Measurement of cosmic ray flux with ECC on the ground

ICMaSS2017

30th Sep, 2017 at Nagoya University

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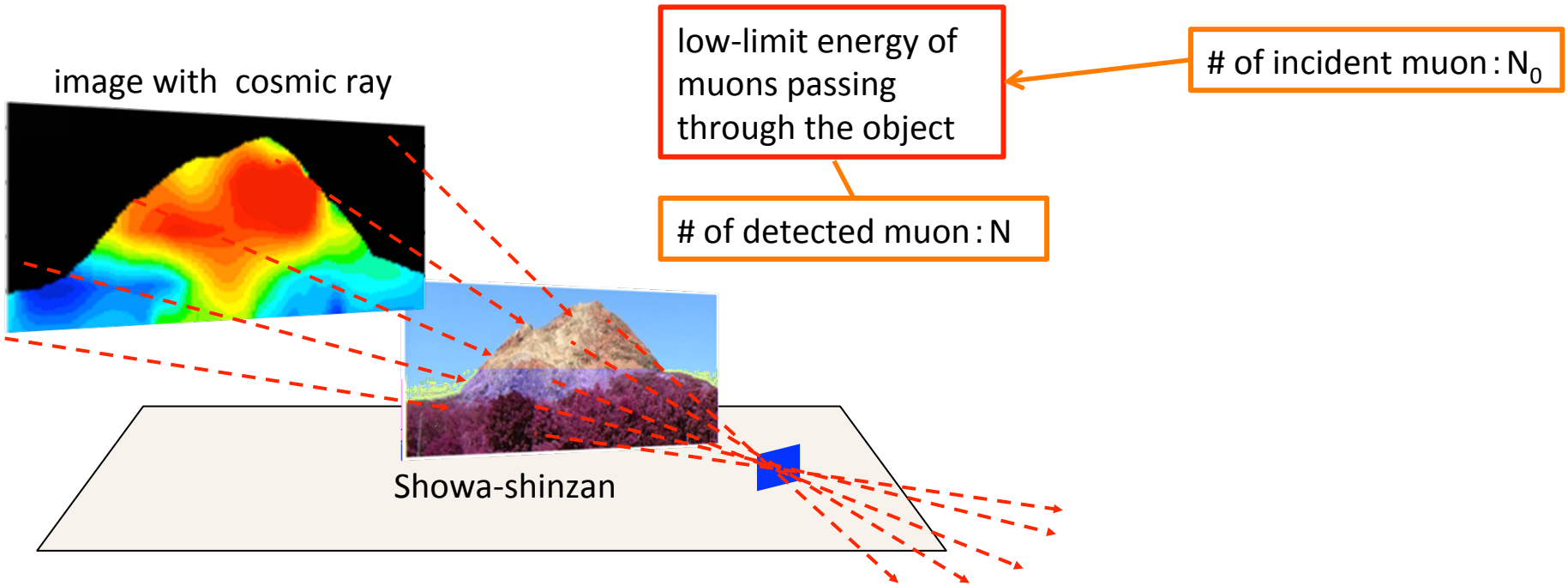
Principle of muon radiography



Detect muons of various angles passing through matter, then reconstruct the 2D transmitted image by the number and angle distribution of detected muon

Motivation

- Understand the incident muon flux at the installation site
- Understand the systematics of muon flux model and our detector
- Calibrate a muon flux model

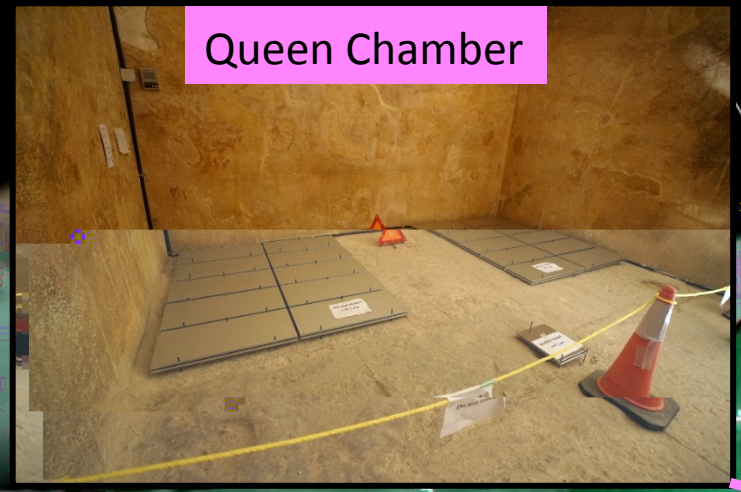
$$I(>E) = \frac{174}{5E\cos\theta + 400}(5E + 10\sec\theta)^{-1.57}\frac{E+15}{E+10+5\sec\theta} \quad (\mathrm{cm}^{-2}\ \mathrm{s}^{-1}\ \mathrm{sr}^{-1})$$

S. Miyake: Int. Conf. Cosmic Rays (Denver) 5 (1973).

Try to observe the omniazimuth muon flux at the same time

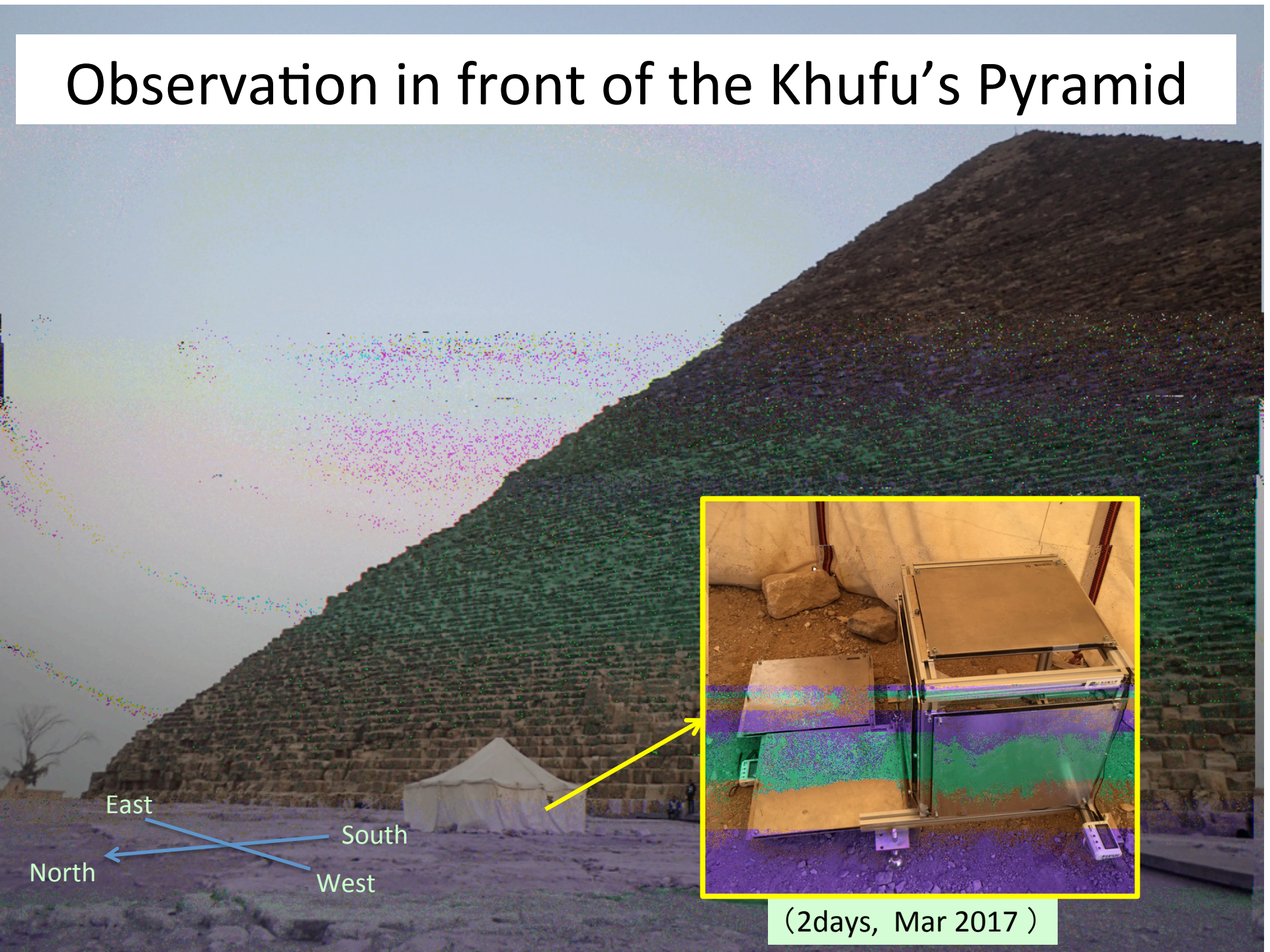
Muon radiography for the pyramids of Egypt

