PRESENTAZIONE ATTIVITÀ DI RICERCA CRISTIAN DE SANTIS

Cristian De Santis (INFN)

Roma, 21 Dicembre 2018

LAUREA MAGISTRALE @ UToV

Laurea in Fisica - Università degli Studi di Roma Tor Vergata

Tesi di laurea: “Classi di universalità in modelli statistici con disordine in 3 dimensioni” (relatore Prof. R. Petronzio)

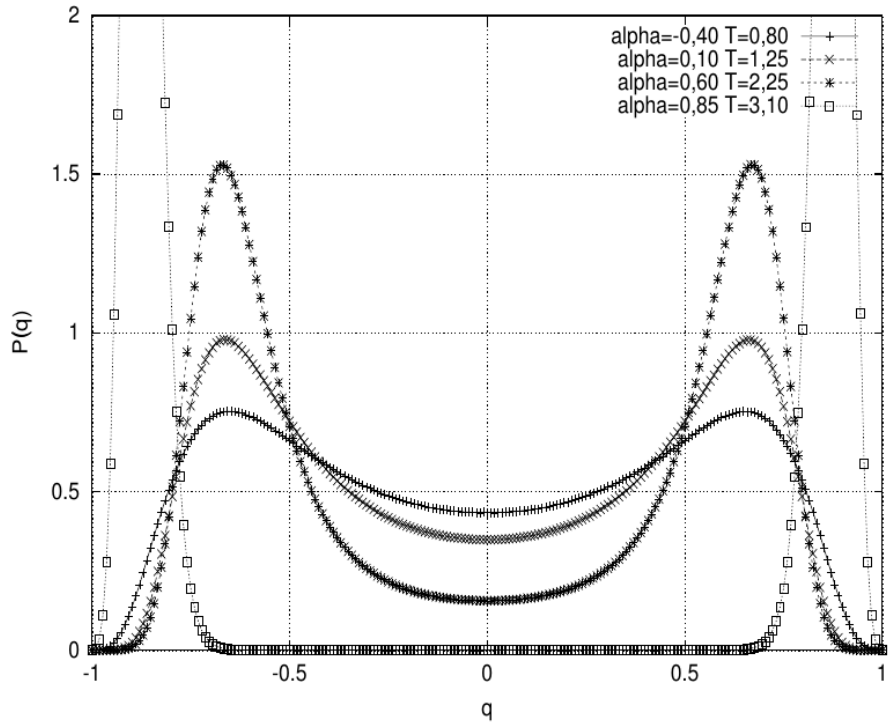
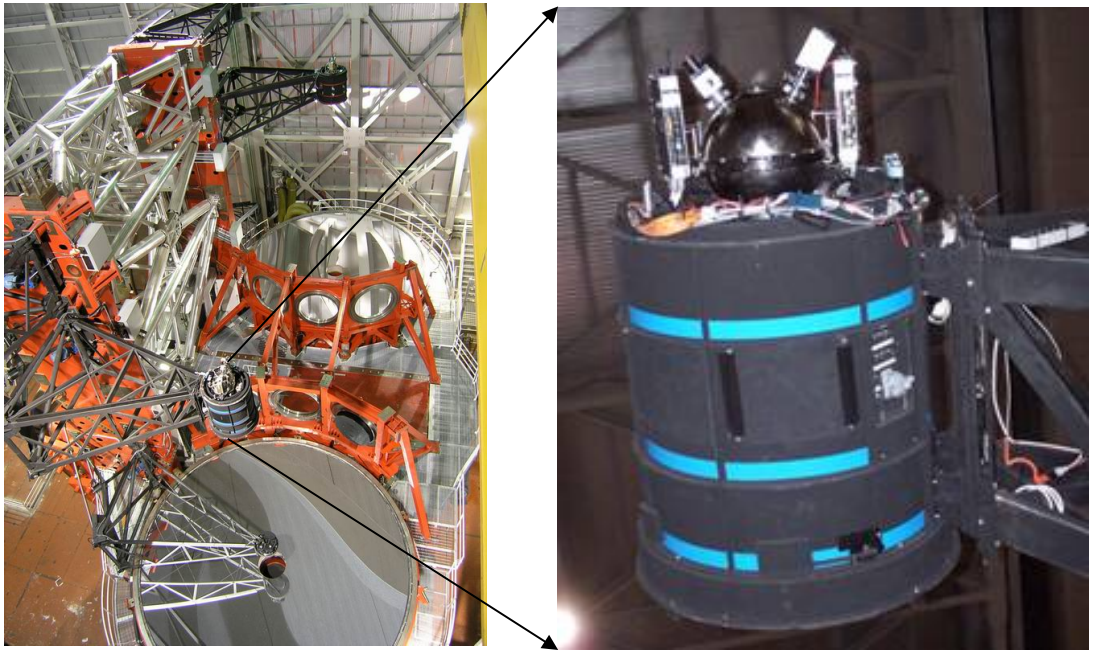


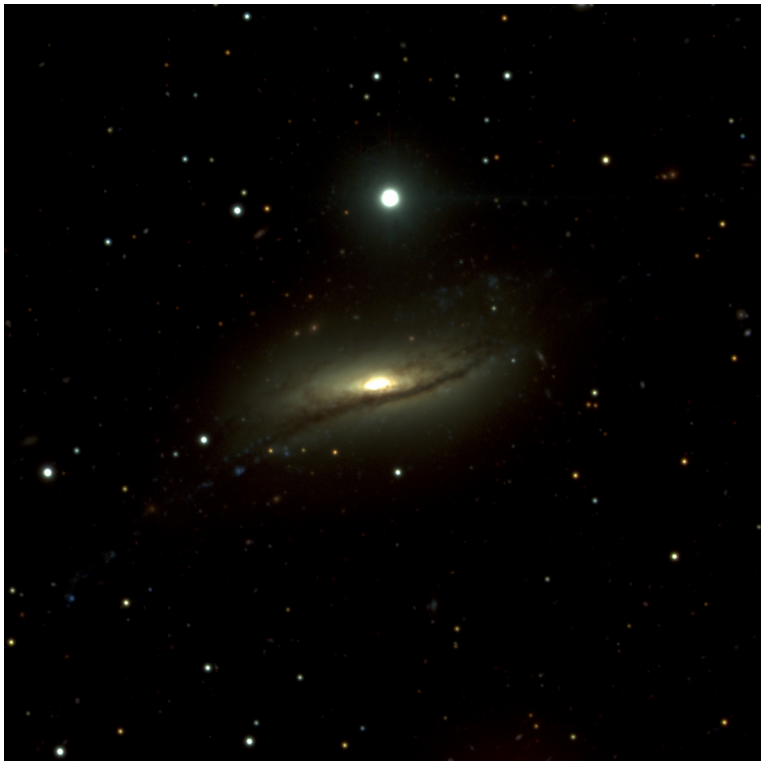
Figura 3.7: Confronto del comportamento della $P(q)$ per differenti valori del parametro di placchetta α_3, per valori della temperatura corrispondenti a $T \approx 0,7T_c$. Il comportamento della $P(q)$ per $\alpha_3 = 0,85$ è tipicamente ferromagnetico.

ATTIVITÀ @ INAF-OAR (2001-2008)

Responsabile:

- design, sviluppo e test di applicativi di simulazione della camera a primo fuoco Large Binocular Camera (LBC) del Large Binocular Telescope (LBT)
- design, sviluppo e test degli applicativi della pipeline per l'analisi dei dati dalla LBC;
- trasferimento, archiviazione, analisi qualità, gestione e disseminazione dati LBC;
- pre-riduzione, riduzione ed analisi immagini LBC;



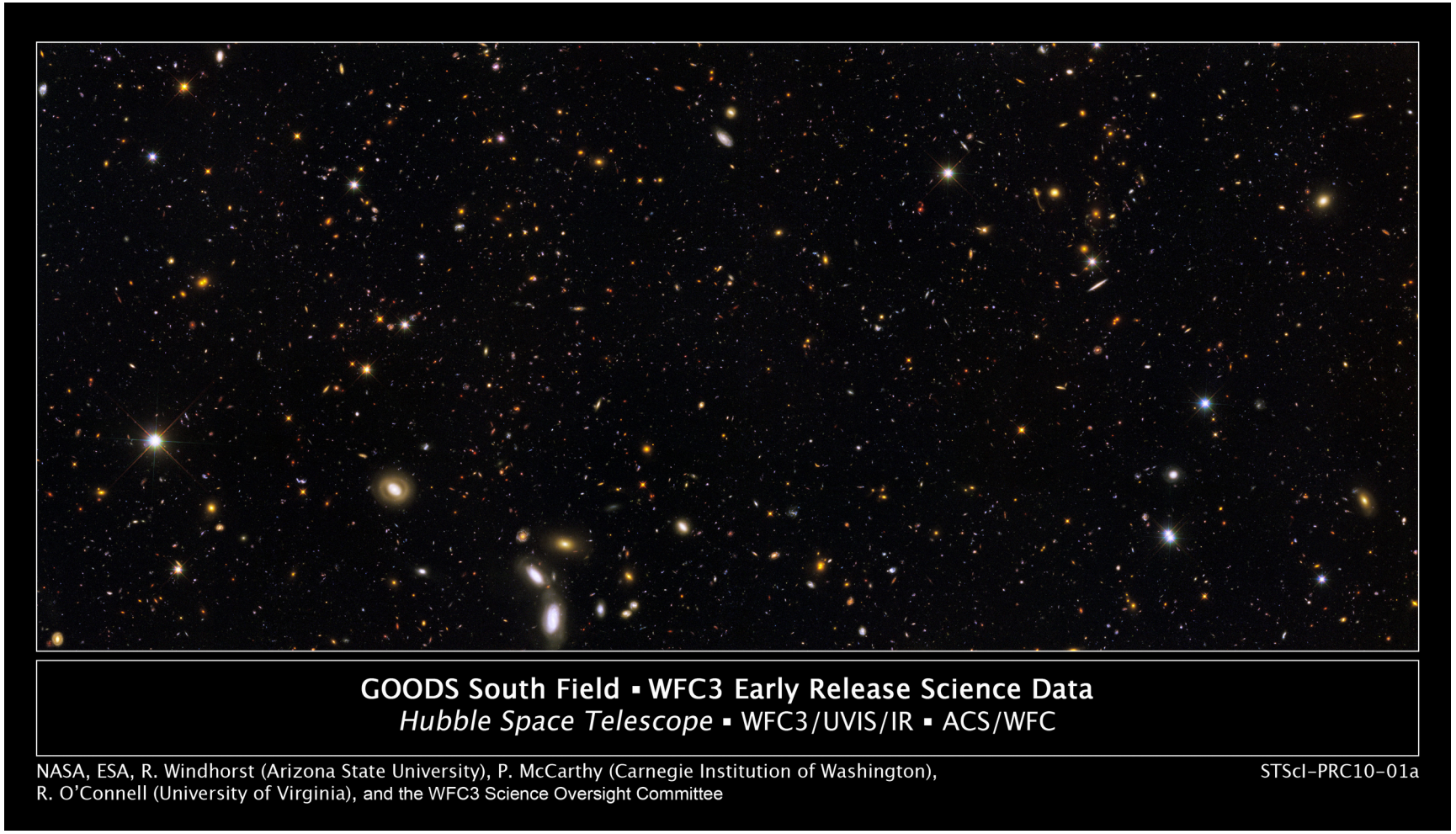


NGC5719 (LBC

ATTIVITÀ @ INAF-OAR (2001-2008)

Sviluppo algoritmi e analisi di immagini multi-banda prodotte da telescopi a terra (LBT, VLT, ...) o spaziali (HST, Spitzer, …):

- Catalogo multicolore GOODS-Music della survey GOODS (Great Observatories Origins Deep Survey)
- Sviluppo software ConvPhot per fotometria di precisione



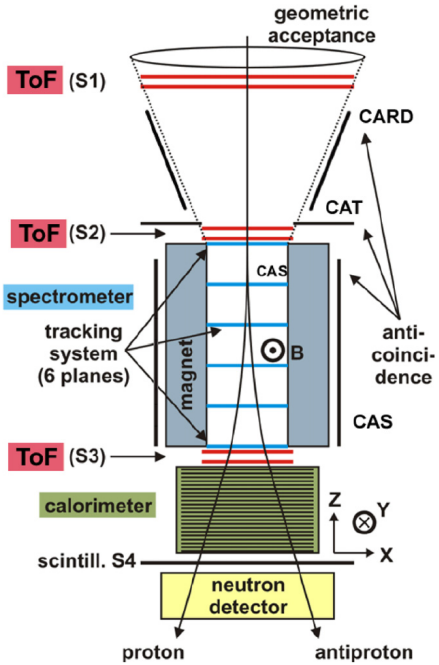
ATTIVITÀ @ INAF-OAR (2001-2008)

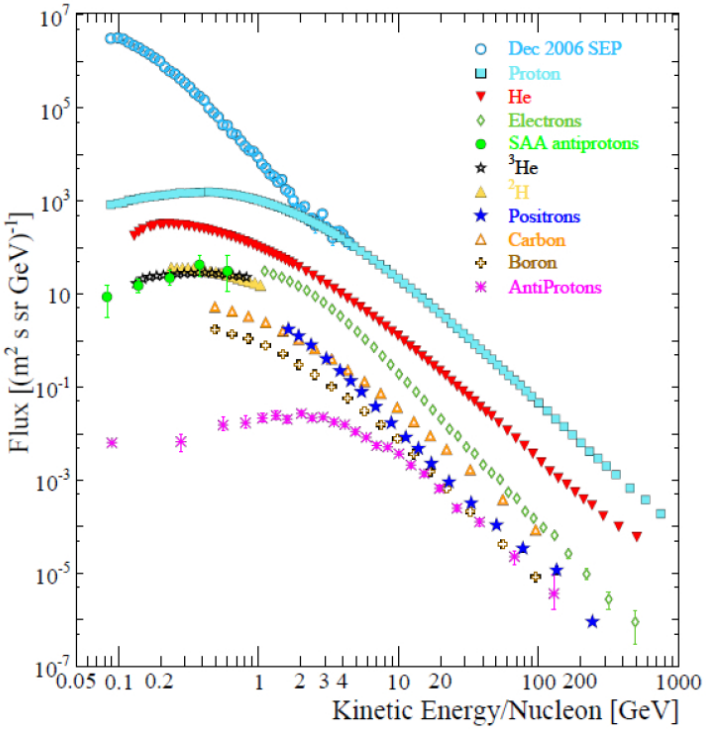
- Fontana, A., et al. *The Galaxy mass function up to z=4 in the GOODS-MUSIC sample: into the epoch of formation of massive galaxies.* ASTRONOMY & ASTROPHYSICS, 459 (3):745–757 (2006) (330 cit. ADS)
- Grazian, A., et al. *The GOODS-MUSIC sample: a multicolour catalog of near-IR selected galaxies in the GOODS-South field*. ASTRONOMY & ASTROPHYSICS, 449 (3):951–U66 (2006) (285 cit. ADS)
- Santini, P., et al. *Star formation and mass assembly in high redshift galaxies.* ASTRONOMY & ASTROPHYSICS, 504 (3):751–767 (2009) (240 cit. ADS)
- Grazian, A., et al. *A comparison of LBGs, DRGs, and BzK galaxies: their contribution to the stellar mass density in the GOODS-MUSIC sample.* ASTRONOMY & ASTROPHYSICS, 465 (2):393–404 (2007) (85 cit. ADS)
- De Santis, C., et al. *ConvPhot: A profile-matching algorithm for precision photometry.* NEW ASTRONOMY, 12 (4):271–288 (2007) (35 cit. ADS)

