NMDB - the European neutron monitor database

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cnrs

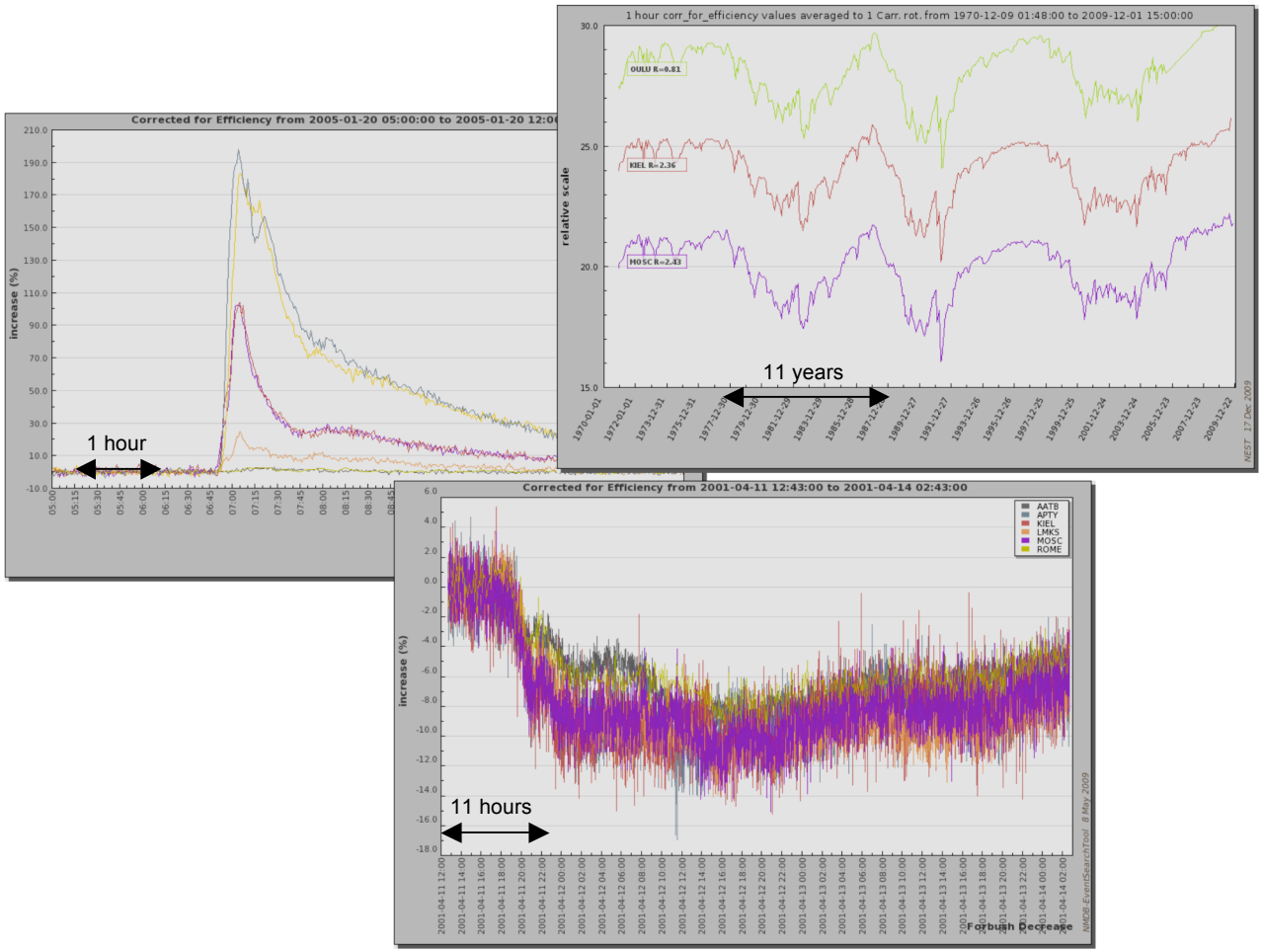
for the NMDB consortium

CAPACITIES

e-infrastructure

NMDB data
Providers

- Initially (2008-09, FP7) 26 stations from Europe and some neighbouring countries (Asia)
- Historical data and real-time data (1 min resolution) - depending on station
- Since 2011: 10 further stations, Bartol Res Inst, Univ Delaware
- Perspective: Australia, South-Africa, Japan, America



