AGILE and Blazars

S. Vercellone – INAF / IASF Milano

on behalf of the AGILE Team

Talk Outline

1. Status of the AGILE Mission and AGILE Performance
2. AGILE Pointing Plan and In-Flight Calibrations
3. Blazar Studies and The AGILE Team AGN Working Group (AT-AWG)

1. **Status of the AGILE Mission and AGILE Performance**
2. **AGILE Pointing Plan and In-Flight Calibrations**
3. **Blazar Studies and The AGILE Team AGN Working Group (AT-AWG)**

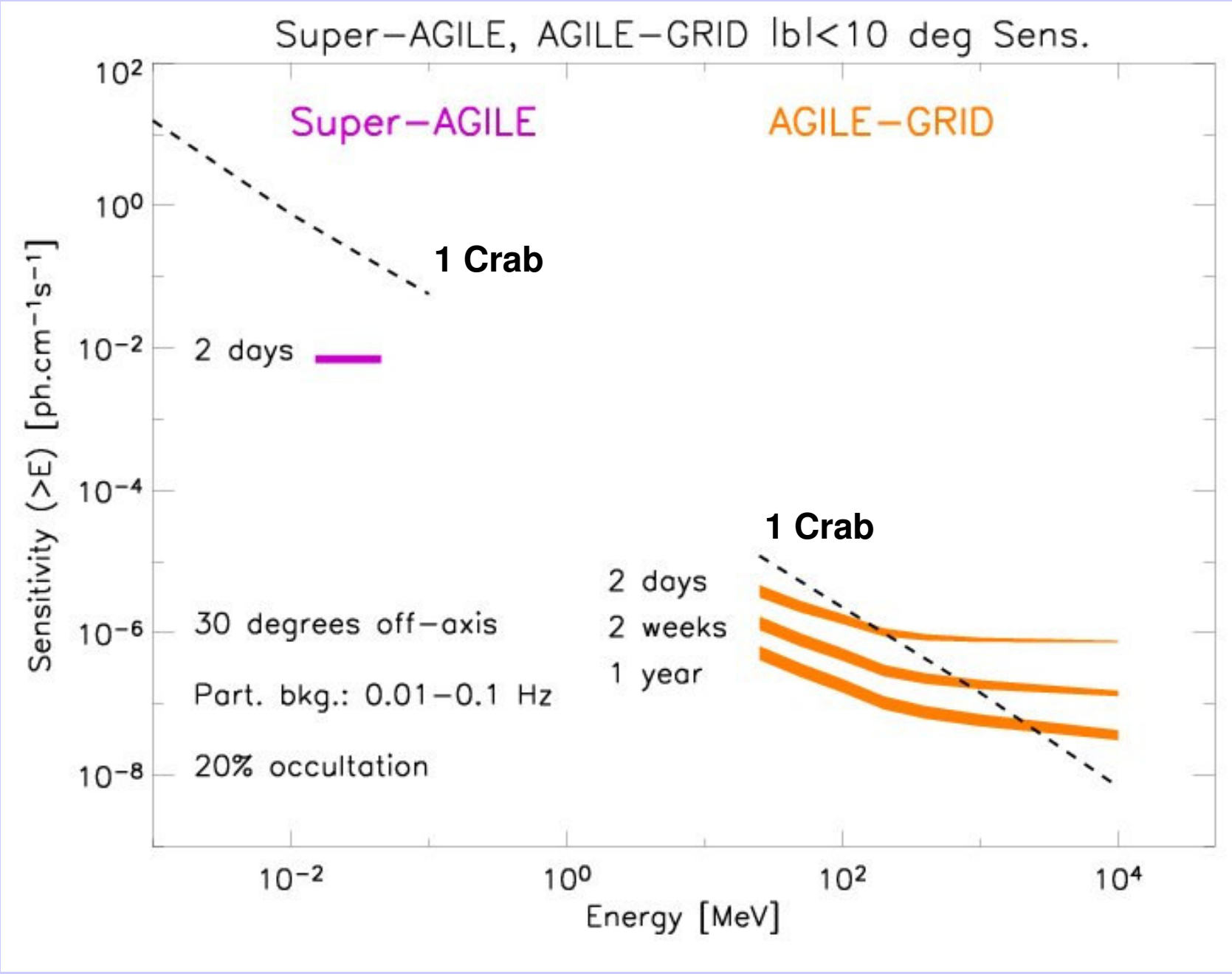
- AGILE is a Scientific Mission supported by ASI with scientific and programmatic participation by INAF and INFN
- AGILE will monitor and detect sources in the energy bands 30MeV – 50 GeV (GRID) and 20 – 45 keV (Super-AGILE)
- Total satellite mass ~ 350 kg (Small Explorer - SMEX - class)
- Scientific Instrument mass: 120 kg
- A highly innovative Instrument !

AGILE Satellite Flight Model (CGS, Tortona)

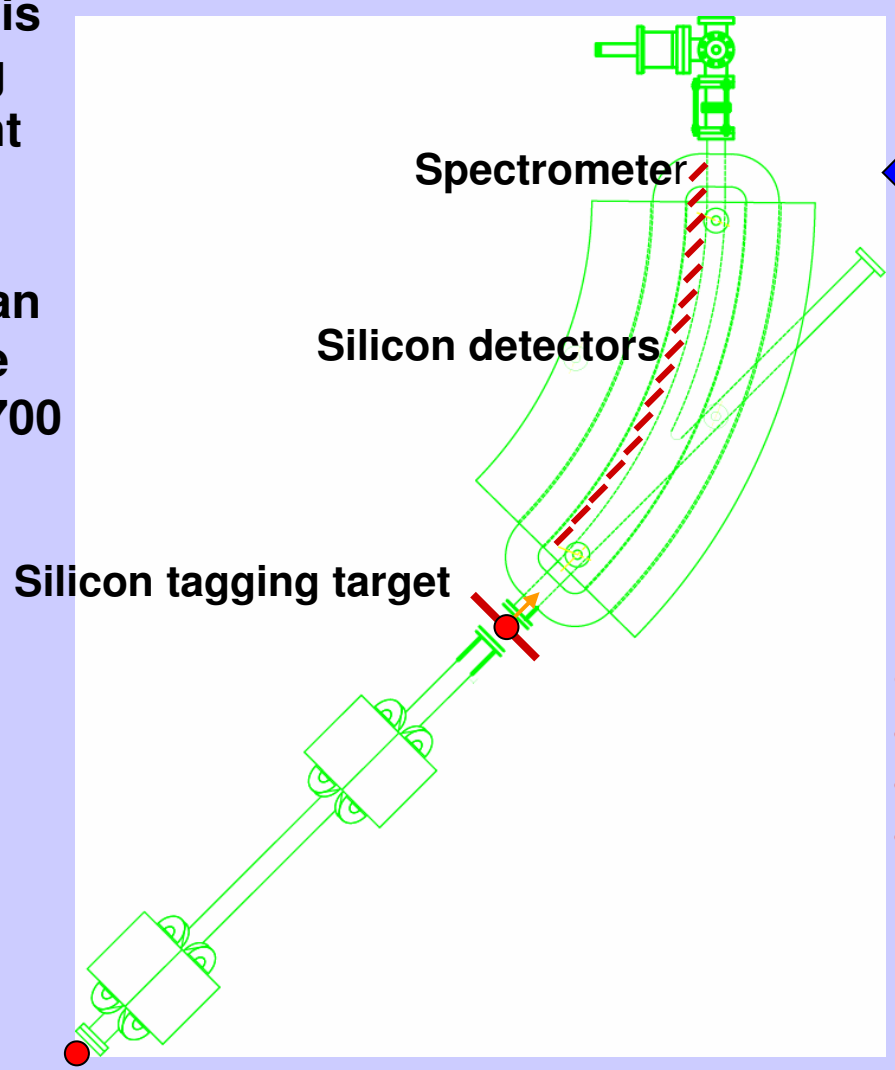
See *http://agile.iasf-roma.inaf.it* for a detailed description of the Instrument

1. **Scientific Payload**
   - Integrated, Calibrated and under final functional testing
2. **Satellite**
   - Integrated and under final functional testing
3. **Software**
   - Standard Analysis SW (V1.0) delivered to the ASI Science Data Centre
4. **Launch windows**
   - October 2006
   - January - February 2007

Gamma-ray Imaging Detector (GRID)	
Energy Range	30 MeV – 50 GeV
Field of view	~ 2.5 sr
Sensitivity at (F>100 MeV)	30×10^{-8} ph cm^{-2} s^{-1}
(5σ in 10^6 sec, on-axis, high GLAT)	
Angular Resolution (68% cont. radius at 400 MeV)	1.2°
Source Location Accuracy	~15 arcmin
(S/N $\sim$ 10 , 90 c.l. radius at high GLAT)	
Energy Resolution	ΔE/E~1 (at 400 MeV)
Absolute Time Resolution	$\sim 2\,\mu$s
Hard X–ray Imaging Detector (Super-AGILE)	
Energy Range	20 – 45 keV
Field of view	107°×68°
(of each half detector FW at Zero Sens.)	
Sensitivity (5σ in 50 ksec, on-axis)	~15 mCrab
Angular Resolution (sky pixel size on-axis)	$\sim$ 6 arcmin
Source Location Accuracy (for sources at 10σ)	~2-3 arcmin
Energy Resolution	ΔE=8 keV
Absolute Time Resolution	$\sim 5\,\mu$s


Super−AGILE, AGILE−GRID |b|<10 deg Sens.
Super−AGILE
AGILE−GRID
1 Crab
2 days
1 Crab
2 days
2 weeks
1 year
30 degrees off−axis
Part. bkg.: 0.01−0.1 Hz
20% occultation
Sensitivity (>E) [ph.cm⁻¹s⁻¹]
Energy [MeV]
10²
10⁰
10⁻²
10⁻⁴
10⁻⁶
10⁻⁸
10⁻²
10⁰
10²
10⁴

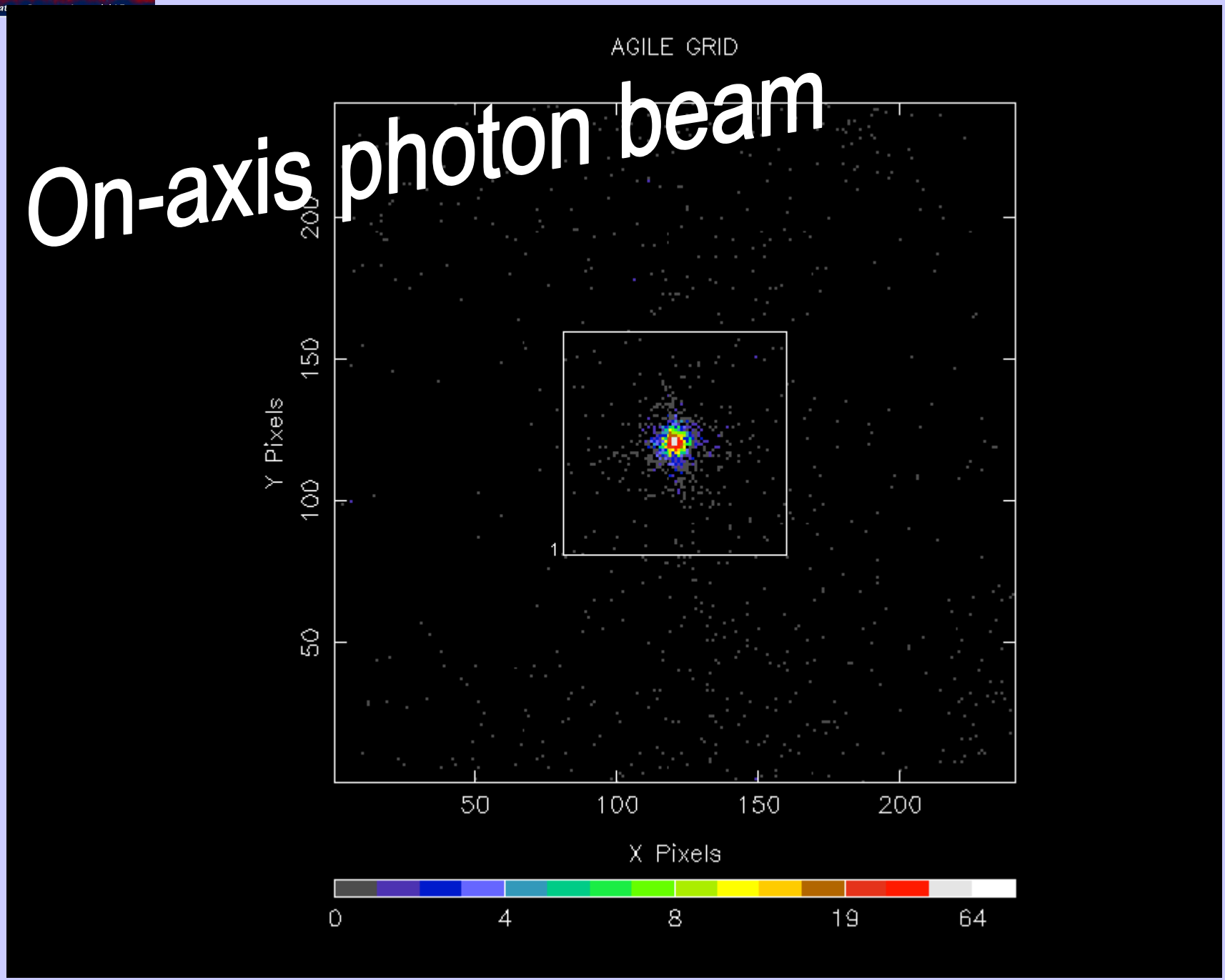
The AGILE Gamma Ray Imaging Detector calibration at BTF is aimed at obtaining data for all relevant geometries and background conditions. BTF can provide data in the energy range (30-700 MeV)



