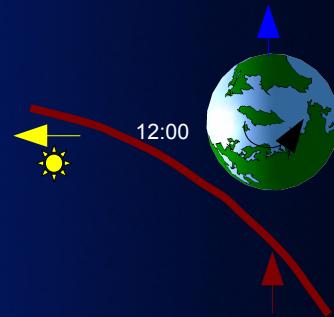
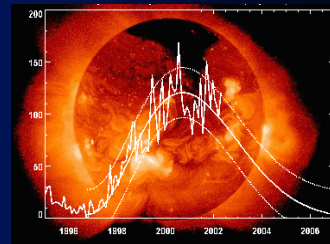
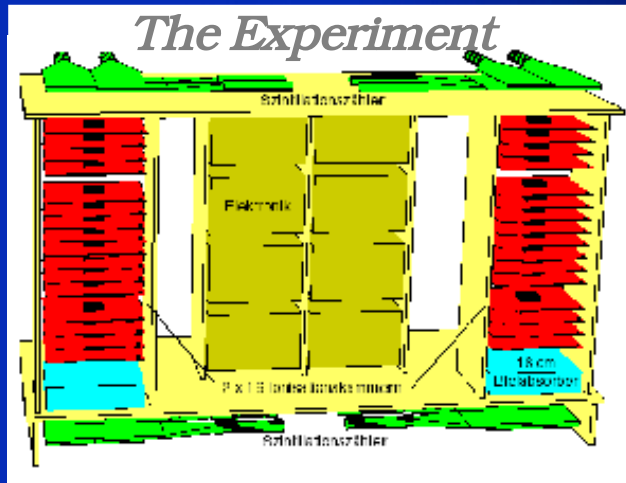


