

The AGILE legacy for Earth observations: the PANGEA project

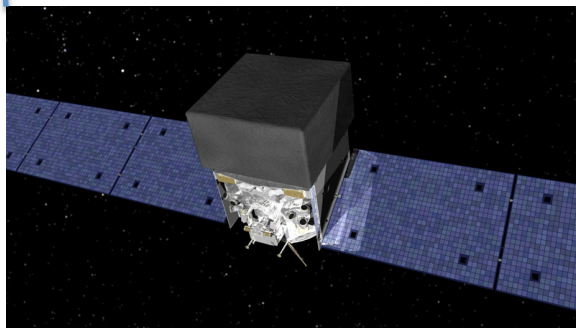
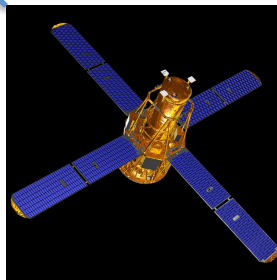
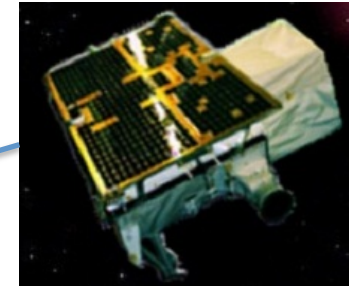
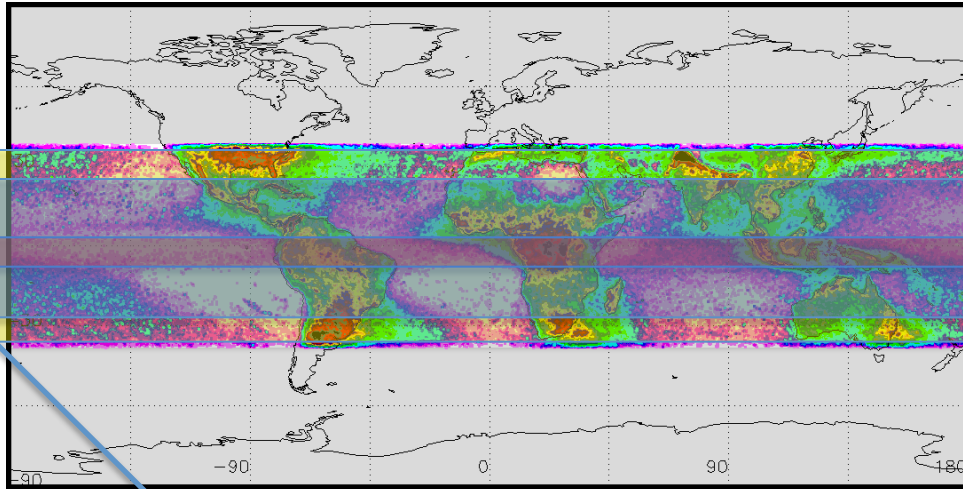
Martino Marisaldi

INAF – National Institute for Astrophysics, Italy
BCSS – Birkeland Centre for Space Science, Norway