Cosmic ray has been measured by 3 kinds of detectors inside and outside of the Khufu's pyramid.
Analyzing the inner structure by the number and direction of penetrated muons.



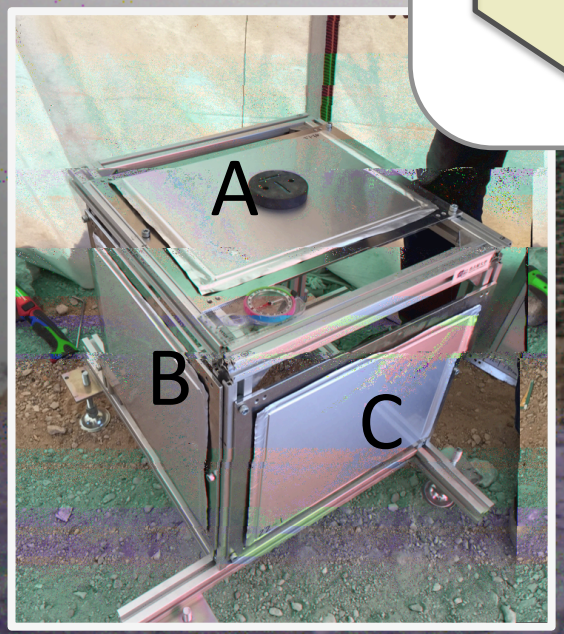
Measurement of cosmic ray with
10m^2 emulsion chamber

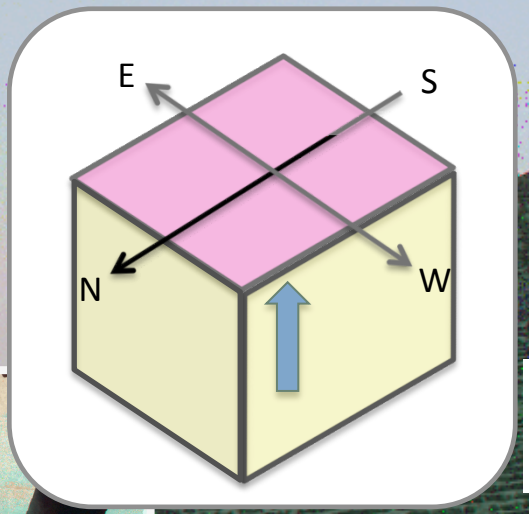
Observation in front of the Khufu's Pyramid

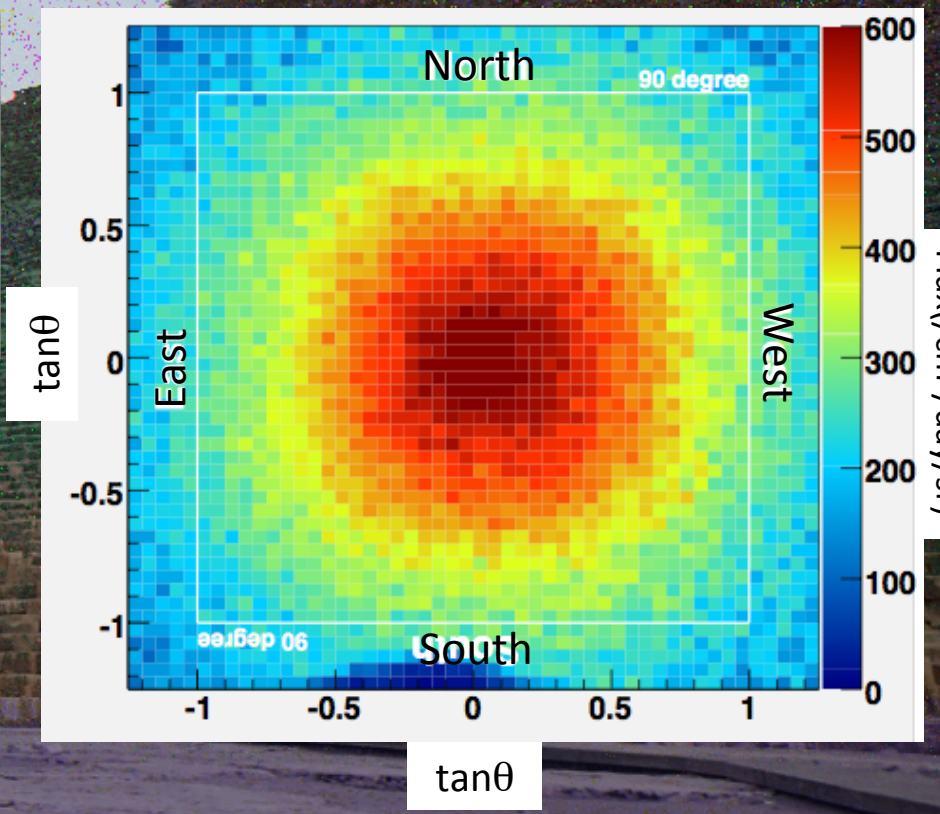


（2days, Mar 2017）

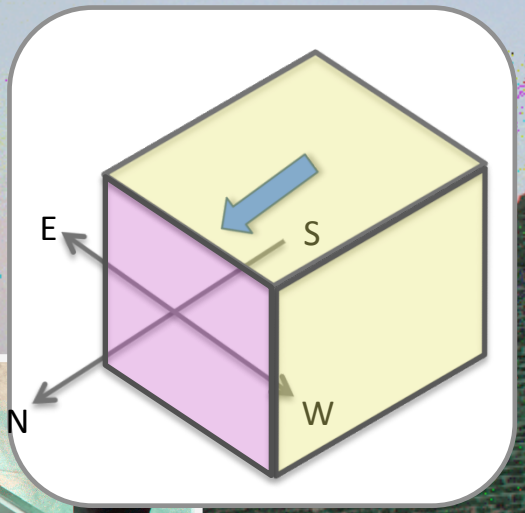
Angle distribution of muon flux (A : horizontal setting)