SOLAR EVENTS SEEN IN THE 10-20 GEV RANGE

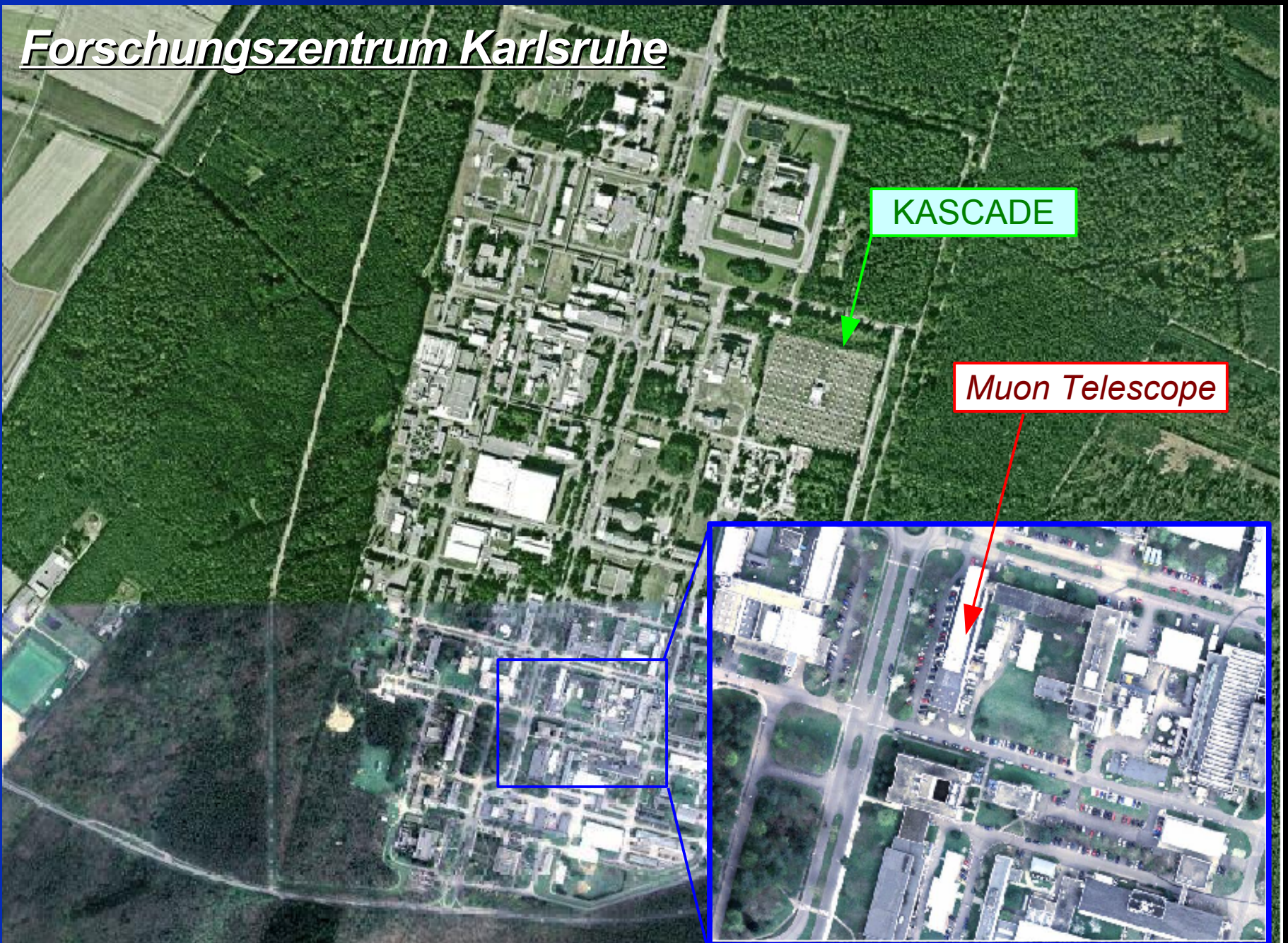
BY A MUON TELESCOPE LOCATED IN KARLSRUHE, GERMANY

I. Braun, J. R. Hörandel, J. Engler and J. Milke

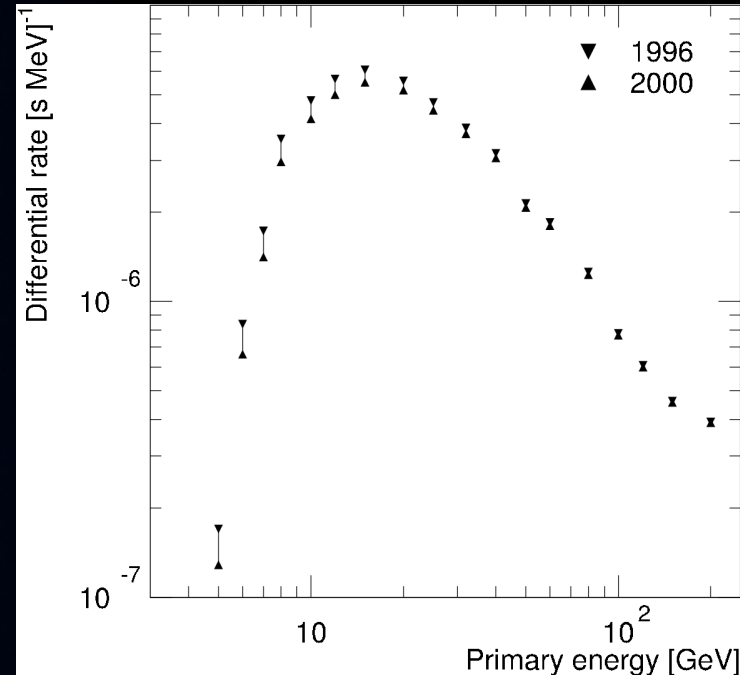
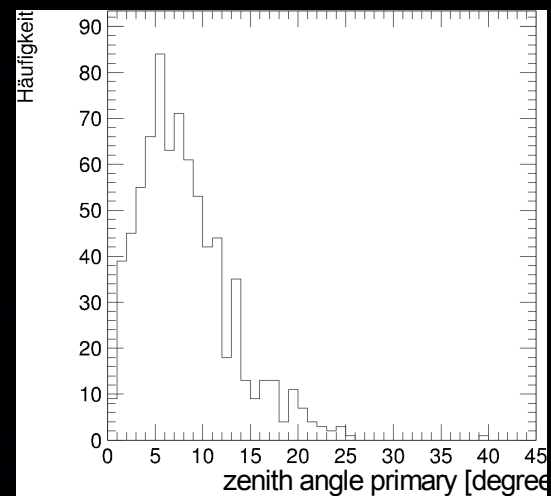
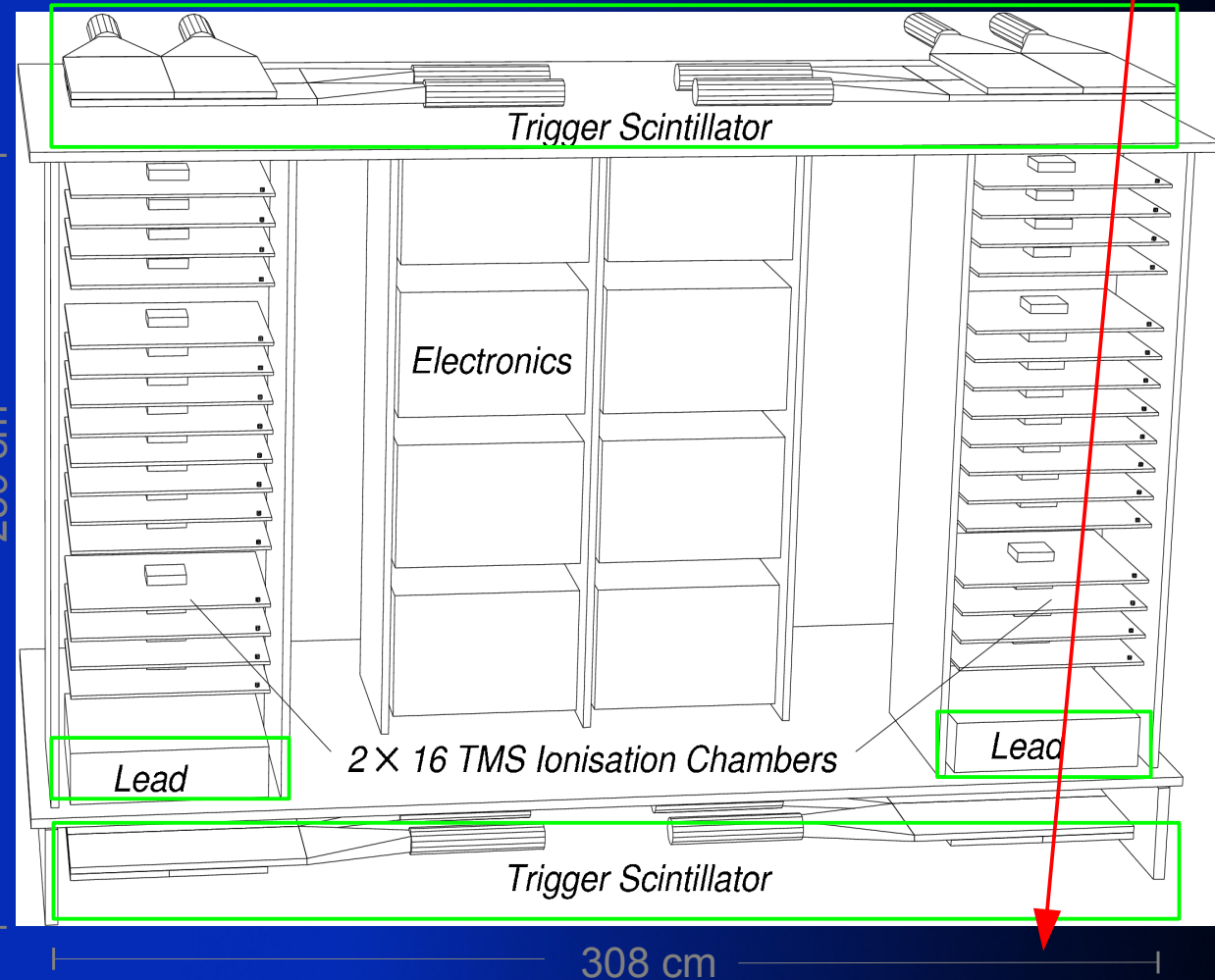


KARLSRUHE MUON TELESCOPE

Forschungszentrum Karlsruhe



KARLSRUHE MUON TELESCOPE



detected secondary:

- >99% $\mu^{+/-}$
- coincidence trigger: incidence angle < 6°
- threshold 0.8 GeV

primary CR (simulations)

