# Environmental Effects on the Neutron Monitor Measurements at High Altitudes as Observed at Junginaujoch

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### **Cosmic Rays in the Atmosphere**



### **Principle of Neutron Monitor**



0 5 10 15 20 cm

# **Bern Cosmic Ray Group**

### University of Bern, Switzerland operates 3 NMs:

- 18-IGY NM at Jungfraujoch, 3570 m asl, since 1958
- 3-NM64 NM at Jungfraujoch, 3475 m asl, since 1986
- Special Neutron Monitor at Bern, 570 m asl, since 1977

### Main interest of Bern group:

- Analysis of solar cosmic ray events (GLEs)
- Analysis of Forbush decreases
- Space Weather

### **18-IGY Neutron Monitor Jungfraujoch**

### Roof of Sphinx building



### **3-NM64 Neutron Monitor Jungfraujoch**

### **Roof of Research Station**



### **Special Neutron Monitor Bern**

Roof of Physics Institute, University of Bern



### **Environmental Effects**

- Atmosphere (mass) over neutron monitor
- Detector environment (housing, rocks, ground)
- Snow accumulations on and around the NM housing

# **Effect of Atmosphere**

- Change in air mass has large effect on count rate
- This change is the only significant meteorological factor
- Barometric pressure is used as a proxy for the air mass
- Barometric pressure coefficient ~1 % / mmHg
  → pressure must be measured very accurately

# Effects of wind on pressure measurements

- Gusty winds cause short-time fluctuations
- Strong winds cause diminished readings of conventional barometers

Bernoulli effect:  $p_{meas} = p_{eff} - \rho v^2/2$ 

# 1-minute pressure data





#### NM count rate

#### atmospheric pressure

wind speed

### Jungfraujoch

THUN T

117 120

OF THE PART AND

IGY

**NM64** 









# **Precipitation**



Meteo station at Interlaken, 18 km NNW from Jungfraujoch



### **NM Simulation with Monte Carlo**

- Simulation of interactions of neutrons with material (detector housing, detector, ground, snow)
- Simulation of detection of slow neutrons in the counter tubes
- Geant4 software package

# Detector and material in the environment





# **View from top**





## Count rate vs. Snow Accumulation on Roof

First preliminary results



# $\Delta N_{IGY}$ vs. Snow Thickness



# Conclusions

- Effects of atmospheric mass and snow accumulations on and around detector must be known for correct interpretations of NM data
- Accurate pressure measurements
- Correct interpretation of pressure measurements during times with gusty and high speed winds
- Monitoring of snow accumulation (measurements of snow height, web cam)
- Consequences may be different for analysis of short and long time NM data

