Use of the equatorial orbit for space missions *Beppo*SAX and AGILE

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Equatorial Low Earth Orbit (LEO)

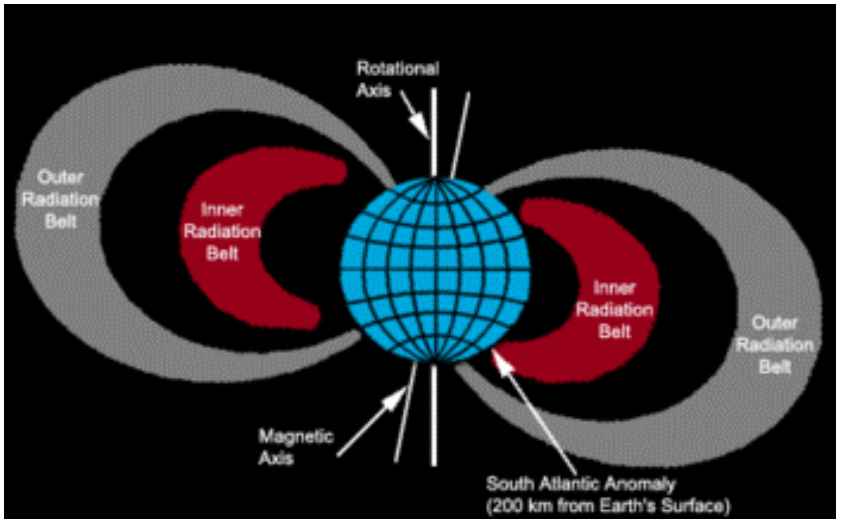
500-600 km altitude, inclination <~ 5 deg.

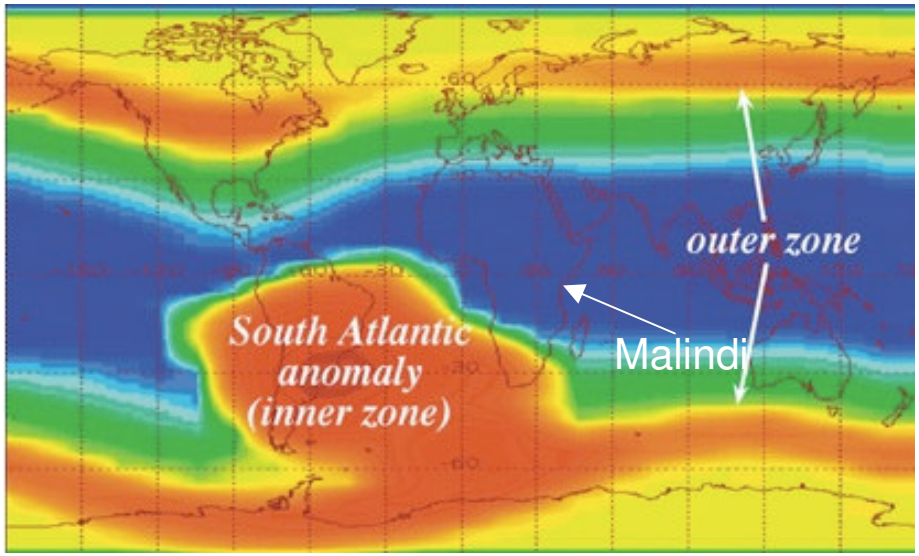
Very good for scientific satellites because of

- Low particle background
- Not strongly affected by SAA (South Atlantic Anomaly)
- Low background modulation by Earth magnetic field

Facilitated the beginning of High Energy Astrophysics
HUHURU, SAS2, ARIEL-V, SAS3
Early X-ray and Gamma-ray missions (1970-1975)
Launched from Malindi Kenya

