Dear Colleagues,

I have been trying to determine the beam energy during the G0 (Ledex) experiment, using the elastic data from kinematics 2 and 11 for different solid (12C, Al, Ta) and cryogenic (H, D) targets. This is related to the pi0 experiment as well (although I hope pi0 suffers from none of the problems below).

In my analysis I have examined distributions of the deviation δ from the central momentum of the spectrometer. To fit the measured spectra I have used the formula from Bryan Moffit's thesis (Eq.3.15) with a slight modification at the end: I have added a Fermi function (involving the c1, c2, and c3 parameters) to fit the the background of the spectra.

$$f(E') = \sqrt{\frac{\pi}{2}}\frac{\sigma}{\alpha}\exp\left(\frac{1}{2\alpha}(\sigma^2/\alpha + 2(E'-b))\right) Erfc\left(\frac{|\alpha|}{\sqrt{2}\sigma\alpha}(\sigma^2/\alpha + (E'-b))\right) + \frac{c_1}{1+\exp((E'-c_2)c_3)}$$

Once I have determined the δ(M) for all the targets (with mass M) I have been able to use these data to find the beam energy and the central angle of the spectrometer by using the formula

$$p_{measured} = \frac{E_0}{1+\frac{E_0}{M}(1-\cos\theta)}$$

To be able to use this formula I have transformed δ to the absolute value of the measured momentum by the expression:

$$E' = p_{central}(1+\delta) = p_0\left(1+\frac{\Delta p_0}{p_0}\right)(1+\delta) = p_0(1+\delta) + \Delta p_0 + \Delta p_0\,\delta \approx p_0 + \delta p_0 + \Delta p_0 + (Something < 0.01\text{MeV})$$

I did not know the true value of the central momentum for the HRS. The assumption is that a single constant parameter (the additional term Δp0) calibrates the absolute scale. Thus the kinematics formula becomes

$$p_{measured} = -\Delta p_0 + \frac{E_0}{1+\frac{E_0}{M}(1-\cos\theta)}$$

In the end I have therefore three parameters that need to be determined from the measured points.

I have used several approaches to fit the data. I have fitted the HRSL and HRSR separately and also together. I have fitted data for kinematics 2 and 11 and while doing that have come across some problems. First thing that was not consistent was that the measured data from HRSR for Kin 2 and Kin 11 were very different although the spectrometer setting didn't change. I have also found out that data from HRSL and HRSR in Kin 11 (although spectrometers have the same nominal setting) had differed by approximately a constant value of 3MeV.

However, the main problem was that whatever I did, the fitted values for the spectrometers' angles always came out wrong for approximately 1deg. Only when I had fitted data for HRSR in kinematics 2, I got a reasonable angle values (error with respect to the set floor-value was approximately 0.1 deg).

All these inconsistencies! Where am I wrong? The Chi^2 function always has a broad minimum and strongly depends of the initial values of the parameters Δp0L and Δp0R for left and right spectrometers. Many apparently valid fits are possible. This is a serious problem which hasn't been resolved yet. I have checked out if this problem causes the shift in the spectrometer angle, but I found out that reasonably large changes in the Δp0L and Δp0R parameters only insignificantly change the fitted spectrometer angles (approx 0.2 deg, much less than needed).

I also checked the run_db.dat file, which is automatically generated from EPICS. The value of the central momentum of the HRSR in the file is not constant but drifts to higher momenta (Approx 1.2 MeV in Kin 11 during approx. 20 runs). I find this very disturbing, because if I would apply this momentum change to my analysis I would get much better results (regarding the angle of the HRSR).