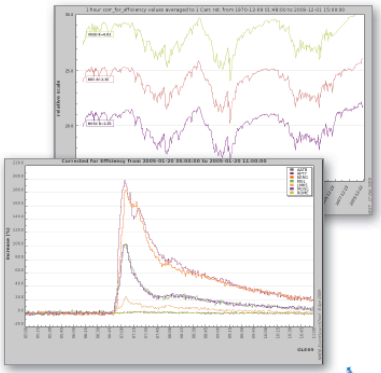
- Long term trends (solar modulation)
- Individual events: Forbush effects & ground level events (GLE)
- Easy-to-use tool for data visualisation and retrieval (ASCII)

Real Time Database for High-Resolution Neutron Monitor Measurements

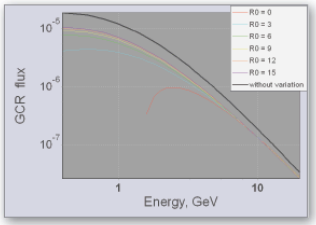
NMDB data
Products

WWW.NMDB.EU

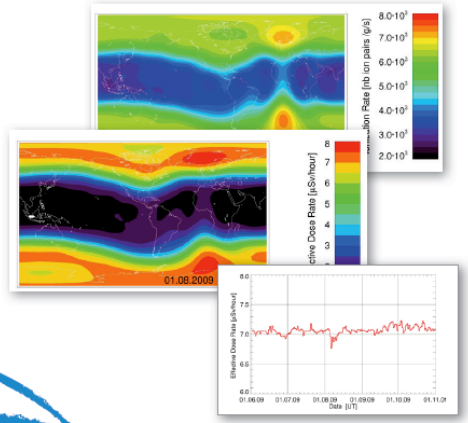
NEST TOOL TO PLOT AND RETRIEVE DATA



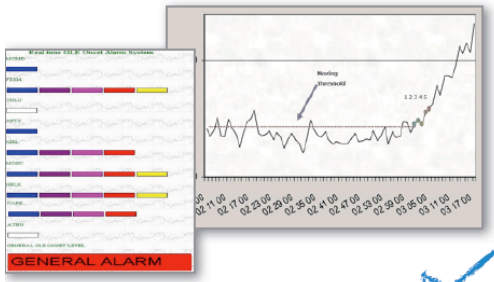
SPECTRUM OF GCR



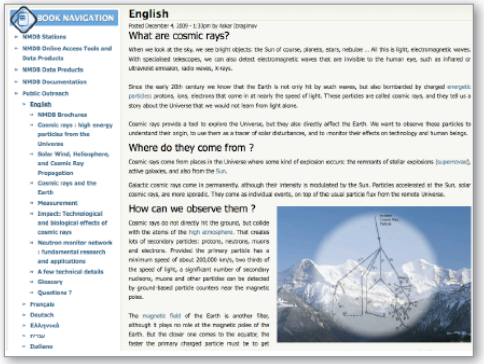
IONISATION RATES AND DOSE RATES IN THE ATMOSPHERE (every 6 hrs)



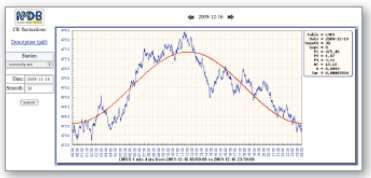
GLE ALERT IN REAL TIME



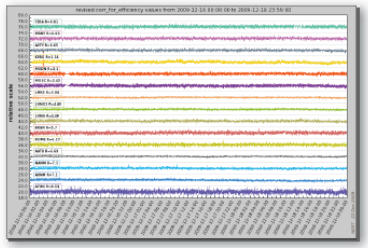
TRAINING AND PUBLIC OUTREACH



DAILY CR VARIATION



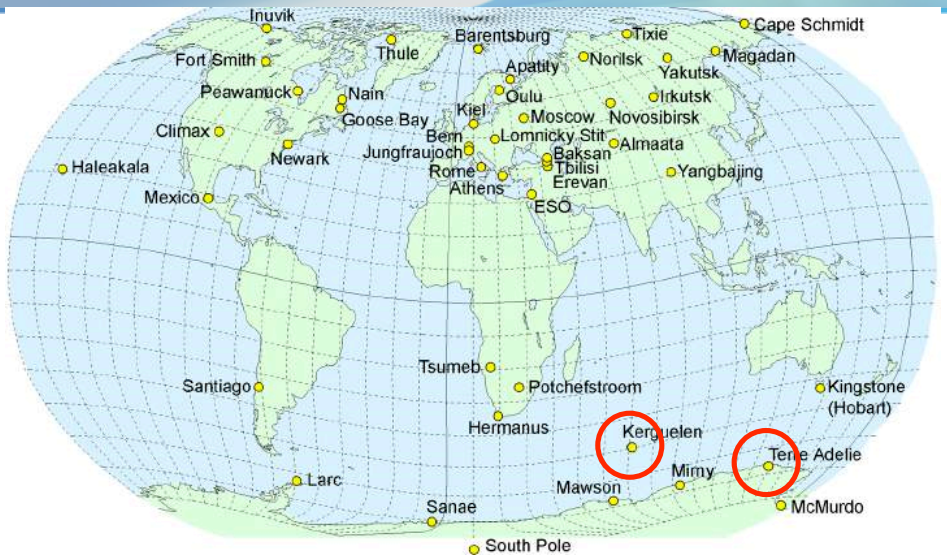
COSMIC RAYS NOW !

