The Neutronmonitor database (NMDB) and its applications to space weather

http://nmdb.eu

mail@nmdb.eu

EU FP7 project Contract No RI-213007

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Germany

CAPACITIES

e-infrastructure

C A U
Christian-Albrechts-Universität zu Kiel

IEP SAS
SPACE PHYSICS

b
UNIVERSITÄT BERN

UNIVERSITY of OULU
OULUN YLIOPISTO

IZMIRAN

l'Observatoire de Paris — LESIA

National & Kapodistrian University of Athens
Athens Neutron Monitor Station

COSMIC RAY DIVISION
Yerevan Physics Institute

INAF - UNIRomaTre
S.V.I.R.CO.

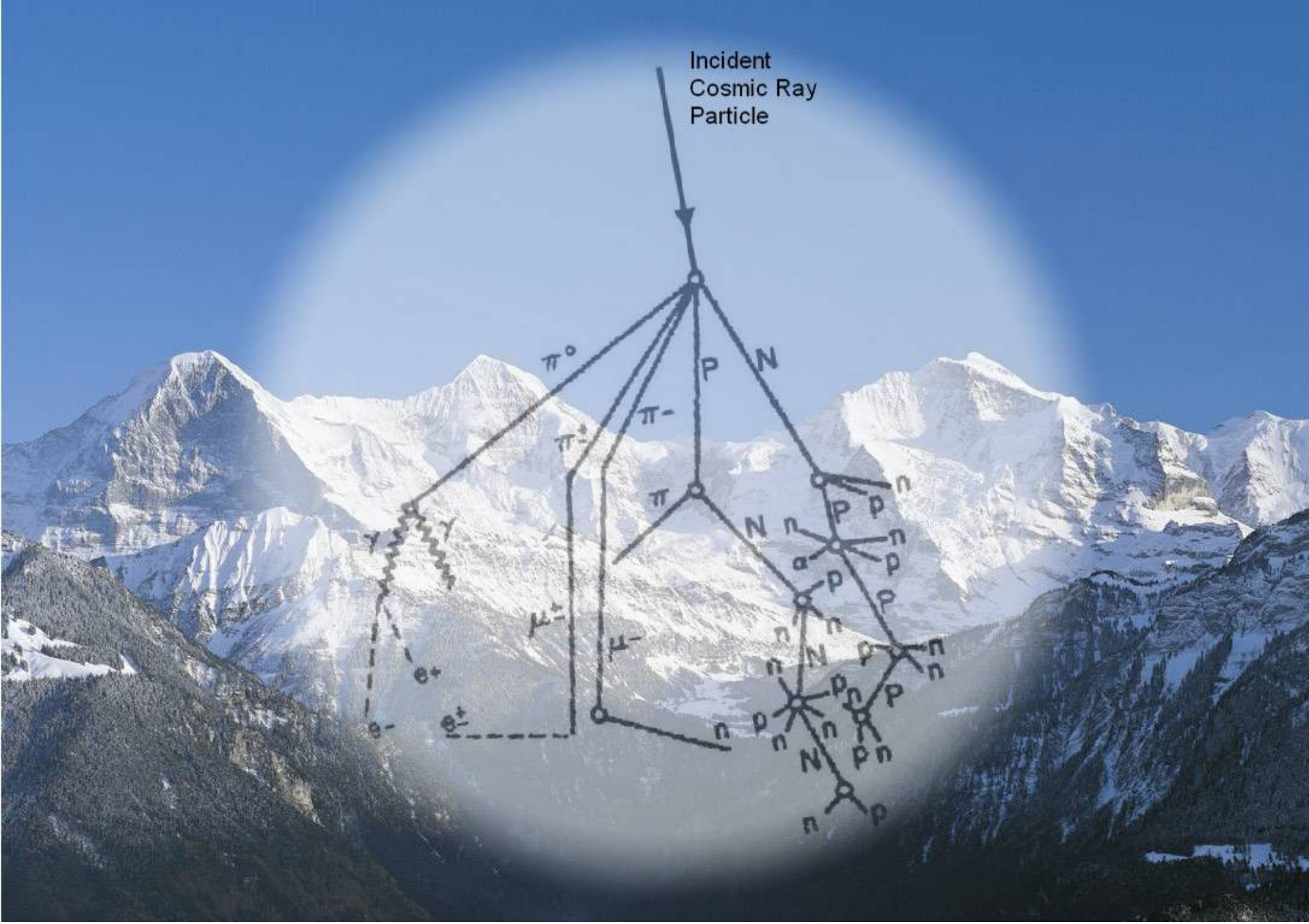
Institute of Ionosphere
Republic of Kazakhstan

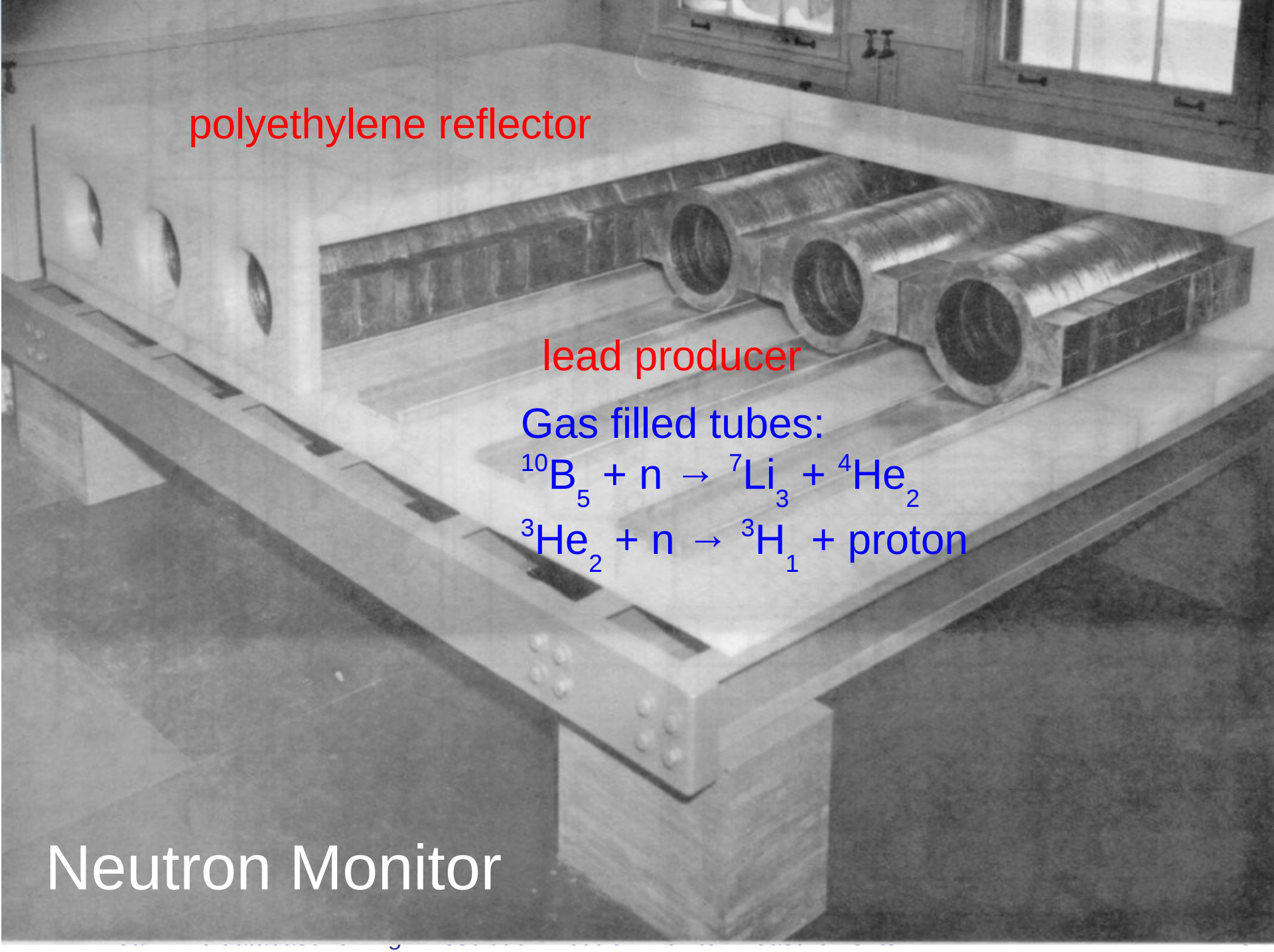
TEL AVIV UNIVERSITY אוניברסיטת תל-אביב
TAU -ICRC