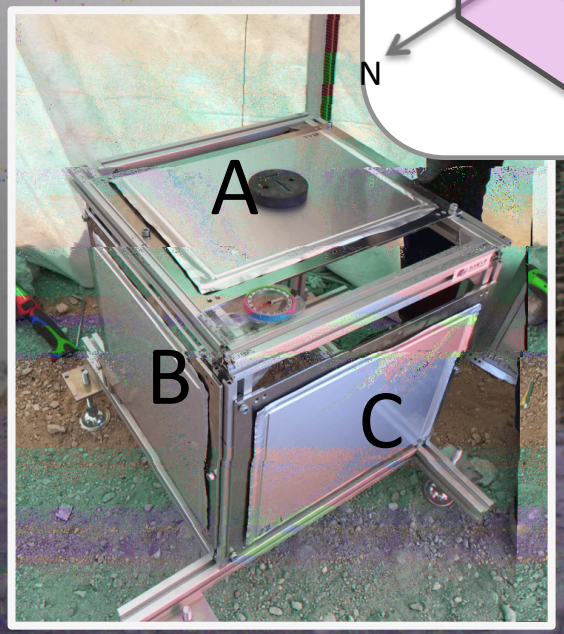


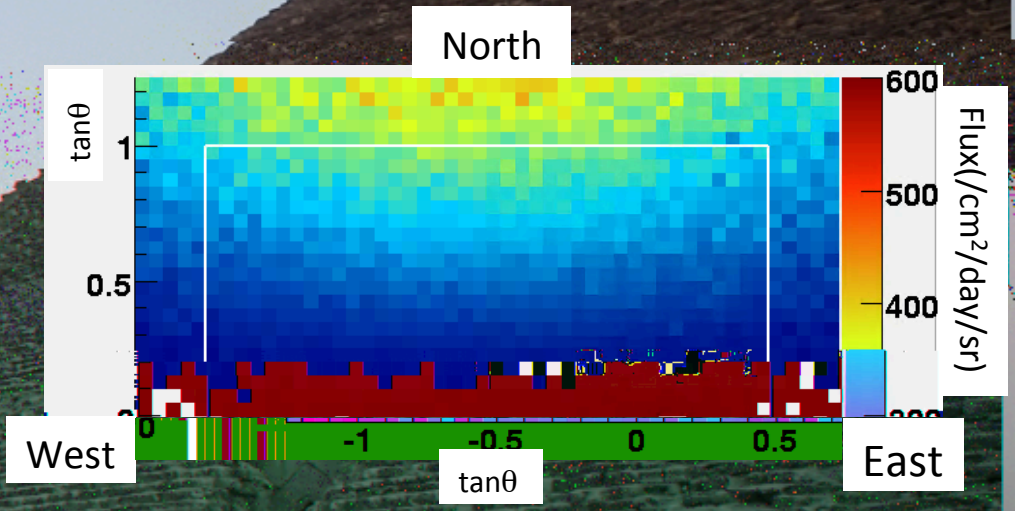


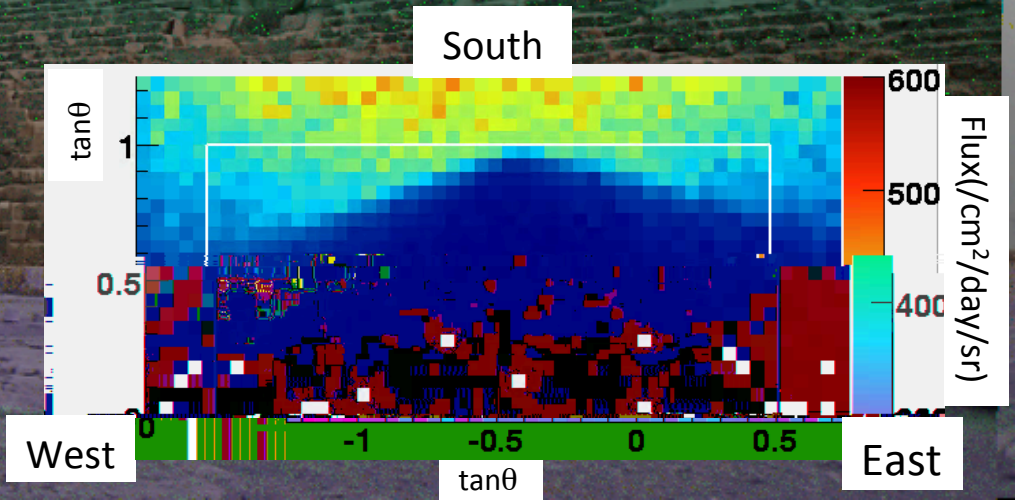


Angle distribution of muon flux (B : vertical setting)