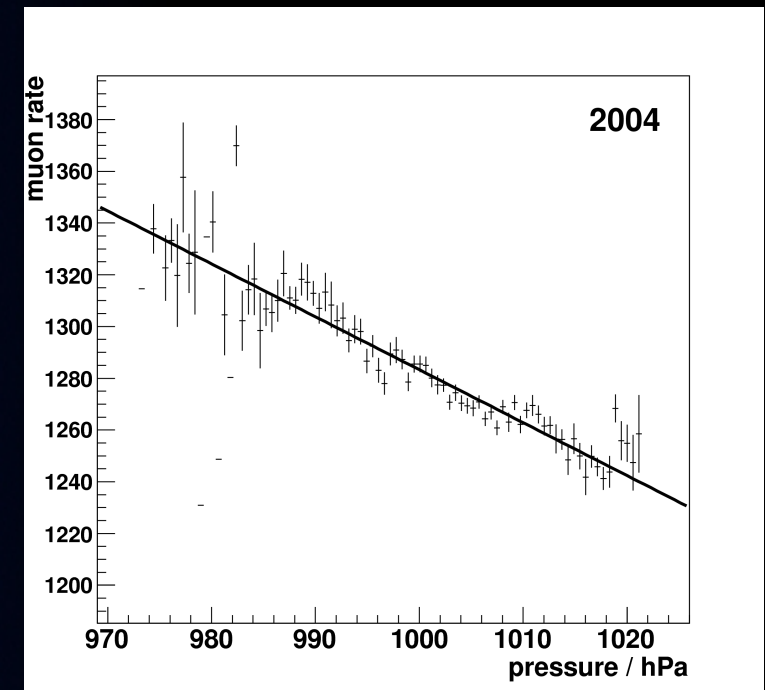
- veto -> small showers -> p
- 95% < 18° zenith angle
- peak @ 15 GeV

ATMOSPHERIC CORRECTIONS

- Pressure

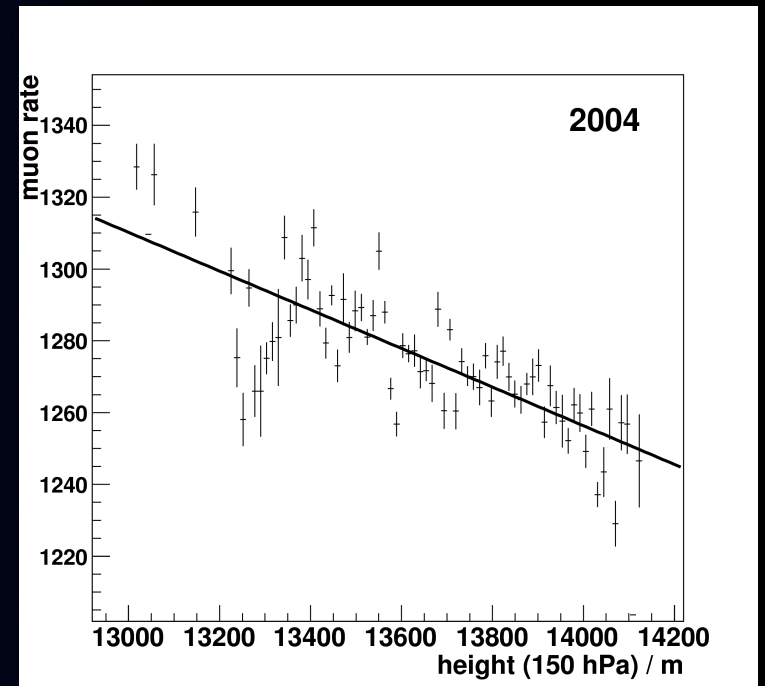
(Forschungszentrum Karlsruhe)

$d(\text{Rate}) / dp = (-0.12 \pm 0.04) \text{ \%/hPa}$
(average of annual values)



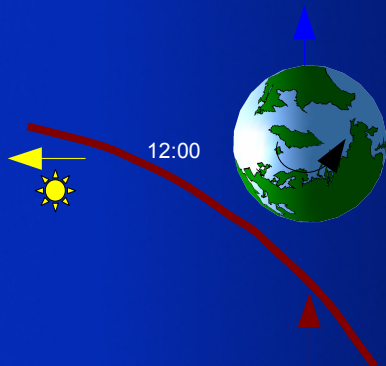
- Height of 150 hpa (~ primary interaction) layer (2 balloons / day, from Stuttgart, DWD)

$d(\text{Rate}) / dh = (-3.8 \pm 1.2) \text{ \%/km}$
(average of annual values)



data set: ~ 80 000 h live time, 1993 - 2006
iterative correction to $p = 1013 \text{ hPa}$, $h = 13.6 \text{ km}$

DAILY VARIATIONS

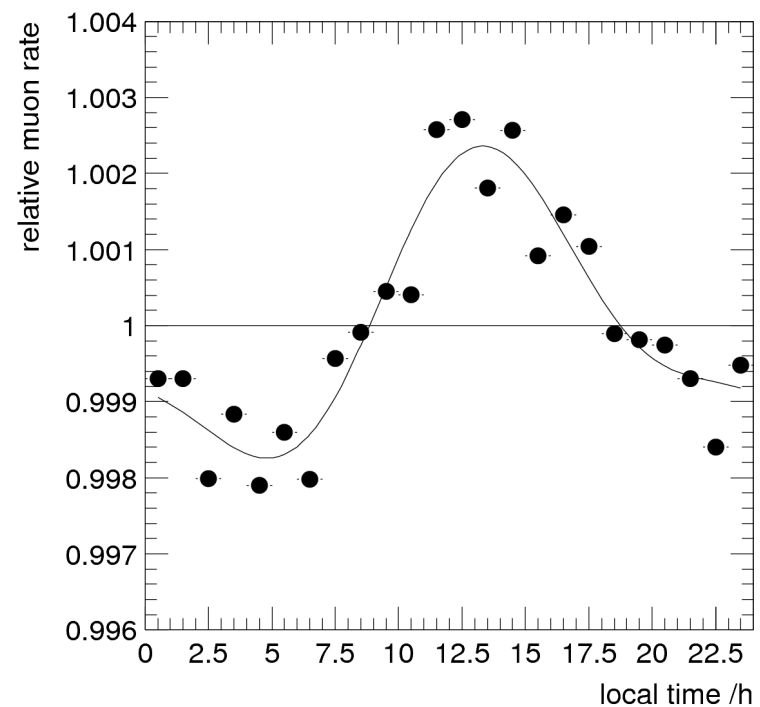


fit:

constant (1.000)