The South Atlantic Anomaly





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*Beppo*SAX

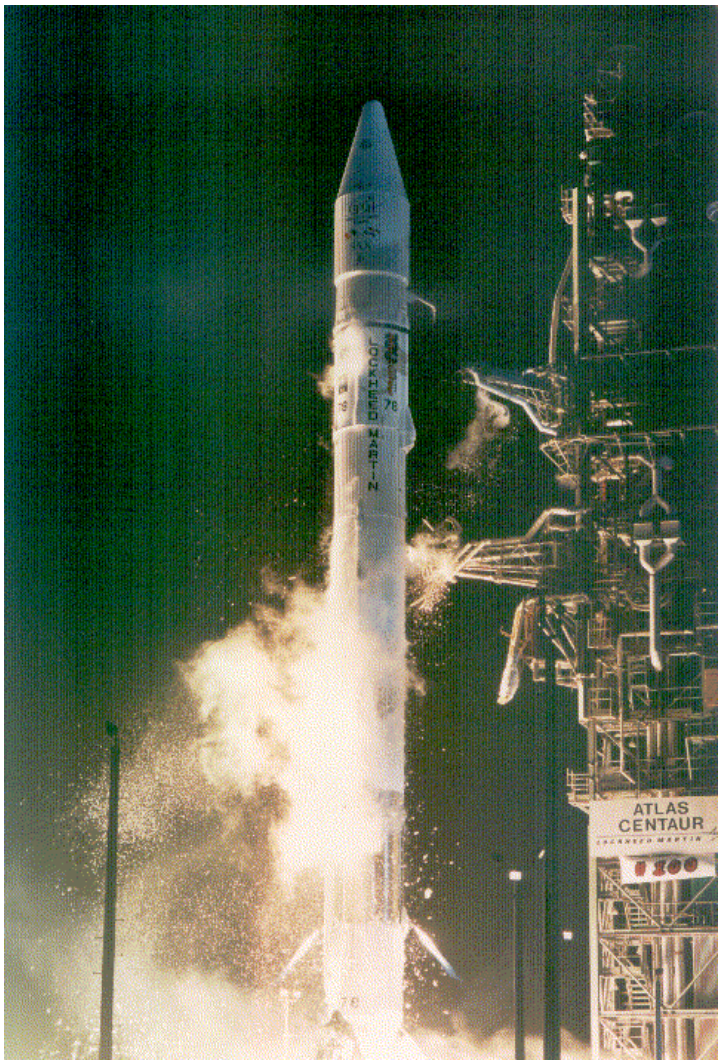
Satellite for X-Ray astronomy

Lauched on 30 April 1996
by an Atlas-centaur in an
equatorial, nearly circular orbit
at 600 km altitude.