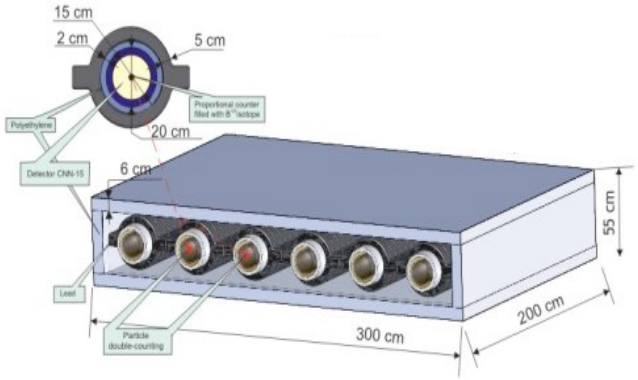


High energy particles from the Universe
Detection at the Earth

Neutron monitor :

- Production of neutrons by secondary particles in a Pb ring
- Detection of the neutrons in the counter tubes
- Despite the name, the primary particles detected by a neutron monitor are most often protons or heavy nuclei !

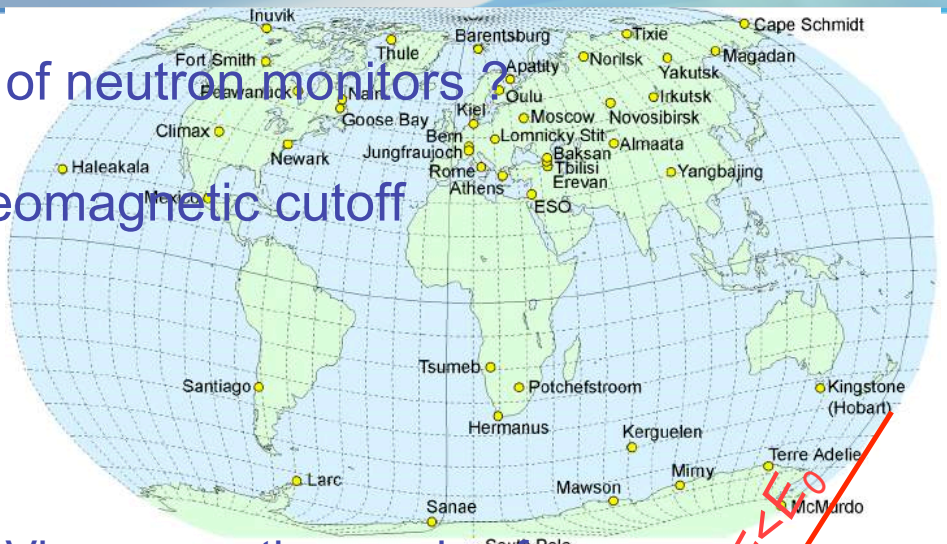




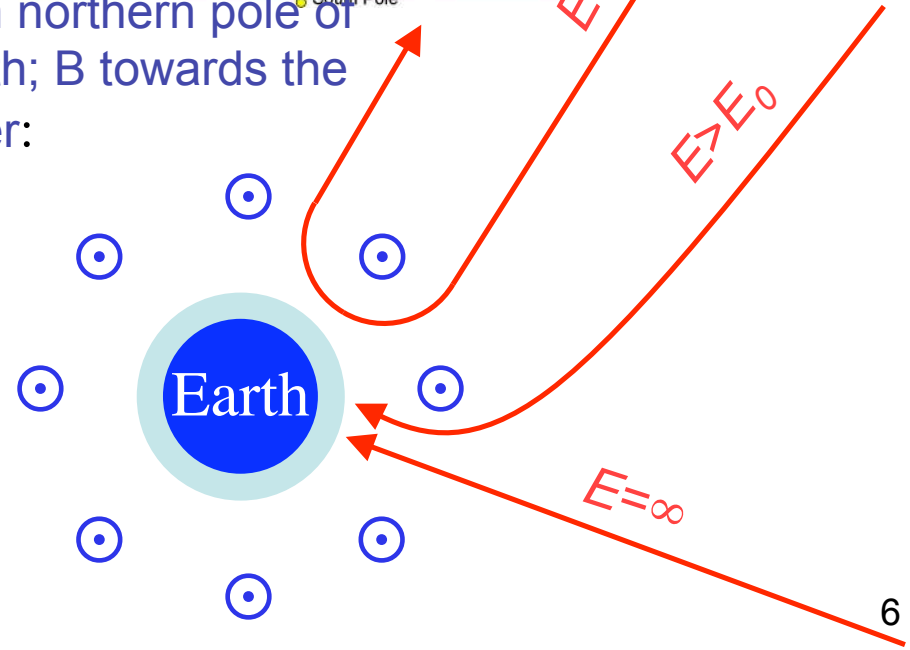
High energy particles from the Universe

Detection at the Earth