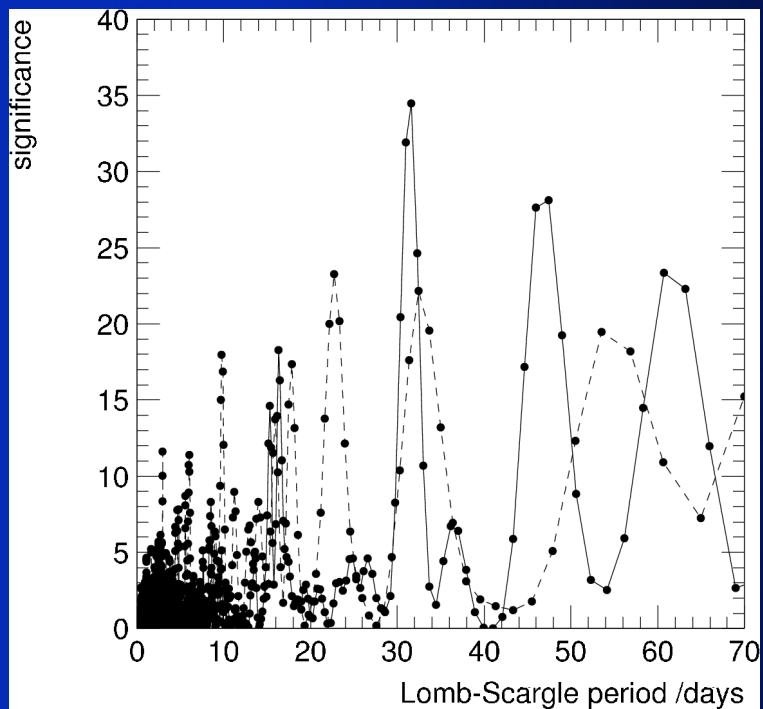
+ sine with 24 h period (0.18% at 14.2 h)

+ sine with 12 h period (0.07% at 0.7 h)