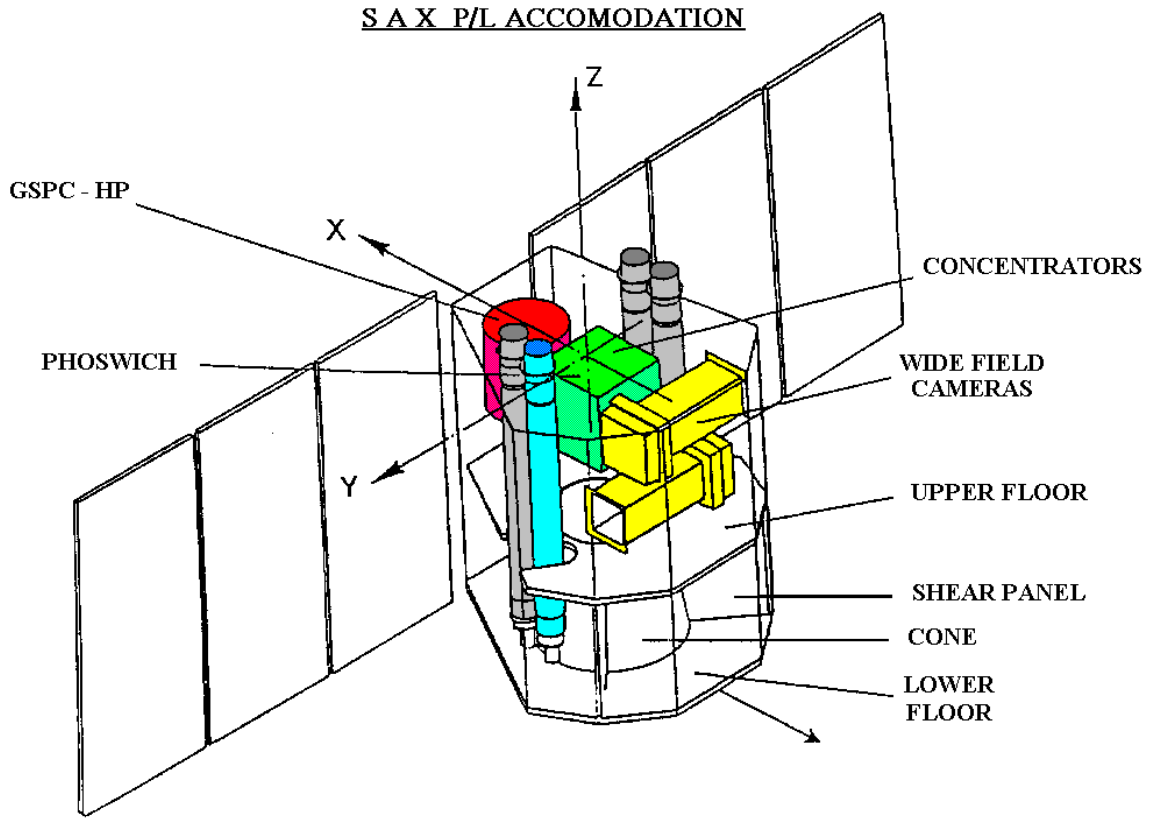
April, 30 1996 – April, 30 2002

6 years of X-ray astronomy

Re-entry on April, 30 2003



*Beppo*SAX, the payload

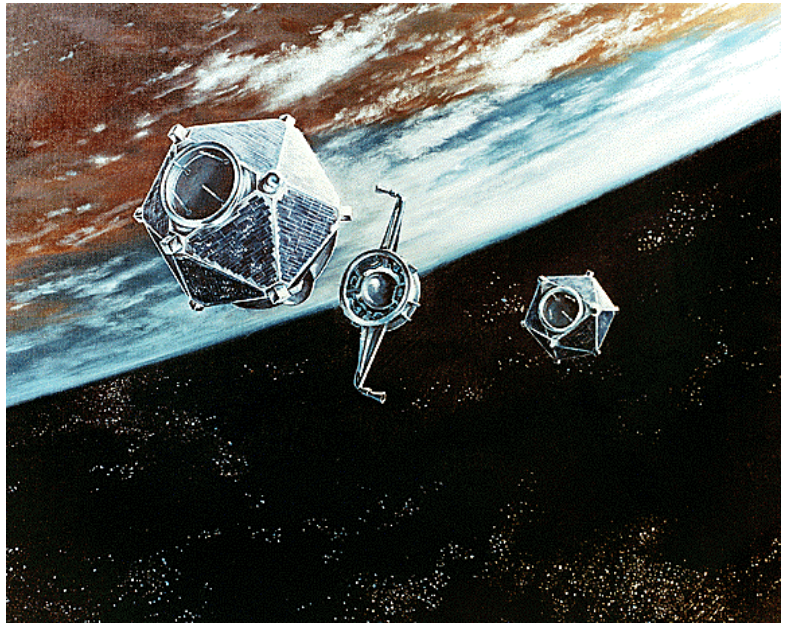


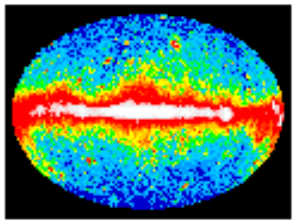
Dedicated to X-ray astrophysics (0.1 - 200 keV)