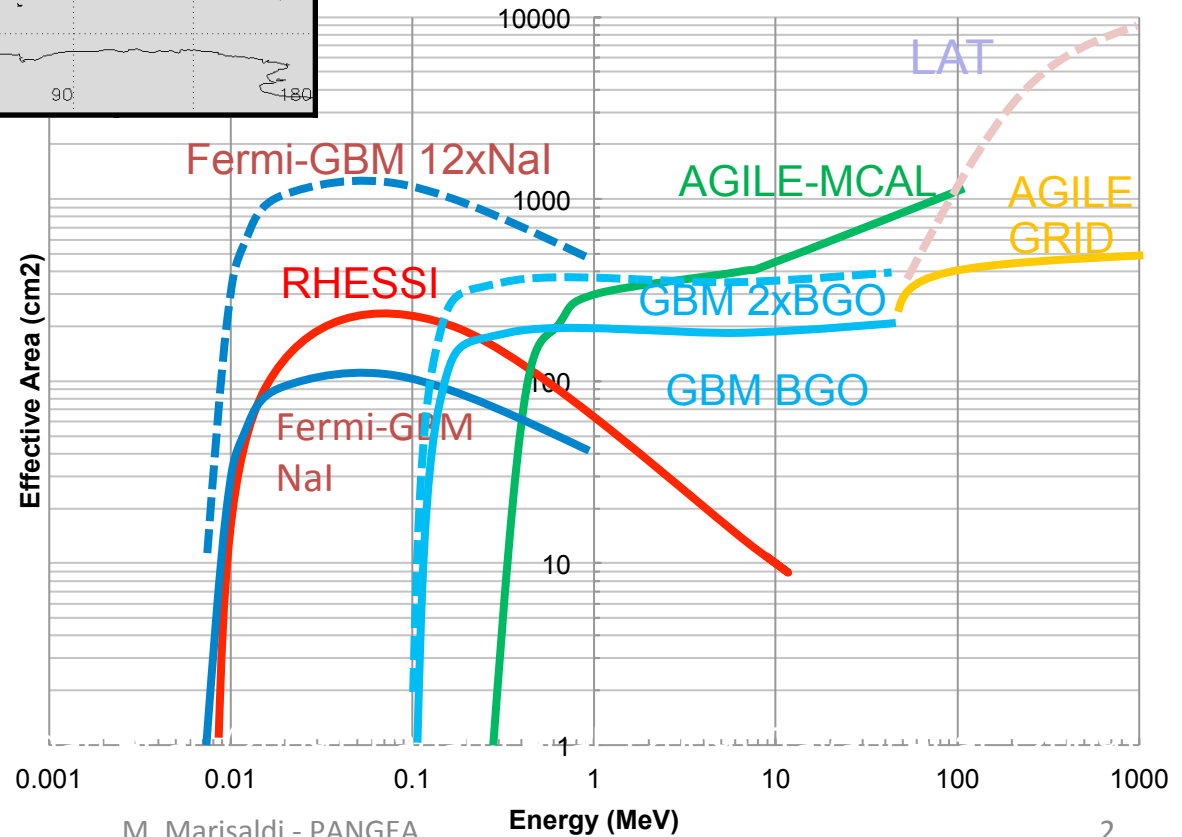
on behalf of the PANGEA collaboration

14th AGILE Workshop, Rome, 20-21 June 2016

Operating TGF detectors



Roma, 21/06/16



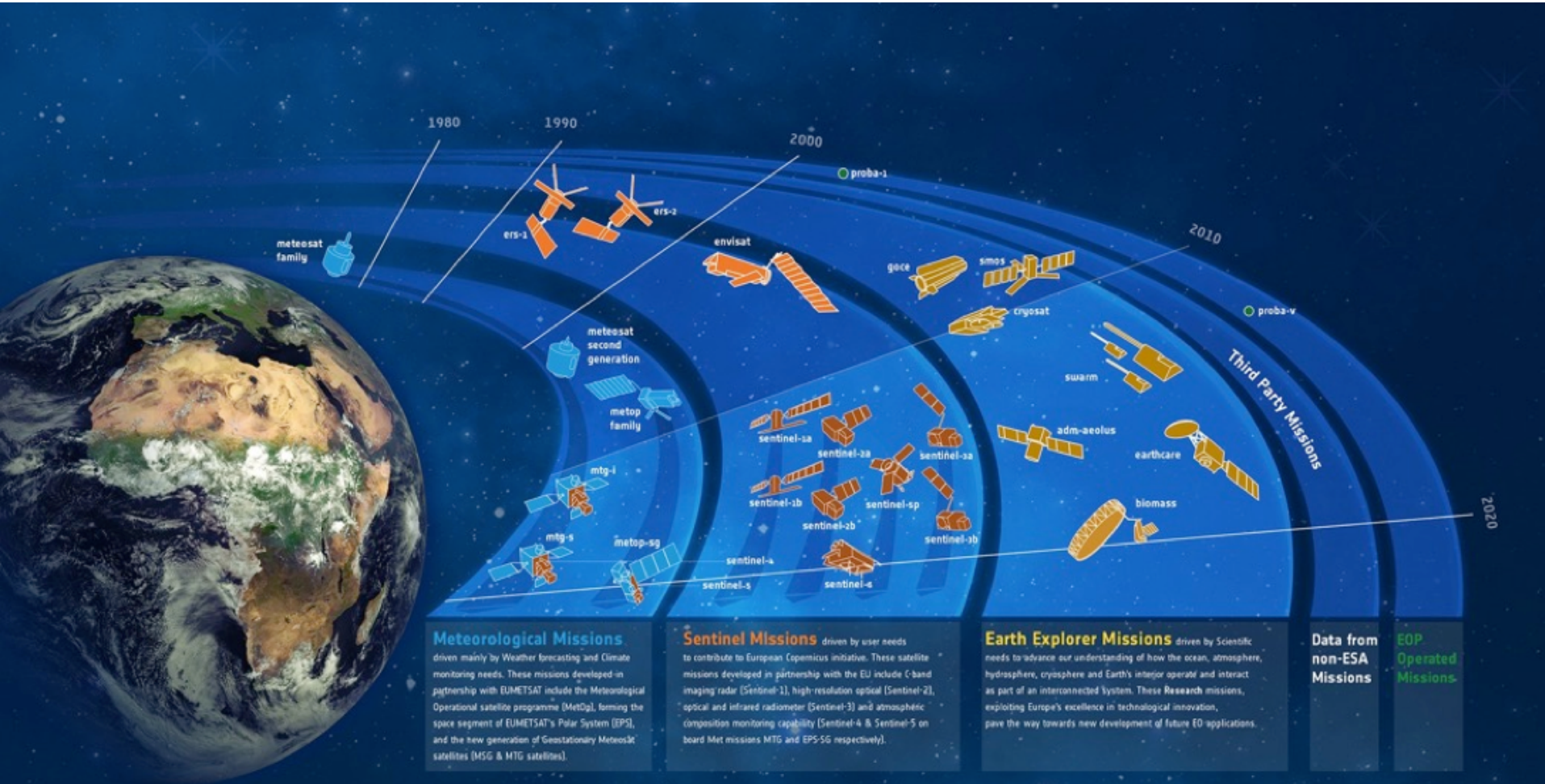
M. Marisaldi - PANGEA

ESA call for Earth Explorer mission EE-9

- 120 MEUR cost at completion to ESA (includes P/L)
- High technology and scientific readiness level requirements
- Baseline: Vega launcher in dual-launch configuration

- Letter of intent due Feb 1
- Proposers workshop in ESA ESTEC on 8 Mar
- Internal PANGEA meeting on 19 Apr in Vienna
- Proposal due Jun 24 12:00 CET
- Max 2 candidates selected by the end of 2016
- Phase A/B1 end 2018 -> downselection
- Launch 2024