AGILE Payload

BTF-AGILE Schedule

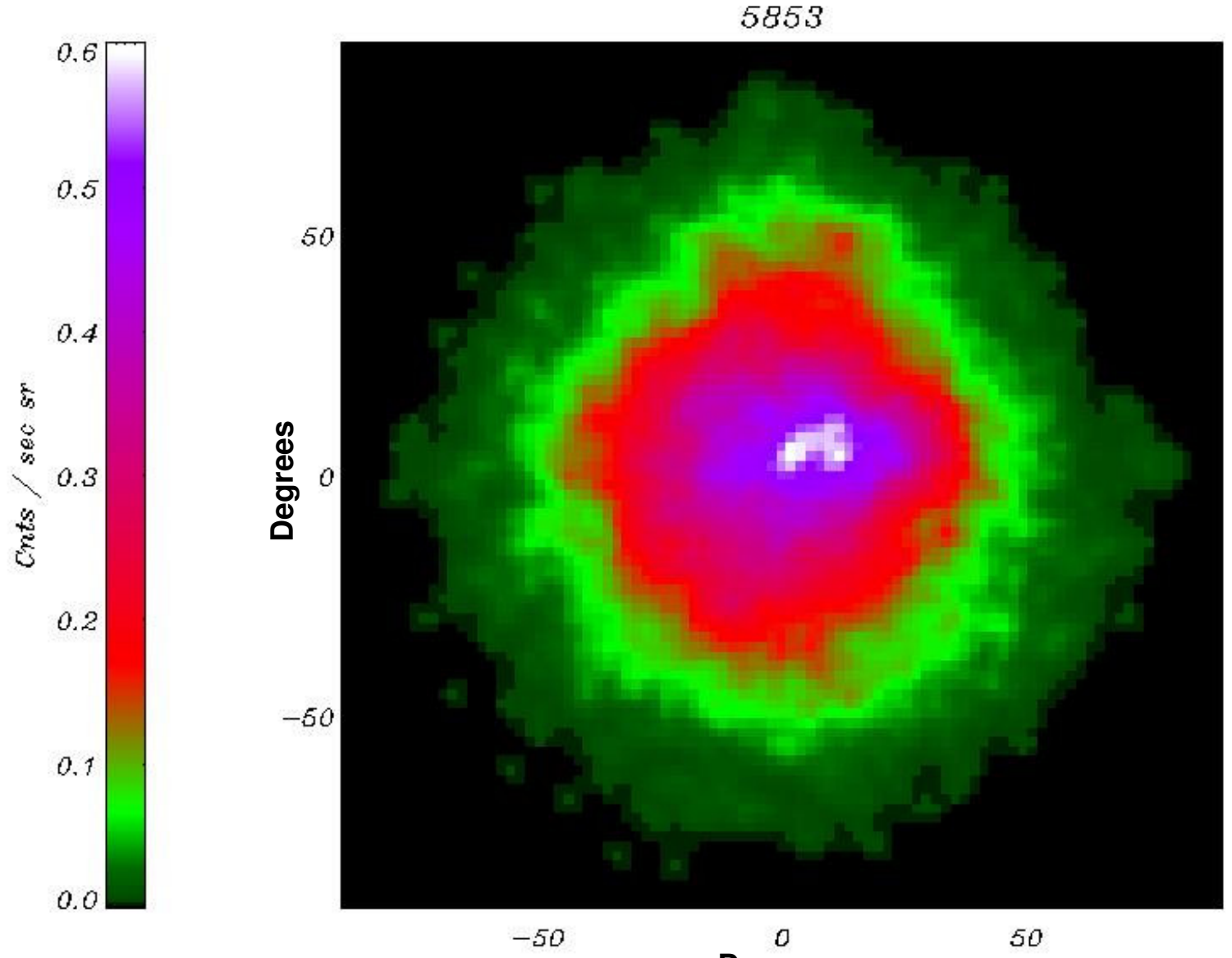
- **photon tagging system (PTS)**
- **spectrometer PTS calibration**
- **final equipment test (Oct. 2005)**
- **AGILE calibration, 3 weeks of data collection**


AGILE GRID
On-axis photon beam
Y Pixels
X Pixels
50
100
150
200
1
0
4
8
19
64

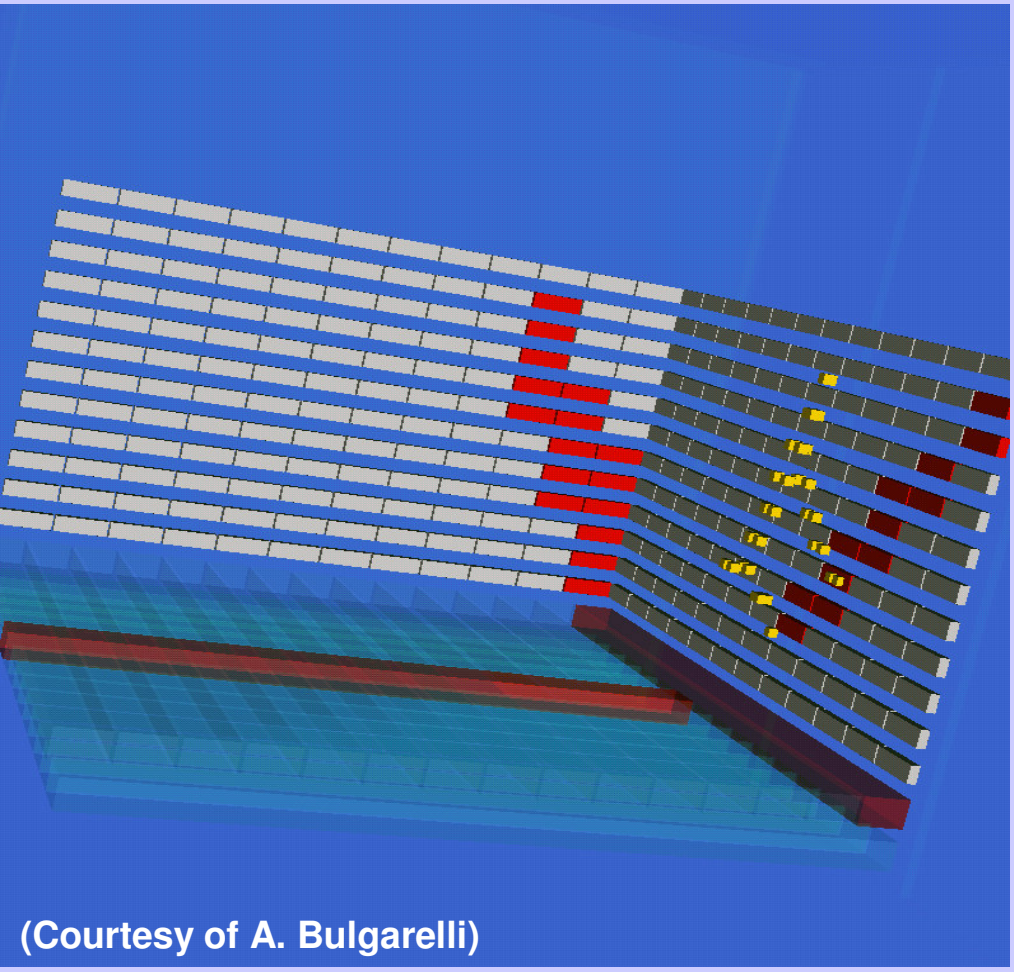
Astro-rivelatore Gamma a Immagini LEggero

Gamma-Rays detected by the AGILE-GRID during the May 2006 final functional test campaign.

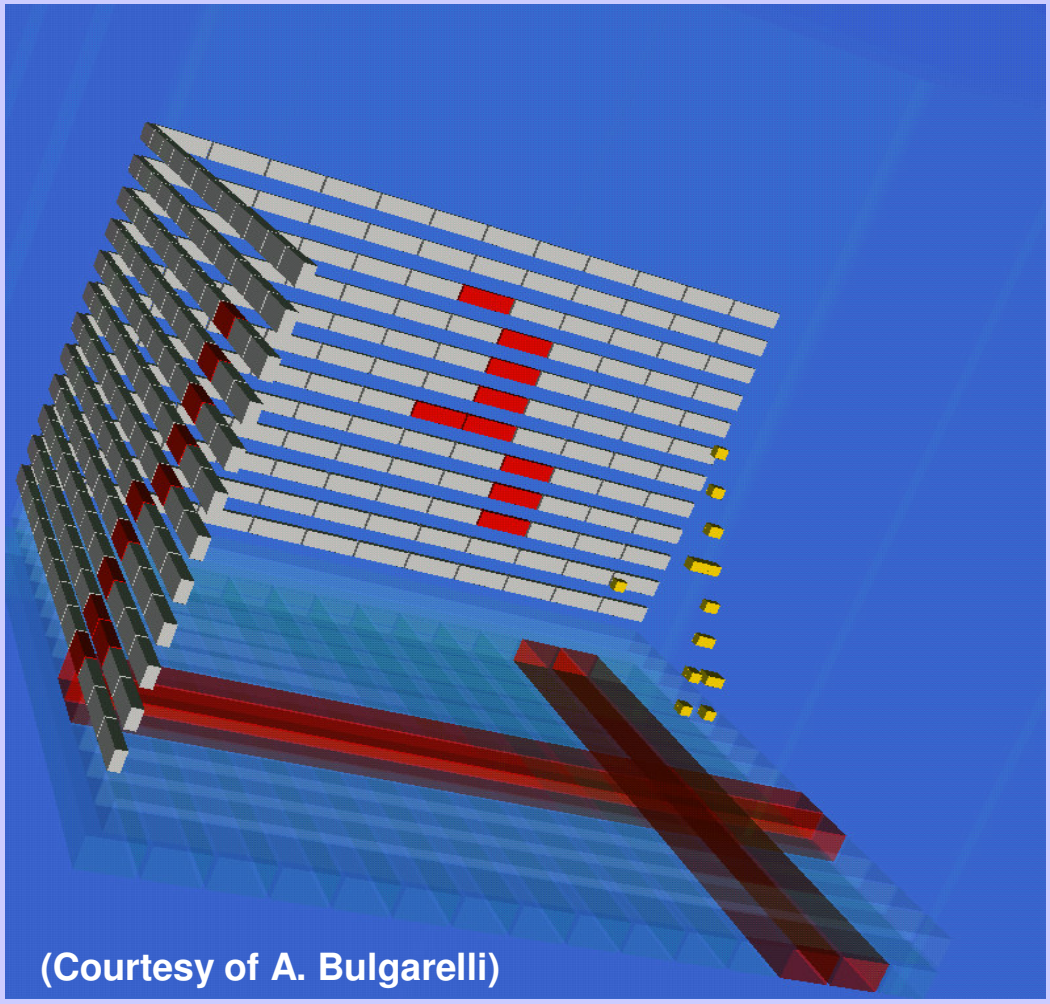
WIDE Field of View and GOOD γ-ray sensitivity



(Courtesy of A. Giuliani)



(Courtesy of A. Bulgarelli)



(Courtesy of A. Bulgarelli)

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2. **AGILE Pointing Plan and In-Flight Calibrations**
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AGILE overall schedule

Phase	*Duration [months]*
Launch	T_0
Commissioning	T_0– (T_0 + 2)
Science Performance Verification	(T_0+ 2) - (T_0+ TBD)

