------------------------------------

Observers: SPW, FK, TBH, JH, PR, HM

Weather : A
--------
```

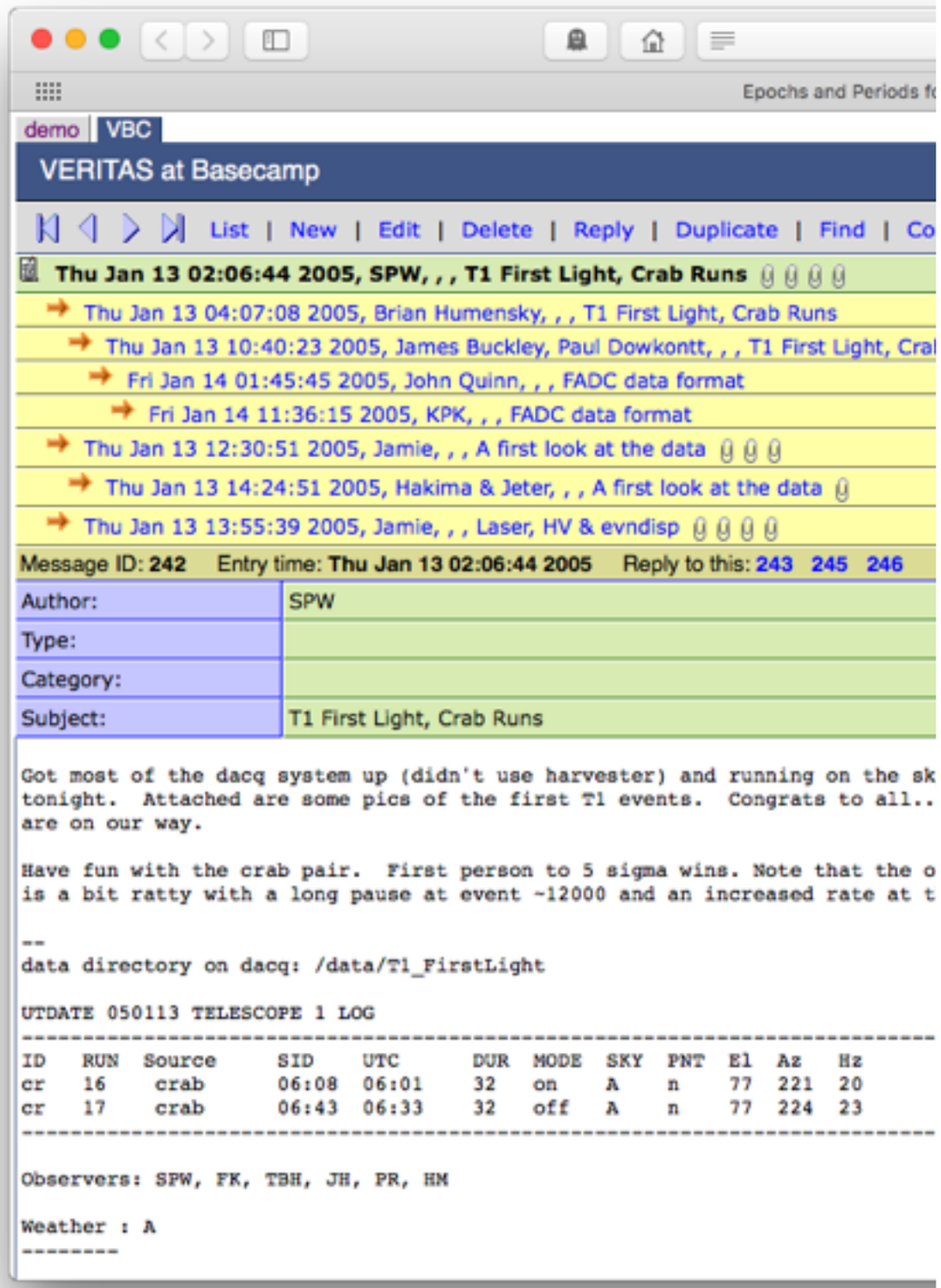
January 2005: f

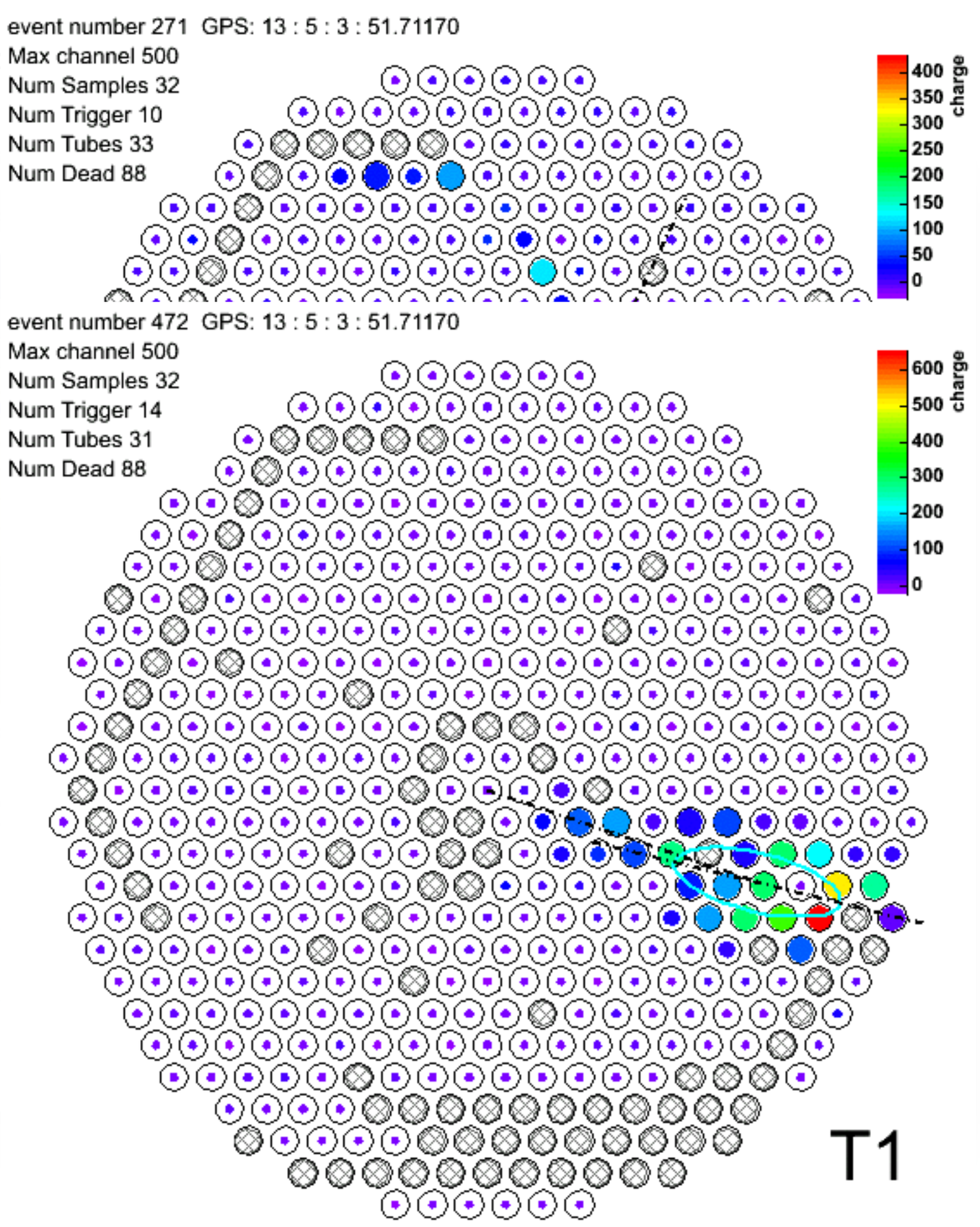




GEO: c_x=0.12, c_y=-0.22, dist=0.25, length=0.7900, width=0.4062, α=53.26, size=3226.50

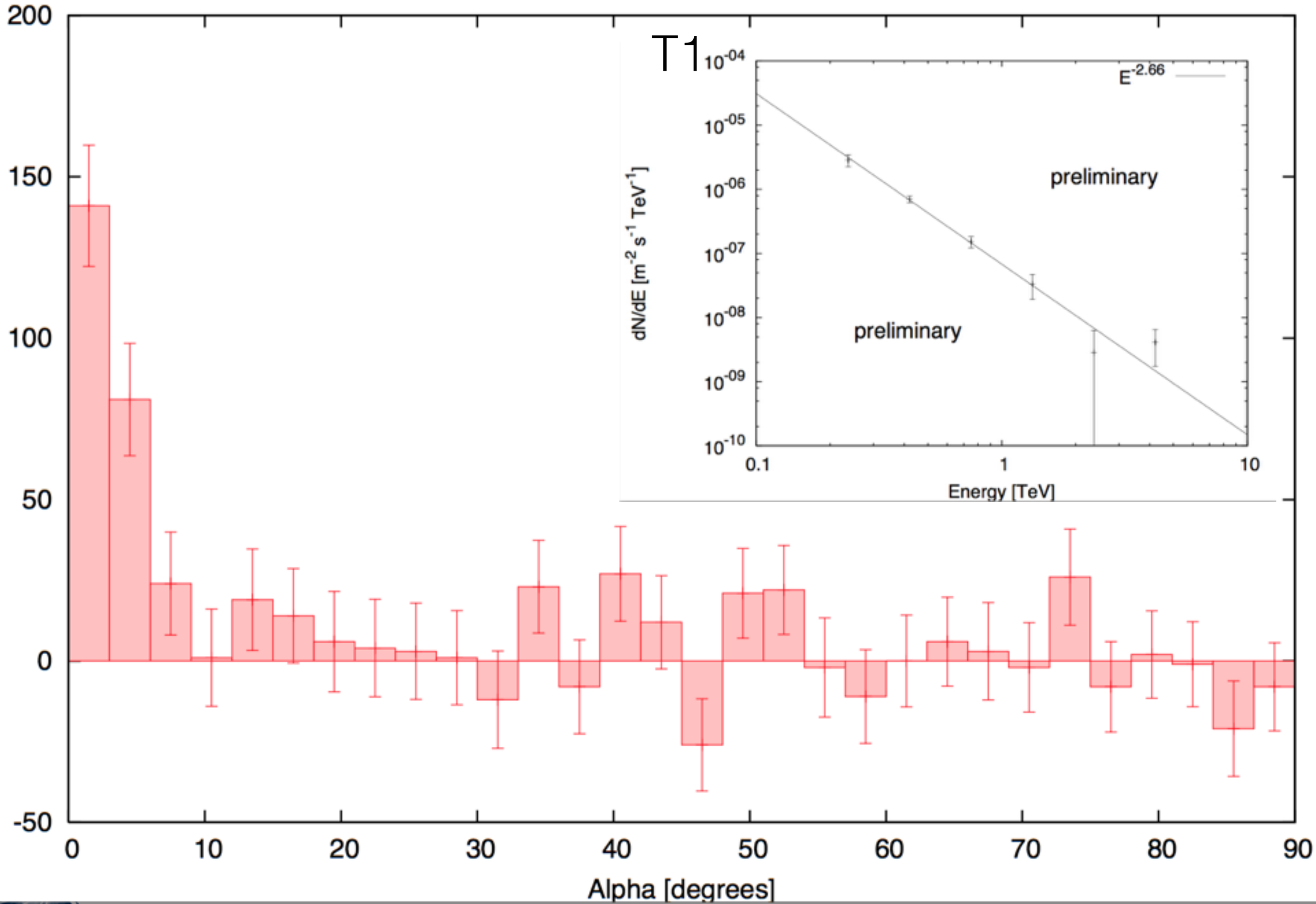
January 2005: f



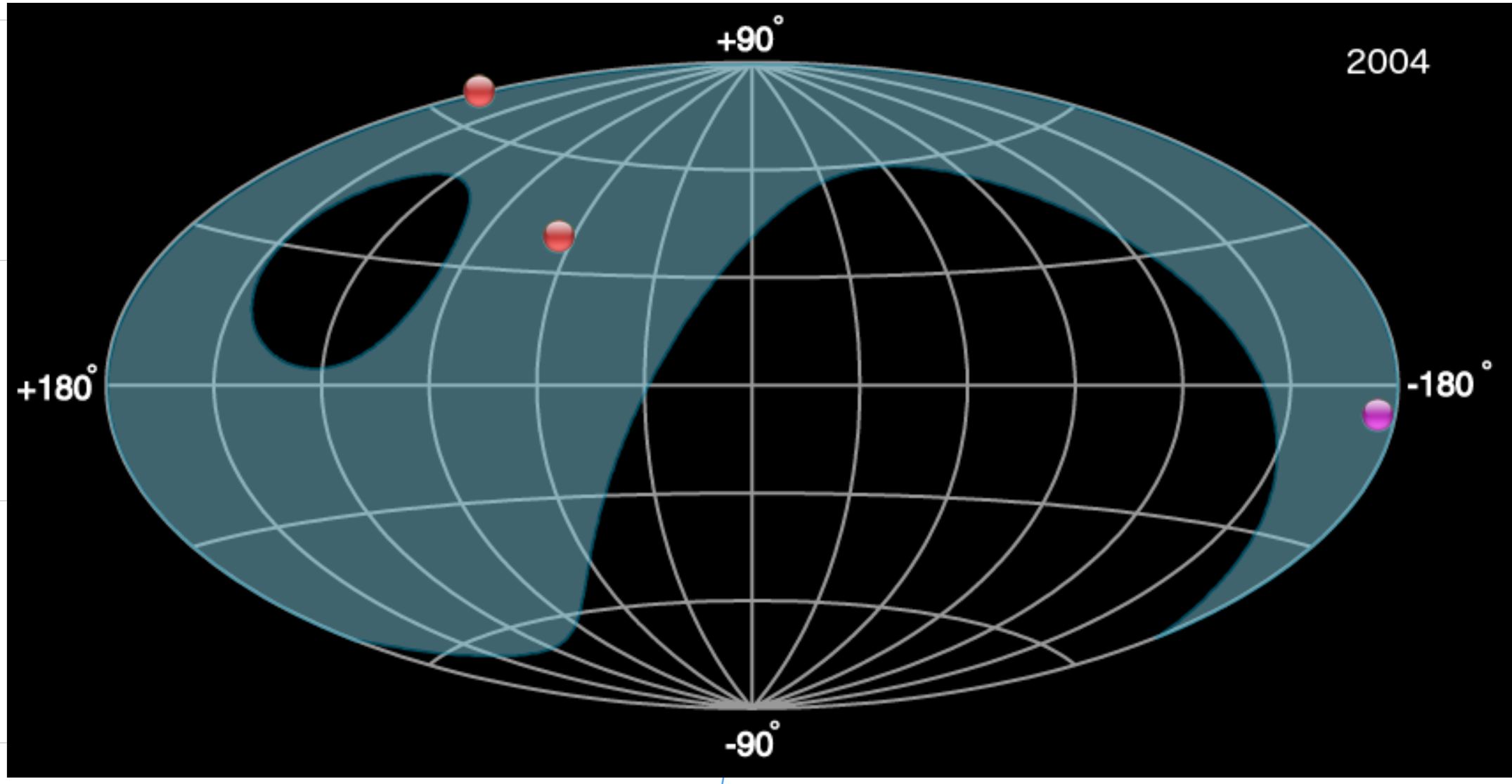


GEO: c_x=1.09, c_y=-0.37, dist=1.15, length=0.3421, width=0.1177, α=5.04, size=4743.60

Crab 11/2005


200
150
100
50
0
-50
0
10
20
30
40
50
60
70
80
90
Alpha [degrees]
T1
dN/dE [m-2 s-1 TeV-1]
10-04
10-05
10-06
10-07
10-08
10-09
10-10
E-2.66
preliminary
preliminary
0.1
1
10
Energy [TeV]

Crab



Rate [γ/min]

40
30
20
10
0

490
109
37
V1
Whipple 10m

1988 1991 1994 1997 2000 2003 2006 2009 2012 2015 2018

Year


SELECT
HESS
SELECT
CHARDONNAY
2004

And it went rather well with the Thanksgiving Turducken

By the end of year we're in pseudo stereo

172.16.0.150

Epochs and Periods for EBs | Manual Cinema | Object Visibility | Wikipedia

ELOG - V2 data analysis (Prof. Finley does not want me to say 'stereo' :-))

demo | VBC

VERITAS at Basecamp

ELOG

List | New | Edit | Delete | Reply | Duplicate | Find | Config | Help

Message ID: **1089** Entry time: **Fri Dec 2 20:38:59 2005**

Author:	Filip
Type:	
Category:	
Subject:	V2 data analysis (Prof. Finley does not want me to say 'stereo' :-))

I just had the time to analyze that very first simultaneous (some would say 'stereo') Crab pair. The result? A 4 s

This analysis is PRELIMINARY. I haven't even bothered to take into account livetime. But the upshot is that even

Here's how the analysis was set up.

- I used the latest QLtools.

- I did a pedestal analysis without using pedestal events (since pedestal events don't get through ql_recons - th

- I integrated samples 4..14 to get charges. But, the analysis is a two-pass analysis, so for large events the

- My Picture/Boundary settings are 4 and 2.

- Applied quality cuts of: nimage>=4, dist<=1.4, size>=100. "Quality cuts" are cuts that allow or deny a s
cuts are no different than regular cuts (since I require two telescopes for stereo reconstruction). But for >2
stereo event (consisting of data from the other two telescopes) being accepted by the stereo cuts.

- Applied stereo Hillas cuts: width<=0.13, length<=0.4. Both telescopes must pass these cuts for the data

- Required the intersections of major axes to have an acute angle >=15 degrees

- Applied stereo cuts: n_ints>=1, n_impact_ints>=1. 'n_ints' tells us how many intersections passed the a
intersected (in the random case rays intersect only 1/4 of the time)

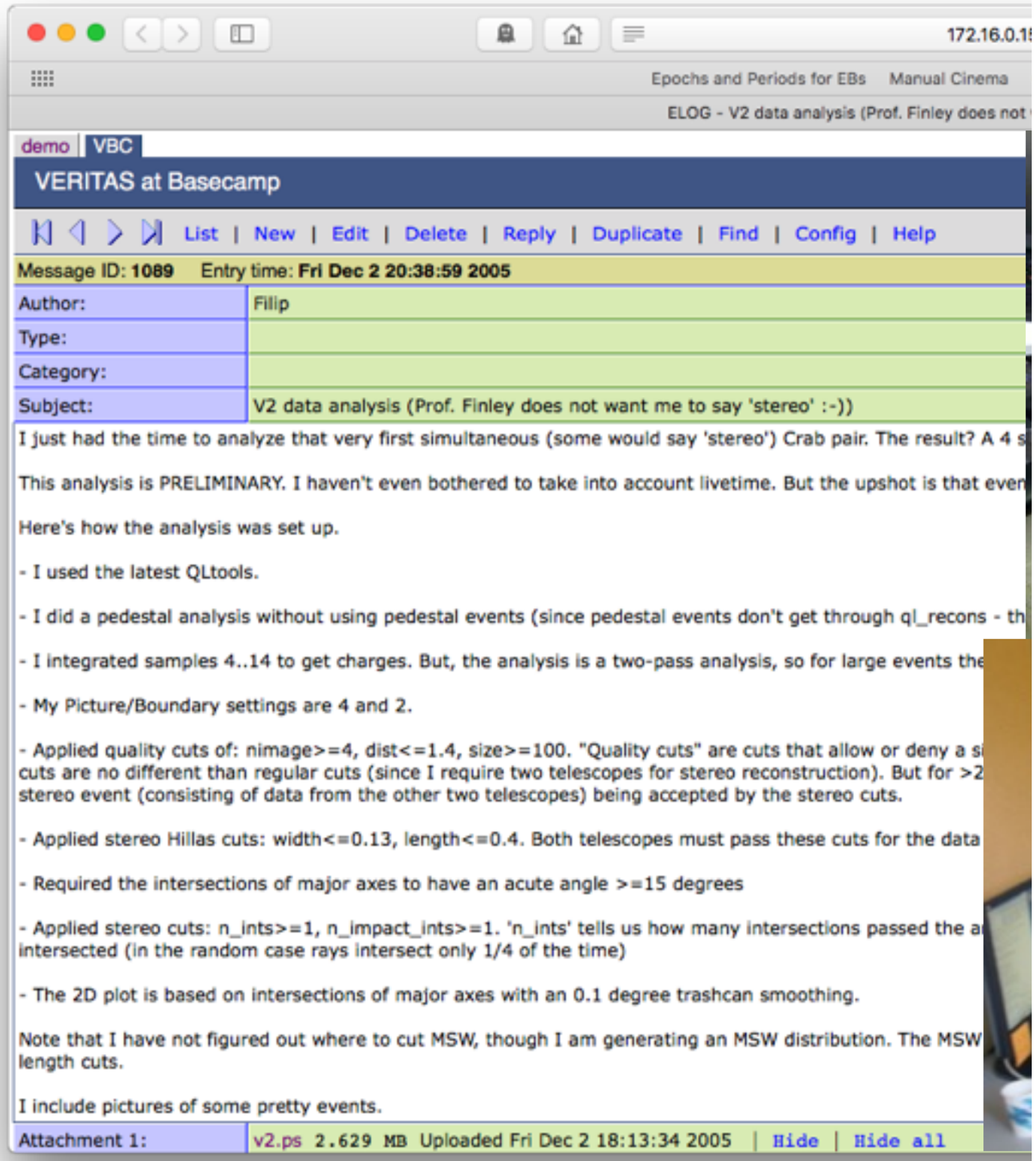
- The 2D plot is based on intersections of major axes with an 0.1 degree trashcan smoothing.

Note that I have not figured out where to cut MSW, though I am generating an MSW distribution. The MSW
length cuts.

I include pictures of some pretty events.