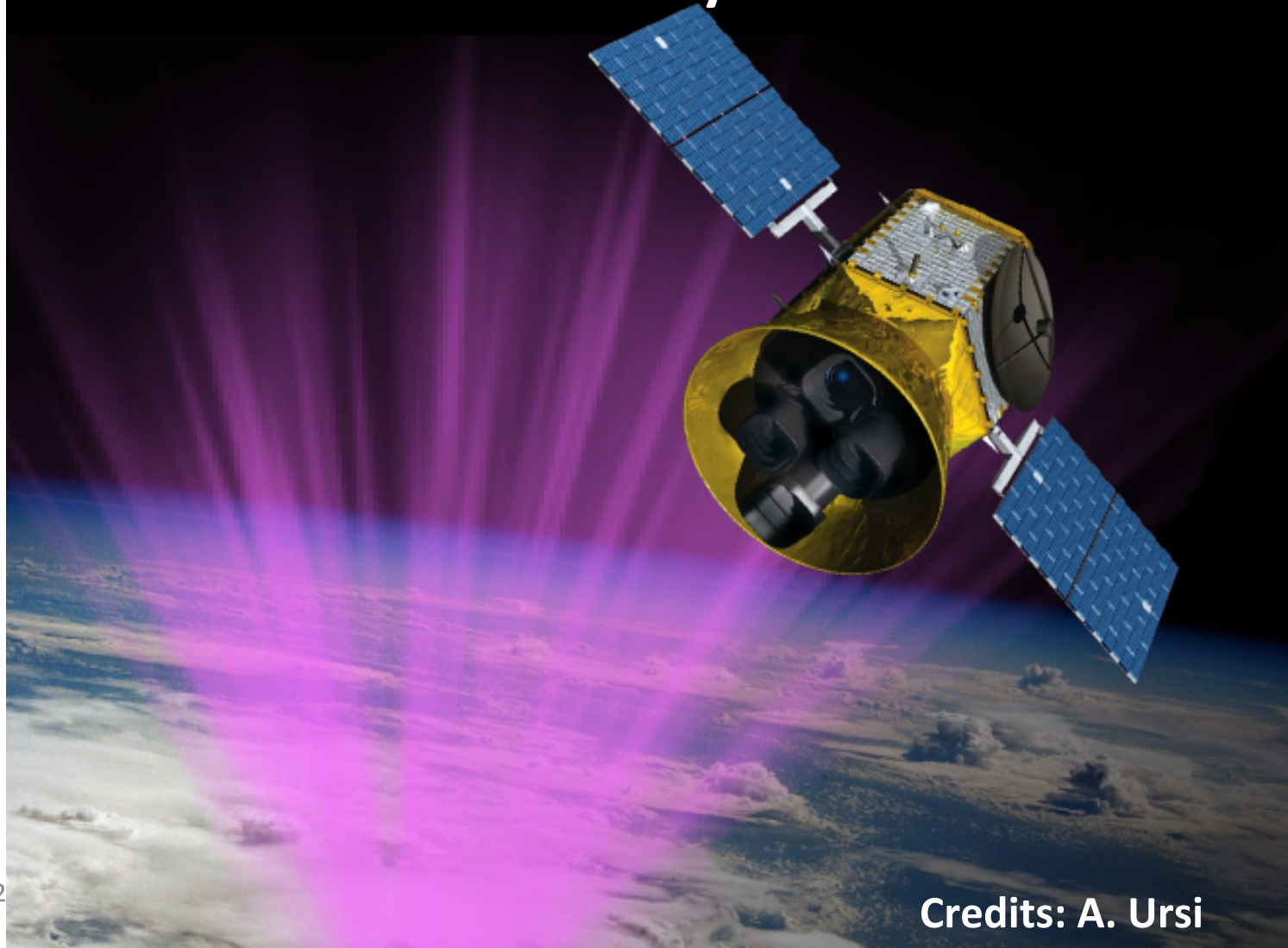
ESA EO science strategy





PANGEA

Particles And Gamma-rays from the EArth

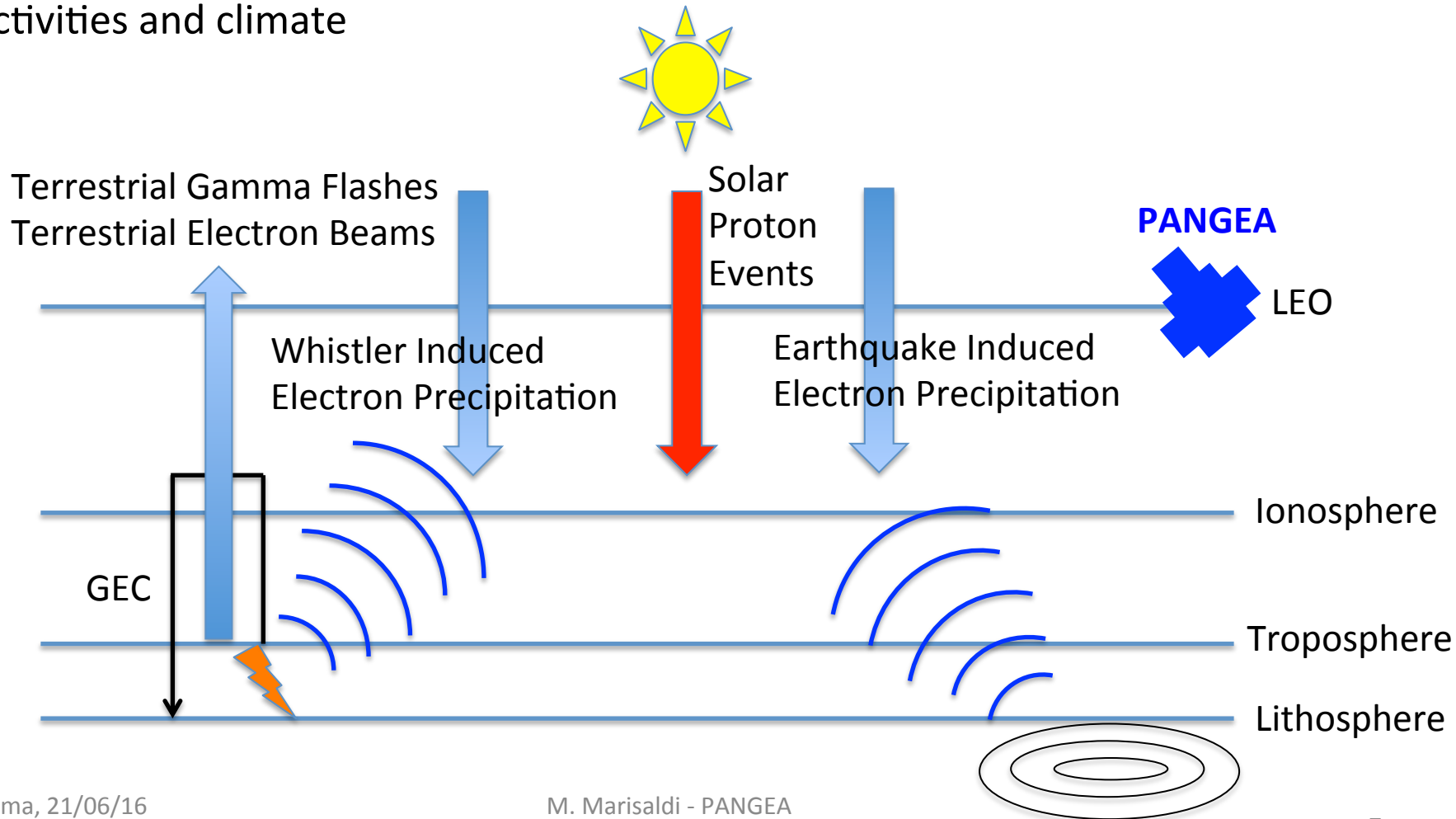


The PANGEA science Team

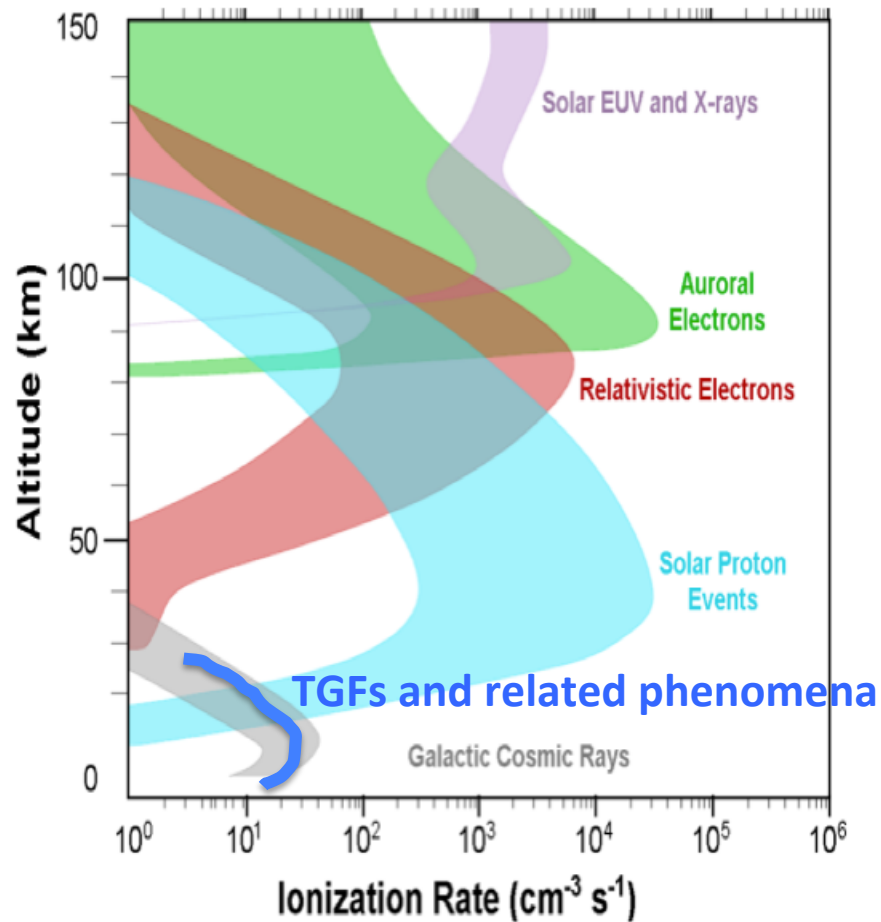
Italy	Andrea Argan	INAF - IAPS Roma
	Piero Benvenuti	University of Padova
	Riccardo Campana	INAF - IASF Bologna
	Livio Conti	Uninettuno Univ. and INFN Tor Vergata
	Fabio D'Amico	Italian Space Agency
	Angelo De Santis	INGV
	Stefano Dietrich	CNR – ISAC
	Ivan Kostadinov	ProAmbiente, Bologna
	Fabio Fuschino	Università di Bologna
	Claudio Labanti	INAF - IASF Bologna
Israel	Martino Marisaldi	INAF - IASF Bologna
	Alessandro Paccagnella	University of Padova
	Piergiorgio Picozza	Università and INFN Tor Vergata
	Marco Tavani	INAF- IAPS and Univ. Rome Tor Vergata
	Colin Price	Tel Aviv University
Germany	Yoav Yair	Interdisciplinary Center (IDC) Herzliya
	Hans-Dieter Betz	Nowcast GmbH
France	Vincent Tatischeff	CNRS/IN2P3 and Univ. Paris Sud, Orsay
	S. Celestin	Univ. Orleans
	J.L. Pincon	Univ. Orleans
Norway	M. Parrot	Univ. Orleans
	Nikolai Østgaard	BCSS and Univ. Bergen
Denmark	Torsten Neubert	DTU Space
Greece	G. Balasis	NOA
UK	M Fullekrug	University of Bath
Spain	Francisco Gordillo-Vasquez	CSIC-IEE, Granada
	Alejandro Luque	CSIC-IEE, Granada
Belgium	Didier Fussen	Institute d'Aeronomie
	Emmanuel Dekemper	Institute d'Aeronomie

Science and mission objectives

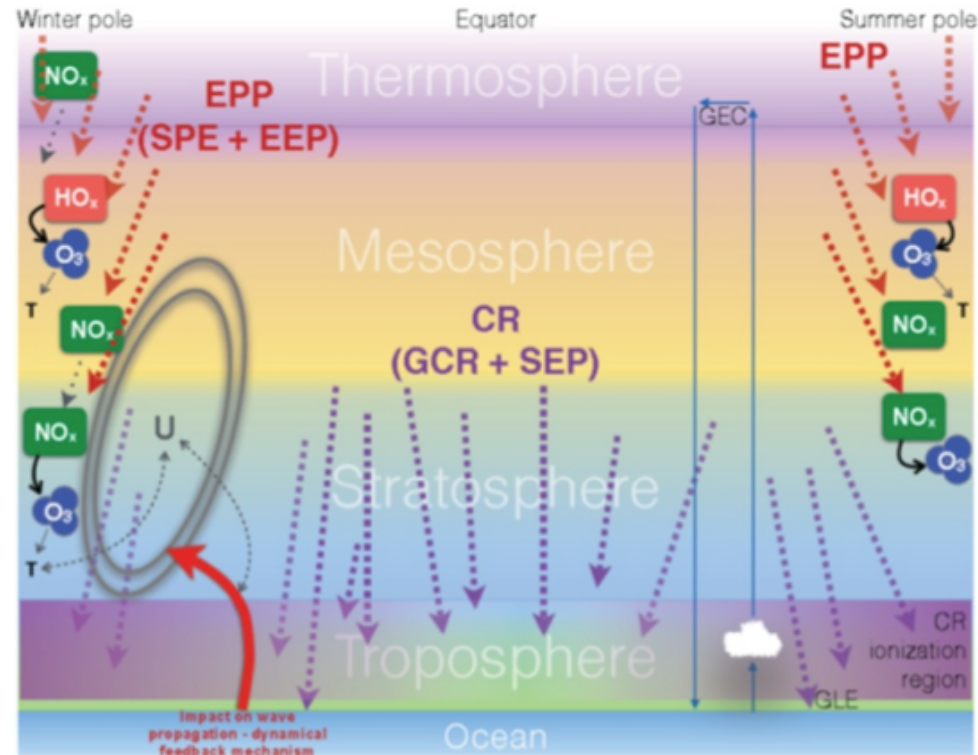
- Study the high-energy radiation coupling between the troposphere, the lithosphere and the inner magnetosphere
- Understand the impact of this coupling on atmospheric dynamics, human activities and climate



Science and mission objectives



From Jackman, HEPPA-Meeting, 2008



From Tsuda et al., 2015

- Although no conclusive evaluation can be made, a feedback is provided based on ESA internal expertise as to why some concepts are expected to fall out of the conditions of the EE-9 Call
- Three main categories, identified in tables (next slides) with colour code:
 - concept implementation will exceed the price boundary
 - concept implementation depends critically on external in-kind deliveries of major items (e.g. platform, launch, instruments)
 - concept may fall within the boundary conditions of the EE9 Call
- It is strongly recommended to carefully consider the feedback provided before preparing a proposal