ATTIVITÀ @ INFN RM2 - PAMELA

Nell'ambito dell'esperimento PAMELA (a Payload for Antimatter Matter Exploration and Light nuclei Astrophysics)

- gestione e trasferimento dati;
- progettazione e messa in opera ed dell'amministrazione farm di calcolo distribuito gruppo Wizard RM2;
- sviluppo di algoritmi ed applicativi per l'analisi dei dati;
- studio e ottimizzazione dell'algoritmo di tracciamento dello spettrometro magnetico;
- analisi componente boro e carbonio raggi cosmici



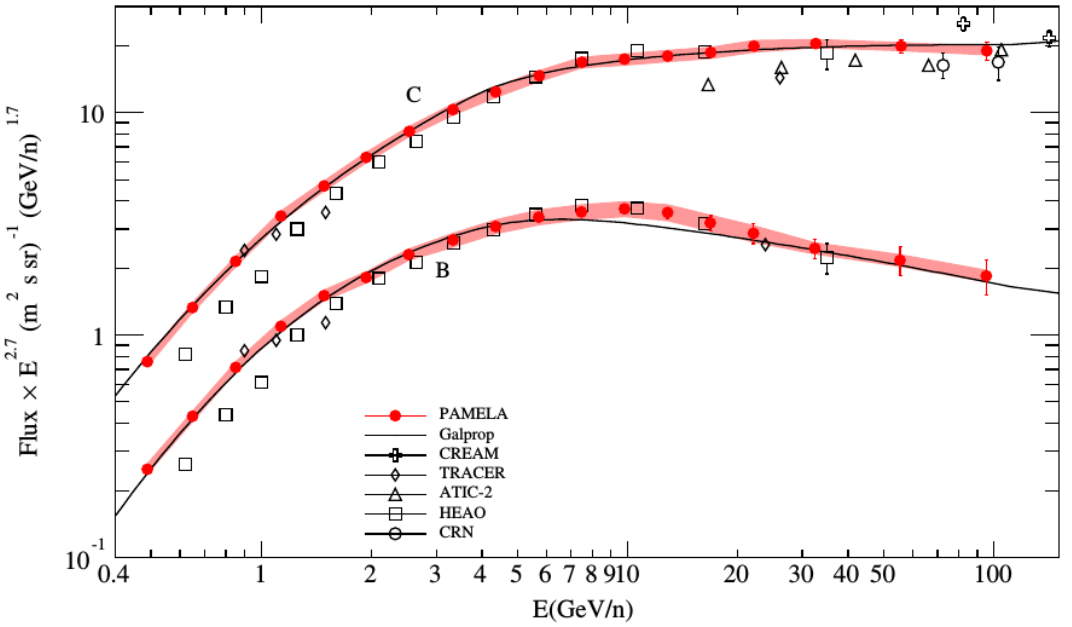


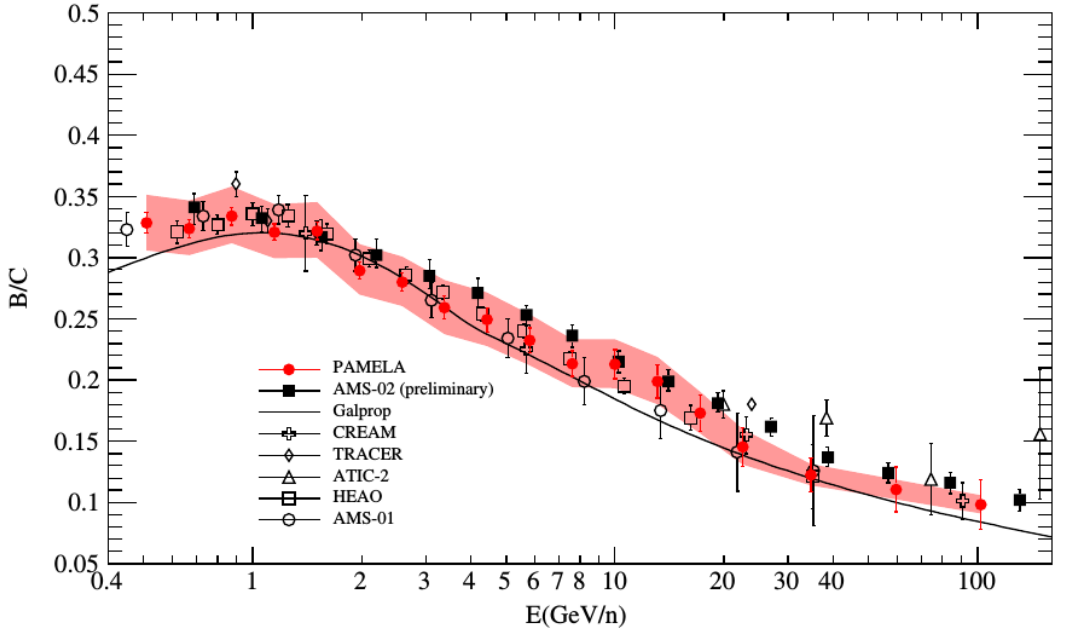
ATTIVITÀ @ INFN RM2 - PAMELA

PhD in Fisica (Ciclo XXV)

Tesi *"PAMELA measurements of boron and carbon spectra and B/C ratio in the energy range 0.44 GeV/n - 129 GeV/n"*

Adriani, O., et al. *Measurement of boron and carbon fluxes in cosmic rays with the PAMELA experiment.* ASTROPHYSICAL JOURNAL, 791 (2) (2014) (63 cit. ADS);



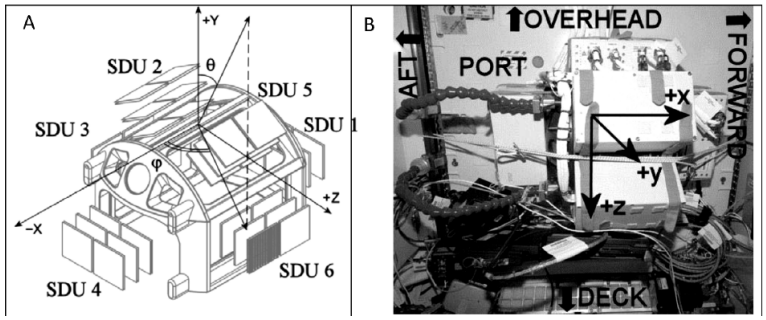


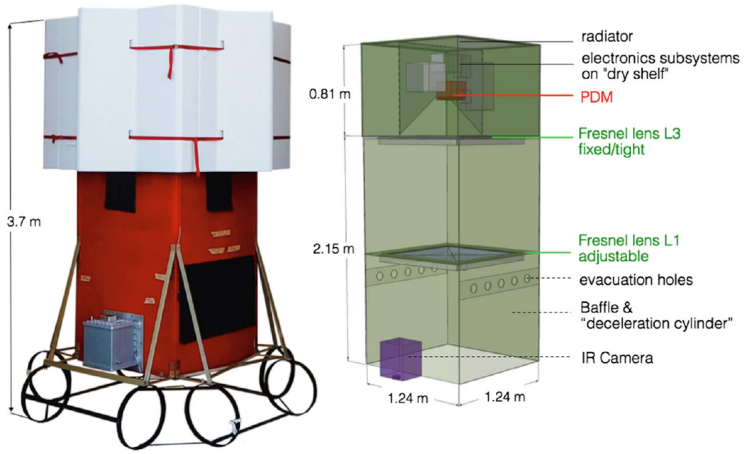
ATTIVITÀ @ INFN RM2 - PAMELA

- Adriani, O., et al. *PAMELA Measurements of Cosmic-Ray Proton and Helium Spectra.* SCIENCE, 332 (6025):69–72 (2011) (436 cit. ADS);
- Adriani, O., et al. *PAMELA Results on the Cosmic-Ray Antiproton Flux from 60 MeV to 180 GeV in Kinetic Energy.* PHYSICAL REVIEW LETTERS, 105 (12) (2010) (410 cit. ADS);
- Adriani, O., et al. *Cosmic-Ray Electron Flux Measured by the PAMELA Experiment between 1 and 625 GeV.* PHYSICAL REVIEW LETTERS, 106 (20) (2011) (218 cit. ADS);
- Adriani, O., et al. *Cosmic-Ray Positron Energy Spectrum Measured by PAMELA.* PHYSICAL REVIEW LETTERS, 111 (8) (2013) (171 cit. ADS);
- Adriani, O., et al. *Time dependence of the proton flux measured by PAMELA during the 2006 July-2009 December solar minimum.* ASTROPHYSICAL JOURNAL, 765 (2) (2013) (137 cit. ADS);
- Adriani, O., et al. *A statistical procedure for the identification of positrons in the PAMELA experiment.* ASTROPARTICLE PHYSICS, 34 (1):1–11 (2010) (123 cit. ADS);
- Adriani, O., et al. *The PAMELA Mission: Heralding a new era in precision cosmic ray physics.* PHYSICS REPORTS-REVIEW SECTION OF PHYSICS LETTERS, 544 (4):323–370 (2014) (80 cit. ADS);

ATTIVITÀ @ INFN RM2 – ALTEA + SILEYE-3, JEM-EUSO, SUPER-B

- ALTEA+Sileye-3/Alteino: database per sistema di calcolo e analisi dati;
- Super-B: responsabile design e sviluppo del database di book-keeping, responsabile alcuni layer del sistema di produzione (WebUI);
- JEM-EUSO:
  - partecipazione esperimenti pathfinder EUSO-Balloon, volo pallone stratosferico CNES, e EUSO-TA @ Telescope Array (USA)
  - responsabile del team di sviluppo del software di data-handling del CPU per i due esperimenti (gestione dell'On-Board Data Handling (OBDH) del Data Processing Unit (DPU))





ATTIVITÀ @ INFN RM2 – ALTEA + SILEYE-3, JEM-EUSO, SUPER-B

- Adams, J. H., et al. *The JEM-EUSO instrument.* EXPERIMENTAL ASTRONOMY, 40 :19–44 (2015)
- Adams, J. H., et al. *JEM-EUSO: Meteor and nuclearite observations.* EXPERIMENTAL ASTRONOMY, 40 : 253–279 (2015)
- Di Fino, L., et al. *Heavy-Ion Anisotropy Measured by ALTEA in the International Space Station.* RADIATION RESEARCH, 176 (3):397–406 (2011)
- Adams, J. H., et al. *Ground-based tests of JEM-EUSO components at the Telescope Array site, "EUSO-TA".* EXPERIMENTAL ASTRONOMY, 40 :301–314 (2015)
- Adams, J. H., Jr., et al. *The EUSO-Balloon pathfinder.* EXPERIMENTAL ASTRONOMY, 40 (1, SI):281–299 (2015)
- Larosa, M., et al. I*on rates in the International Space Station during the December 2006 Solar Particle Event.* JOURNAL OF PHYSICS G-NUCLEAR AND PARTICLE PHYSICS, 38 (9) (2011)
- Larsson, O., et al. *Relative nuclear abundance from C to Fe and integrated flux inside the Russian part of the ISS with the Sileye-3/Alteino experiment.* JOURNAL OF PHYSICS G-NUCLEAR AND PARTICLE PHYSICS, 41 (1) (2014).
- SuperB Collaboration, *SuperB Technical Design Report.* ArXiv:1306.5655 (2013).