Attachment 1: v2.ps 2.629 MB Uploaded Fri Dec 2 18:13:34 2005 | Hide | Hide all

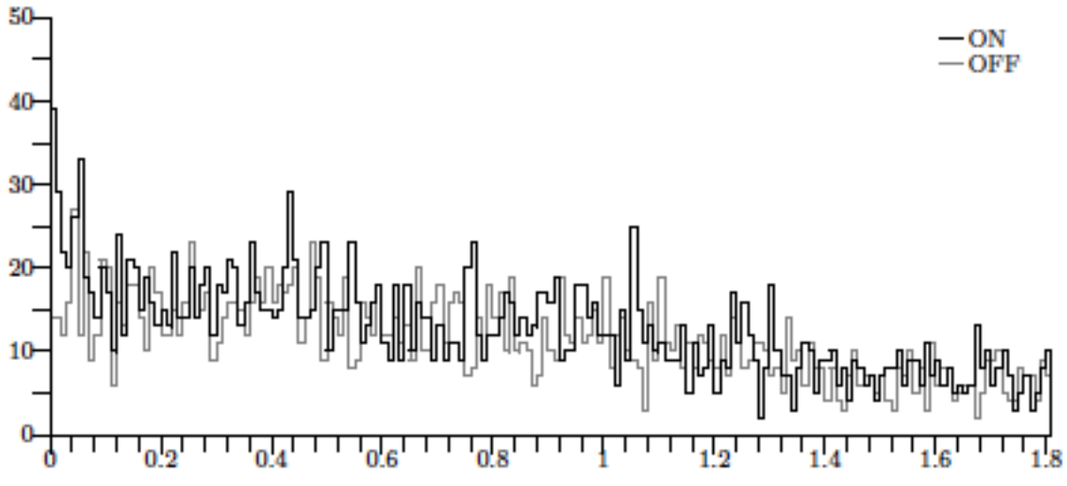
By the end of year we'r



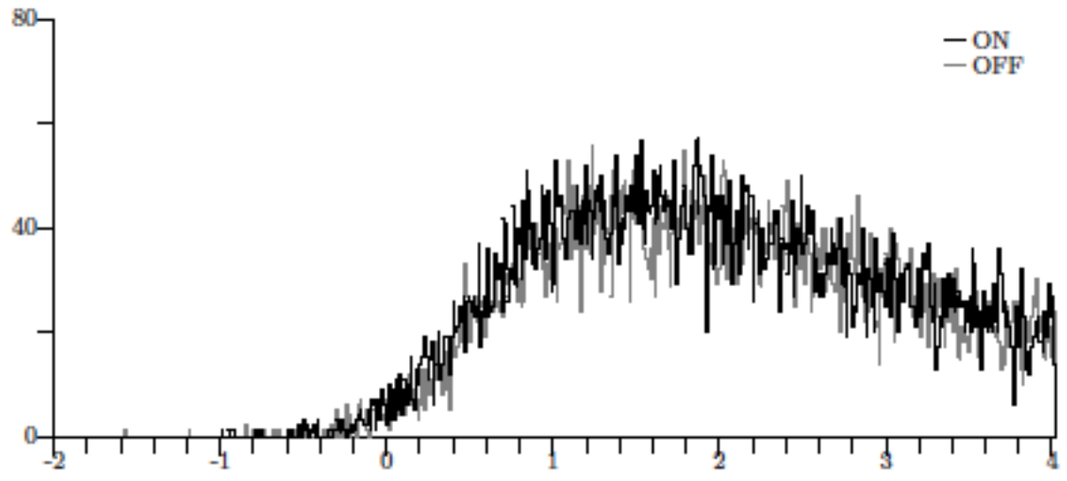
TRK: 20001

QLtools *by Filip Pizlo*

December 1, 2005



θ^2 Histogram After Cuts



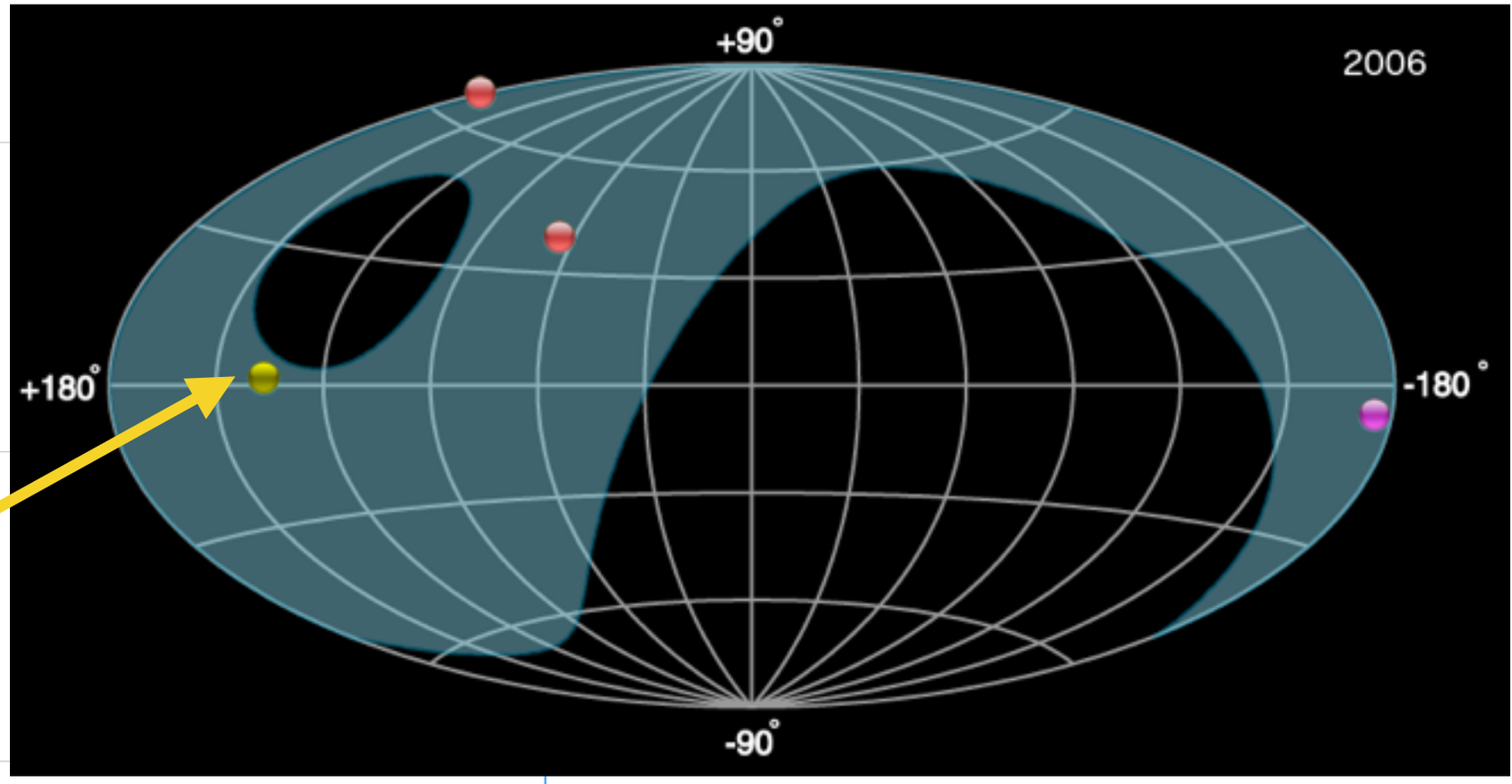
Mean Scaled Width Histogram

1

Sept. 2006

First detection of a non-Whipple source

LSI +61 303



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10
0

37
109
Whipple 10m
490
V1
V2
VERITAS

1988 1991 1994 1997 2000 2003 2006 2009 2012 2015 2018

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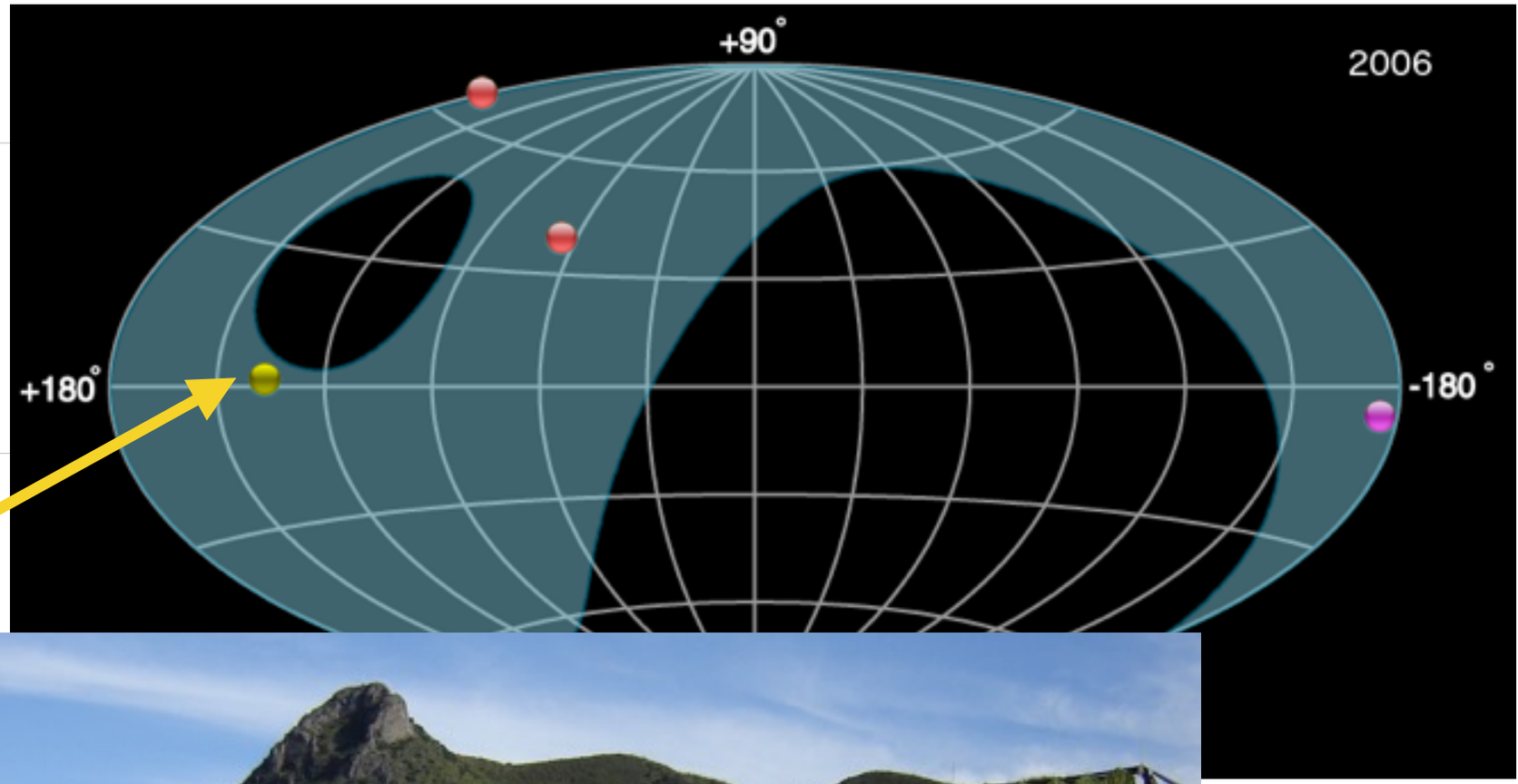

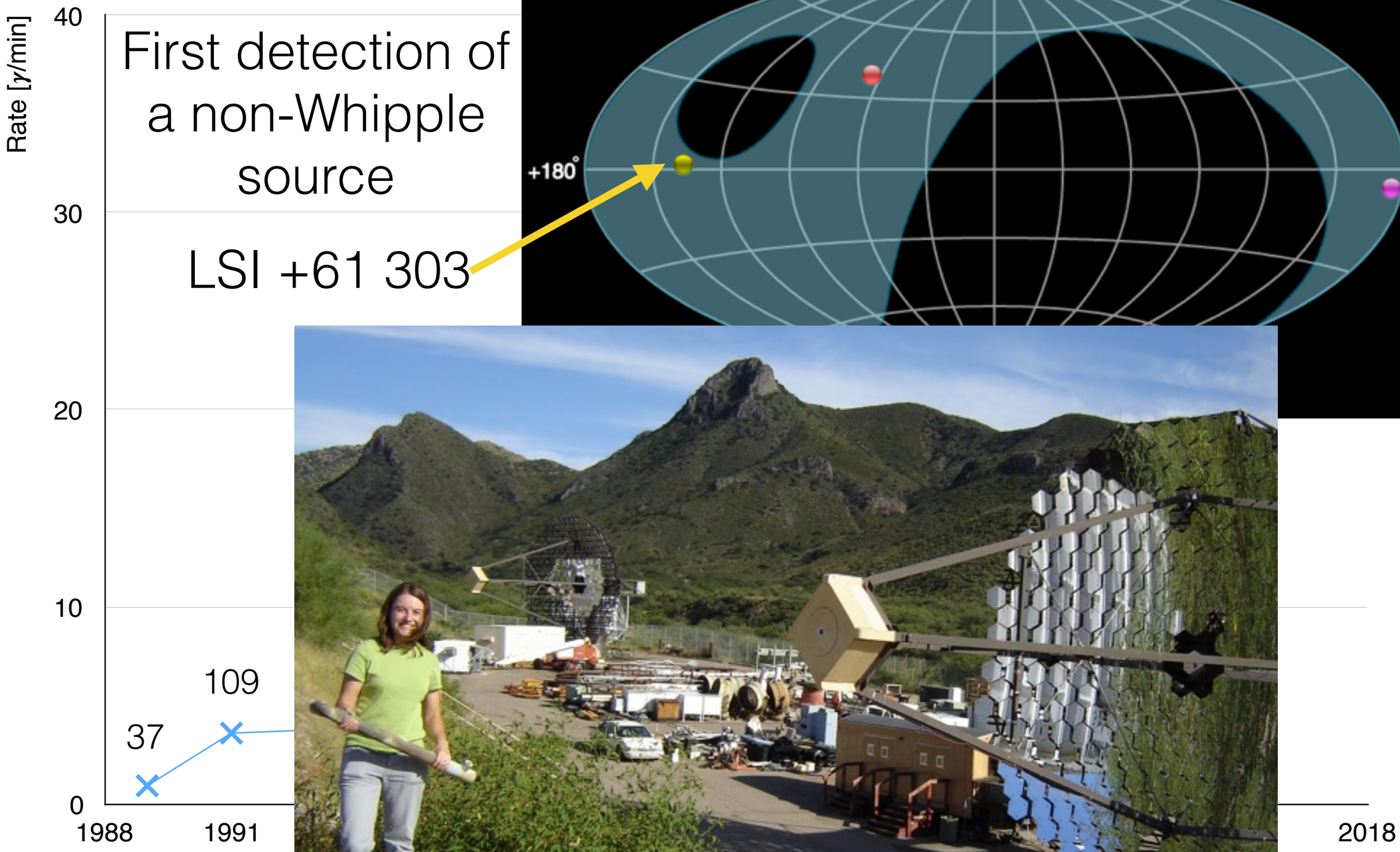

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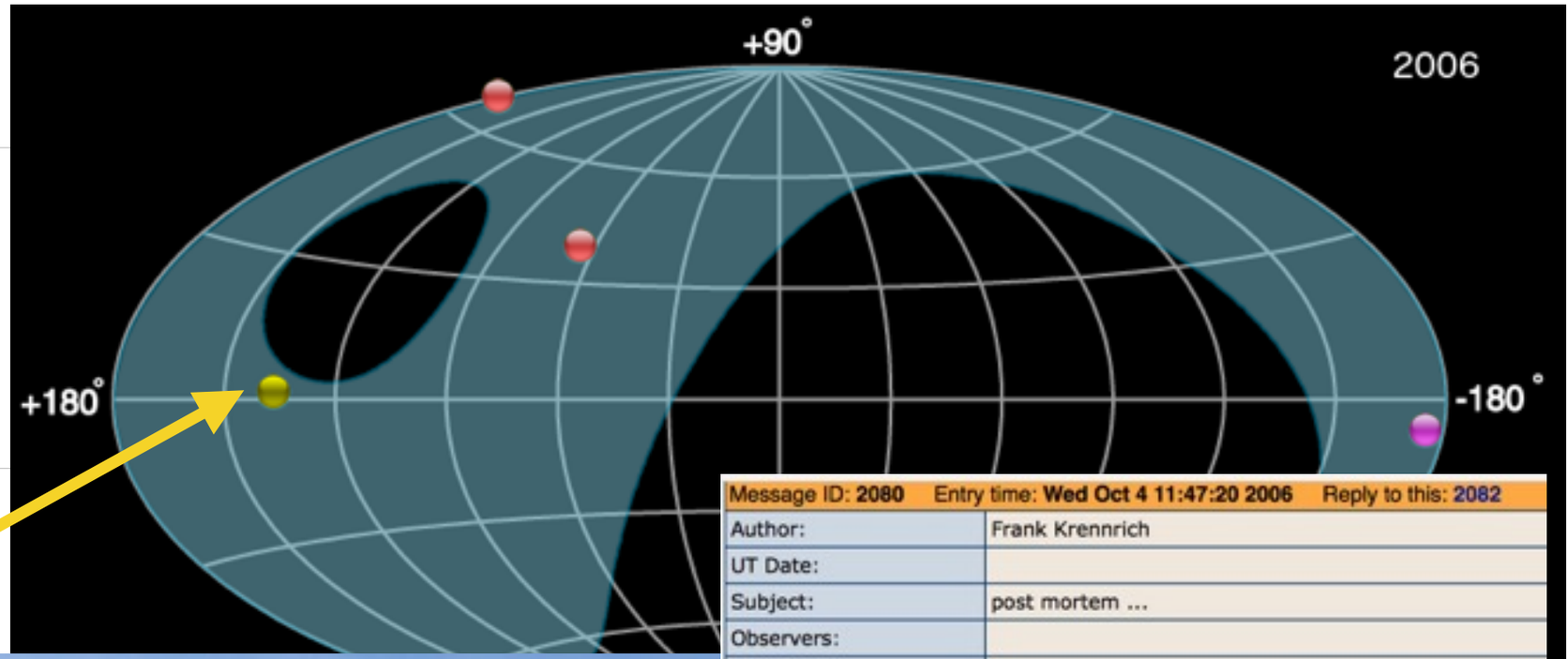
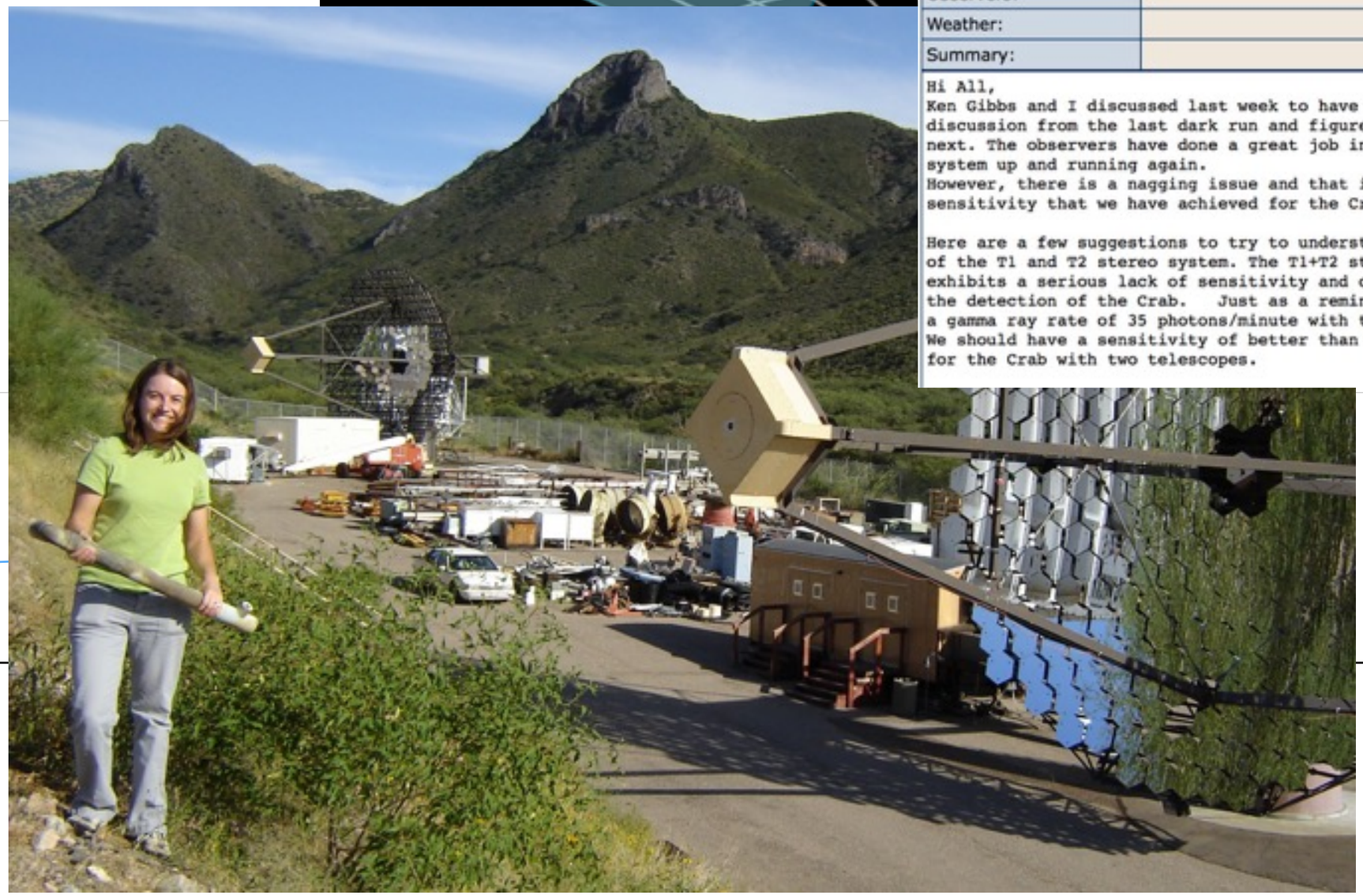
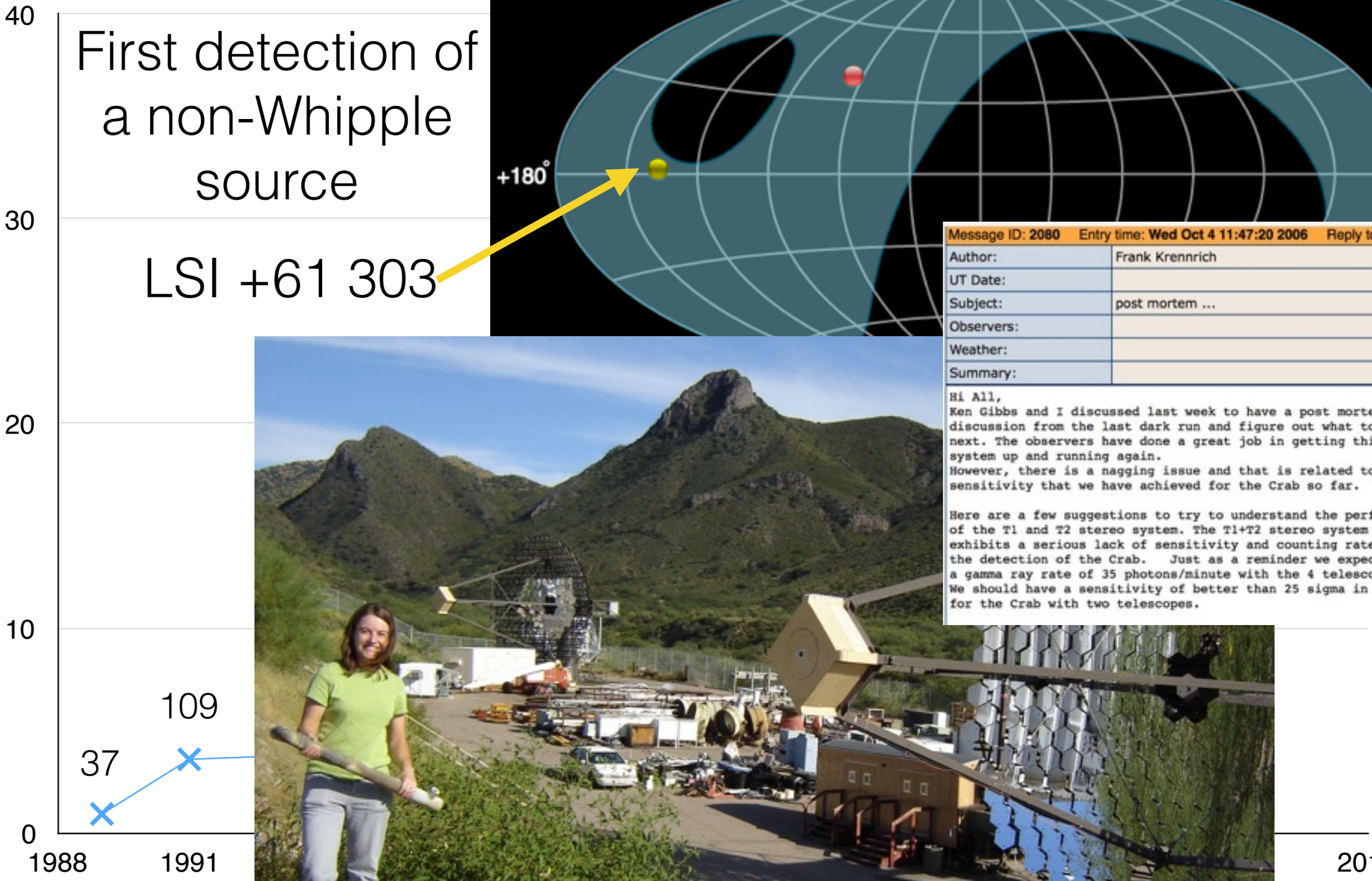


Message ID: 2080	Entry time: Wed Oct 4 11:47:20 2006	Reply to this: 2082
Author:	Frank Krennrich	
UT Date:		
Subject:	post mortem ...	
