Status of big incident angle heavy ion analysis

In order to decrease the tails of heavy ion peak I processed 20 day data sample using the same cuts as for proton selection:

1) multiplicity (number of crystals with energy above the threshold) is calculated for whole CAL layer (not within one tower)

2) multiplicity == 1 in the layer of crystal being calibrated

3) multiplicity <= 2 in all other layers parallel to the one being calibrated

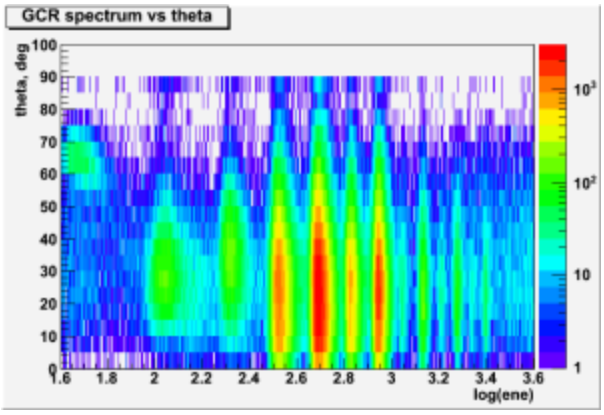
4) multiplicity <=4 in all other layers perpendicular to the one being calibrated (to allow big angles)

5) extention of tracker track passes through top and bottom of the calibrated crystal

6) tkr1NumHits>5

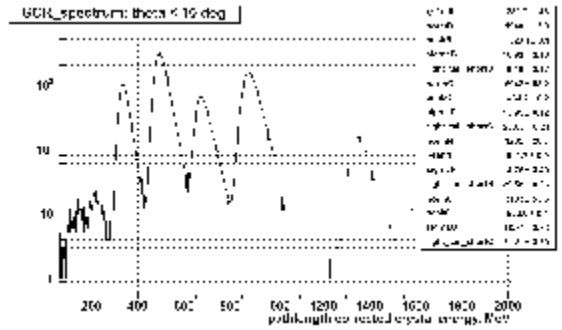
7) 4-range readout

The 2-d plot of GCR spectrum vs theta angle is show on the following plot:

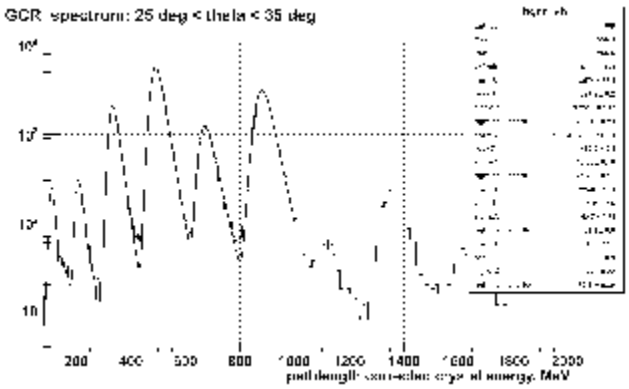


I've made four slices of this for different theta angle bands and fit B,C,N and O peaks on each slice:

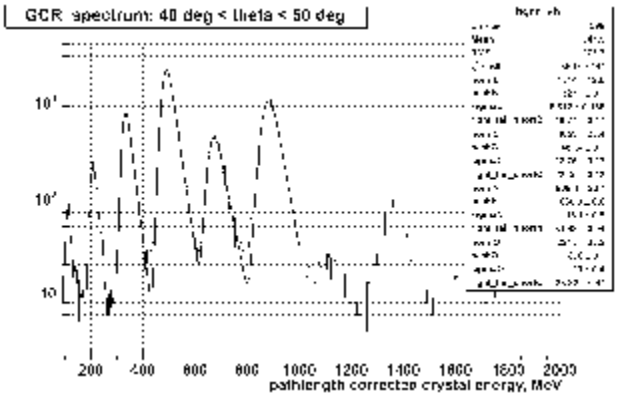
0< theta < 10 deg



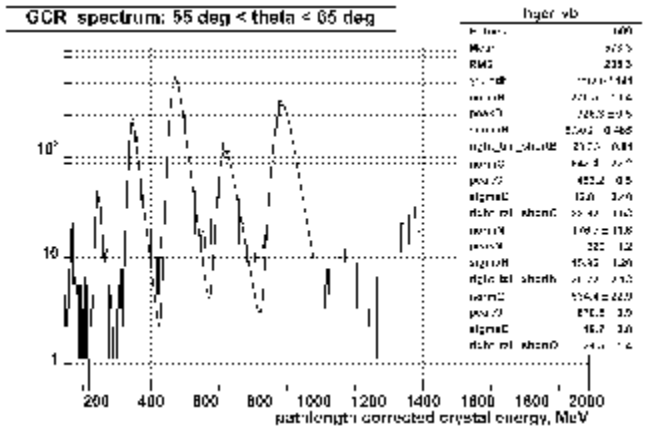
25 deg < theta < 35 deg



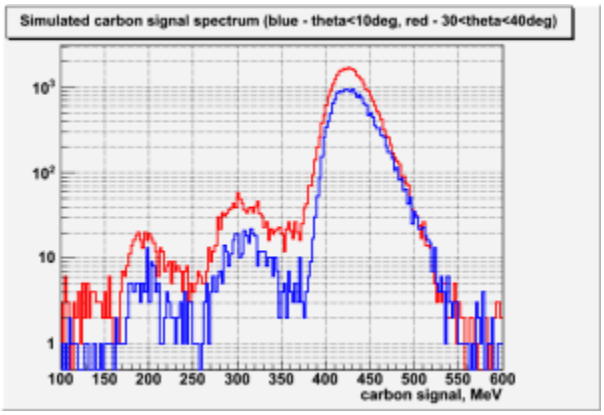
40 deg < theta < 50 deg



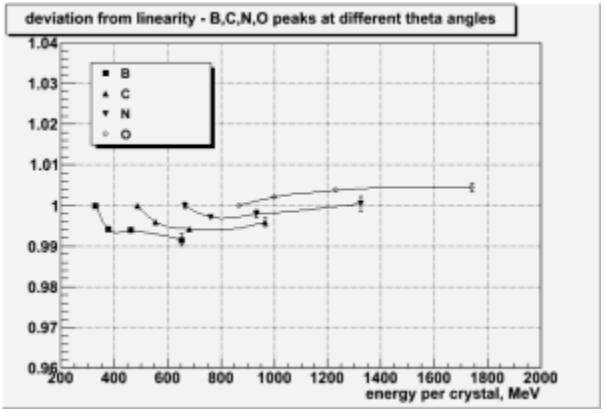
55 deg < theta < 65 deg



The visible deviations of fit from the spectrum is explained by low energy tails increasing with theta angle, as confirmed by simulation:



Using peak position for theta < 10 deg as normalization I found the deviation for linearity as a function of crystal energy (not corrected for angle):



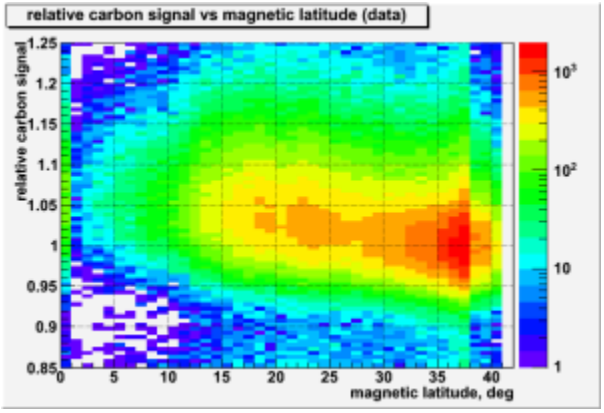
While there is some systematics ~ 0.5% in curves for all peaks, we can conclude that deviation from linearity between 300 MeV and 1700 MeV is better than 1%.

