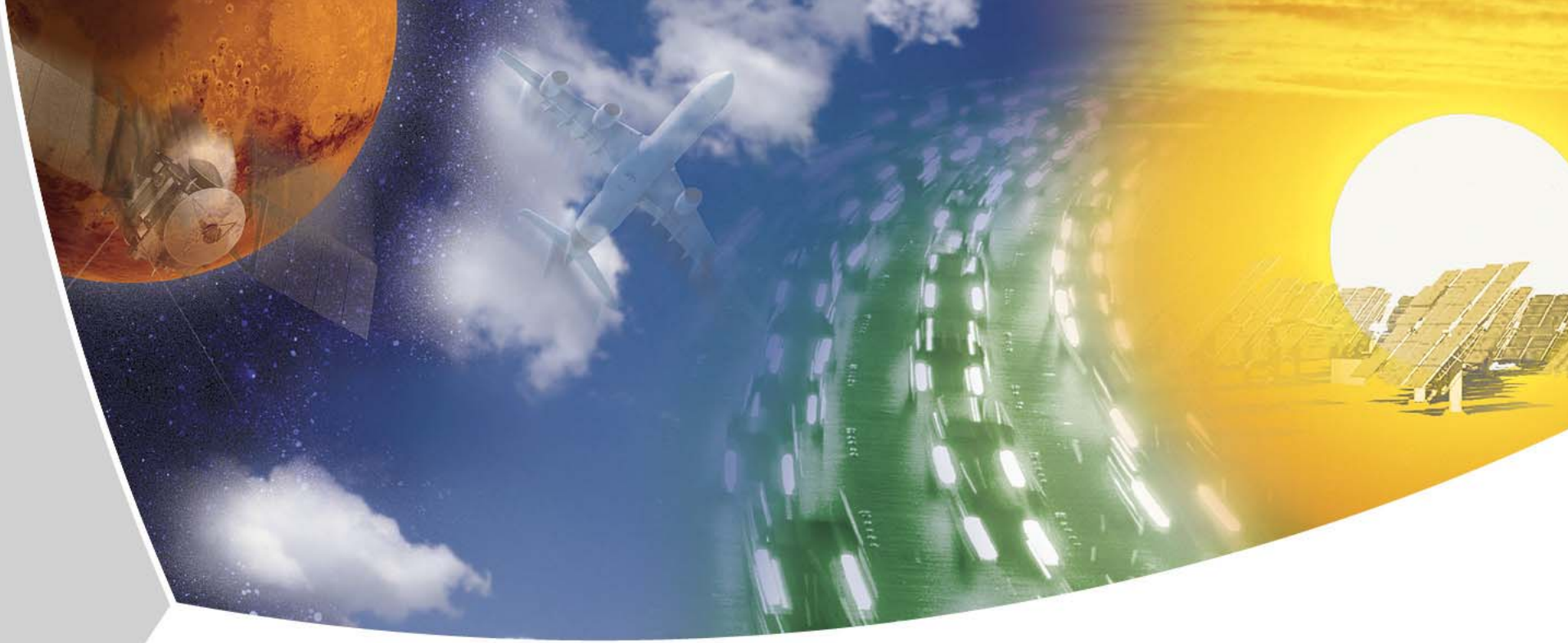

Space Situational Awareness Activities at the Institute of Space Systems Bremen

Frank Jansen, Jörg Behrens
DLR Institute of Space Systems, Hansestadt Bremen (ISSHB), Germany

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Deutsches Zentrum
DLR für Luft- und Raumfahrt e.V.
in der Helmholtz-Gemeinschaft

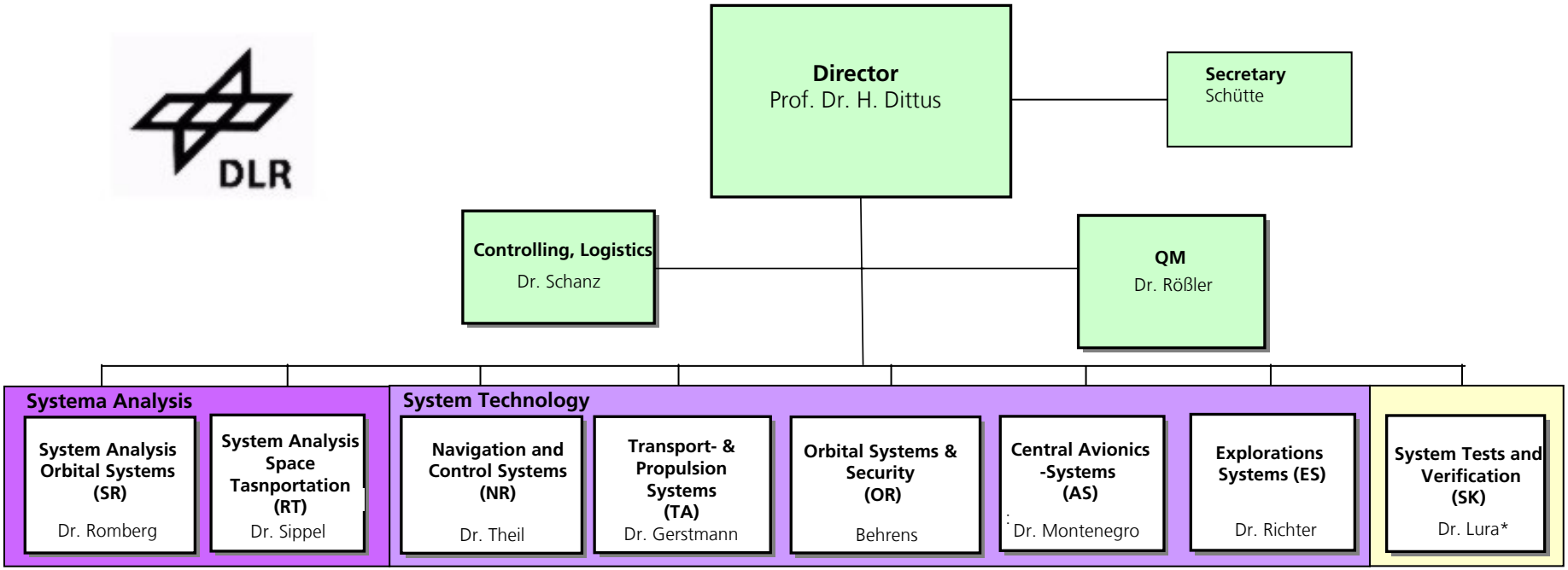
Content

1. DLR Institute of Space Systems Bremen (ISSHB)
2. Overview of past and contemporary projects towards SSA (10 years: 1998 – 2008)
3. Sketch of (nearby) future SSA related activities at ISSHB