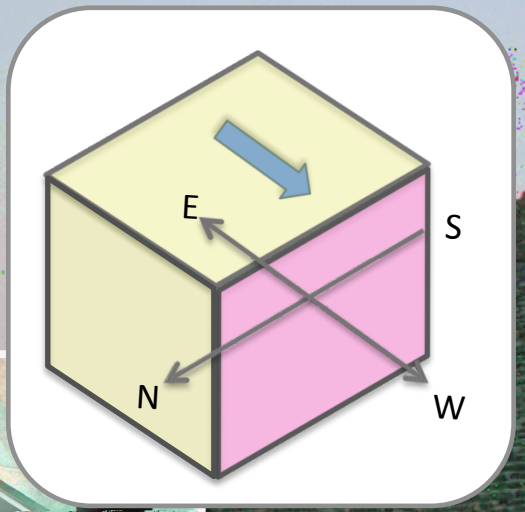


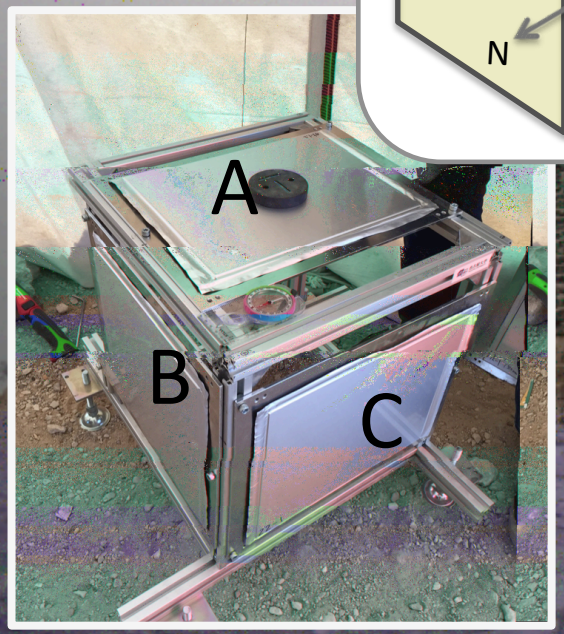


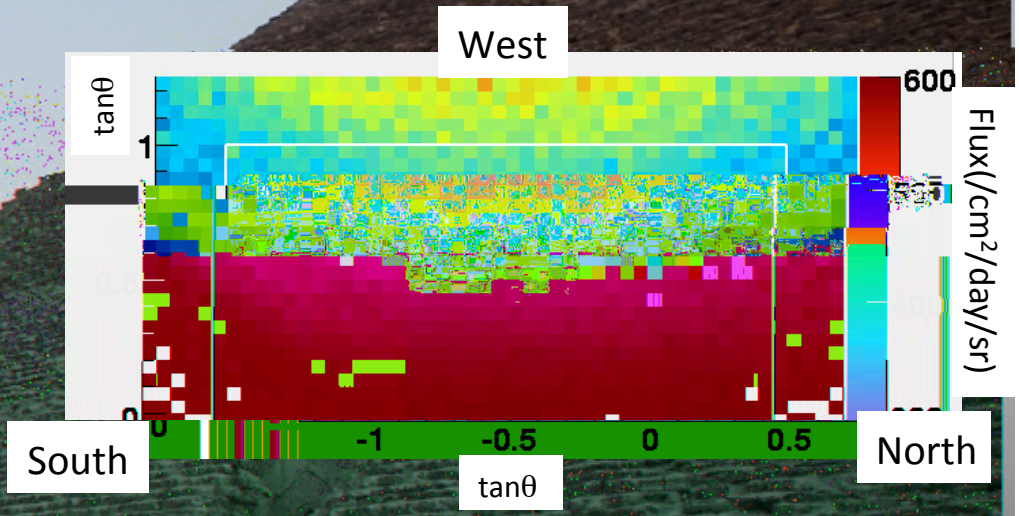


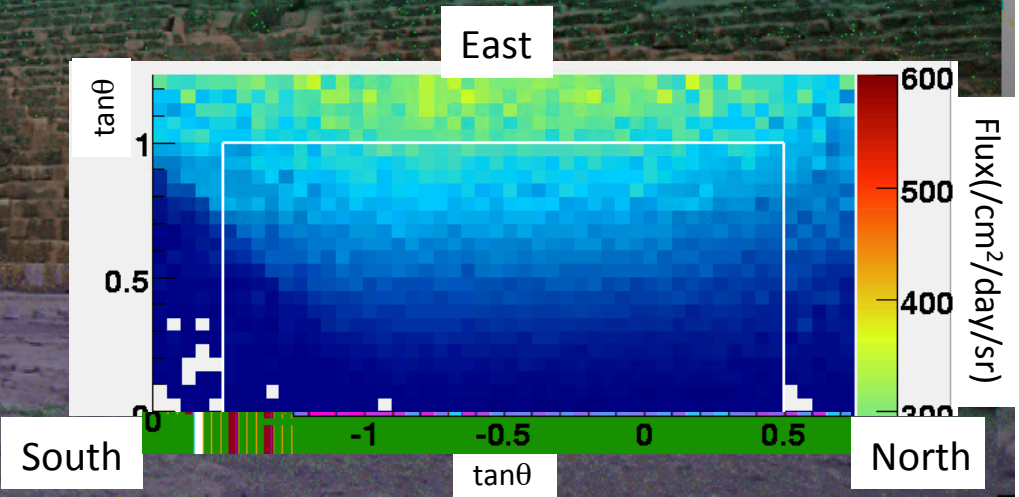


Angle distribution of muon flux (C : vertical setting)