SRG

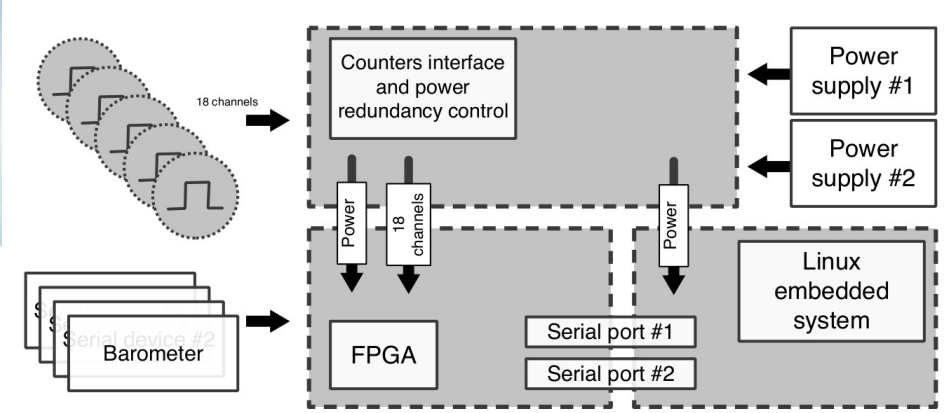
NMDB contributing stations:

Apatity, Baksan, Magadan, Norilsk, Novosibirsk
Climax, Huancayo, New Hampshire, Leadville
Pic de Bure
Calgary
Dourbes
Fort Smith, Inuvik, Mac Murdo, Nain, Newark,
Peawanuk, South Pole, South Pole Bare, Thule
Hermanus, Potchefstrom, Sanae, Tsumeb
Tixy Bay, Yakutsk
Kingston, Mawson
Mexico
Neumeyer, Polarstern
Tibet
Thailand


Incident
Cosmic Ray
Particle
π°
π+
π-
π
p
N
γ
γ
e+
e-
e+
μ+
μ-
n
p

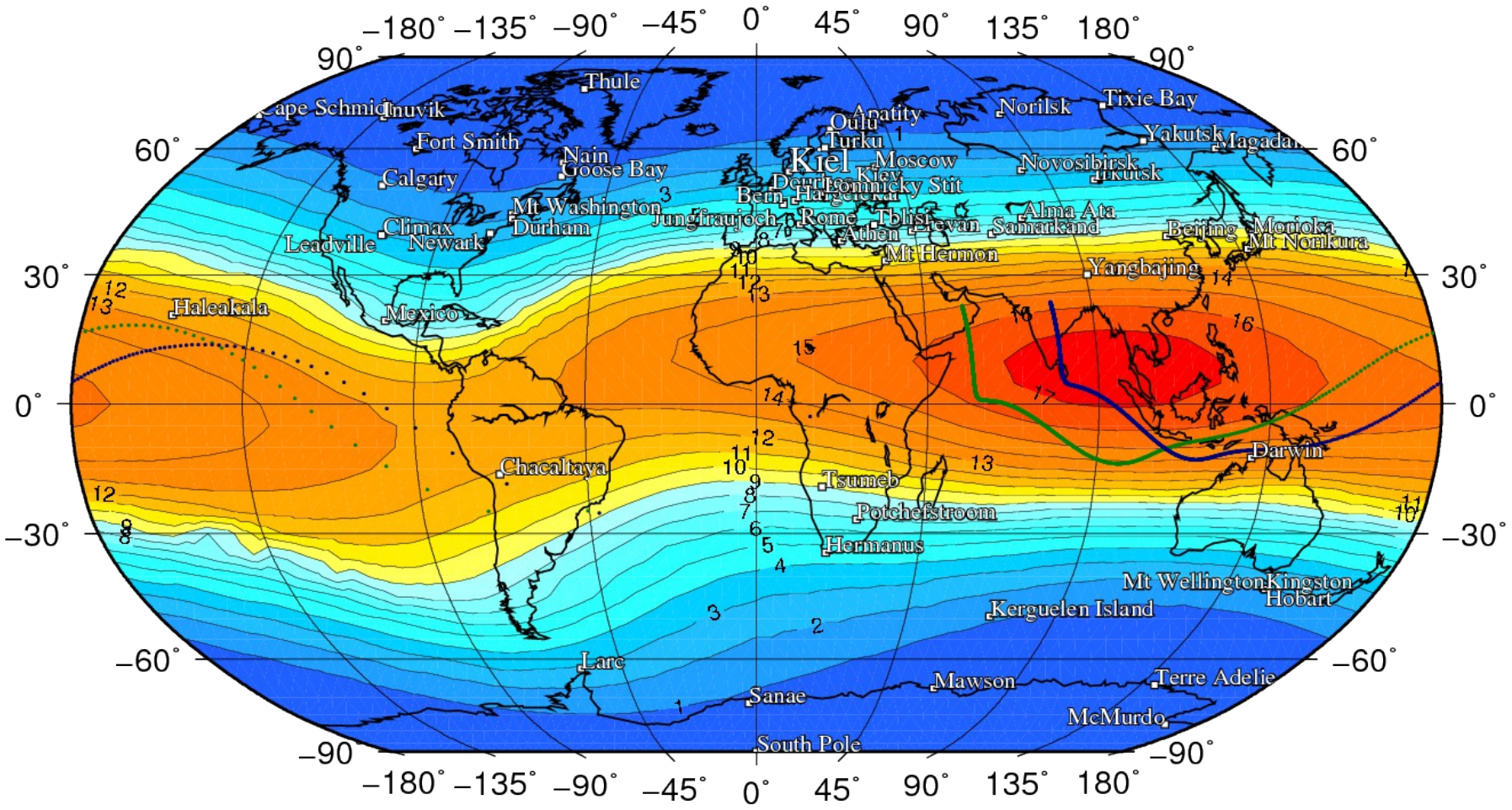


Neutron Monitor

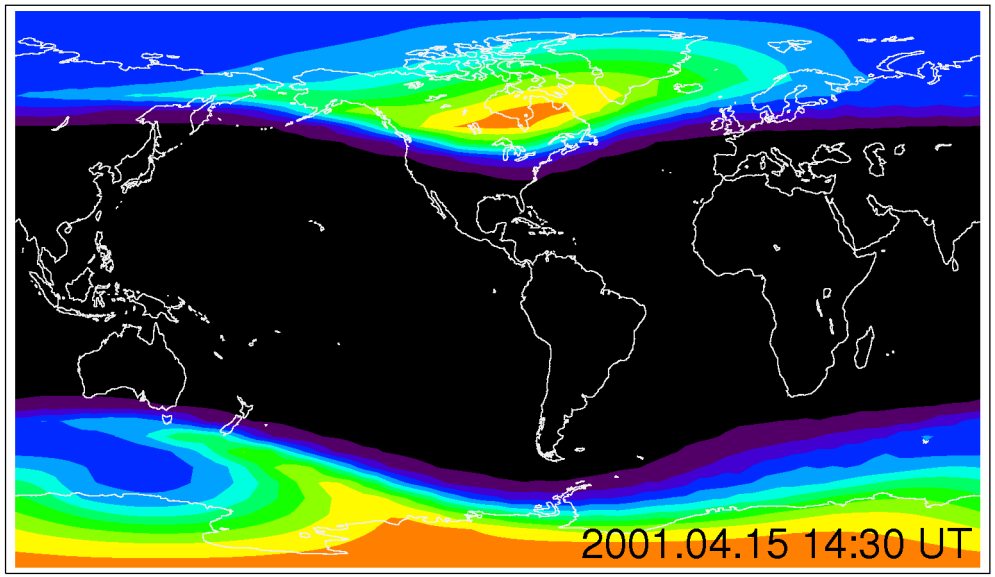

18 channels
Counters interface and power redundancy control
Power supply #1
Power supply #2
Power
18 channels
Power
Linux embedded system
Barometer
FPGA
Serial port #1
Serial port #2