CNSA

CHINA EARTHQUAKE ADMINISTRATION
中国地震局

asi
agenzia spaziale italiana

电磁监测卫星计划

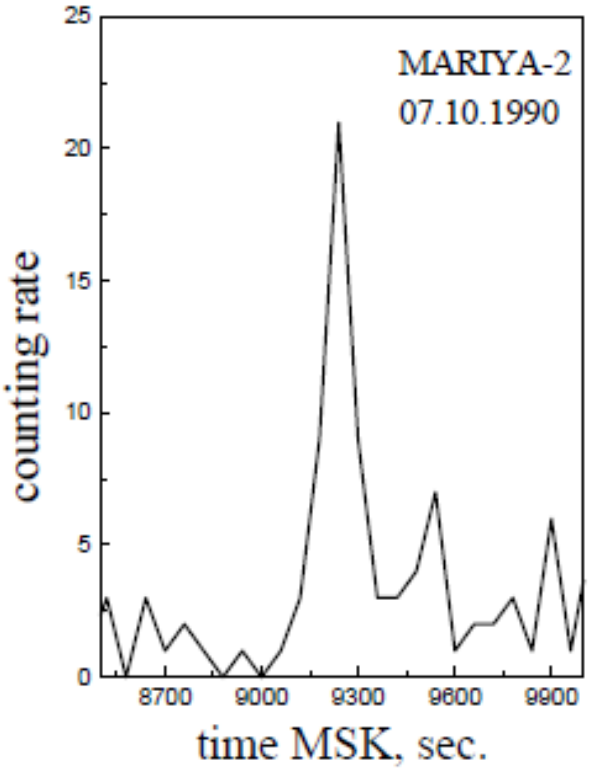
China Seismo-Electromagnetic Satellite Program

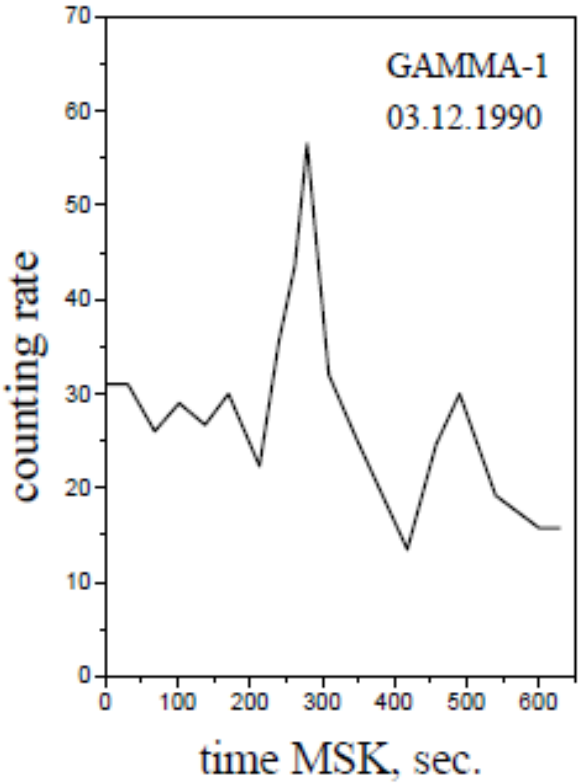
EARLY SPACE MISSIONS

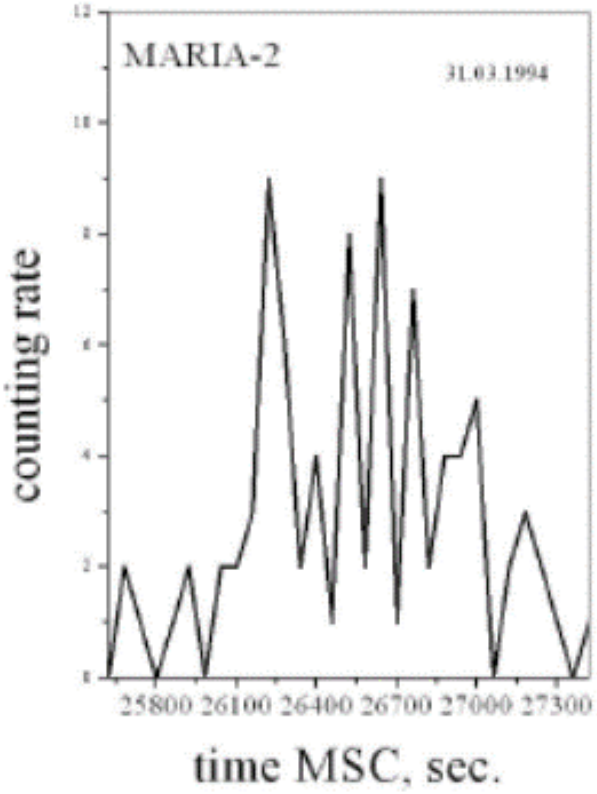
Space missions observed electron and proton flux variations below the radiation belts

- Electron Intercosmos Bulgaria-1300 and Meteor 3
- Mariya Salyut 7
- Mariya-2 MIR
- Gamma 1 GAMMA Astrophysical Station
- Meteor 3A
- Oreol 3
- Sampex

SINGLE AND MULTIPLE ELECTRON BURST

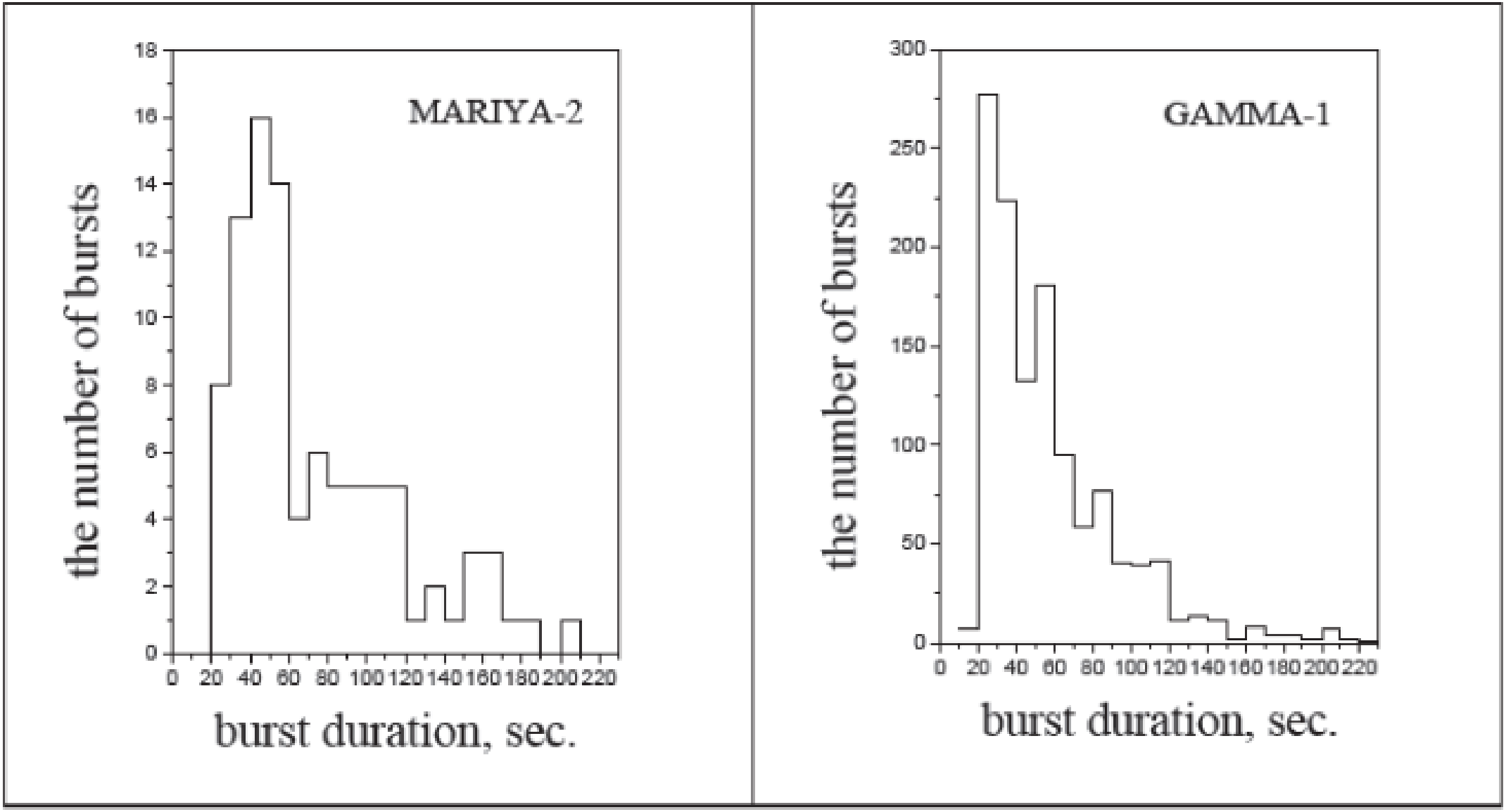




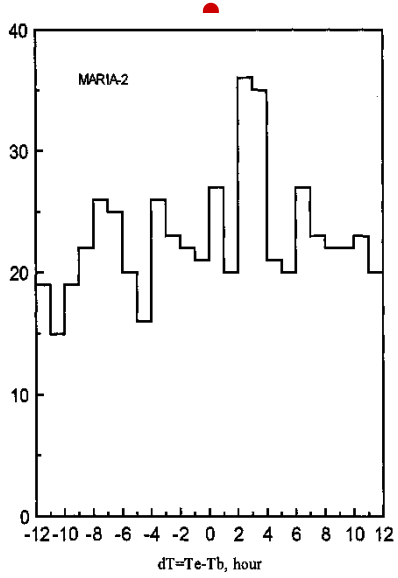


ELECTRON BURST DURATION

Distribution of electron burst duration recorded by Mariya-2 and Gamma-1 experiments



CORRELATIONS BETWEEN EQ AND PB: ΔT_{EQ-PB} DISTRIBUTIONS



MIR mission

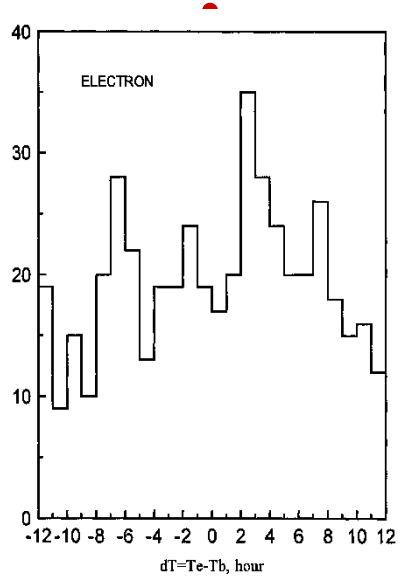
1985-2000

Altitude: 400 km

Inclination: 51°

E_e: 20–200 MeV

E_p: 20–200 MeV



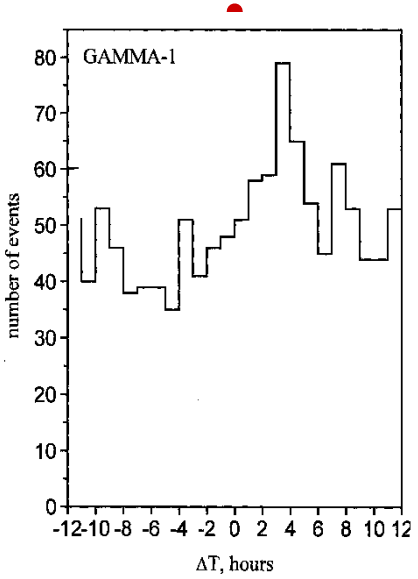
METEOR-3 mission

1985-1986

Altitude: 1250 km

Inclination: 82°

E_e: ≤ 30 MeV



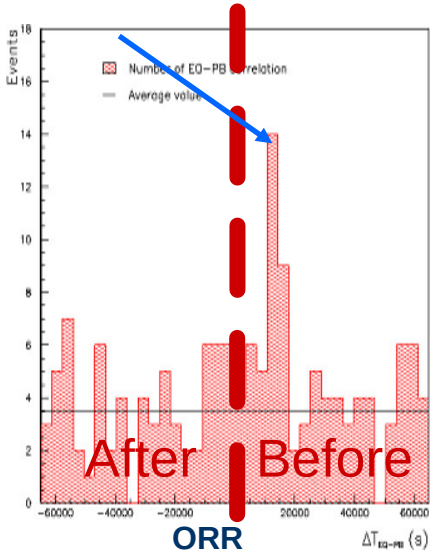
GAMMA-1 mission

1990-1992

Altitude: 350 km

Inclination: 51°

E_e: > 50 MeV



(Orbit Rate Rotation;
July 1992 - May 1994)

SAMPEX/PET mission

1992-1999

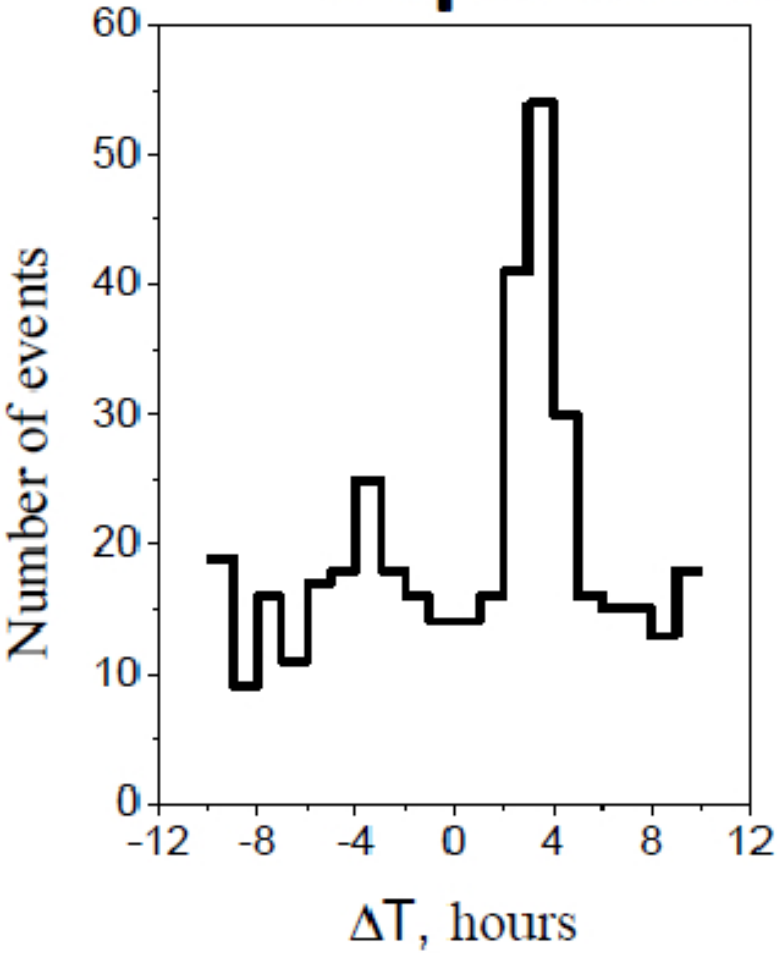
Altitude: 520–740 km

Inclination: 82°

$4 \leq E_e \leq 15$ MeV

ΔT_{EQ-PB} DISTRIBUTION OF PET/SAMPEX DATA

ΔT distribution of events (particle bursts and earthquakes). $\Delta T = T_{earthq} - T_{burst}$. Experimental data of PET/SAMPEX.



Event selection:

1) $|\Delta L| < 0.05$

2) Magnitude of earthquakes M>5.0

S.V.Aleksandrin, A.M.Galper, S.V.Koldashov et al. Annales Geophysical, 2003, 21, 597.