1. DLR Institute of Space Systems

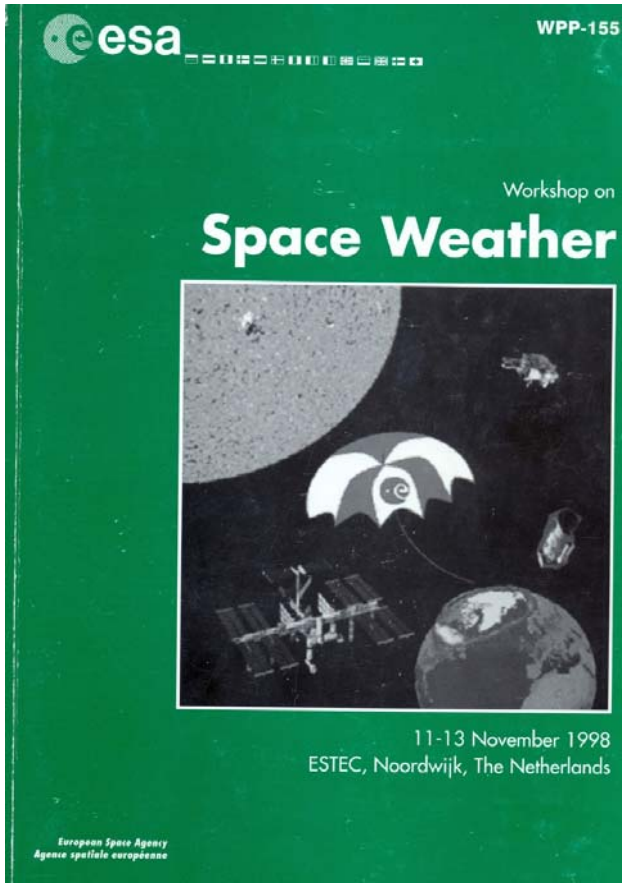
- A new DLR Institute in Bremen
  - Founded 26 January 2007
  - Today: 82 staffs (12 in Berlin)
  - Target 2010: 120 – 150 staff members
- Objectives
  - Analysis and assessment of **concepts for space missions** with high visibility
  - Space based **applications** in scientific, commercial and **security projects**
  - **Advice** to agency and politics in the decision process on space activities
  - Contribution to the training of **space system engineers**

1. DLR Institute of Space Systems



Structure of the Institute of Space Systems in Bremen

2. Overview of past and contemporary projects towards SSA (examples: ESA, Swiss Re)



1998 … 2008: ESA / ESTEC

2000: http://www.swissre.com/

2. Overview of past and contemporary projects towards SSA (examples: ESA, EU)

ESA Space Weather Studies

CLRC

ALCATEL SPACE

2000 / 2001 : SW Feasibility Studies

2002 / 2003: EU / FP 5 SWE (Space Weather and Europe)

2. Overview of past and contemporary projects towards SSA (example: Alcatel team)

CONSORTIUM Members

- Team Members (2/2) :
  - LPG (Grenoble-Fr) : Parameters and mo
  - LPSH/ Obs de Paris(Meudon-Fr) : Ground Segment & Sun Observation
  - Imperial College (UK) : Prototyping and Modelling
  - Université Greifswald (D) : SW Paramete

2. Overview of past and contemporary projects towards SSA (example: towards CME via CRs)

Operational Scenarios : Ground Segment

	Full Scale	Medium Scale	Low Scale
Solar observations	Broad frequency radio spectrographe (above 40 MHz) Radio imaging.	Broad frequency radio spectrographe (above 40 MHz) Radio imaging.	Broad frequency radio spectrographe (above 40 MHz) Radio imaging. Magnetograph network. Hα network.
Upstream (including interplanetary)	Broad frequency radio spectrograph. Radio imaging. Neutron and Muon detectors.	Broad frequency radio spectrograph. Radio imaging. Neutron and Muon detectors.	Broad frequency radio spectrograph. Radio imaging. Neutron and Muon detectors.
Magnetospheric monitoring	Covered under I/T monitoring	Covered under I/T monitoring	Covered under I/T monitoring
Ionosphere/thermosphere Monitoring	Magnetometer networks. Positioning networks SuperDARN network. F10.7cm	Magnetometer networks. Positioning networks SuperDARN network F10.7cm Ionosonde Network	Magnetometer networks. Positioning networks SuperDARN network F10.7cm Ionosonde Network