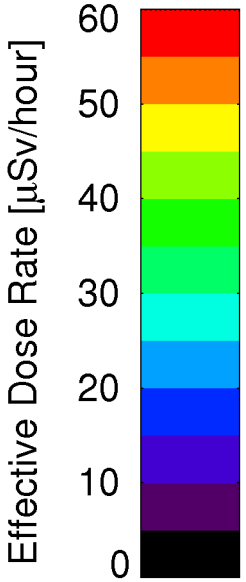

14 3 2006

Worldwide Neutron Monitor network



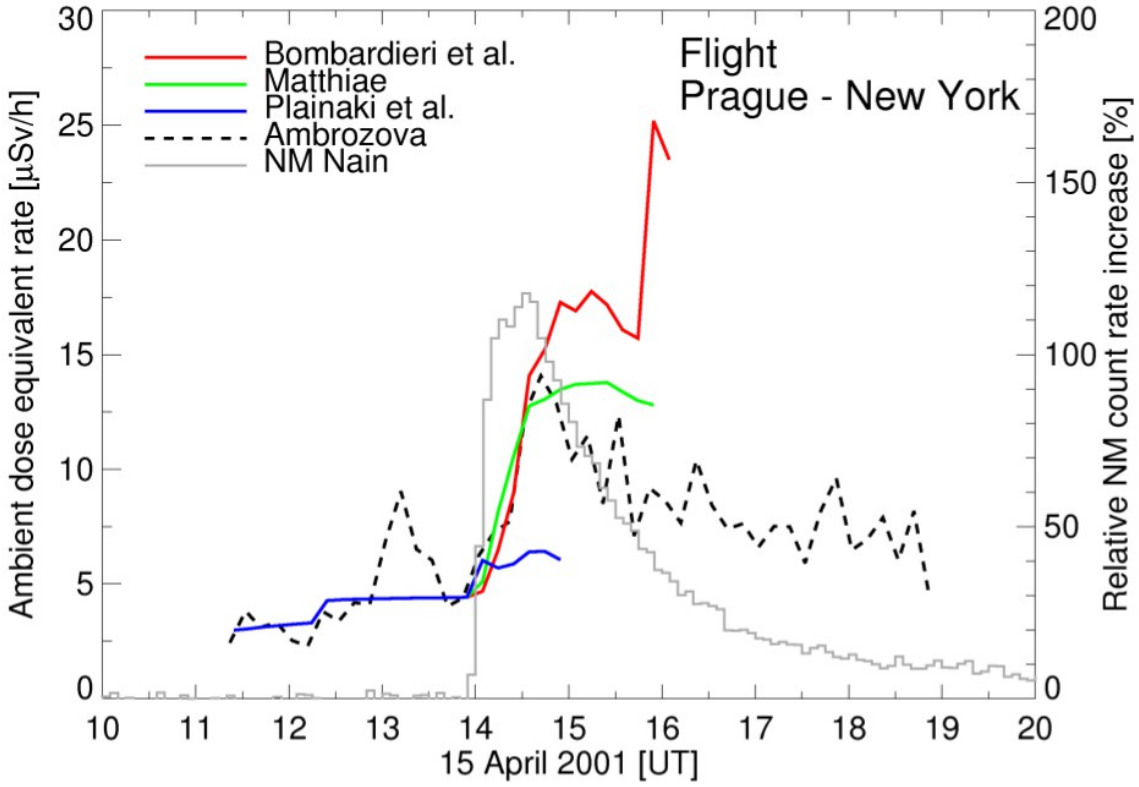
Effective Dose Rate during GLE60 at flight altitudes (250g/cm²)





calculations by Bombardieri

Ambient dose equivalent rate along flight Prague to New York



Calculations,
measurement,
nearest Neutron Monitor station
Bütikofer, EURADOS 2011

Data with one minute resolution, but in varying formats:

0701MOSC.W1C:

```
 9798  9986  9939 10007 10076 10231  9784  9962  9890  9777  9899  9967
10141  9957 10148  9804 10118  9851  9880  9924  9685  9806  9703 10012
 9951 10003  9945  9790  9990  9807  9796  9973  9808  9851 10004  9945
 9908  9851 10071  9902 10028  9919  9834 10072  9767  9820  9966 10026
 9954  9888  9944 10117  9983 10073 10027 10145 10102  9875  9833  9945  0701  1  0.
 9943  9790  9968  9854  9913  9665  9825  9954  9907 10035  9828 10002
 9744  9927  9680  9999  9813  9926 10044  9996  9765 10030  9853 10064
 9957 10208  9913  9898 10162  9827  9970  9676  9993  9830  9995 10118
 9944  9937 10130  9846 10166  9795  9760 10033 10045 10002  9952 10262
 9830  9799 10147 10060  9782 10027 10076 10011  9824  9956  9690 10145  0701  1  1.
```

50 stations:

50 formats

50 formats:

50 conversions

50 programs:

50 chances to fail

and every station writes their own software...

0701BKSN.W1C:

```
 6200  6284  6126  6429  6045  6382  6307  6193  6251  6300  6060  6254
 6449  6460  6075  6115  6373  6591  6387  6084  6201  6044  6513  6142
 6224  6132  6511  6257  6106  6237  6534  6217  6348  6356  6367  6125
 6338  6137  6175  6467  6190  6365  6135  6312  6293  6114  6160  6272
 6152  6223  6367  6404  6489  6353  6269  6272  6405  6306  6228  6210   1  0
 6223  6343  6299  6247  6130  6119  6256  6189  6269  6240  6361  6279
 6075  6278  6346  6130  6577  6354  6351  6466  6386  6480  6221  6508
 6301  6392  6359  6268  6283  6359  6187  6232  6300  6175  6394  6283
 6393  6289  6041  6203  6201  6389  6124  6114  6378  6388  6329  6221
 6010  6318  6070  6409  6036  6177  6227  6319  6089  6233  6180  5998   1  1
```

0701mcrl.01c.txt:

```
2007-01-01 00:00:00+00      2716
2007-01-01 00:01:00+00      2788
2007-01-01 00:02:00+00      2700
2007-01-01 00:03:00+00      2681
2007-01-01 00:04:00+00      2728
2007-01-01 00:05:00+00      2858
2007-01-01 00:06:00+00      2683
2007-01-01 00:07:00+00      2629
2007-01-01 00:08:00+00      2719
```

