Calorimeter Elastic Calibrations

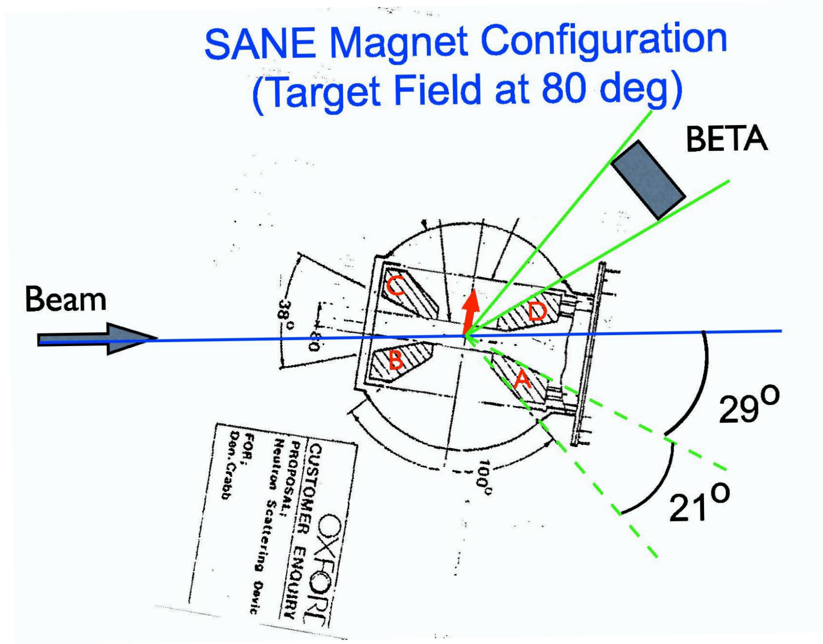
Garth Huber

Department of Physics, University of Regina, Regina, SK, Canada

The purpose of the elastic calibrations is to provide an absolute energy calibration of elastically scattered electrons in the calorimeter.

- Elastically scattered electrons are tagged by the detection of the conjugate protons in the HMS.
- The beam, scattered electron and proton are deflected in the target magnetic field, but the calibrated electron energy can be determined from Monte Carlo.
- Since BETA is 20^o wide, a series of runs with different HMS angles and momenta are required to span the angular width of the calorimeter.
- Only the central height of the calorimeter can be calibrated in this manner.
- It would be best if calibrations are performed with target field on as well as off.

Two configurations were investigated. Target field at 80^o and 180^o.



Calibration with target field on and off at 80^o is desired because the reconstruction of the elastic peak is very sensitive to both the vertical offset and the target field details.

Problems encountered:

1. HMS angles between 29^o and 50^o are blocked, greatly restricting the available kinematics for elastic calibration.

2. 750 MeV is the maximum beam energy that allows calibration across the full width of the calorimeter.

   - Five HMS angle settings of 51^o, 54^o, 57^o, 60^o and 63^o would provide calibration electrons between 583 and 677 MeV.