2001: ground based space weather telescope based on cosmic ray muon detection

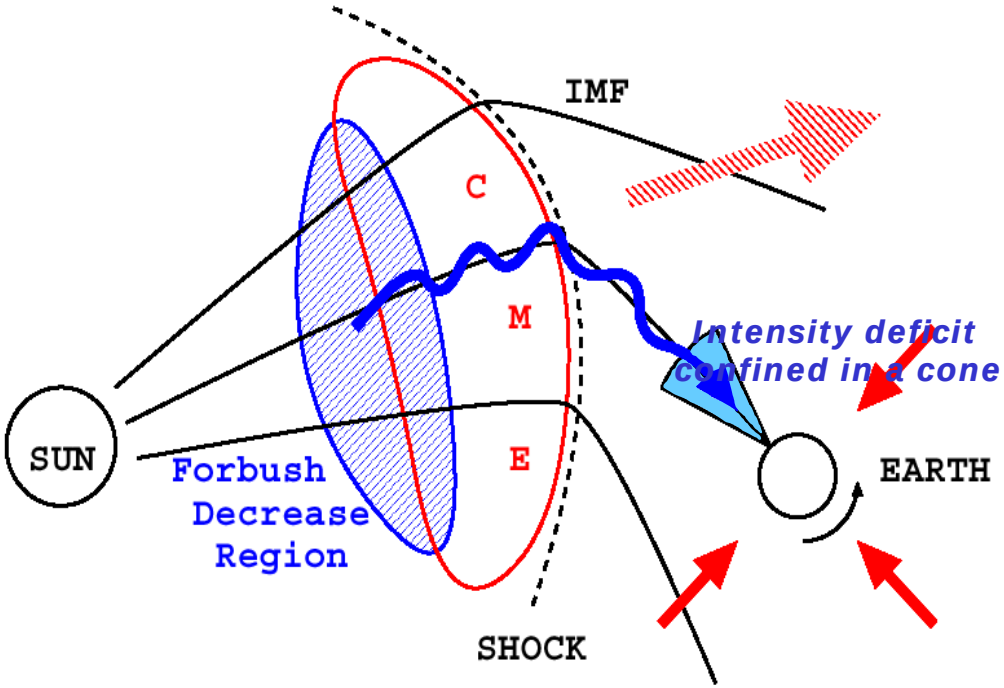
result: MuSTAnG 2004 - 2006

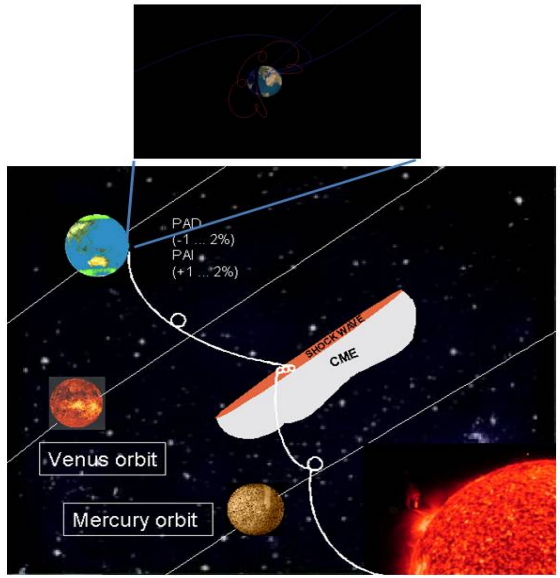
ESA Study for SPACE WEATHER PROGRAMME

Alcatel Space Industries

December 17th 2001 - OSM/IE - Page : 9 / 17

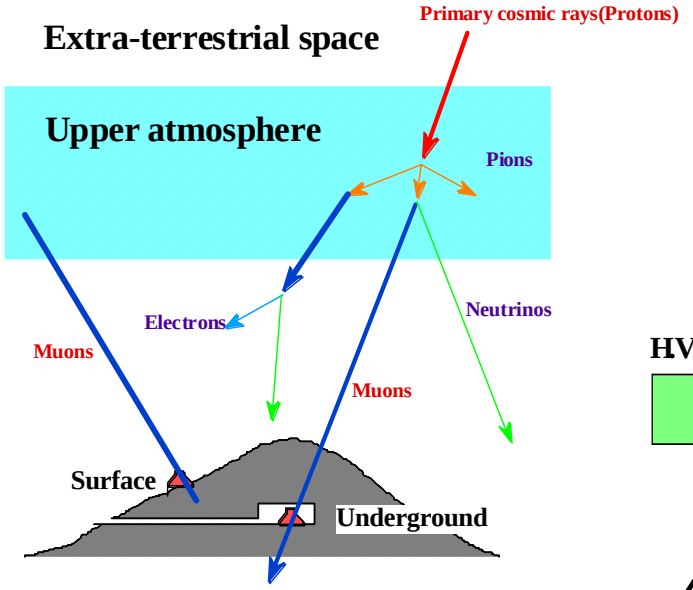
2. Overview of past and contemporary projects towards SSA (principle: CME via CRs?)



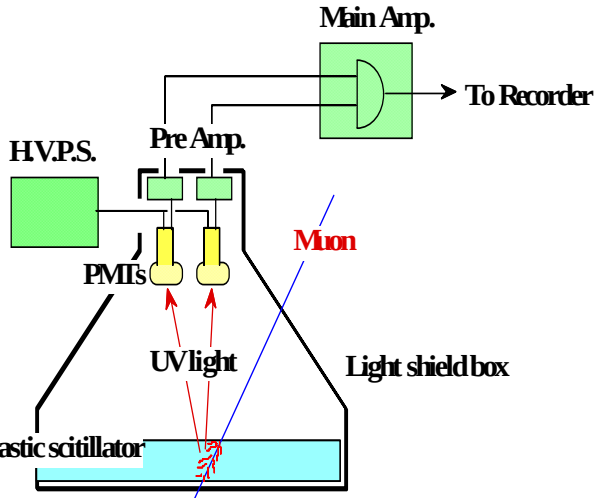


Galactic CRs interact with CME / shock, propagate from FD region to the upstream Earth with the speed of light overtaking the CME shock ahead => isotropic versus anisotropic distribution on ground and in NEO.

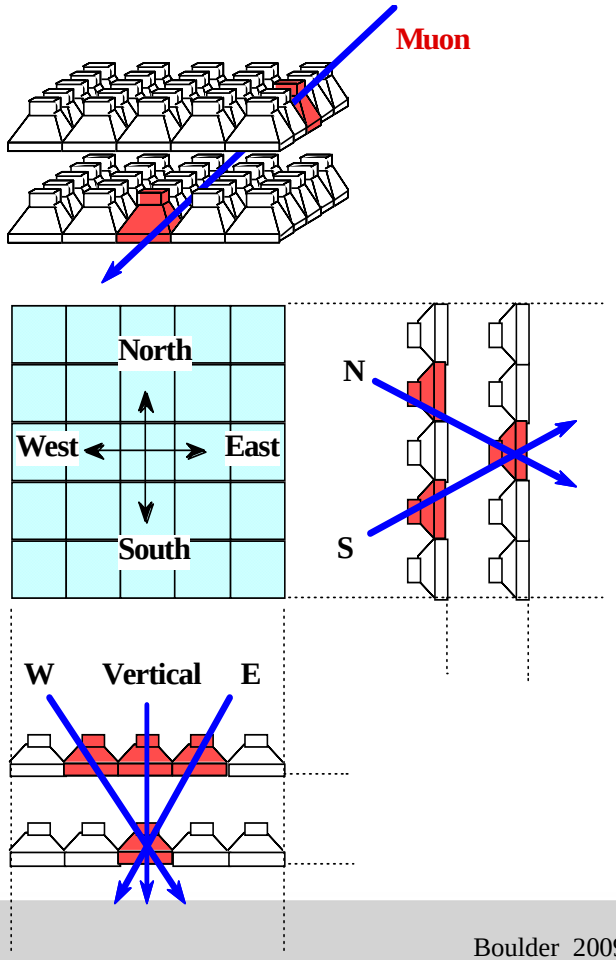
2. Overview of past and contemporary projects towards SSA (principle: muon telescopes)



Typical energy of primary ~50 GeV for Galactic cosmic rays (surface muon detector)



The detector of the Muon Telescopes at SSO / Brazil



2. Overview of past and contemporary projects towards SSA (GMDN telescopes)

Ground bases compared to space based CME / CR telescopes?