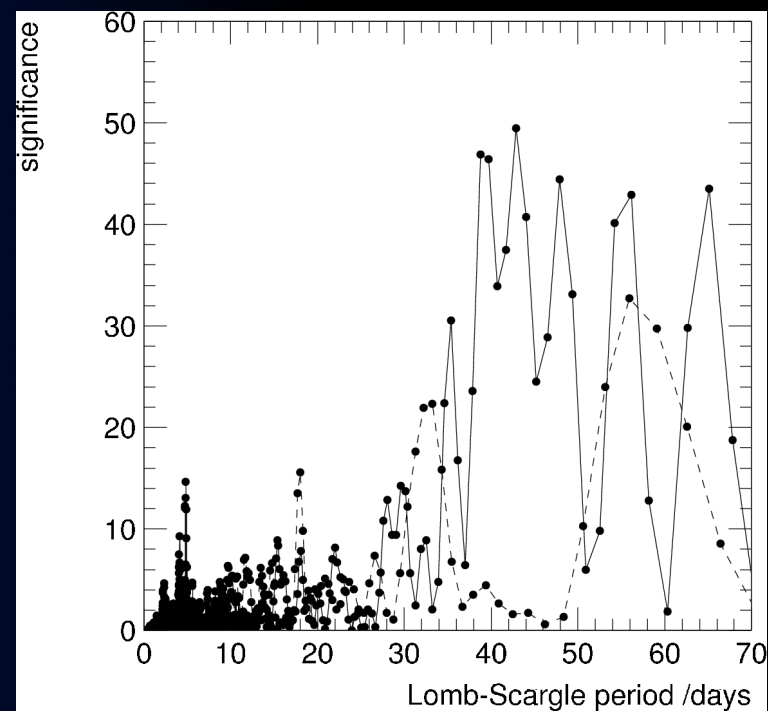


LOMB-SCARGLE ANALYSIS

Karlsruhe Muon Telescope



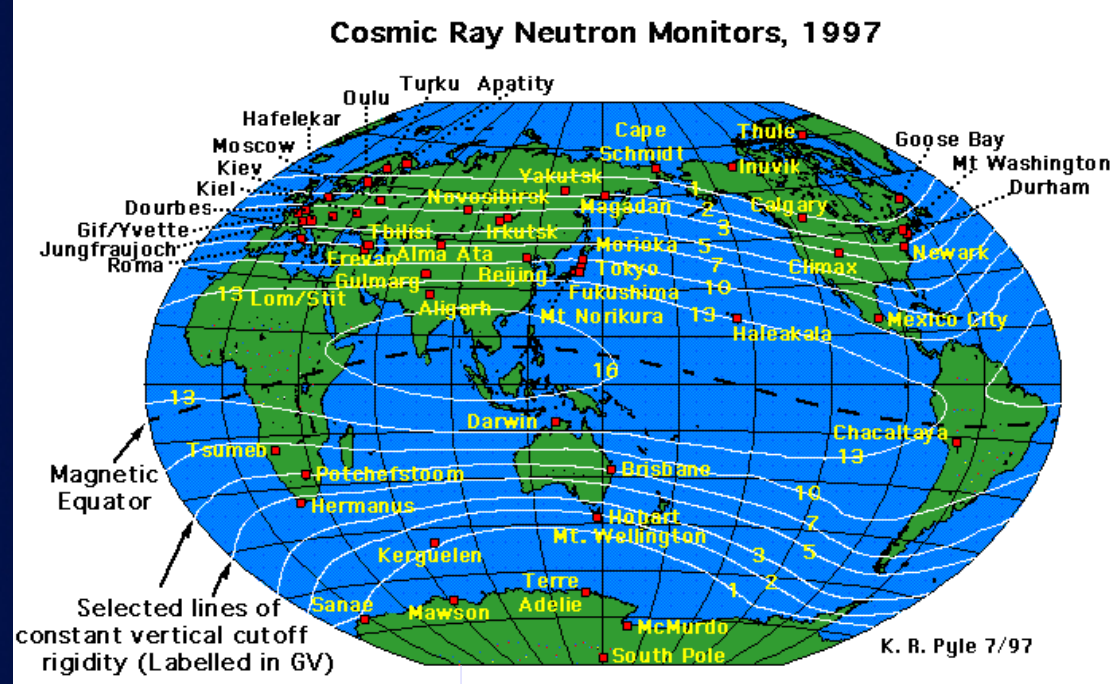
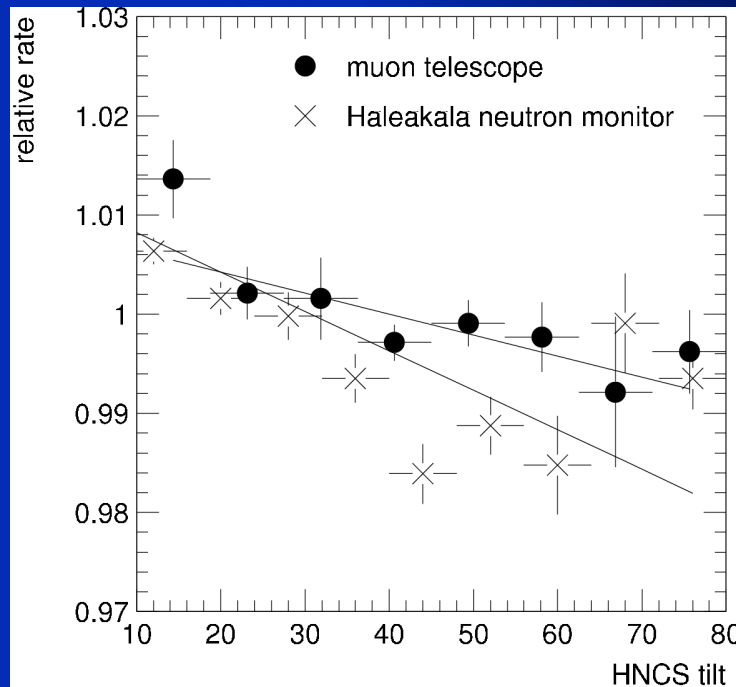
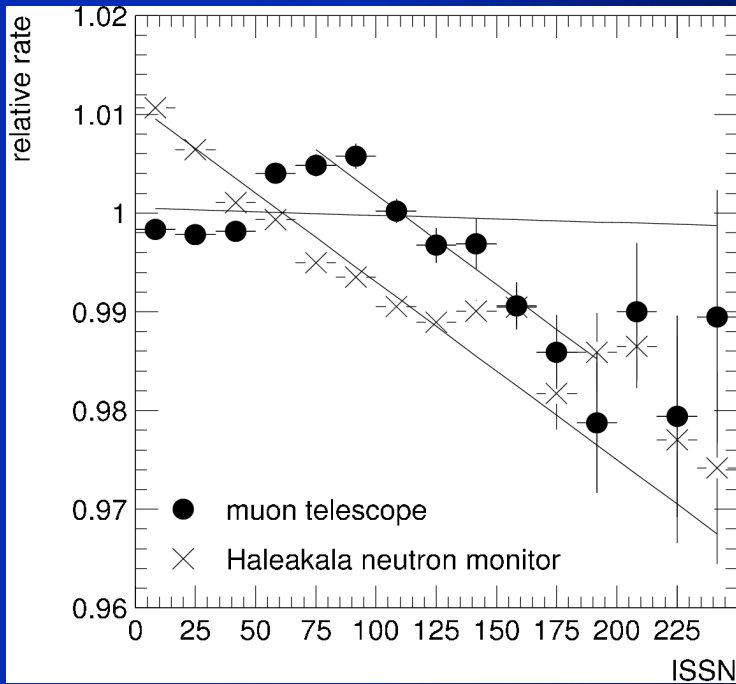
Jungfraujoch neutron monitor



----- until 2000, A+

- - - since 2002, A-

SOLAR CYCLE VARIATIONS



Geomagnetic Cutoff
[GV]

neutron monitor

0.6

Apatity, Russia

0.8

Oulu, Finland

2.4

Moskau, Russia

3.0

Climax, USA

3.6

Irkutsk, Russia

7.0

Potchefstroom, South Afrika

9.2

Tsumeb, Namibia

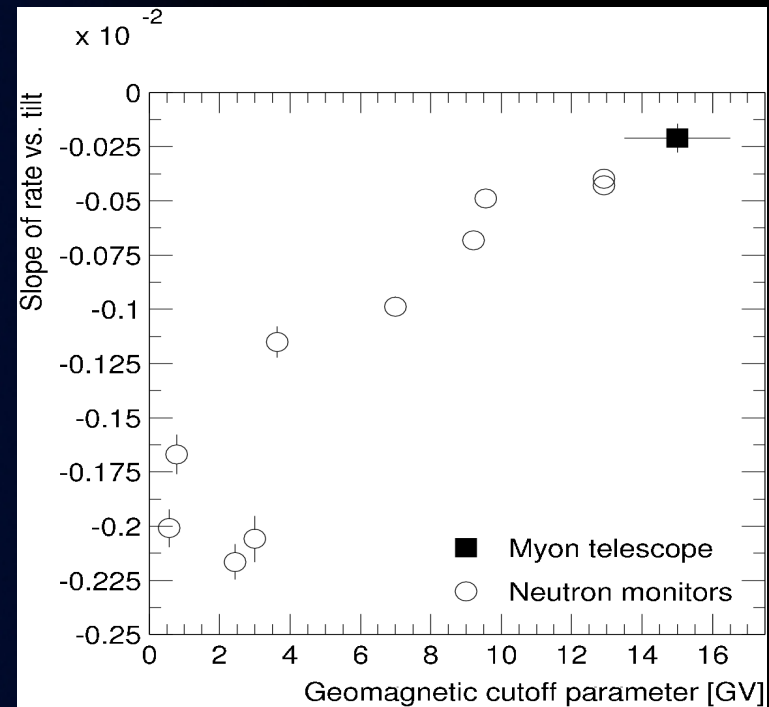
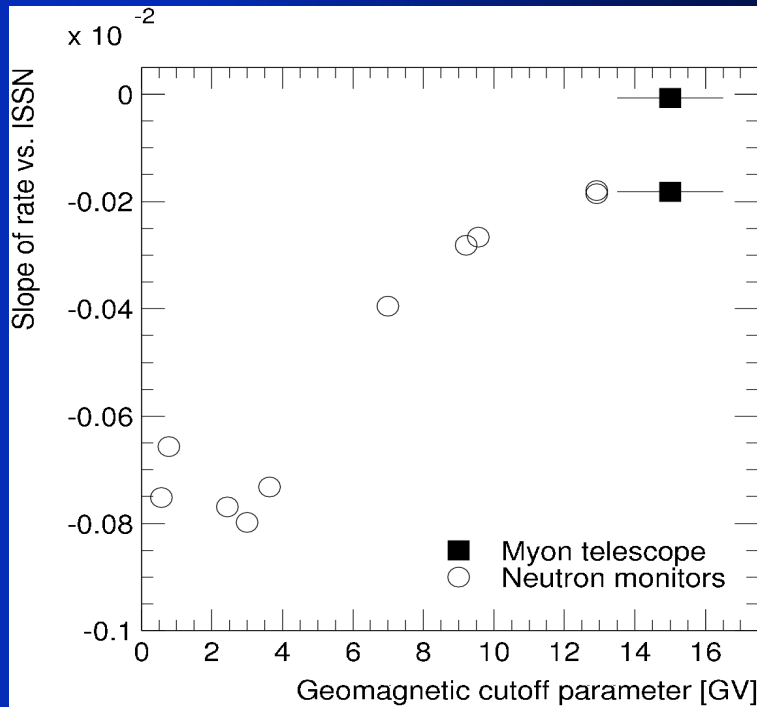
9.6