INOSPHERE-LITHOSPHERE COUPLING

- The lithosphere may produce EM perturbations that can propagate in the ionosphere and inner magnetosphere
- An earthquake is a sudden perturbation that can induce e.m. and particle signals in the ionosphere/lower magnetosphere

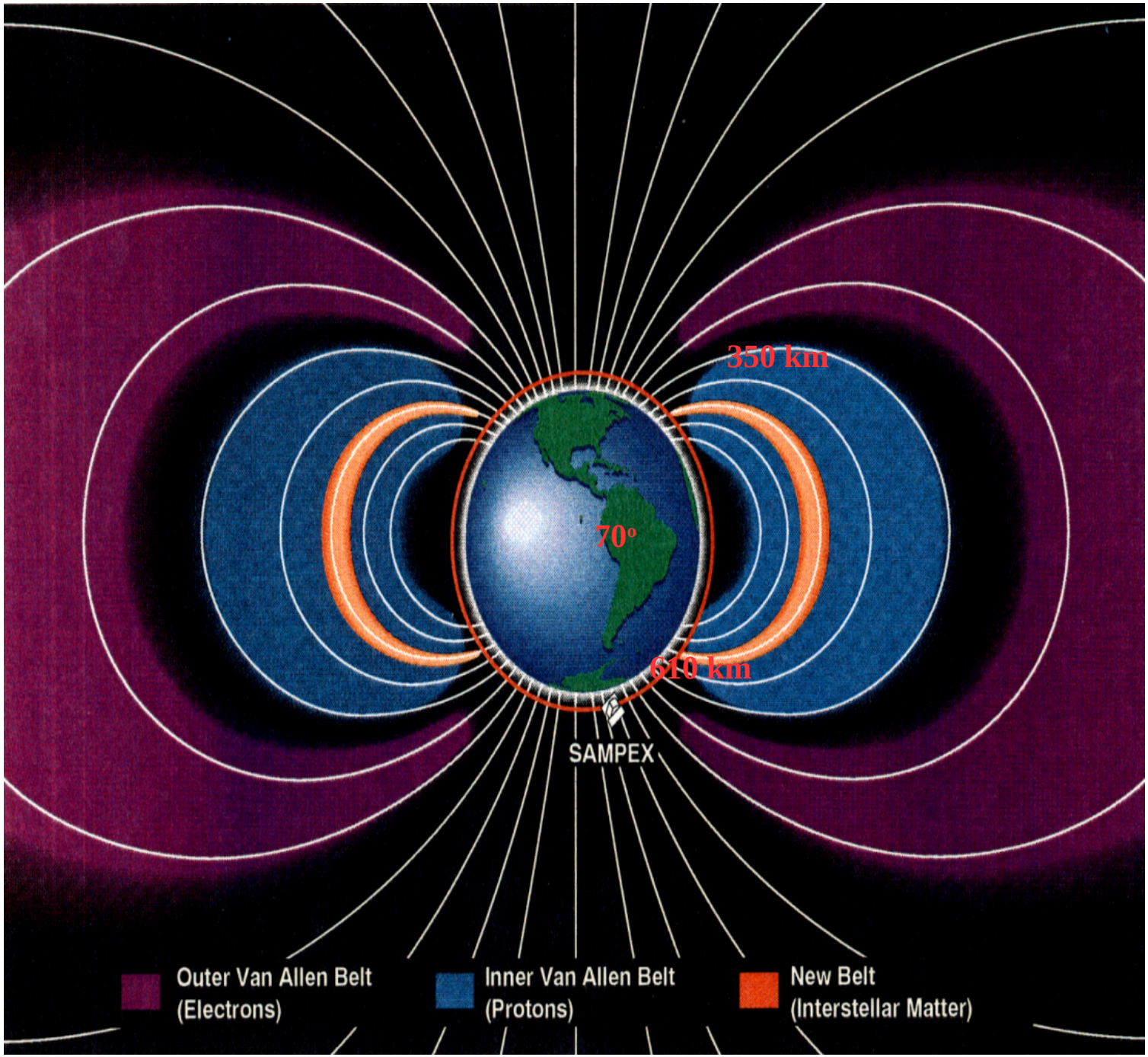
IONOSPHERIC-MAGNETOSPHERIC PERTURBATIONS

Electro-Magnetic Emission (EME)

- Natural emissions (earthquakes and volcanic eruptions)
- Anthropogenic emissions (PLHR, VLF & HF transmitters)

ULF EME: wave-trapped particle interaction?

VAN ALLEN BELTS

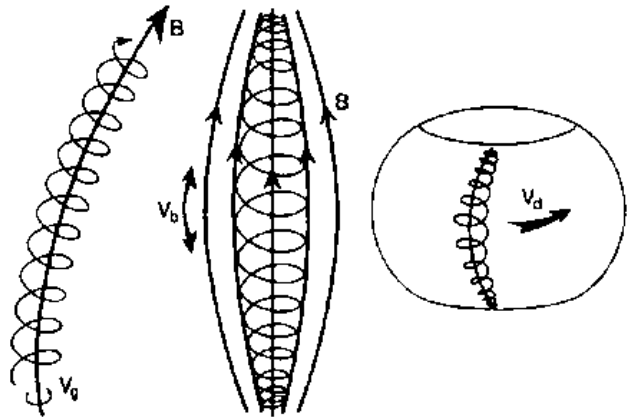


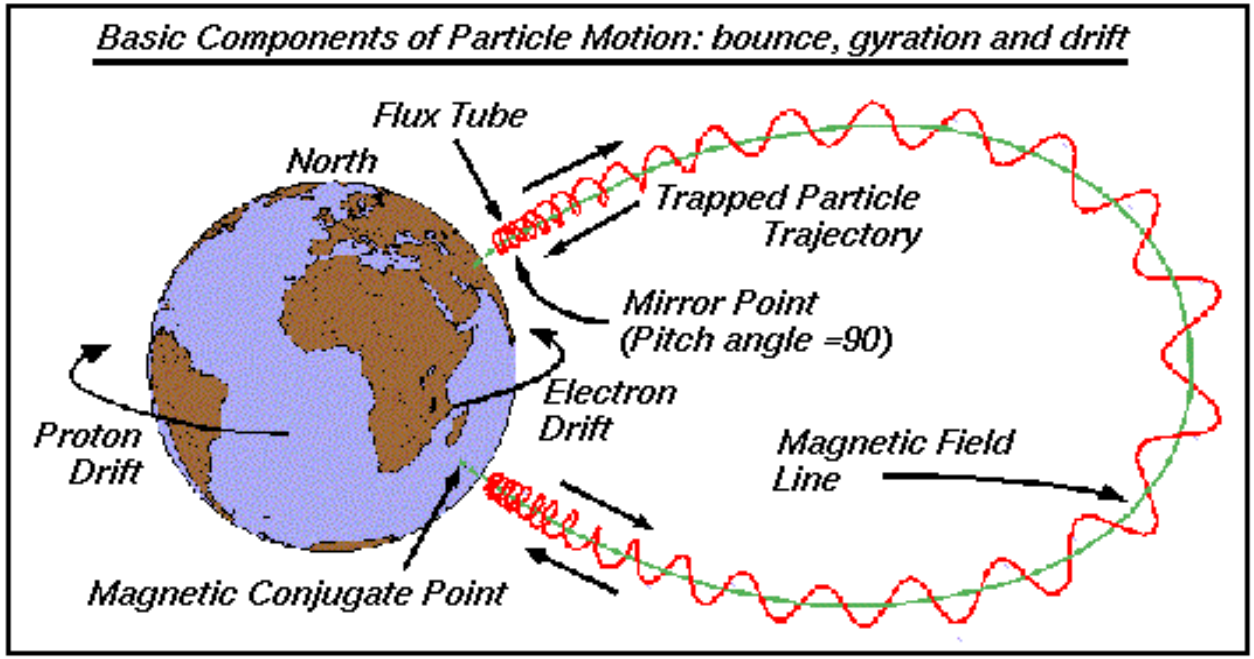
VAN ALLEN RADIATION BELTS

A. Gyro

B. Bouncing

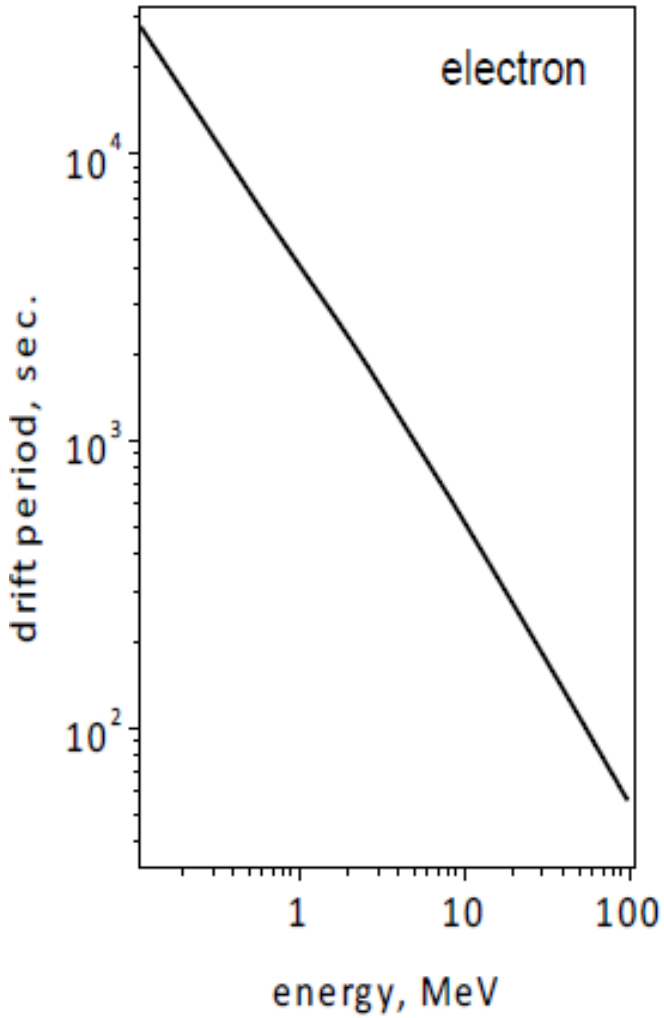
C. Longitudinal drift

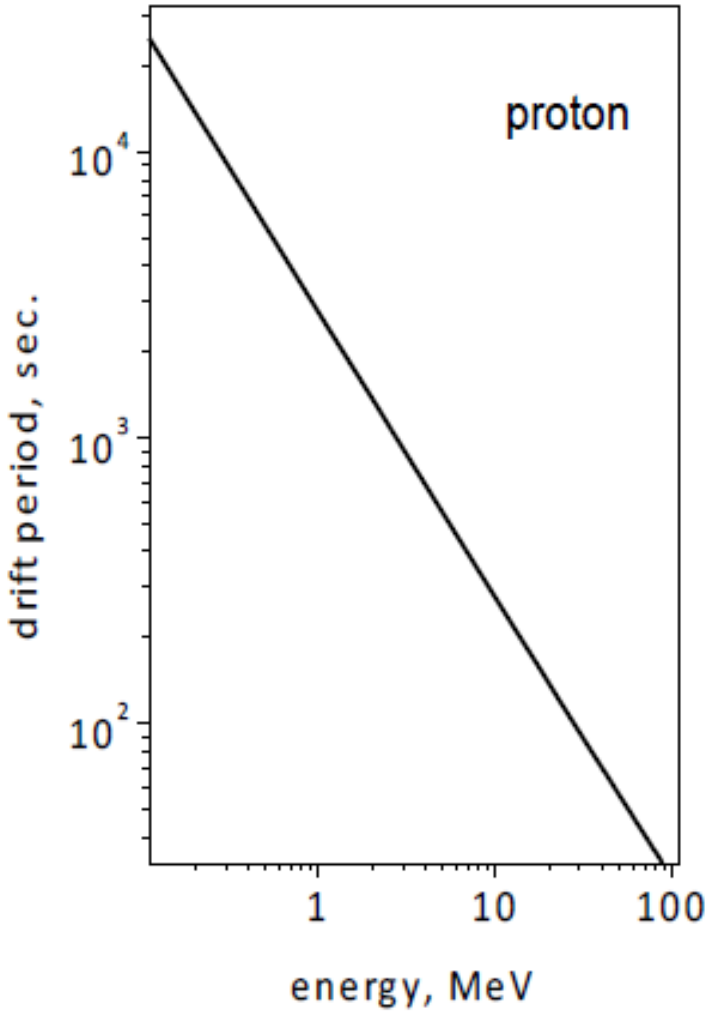




PERIOD OF LONGITUDINAL DRIFT

Periods of longitudinal drift of electrons and protons in radiation belt (for L=1.2)





WAVE-PARTICLES INTERACTION MECHANISM

Schematic representation in a meridian plane of the trapped particle trajectories

1 EARTHQUAKE PREPARATION AREA

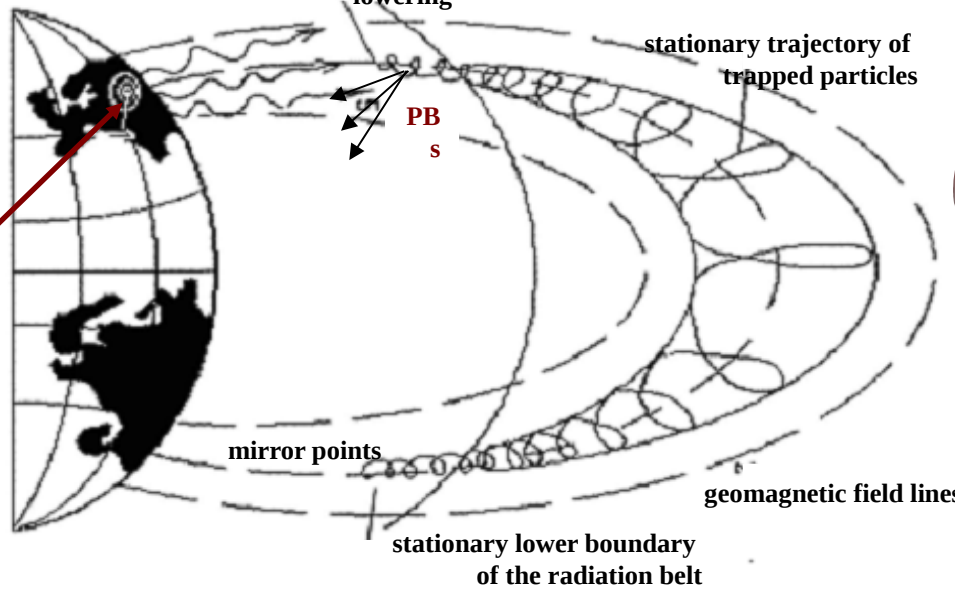
2 EM WAVES PROPAGATION INTO THE IONO-MAGNETOSPHERE

3 EM WAVES GENERATE PERTURBATIONS IN THE LOWER IONOSPHERE

4 EM WAVES INTERACT WITH CHARGED TRAPPED PARTICLES IN THE INNER RADIATION BELT

5 PARTICLE PITCH ANGLE CHANGES
⇓
MIRROR POINTS LOWERING
⇓
PARTICLE PRECIPITATION

6 PBs PROPAGATE AROUND THE EARTH ALONG THE L-SHELL
⇓
(LONGITUDINAL DRIFT)
PBs DETECTABILITY AT ANY LONGITUDE



CSES-LIMADOU COLLABORATION

- Mission Principal Investigator: Xuhui Shen
- Limadou P.I.: Piergiorgio Picozza
- Limadou P.M. ASI: Simona Zoffoli
- Limadou P.M. INFN: Cristian De Santis