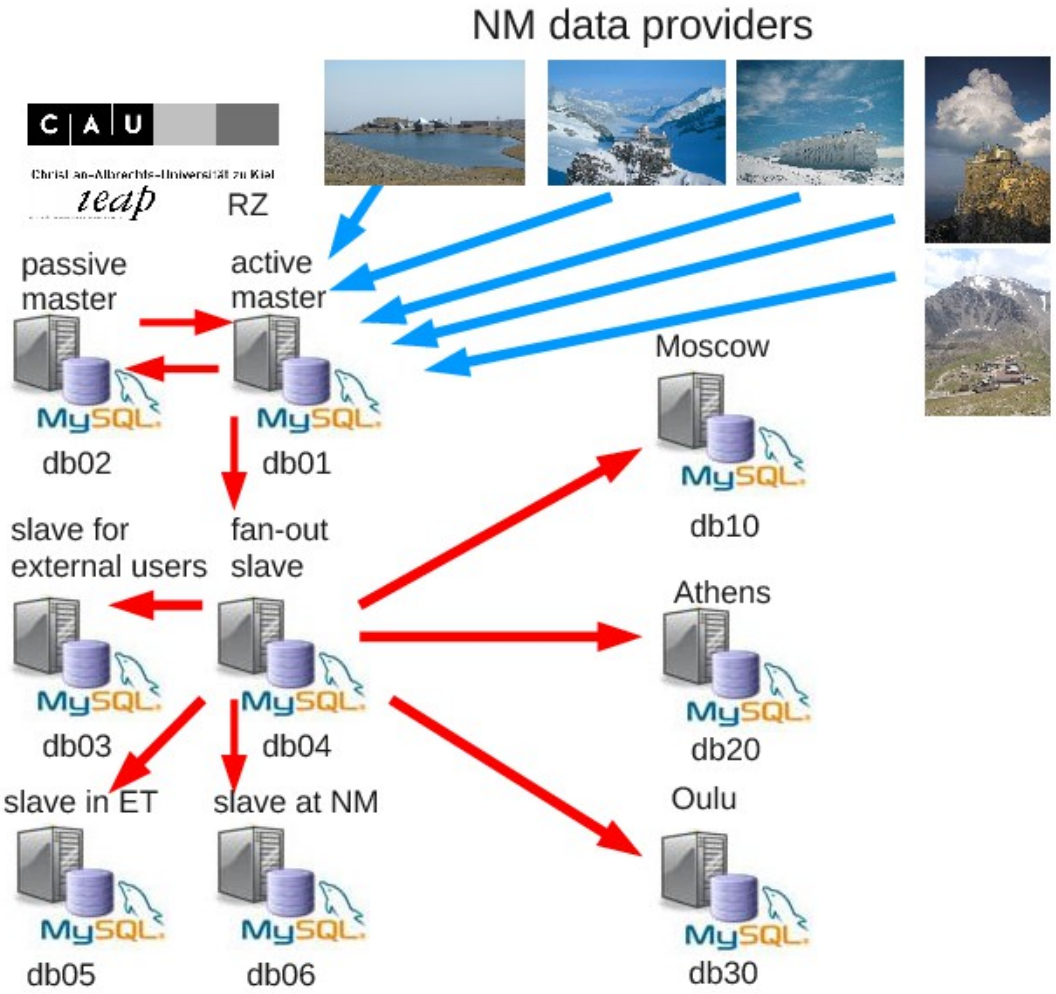
Status in 2007

- Data in 1h resolution and common format available at World Data Center (WDC)
- No real-time data
- No high-resolution data
- Not suitable for Space Weather applications

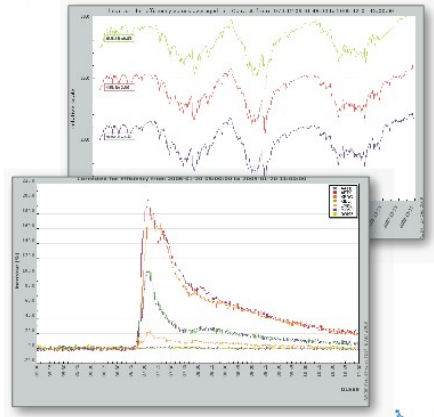
NMDB goals

- Provide data in standard format
- Provide high resolution data
- Provide real-time data (< 5 min delay)
- Make data easily accessible
- Provide designs for modern registration systems
- Applications

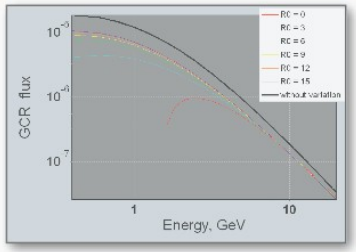
- Two masters (active <-> passive)
- Fan-out mirror
- Mirrror for external users
- Read-only mirrors in several locations
- All mirrors are a complete copy of NMDB (redundancy)



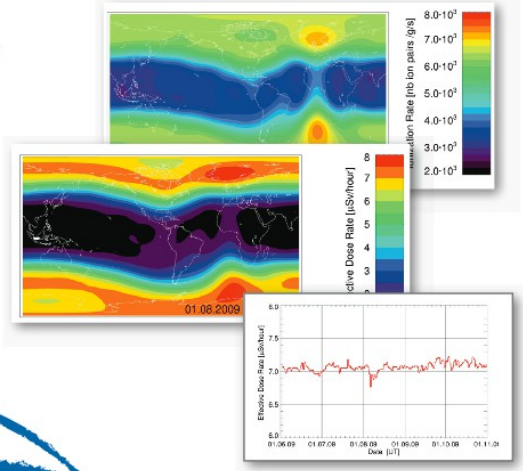
NEST TOOL TO PLOT AND RETRIEVE DATA



SPECTRUM OF GCR

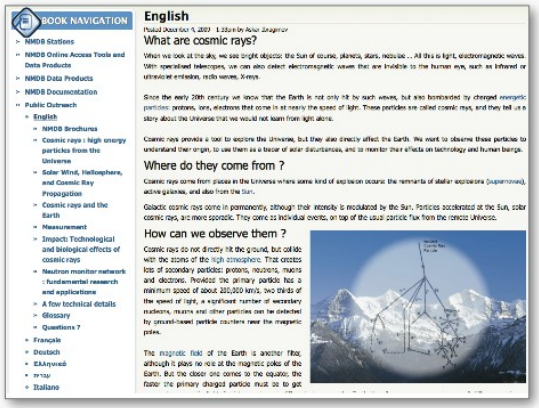


IONISATION RATES AND DOSE RATES IN THE ATMOSPHERE (every 6 hrs)



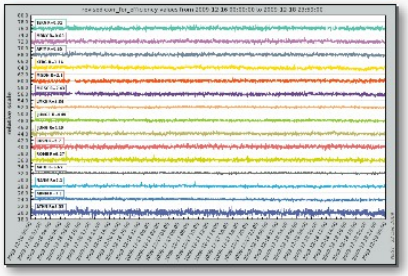
GLE ALERT IN REAL TIME

TRAINING AND PUBLIC OUTREACH

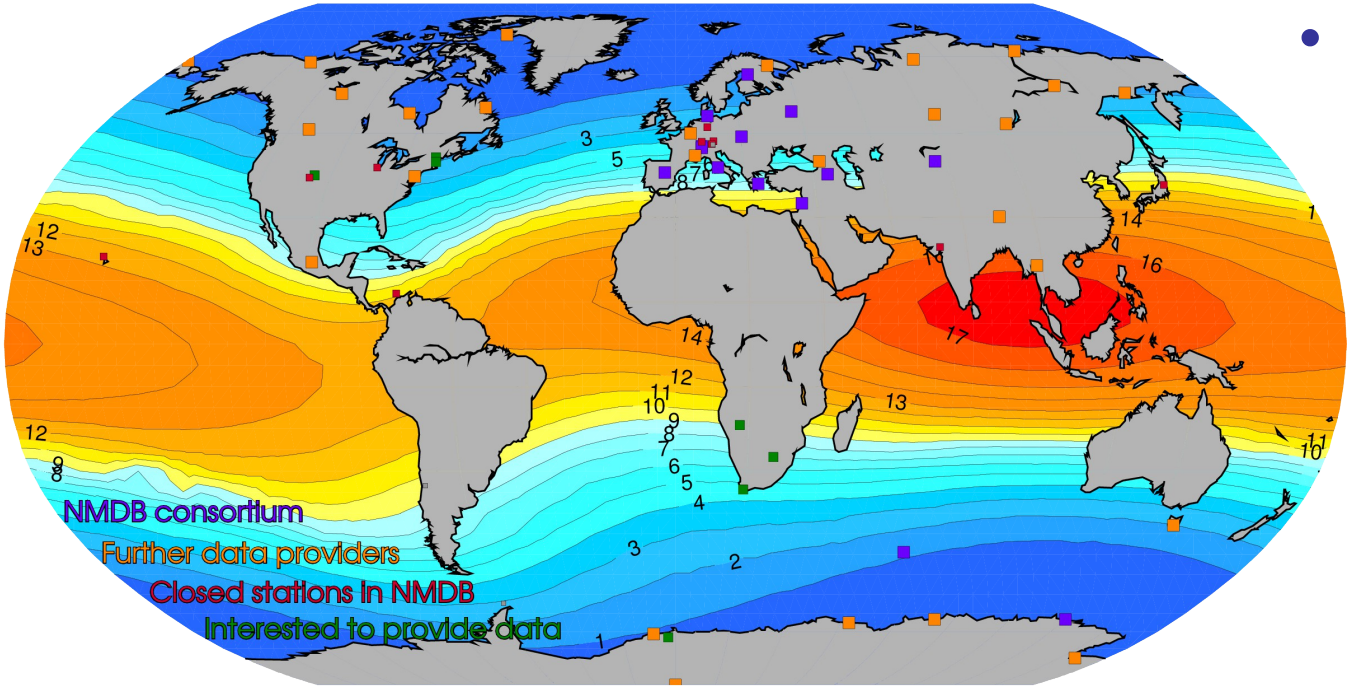


DAILY CR VARIATION

COSMIC RAYS NOW !