- Why a worldwide network of neutron monitors ?
- Spectroscopy using the geomagnetic cutoff



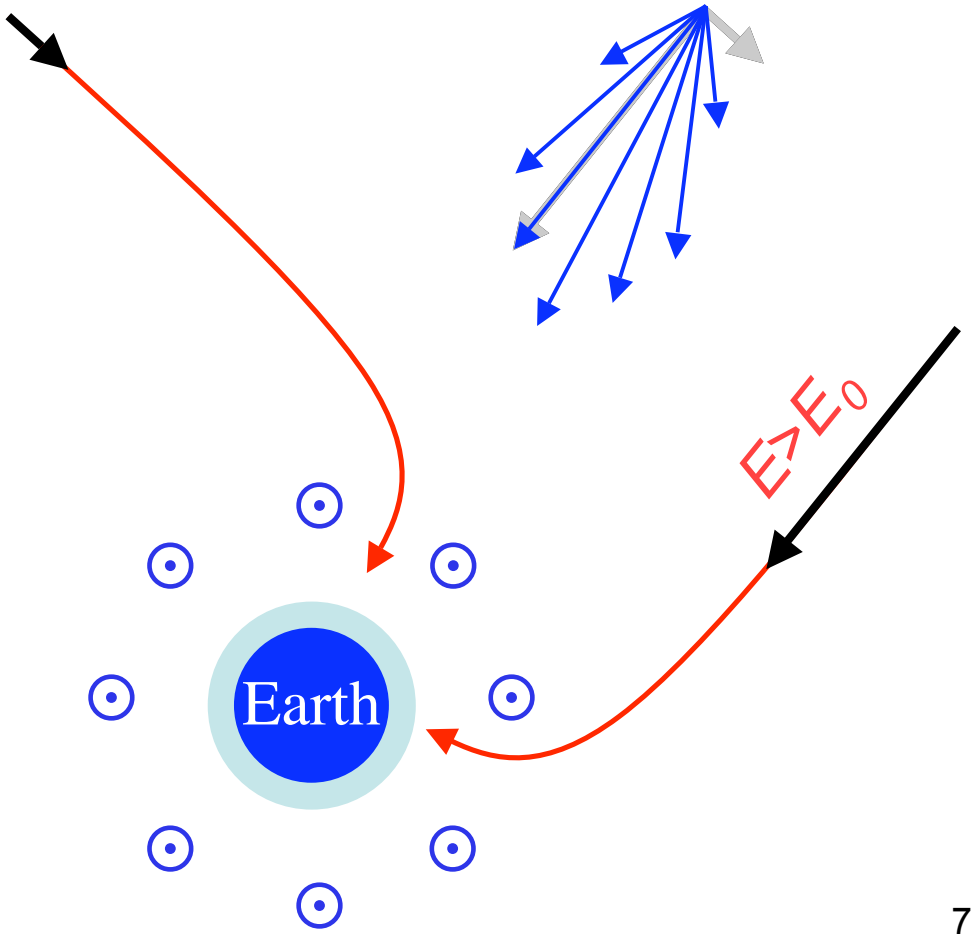
View on northern pole of the Earth; B towards the observer:



High energy particles from the Universe

Detection at the Earth

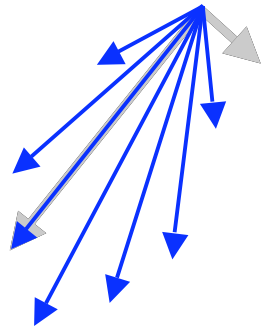
- Why a worldwide network of neutron monitors ?
- Spectroscopy using the geomagnetic cutoff
- Measurement of the angular distribution of the incoming particles using the asymptotic directions at the different sites.