Chinese Collaboration

- China National Space Administration (CNSA)
- China Earthquake Administration (CEA)
- China Aerospace Science and Technology Corporation (CASC)
- China Academy of Space Technology (CAST)
- DFH Satellite Co., Ltd
- Lanzhou Institute of Physics (LIP)
- Space Star Techonology Co.
- National Space Science Center (NSSC)
- Centre for Space Science and Applied Research - Chinese Academy of Science

LIMADOU COLLABORATION

In the framework of the CSES Mission, ASI has funded the “Progetto Premiale Limadou” (Limadou Project, KOM May 2014)

The Italian Institute for Nuclear Physics (INFN) is the prime contractor of the Limadou Project in collaboration with Italian institutes and universities

- INFN - Roma “Tor Vergata”, Bologna, Perugia, LNF, Naples, TIFPA
- University of Rome “Tor Vergata”
- University of Trento
- National Institute for Astrophysics - Institute for Space Astrophysics and Planetology (INAF-IAPS)
- UniNettuno University
- Istituto Nazionale di Geofisica e Vulcanologia (INGV)

Deliverables:

- Four models (EM, STM, QM, FM) High Energy Particle Detector (HEPD)
- Engineering Model (EM) Electric Field Detector (EFD)

CSES – SCIENTIFIC OBJECTIVES

- Monitoring of the electromagnetic near-Earth space environment
- Analysis of the ionospheric and plasmaspheric fluctuations
- Measurements of iono-magnetospheric perturbations possibly due to seismo-electromagnetic phenomena
- Study of fluxes of high & low energy charged particles precipitating from the Inner Van Allen radiation belt
- Measurements of magnetospheric and solar activity
- Monitoring of the e.m. man-made effects at LEO altitude
- Observations of e.m. transient phenomena caused by tropospheric activity

CSES – PLATFORM & ORBIT

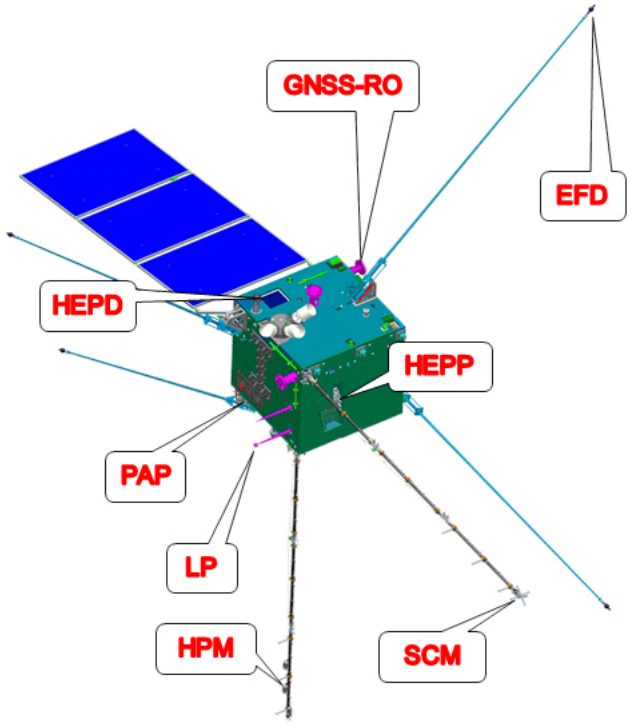
Platform

- CAST-2000 baseline
- Earth oriented 3-axis stabilization system
- X-Band Data Transmission,120Mb ps.
- USB TT&C System.
- Total Mass: 730kg
- Peak Power Consumption: ~900W
- Design Life-span: 5 Years

Orbit

- Circular Sun Synchronous Orbit
- Local Time at Descending Node ar ound 14:00

Launch 2nd February 2018 15:51:04

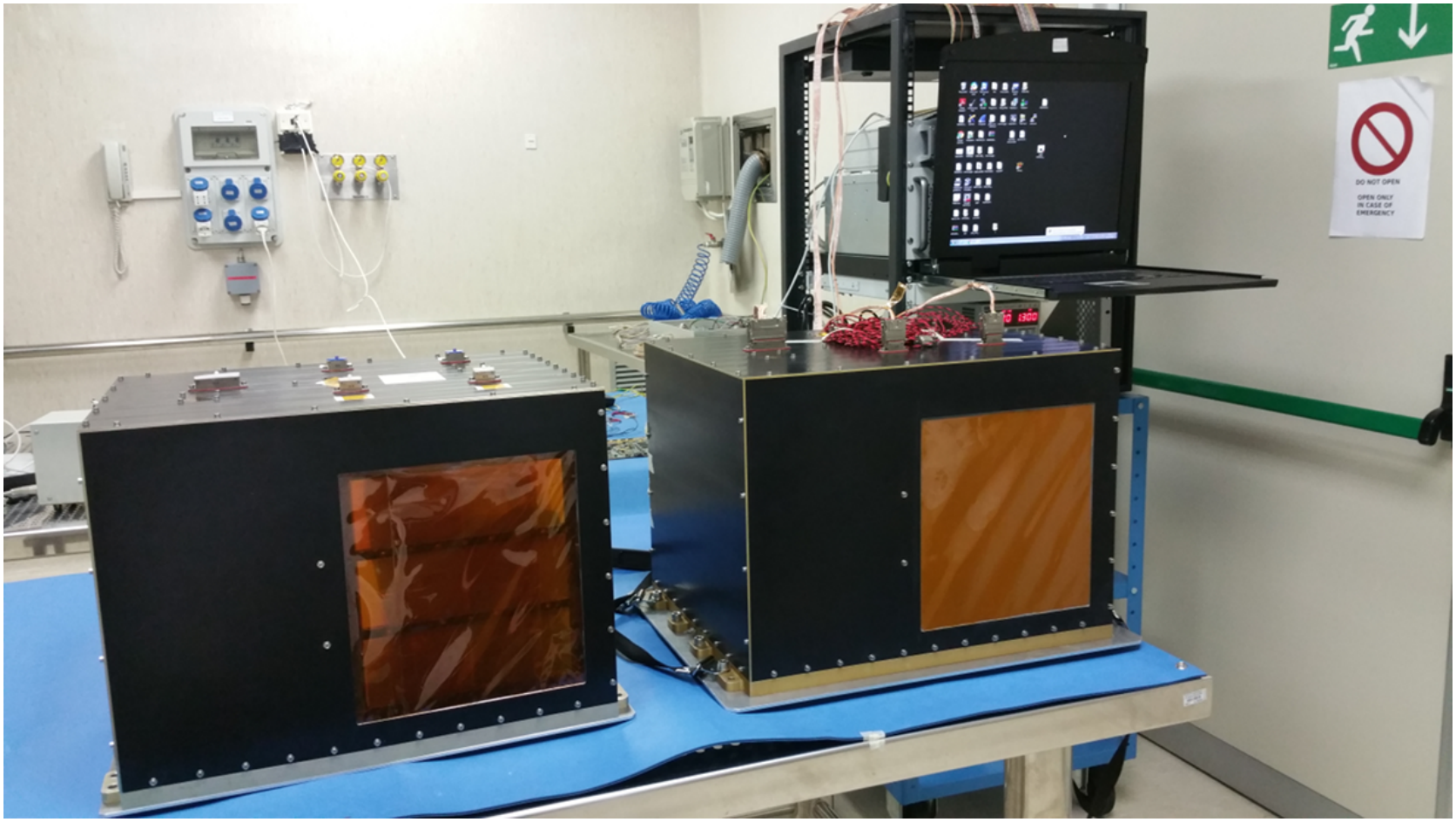


Parameter	*Design Value*
Semi-Major Axis	*6877.9km*
Orbit Altitude	*506.9km*
Inclination Angle	*97.4°*
Eccentricity	*0*
Circles per Day	*15 + 1/5*
Recursive Period	*5Days*

CSES – INSTRUMENTS

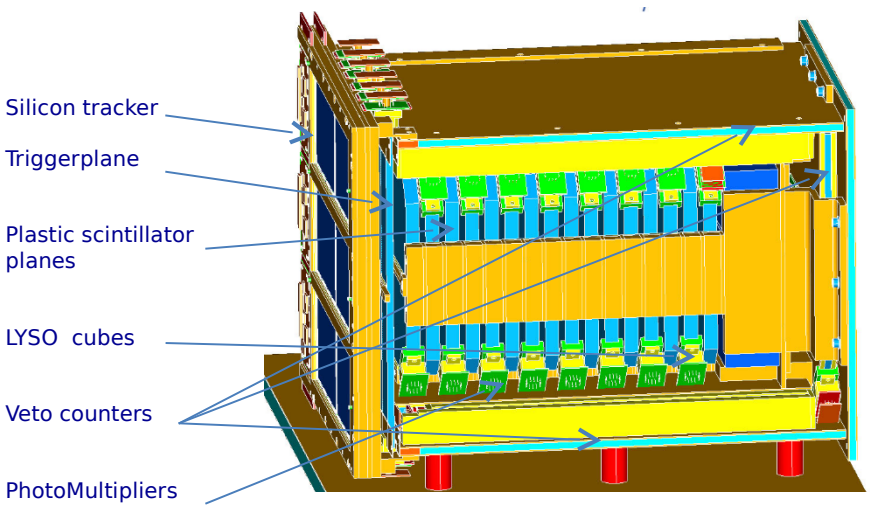
Measurements	Instruments
Measurement of the electrical and magnetic fields and their perturbations in ionosphere	Search-Coil Magnetometer
	Fluxgate Magnetometer
	Electrical Field Detector
Measurement of the disturbance of plasma in ionosphere	Plasma analizer
	Langmuir probe
Measurement of the flux and energy spectrum of the particles in the radiation belts	Two High Energy Particle Detector - Electrons - Protons
Measurement of the profile of electronic content	GPS Occultation Receiver
	Tri-frequency transmitter

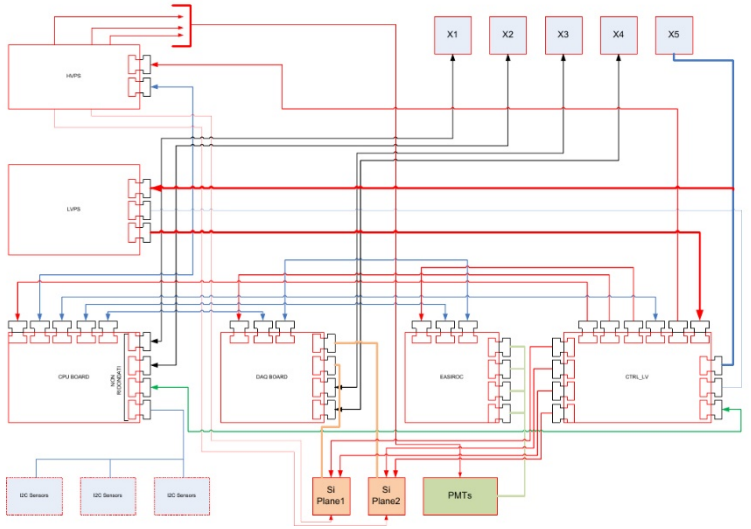
HIGH ENERGY PARTICLE DETECTOR (HEPD)



HEPD GENERAL DESIGN

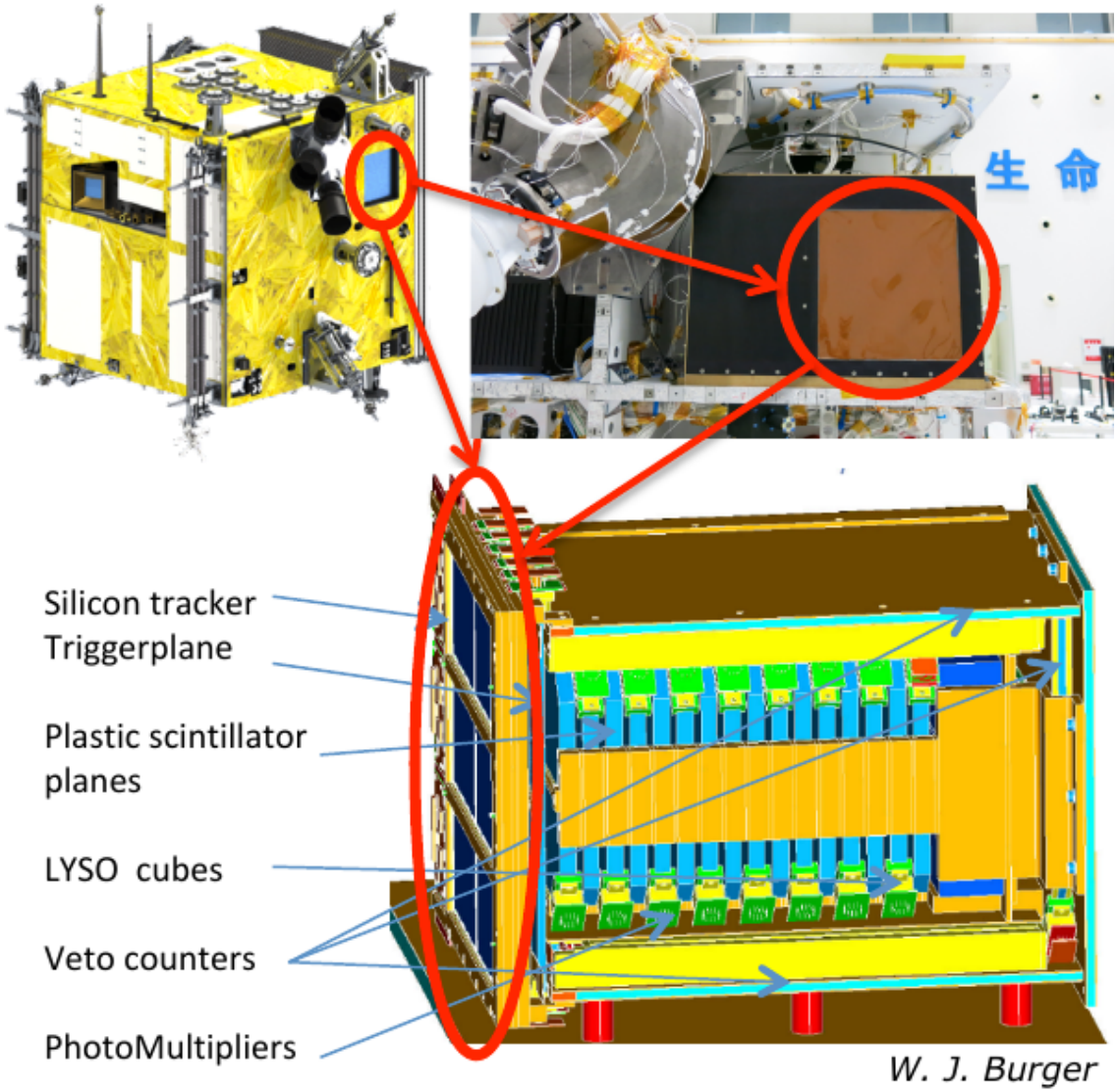
- two planes of double-side silicon microstrip detectors which provide the direction of the incident particle
- two layers of plastic scintillators for trigger (one thin segmented counter S1 and one deep counter S2)
- a range calorimeter made of:
  - 15 layers of plastic scintillator planes (15 × 15 × 1 cm^3) read out by PMTs;
  - a 3 × 3 matrix of inorganic scintillator LYSO (15 × 15 × 4 cm^3) read out by PMTs;
- the calorimeter volume is surrounded by 5 mm thick plastic scintillator veto planes;
- a main Power Supply (PS) provides low voltages for the detector electronics and a High Voltage PS (HVPS), controlled by a custom board, provides high bias voltages for PMTs and Silicon modules;
- four electronic boards: CPU (CAN interface, housekeeping), DAQ (silicon detector acquisition & RS-422 interface), PMT/Trigger (PMT acquisition and trigger control), Power Control (HEPD power distribution, P/L power and TM/TC interface)