Ref. no	Short Name	Proposal Title	Proposer
CEE9/001	MICROWAT	MICROWAT, a mission for "all weather" and high spatial resolution ocean surface temperature and ice concentration	Dr. Filipe AIRES
CEE9/002	OCAPI	OCAPI ¹ : the "Ocean Colour Advanced Permanent Imager"	Dr. David ANTOINE
CEE9/003	MAGEAQ	MAGEAQ - Monitoring of the Atmosphere from Geostationary orbit for European Air Quality	Prof. JEAN-LUC ATTIE
CEE9/004	E-GRASP	European-Geodetic Reference Antenna in Space E-GRASP/Eratosthenes	Dr. Richard Biancale
CEE9/005	HYPEX-2	European Hyperspectral Explorer: HYPEX-2	Dr. Xavier Briottet
CEE9/006	STRATUS	SaTellite RADar sounder for earTh sUb-surface Sensing	Prof. Lorenzo Bruzzone
CEE9/007	TMAX	Thermal Monitoring Advanced eXplorer	Dr. Maria Fabrizia Buongiorno
CEE9/008	SKIM	Surface Kinematics Monitoring Mission	Dr. Bertrand Chapron
CEE9/009	NITROSAT	NITROSAT - The first mission dedicated to monitoring reactive nitrogen	Dr. Pierre Coheur
CEE9/010	TWIST	Sea Surface Temperature, Wind and Salinity (TWIST)	Dr. Fabrice Collard
CEE9/011	LIFE	The LIFE (LIghtning and Fire Explorer) mission	Dr. Eric Defer
CEE9/012	Raven	The Raven Mission	Prof. Doug Degenstein
CEE9/013	UPDRAFTS	Updraft-measuring Satellites (UPDRAFTS)	Dr. Hartwig Deneke
CEE9/014	ATLAS	Atmospheric Thermodynamics LidAr in Space	Prof. Paolo Di Girolamo
CEE9/015	COOL	Carbon stocks Observation in Ocean and Land by Lidar in space	Dr. Pierre FLAMANT
CEE9/016	TRUTHS	Traceable Radiometry Underpinning Terrestrial and Helio- Studies (TRUTHS)	Dr. Nigel Fox
CEE9/017	LOCUS	Linking Observations of Climate, The Upper atmosphere and Space weather	Dr. Daniel Gerber
CEE9/018	SEASTAR	SEASTAR: A mission to study small scale upper ocean dynamics and ocean-atmosphere coupling	Dr. Christine Gommenginger
CEE9/019	e.motion2	Earth System Mass Transport Mission 2	Dr. Thomas Gruber
CEE9/020	WIVERN	WIVERN: A 'Wind VELOCITY RADAR Nephoscope' to observe global in-cloud winds.	Dr. Anthony Illingworth
CEE9/021	HAPI	HIGH RESOLUTION ANTHROPOGENIC POLLUTION IMAGER	Dr. Roland Leigh
CEE9/022	ISE-PAC	Ice and Snow Explorer – Passive Active Convoy	Dr. Juha Lemmetyinen
CEE9/023	SESAME	SEntinel-1 SAR Companion Multistatic Explorer (SESAME)	Dr. Francisco Lopez-Dekker
CEE9/024	PANGEA	Particles ANd Gamma-rays from the EArth	Dr. Martino Marisaldi
CEE9/025	GeoSTARe	GEOsynchronous SAR for Terrain & Atmosphere with short Revisit	Dr. Andrea Monti Guarnieri
CEE9/026	MISRIite	MISRlite	Prof. Jan-Peter Muller
CEE9/027	FORUM	Far-infrared-Outgoing-Radiation Understanding and Monitoring	Dr. Luca Palchetti
CEE9/028	TCM	Tropical Carbon Mission	Prof. Paul Palmer
CEE9/029	EARTHSAT	EARTHsat prediction by SATellite	Mr. Filippo Sciarrino
CEE9/030	TIREX	Thermal InfraRed EXplorer	Prof. Jose Antonio Sobrino
CEE9/031	Sentinel-1CS	Sentinel-1 companion satellite	Dr. Svein Solberg

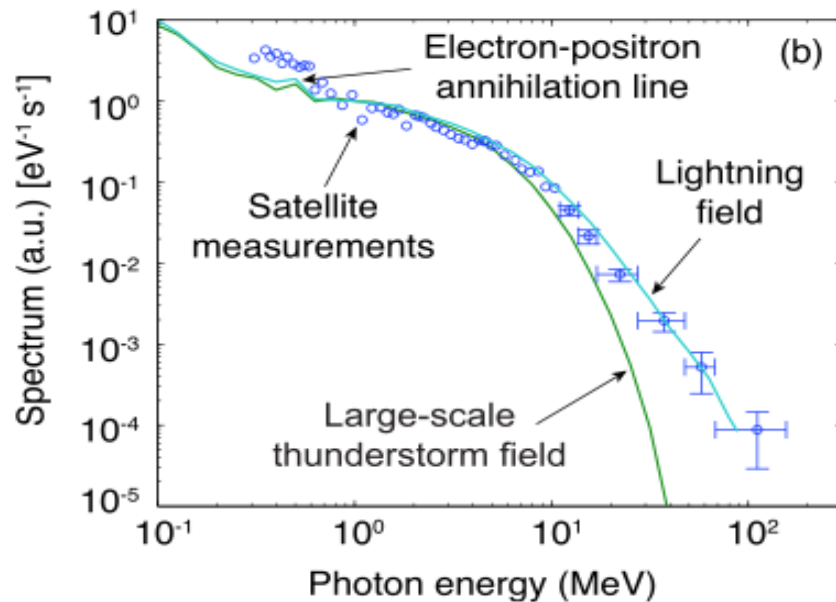
Color Legend:

- Implementation likely to exceed boundary conditions of the EE9 Call
- Concept implementation depends critically on external in-kind deliveries of major items
- Concept may fall within the boundary conditions of the EE9 Call

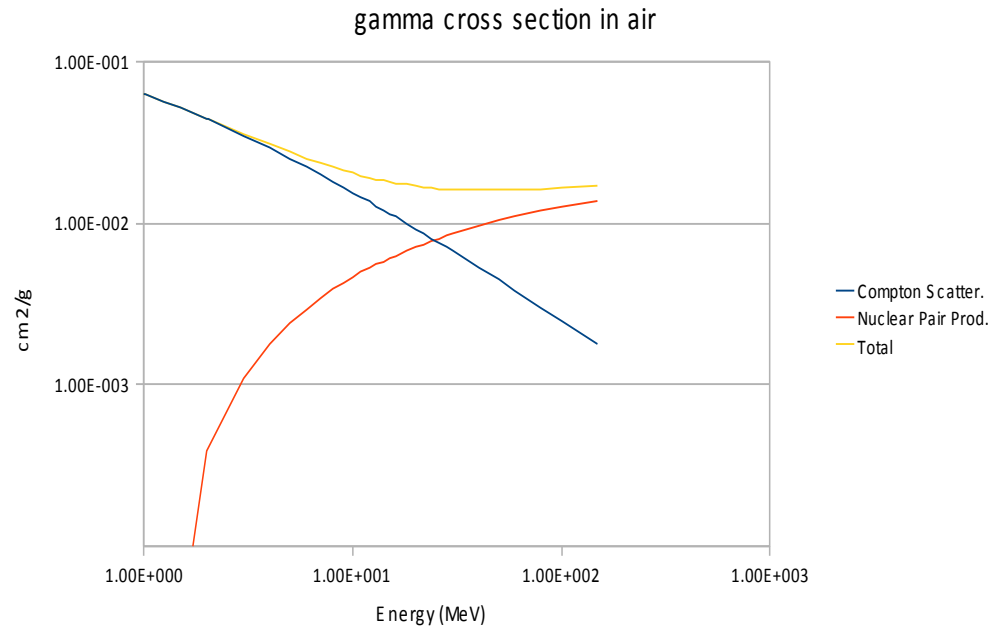
Warning: be complementary to ASIM and TARANIS