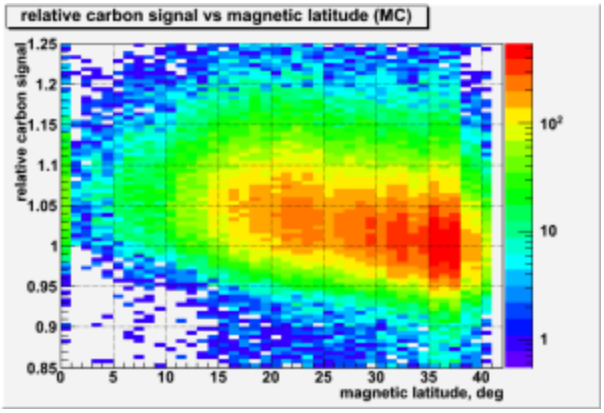
Systematics is probably due low energy tail seen in simulation and on data histograms above - could be corrected using simulated shape.

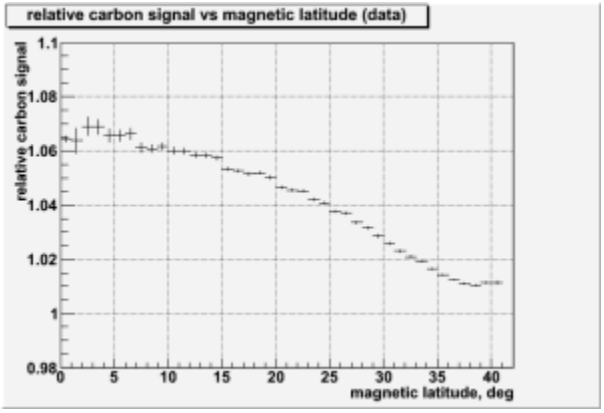
The method could be extended down to Be peak (200 MeV), but not to Li peak because ratio peakBe/peakLi ~2 and Li is absent at small angles.
After adding statistics, we could try to use Ne and Mg (2.0 GeV)

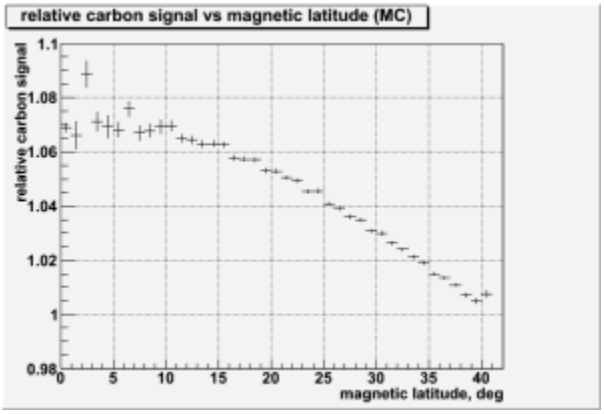
I'm developping alternative method, which could be applied to all peaks, including p, He, and Li.
Method is based on energy split between adjacent crystals.

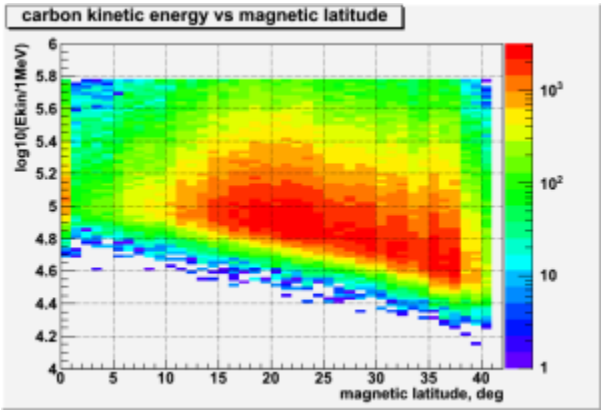
The high energy tail of GCR peak is explained by GCR energy spectrum and rather well reproduced by simulation:









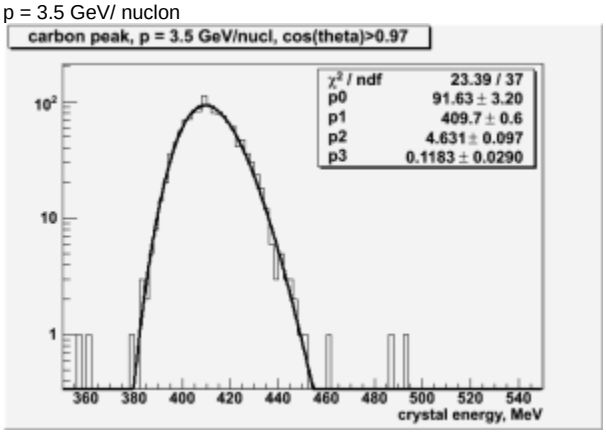


So far, the effect of GCR spectrum was not properly taken into account for protons and He peaks fitting.

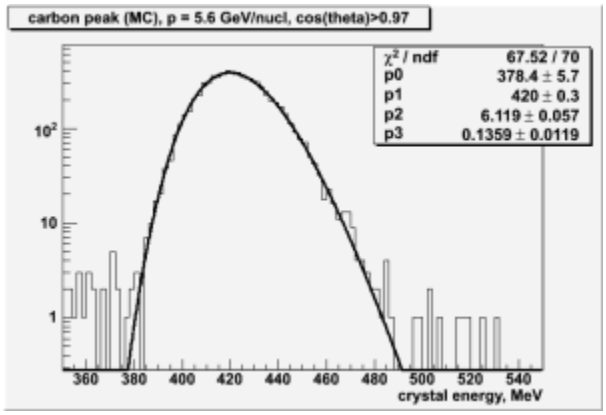
I plan to do it and hope it will improve data/MC agreement and will allow to use big angle protons for calibration.

GCR peak shape depends on momentum of incident ion

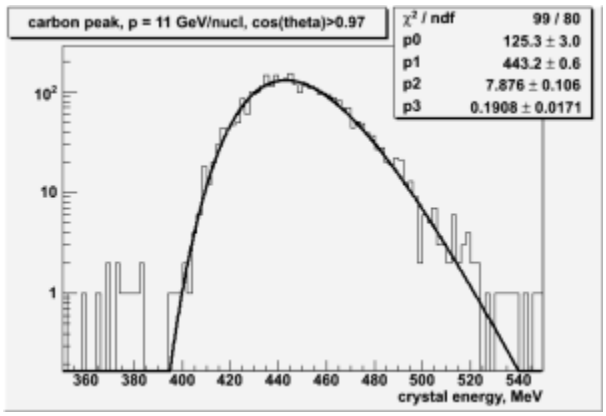
p = 3.5 GeV/ nuclon



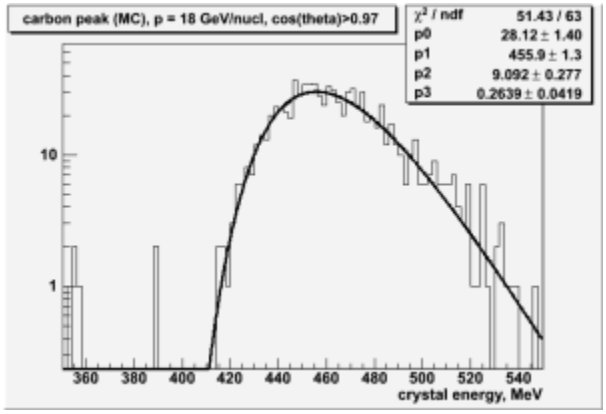
p=5.6 GeV/nuclon



p=11 GeV/nuclon



p=18 GeV/nuclon



Peaks are perfectly fitted with lognormal function, but its parameters significantly depend on ion momentum.
Explaination: while for p=3.5 GeV/nucl the maximum energy of secondary electron is 12 MeV, for p=18 GeV/nucl this energy becomes 320 MeV

and high energy tail increases.

To get proper peak shape for fitting data we have to find peak shape versus momentum and then fold it with GCR spectrum.

Non-gaussian tracker PSF for GCR's