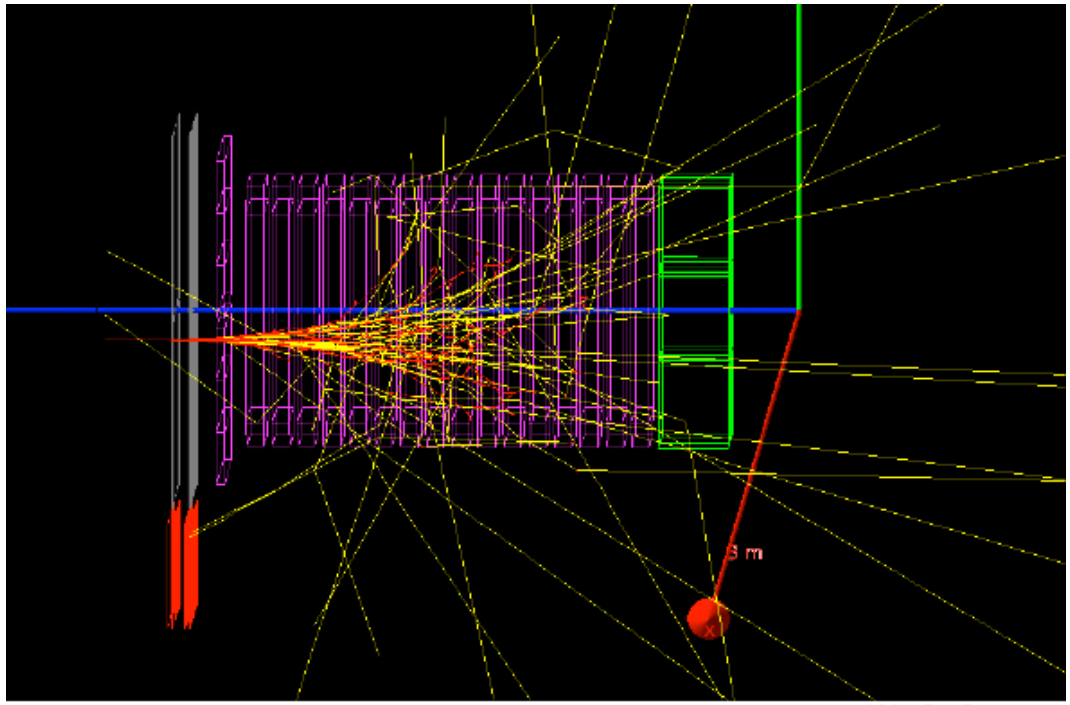


HEPD Electronics connection scheme

HEPD ON-BOARD CSES



W. J. Burger



W. J. Burger

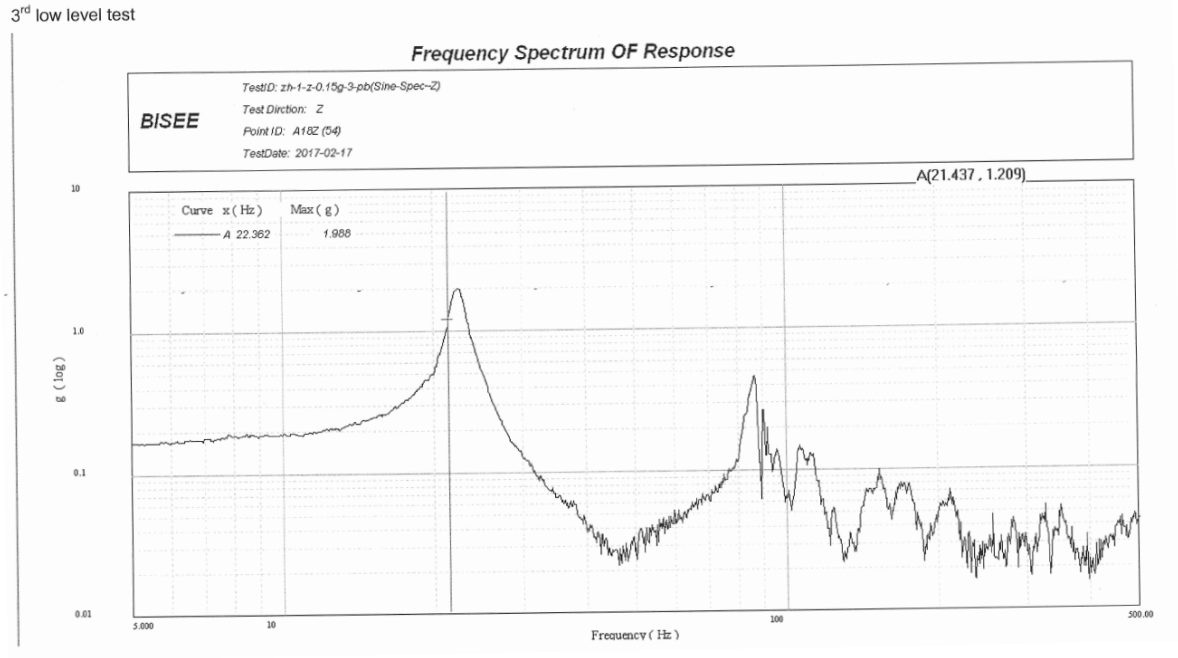
GEANT4 simulation of a 25 MeV electron entering the HEPD from the left. Red tracks represent electrons, yellow tracks photons. Gray planes make the silicon tracker, whereas purple blocks are scintillators. Green cubes on the right are LYSO crystals to contain higher energy particles.

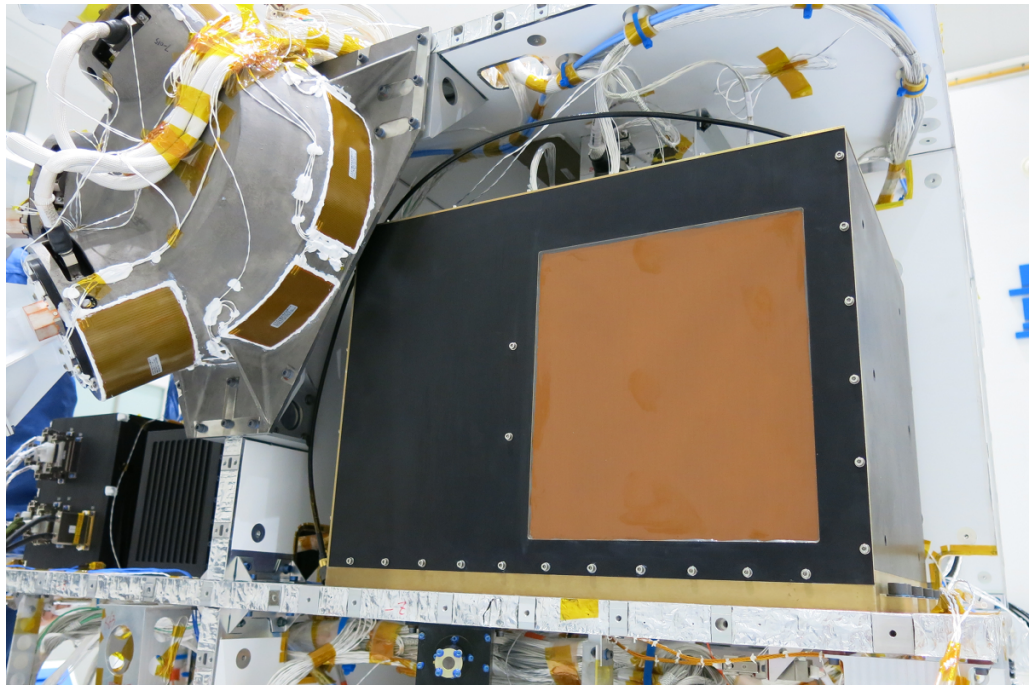
HEPD TESTING ACTIVITIES IN BEIJING

- January 2017: Assembly and Integration Verification
- February 2017: Sine (0.75 g) & Random (2.37 GRMS) Vibration Test
- March 2017: HEPD command & control software upgrade
- April 2017: Thermal Balance & Thermal Vacuum Test (4 cycles, -10 °C - +40 °C)
- December 2017: Pre-Lauch Site Transfer Functional Test

25th December 2017: CSES transfer to Jiuquan Satellite Launch Center (JSLC)

- Functional test and atmospheric muon acquisitions (7-8 January, 2018) @ JSLC





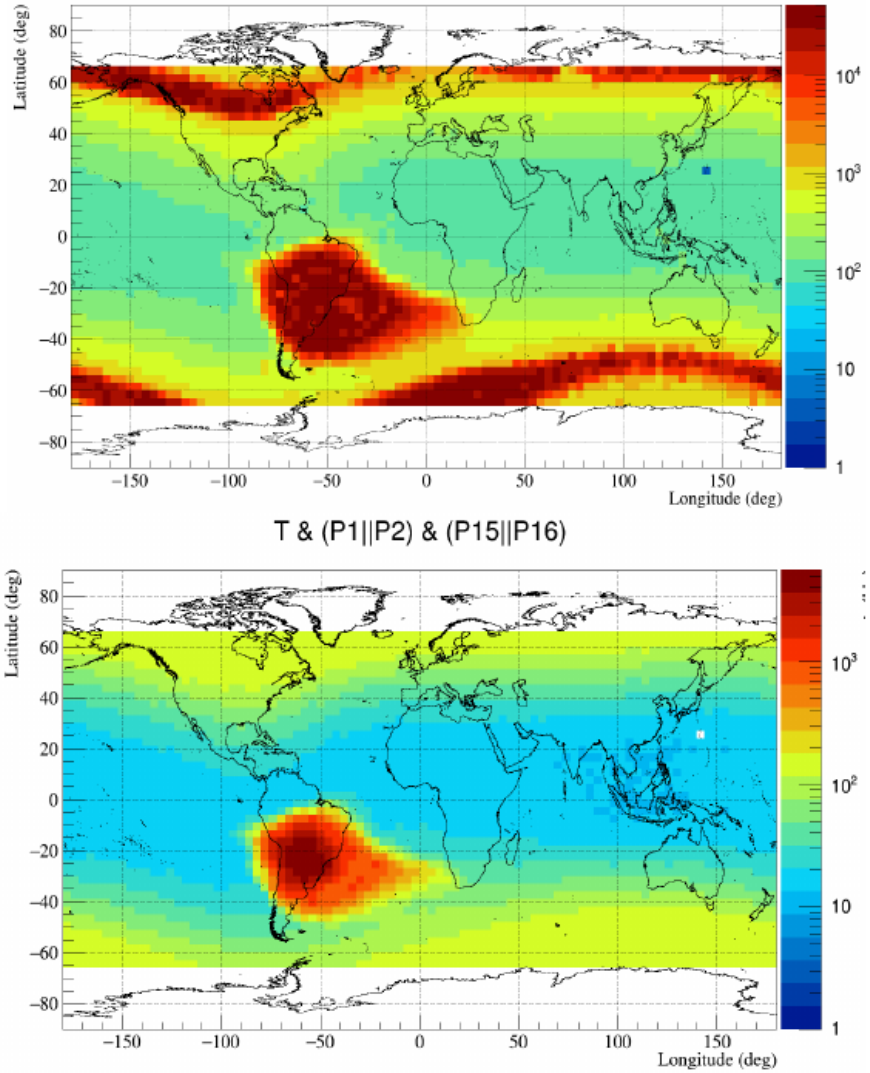
2 FEBBRAIO 2018 15:51:04 BJT

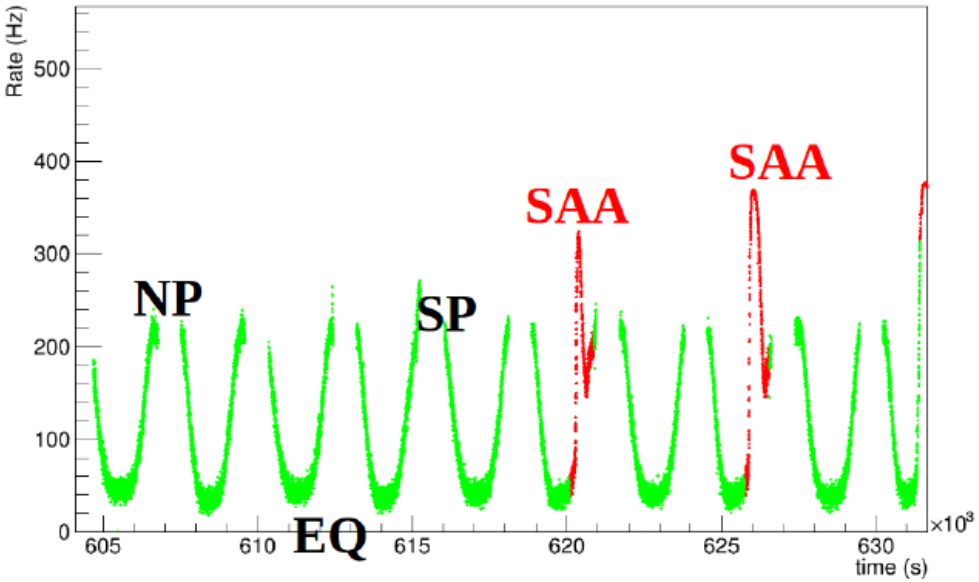

中国酒泉卫星发射中心 2018.02.02
热烈祝贺电磁监测试验卫星任务发射圆满成功
Congratulazioni per il pieno successo della missione di lancio del
"China Seismo Electromagnetic Satellite"
杨 晗
田玉龙
郑国光
郑卫平
王 程
余 琦
胡东华

HEPD FLIGHT DATA ANALYSIS – TRIGGER RATES

Trigger threshold scan performed.
Many different trigger configurations tested and validated.