Data

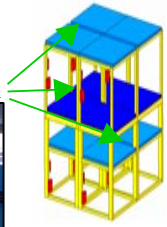
Access

Technology

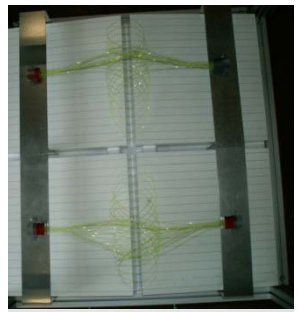
MPC

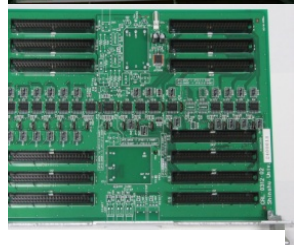
HST

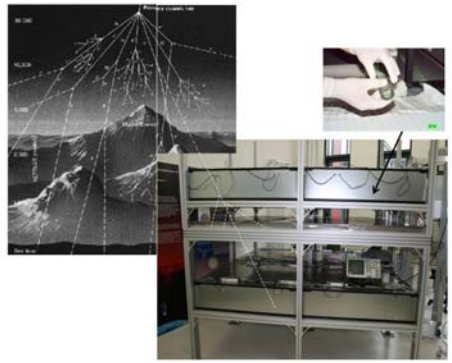
NST



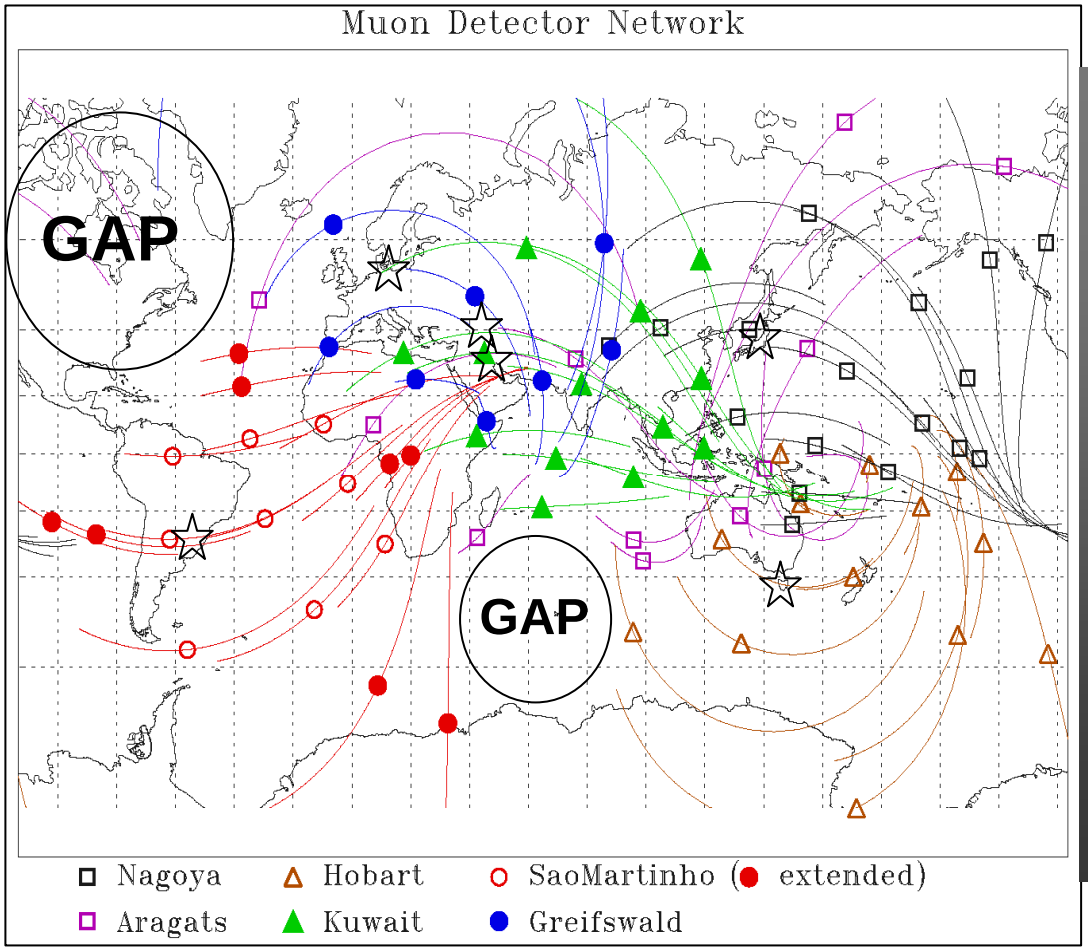
MuSTAnG







2. Overview of past and contemporary projects towards SSA (GMDN: viewing, overlapping, time)

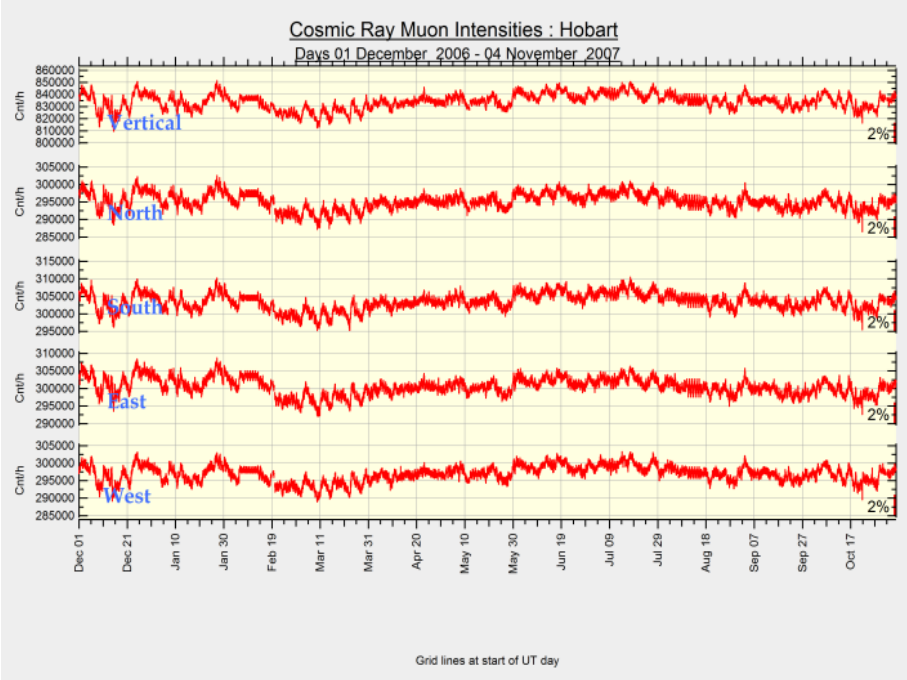


Observing directions:

Nagoya, Japan 17
Hobart, Australia 13
Greifswald, Germany 9
Aragats, Armenia 11
Kuwait, Kuwait 13
São Martinho da Serra, Brazil 17

!!! 10 – 20 hours in advance the CME detection !!!