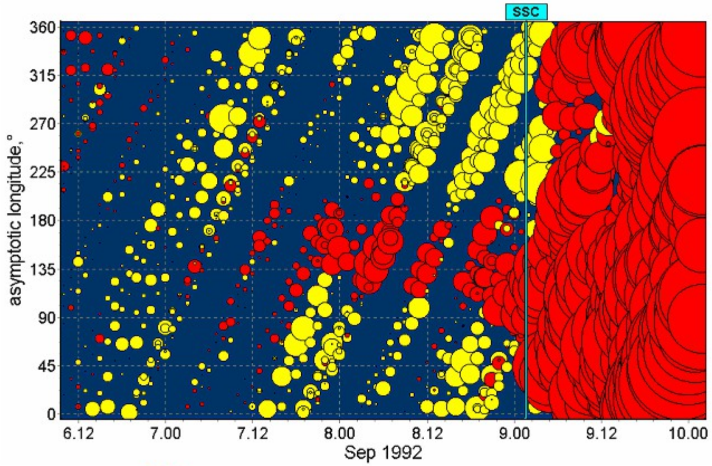
NMDB data providers

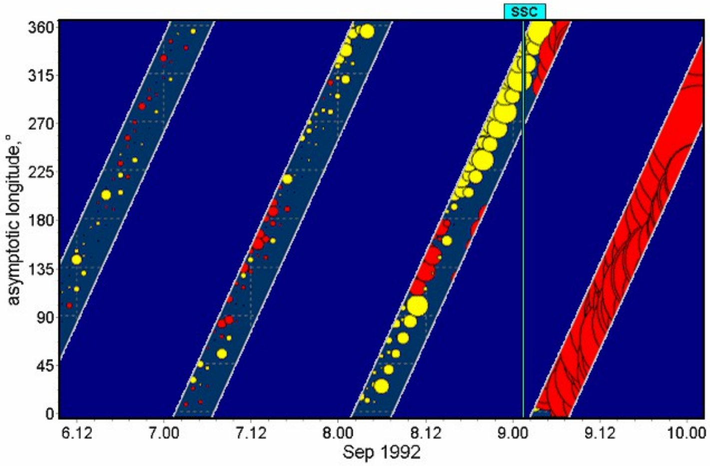


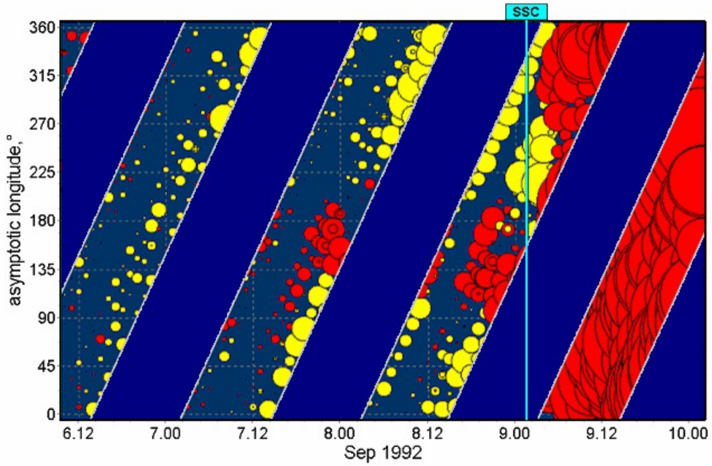
- ~ 50 stations
- 20-30 real-time
- “New” stations:
  - Delaware (8NMs)
  - Mexico
  - Kingston, Mawson
  - Tibet
  - Dourbes
  - Calgary
  - Thailand
  - South Africa
  - New Hampshire
  - Austria

IZMIRAN: CR anisotropy monitor

- ICMEs modulate cosmic ray intensity
- Unusual anisotropy distribution can be seen hours before the onset of Fd
- Data of entire worldwide network of NM stations are needed for reliable forecasts
- Precursor monitor possible



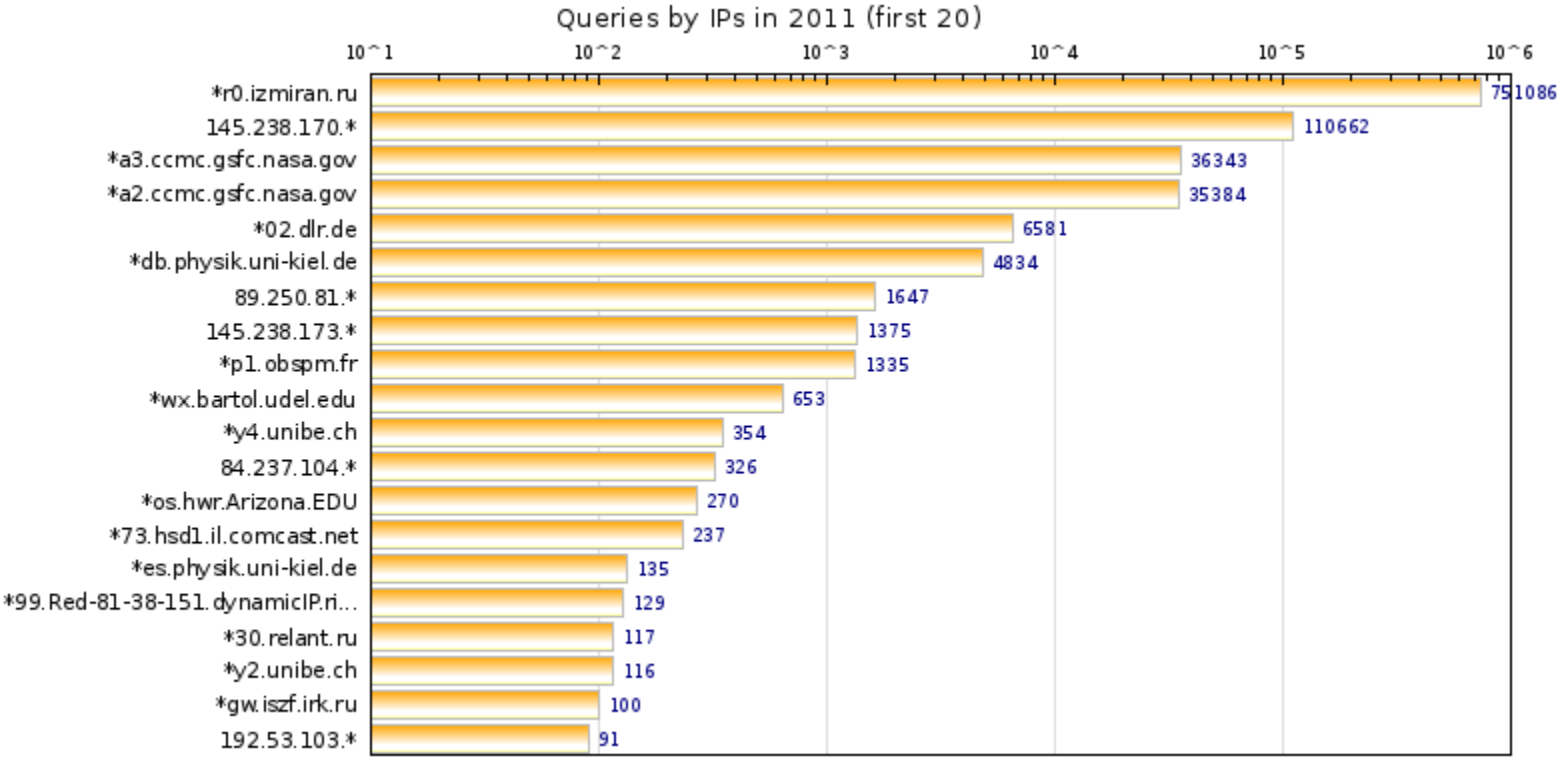




NMDB users

- NMDB Alerts, fluctuations, GLE, solar neutrons, dosimetry...