Observers:		
Weather:		
Summary:		

Hi All,
Ken Gibbs and I discussed last week to have a post mortem discussion from the last dark run and figure out what to do next. The observers have done a great job in getting this system up and running again.
However, there is a nagging issue and that is related to the sensitivity that we have achieved for the Crab so far.

Here are a few suggestions to try to understand the performance of the T1 and T2 stereo system. The T1+T2 stereo system apparently exhibits a serious lack of sensitivity and counting rate for the detection of the Crab. Just as a reminder we expect to see a gamma ray rate of 35 photons/minute with the 4 telescope system. We should have a sensitivity of better than 25 sigma in one hour for the Crab with two telescopes.





A stereo system needs a new kind of analysis :-)

Offline Analysis Software:
A Tale of Two Johns

but let us not forget ChiLA, GrISU(tah), HTools, QL, Violator, WUParam et al…

Eventdisplay


GERAD
23

VEGAS structure

Management

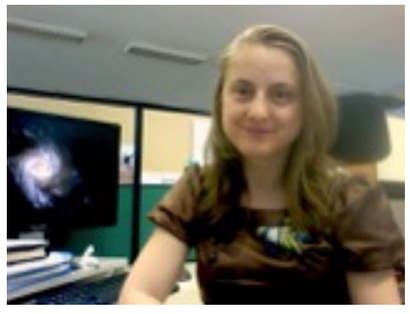
Common:

Stage1: Calibration Calc.

Stage2: Calibration App.

Stage3: Image Param.

Stage4: Stereo Rec.

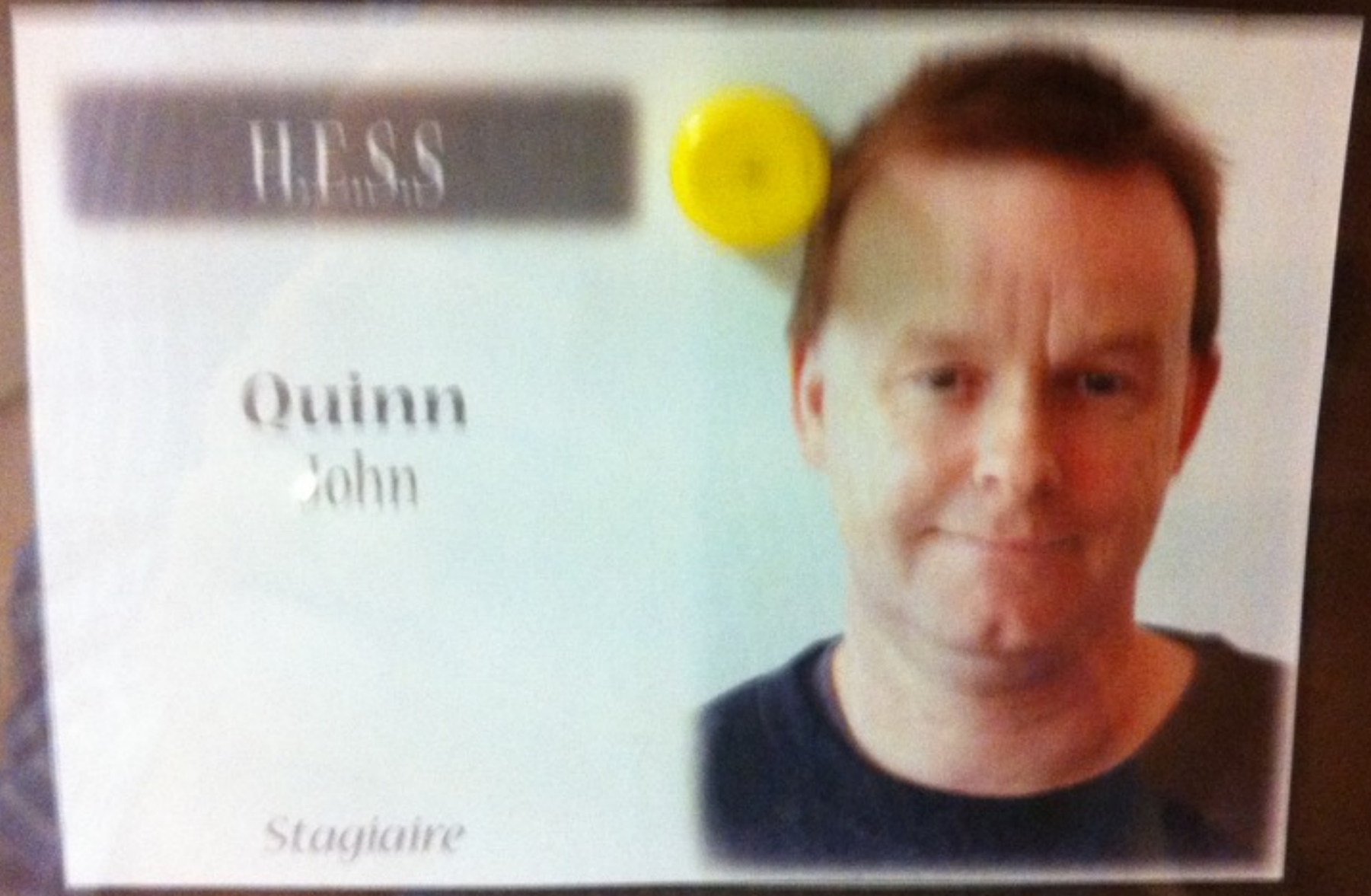


Stage5: Cuts

Stage6: Analysis

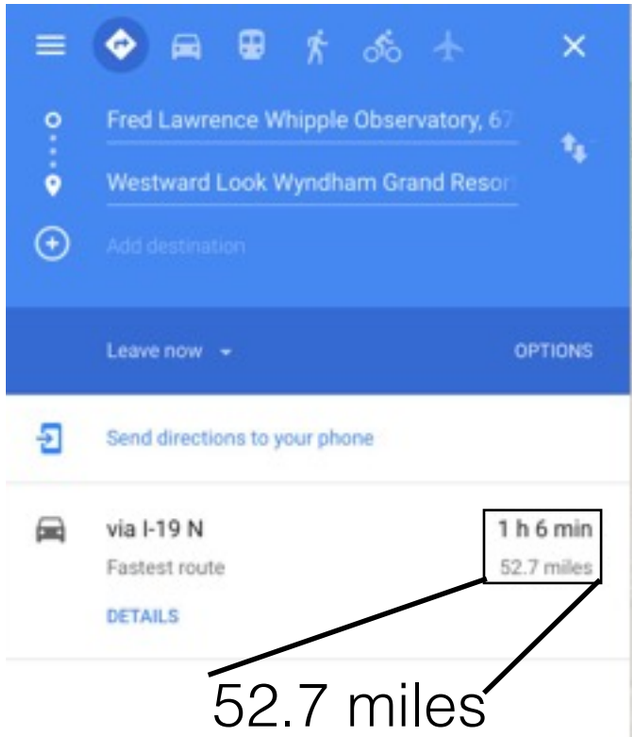
Documentation:


"...a horse designed by committee"
Sir Alec Issigonis

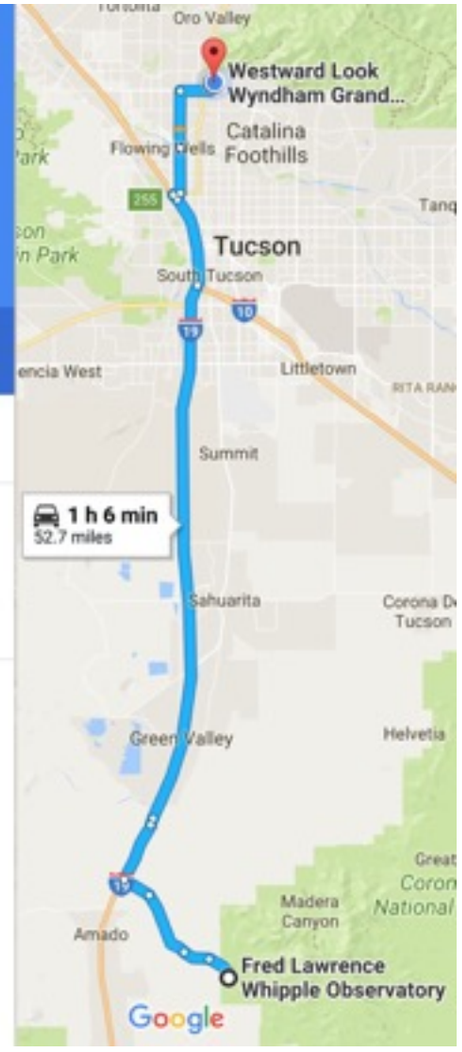


Bird

Utah army

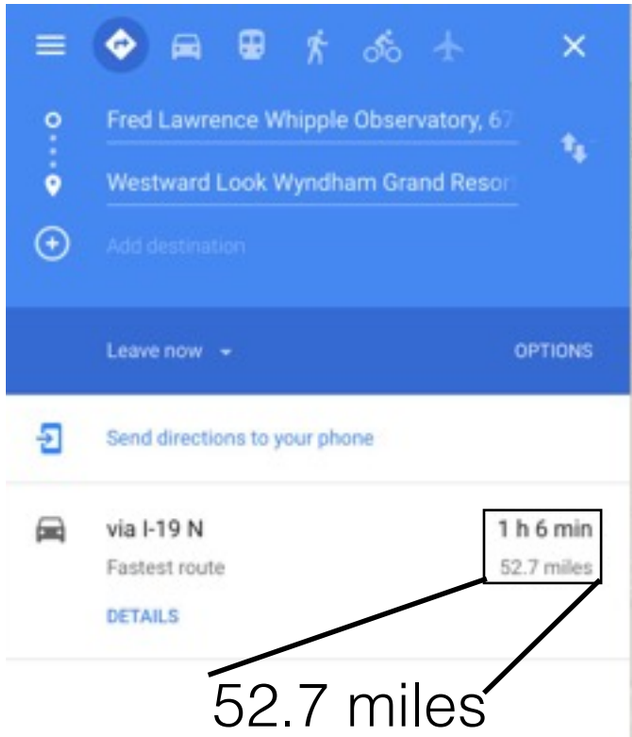


52.7 miles

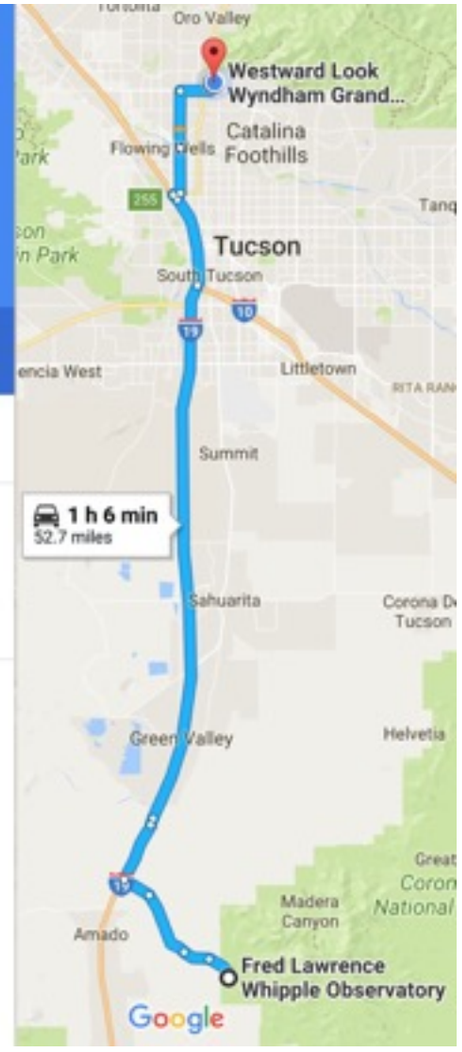


90 miles of cable were pulled

Utah army

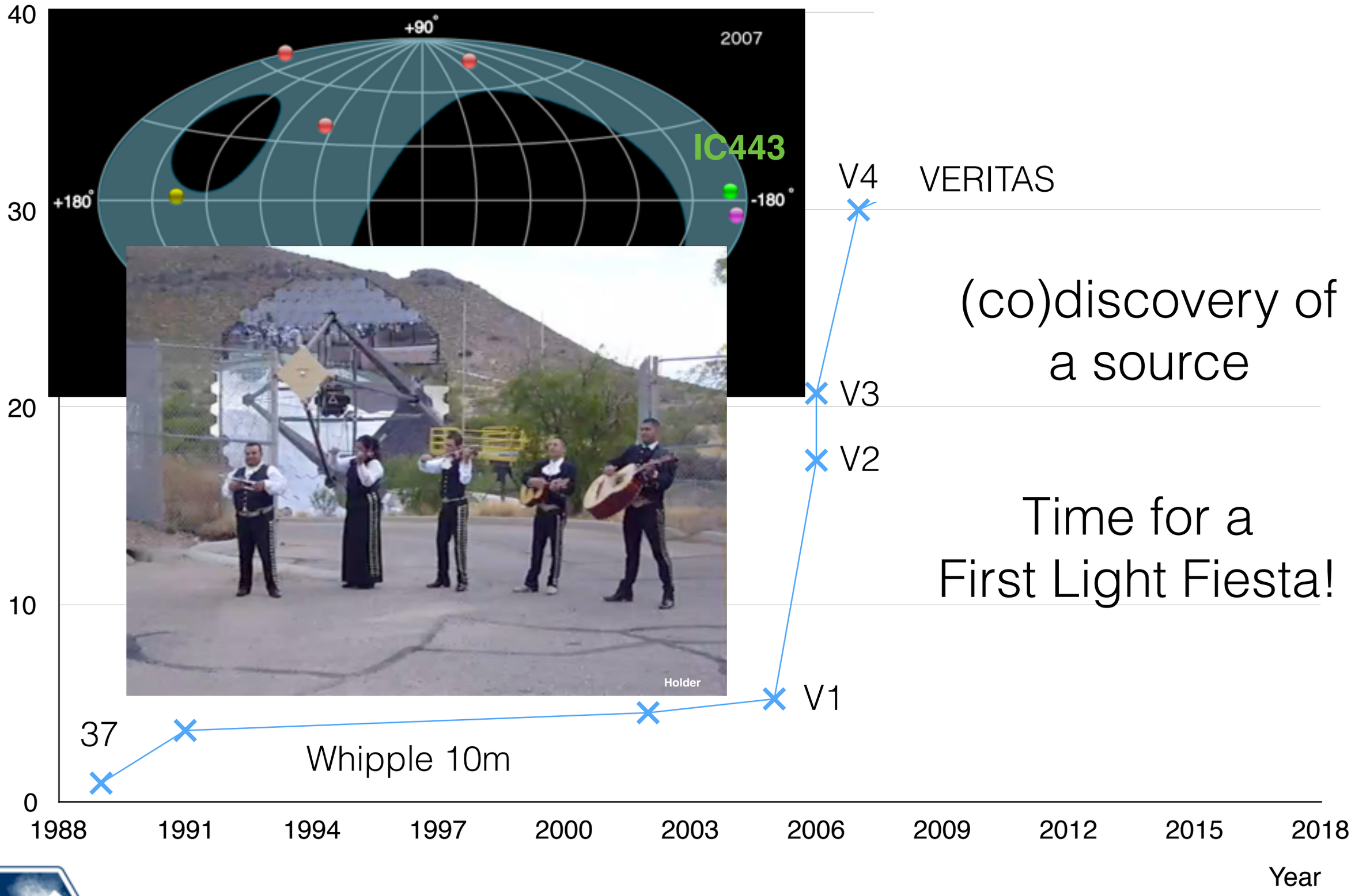


52.7 miles



90 miles of cable were pulled

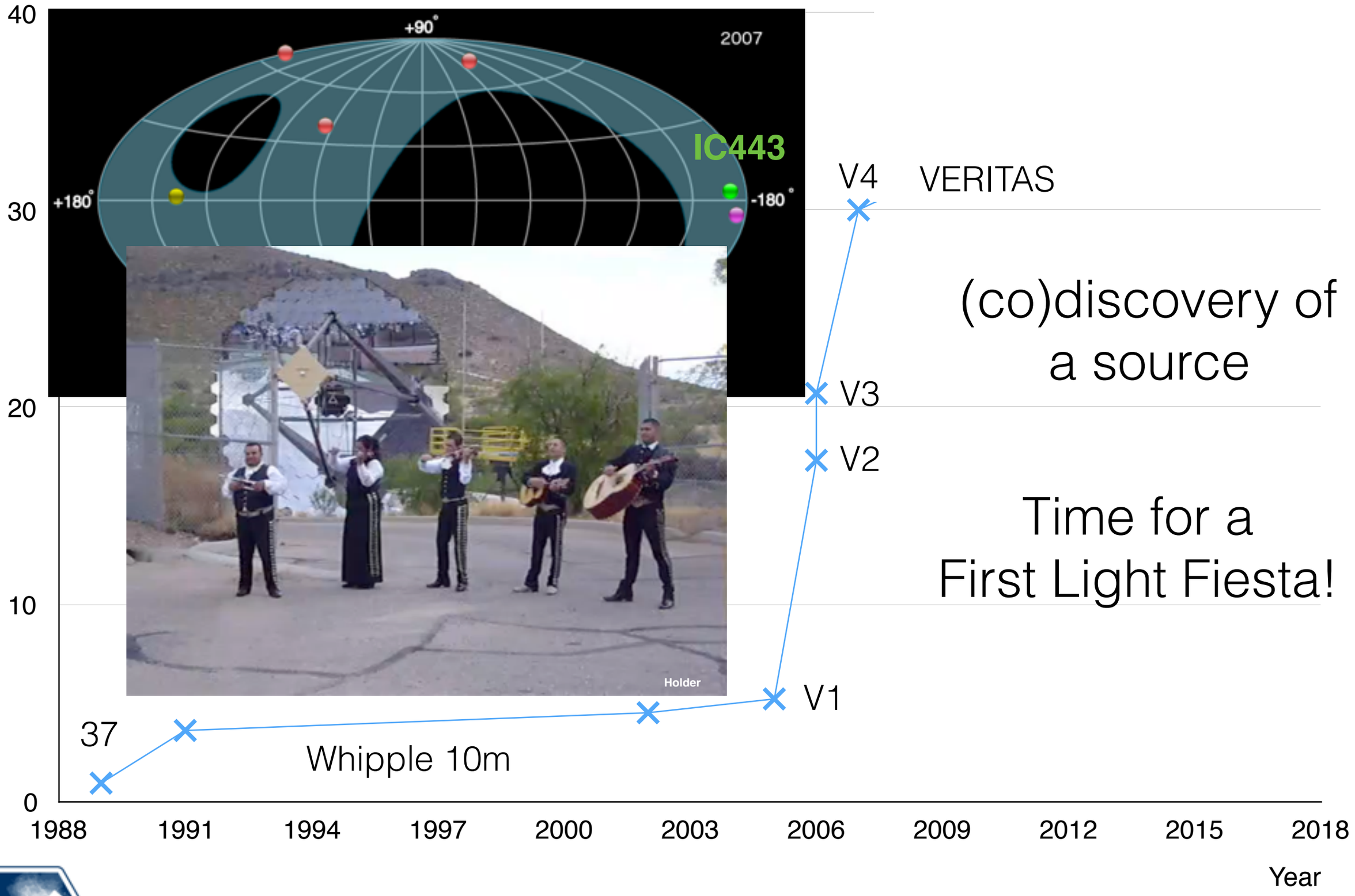
2007



(co)discovery of a source

Time for a First Light Fiesta!