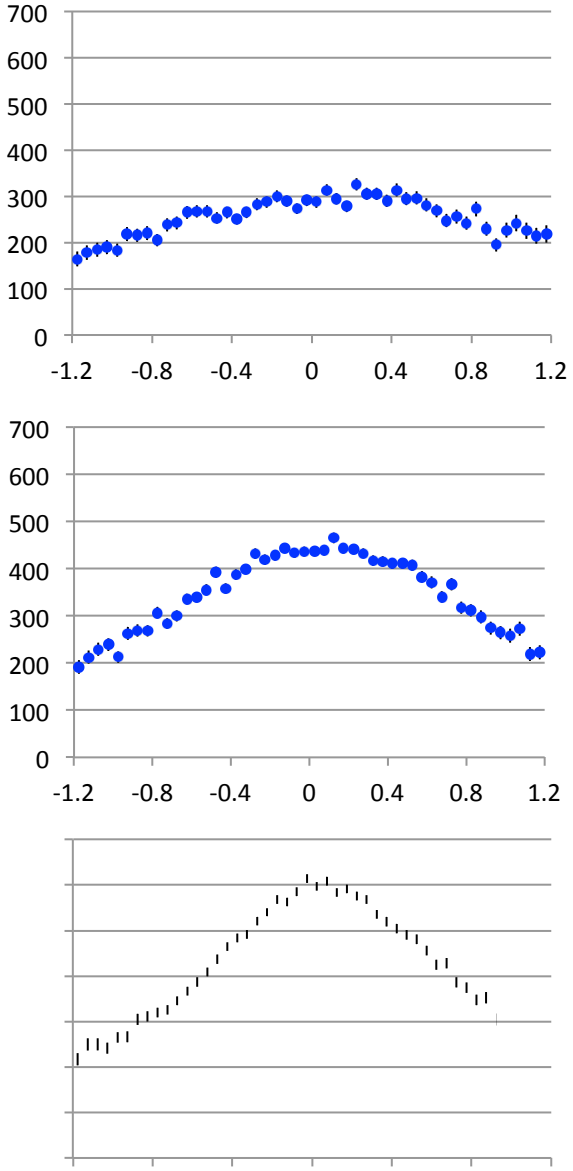




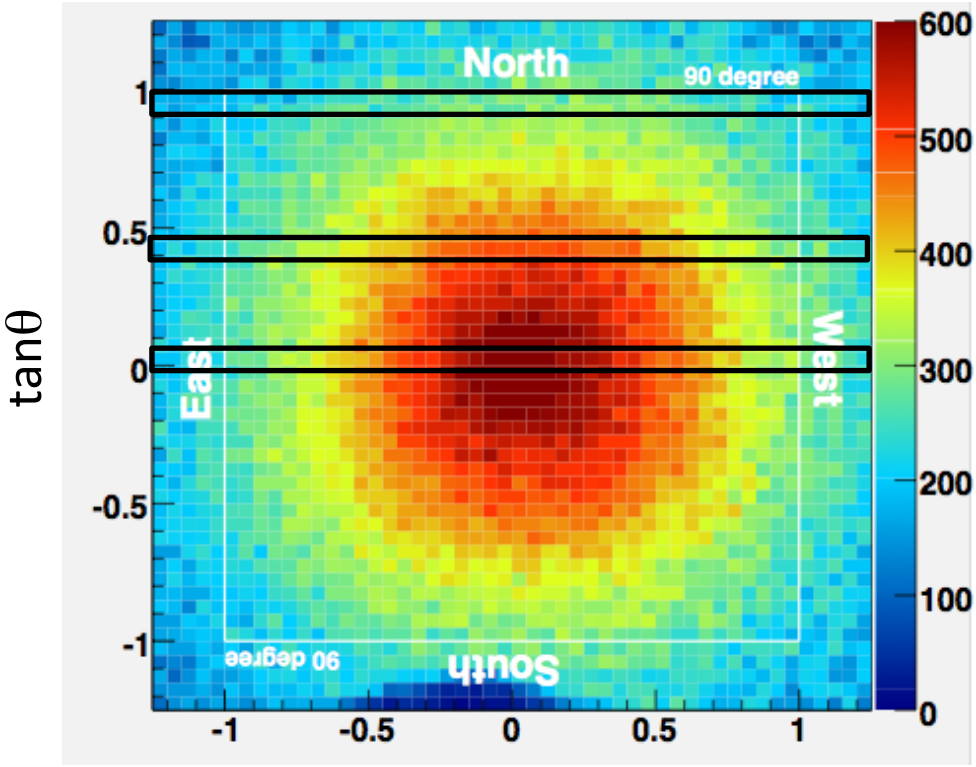




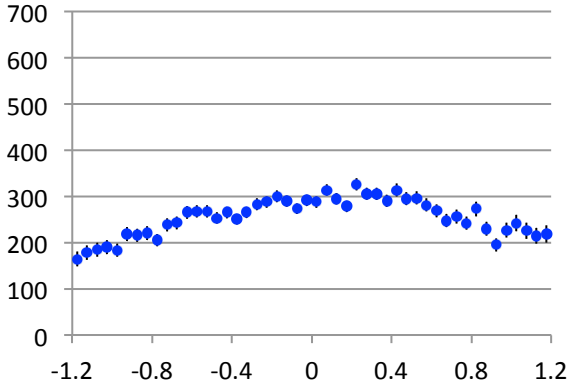
Muon flux detected in chamber A

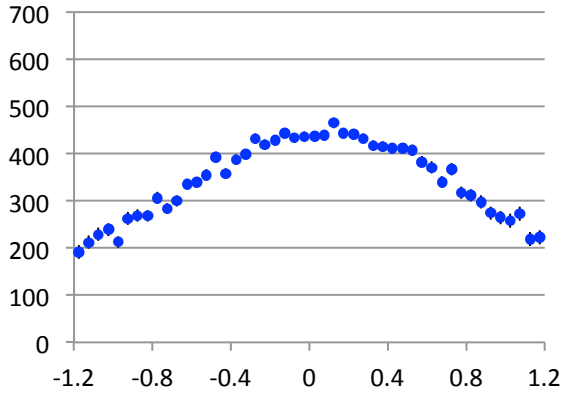


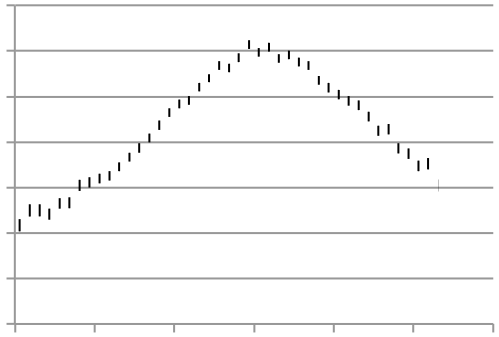
A

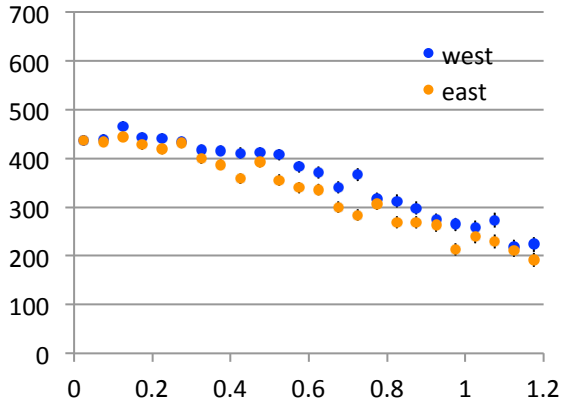


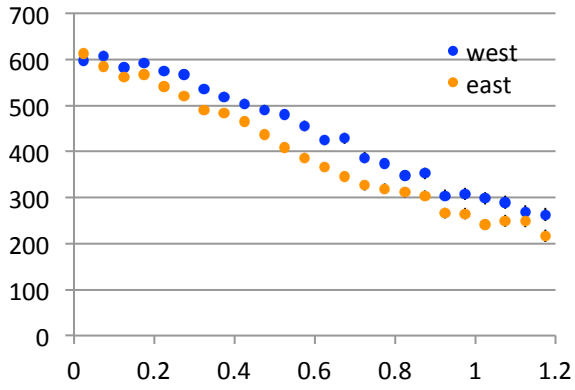
Comparison the flux of west side with east side