Bejing, China

12.9

Haleakala, Hawaii

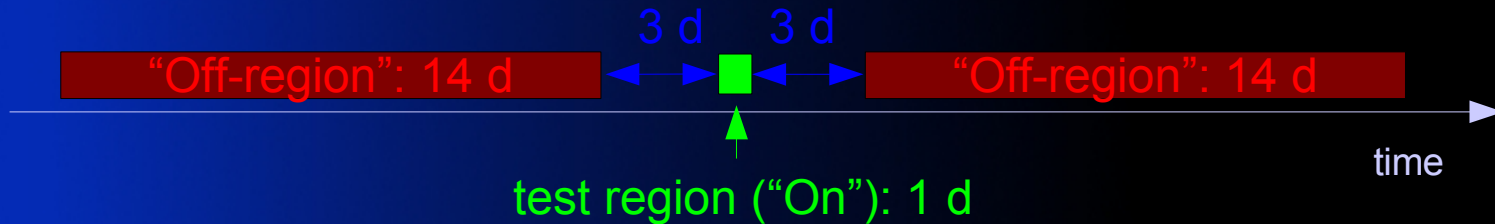
SOLAR CYCLE VARIATIONS



but: significantly different behaviour seen in different solar activity phases...

EVENT SEARCH

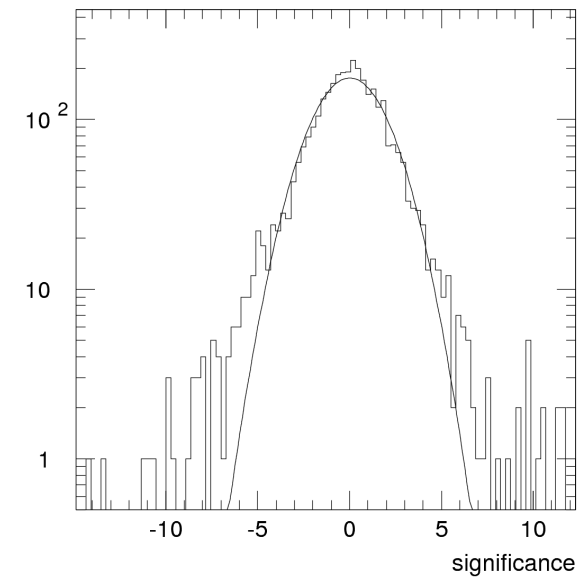
Li-Ma Significances



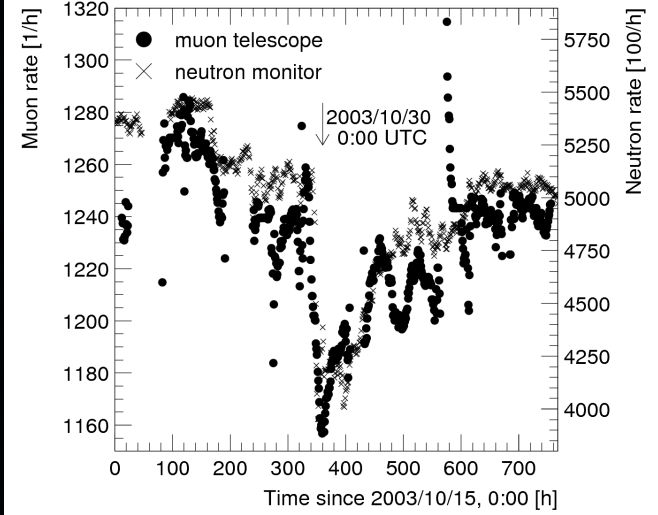
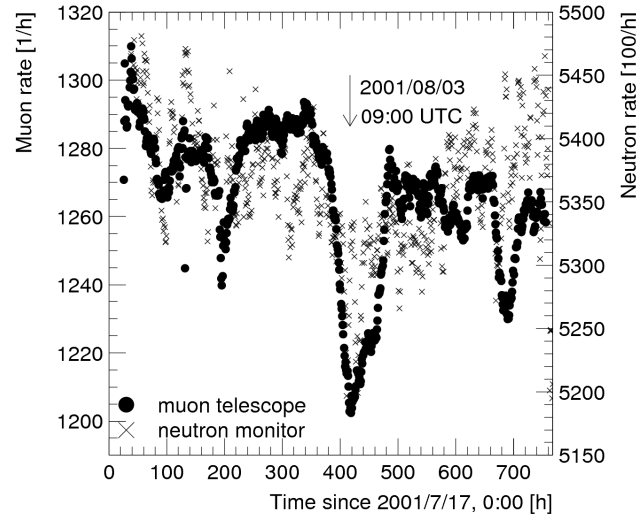
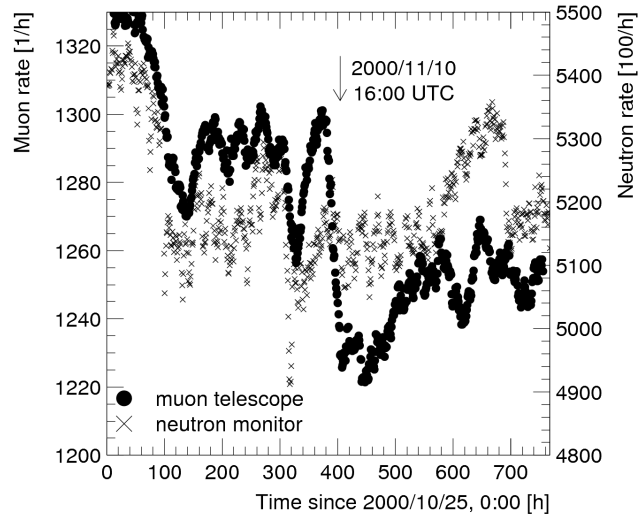
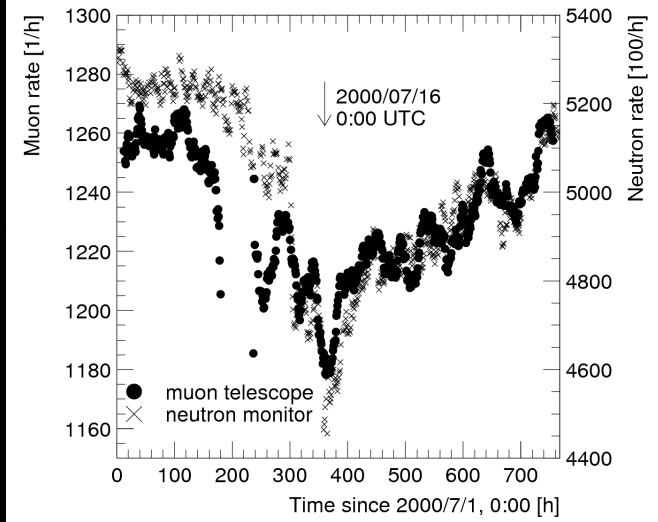