- Dosimetry for airplane personel at Air France, DLR, Globalog
- Space Weather Alerts at NOAA
- Integrated Space Weather Analysis at CCMC (NASA/GSFC)
- Cosmic Rays and Climate
- Cosmic Ray – cloud connections
- Cosmic Rays and the geomagnetic field
- Soil moisture measurements (US, AUS, UFZ Leipzig, UK)
- Department of Homeland Security / NUSTL ???
- Space Weather Forecaster at USAF


Queries by IPs in 2011 (first 20)
10^1
10^2
10^3
10^4
10^5
10^6
*r0.izmiran.ru
145.238.170.*
*a3.ccmc.gsfc.nasa.gov
*a2.ccmc.gsfc.nasa.gov
*02.dlr.de
*db.physik.uni-kiel.de
89.250.81.*
145.238.173.*
*p1.obspm.fr
*wx.bartol.udel.edu
*y4.unibe.ch
84.237.104.*
*os.hwr.Arizona.EDU
*73.hsd1.il.comcast.net
*es.physik.uni-kiel.de
*99.Red-81-38-151.dynamicIP.ri...
*30.relant.ru
*y2.unibe.ch
*gw.iszf.irk.ru
192.53.103.*
751086
110662
36343
35384
6581
4834
1647
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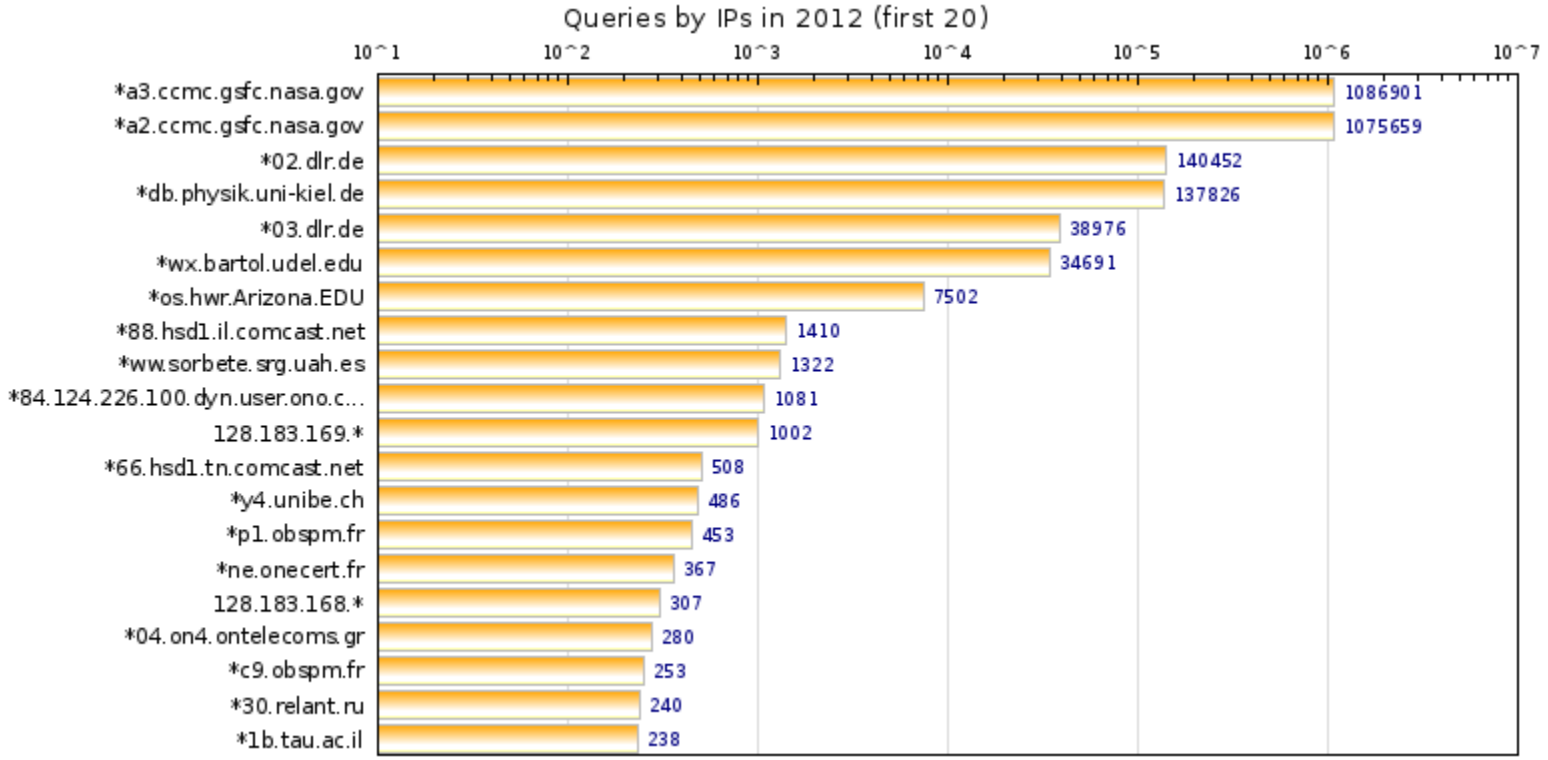
1335
653
354
326
270
237
135
129
117
116
100
91


Queries by IPs in 2012 (first 20)
10^1
10^2
10^3
10^4
10^5
10^6
10^7
*a3.ccmc.gsfc.nasa.gov
1086901
*a2.ccmc.gsfc.nasa.gov
1075659
*02.dlr.de
140452
*db.physik.uni-kiel.de
137826
*03.dlr.de
38976
*wx.bartol.udel.edu
34691
*os.hwr.Arizona.EDU
7502
*88.hsd1.il.comcast.net
1410
*ww.sorbete.srg.uah.es
1322
*84.124.226.100.dyn.user.ono.c...
1081
128.183.169.*
1002
*66.hsd1.tn.comcast.net
508
*y4.unibe.ch
486
*p1.obspm.fr
453
*ne.onecert.fr
367
128.183.168.*
307
*04.on4.ontelecoms.gr
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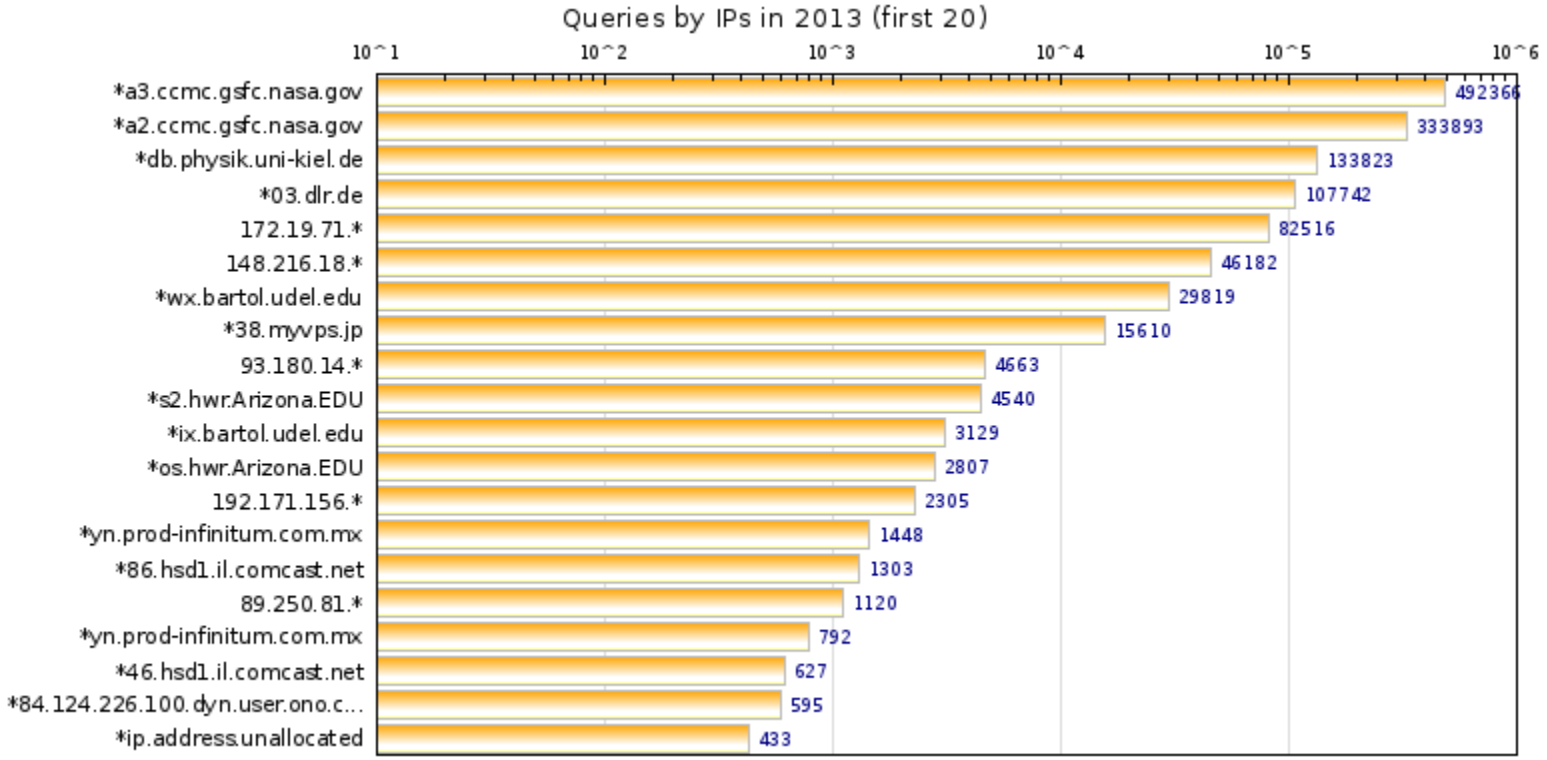
240
*1b.tau.ac.il
238