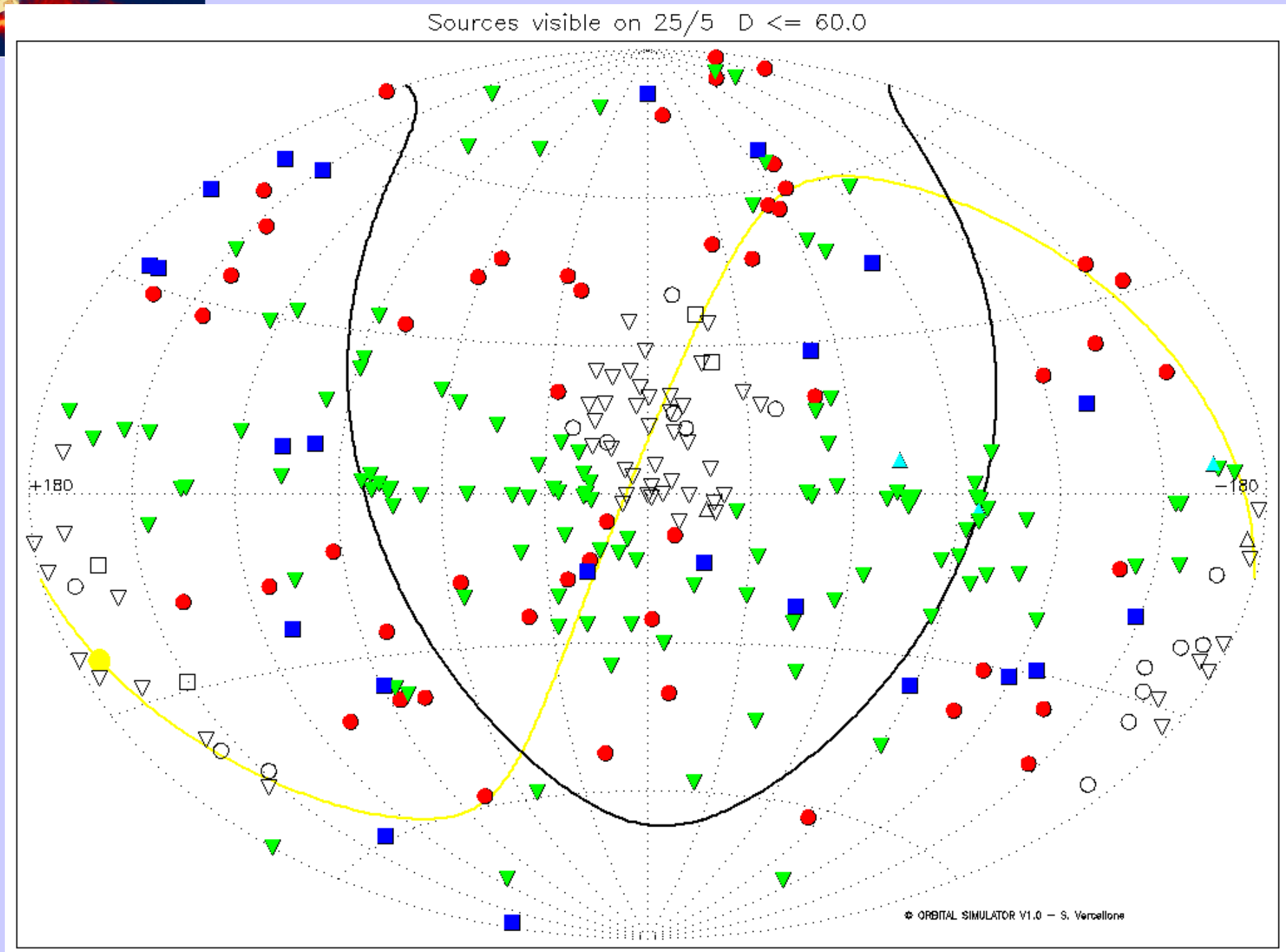
AGILE pointing Constraints:

1. Solar panels always orthogonal to the Sun vector.
2. On-axis pointing directions are limited to a great circle, changing day-by-day

...BUT...

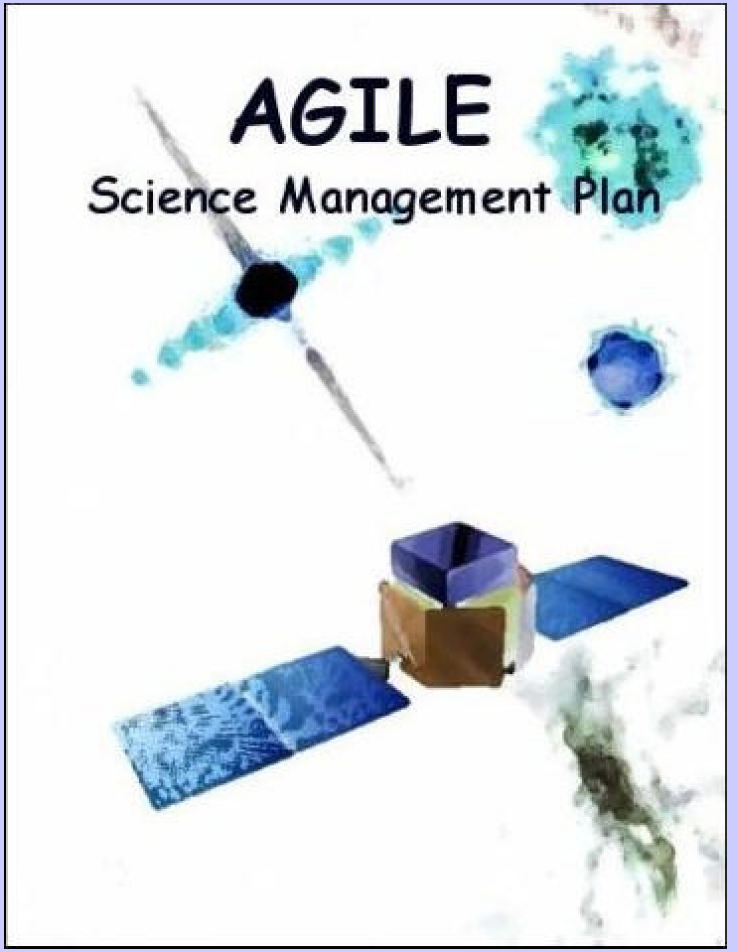
AGILE-GRID wide field of view (60 deg radius)

- Easy to include particular sources with a fine-tuning of the pointing direction
- Increased chances to detect a transient source


Sources visible on 25/5 D <= 60.0
+180
-180
© ORBITAL SIMULATOR V1.0 – S. Vercellone

AGILE Science Management Plan

- High level document issued in February 2004
- Defines:
  - Scientific Management of the mission
  - Guidelines for Pointing Program
  - High level project organization and share of responsibilities for ground segment
  - Scientific Programs and Data Rights Policies



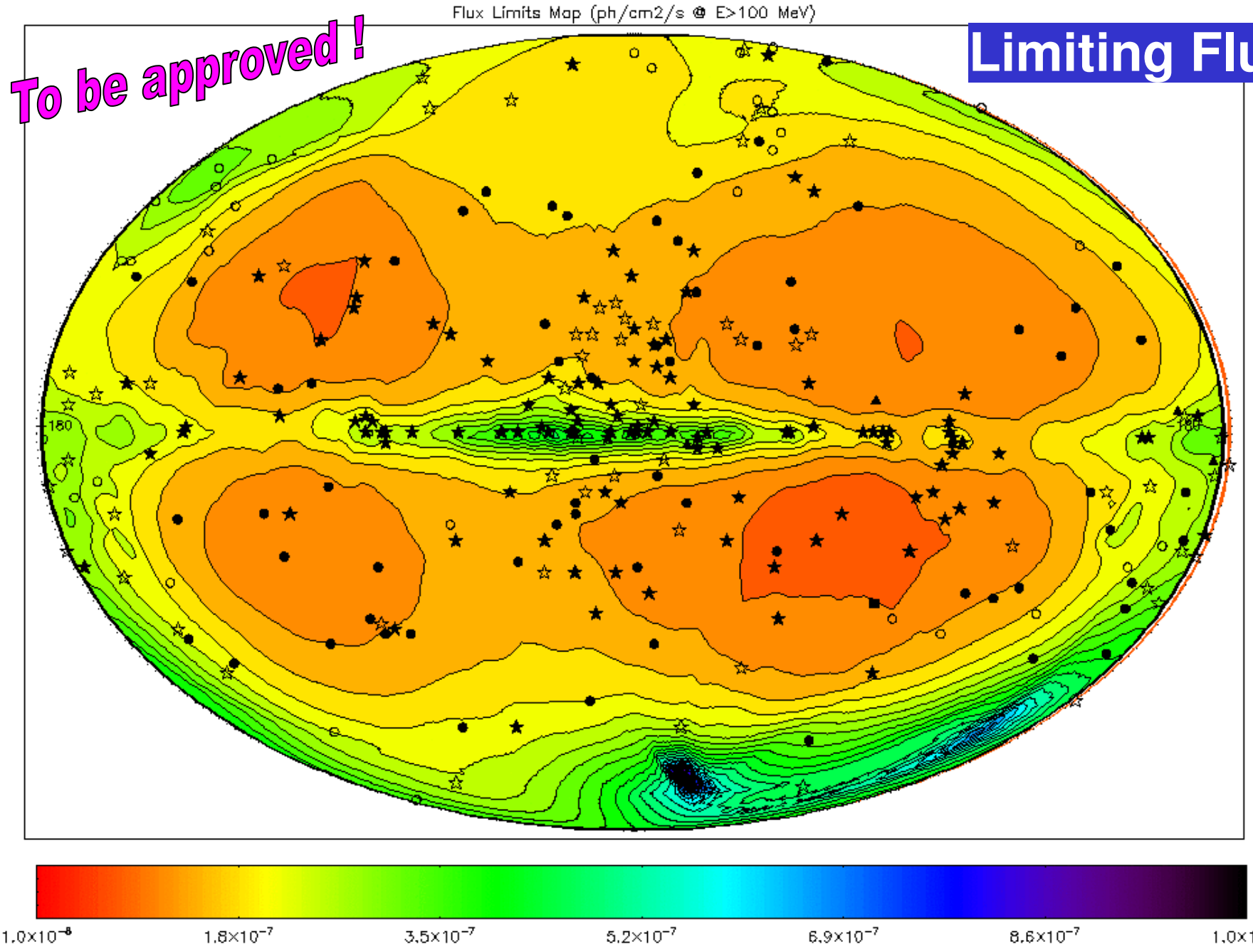
AGILE Scientific Program

- **Pointing Plan defined a priori**
  - **to optimize sky coverage, multi-λ programs, etc….**
  - **"Data" allocation instead of "Time" allocation**

- **SuperAGILE (20 - 40 keV) → publicly available RESULTS (no SuperAGILE data distributed)**

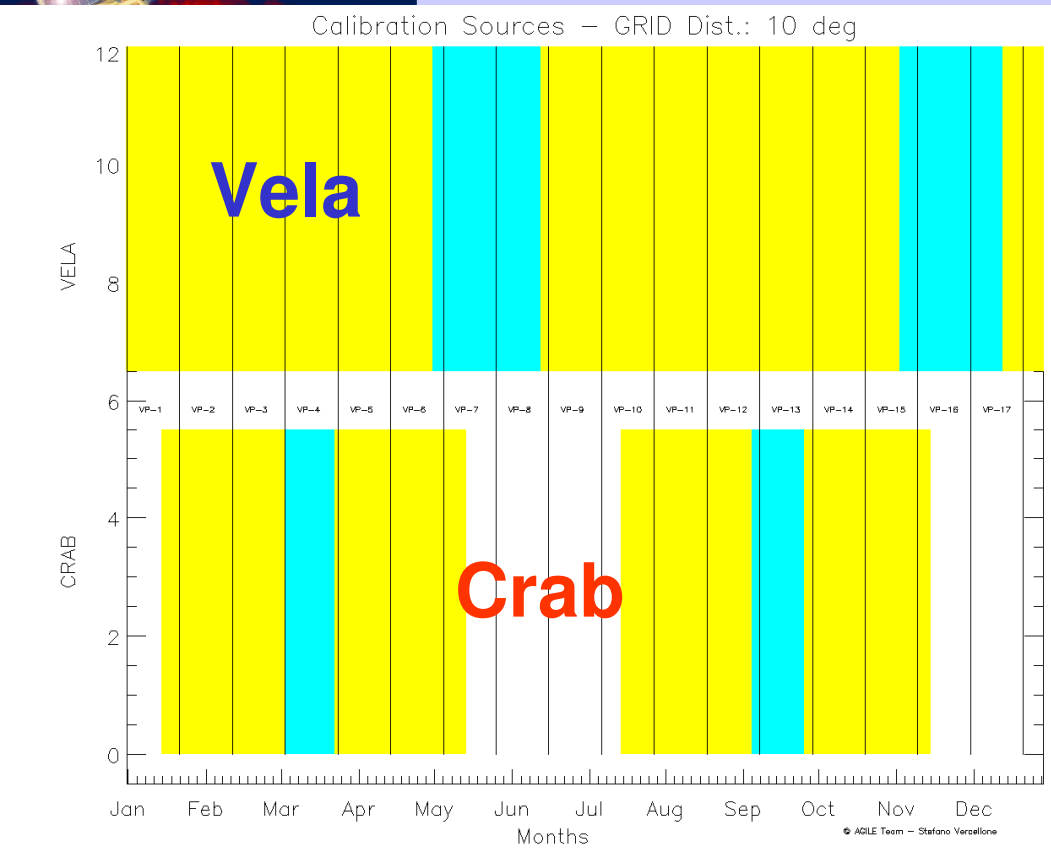
- **GRID data (30 MeV – 50 GeV)**
  - **→ AGILE Team Projects**
  - **→ Guest Observers Program**

AO document in Preparation (AT + ASI)


Flux Limits Map (ph/cm2/s @ E>100 MeV)
To be approved !
Limiting Flux
1.0x10⁻⁸
1.8x10⁻⁷
3.5x10⁻⁷
5.2x10⁻⁷
6.9x10⁻⁷
8.6x10⁻⁷
1.0x10⁻⁶