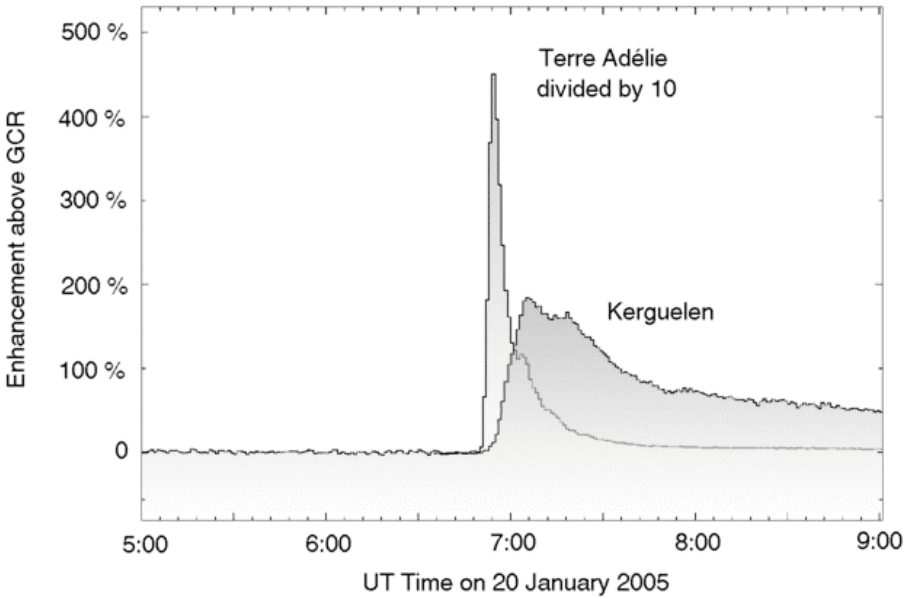


High energy particles from the Universe

Detection at the Earth

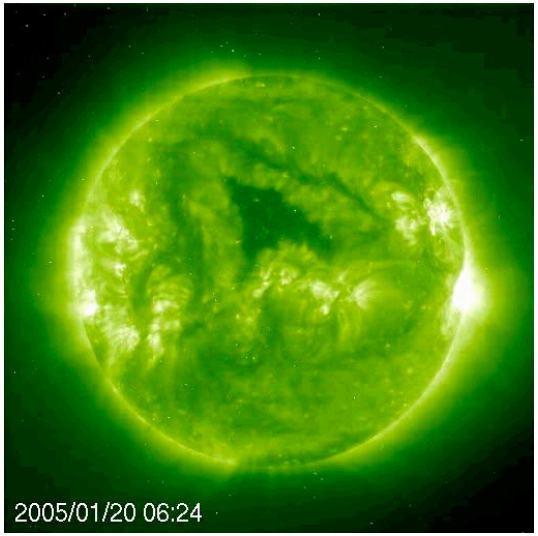
- Why a worldwide network of neutron monitors ?
- Spectroscopy using the geomagnetic cutoff
- Measurement of the angular distribution of the incoming particles using the asymptotic directions at the different sites.
- Illustration: 2005 Jan 20, Kerguelen Island and Terre Adélie - an initial pulse of highly collimated protons (TAd), followed by ~isotropic protons.