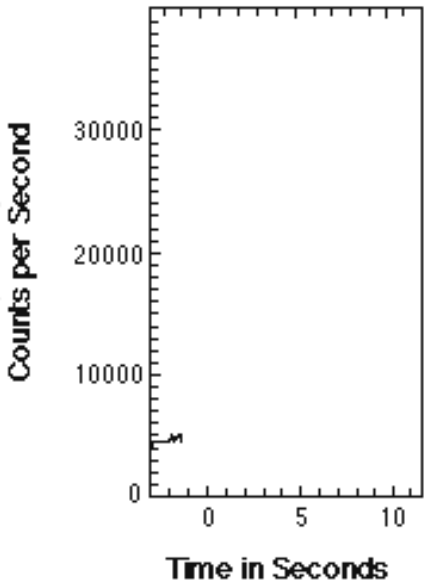
Rossi prize 1998 for GRB discoveries

The discovery of Gamma Ray Bursts

- 1967-1973 Vela 4,5,6 satellites: looked for X and gamma rays to monitor compliance with the Geneva Limited Nuclear Test Ban Treaty of 1963 (no nuclear tests in space and atmosphere)
- Discovery of intense flashes of Gamma-rays of cosmic origin:
  GAMMA RAY BURSTS (GRBs)
  (Klebesadel et al. 1973; Strong et al 1974)





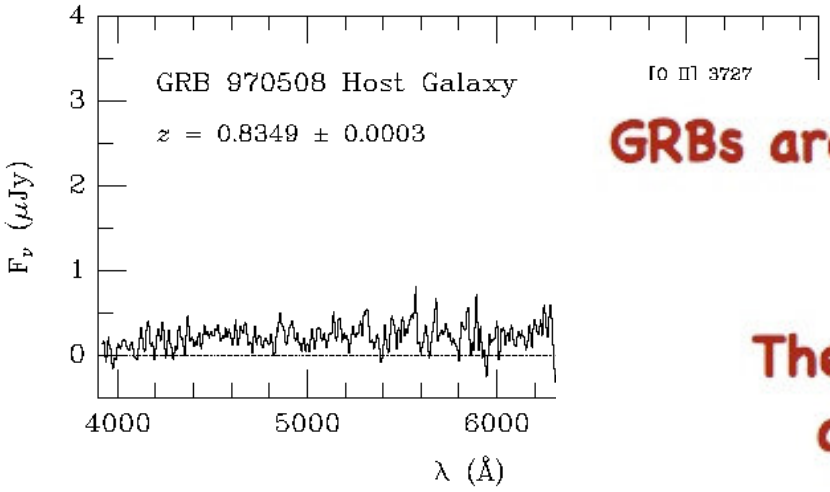


-Hundreds GRBs discovered from satellite networks through the 80's
No clue on source distance

-Early models often involved neutron stars

- Remarkably little is known about gamma- ray bursts (Harwit 1984 in "Cosmic Discovery")