1. **Calibration Sources**
   - Sources with known X-ray and gamma-ray flux
   - Intense and steady
   - PULSARS!
2. **Calibration strategy**
   - Calibration of the entire field of view: large amount of time
   - GRID and SA calibration: small off-axis required (SA)

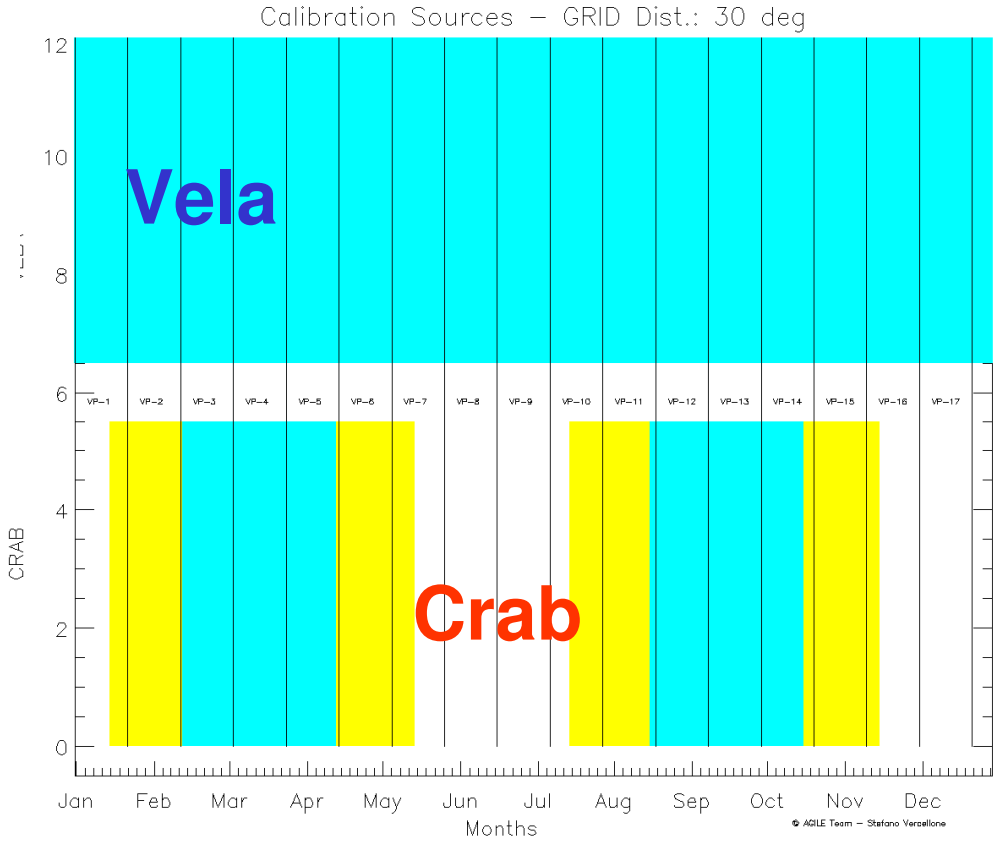
In-Flight Calibration & SPV Issues



Theta < 10°

10°<Theta<60°

Theta > 60°



Theta < 30°

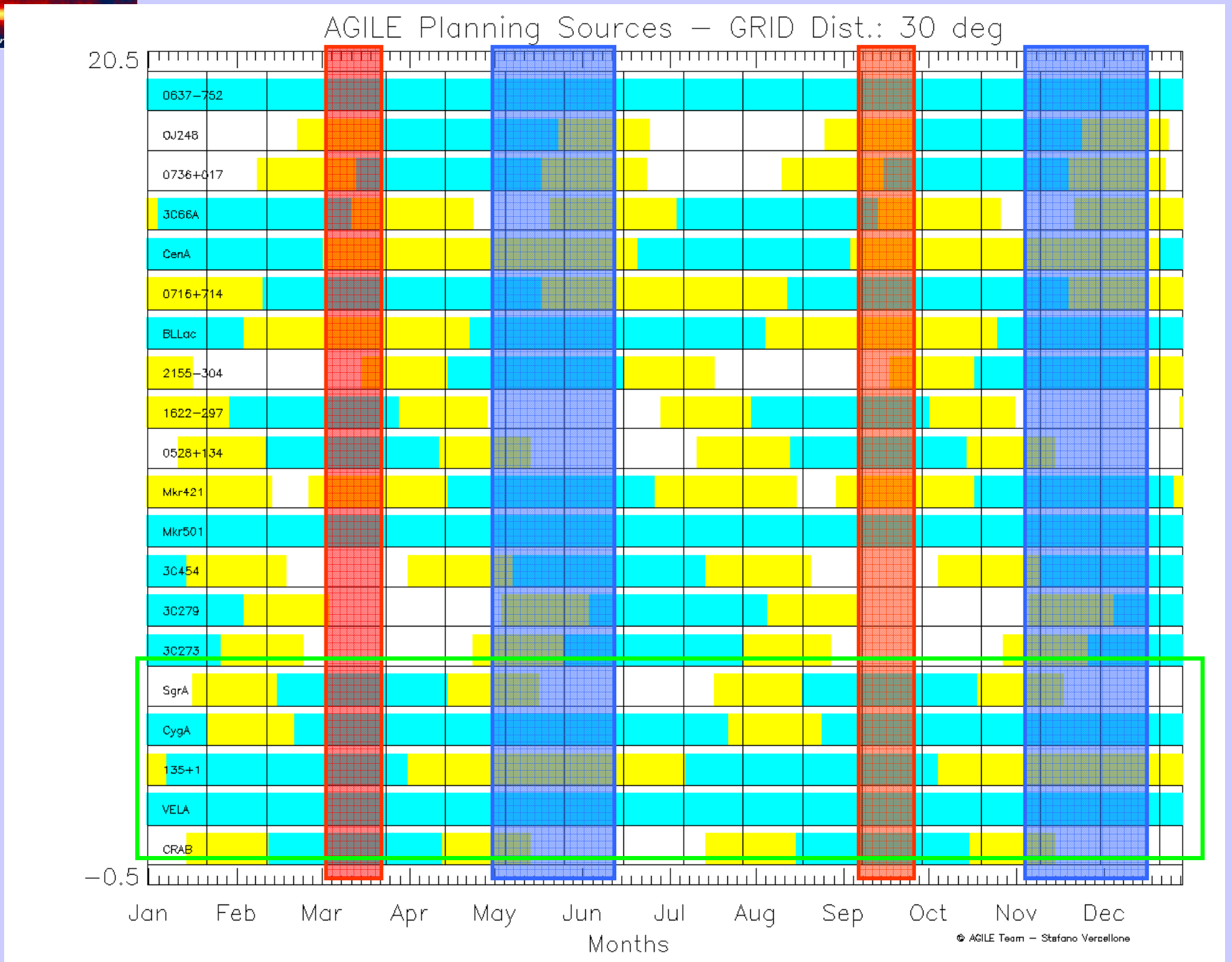
30°<Theta<60°

Theta > 60°

AGILE Pointing Plan : Calib. Constr.

Crab

Vela



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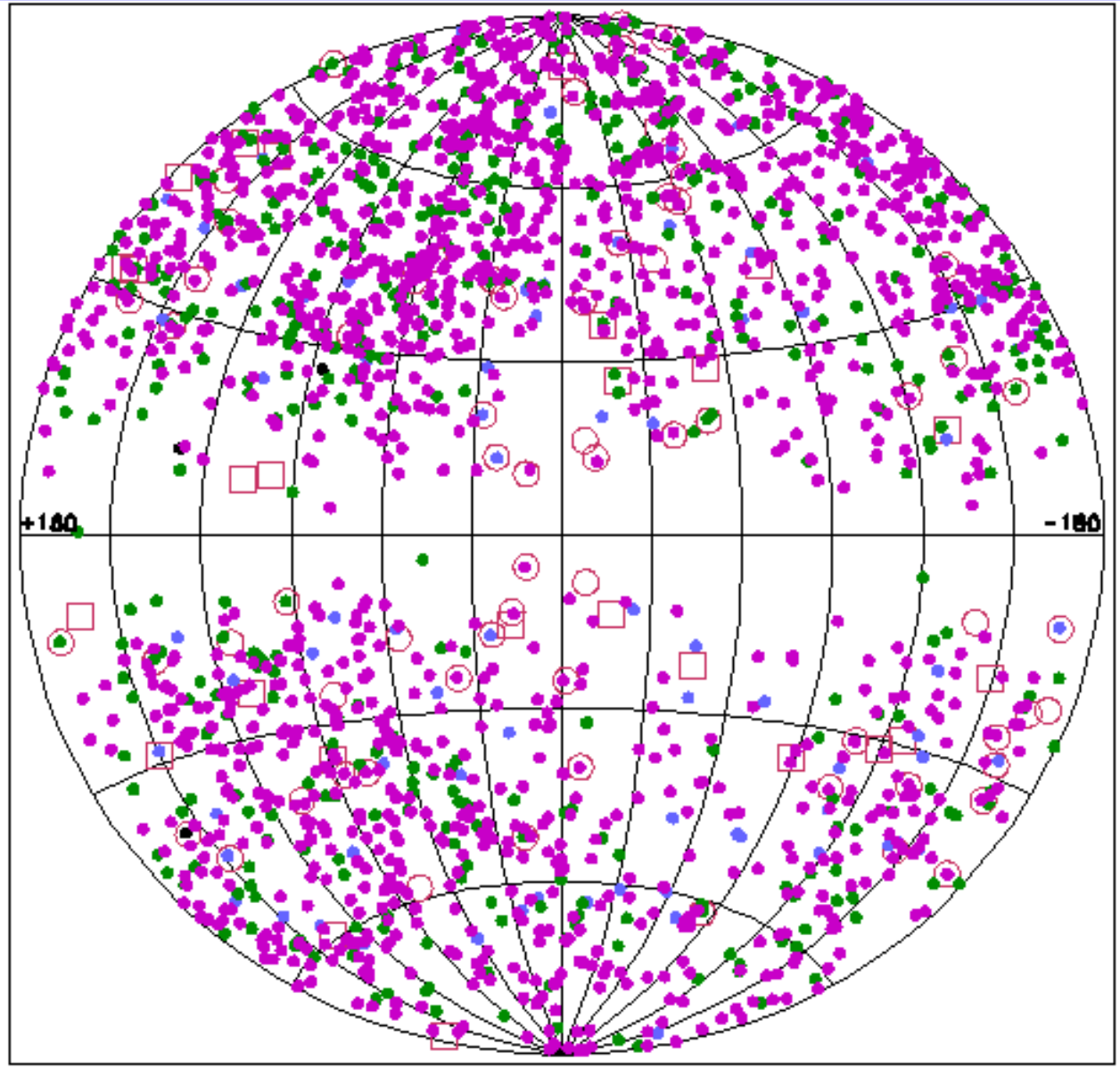
Multi-λ Studies : so many Blazars !