Queries by IPs in 2013 (first 20)
10^1
10^2
10^3
10^4
10^5
10^6
*a3.ccmc.gsfc.nasa.gov
492366
*a2.ccmc.gsfc.nasa.gov
333893
*db.physik.uni-kiel.de
133823
*03.dlr.de
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148.216.18.*
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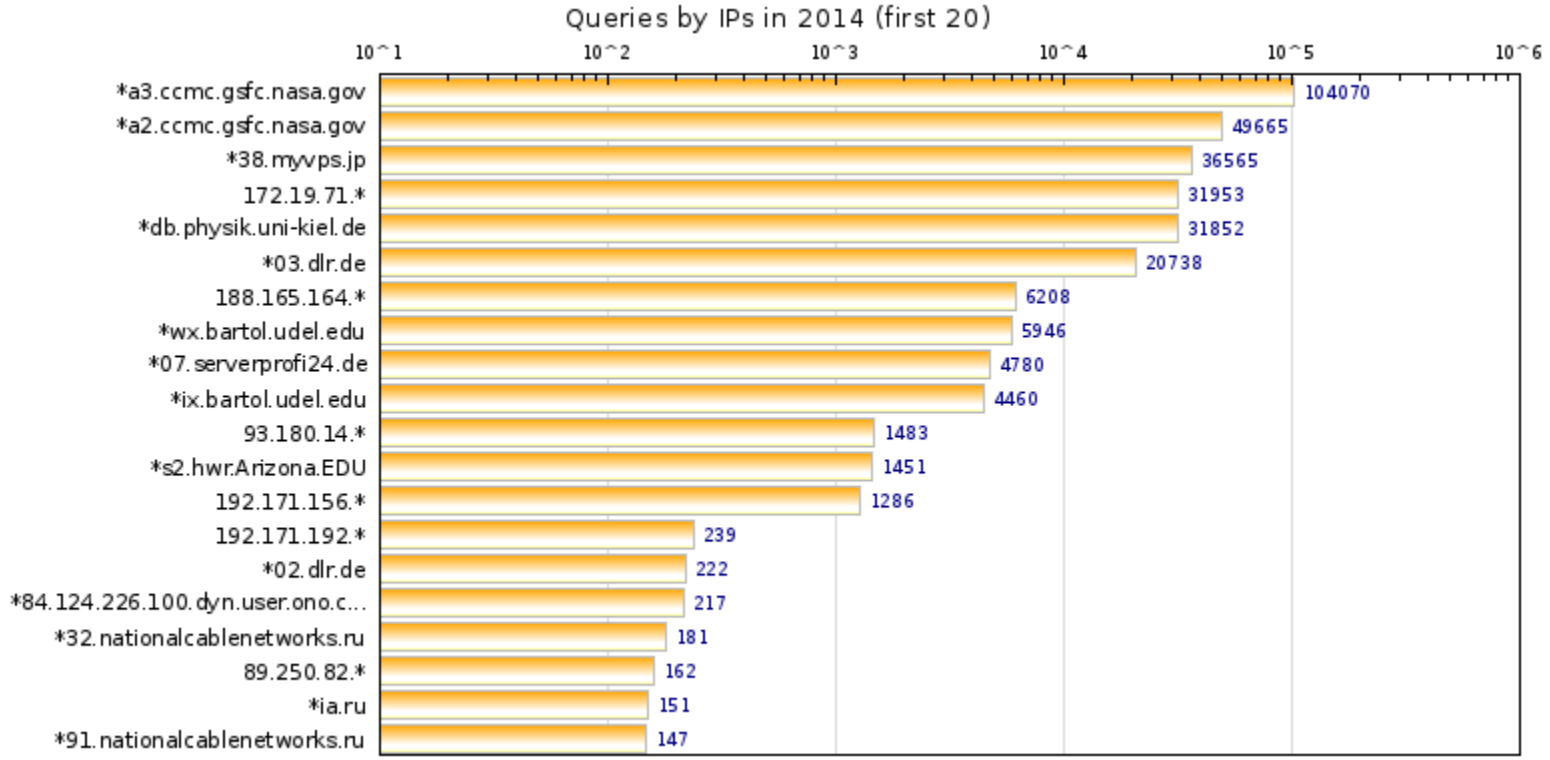
Queries by IPs in 2014 (first 20)
10^1
10^2
10^3
10^4
10^5
10^6
*a3.ccmc.gsfc.nasa.gov
104070
*a2.ccmc.gsfc.nasa.gov
49665
*38.myvps.jp
36565
172.19.71.*
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*db.physik.uni-kiel.de
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*03.dlr.de
20738
188.165.164.*
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*ix.bartol.udel.edu
4460
93.180.14.*
1483
*s2.hwr.Arizona.EDU
1451
192.171.156.*
1286
192.171.192.*
239
*02.dlr.de
222
*84.124.226.100.dyn.user.ono.c...
217
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89.250.82.*
162
*ia.ru
151
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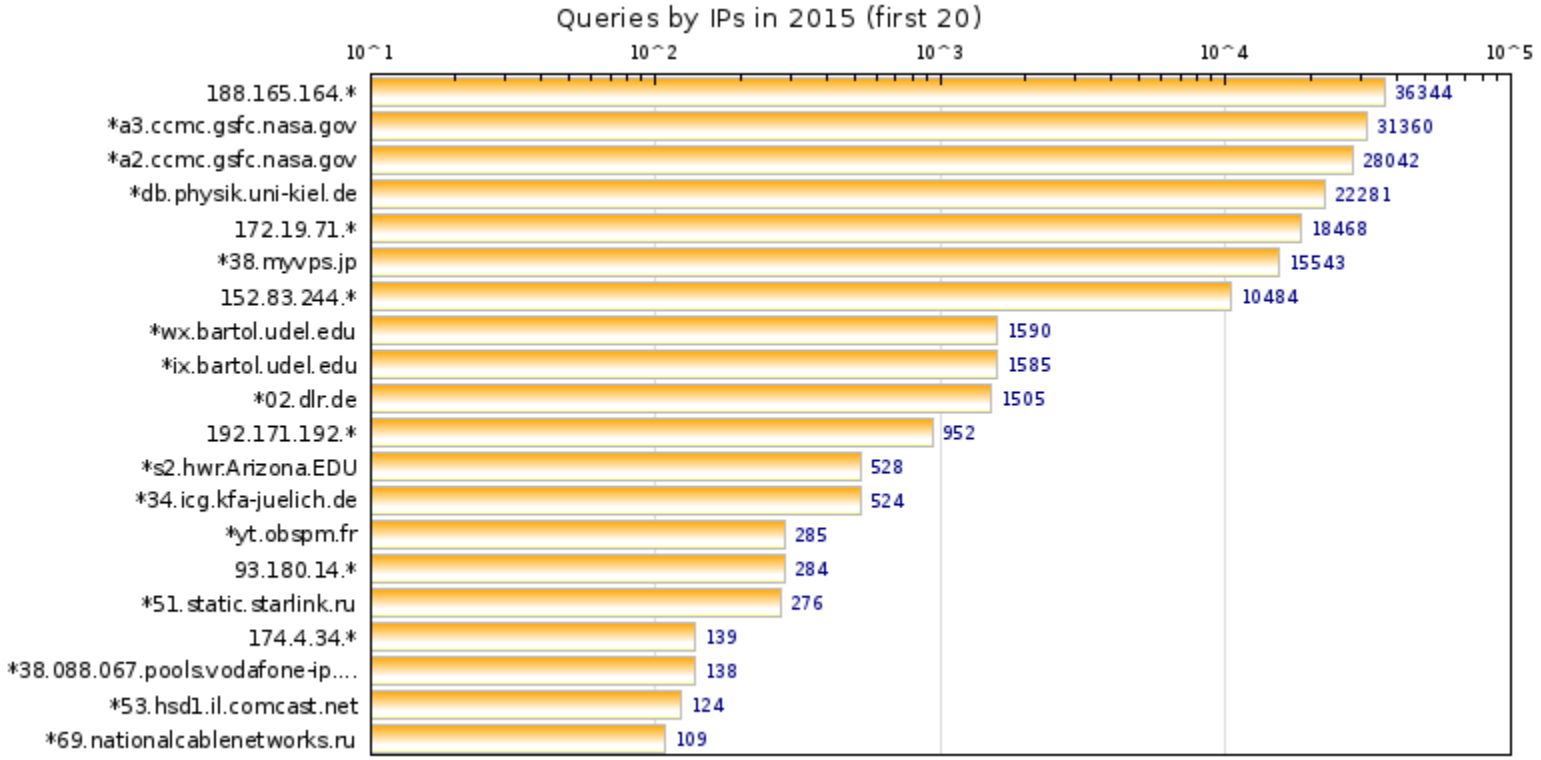
147