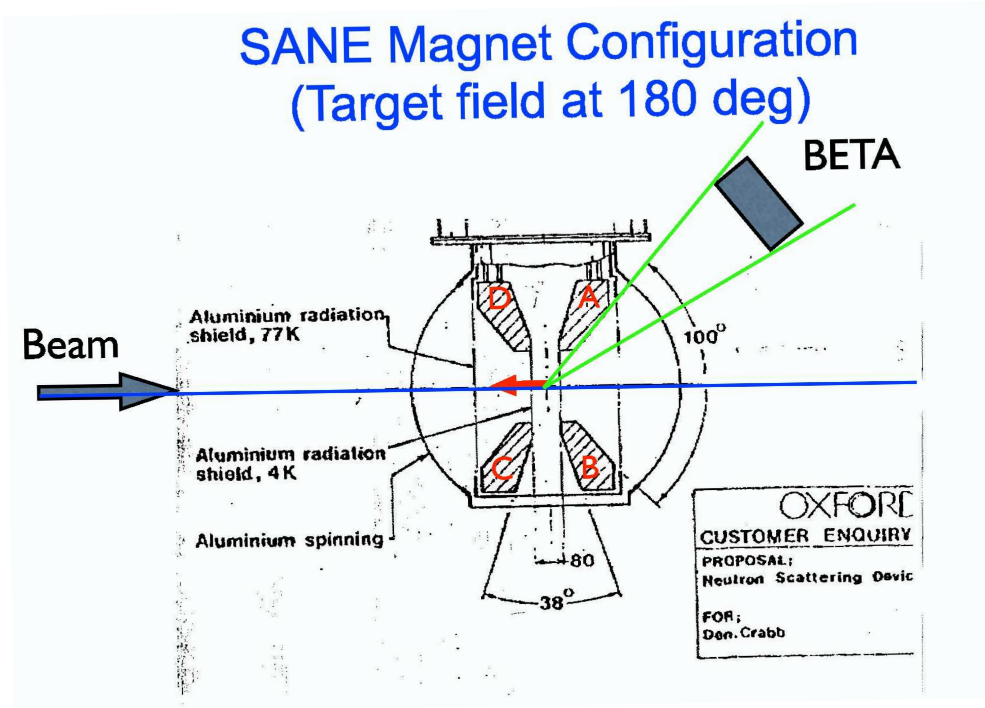
3. 1 GeV electron beam suffers 13^o vertical deflection by the target field, and this is more than can be accomodated by the Hall C chicane.

   (a) Only electron beam energies > 2 GeV can be accomodated.

   (b) Target field on calibrations at the most useful electron energies are precluded.

4. With field on, protons are blocked by the coils unless the beam energy is > 4 GeV. In this case, the elastic coincidence rate is too low to allow the calibrations to be done in any reasonable time.

CONCLUSION: Field on elastic calibrations in 80^o field configuration are not practical.



Because of the symmetric configuration of BETA at 40^o and the field at 180 or 80^o, the deflection of the scattered particles is similar for both field directions. Thus, the calibration for both 180 and 80^o could be done just the antiparallel field.

- HMS angles between 10.5^o and 50^o are possible.
- Beam is anti-parallel to the magnetic field, so is undeflected.
- For a 5 pass=5.7 GeV linac tune, the useful calibration beam energies are 1 pass=1.19 GeV and 2 pass=2.32 GeV.
- 1 pass beam will not allow ep coincidences at the central calorimeter angle of 40^o, due to the obstruction of the HMS viewing angle at 50.5^o.
  - Only the portion of the calorimeter from 40^o-50^o can be placed in coincidence with the HMS.
- 2 pass beam will allow a calibration scan across the full horizontal acceptance of the calorimeter. The calibrated electron energy varies with angle from 1.25-1.80 GeV.

Target field off kinematics - 180^o configuration

Approximate coincidence rates per crystal, assuming 1 μA on 3 cm target

Electron beam energy: 2.317 GeV

$\theta_{e'}$	Q^2	$E_{e'}$	θ_p	P_p	$d\sigma$(nb/sr)	Hrs/(400coin/crystal)
29.1	1.03	1.77	-48.0	1.16	14.	0.2
32.2	1.20	1.68	-45.0	1.27	7.0	0.4
35.5	1.37	1.59	-42.0	1.38	3.6	0.9
39.2	1.55	1.49	-39.0	1.50	1.8	1.6
43.3	1.75	1.39	-36.0	1.62	0.9	3.1
47.9	1.95	1.28	-33.0	1.74	0.46	6.4

Target field vertical deflections and accurate coincidence rates require a SIMC simulation, to be done later.

CONCLUSIONS:

1. The HMS will require a target viewing window from 31^o-50^o, plus allowance for proton deflection in the target field.
2. In the field-on calibration, the electron vertical deflection is approximately 30 cm, so some blocks away from the center can be calibrated. The band of calibrated off-center blocks could be doubled by a second run with reversed target field.
3. If we aim for 400 coincidences per crystal for all settings, the full scan can be completed in about 13 hours (at 100% efficiency). Folding in the standard 60% efficiency, this is 21 hours of real beam time. Including set-up and two scans with reversed and off target field gives a total of 2-3 days at this beam energy.
4. This is somewhat more than the 1 day (folding in efficiency) requested for this purpose in Table 10 of the proposal, although probably only one scan was planned then.