EGRET IDEN. AGNs: 67

EGRET CAND. AGNs: 27

KUEHR BLLAC OBJ.: 26

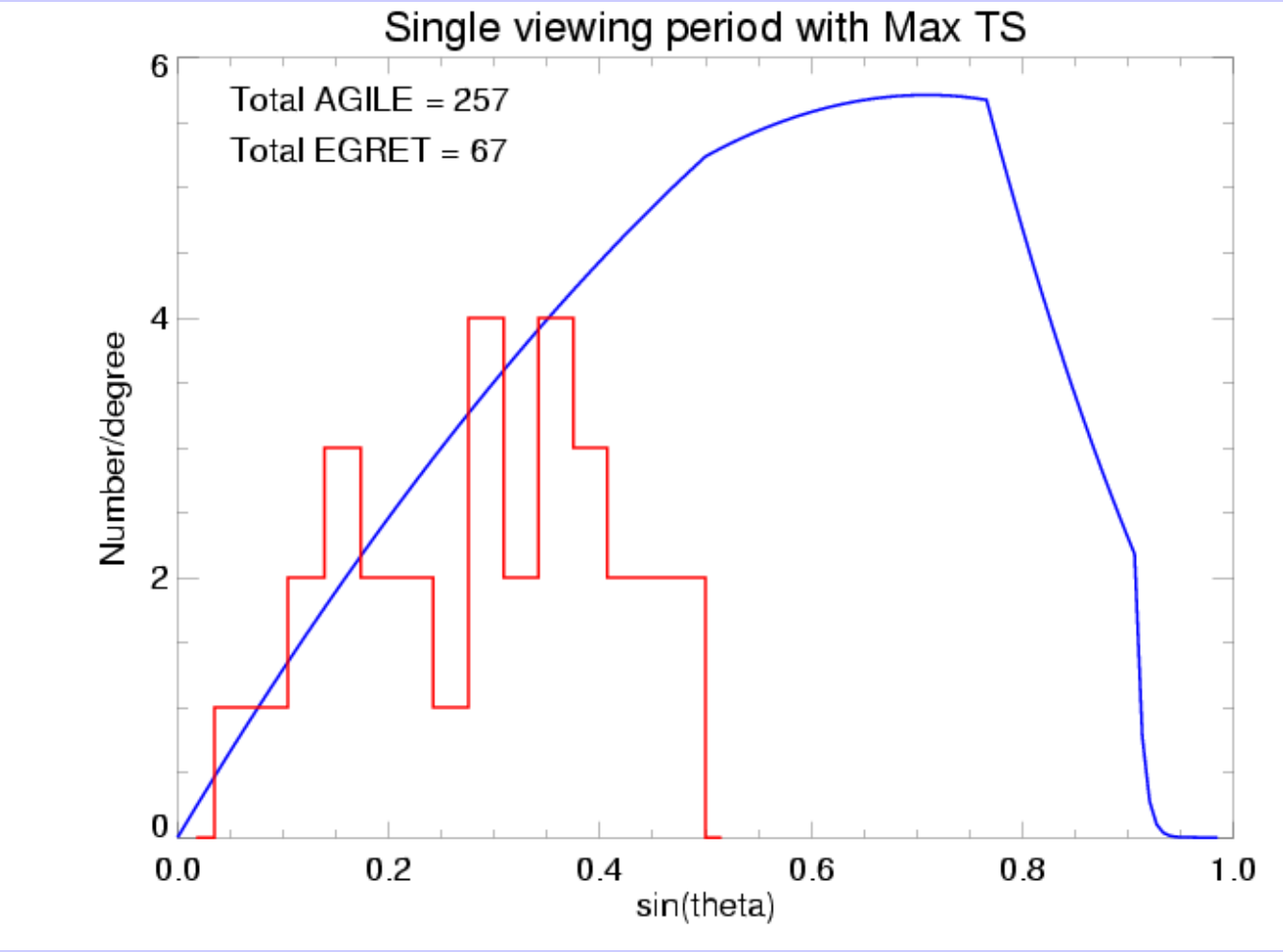
KUEHR FSRQ OBJ.: 203

VERON BLLAC OBJ.: 447

VERON QSO OBJ.: 1426

Not all blazars are gamma-ray emitters…

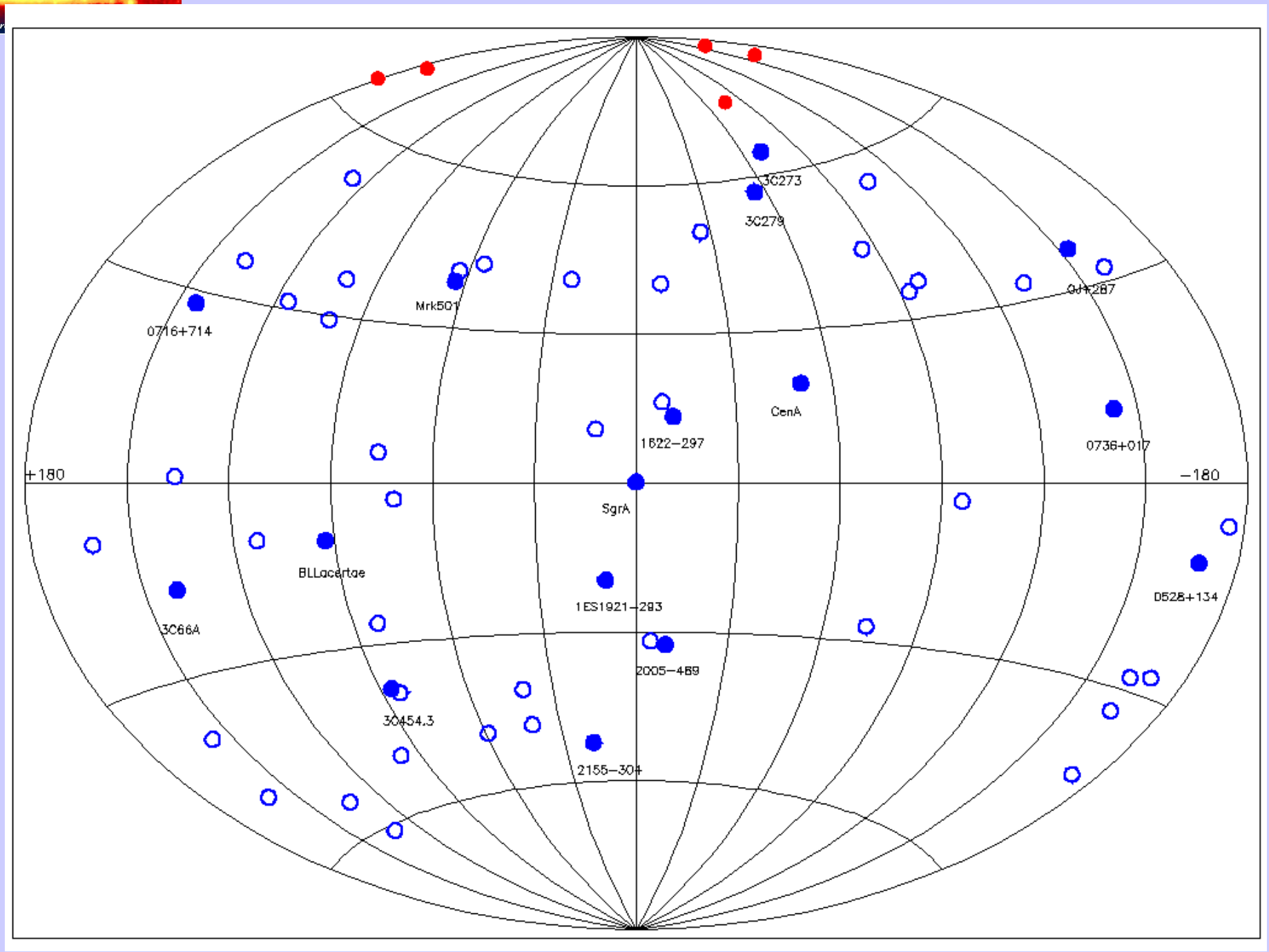
1. **Blazar gamma-ray duty-cycle**
   - Stecker and Salamon, 1996
   - Vercellone et al., 2004
2. **Radio – gamma-ray relationship**
   - Padovani et al., 1993 — Y
   - Dondi & Ghisellini, 1996 — Y
   - Mucke et al., 1997 — N
   - Jorstad et al., 2001 — Y
3. **Lorentz factor and Doppler factor**
   - Kellermann et al., 2004
4. **Structured Jets (radio galaxies)**
   - Ghisellini et al., 2005

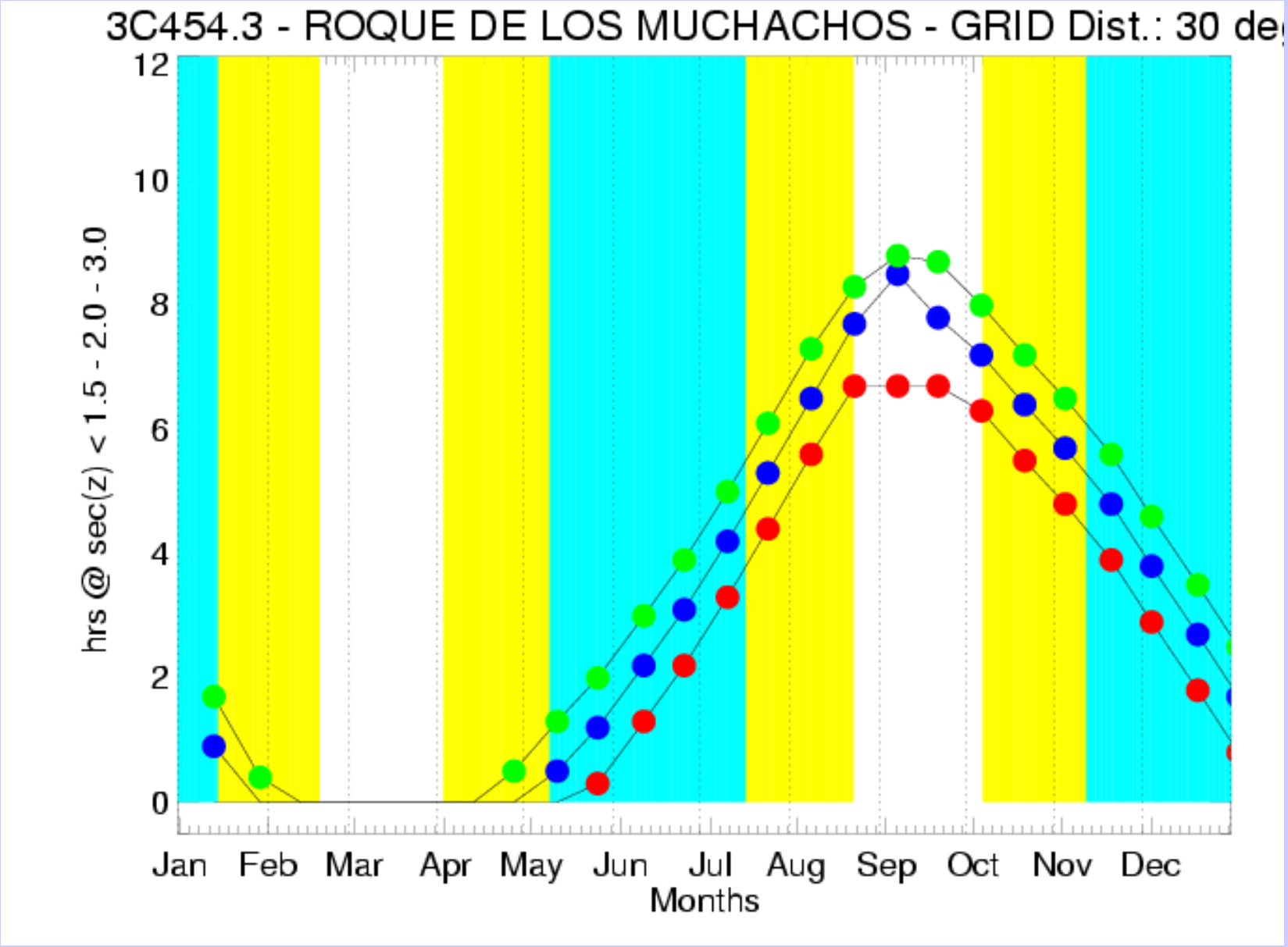


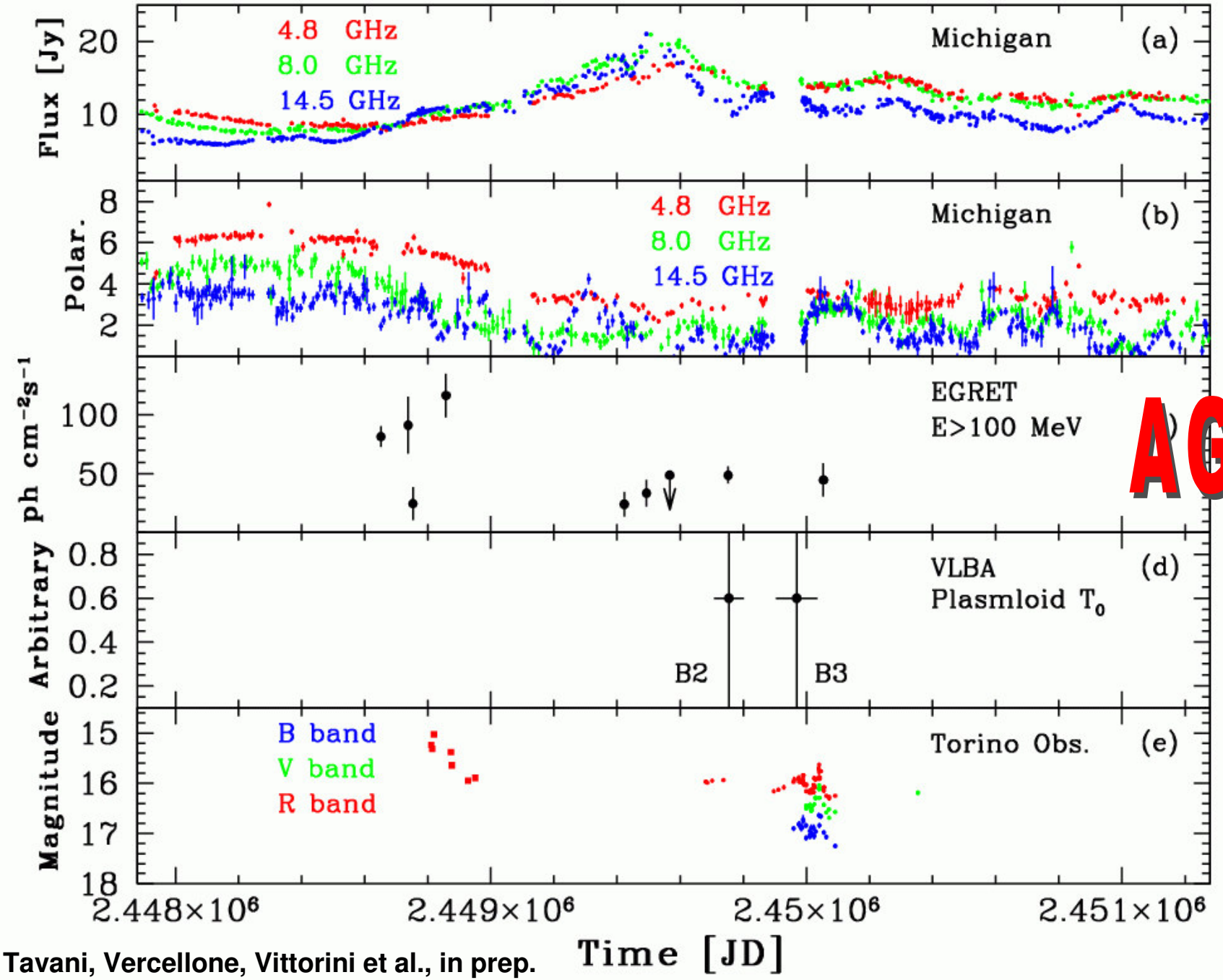
We expect :

- **to detect about 2 – 3 times more AGNs than EGRET.**
- **a dozen of AGNs simultaneously within the GRID FoV during each viewing period.**
- **5 – 10 blazars flaring above 100x10^{-8} ph/cm^2/s (E>100MeV) during the first year of AGILE observations.**

Multi-λ Studies : hottest AGNs ?