2. Overview of past and contemporary projects towards SSA (GMDN: counts / anisotropy)



$$I_{i,j}^{cal}(t) = c_{0i,j}^{0} I^{0}(t) + \xi_{x}^{GEO}(t)\left(c_{li,j}^{l}\cos\omega t_i - s_{li,j}^{l}\sin\omega t_i\right) + \xi_{y}^{GEO}(t)\left(s_{li,j}^{l}\cos\omega t_i + c_{li,j}^{l}\sin\omega t_i\right) + \xi_{z}^{GEO}(t)c_{li,j}^{0}$$

$$I^{0}(t), \xi_{\mathrm{x}}^{\mathrm{GEO}}(t), \xi_{y}^{GEO}(t), \xi_{z}^{GEO}(t)$$

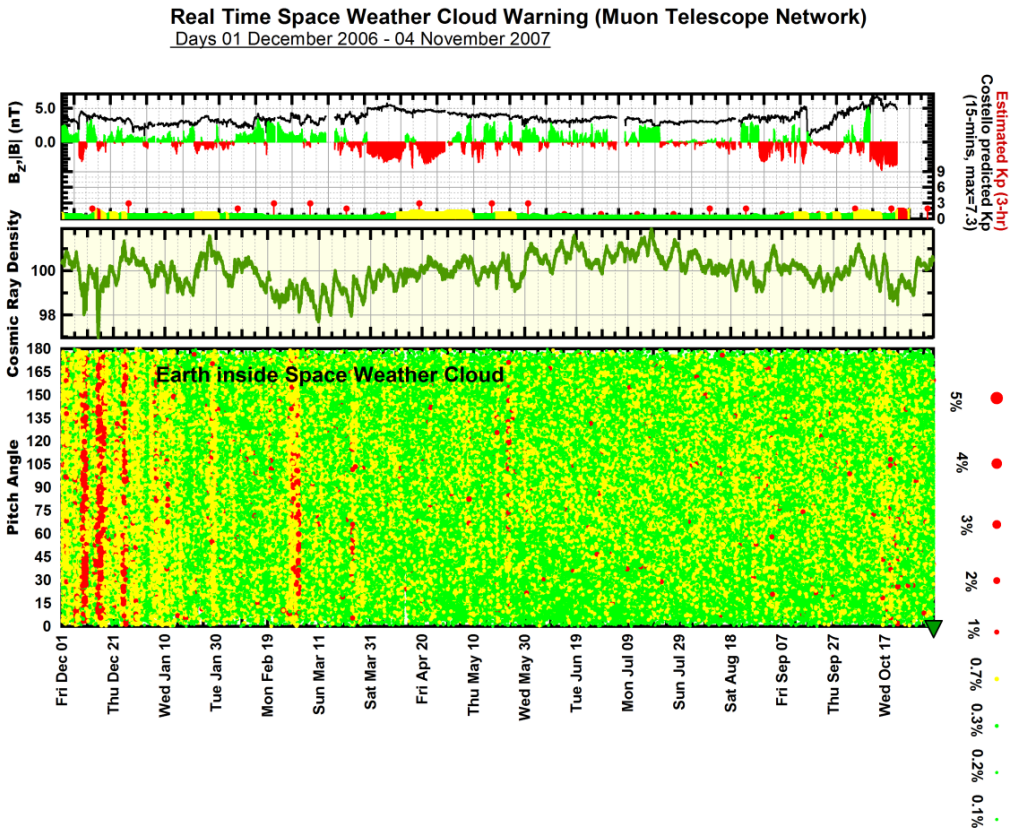
$$\omega = 2\pi / 24$$

CR muon data:
K.Munakata 1, M. Duldig 2, J. Bieber 3, J. Kuwabara 3, E. Flückiger4, I. Sabbah 5, N.J.Schuch 6

1Shinshu University Japan, 2 Australian Antartic Division Australia, 3University of Delaware, U.S.A.

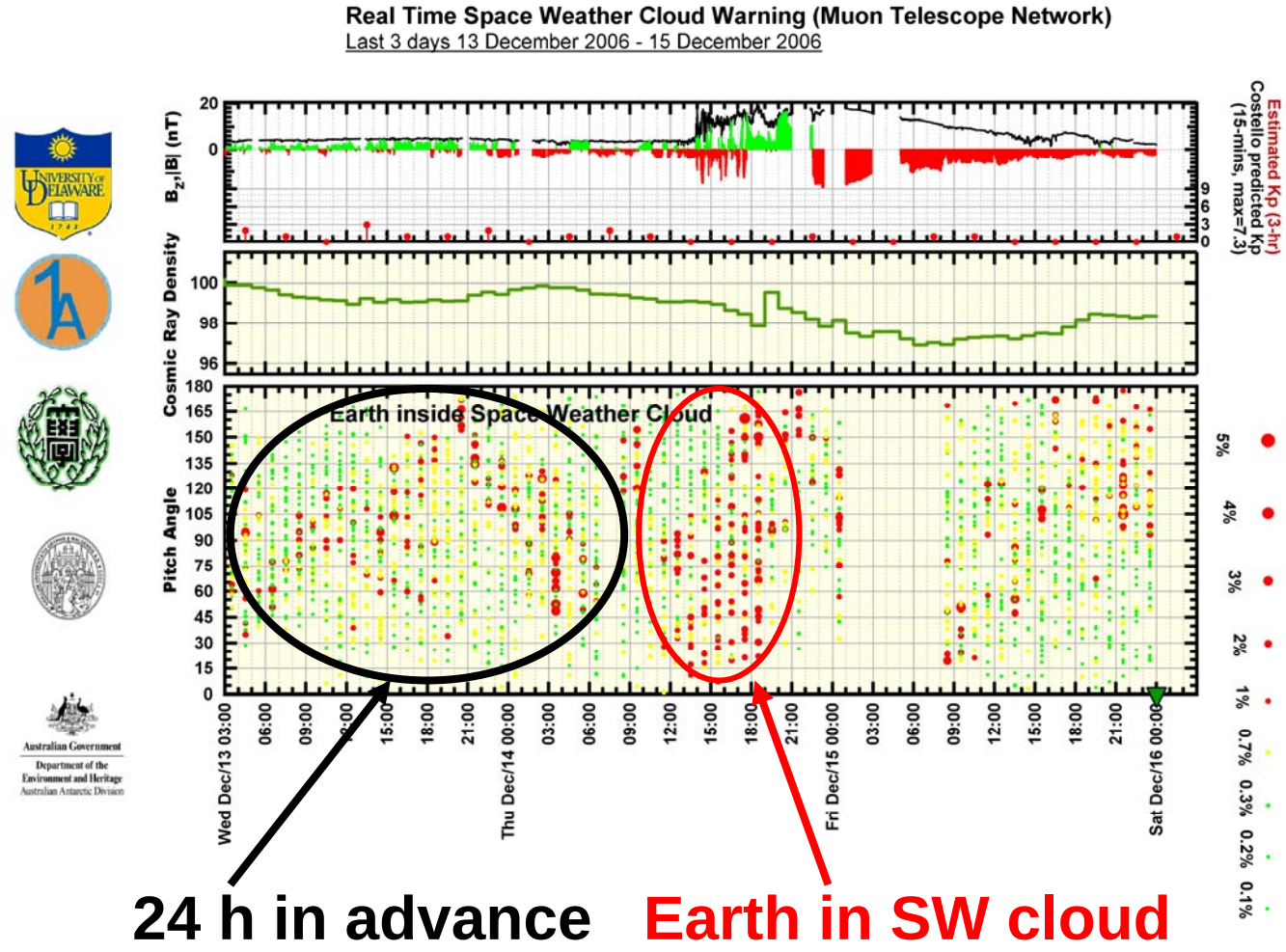
4 University of Bern Switzerland, 5 University of Kuwait, 6 Brazilian Southern Space Observatory