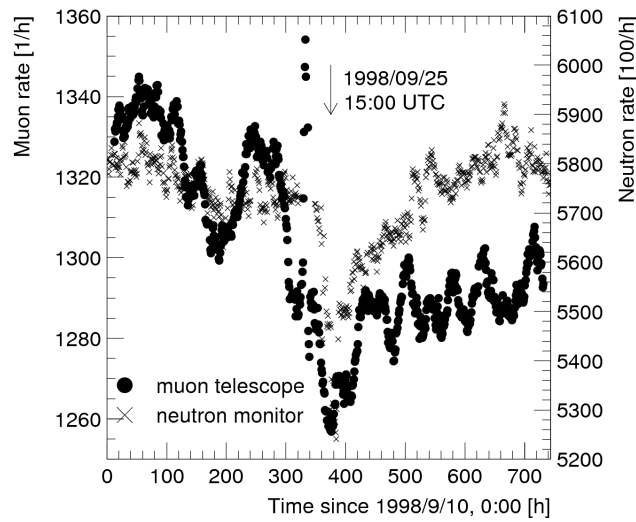
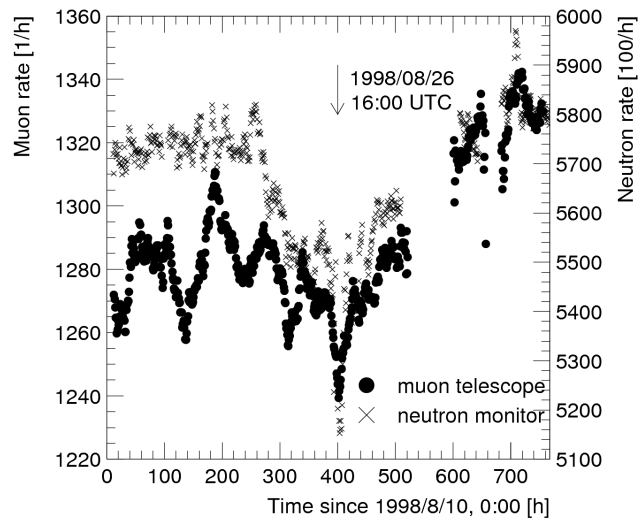
strongest decreases:

1998/08/26	6.1 σ	3.6%
1998/09/25	6.2 σ	3.7%
2000/07/15	8.3 σ	4.8%
2000/11/10	6.1 σ	3.5%
2001/08/03	8.7 σ	4.9%
2003/10/30	8.4 σ	5.2%
2004/11/10	5.0 σ	2.9%
2005/01/19	10.6 σ	6.1%
2005/09/11	5.5 σ	3.2%

pre-trials significance distribution

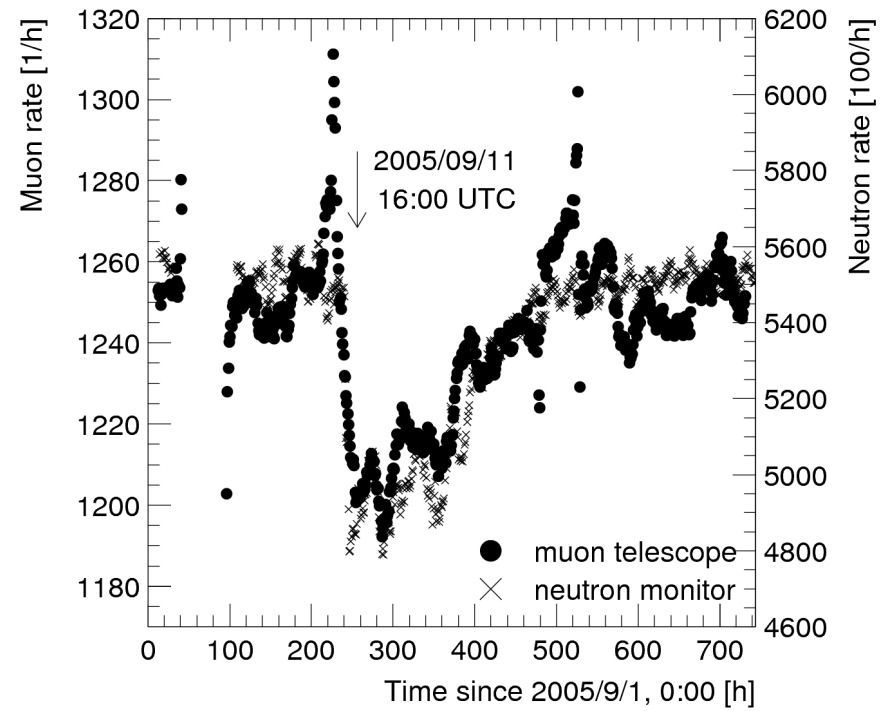
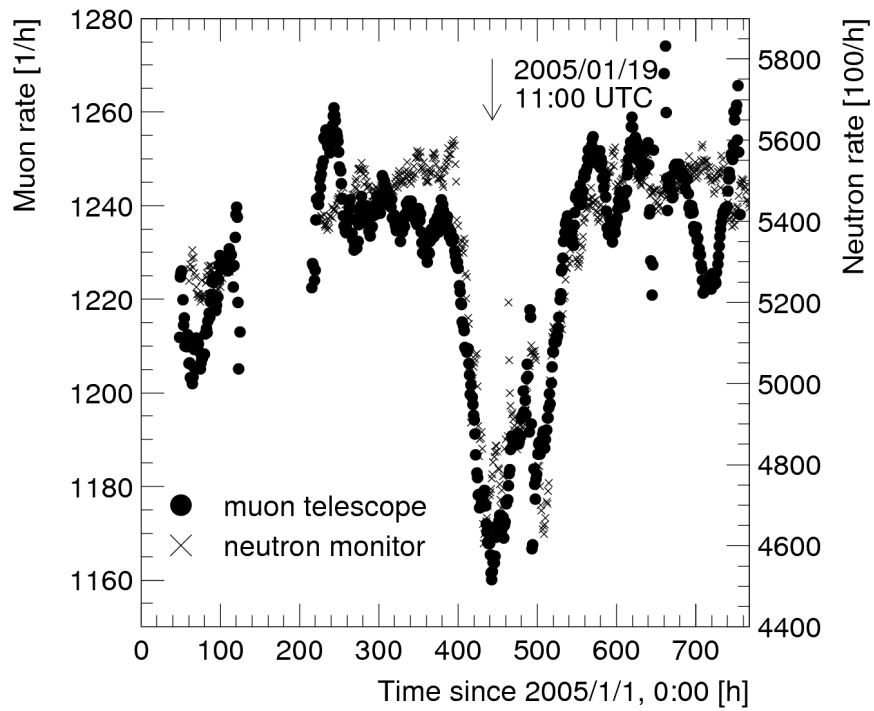