Science driver #1: sensitivity in the 30-100 MeV band

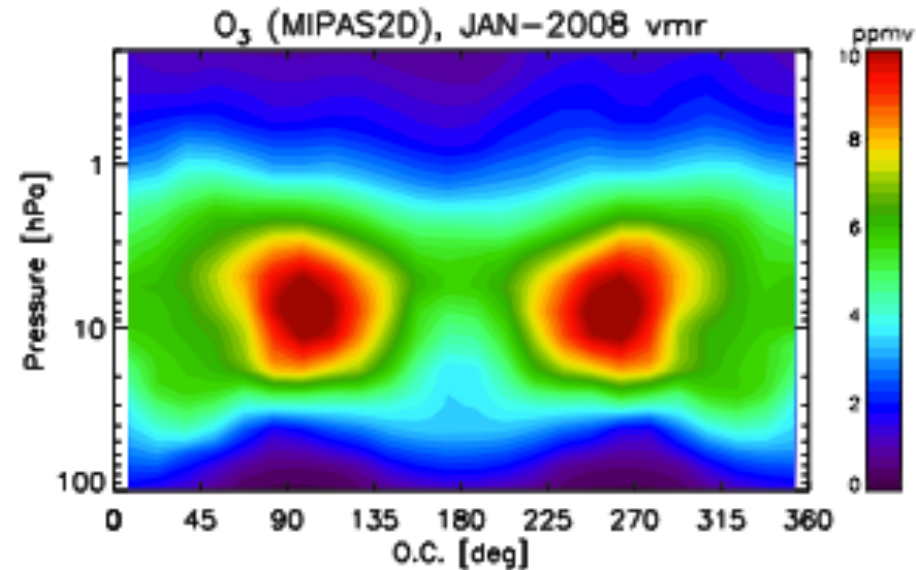
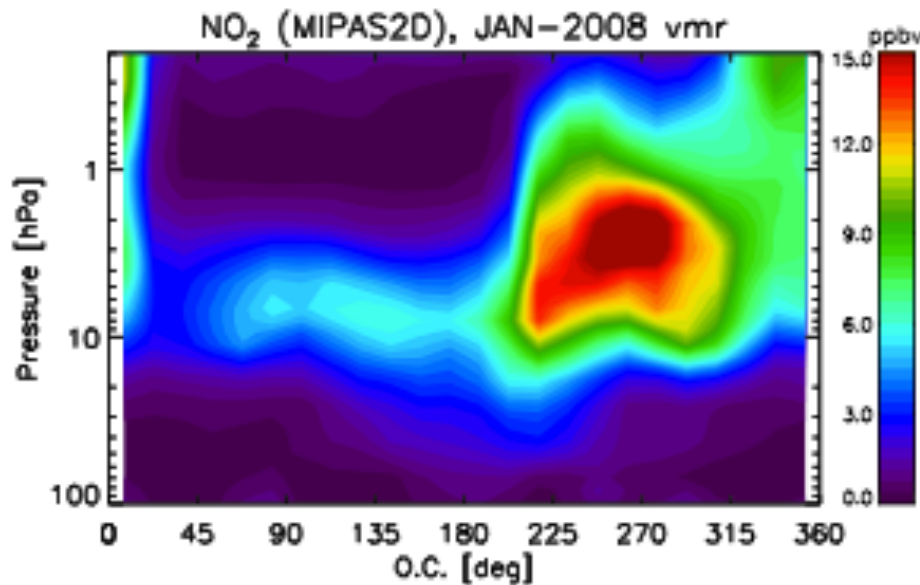


Celestin+ 2012



Need a 'thick' gamma / particle calorimeter

Science driver #2: measure the chemical impact of TGFs and other transients

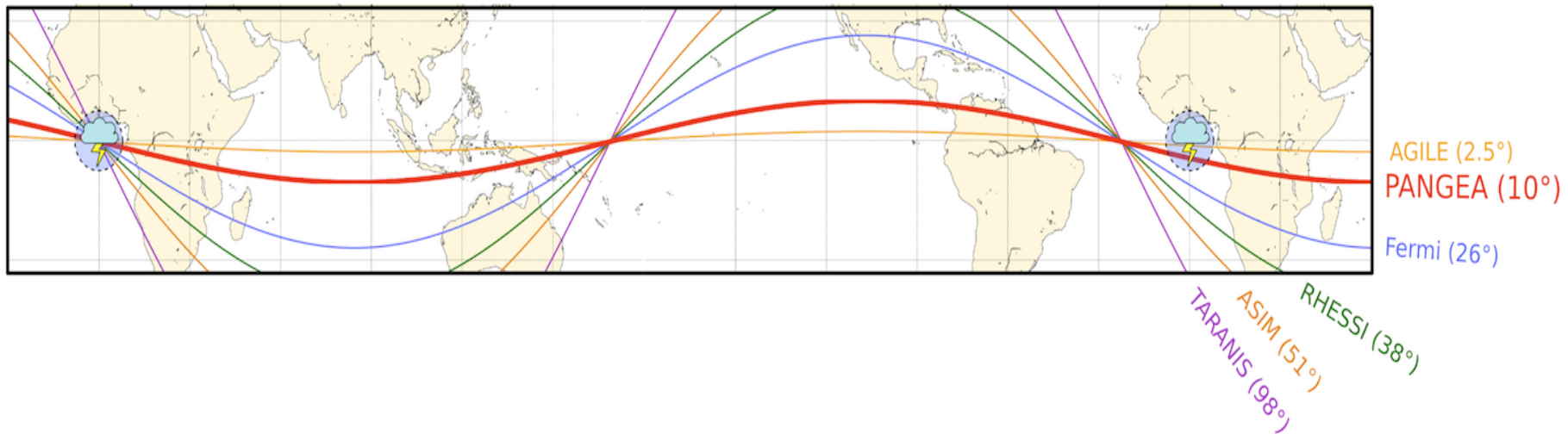


Arnone+ 2012



Need a limb sounder
Need high-energy + chemistry
concurrent observations

Science driver #3: minimum revisit time



Adapted from Ursi+ in prep.



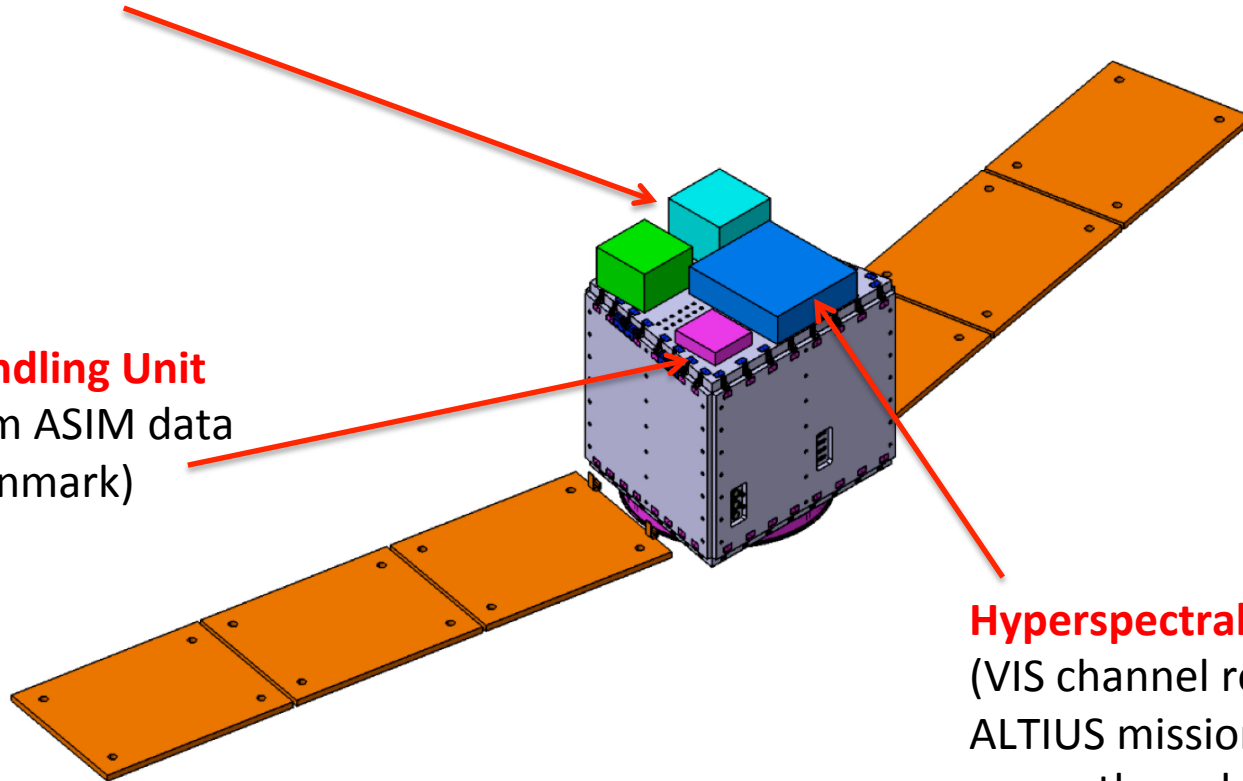
Need a low inclination
equatorial LEO

The PANGEA payload

~100 kg payload
~300 kg total

Calorimeter and particle detector
(Derived from AGILE MCAL and AC)

P/L Data Handling Unit
(Derived from ASIM data handling, Denmark)