2. Overview of past and contemporary projects towards SSA (GMDN: SW service from CR anisotropy)



- CR muon anisotropy (%) is a measure of interplanetary CME
- data from CR muon anisotropy: HST, NST, SMST, KPC
- space weather operator friendly displays for Bz, Kp and CR muon anisotropy
- real time service: ACE, CR, CME

2. Overview of past and contemporary projects towards SSA (GMDN: December 2006)



2. Overview of past and contemporary projects towards SSA (COST, SWEETS)

2003 – 2007: EU COST 724 action

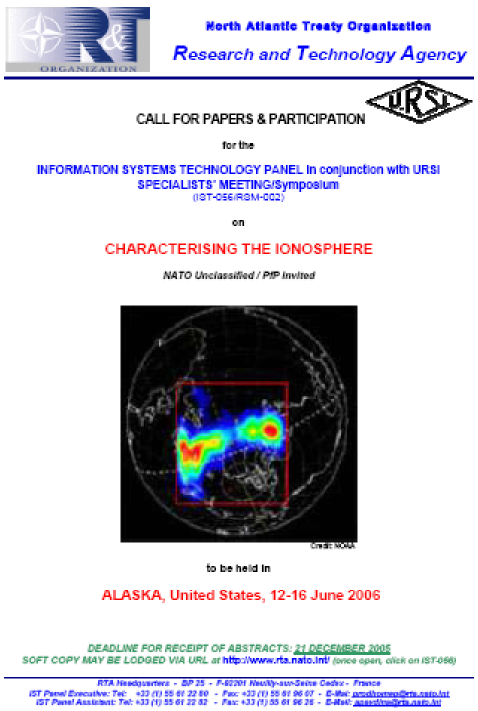
„Developing the basis for monitoring, modelling and predicting space weather“

Result: European Space Weather Web Portal under

http://www.spaceweather.eu

EU FP6 2007: SWEETS
(Space Weather and Europe – an Educational Tool with the Sun)

2. Overview of past and contemporary projects (NATO 2006)


North Atlantic Treaty Organization
Research and Technology Agency

CALL FOR PAPERS & PARTICIPATION

for the

INFORMATION SYSTEMS TECHNOLOGY PANEL in conjunction with URSI SPECIALISTS' MEETING/Symposium
(IST-056/RSM-002)

on

CHARACTERISING THE IONOSPHERE

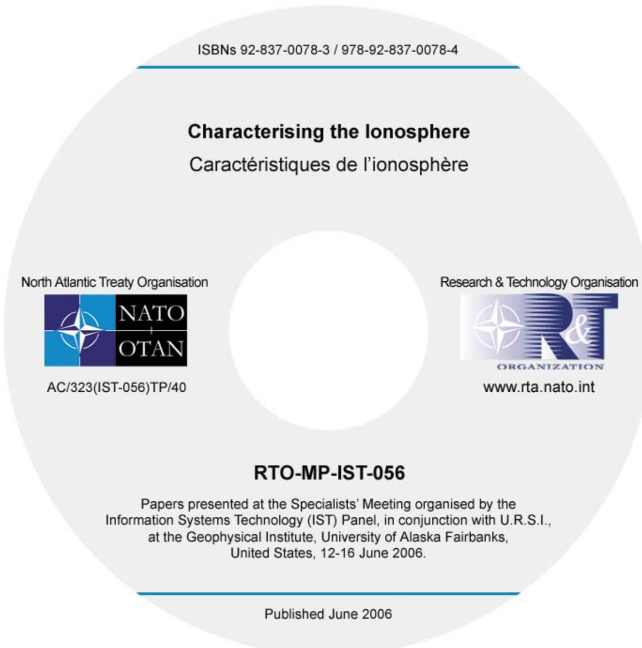
NATO Unclassified / PfP invited

to be held in

ALASKA, United States, 12-16 June 2006

DEADLINE FOR RECEIPT OF ABSTRACTS: 21 DECEMBER 2005
SOFT COPY MAY BE LODGED VIA URL at http://www.rta.nato.int/ (once open, click on IST-056)

RTA Headquarters - BP 25 - F-92201 Neuilly-sur-Seine Cedex - France



Ionosphere and space weather

Deutsches Zentrum für Luft- und Raumfahrt e.V. in der Helmholtz-Gemeinschaft

2. Overview of past and contemporary projects towards SSA (EU ESP White Paper => ESA SSA)

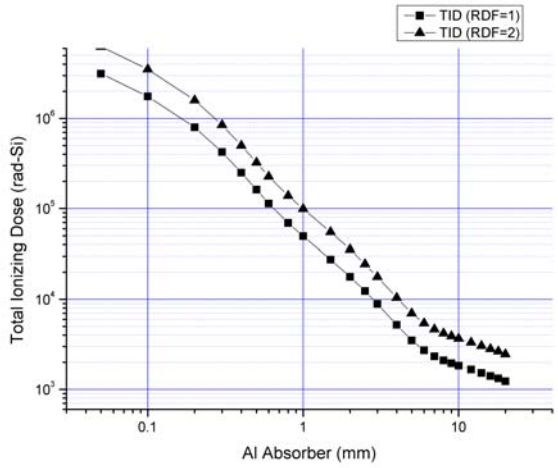
- European Space Policy (ESP) in the White Paper (2003)
  „…be needed to ensure that Europe has the capacity to supply to the different users **critical information on solar flares, near Earth objects, space debris („space weather prediction“)…“**
- implementation of European Space Policy (ESP) by SSA
  ESP:
  - peaceful use of outer space,
  - space has a security dimension and security has a space dimension
    => global monitoring, navigation, communication, early warning, space surveillance…
- ESA Ministerial Council November 2008
  - definition and scope of an European SSA system
  - safe usage of space infrastructures, protection of infrastructure
  - space infrastructures as a key for economic development, protection of population