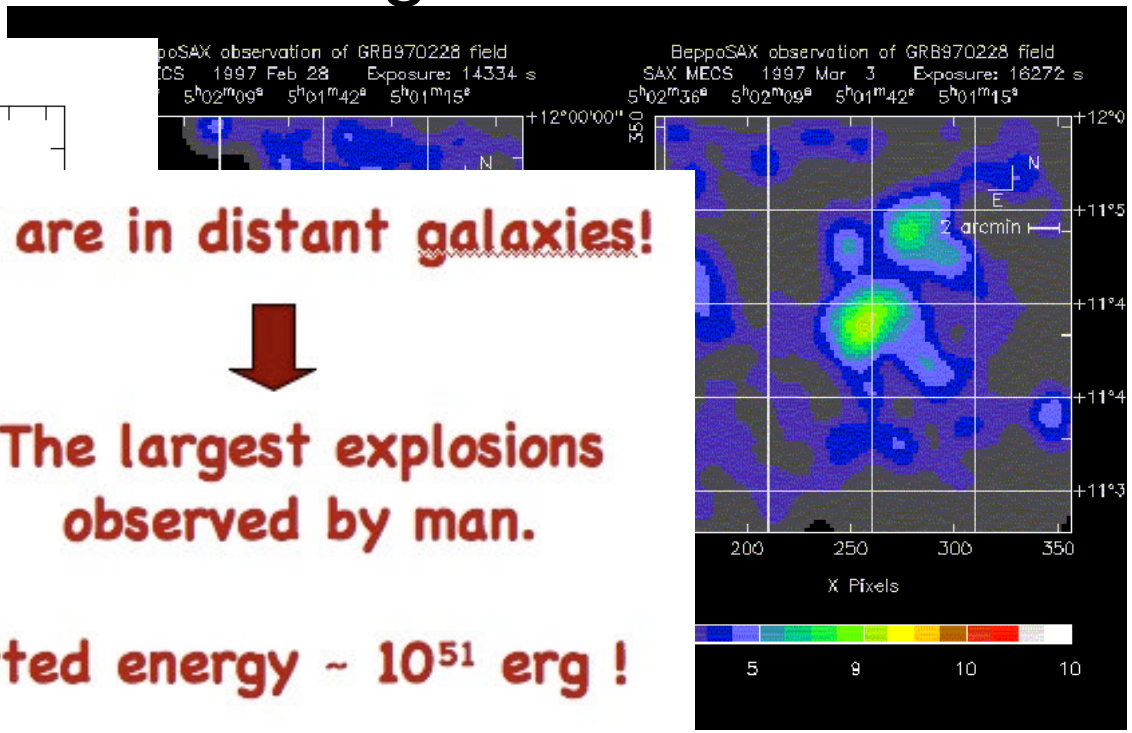
GRB970228: the 1st X-ray and Optical afterglow



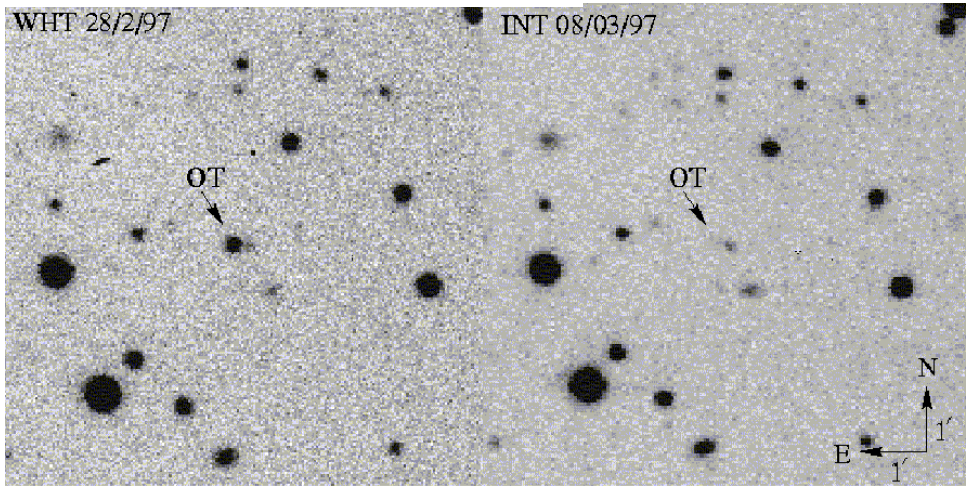
GRBs are in distant galaxies!

The largest explosions observed by man.

emitted energy ~ 10^{51} erg !



- Accurate (~1 arcmin) X-ray position led to the identification of a fading optical source from ground based telescopes



(Van Paradijs, et al., 1997)

The AGILE mission

The AGILE mission

- ✓AGILE is a project of the ASI Scientific Program dedicated to gamma-ray astrophysics
- ✓The Launch is planned for March 30 2007
- ✓Only mission entirely dedicated to gamma-ray astrophysics (E>30 MeV) in 2007
- ✓Multi-wavelength follow-up program
- ✓Small Mission with a Guest Observer Program