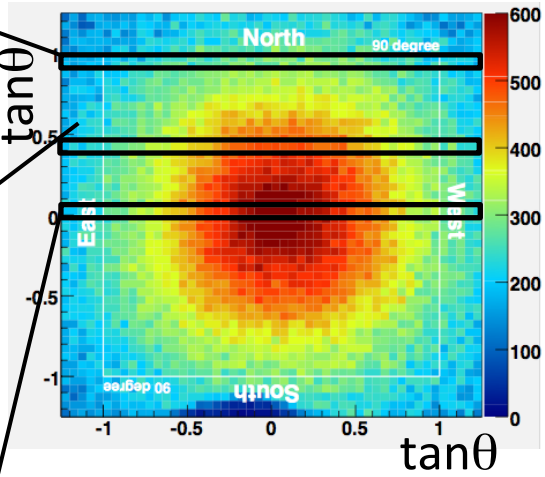






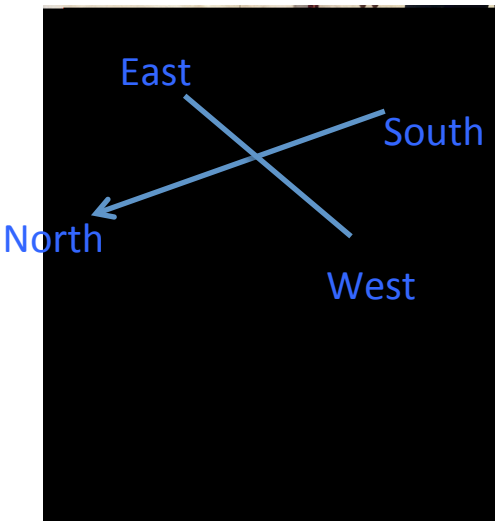


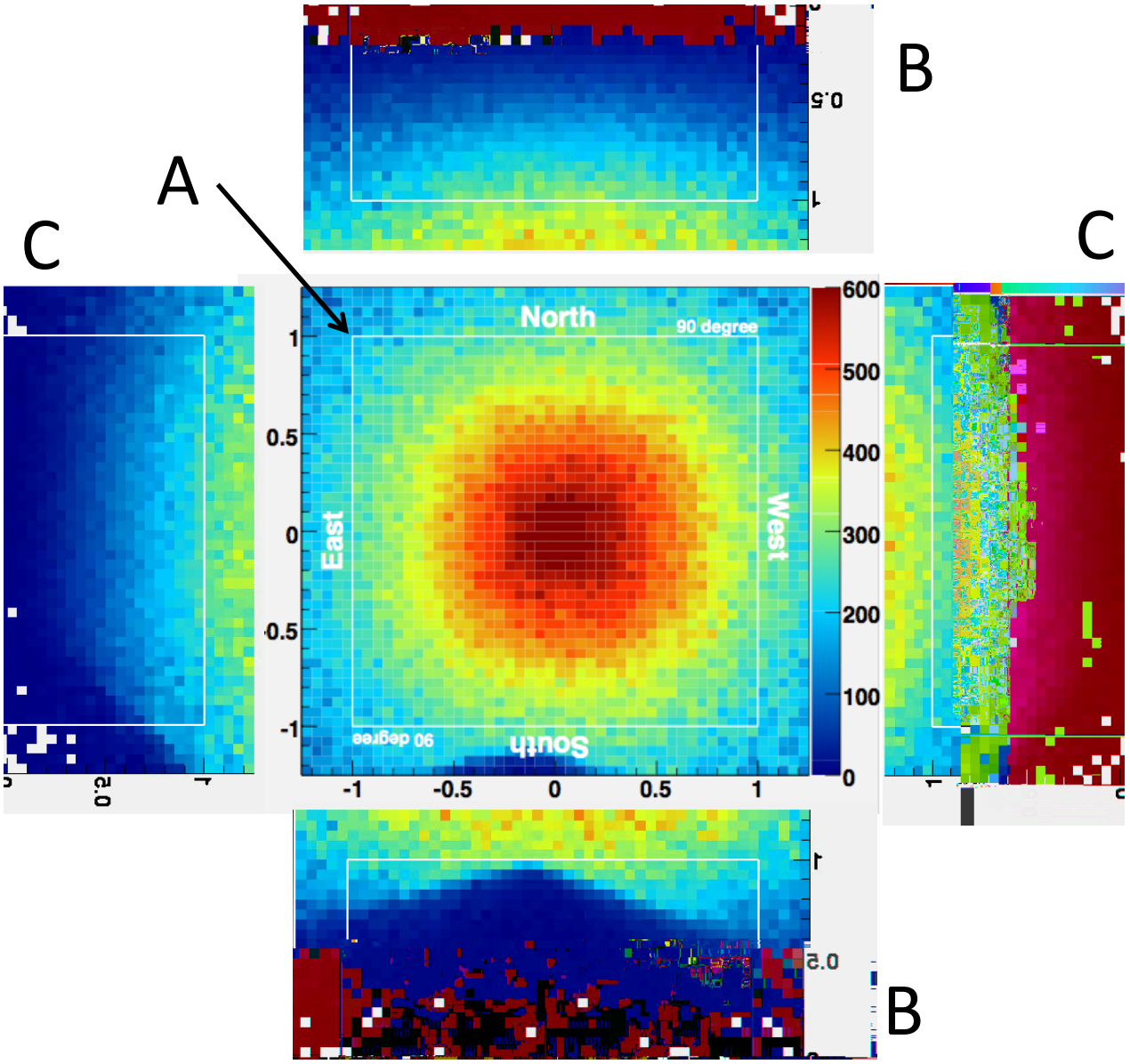
A



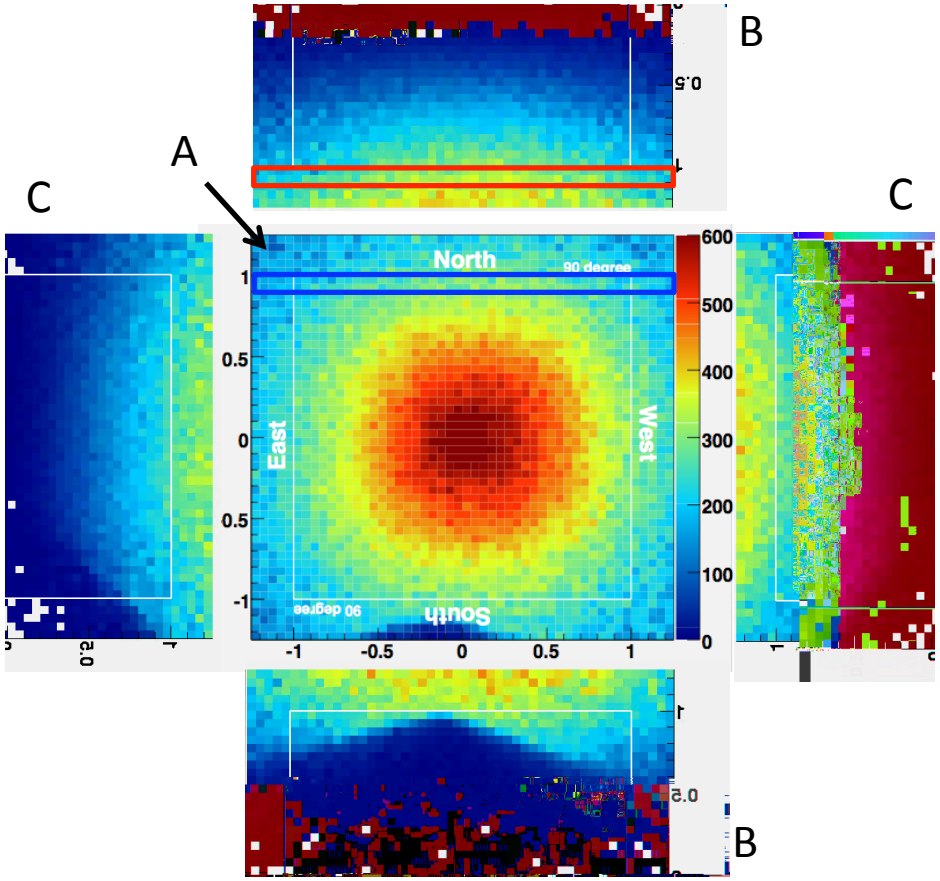
only statistical error