Queries by IPs in 2015 (first 20)
10^1
10^2
10^3
10^4
10^5
188.165.164.* 36344
*a3.ccmc.gsfc.nasa.gov 31360
*a2.ccmc.gsfc.nasa.gov 28042
*db.physik.uni-kiel.de 22281
172.19.71.* 18468
*38.myvps.jp 15543
152.83.244.* 10484
*wx.bartol.udel.edu 1590
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*02.dlr.de 1505
192.171.192.* 952
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*yt.obspm.fr 285
93.180.14.* 284
*51.static.starlink.ru 276
174.4.34.* 139
*38.088.067.pools.vodafone-ip.... 138
*53.hsd1.il.comcast.net 124
*69.nationalcablenetworks.ru 109

NMDB EVENT SEARCH TOOL

NEST

3 ways 2 use NEST

Quick Plots

Last Data | GLE 71 | GLE 70

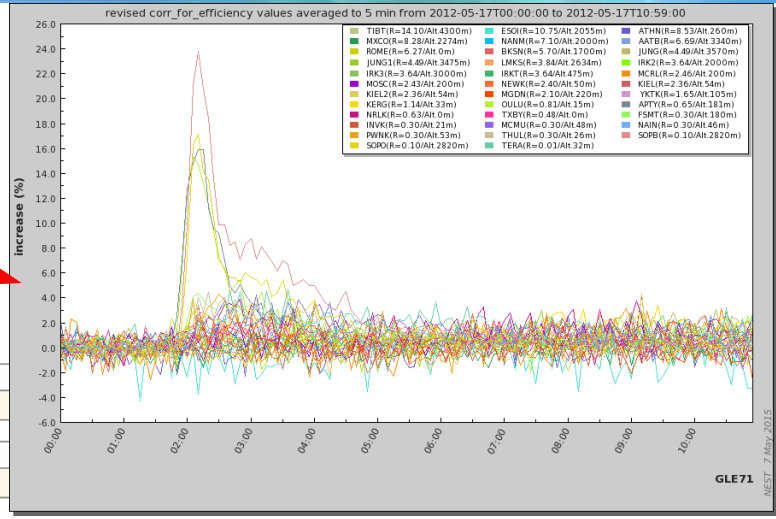
conditions & information to use data

Last 3 days

Plot Examples

[march 2013] CALM test phase completed

[sept 2012] New header in ascii files, more here



Stations

AATB	APTY	ATHN	BKSN	BURE
CALM	DRBS	ESOI	FSMT	INVK
IRK2	IRK3	IRKT	JUNG	JUNG1
KERG	KGSN	KIEL	LMKS	MCMU
MCRL	MGDN	MOSC	MWSN	MXCO
NAIN	NEWK	NRLK	OULU	PWNK
ROME	SOPB	SOPO	TERA	THUL
TXBY	YKTK			

All stations | Online stations | one color | reset colors

Overplot main

Overplot extras

NMDB tables

Env. & meta data

Scaling Options

Event Options

Ascii Options

Style Options

Contact: questions@nmdb

NEST2 is here

Date Selection (UTC)

Last 1 days | hours | mins

From 7 May 2015 0h 0mn

To 7 May 2015 23h 59mn

GLE number/date 71 (2012-05-17) detailed list

FD number/date 53 (2011 Fev 18)

Resolution

Time resolution: best

Force**

Data type

- Pressure & efficiency corr.
- Pressure corrected
- Uncorrected
- Pressure

Scale

- Relative scale
- Counts/s (or mbar)
- Log scale

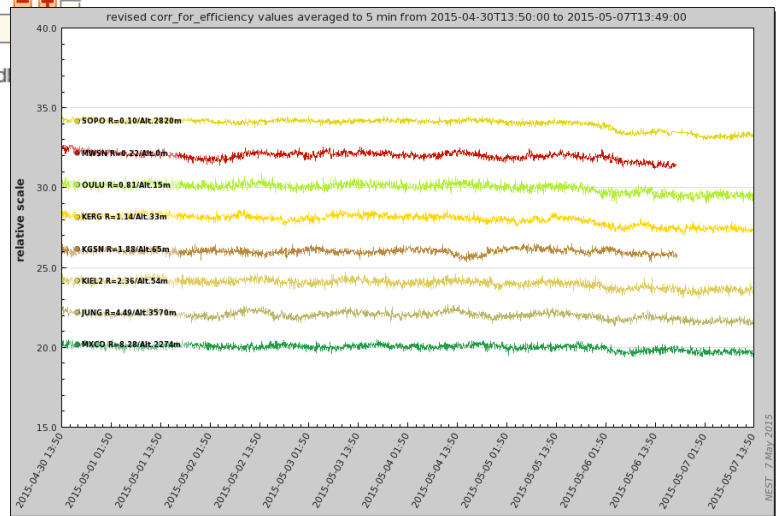
Output

- Plot
- Ascii
- Plot & ascii

Submit | Reset

** This may slow down your request. *** Table format here.

Webinterface to data:
nest.nmdb.eu



NMDB: one stop shop for...

- real-time cosmic ray data
- historical cosmic ray data
- GLE alerts, CR and GLE spectra
- background information on cosmic rays
- training for cosmic ray science
- information on registration systems and components

questions@nmdb.eu

Acknowledgements

The research leading to these results has received funding from the European Community's Seventh Framework Programme (FP/2007-2013) under grant agreement no 213007.

Data retrieved via NMDB are the property of the individual data providers. We acknowledge the PIs of individual neutron monitors for providing data.