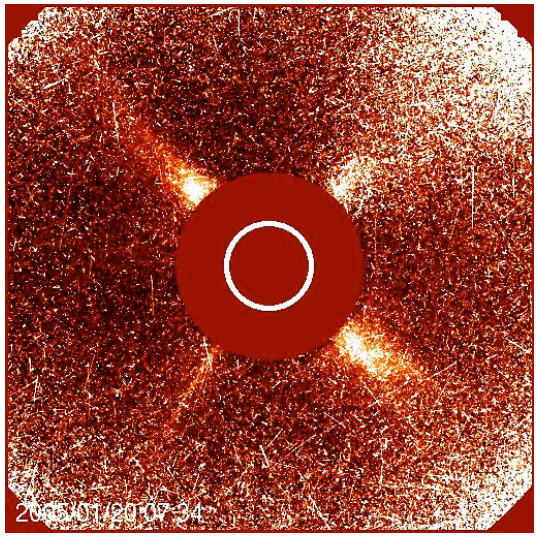




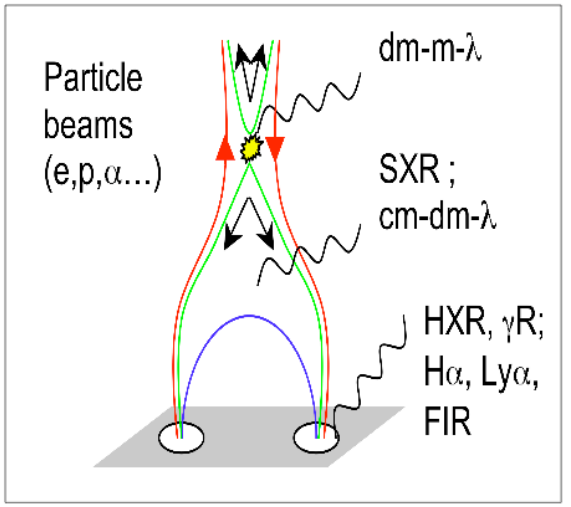
Solar energetic particle events
Parent solar activity: flares and CMEs