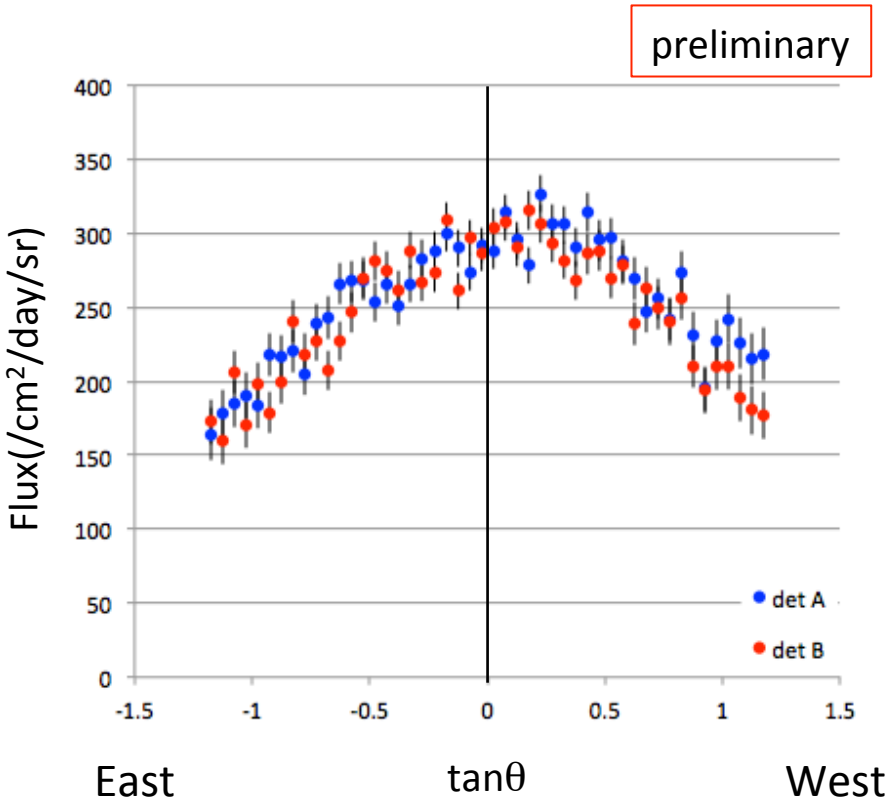
Combination of muon flux of 3 detectors



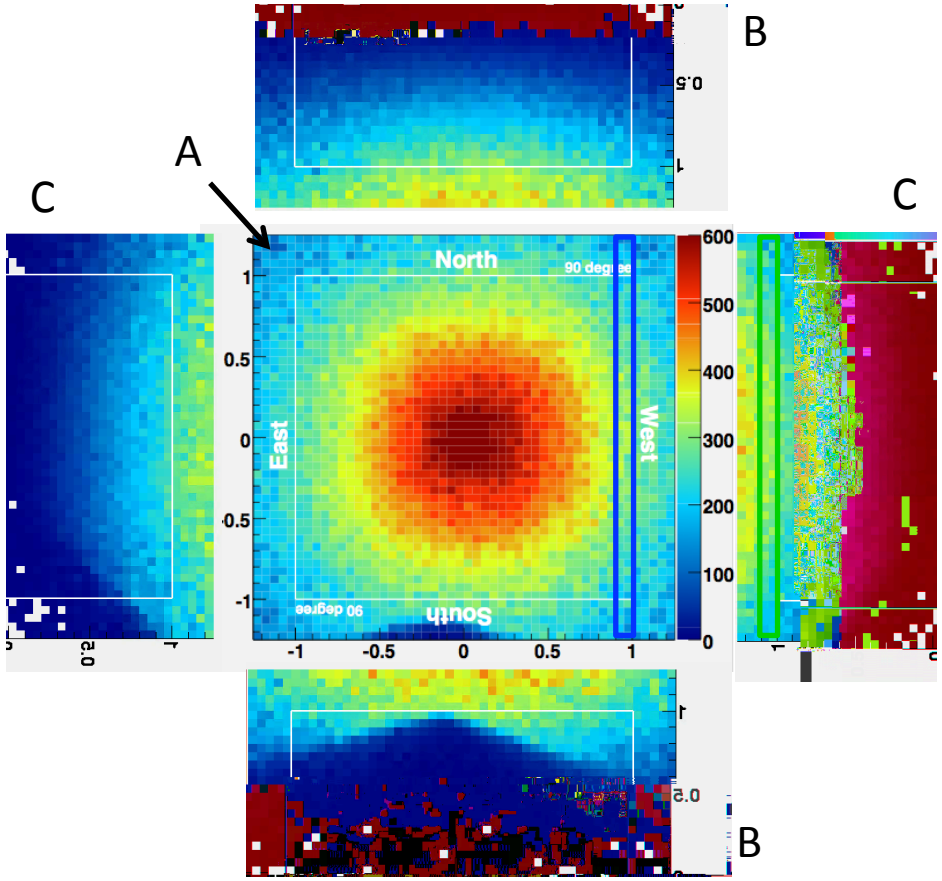


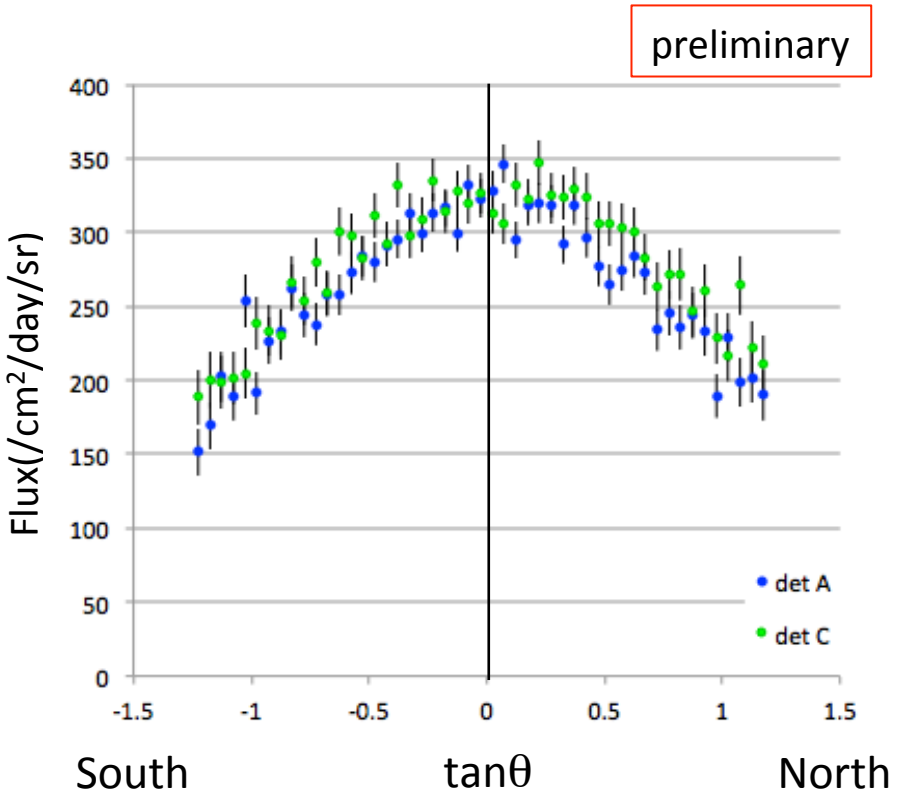
Flux of A and B at 45 degree at north side