The AGILE mission

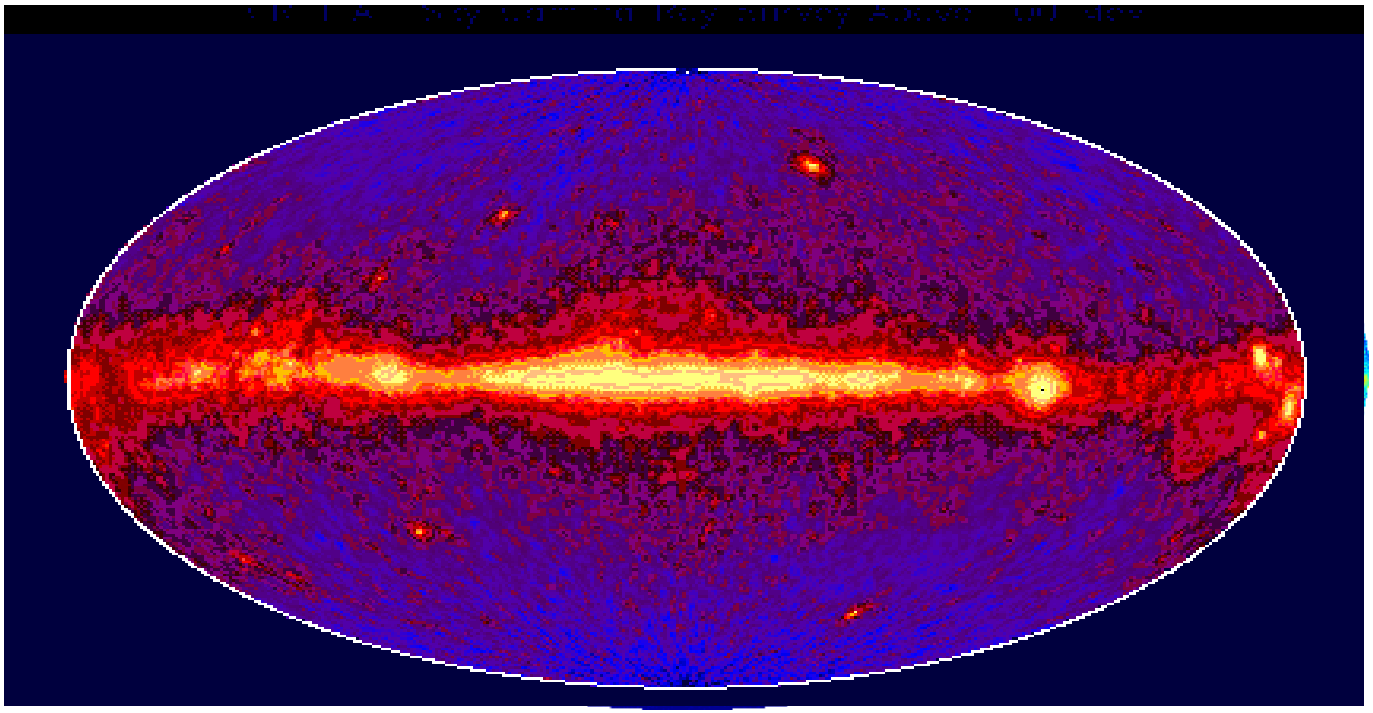
- Total satellite mass ~ 350 kg (equivalent to a Small Explorer, SMEX - class satellite)

- Scientific Instrument mass: 120 kg
  (extremely low for a gamma-ray detector)

- A highly innovative Instrument including :
  two imaging detectors:

the Gamma-Ray Imaging Detector (GRID)
made of a Silicon Tracker supported by
a Mini-Calorimeter (MCAL) and Super-AGILE (SA).