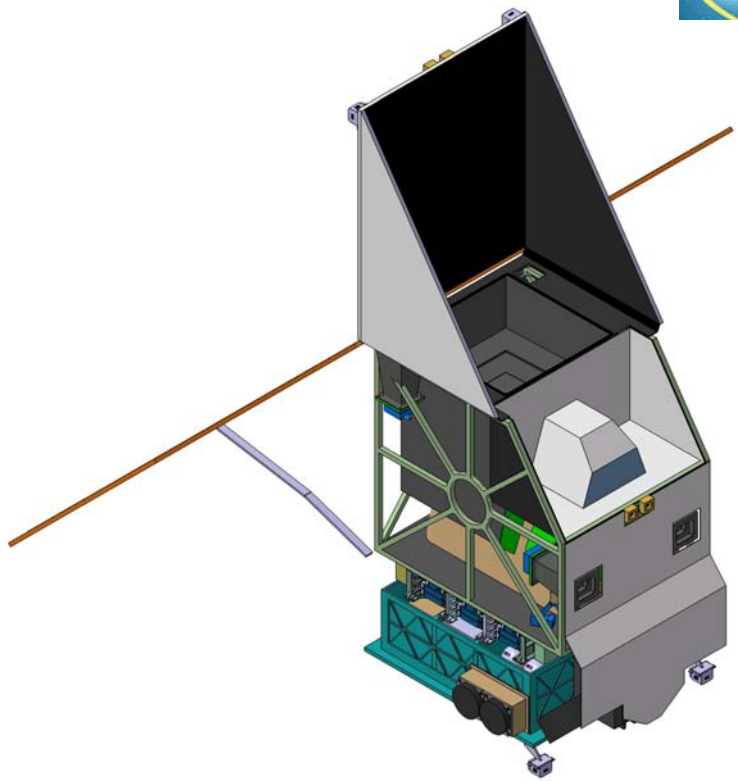
- SSA fields: **space weather, space debris, asteroids / NEO impacts**

3. (Nearby) future SSA related activities at DLR / ISSHB (DLR / ISSHB to NEO field)

Compact satellite AsteroidFinder

- satellite bus based on BIRD (TET)
- phase A finished
- phase B in 2009
- launch in 2012
- to be operated by GSOC





- CREME 96 + SPENVIS
- TID (trapped + solar particles)
- 3 years at 850 km orbit

3. (Nearby) future SSA related activities at DLR / ISSHB (DLR ISSHB to SW field)

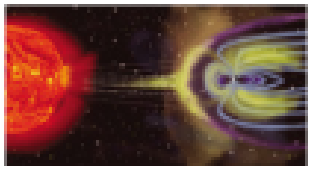
etamax ONERA DCH DLR IRF solenix

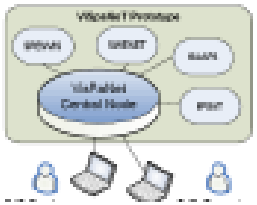
Proposal

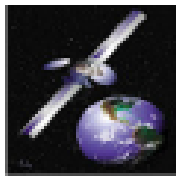
for a

Space Weather Warning for Space Systems

ITT AO/1-5980/08/NL/AT

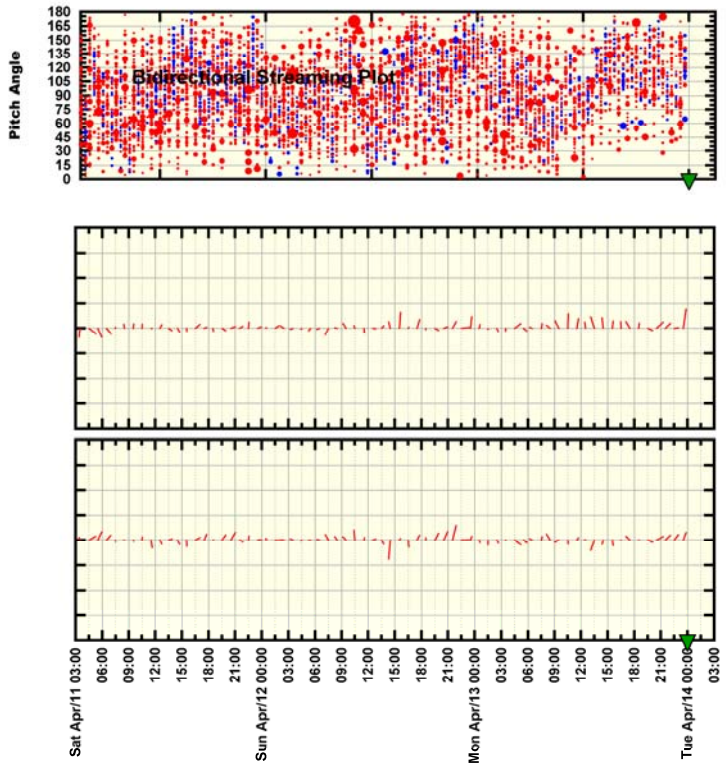






Proposal to ESA 02/09

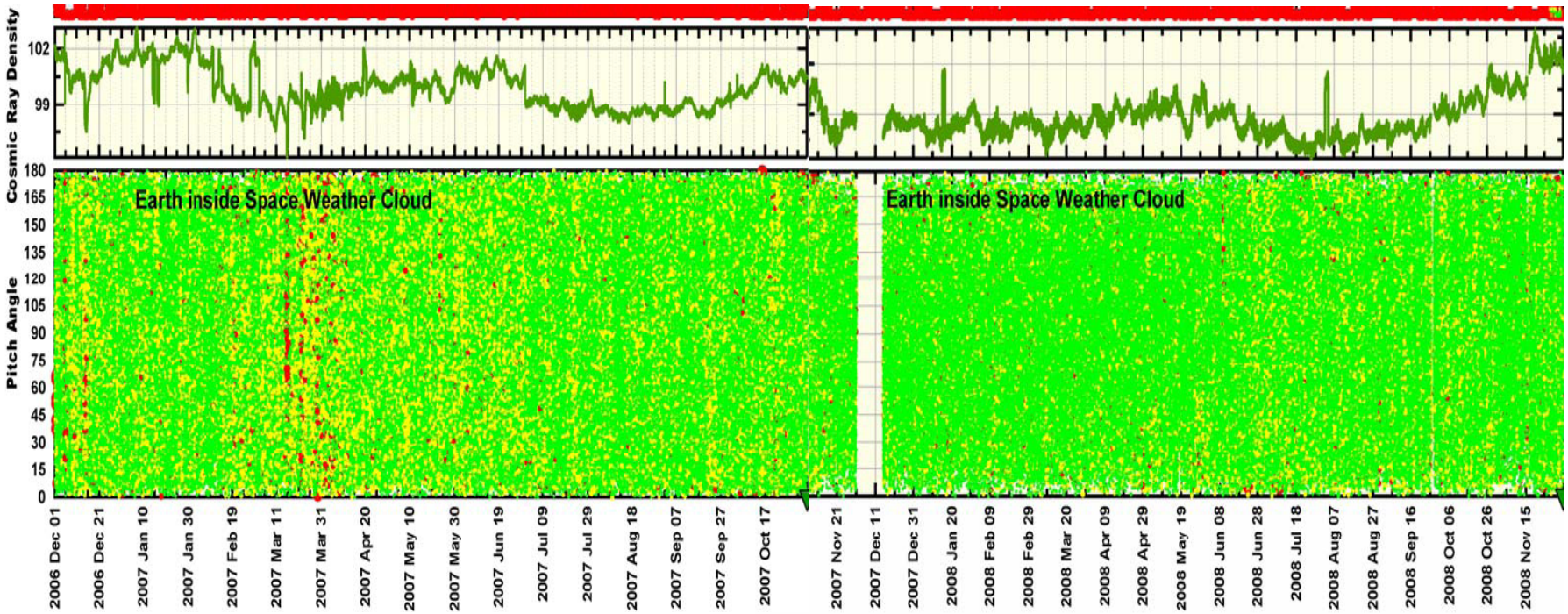
Bidirectional Streaming Plot and Cosmic Ray Flow Direction from Muon Network
Last 3 days 11 April 2009 - 14 April 2009