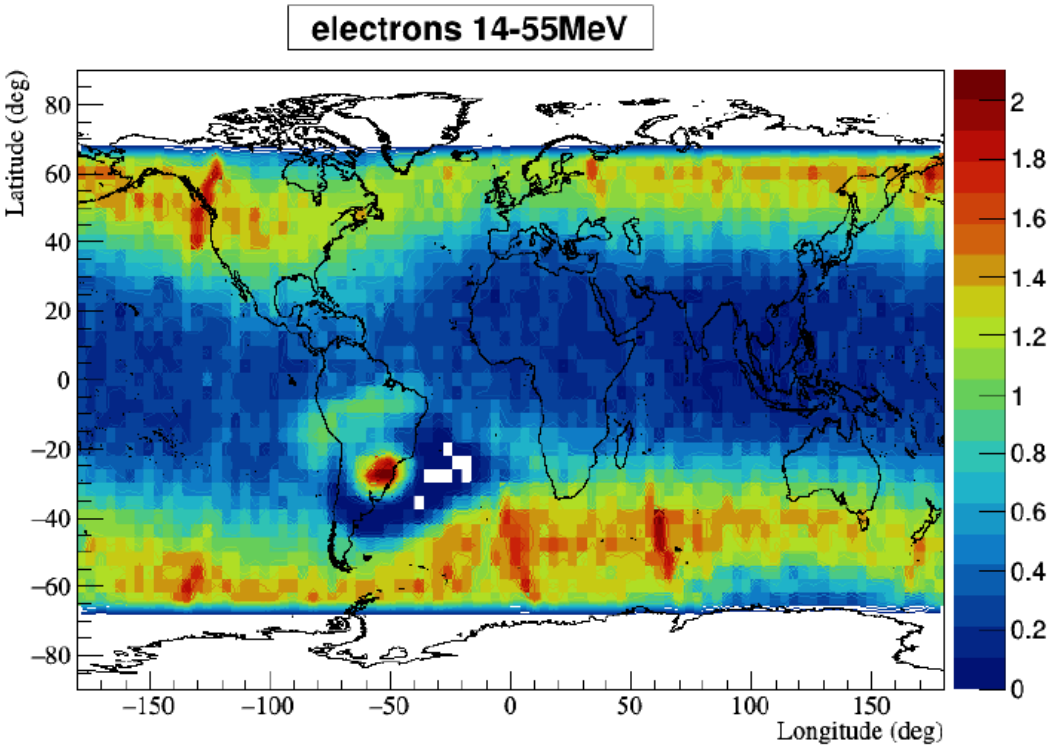
Particle counting rates used to define the best trigger configuration to adopt (best compromise between particle rate and data tranmission band).

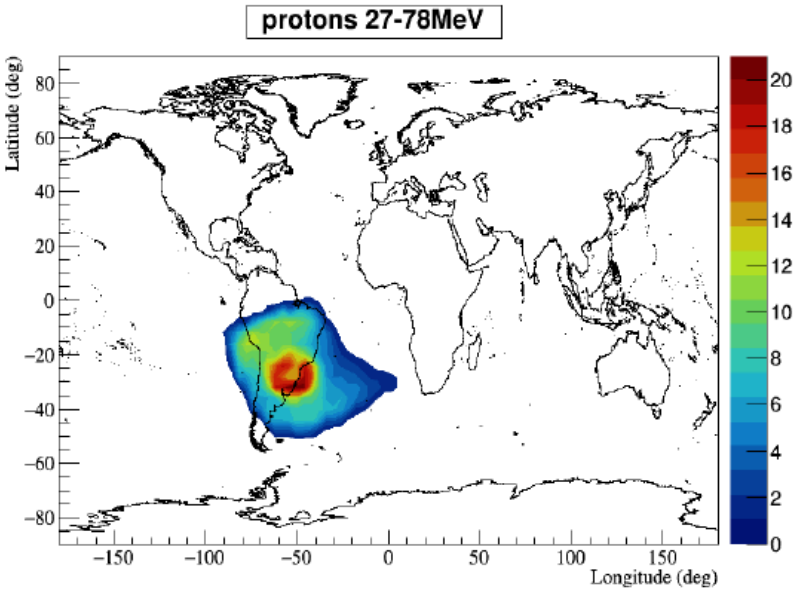




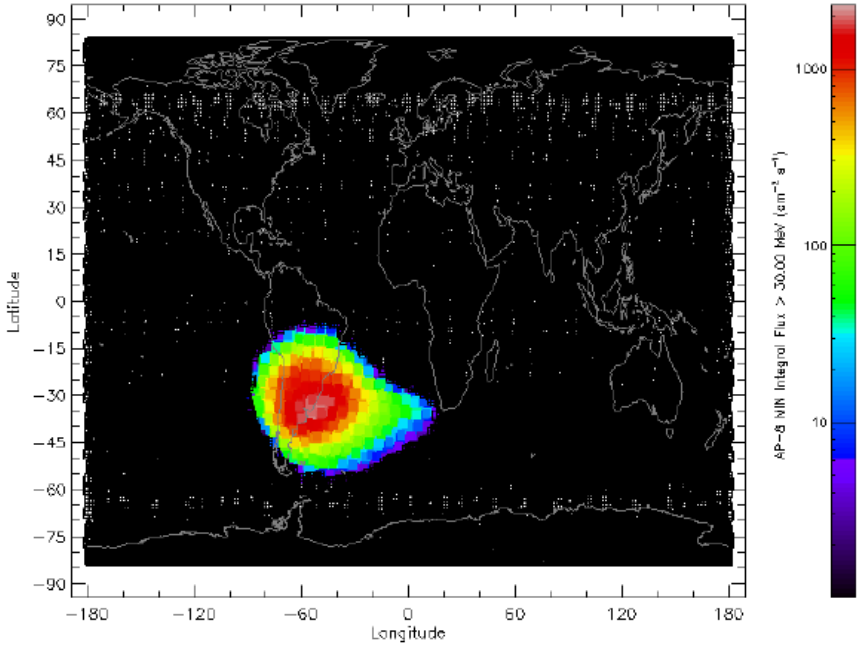
Verification of the event trigger rate along the orbit as a function of time.

HEPD FLIGHT DATA ANALYSIS – PARTICLE SELECTIONS





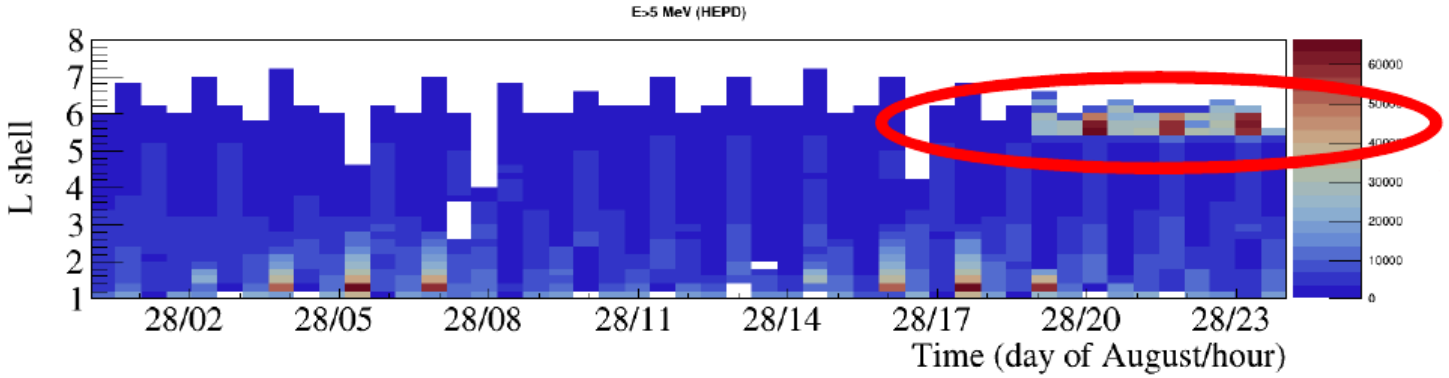
Comparison of the rate map with those obtained with models of trapped particle

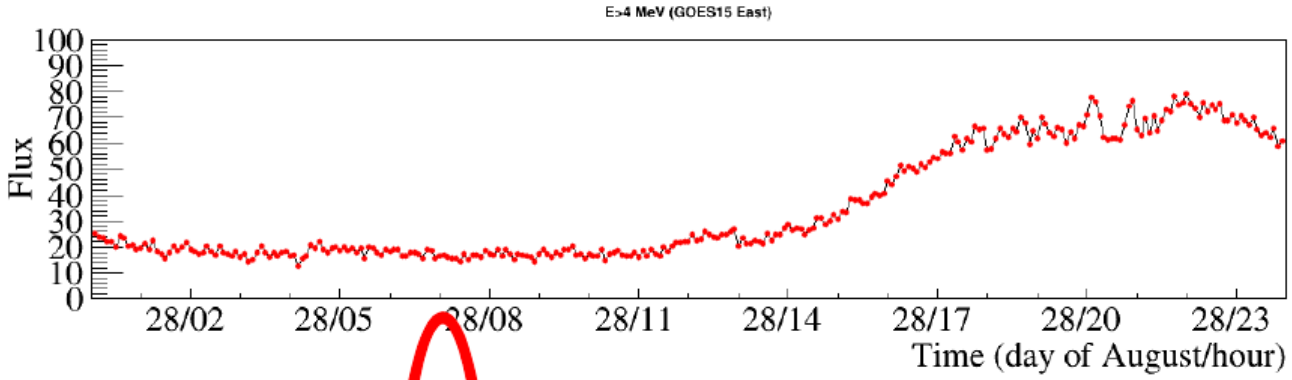


SPENVIS AP9 model

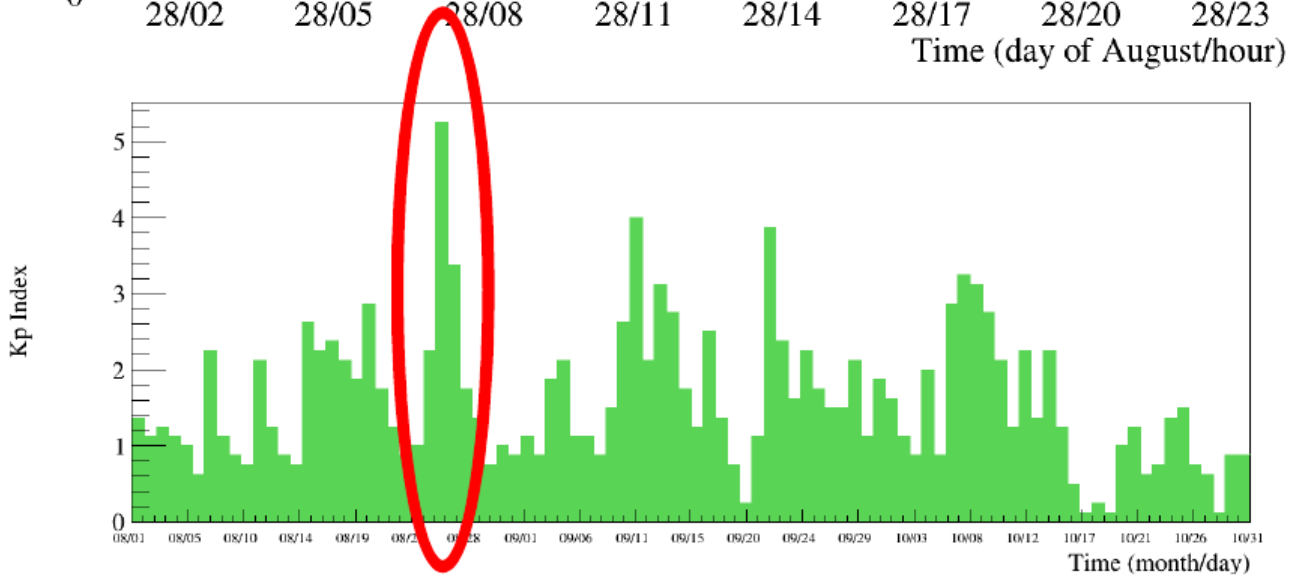
HEPD FLIGHT DATA ANALYSIS – SPACE WEATHER

- HEPD registered a rise in particle counts around 1900 UTC of August 28th, after GOES observed a similar rise in electron flux (E>4 MeV)