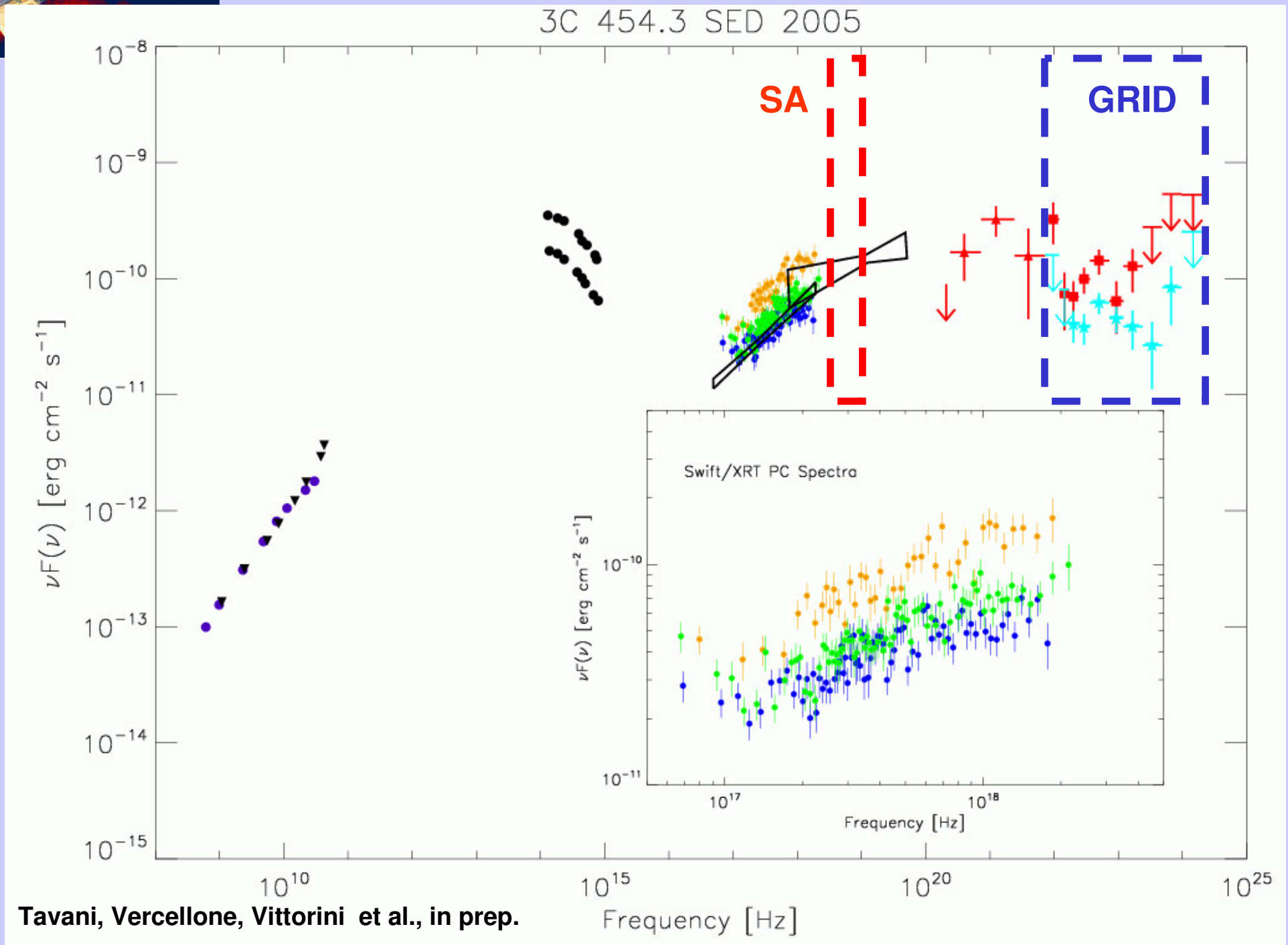



3C454.3 - ROQUE DE LOS MUCHACHOS - GRID Dist.: 30 de
hrs @ sec(z) < 1.5 - 2.0 - 3.0
0
2
4
6
8
10
12
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Months



Tavani, Vercellone, Vittorini et al., in prep.

Multi-λ Studies : 3C454.3



Tavani, Vercellone, Vittorini et al., in prep.

AT – AWG current members (alphabetical order):

- PI, co.PI and members of the AGILE Team Science Board, or their representatives;
- A. Ferrari (Turin University), Chair.
- 1 representative ENIGMA Network
- 1 representative INAF-IRA, Bologna
- 1 representative Perugia Observatory
- 1 representative REM project, Brera Observatory
- 1 representative Turin Observatory
- 1 representative University of Como
- 1 representative University Tor Vergata, Rome
- 1 representative WEBT Consortium.

AT – AWG role:

- optimizing the scientific return of future proprietary data obtained by the AGILE Team for the study of AGNs.

AT – AWG Scientific goals:

- provide the forum for general discussion and coordination between the AGILE Team and the Community

- rapid reaction to alerts for AGN flaring activity carrying out ground-based multiwavelength observations simultaneously with AGILE. In particular, a primary AT-AWG goal is to obtain, for a selected set of sources, a continuous coverage of optical observations of AGNs during gamma-ray flares lasting several days/weeks.

- long-timescale (months-years) monitoring of a selected number of AGNs to be used jointly with AGILE data for correlative multiwavelength (optical-radio) studies.

- VLBI/VLBA deep radio imaging of AGNs, with regular monitoring and through ToO observations following high-energy flaring activity of interest to AGILE.

Some example of AGNs Science with AGILE:

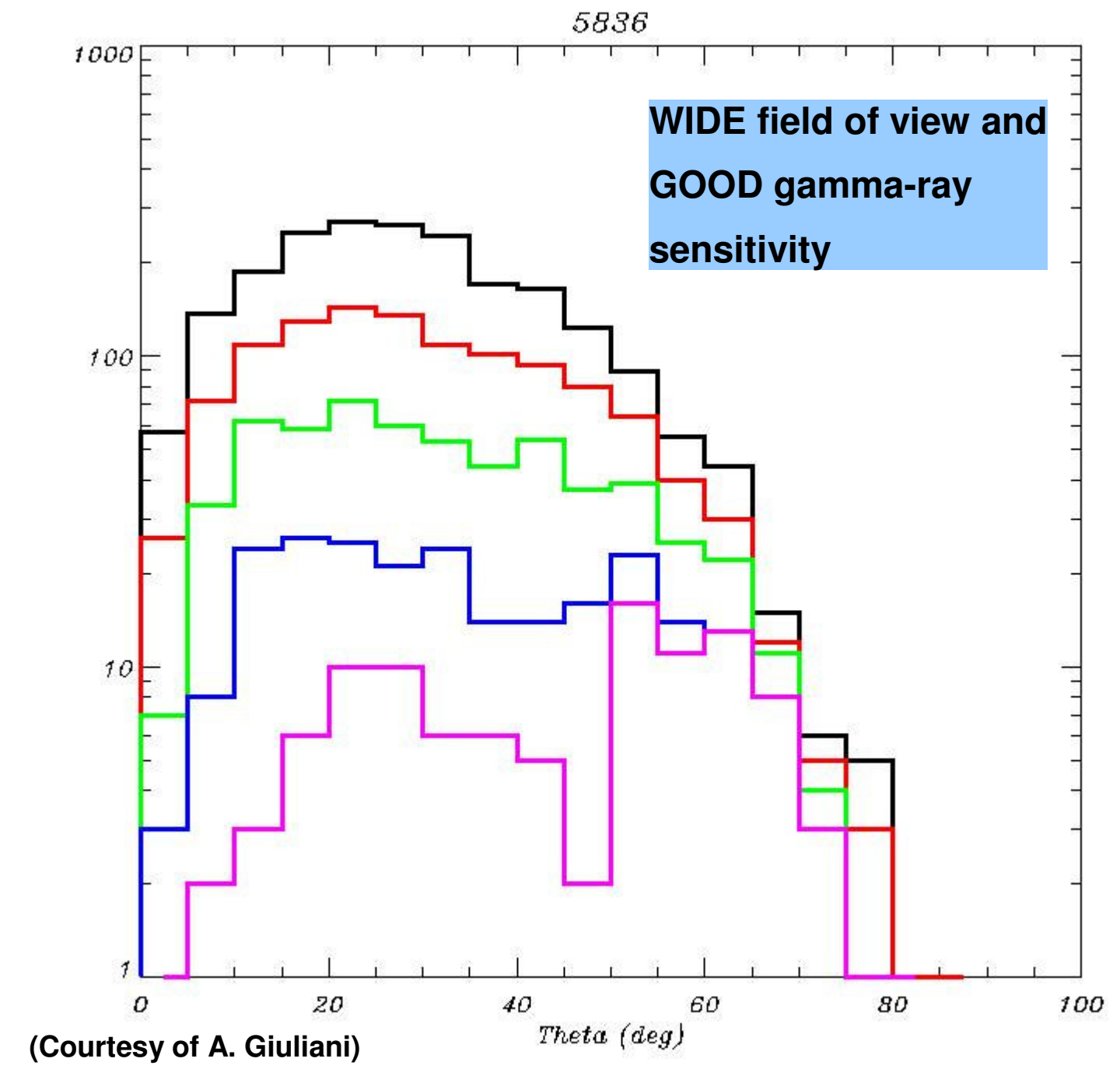
- The study of the **acceleration and radiation processes** of AGNs jets thanks to multi-λ studies and γ-X-ray detections.
- The **AGN duty-cycle** of the γ-ray flare and "plateau" states, because of its large FOV and long-term monitoring programs.
- The study of **AGN SEDs** with X-ray and γ-ray simultaneous data.
- The study of the correlation between **γ-ray flares and radio plasmoid** ejections.

http://agile.iasf-roma.inaf.it

THE END

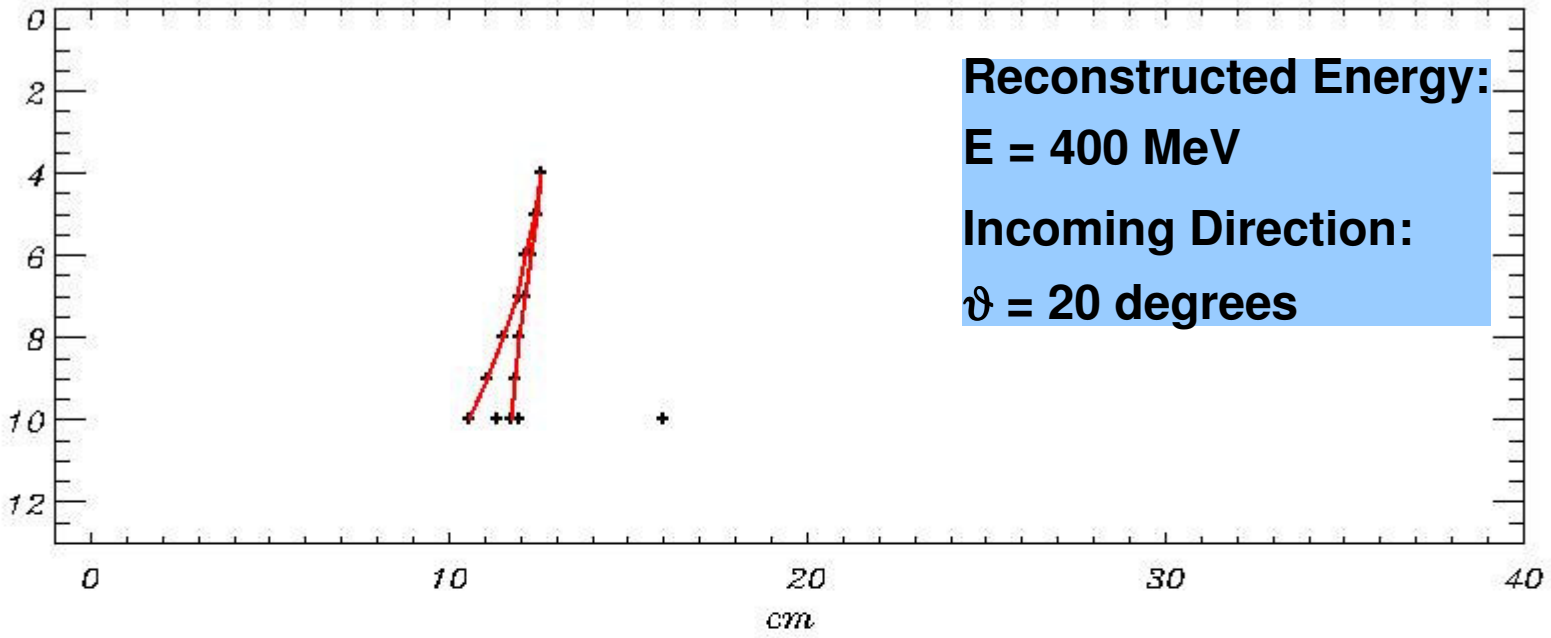
E > 50 MeV
E > 100 MeV
E > 200 MeV
E > 400 MeV
E > 800 MeV

Gamma-Rays detected by the AGILE-GRID during the May 2006 final functional test campaign.