At the Sun: flare & CME

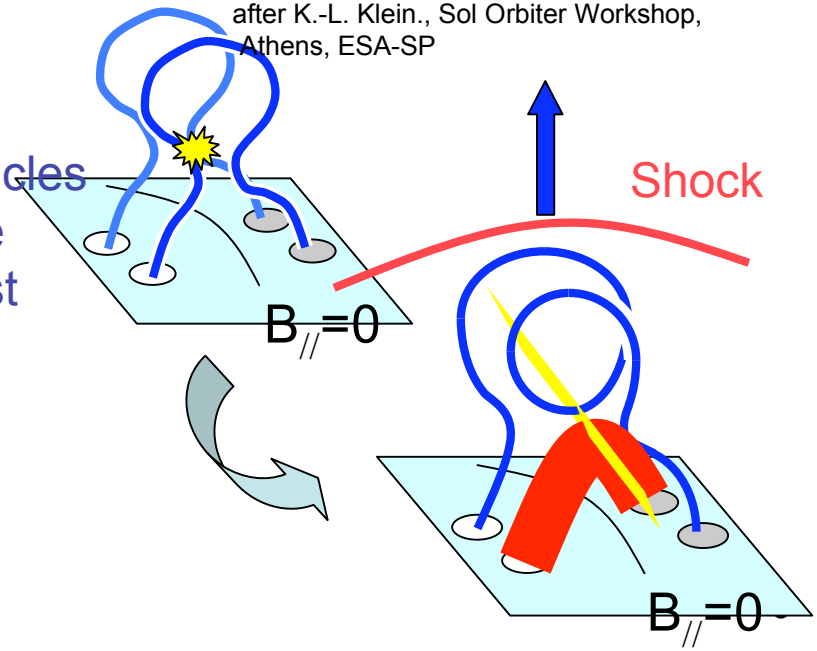




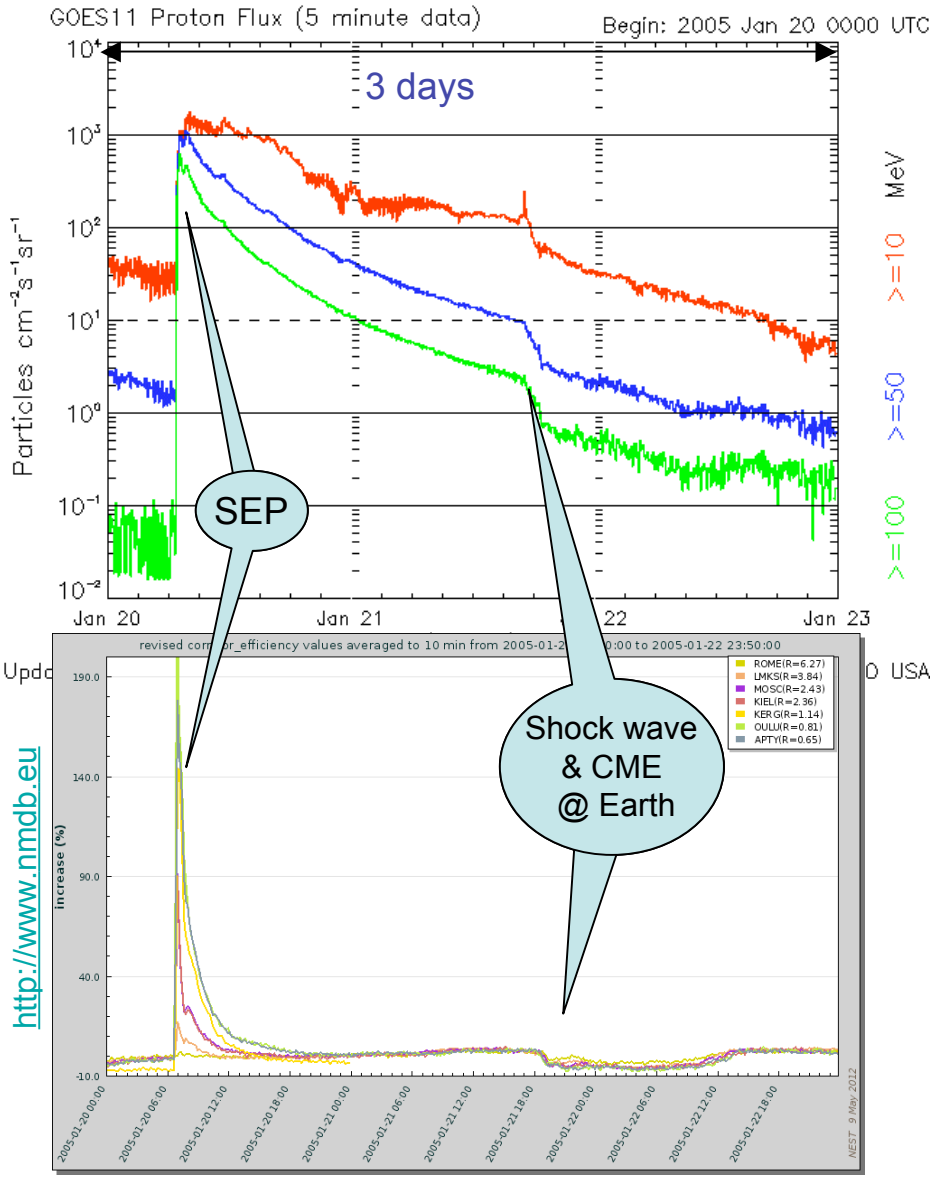
- "Flare acceleration": particles accelerated in complex magnetic configurations in the corona (particles radiating γR, HXR, radio; particles escaping along open field lines towards IP space).
- CME shock acceleration: particles accelerated at the bow shocks of fast CMEs (mainly SEP=particles detected in situ); corona, IP space.