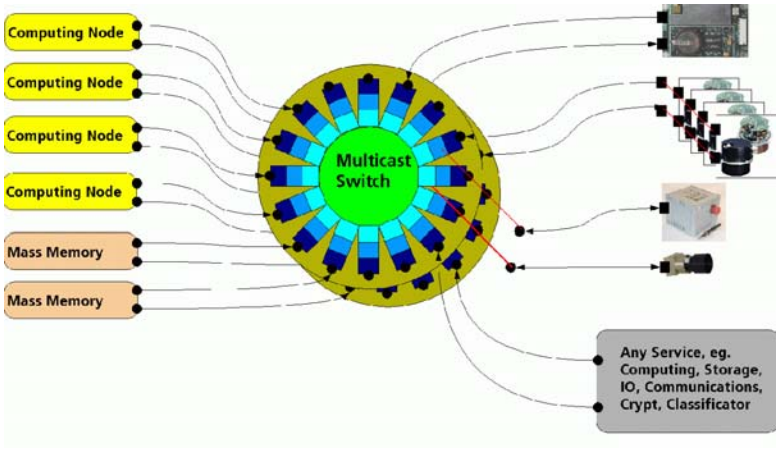
GMDN: CR WIND (Test Phase)

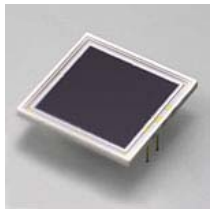
3. (Nearby) future SSA related activities at DLR / ISSHB (DLR ISSHB to SW field)

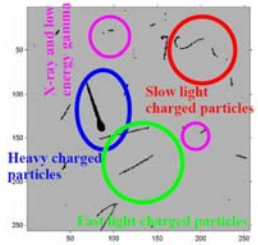
- user friendly service: real time, early, monthly, 27, 3 days and others plots from GMDN
- University of Delaware / Bartol and DLR Institute of Space Systems / Bremen

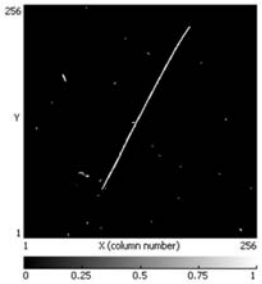


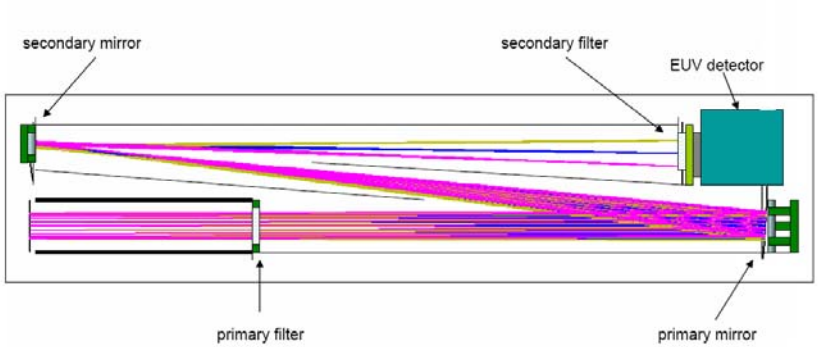
3. (Nearby) future SSA related activities at DLR / ISSHB (DLR ISSHB to SW field: proposal NESTEC – SSA / SW orientated s/c)



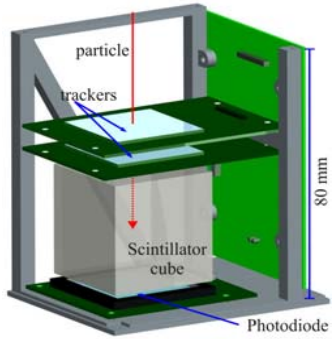








DLR DESY IEP SAS SPACE PHYSICS TUDelft Delft University of Technology MPS Max-Planck-Institut für Sonnensystemforschung cosine



3. (Nearby) future SSA related activities at DLR / ISSHB
(DLR ISSHB to SW field: space radiation monitors)

PAUL SCHERRER INSTITUT PSI TU Delft oerlikon space DLR

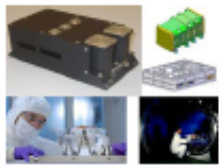
Highly Miniaturized Active MEO Radiation Monitor Phase A-B

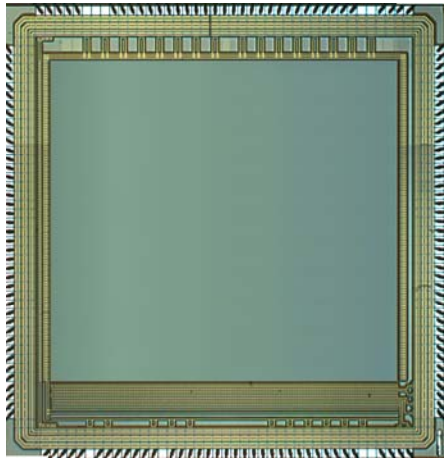
Proposal

for a

Highly Miniaturized Active MEO Radiation Monitor Phase A-B

ITT AO/1-6878/08/NL/AT





Proposal to ESA (04/09)

(successor of SREM / Galileo)

New Laboratory Building
DLR Institute of Space Systems

2010 Bremen: 38th COSPAR Scientific Assembly, SSA session !