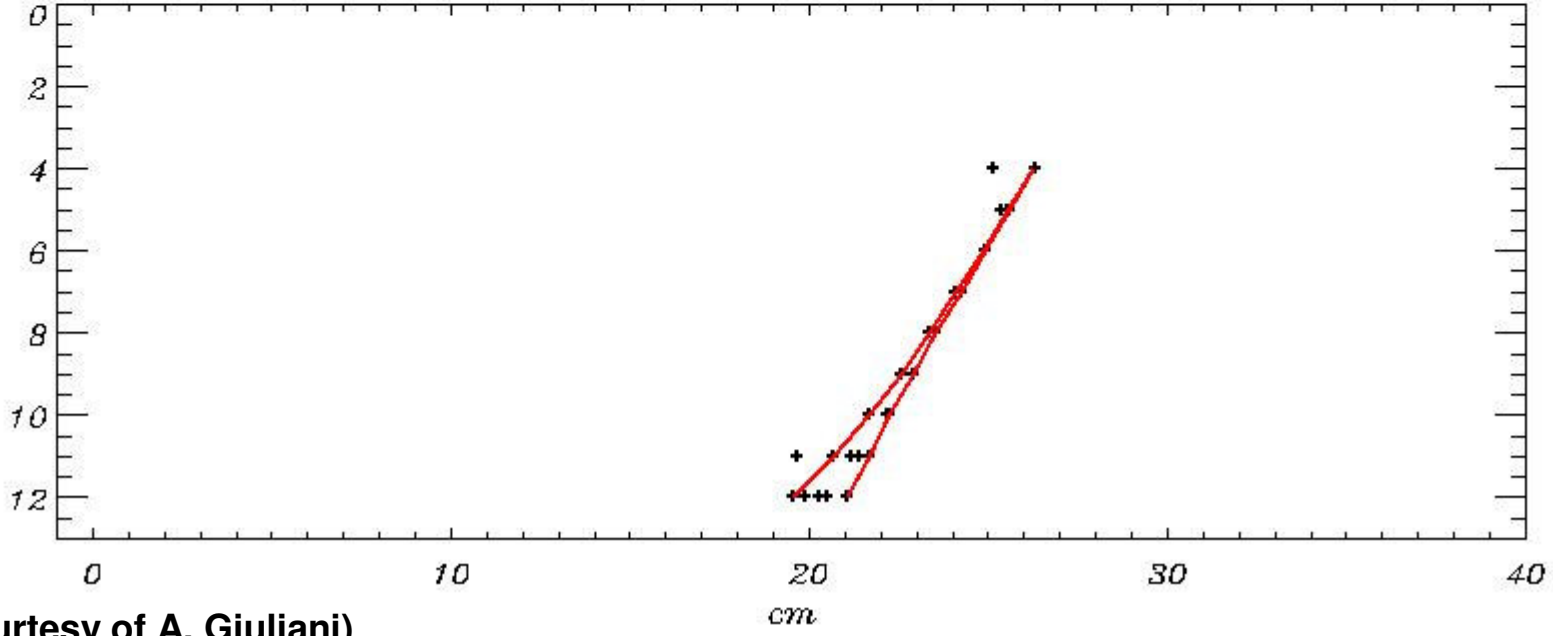
(Courtesy of A. Giuliani)

X-view



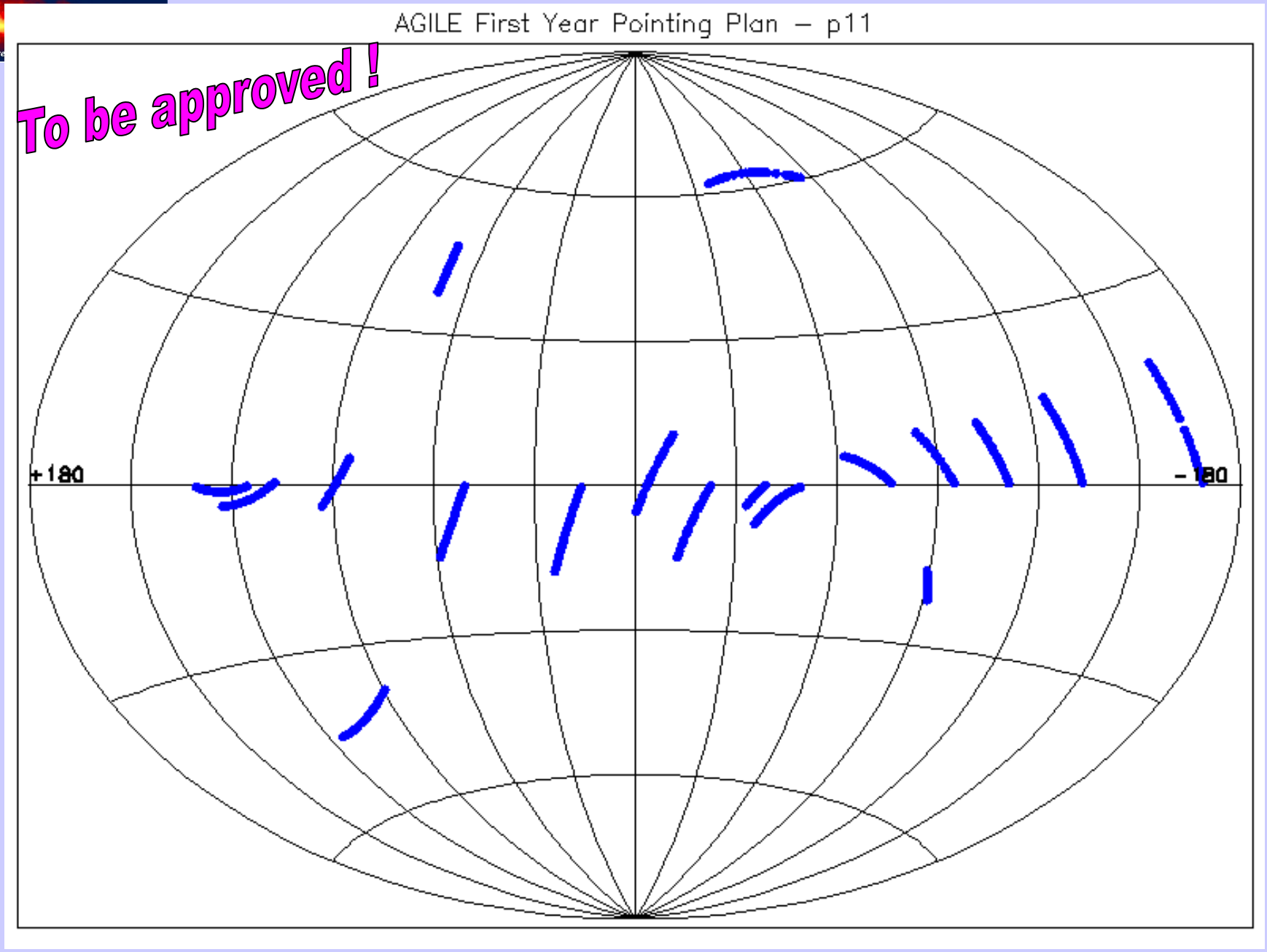
Reconstructed Energy:
E = 400 MeV
Incoming Direction:
ϑ = 20 degrees

Z-view



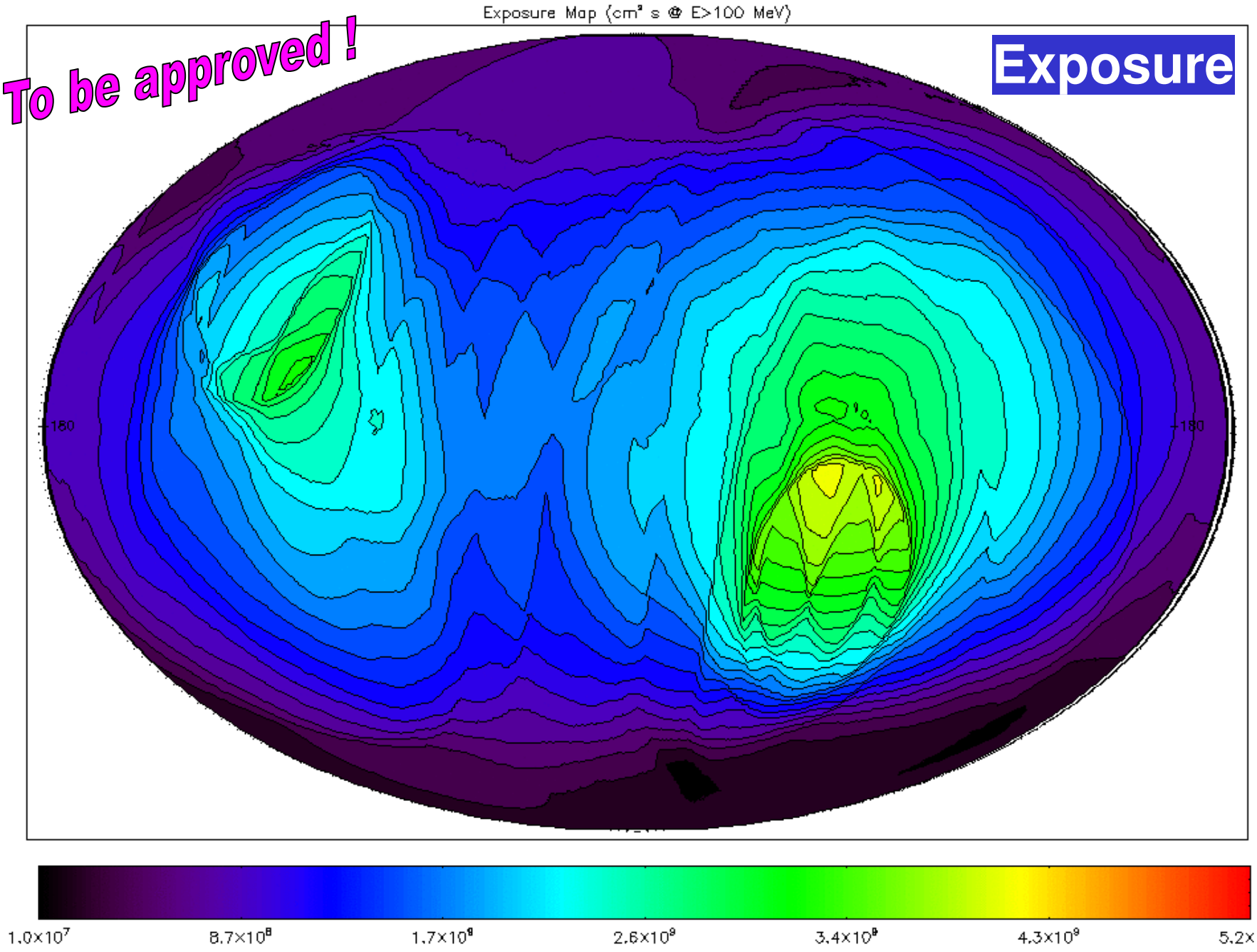
(Courtesy of A. Giuliani)