EVENT SEARCH

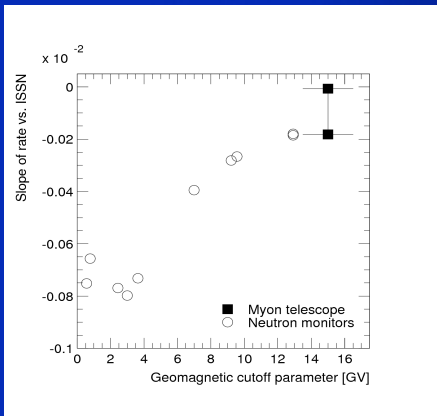
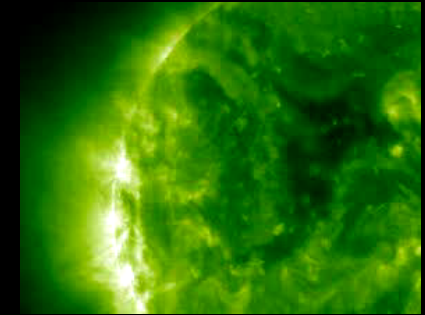
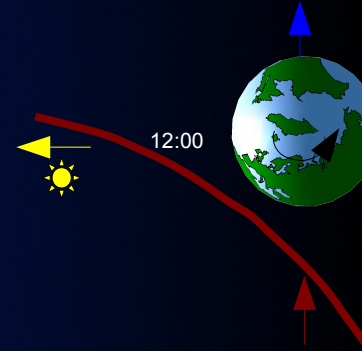
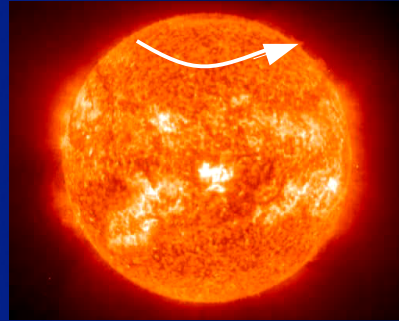
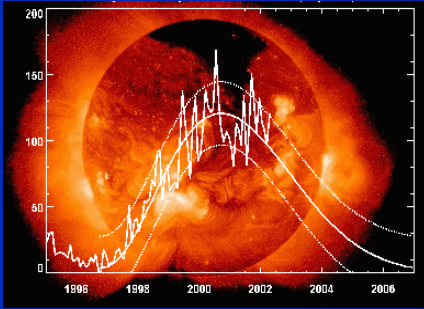


muon data smoothed over 24h

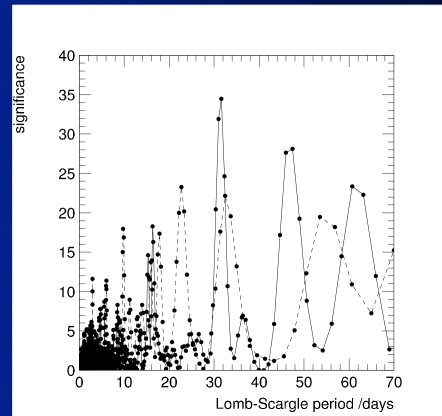
EVENT SEARCH



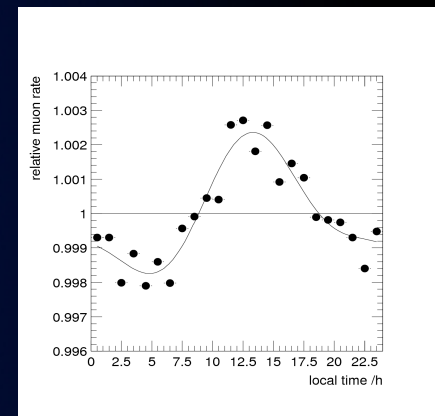
SUMMARY



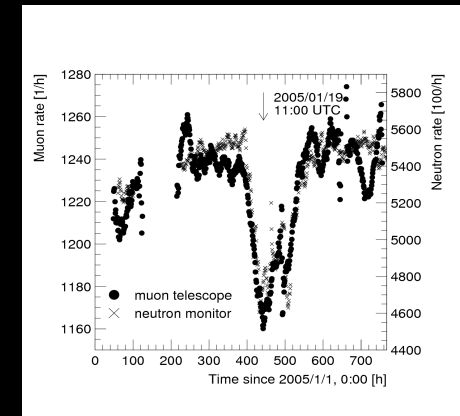
~ 2 %



0.5 - 3 %



~ 0.2 %



up to 6 %

Karlsruhe Muon Telescope – an alternative application of a testing facility