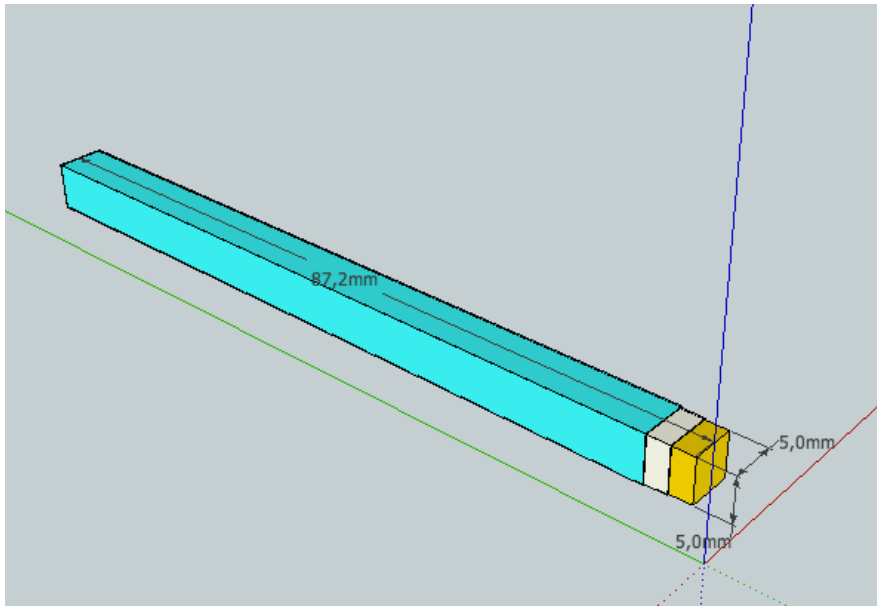


Hyperspectral Imager
(VIS channel recurrent from the ALTIUS mission, Belgium, currently end phase B1)

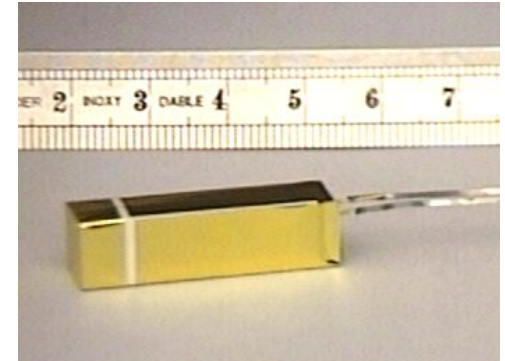
Credits: Thales Alenia Space Italia

Detector bar

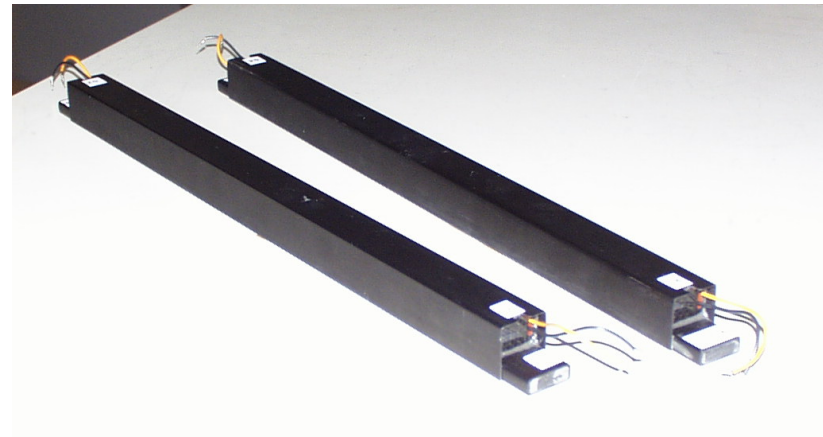
PANGEA:
0.5x0.5x8 cm³ (TBD) with SDD readout
CsI(Tl) scintillator bars



Heritage and TRL:
IBIS – PICsIT
0.8x0.8x3 cm³
CsI(Tl) scintillator bars

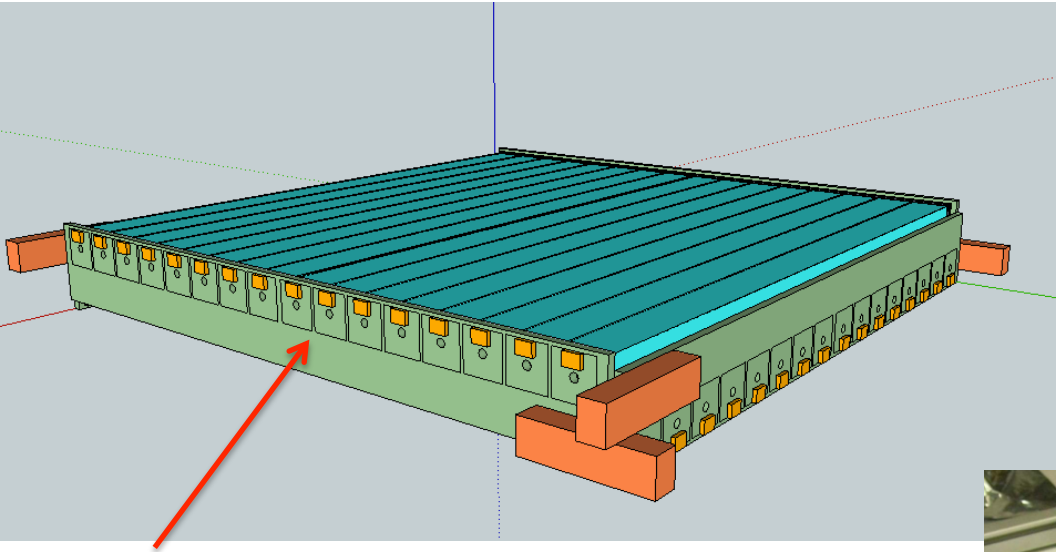


AGILE - MCAL
2.5x1.5x37.5 cm³
CsI(Tl) scintillator bars



Two crossed detection planes

PANGEA

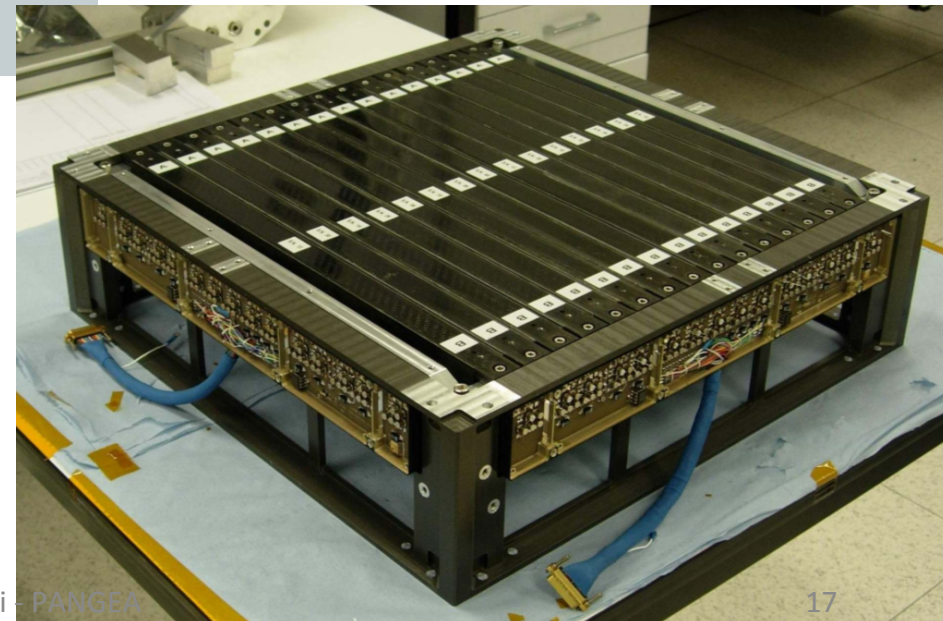


Heritage and TRL:

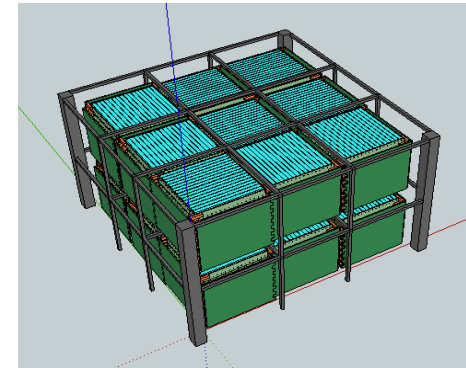
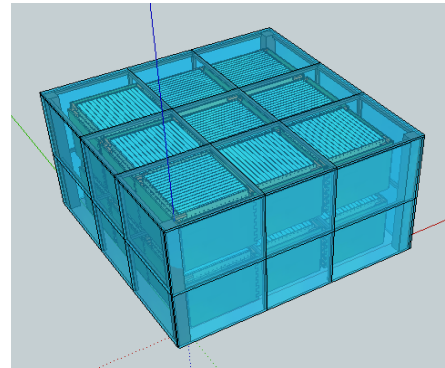
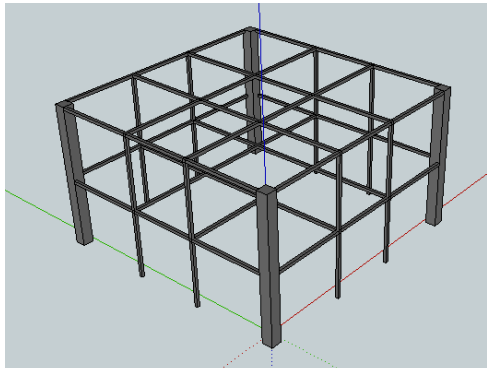
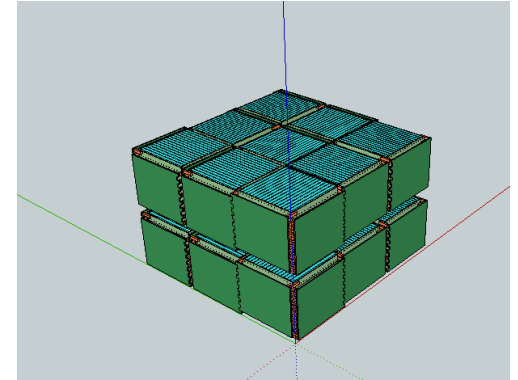
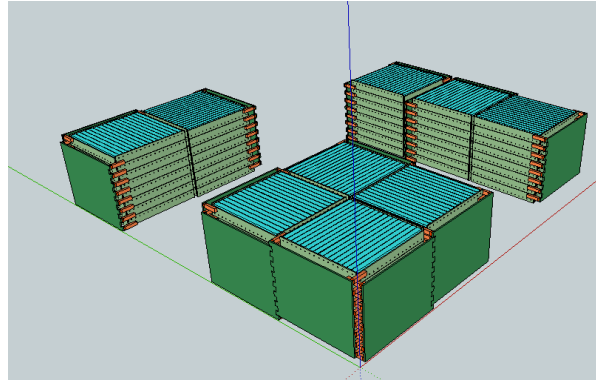
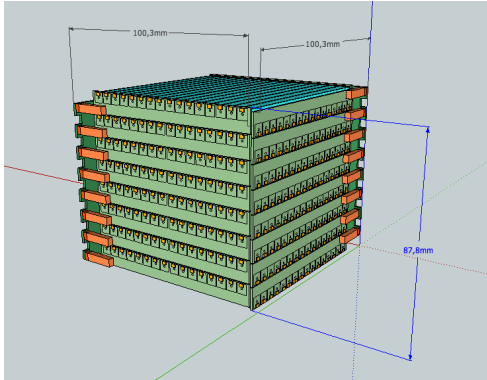
AGILE MCAL: two crossed layers of
CsI(Tl) bars with solid state readout
and hodoscopic architecture

Key technology:
Silicon Drift Detector readout with low-noise
front-end electronics

>10 year R&D effort of a large collaboration
INFN XDXL and ReDSOX projects
+ INAF and ASI R&D
+ LOFT legacy

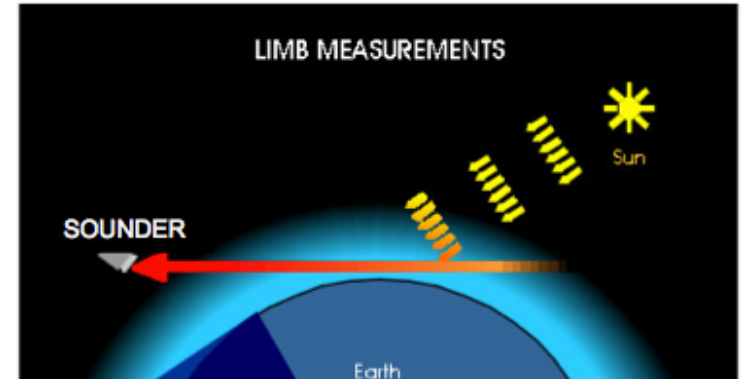
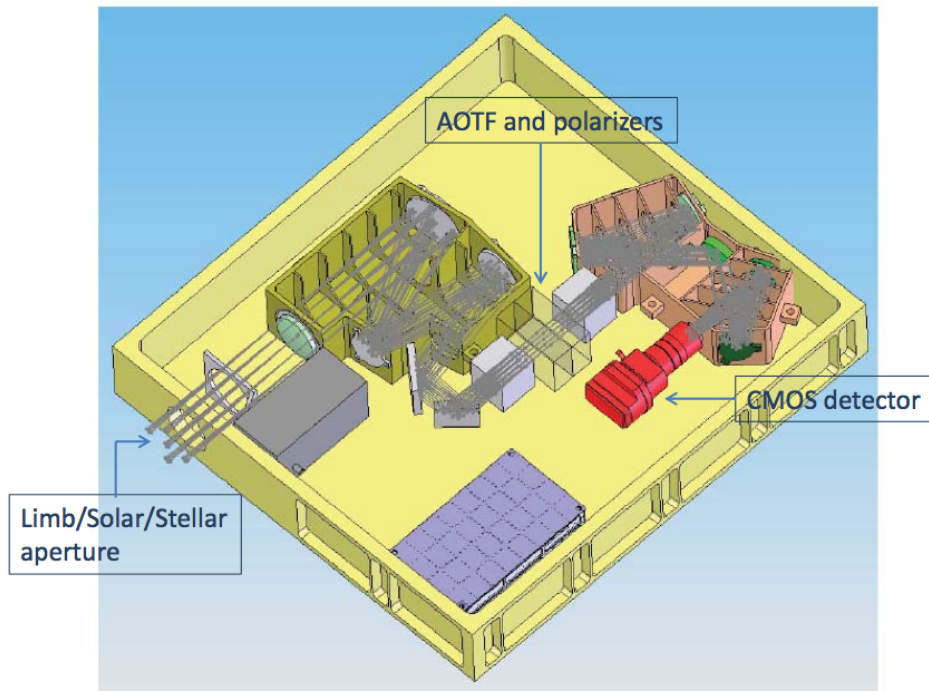