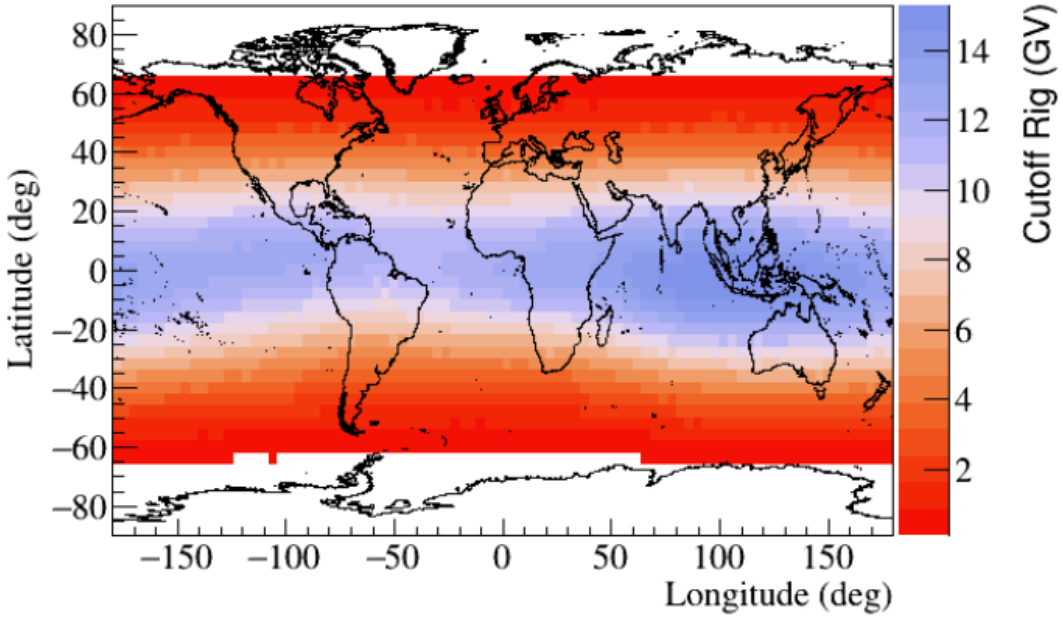


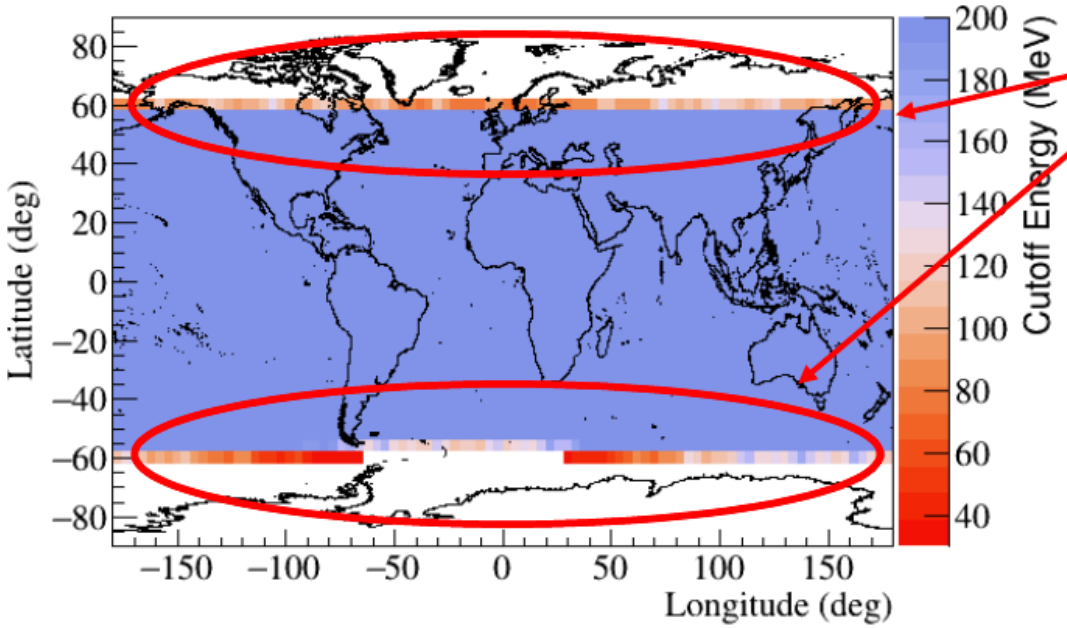


Moderate geomagnetic storm during August 26th-27th



HEPD FLIGHT DATA ANALYSIS – GALACTIC PROTONS



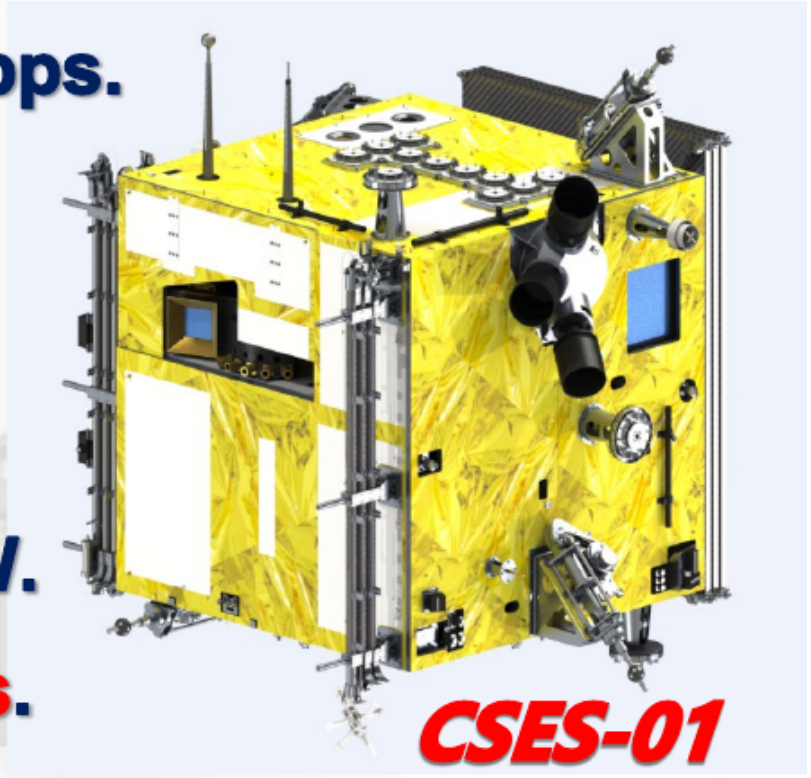


- HEPD proton energy range (30 – 300 MeV) is above cutoff rigidity at polar regions
- HEPD is capable to measure the lowest galactic particles (i.e. 35-45 MeV) for ~6% of the orbit

CSES-02 PLATFORM

CSES 02 Select Same platform CAST-2000 and some minor upgrade will be made.

- Earth oriented 3-axis stabilization system, with orbit maneuver ability.
- X-Band Data Transmission,120Mbps.
- Storage 160Gb/512Gb
- USB TT&C System.
- Total Mass: 730kg/900kg
- Peak Power Consumption: ~900W.
- Design Life-span: 5 Years/6 Years.



Credits: X. Zhu (DFH)

CSES-02 CONFIGURATION

➢ New Payloads configured

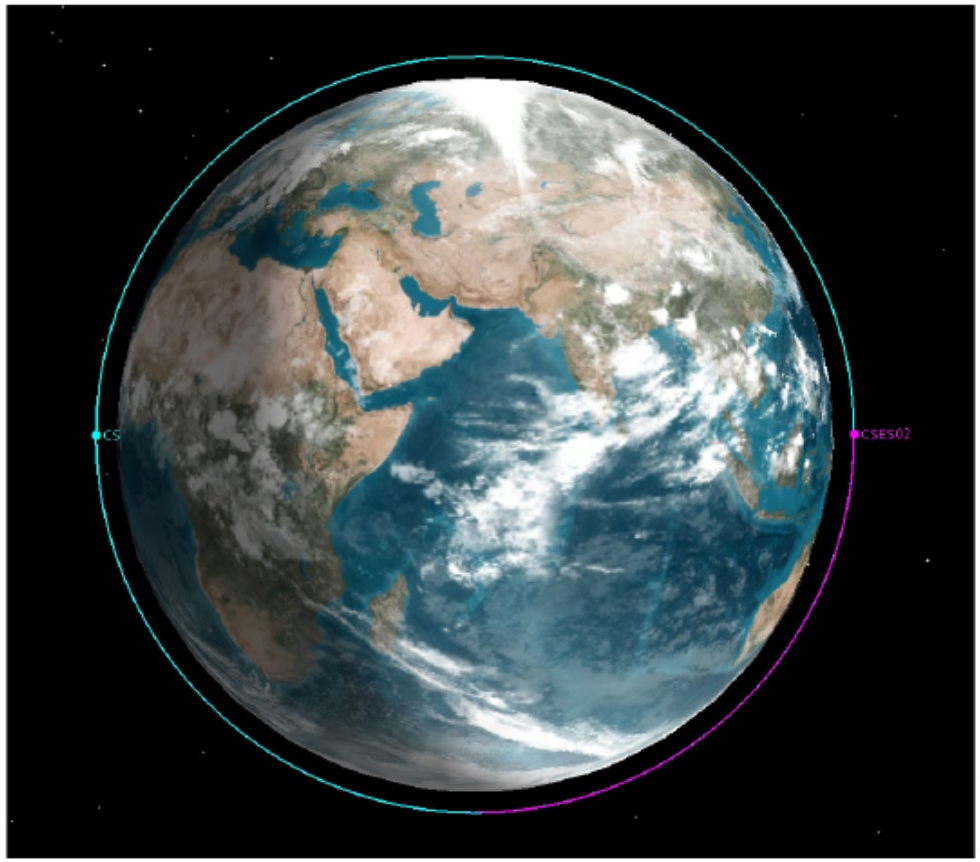
Category	Payload Name	Observation Targets
Energetic Particle	Italian HEPD Low Energy Electron Spectrometer	Proton： 2MeV~200MeV Electron： 30keV~50MeV
Electro-Magnetic Field	Electric Field Detector	Electric Field: DC~3.5MHz
	High Precision Magnetometer	Magnetic Field: DC~15Hz
	Search Coil Magnetometer	Magnetic Field: 10Hz~20kHz
In Situ Plasma	Plasma Analyzer Package	Composition： H^+、He^+、O^+ N_i： 5×10^2~$1\times10^7 cm^{-3}$ T_i： 500K~10000K
	Langmuir Probe	N_e： 5×10^2~$1\times10^7 cm^{-3}$ T_e： 500K~10000K
Plasma Profile Construction	GNSS Occultation Receiver	TEC by GNSS Occultation Signal
	Tri-Band Beacon	TEC by transmit VH/U/L Signal
	Ionospheric Photometer	135.6nm and N_2LBH airglow

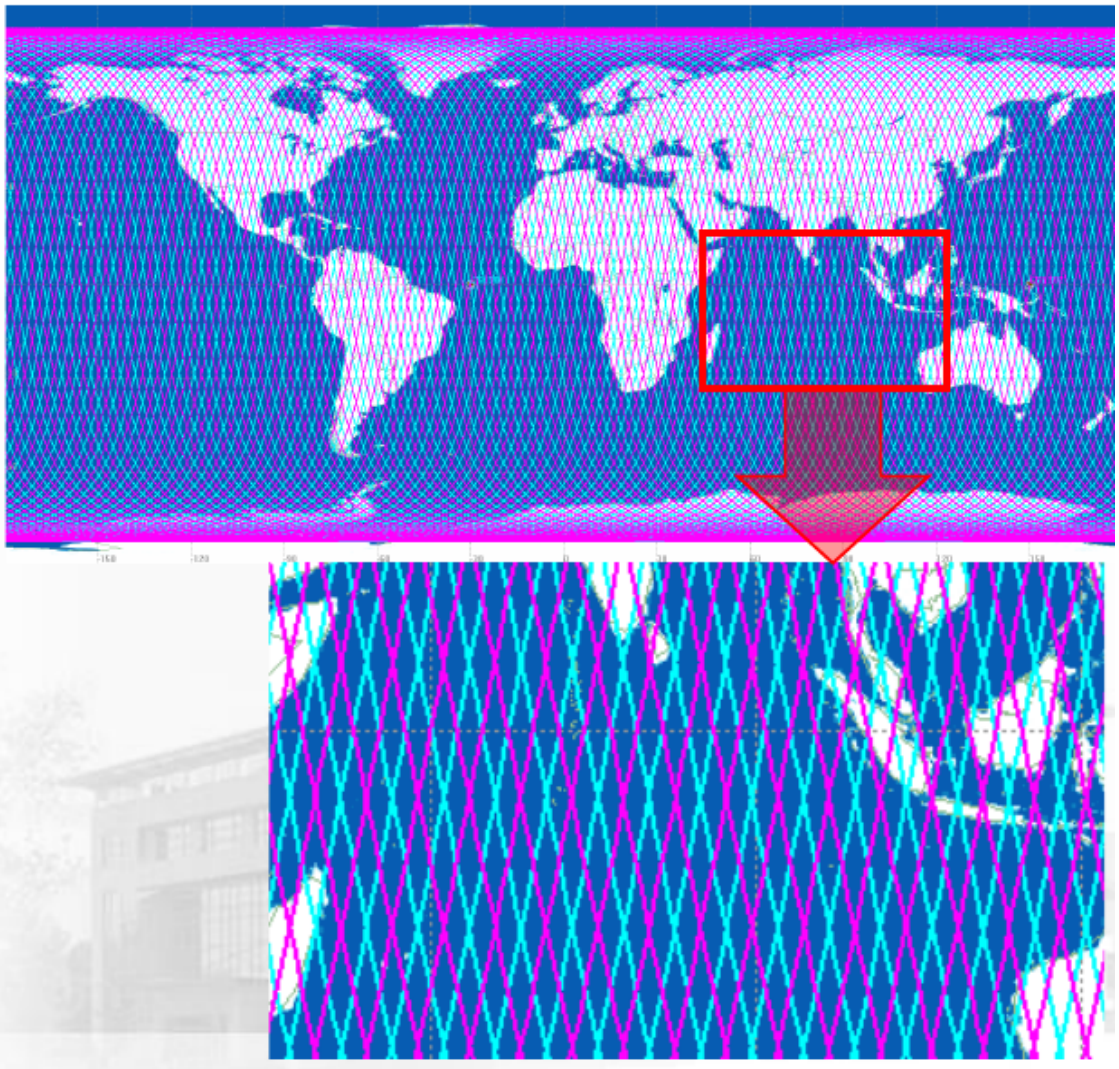
Credits: X. Zhu (DFH)

CSES-02 ORBIT DESIGN

Complementary Ground Track W.R.T. CSES01.

- Identical Orbit Plane
- 180°Phase Difference





Credits: X. Zhu (DFH)