The Gamma-Ray Sky

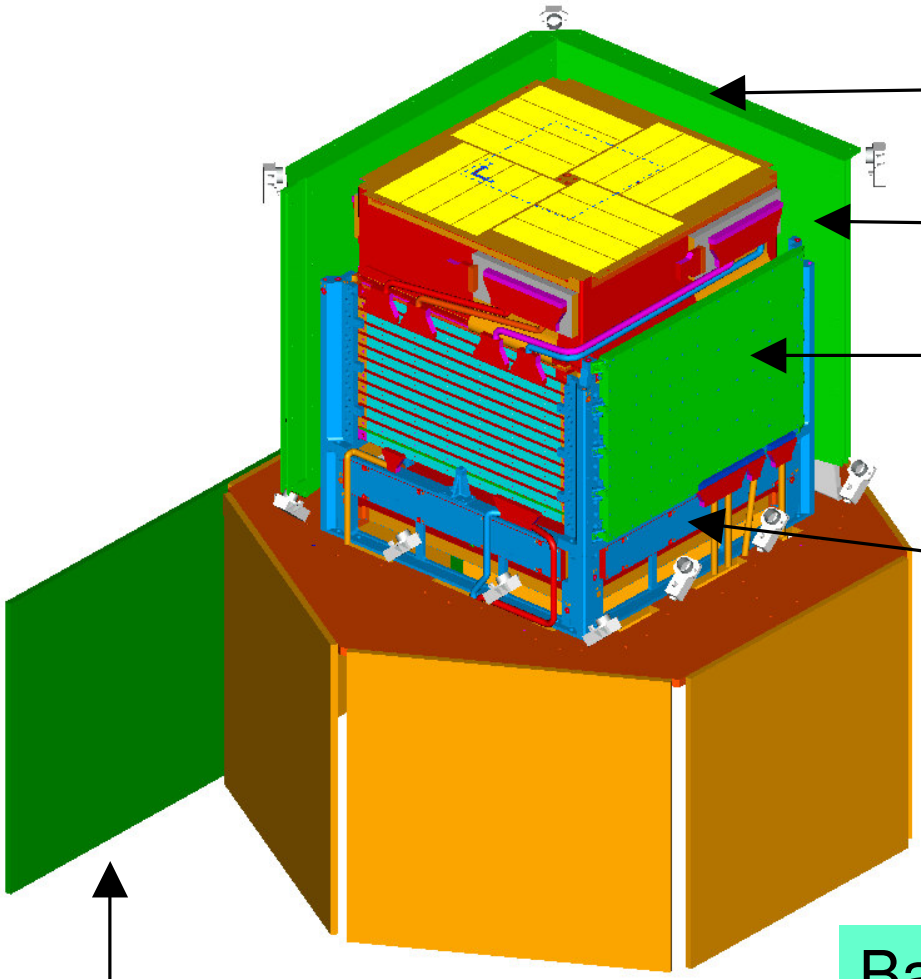


EGRET
1991-1999

AGILE
2007-2009

GLAST
2008-2013

AGILE Instrument



ANTICOINCIDENCE

SUPER-AGILE
(10 - 40 keV)

GRID { SILICON TRACKER
(30 MeV – 50 GeV)

MINI-CALORIMETER
(250 keV – 200 MeV)