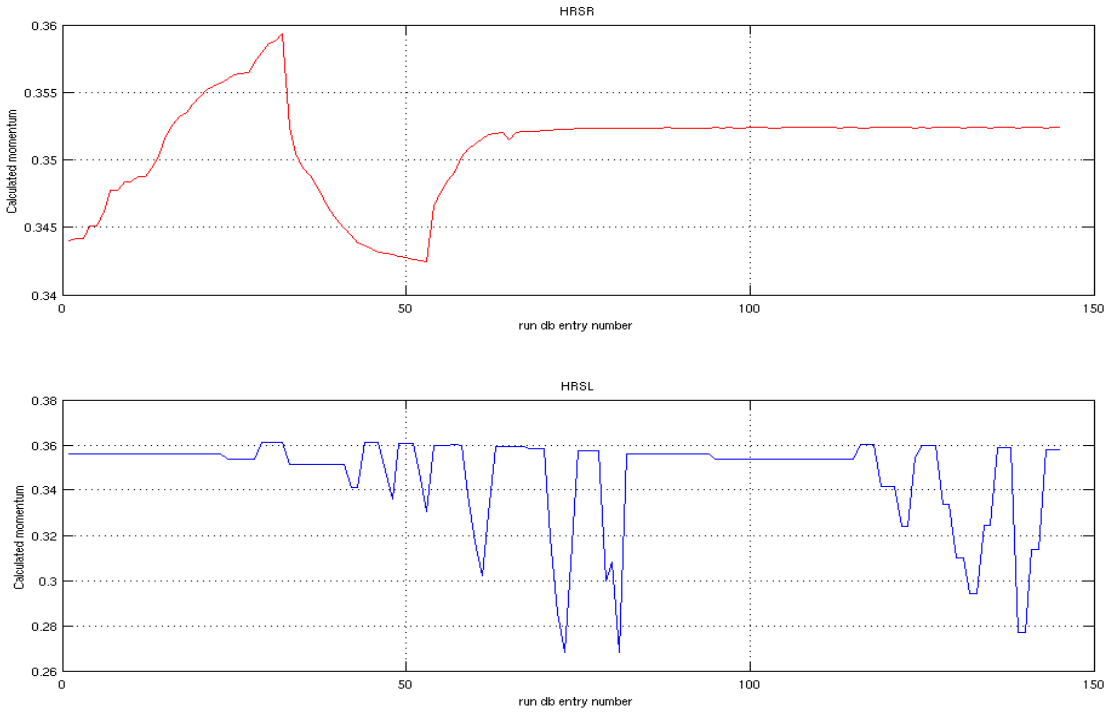

Illustration 1: The central momenta of HRSR and HRSL read from db_run.dat file

I have examined more closely how the central momentum is calculated and what causes its shift. From the "ledex script" that generates the db_run.dat file I found out that the momentum of the spectrometer is calculated from the dipole's hall probe data using the formula from John Lerose's report on how to set the momentum of the spectrometer when p<500MeV.
(http://www.jlab.org/~lerose/instructions /CSR_magnets_inst.htm)

Finally, this brought me to the nitty-gritty of the HALOG entries. I have tried to determine how the magnetic field and consequently the momentum changes with the run number and what causes these changes. I believe that the changes in the magnetic field (momentum) are caused by the changes in the currents through the magnets. When the rapid change in the electric current occurs the magnetic field slowly follows to these changes (exponentially). If this interpretation is true, I.e. if these readouts are genuine, this causes the drift of the momentum during runs in kin. 2 and 11.