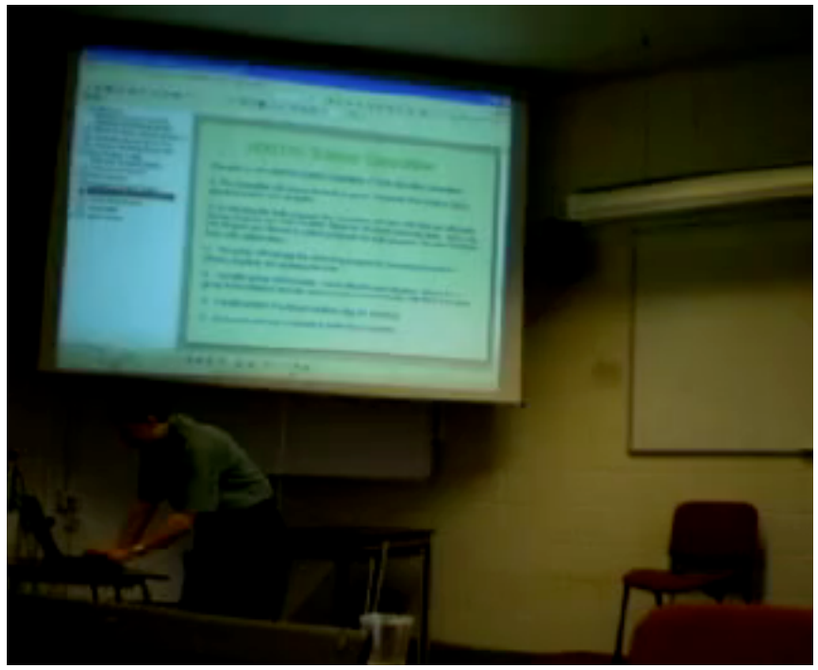
2007



(co)discovery of a source

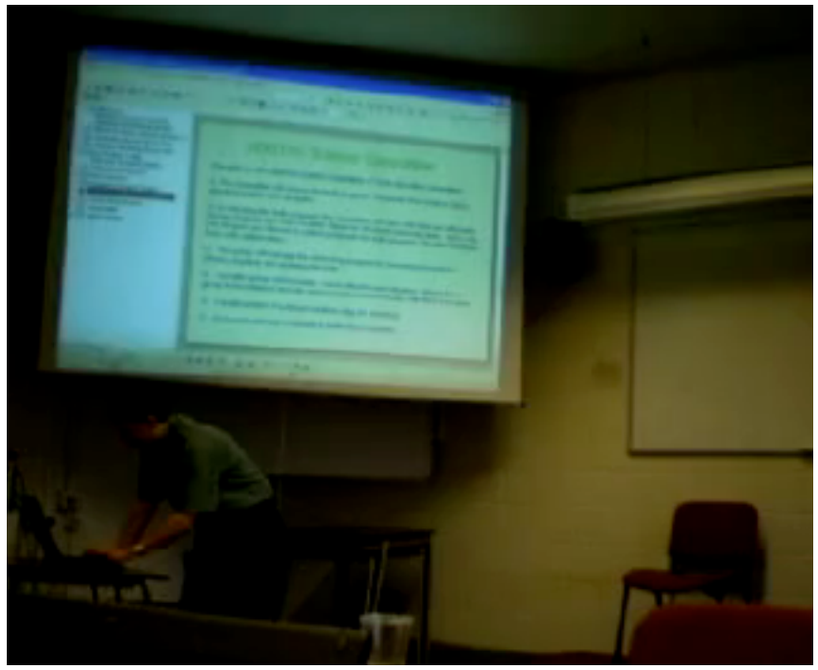
Time for a First Light Fiesta!

Leeds 2006:
Discussing how to fit the Key Science Programme into 500h



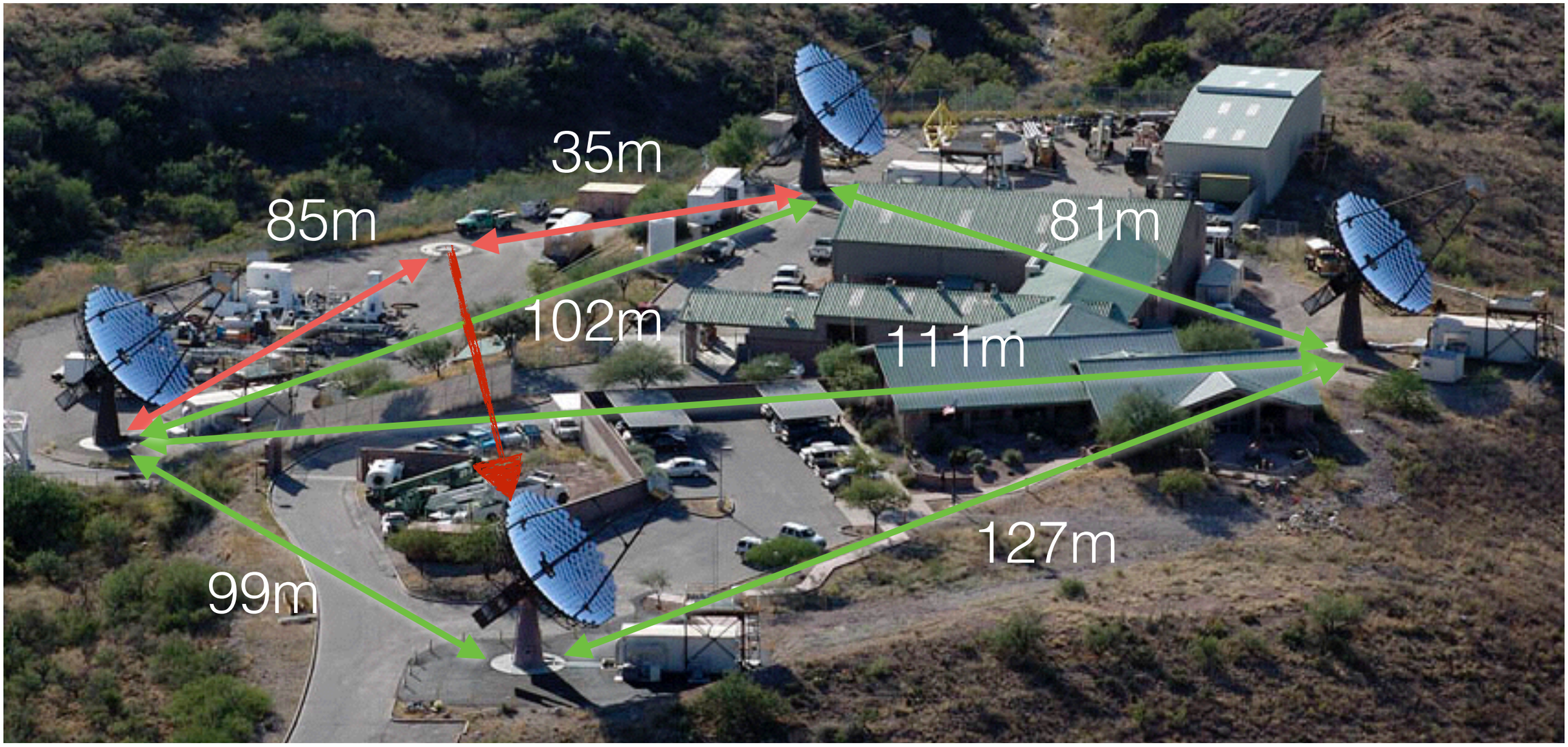
12,220h of data later (585h of which are Crab)

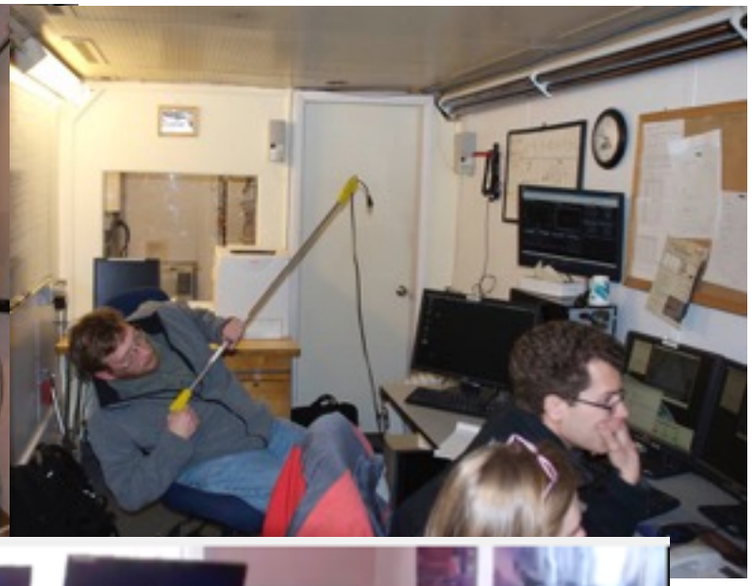
Leeds 2006:
Discussing how to fit the Key Science Programme into 500h

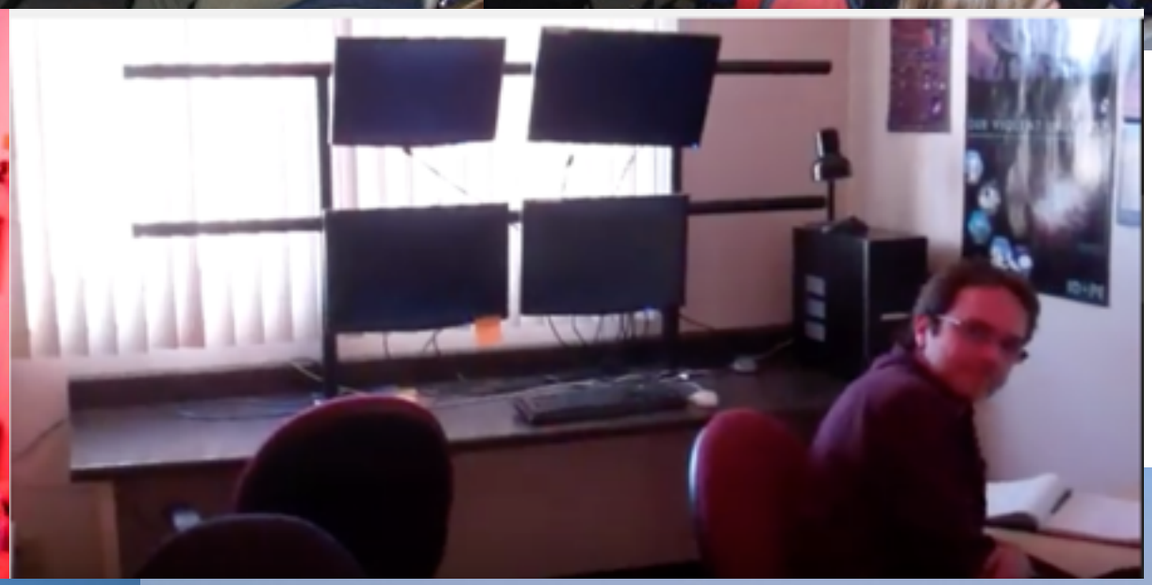


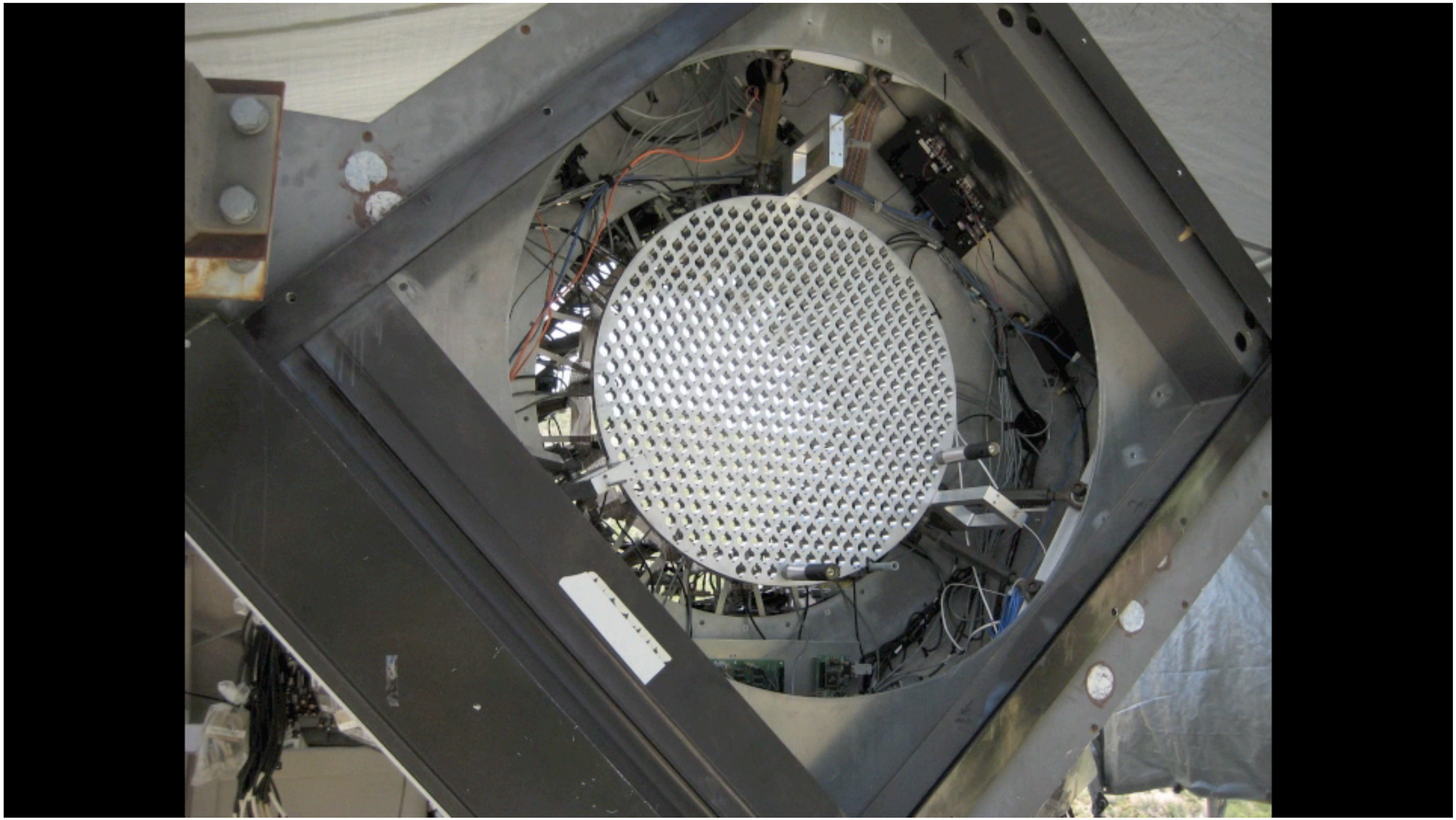
12,220h of data later (585h of which are Crab)

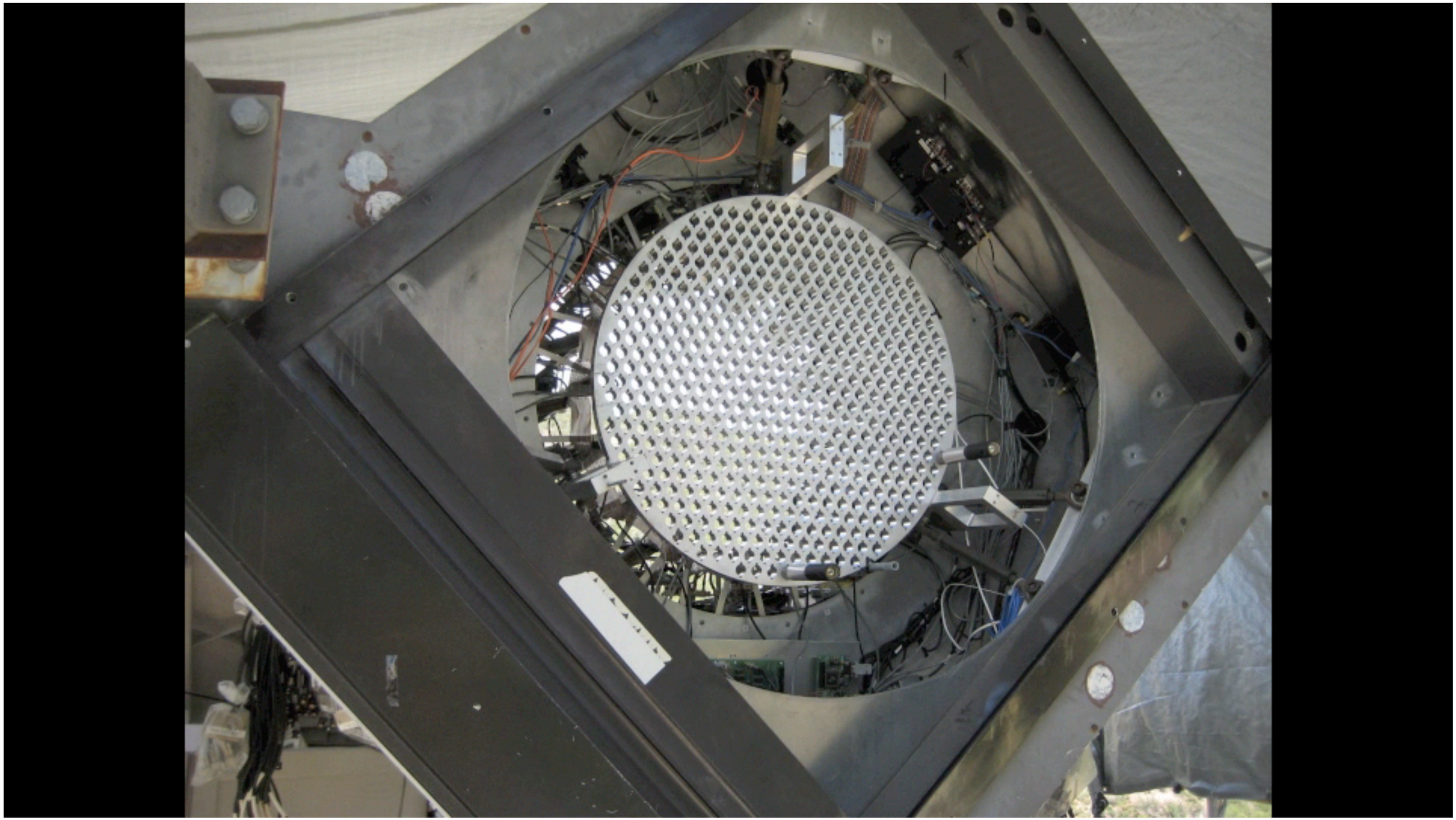
2009



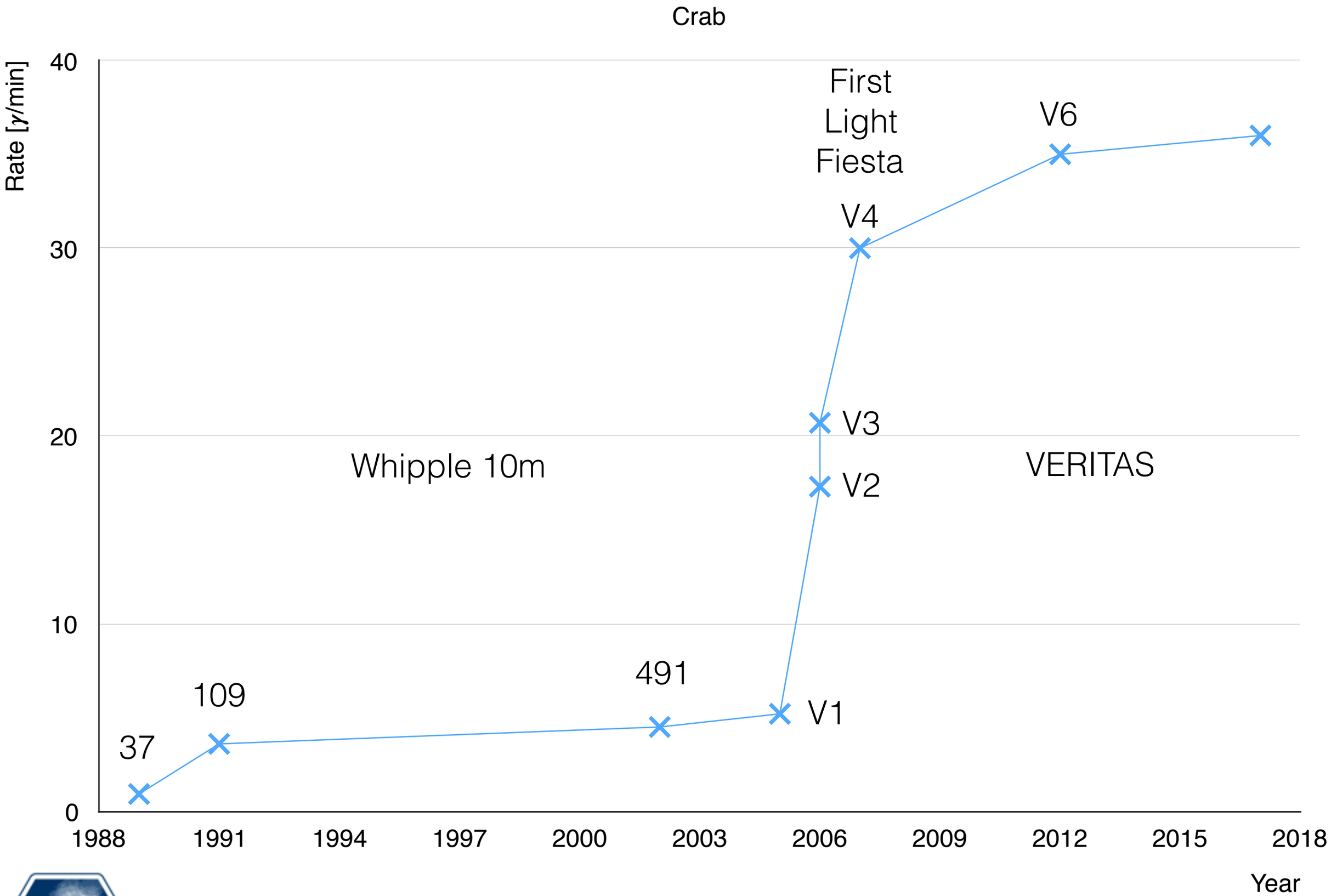









SPAM


Crab
Rate [γ/min]
40
30
20
10
0
1988
1991
1994
1997
2000
2003
2006
2009
2012
2015
2018
Year
Whipple 10m
First Light Fiesta
VERITAS
37
109
491
V1
V2
V3
V4
V6

What is in a name?