MITA Bus

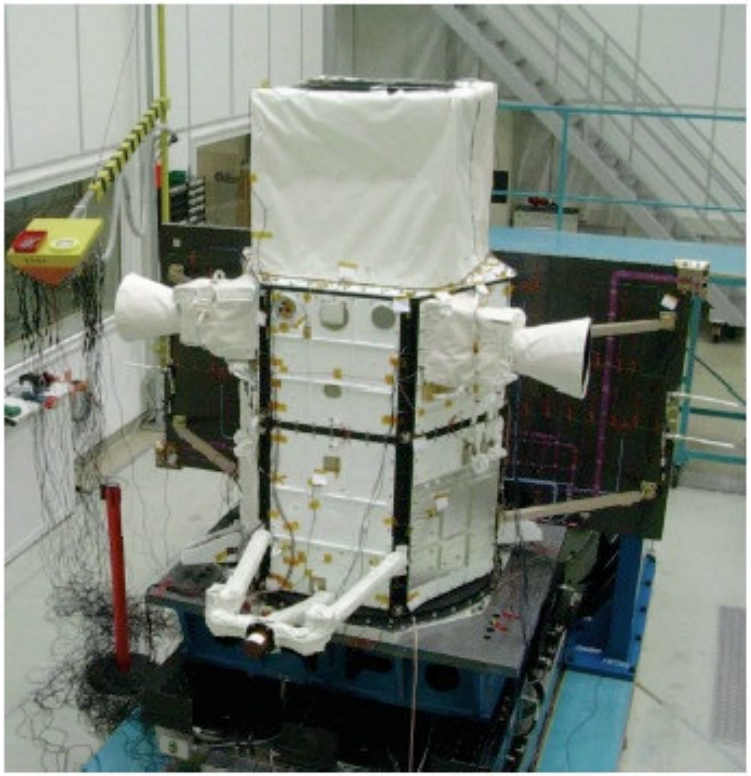
SOLAR PANELS

Baseline equatorial orbit: 550 Km, < 5º inclination

AGILE getting ready for launch

AGILE Satellite (Tortona, Dec. 27, 2006)

AGILE Satellite (IABG, Munich February, 2007)

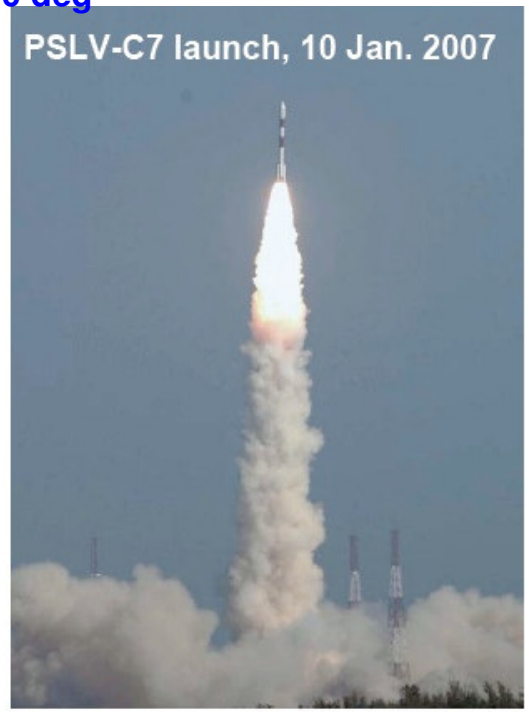


AGILE Launch

(Planned date: March 30th 2007)

Mission characteristics

- **Payload:**
  - **AGILE:** **321 kg ±10%**
- **Nominal Orbit:**
  - **Circular at altitude:** **550 ± 10 km**
  - **Inclination:** **Nominal 0 deg**
- **Launch station at Sriharikota (SHAR):**
  - **Geodetic Latitude:** **13.73 deg**
  - **Longitude:** **80.24 deg**
  - **Launch Azimuth:** **100 deg**



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The Malindi Broglio Space Center.

An ASI facility for BeppoSAX, HETE-2, Swift, AGILE, Simbol-X and other future scientific missions

Broglio Space Center

- **Location: close to the Equator on the Kenyan coast**
  - Lat. 2,9° S
  - Long. 40,2° E
  - 30 km North of the town of Malindi, near the village of Ngomeni
  - Climate: tropical (rainy season from April to August); allows to launch almost all year around

Broglio Space Center

- **Orbital and suborbital launches for scientific payloads from off-shore platforms;**
- **Number of Launches: 27 (9 satellites); 100% success;**
  - LV: Scout; Nike; SuperARCAS, ASTROBeed
  - First Launch: NIKE APACHE (March 1964)
  - Last Launch: SCOUT SV 206 (San Marco D/L – 25 March 1988)
- **Platforms located in Ungwana Bay:**
    - San Marco (launch) 27,5/91 m; 2500 tons (5000 tons deck capacity)
    - Santa Rita 1 (control) 35/35/30 m;
    - Santa Rita 2 (radar for vehicle tracking and control) 30/21 m;
    - Scope/Micoperi (power generation): 4 250 kVA Diesel Motogenerators.

Conclusions

- Equatorial orbit is particularly good for scientific satellites
- ASI's present and past satellites use equatorial orbit
- Malindi is particularly well placed for equatorial satellites (close to the equator and away from SAA)