The CAL: a fully modular approach

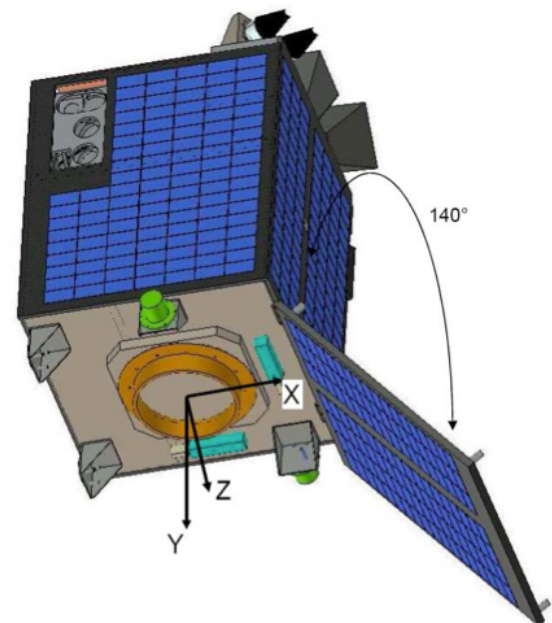


The Hyperspectral Imager

VIS channel

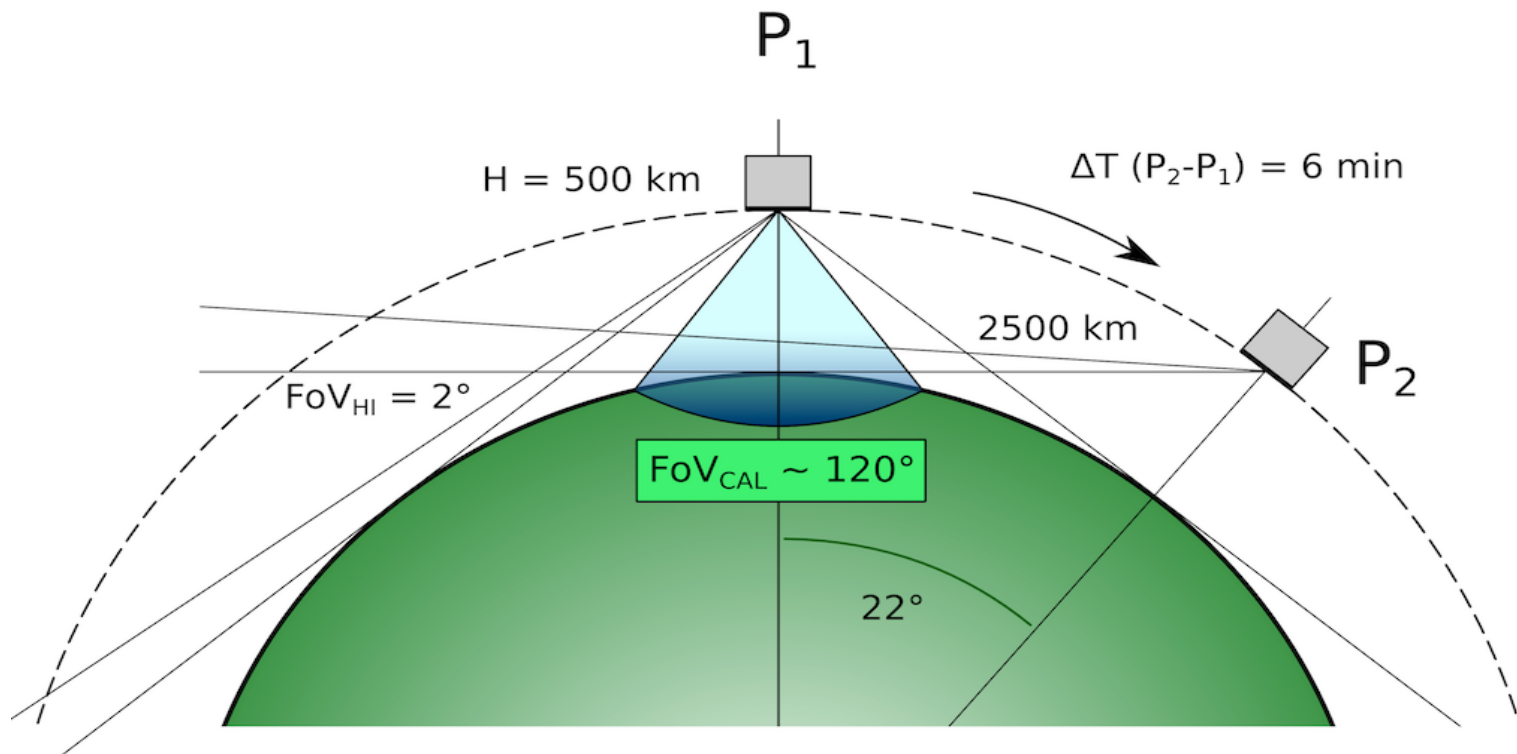


ALTIUS

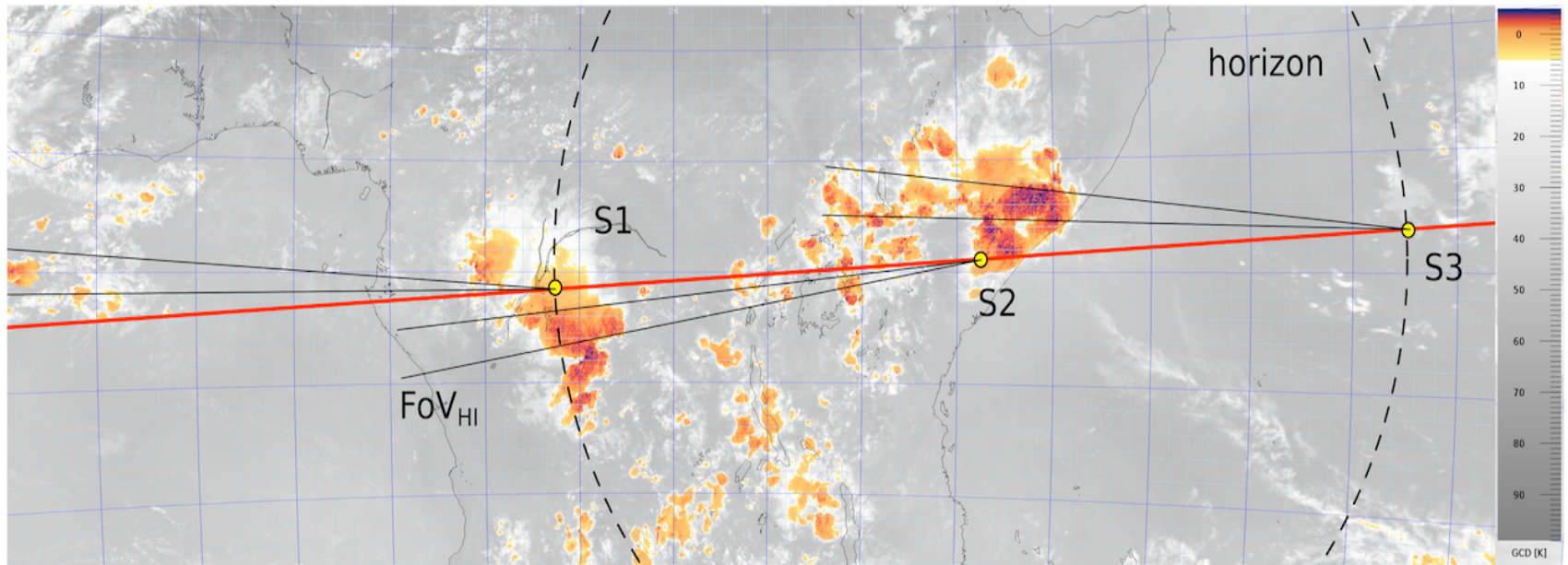


Credits: D. Fussen
7th Limb Conference, Bremant, 2013

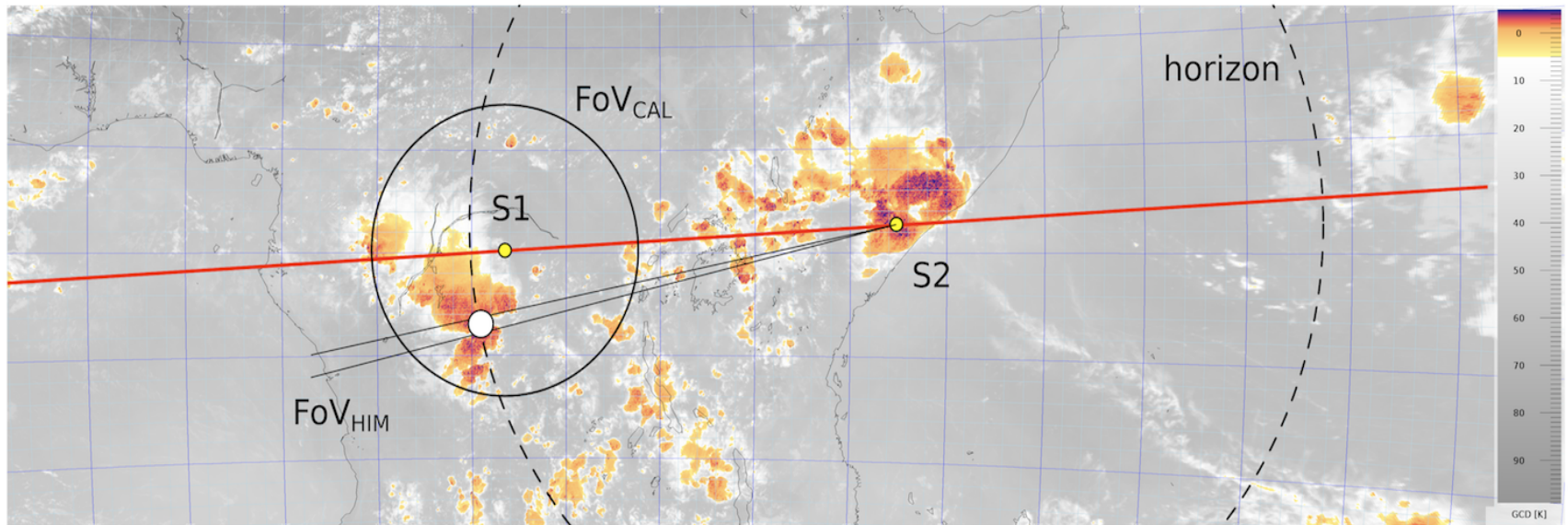
Observing geometry



Observing strategy: nominal observations



Observing strategy: triggered observations



Summary

- PANGEA proposal: a particle physics experiment for earth observation
- Challenging opportunity
- Worst case: create a team / community for forthcoming ESA calls
- AGILE heritage crucial for science AND technology
- SDDs + low-noise FEE (INFN, INAF, ASI ~10 year R&D effort) plays a crucial role in the PANGEA concept
- Submission due this Friday! Fingers crossed!