Voila! in view a humble **Vaudevillian Veteran** cast **Vicariously** as both **Victim** and **Villain** by the **Vicissitudes**. This **Visage**, no meer **Veneer** of **Vanity**, is a **Vestige** of the **Vox**-Populi, now **Vacant**, **Vanished**. However, this **Valorous Visitation** of a by-gone stands **Vivified** and has **Vowed** to **Vanquish** these **Venal** and **Virulent Vermin Vanguarding Vice** and **Vouch**-safing the **Violently Vicious** and **Voracious Violation** of **Volition**. The only **Verdict** is **Vengeance**; a **Vendetta**

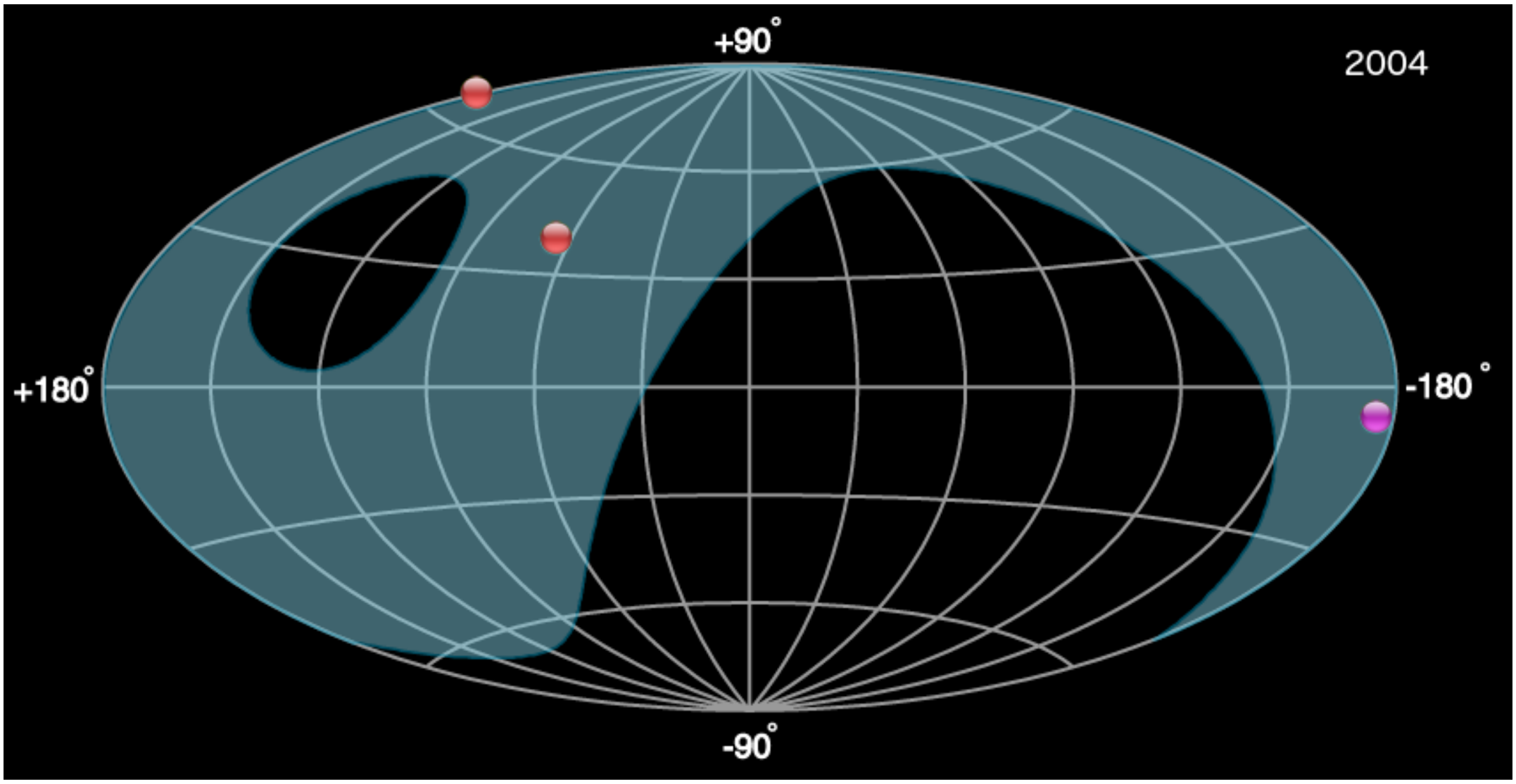
V

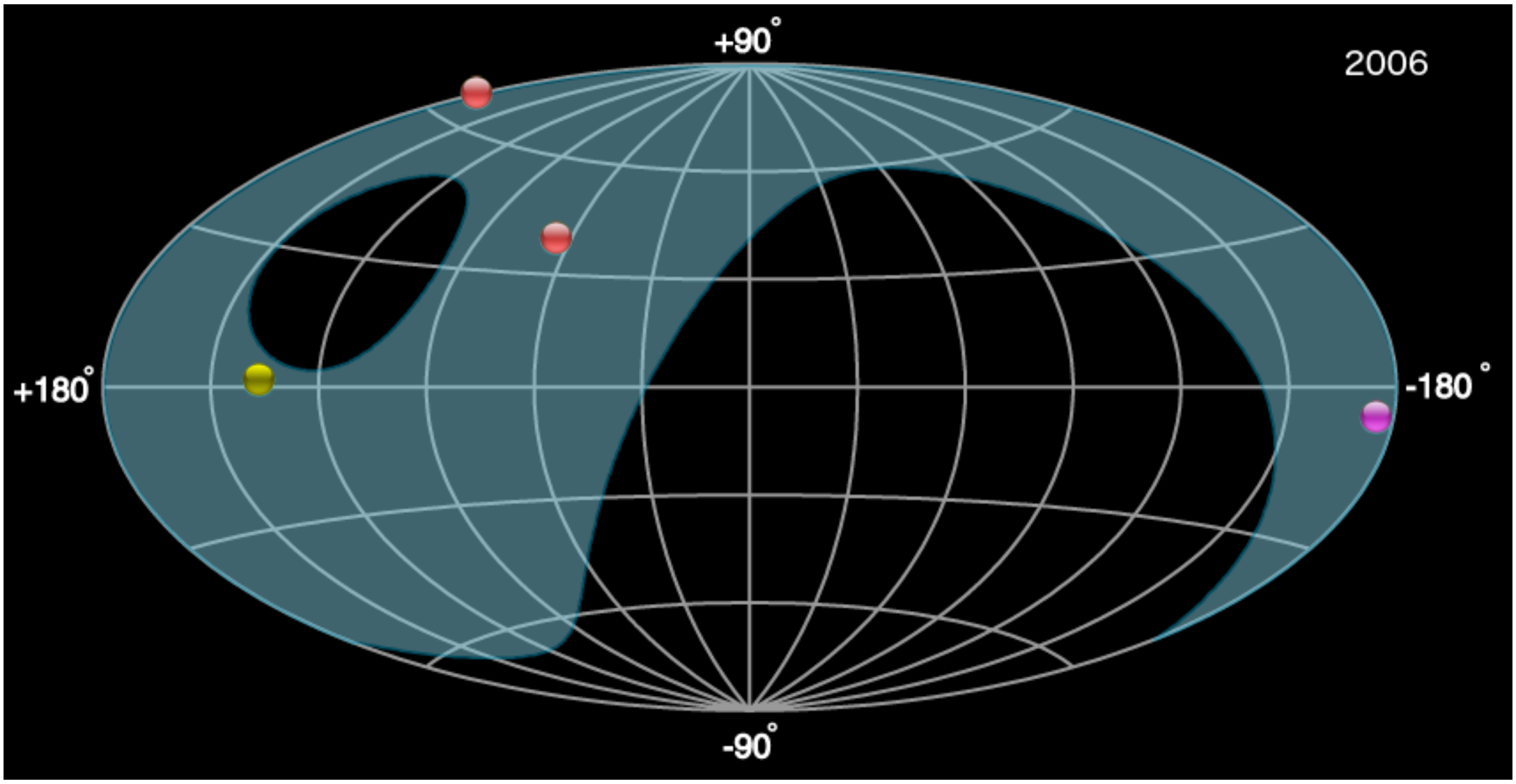