AGILE Pointing Plan : current status



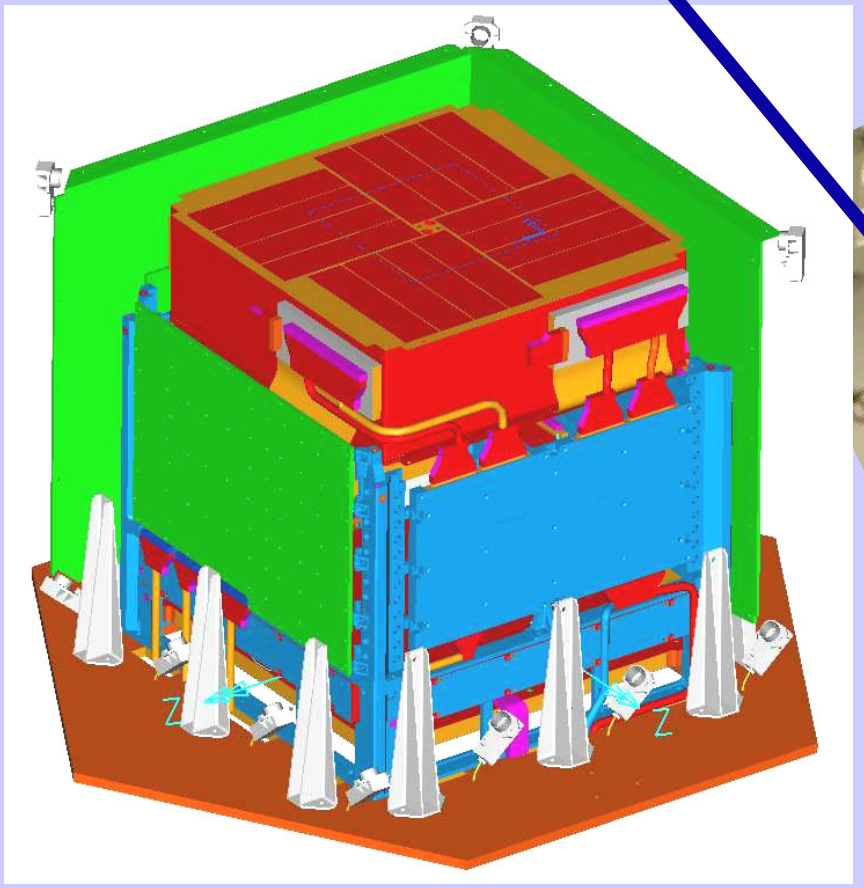
18 pointings (21 days each)

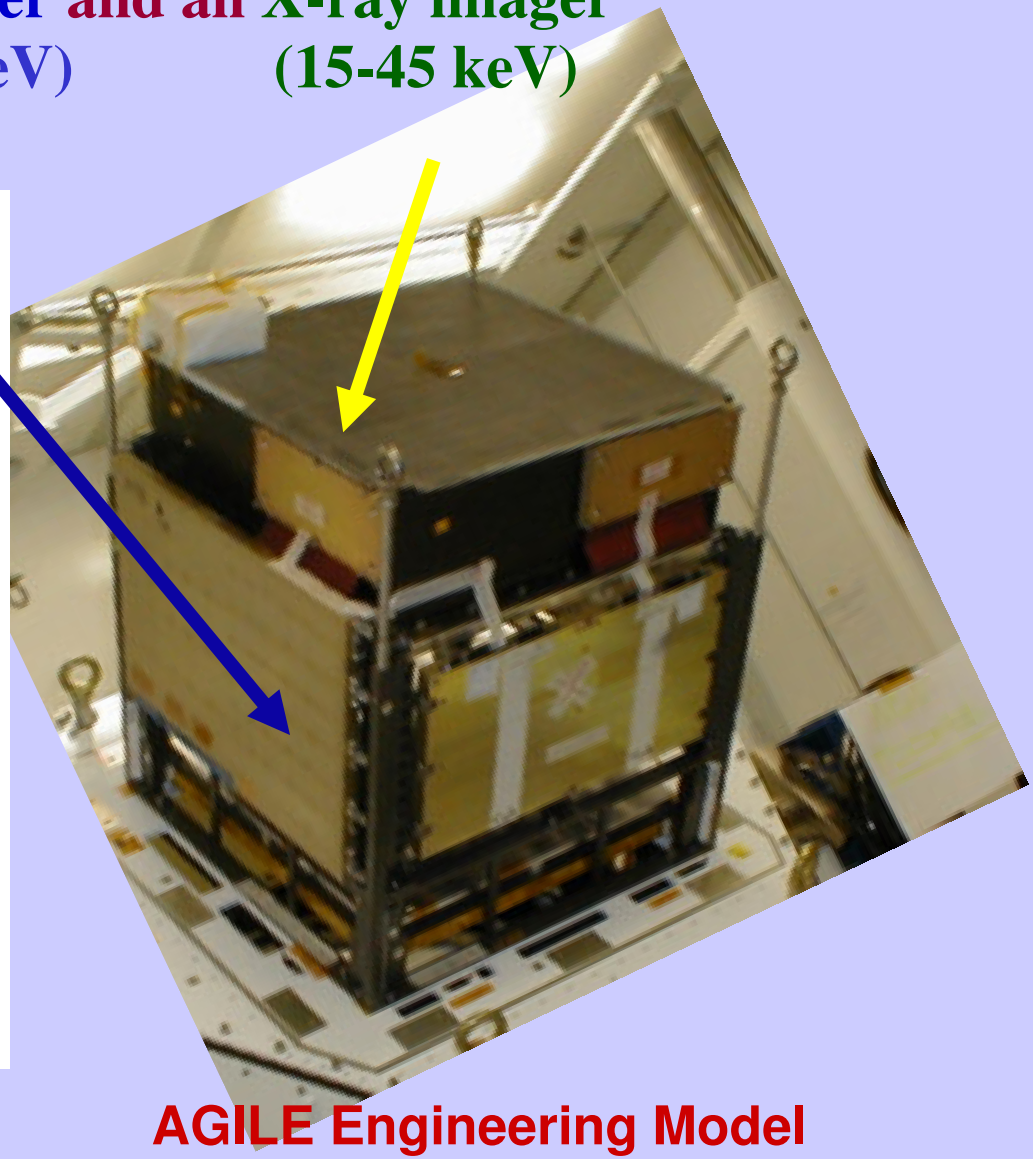
AGILE Pointing Plan : current status



Agile: FIRST and unique combination of a gamma-ray imager and an X-ray imager

(30 MeV-30 GeV) (15-45 keV)

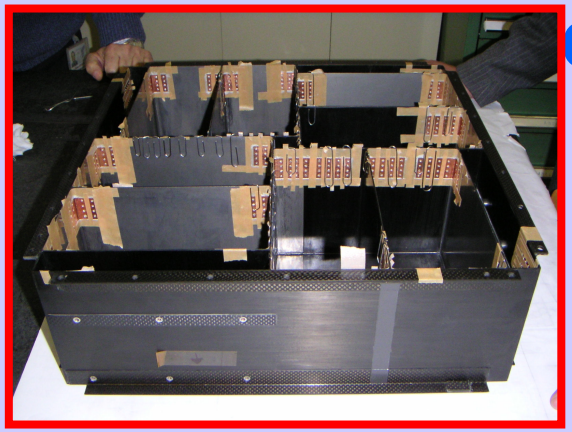




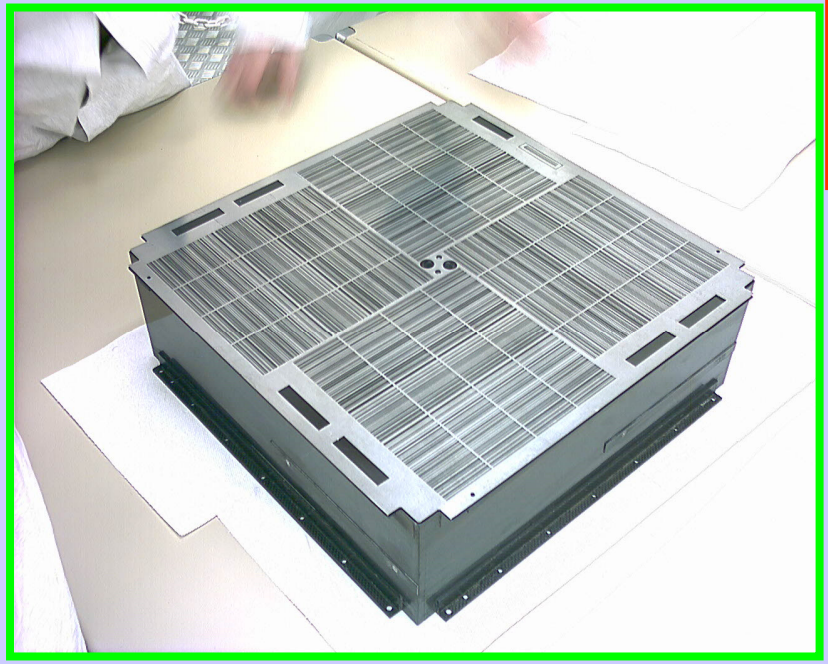
AGILE Engineering Model

B) SuperAgile - Sviluppo Unità PFM

COLLIMATORE-MASCHERA



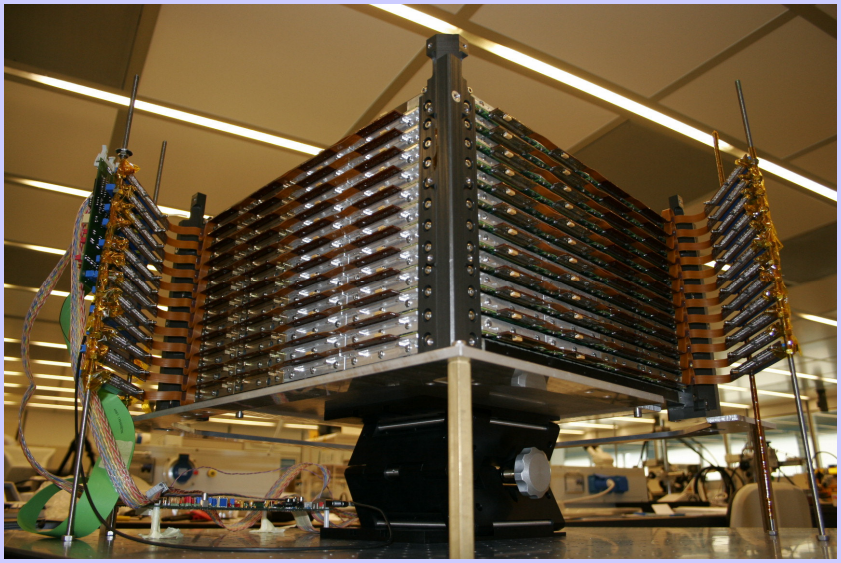
Collimatore

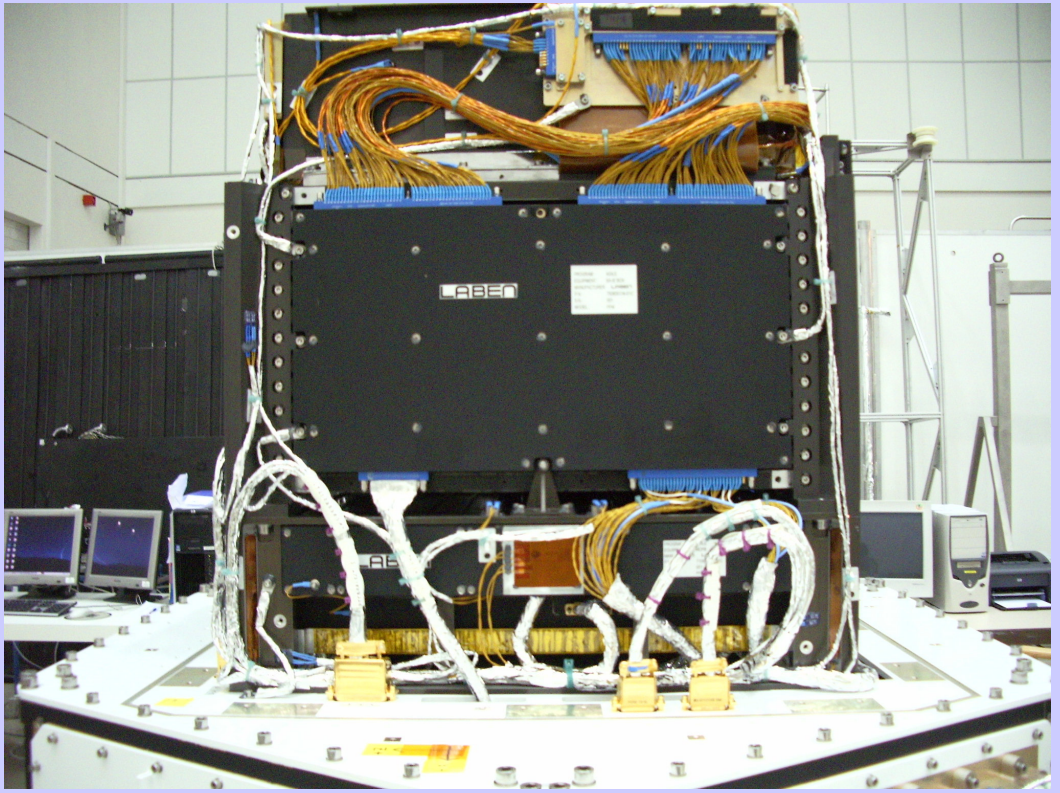


Assembly

Maschera


agile
Astro-rivelatore Gamma a Immagini LEggero




LABEN