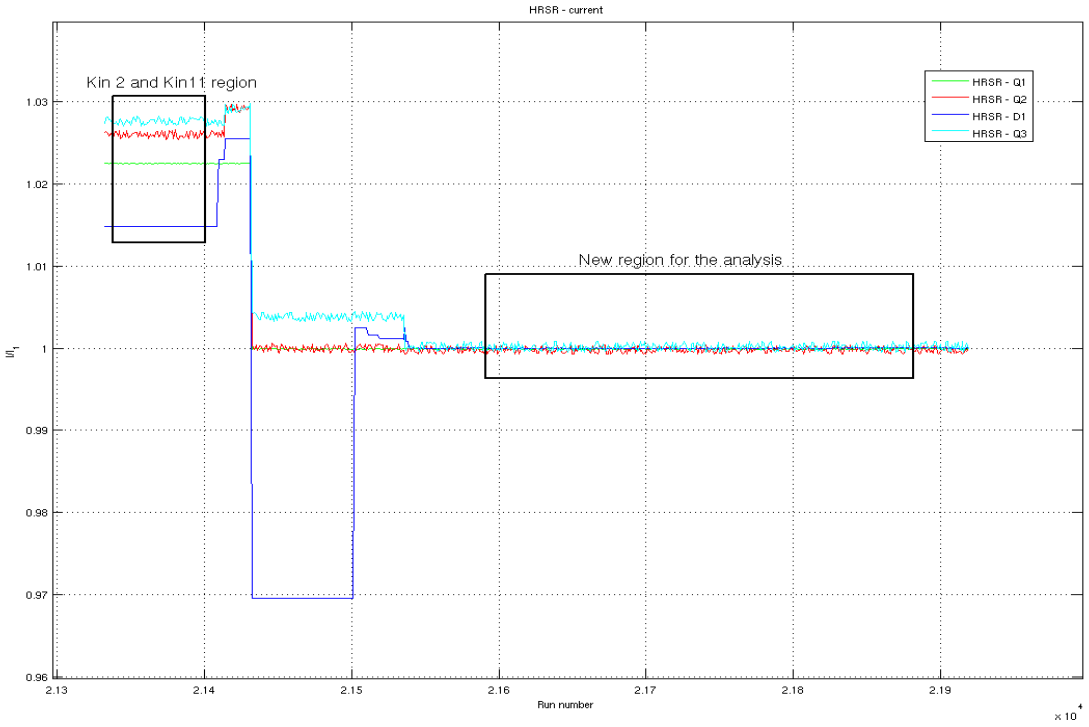

Illustration 2: Normalized currents in all magnets of HRSR for different runs

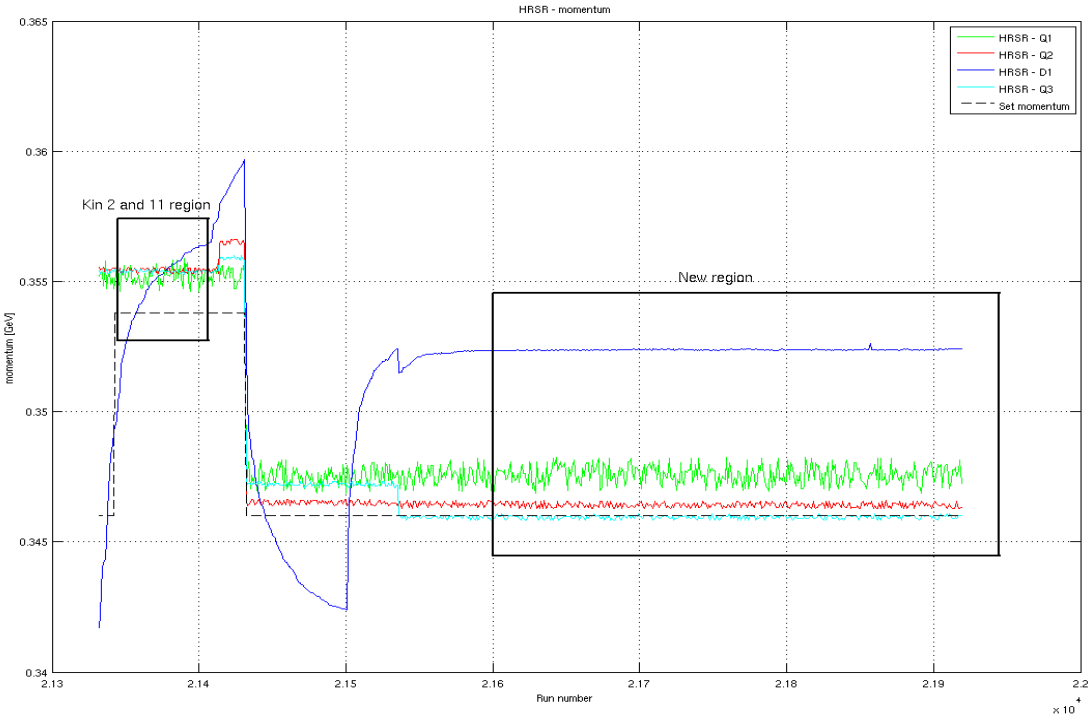

Illustration 3: Calculated momentum for different magnets in the HRS

The strange thing I have also noticed is that the current in the magnets was changing although the set momentum was constant.

I would suggest the following changes in the analysis of these data in order to get better results. Instead of data from kinematics 2 and 11, where the magnetic field in HRSR drifts, I would use data from the region where the magnetic field in the HRSR is constant (run number > 21600). In this case I will be mostly using data from the HRSR. Because the momentum setting of the HRSR is fixed there, I can use the data from different kinematics and get good statistics. In the case of kinematics 10, I will be also able to use data from the HRSL.