Some might say

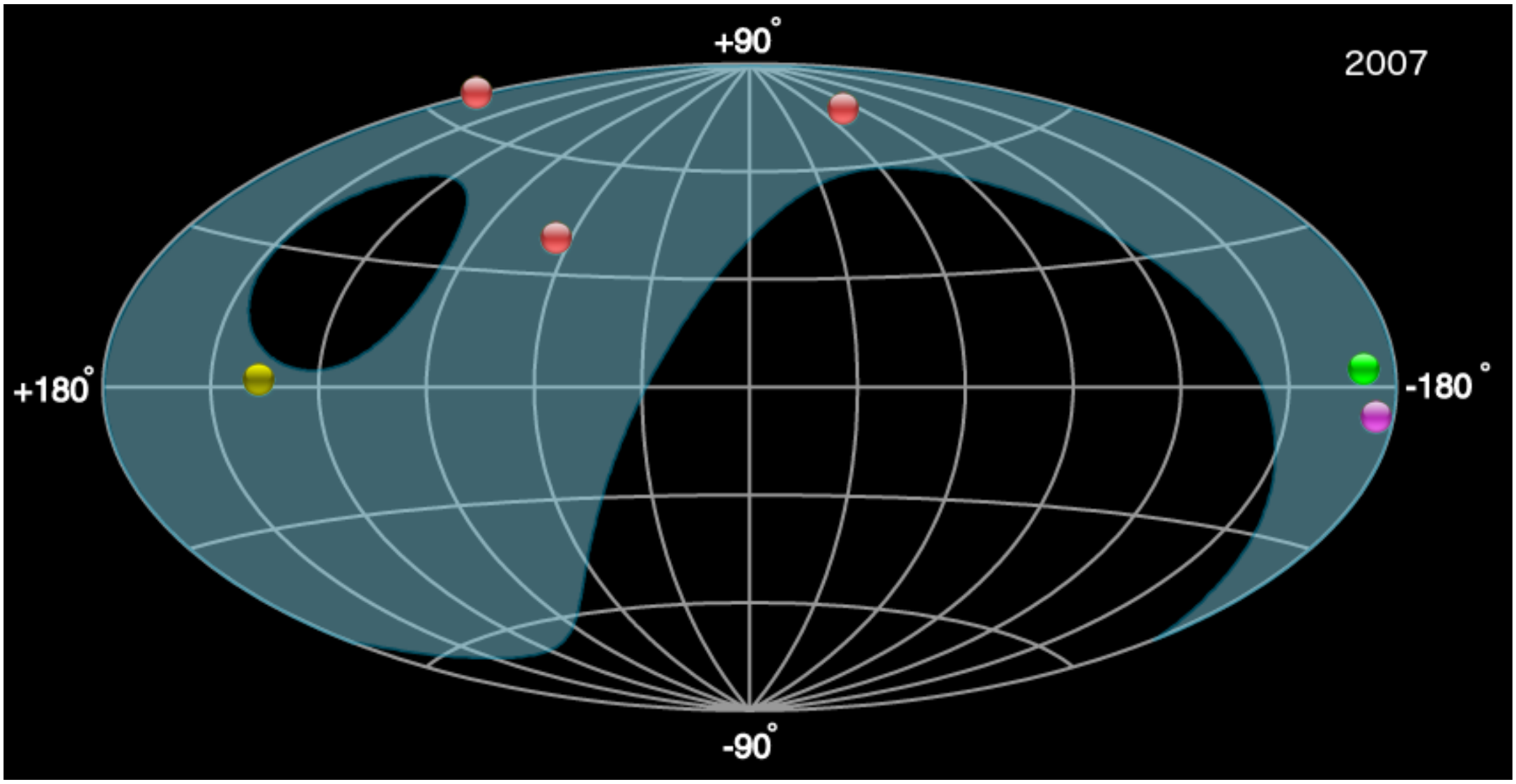
Where sophisticated
Monte Carlo simulates

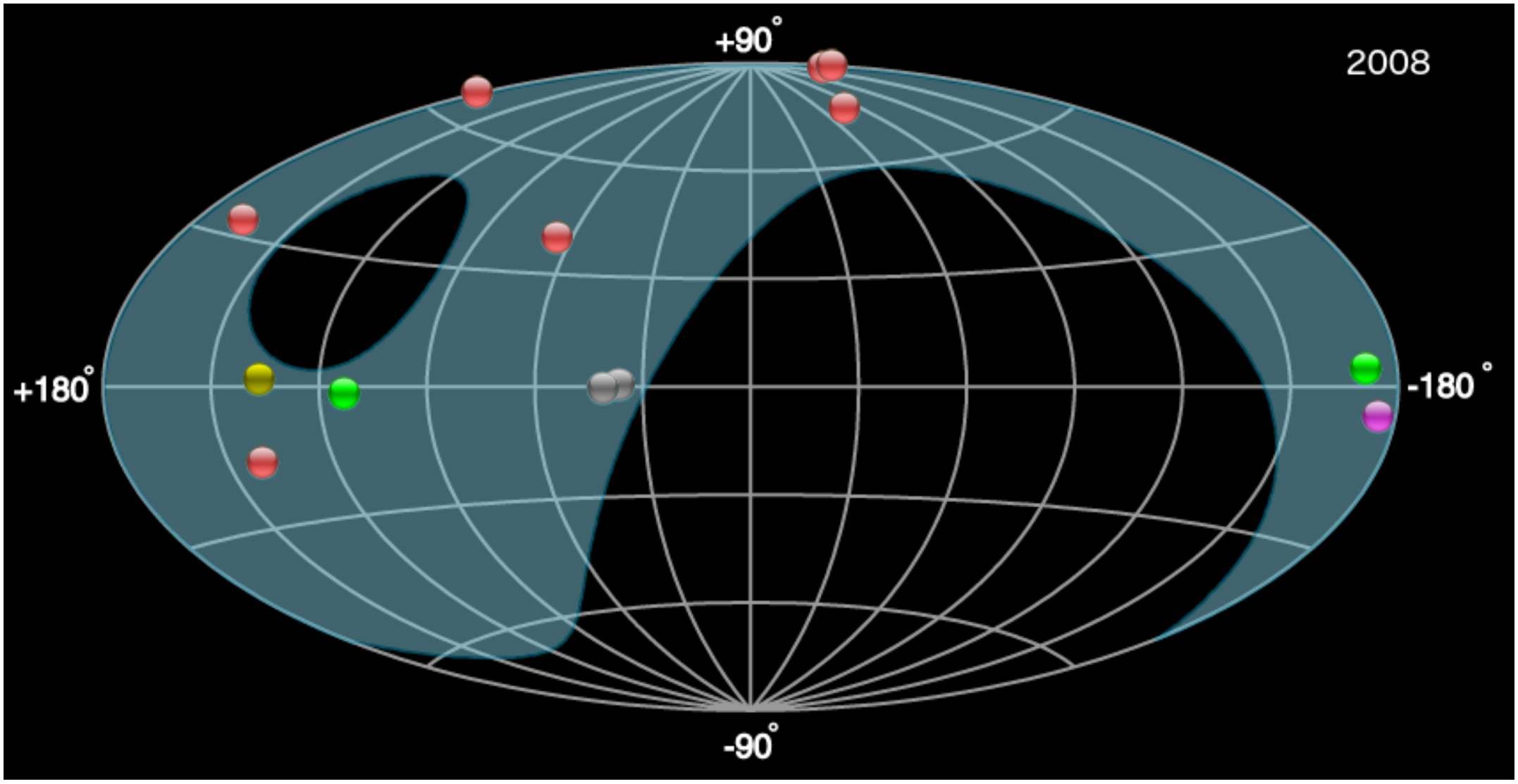
In reality…

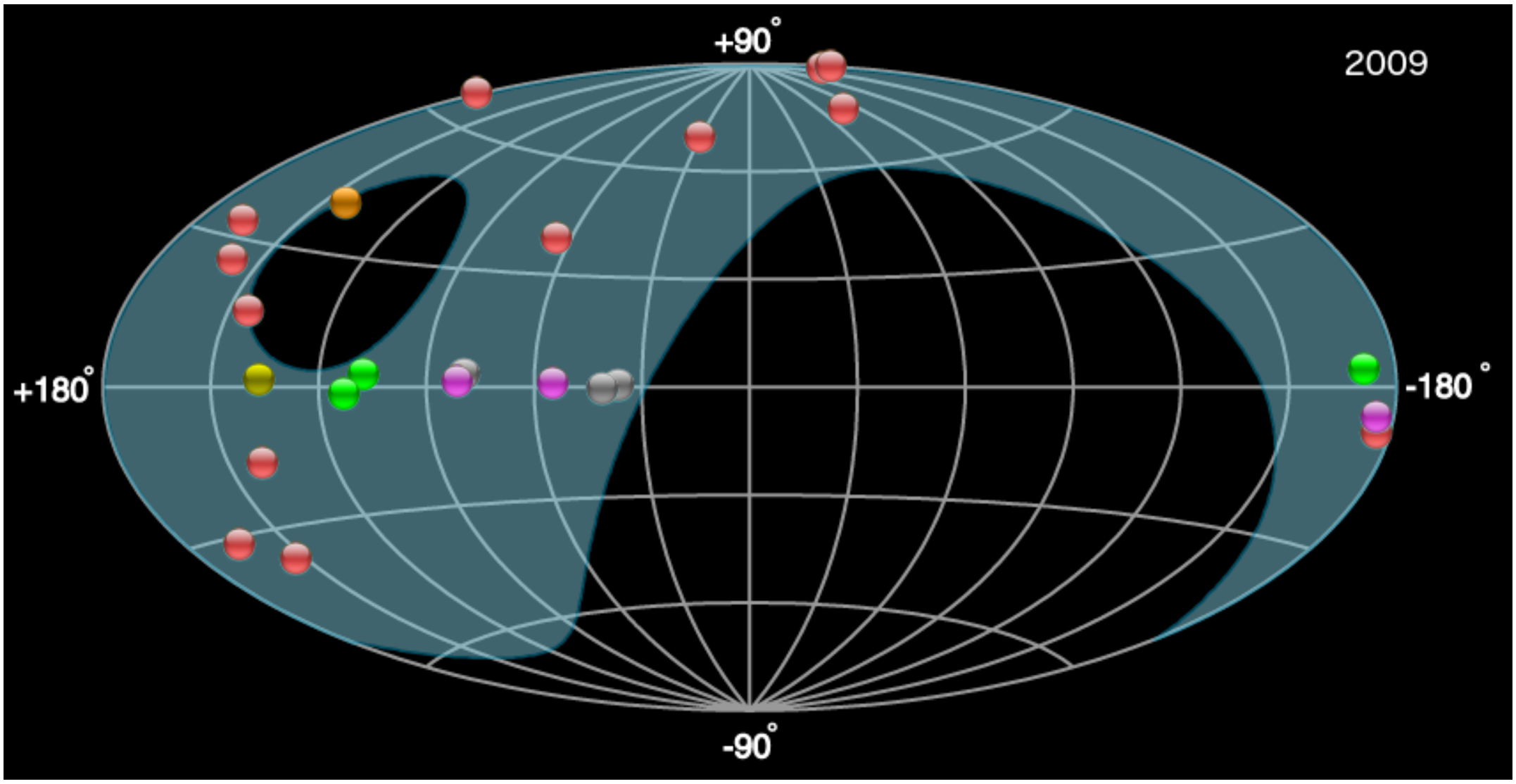
vegas (*n*): fertile plains

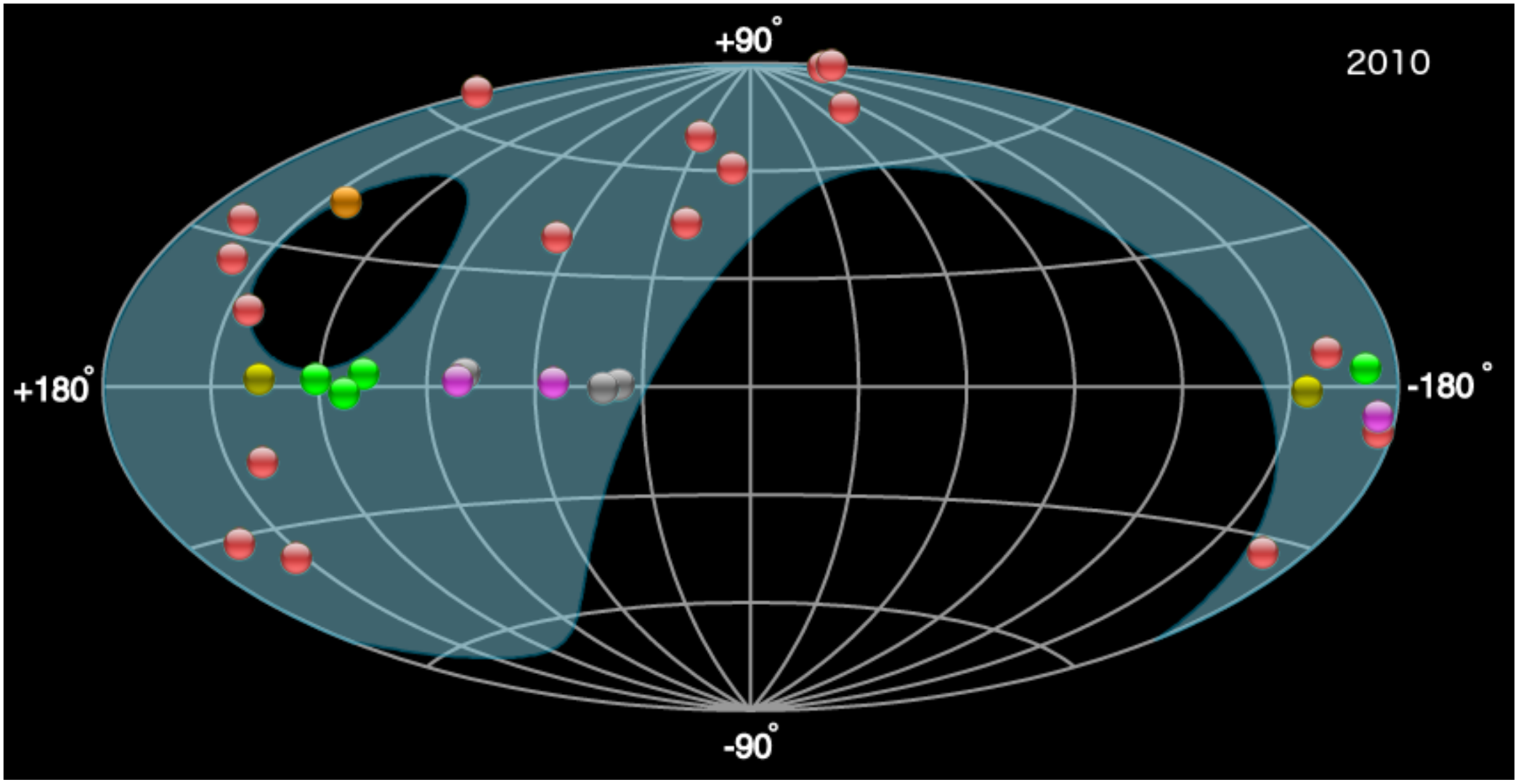

+90°
2004
+180°
-180°
-90°

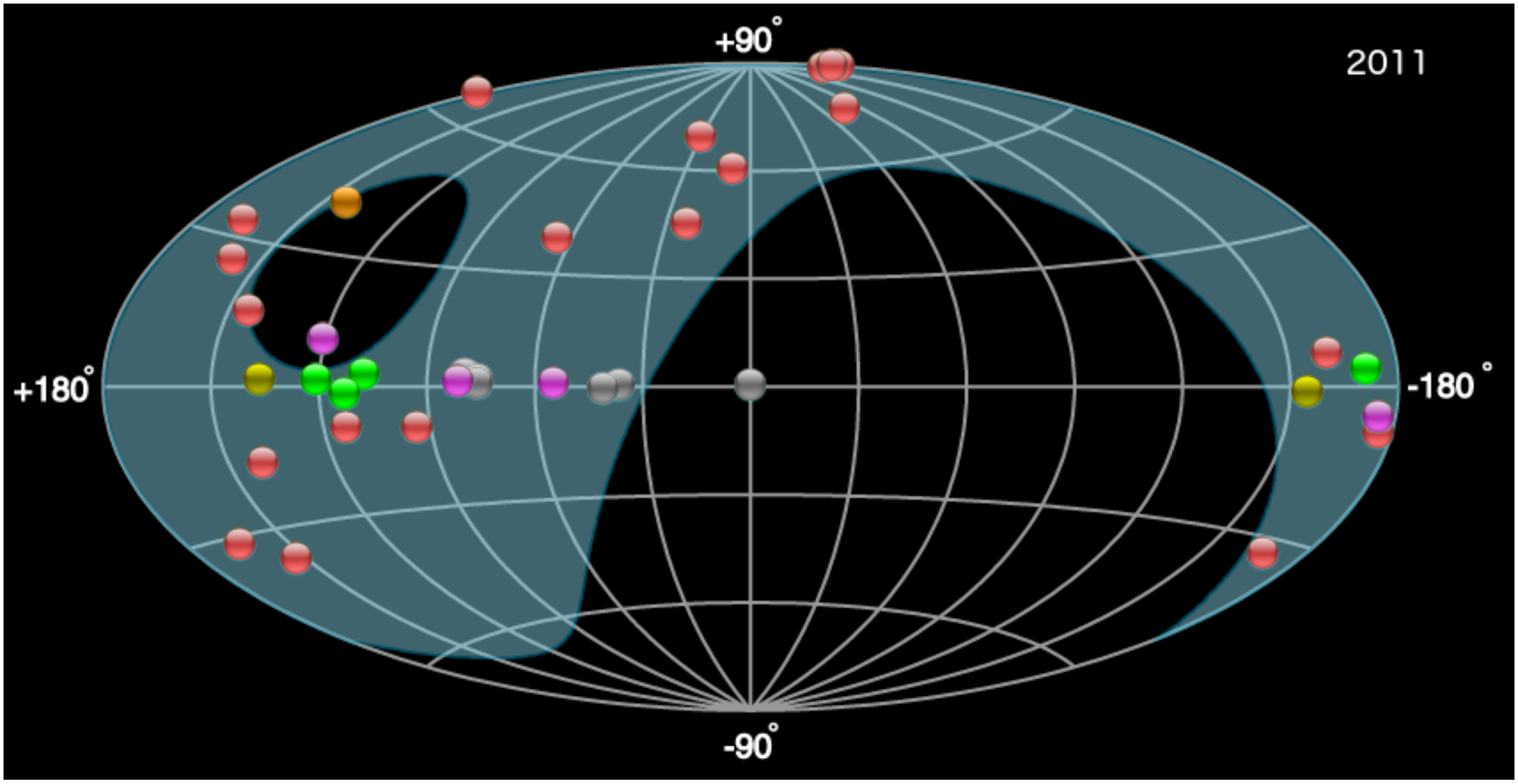

+90°
2006
+180°
-180°
-90°

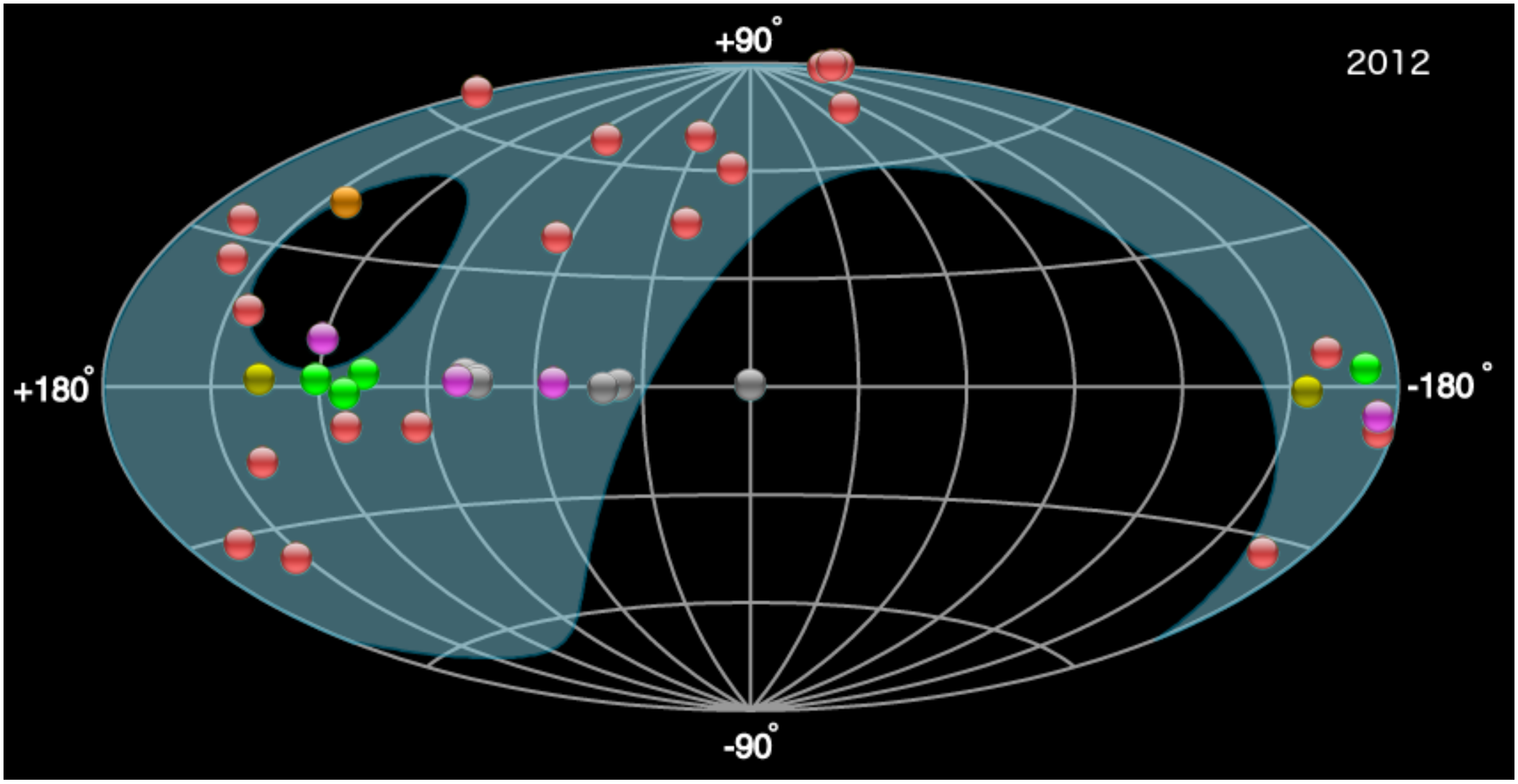

+90°
2007
+180°
-180°
-90°

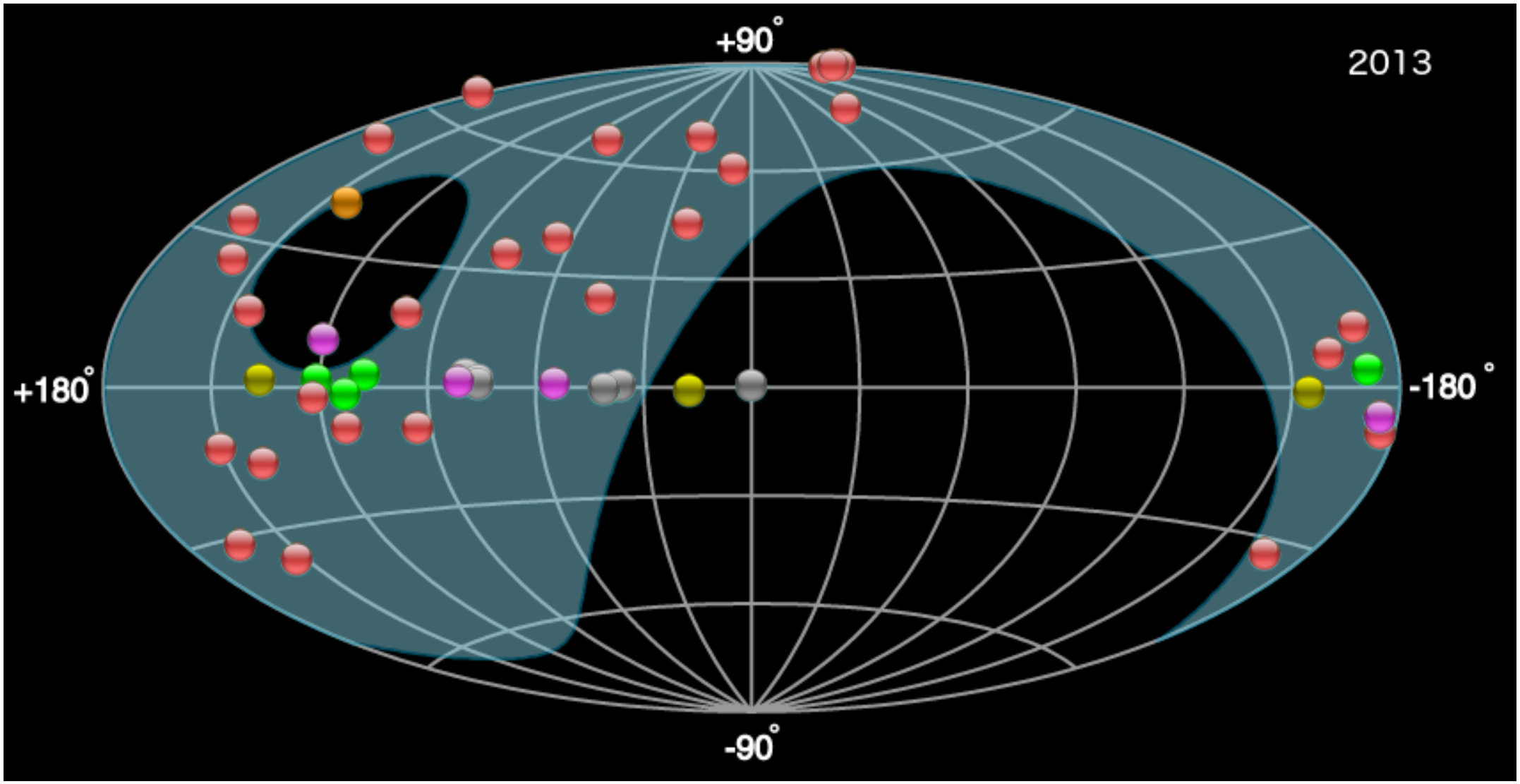

+90°
2008
+180°
-180°
-90°

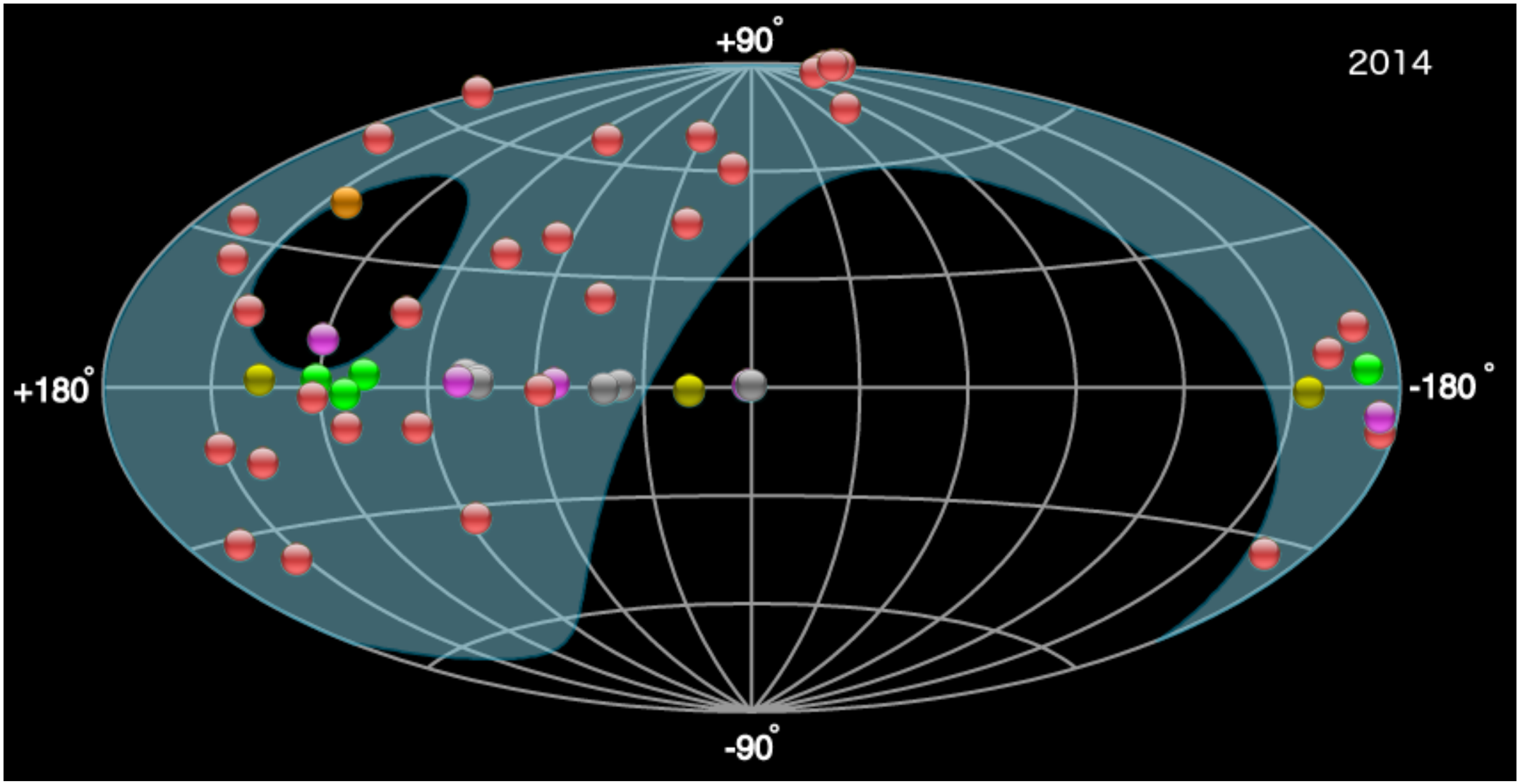

+90°
2009
+180°
-180°
-90°

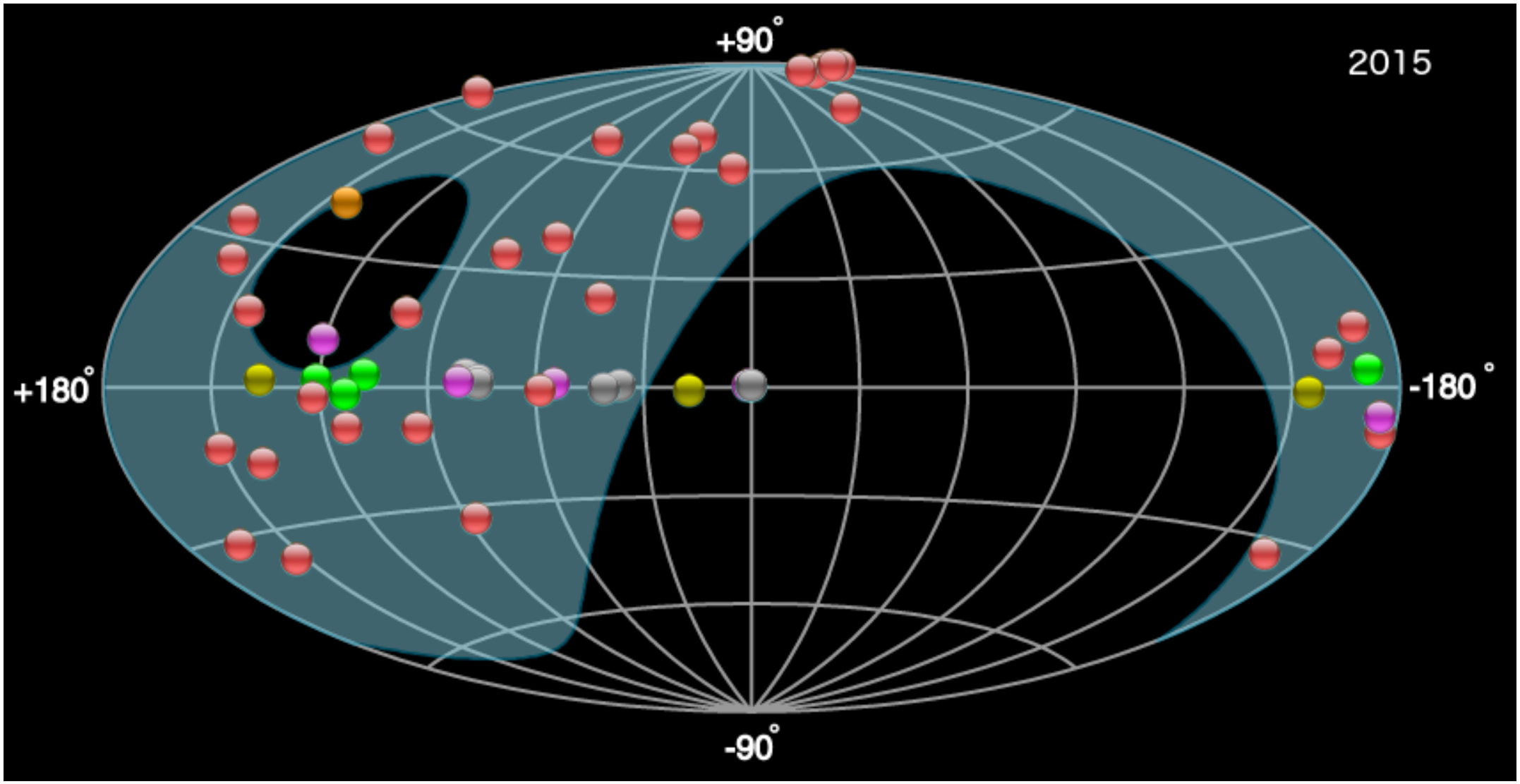

+90°