after K.-L. Klein., Sol Orbiter Workshop, Athens, ESA-SP

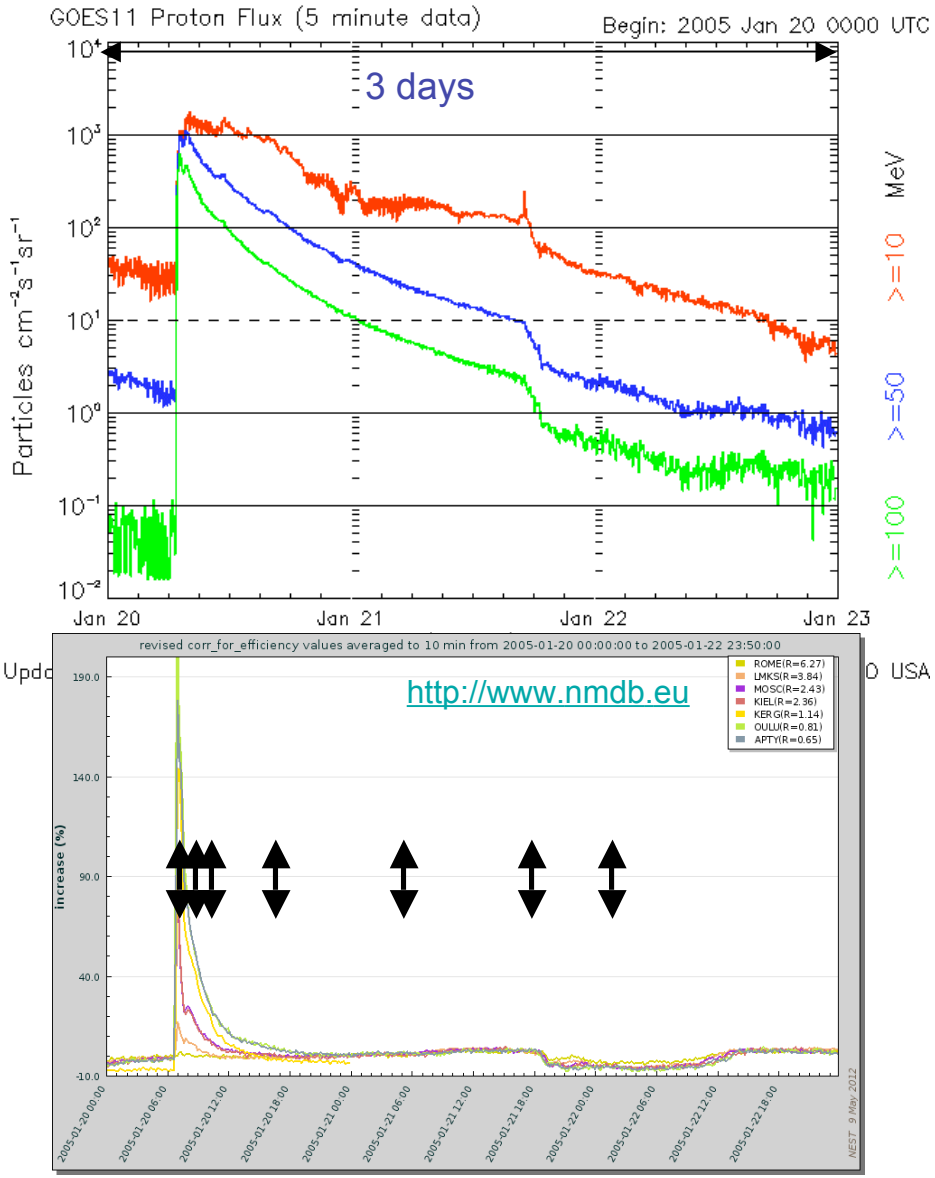


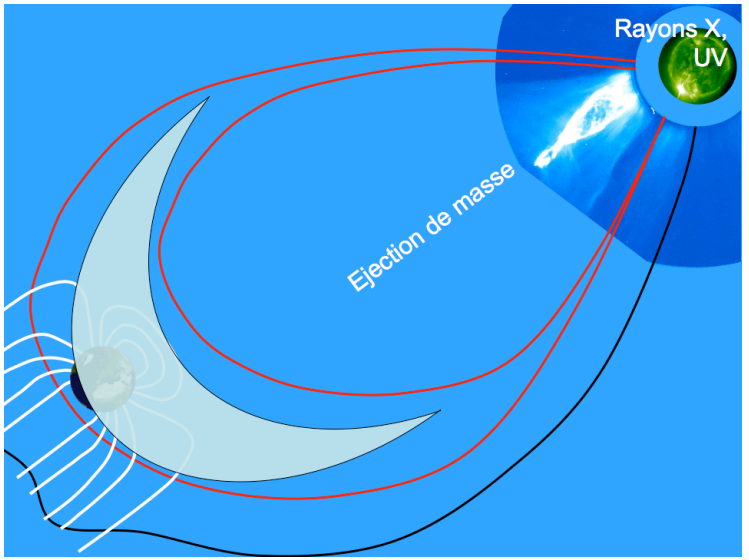
Solar energetic particle events
Protons from some MeV to several GeV



- SEP (solar energetic particles) event (protons 10 MeV - some GeV)
- At tens of MeV (GOES): duration > 1 day, solar particles + peak (at LE) as shock approaches Earth (energetic storm particle event; shock acceleration near Earth)
- At GeV (neutron monitors): short duration (tens of min - a few hrs), no signature of shock acceleration in IP space. Rare events: the most energetic protons accelerated in the solar atmosphere.

Solar energetic particle events
Scenarios of acceleration





- Scenario: from the Sun to the Earth
  - Flare, particle acceleration
  - CME, particle acceleration (shock)
  - ICME, particle acceleration
  - ICME at Earth, shielding of galactic cosmic rays

Neutron monitors and solar energetic particles

Summary and outlook

- NMDB provides data from all European, some Asian and some US-American neutron monitors.
  - Time resolution up to 1 min, some in real time (space weather applications)
  - Data belong to the providers, but are free for use in scientific research.
- The project continues to work 3 years after the end of the FP7 funding.
- Hopefully further extension in the future (other American providers, South Africa, Australia, Japan ?)
- Special arrangements available for people who need data on a regular basis. Contact: Christian Steigies, University of Kiel, steigies@physik.uni-kiel.de or questions@nmdb.eu
- Development of further tools (SEPServer, follow-up FP7 project ?) to provide physical data on relativistic solar particles as a complement to future space missions (Solar Orbiter, …)