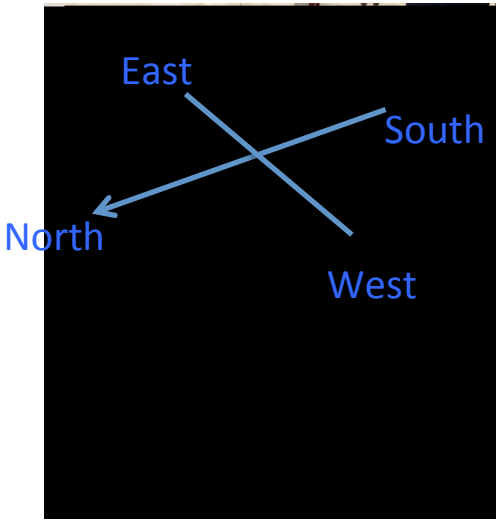


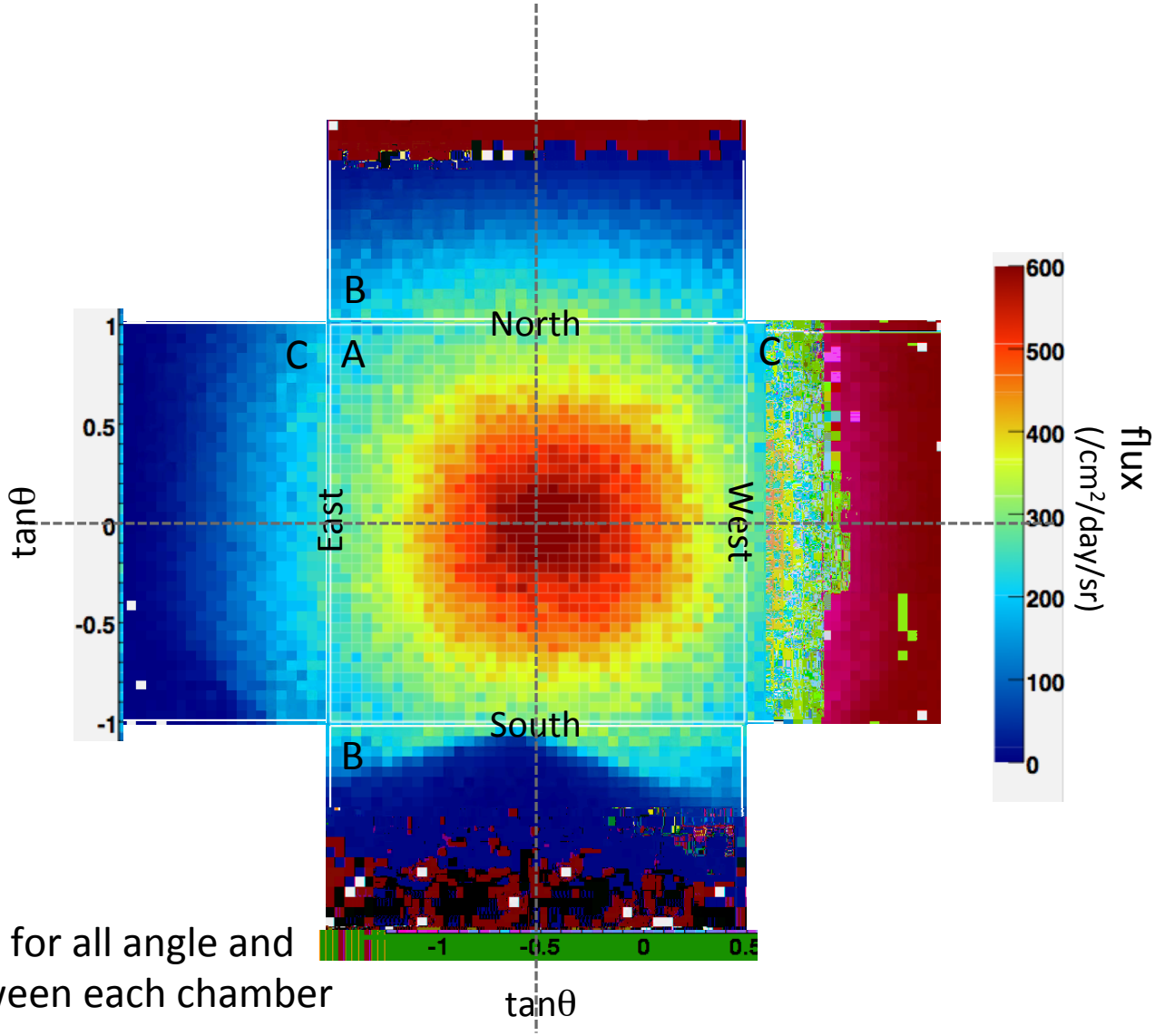
Flux of A and C at 45 degree at west side





Combination of muon flux of 3 detectors





Need the efficiency correction for all angle and the alignment correction between each chamber for precise measurement

Conclusion

- Observed cosmic ray muons in front of the Khufu's Pyramid with the emulsion chambers (pair of emulsion films) for understanding the systematics of our detector and the muon flux model

- From our preliminary results,

  - confirmed the possibility of the observation of omniazimuth muon flux with emulsion chambers
  - observed the asymmetry between East and West ???

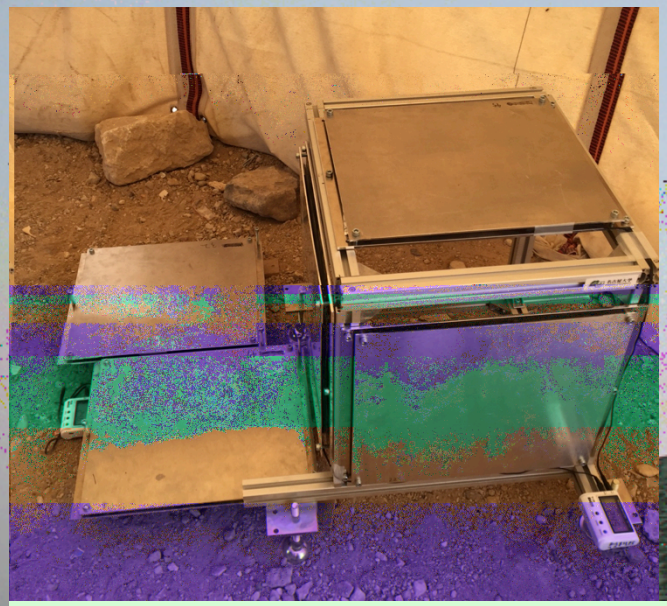
  Should be done efficiency correction and alignment correction for each chamber

<Prospect>

Analyze ECCs installed at same location and add the information of momentum distribution

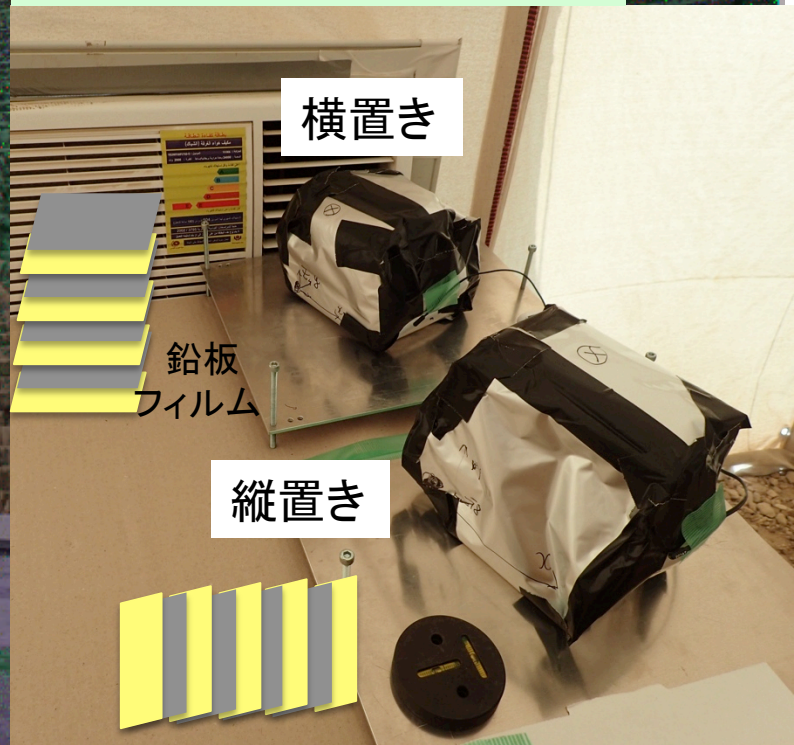
Back Up

Observation with ECC in front of Pyramid



①pairs of emulsions （2days，Mar 2017 ）

②ECC （5days，Aug 2016 ）



East
South
North
West