2010
+180°
-180°
-90°

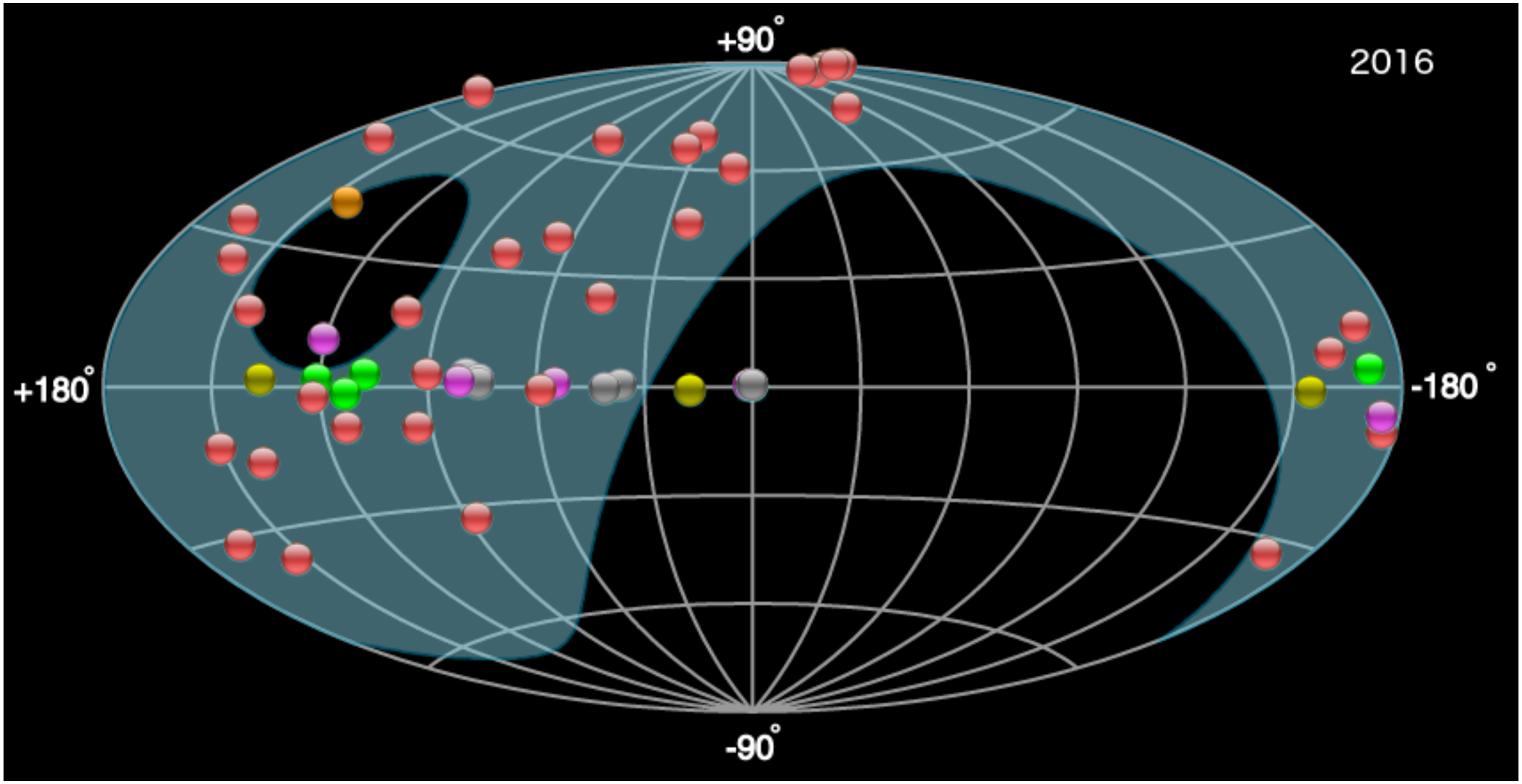

+90°
2011
+180°
-180°
-90°

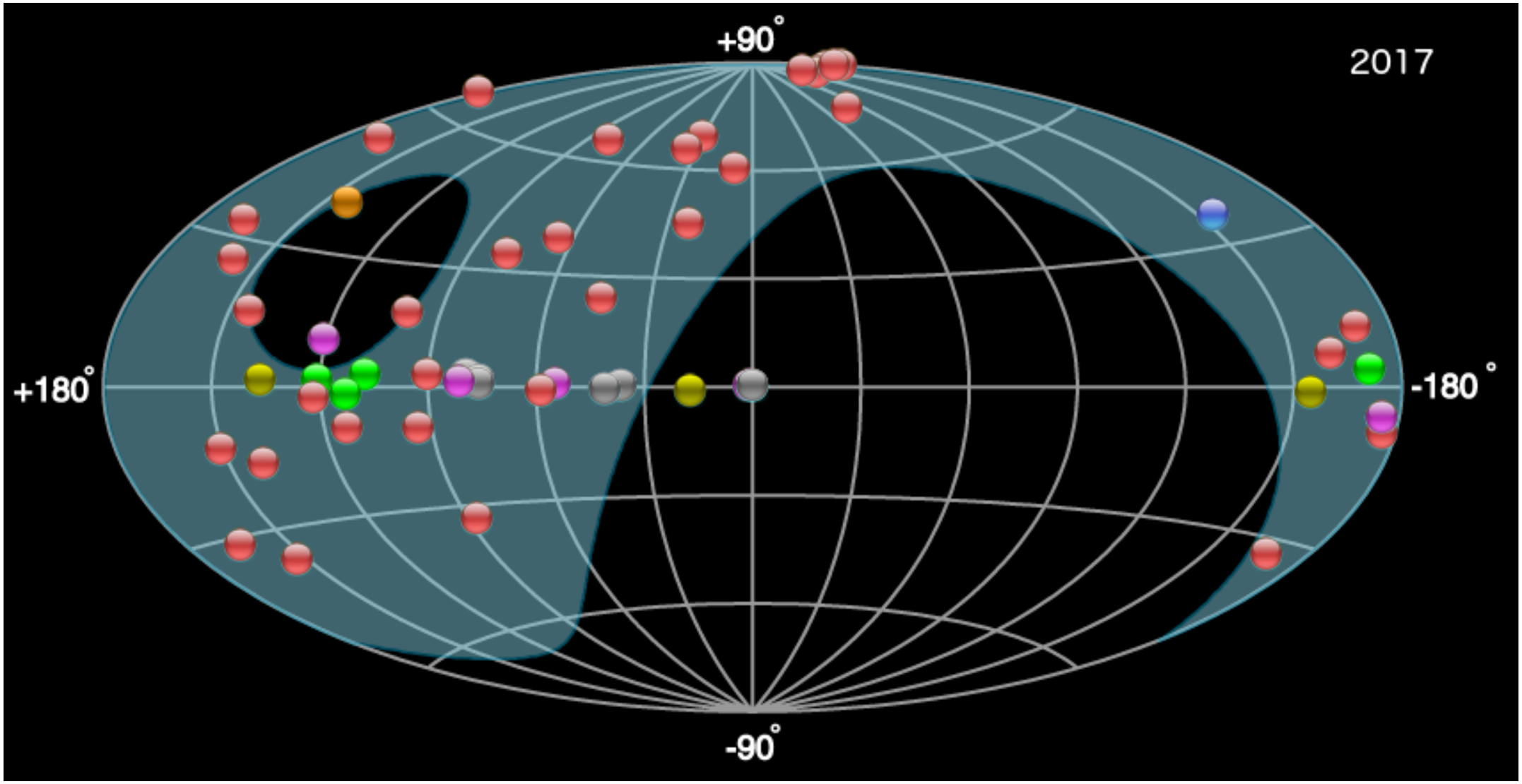

+90°
2012
+180°
-180°
-90°


+90°
2013
+180°
-180°
-90°

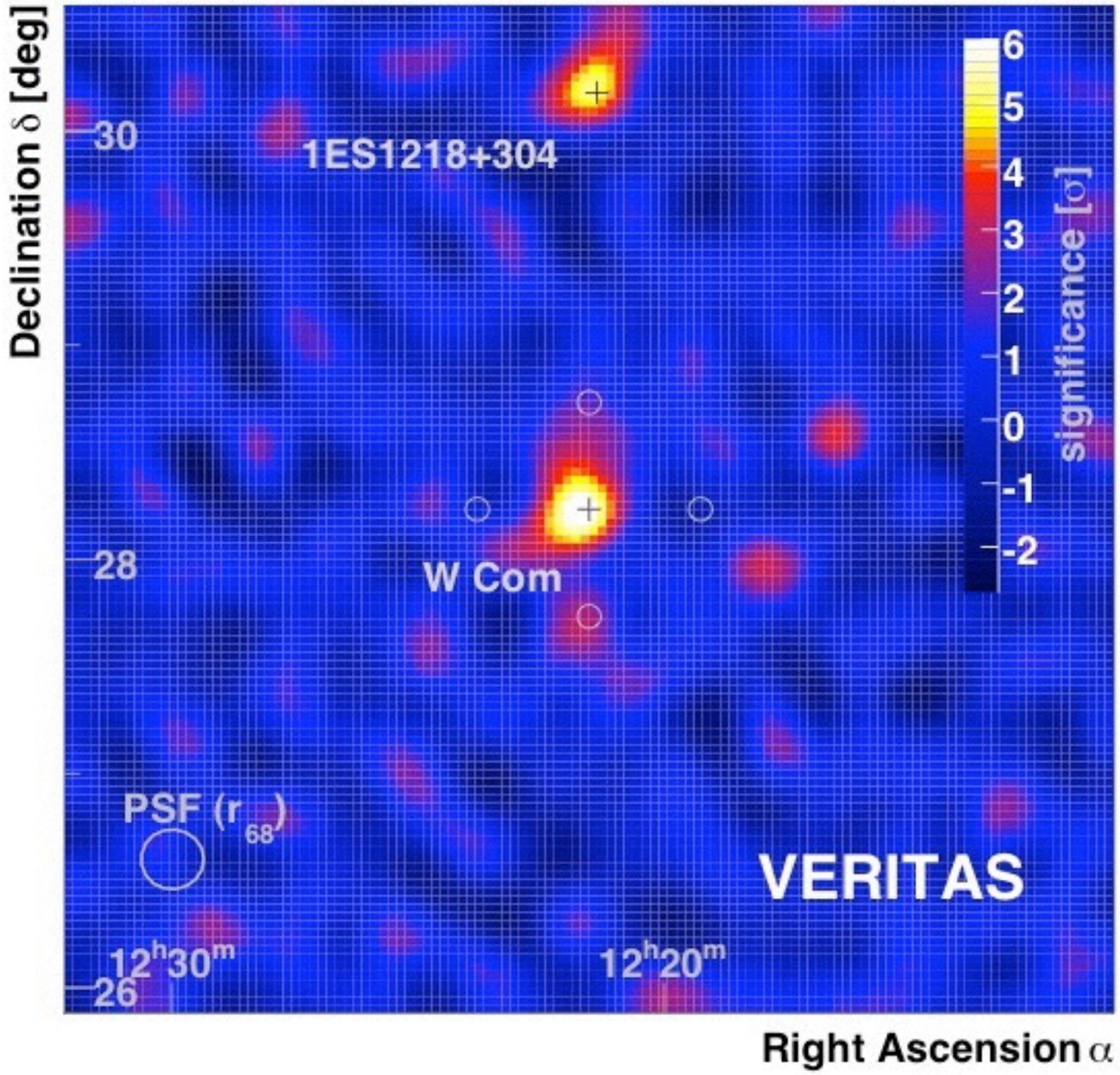

+90°
2014
+180°
-180°
-90°


+90°
2015
+180°
-180°
-90°


+90°
2016
+180°
-180°
-90°


+90°
2017
+180°
-180°
-90°

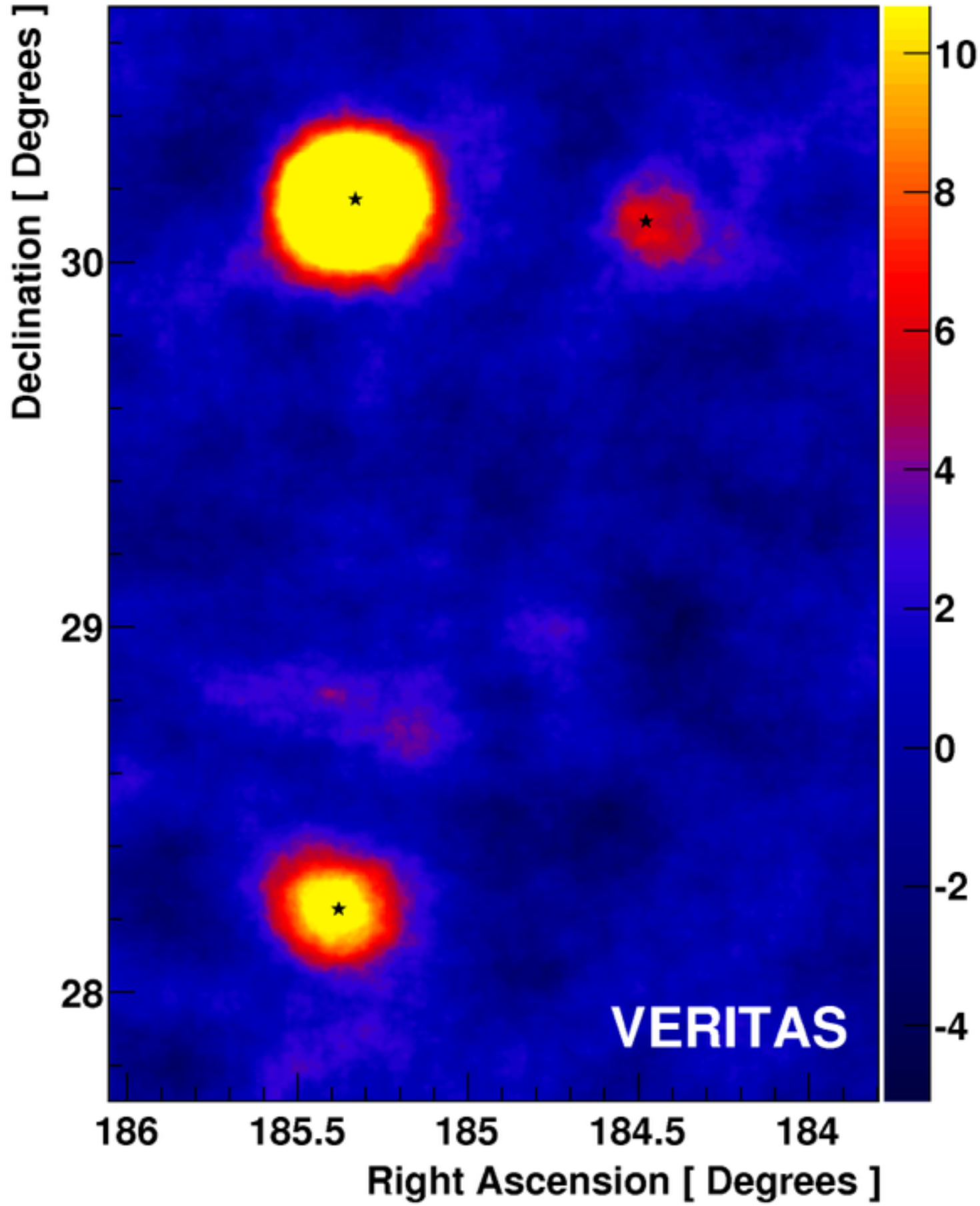
2008


Declination δ [deg]
30
28
26
1ES1218+304
W Com
PSF (r 68)
12h30m
12h20m
Right Ascension α
VERITAS
6
5
4
3
2
1
0
-1
-2
significance [σ]

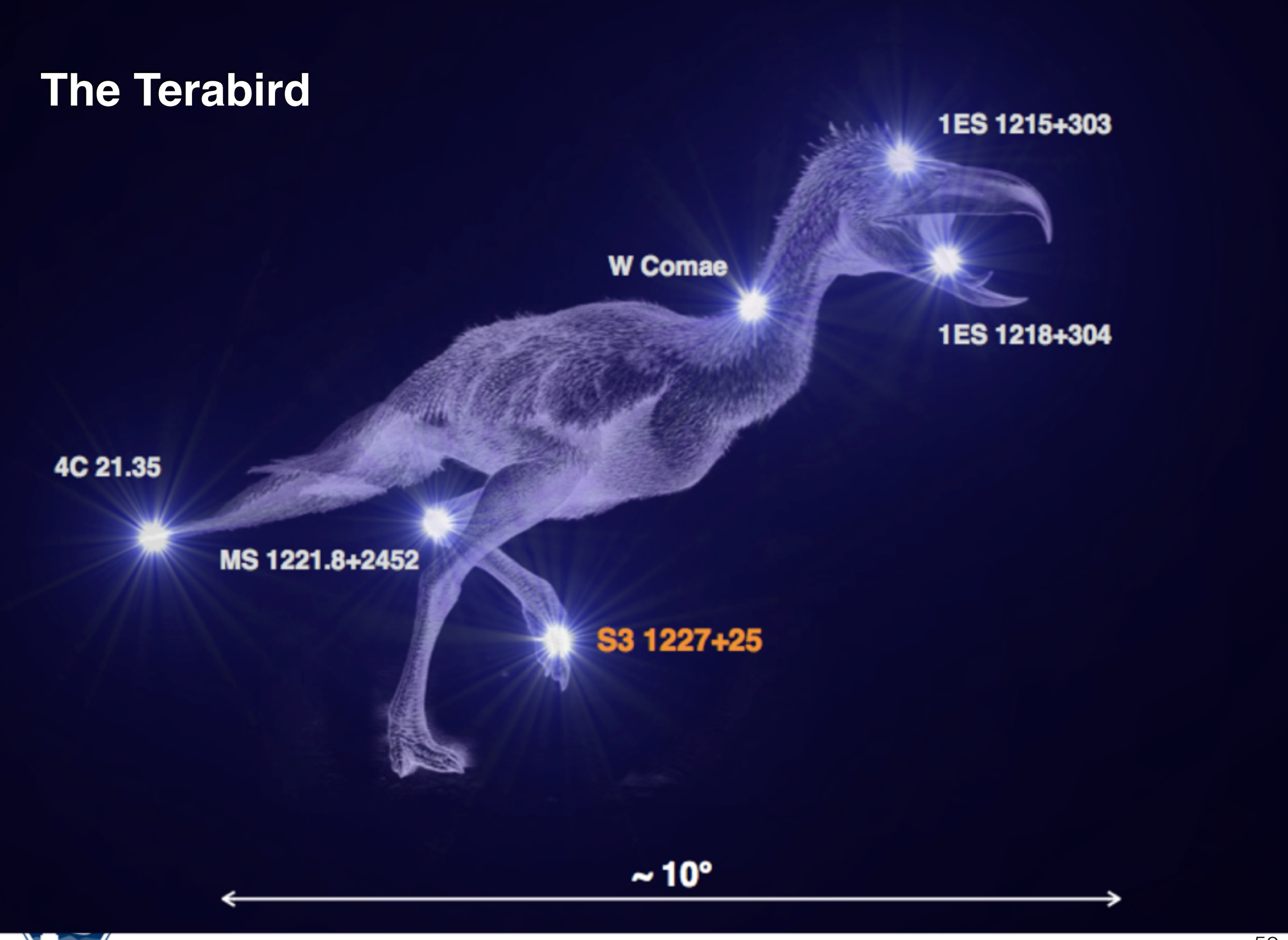
2011

3 extragalactic sources in the same fov!

What next?

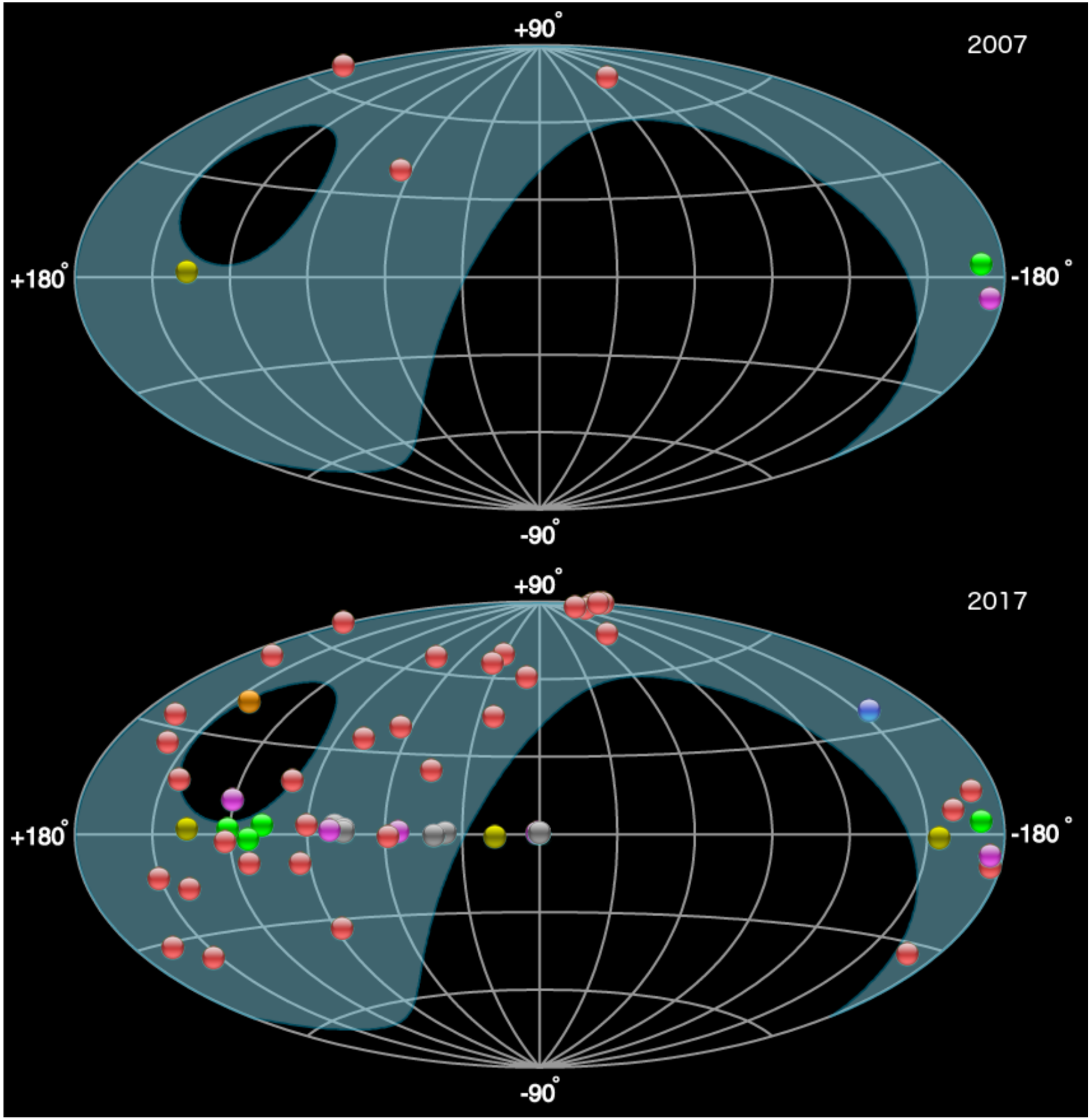


The Terabird



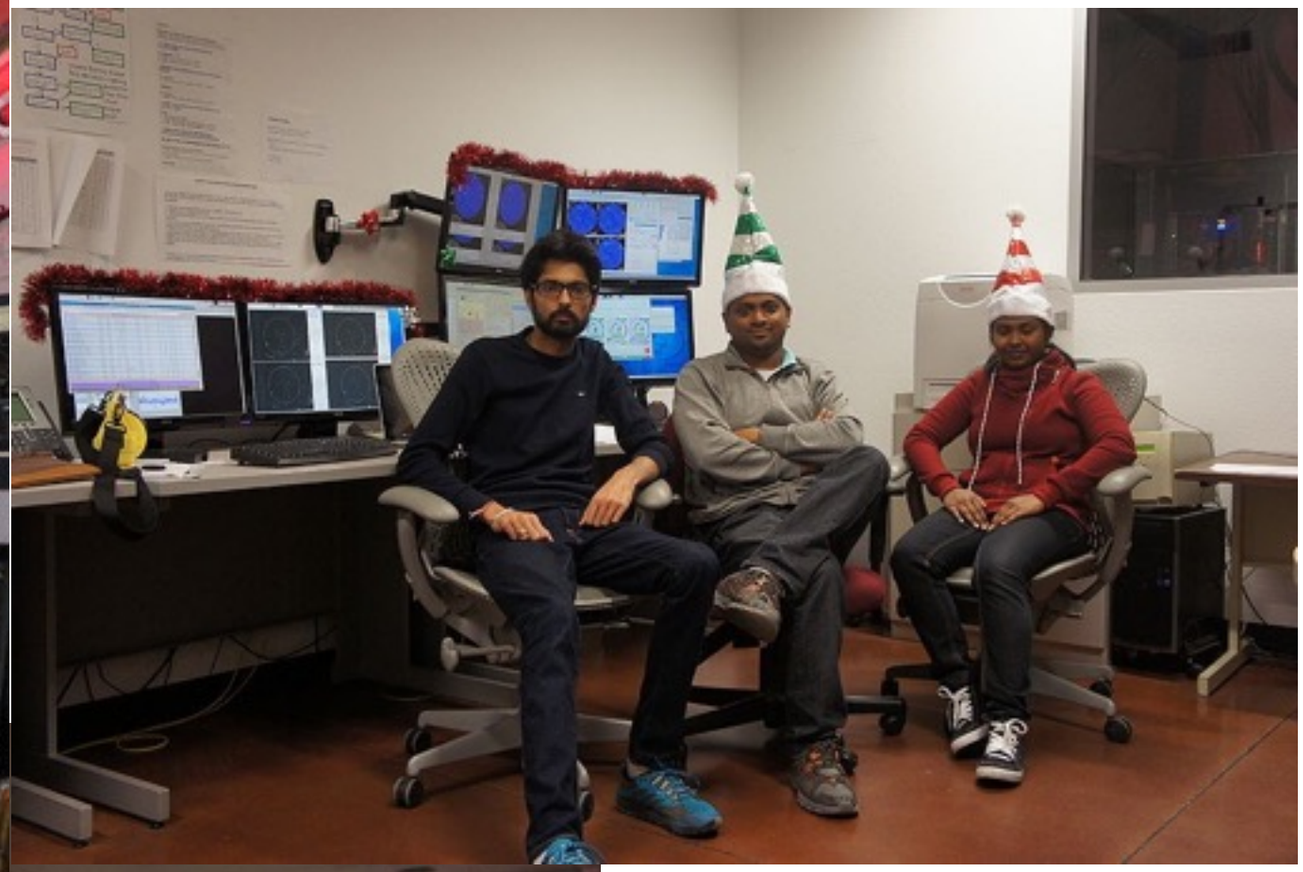
Source Types

- PWN
- Binary XRB PSR Gamma BIN
- HBL IBL FRI FSRQ Blazar LBL AGN (unknown type)
- Shell SNR/Molec. Cloud Composite SNR Superbubble
- Starburst
- DARK UNID Other
- uQuasar Star Forming Region Globular Cluster Cat. Var. Massive Star Cluster BIN BL Lac (class unclear) WR



FLWO Basecamp visit

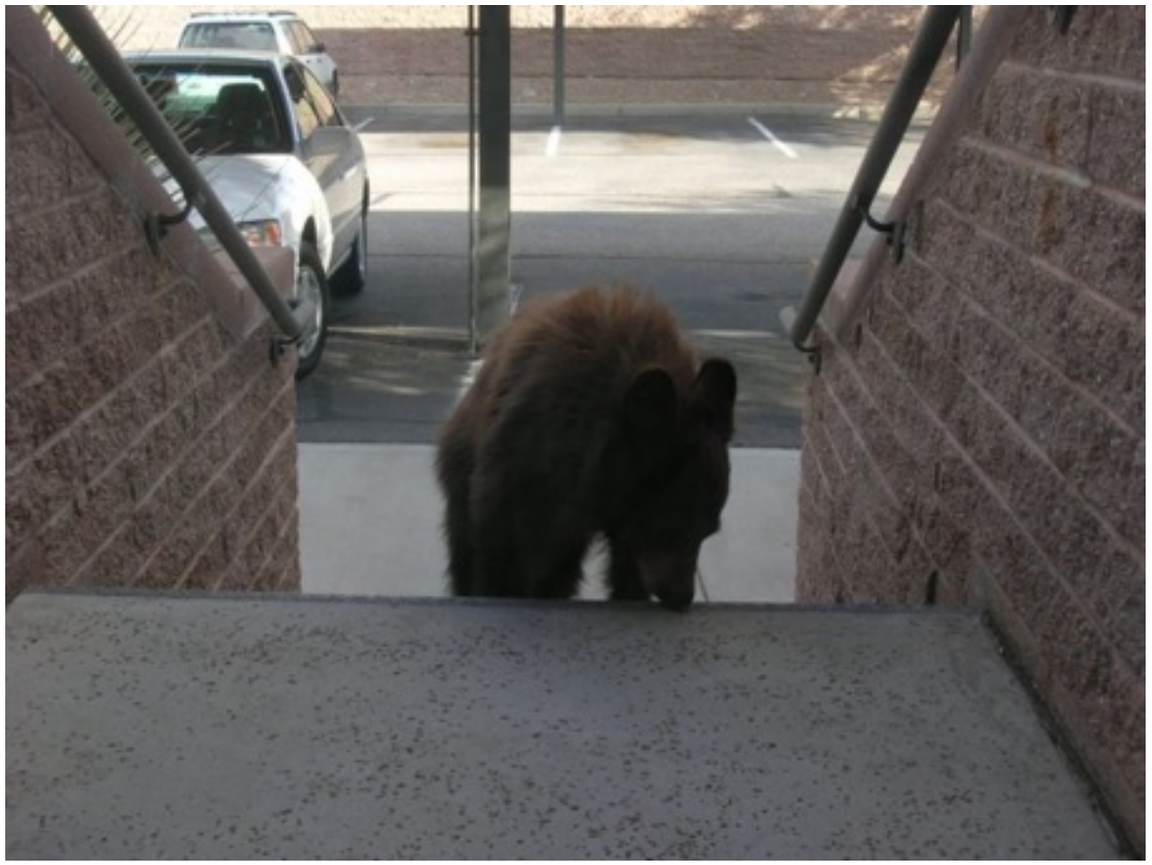

SMART

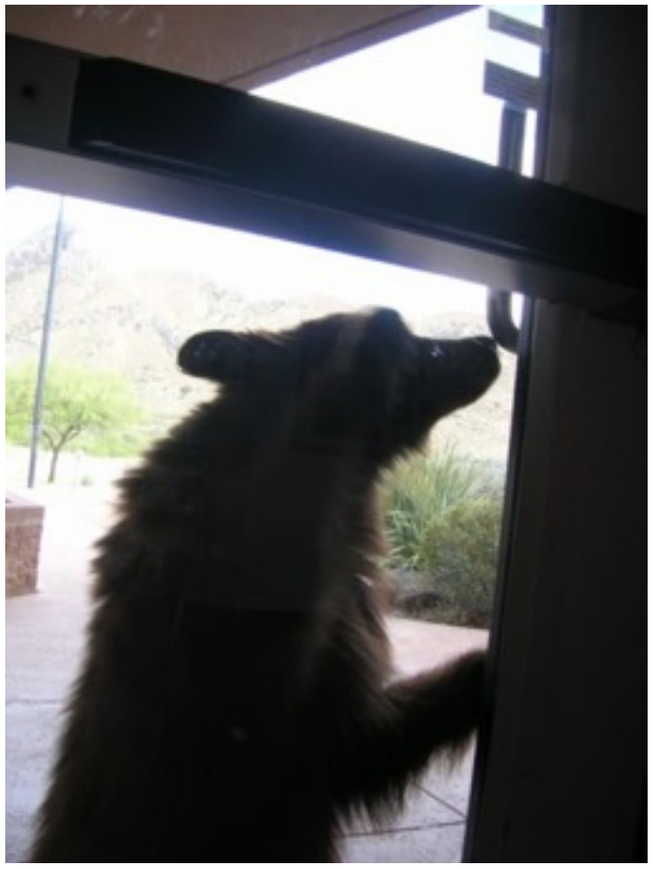


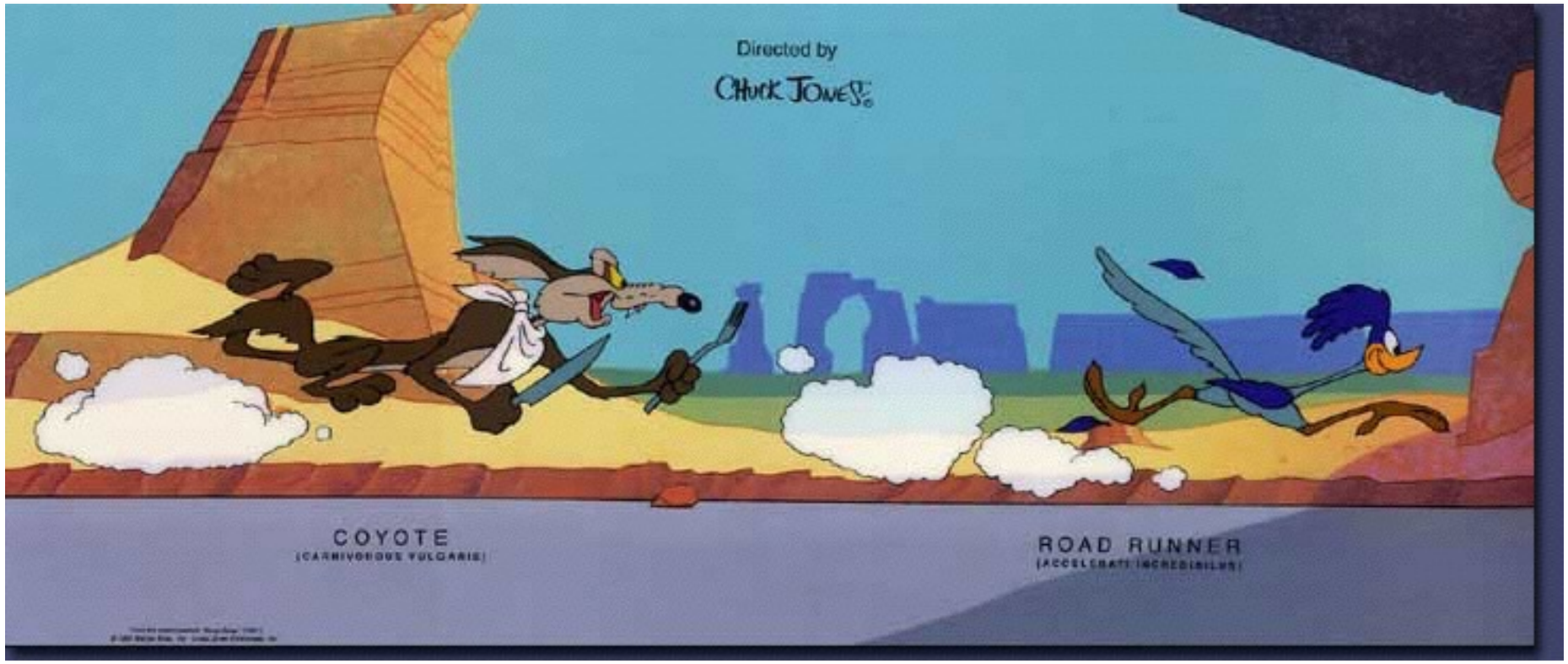

Sigo
Siendo
el
triathlon


SOL
SOL
SOL

Remember it is a wilderness area






Directed by
Chuck Jones
COYOTE
ROAD RUNNER








4
DO NO
REMOV
THIS TAG


GoldStar





172.16.0.150

Welcome! — ...m home page | Epochs and Periods for EBs | Manual Cinema | Object Visibility | Altmetric it! | Apple | iCloud | Google | Wikipedia | Facebook | Twitter | LinkedIn | The Weather Channel

ELOG VBC | ELOG -

```
Bias Curve:
==========
Sponsored by Scott's scalers

Thresh | Rate (Hz)
-----------------
 1430  |   8300
 1440  |   2700
 1450  |   132
 1460  |   28
 1470  |   6
 1480  |   2.8
 1490  |   2.0
 1500  |   1.6
 1510  |   1.3
 1520  |   1.0
 1530  |   1.0

Threshold disc.

TD mode  | Rate (Hz)
-----------------
 1510  | 42
 1505  | 62
 1500  | 86 1490  | 192
 1485  | 279
 1480  | 424
 1475  | 605
 1470  | 888
 1465  | 1386
 1460  | 1831
 1455  | 2575
 1450  | 3568
 1445  | 5087
 1440  | 6594
 1435  | 8616
 1430  | 11676
 1425  | 16929
 1420  | 43306
 1415  | 231291
 1410  | 1.4e+6
 1405  | 4.3e+6
```

The thing on the ridge came back tonight, it seems to be watching us.

```
The thing on the ridge came back tonight, it seems to be watching us.

 1495  | 130
```

The thing on the ridge came back tonight, it seems to be watching us.

A Studentis Hard@workus

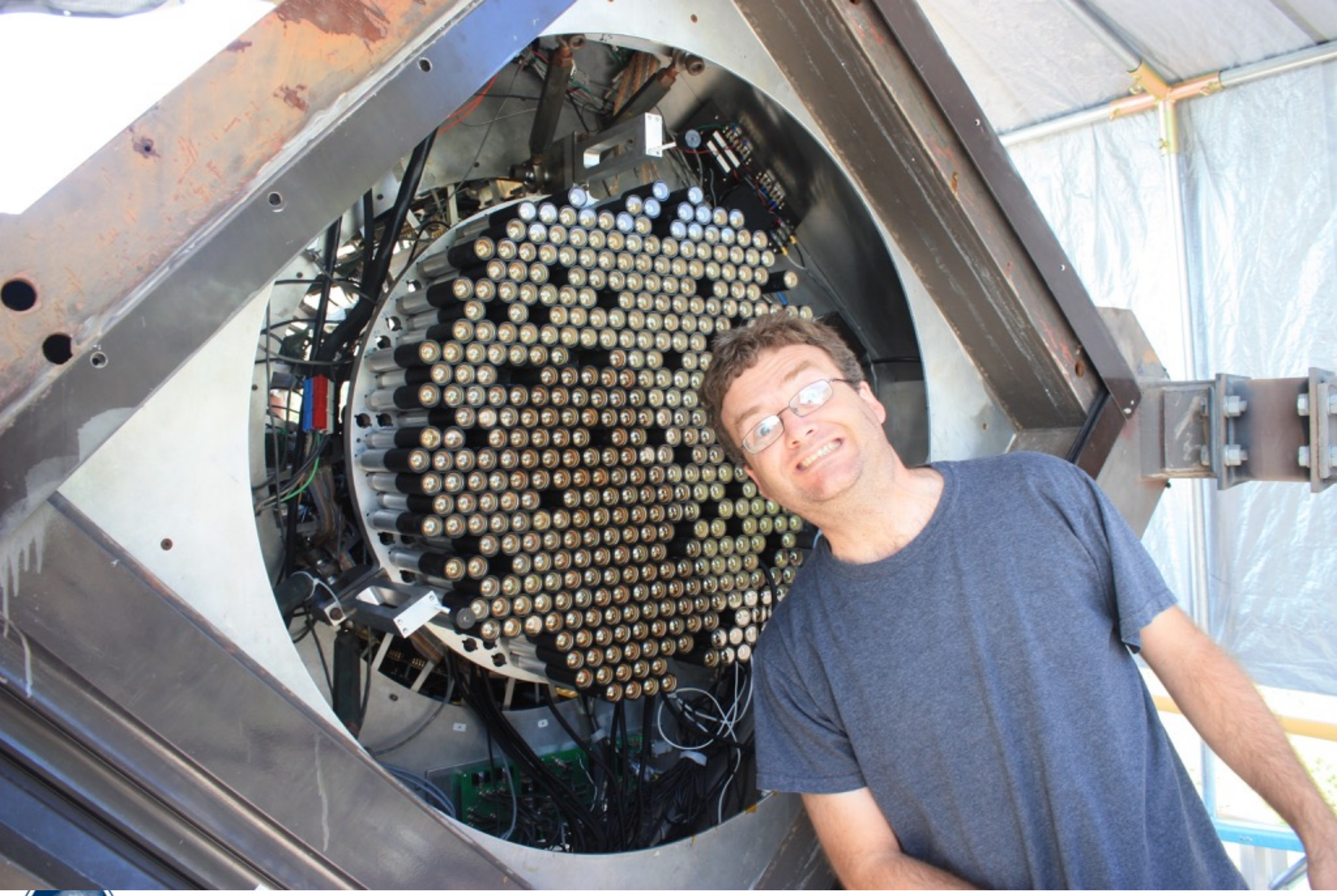
A Studentis Hard@workus

The Lesser Spotted Operations Manager

The Lesser Spotted Operations Manager

Professorae Confusedalot

Professorae Confusedalot



VERITAS

The Collaboration Meetings

VERITAS

The Collaboration Meetings

Winter 2003

VERITAS Collaboration Meetings

Chicago Summer 2003








Winter 2005 - Rio Rico

VERITAS Collaboration Meetings

Montreal Summer 2005

VERITAS Collaboration Meetings

Leeds Summer 2006

VERITAS Collaboration Meetings

Tucson Winter 2007

Delaware Summer 2007

VERITAS Collaboration Meetings

Dublin Summer 2008

Cork Summer 2010

VERITAS Collaboration Meetings

Tucson Winter 2011

VERITAS Collaboration Meetings

Montreal Summer 2011

VERITAS Collaboration Meetings

Tucson Winter 2012

Santa Cruz Winter 2013

VERITAS Collaboration Meetings


DESY Summer 2013

Tucson Winter 2015

Galway Summer 2015

VERITAS Collaboration Meetings

Tucson Winter 2016


WELCOME TO
BARNARD
VERITAS Collaboration Meeting Group Photo
NYC, 20 July 2016
Photo: Deivid Ribeiro

Tucson Winter 2017