

Polarimeter energy dependence

What design works for each energy range?

Efficiency?

Average analyzing power?

Are there optimum energies for polarimetry?

What systematic errors appear for each design?

Are there gaps in our information?

What new data is needed?

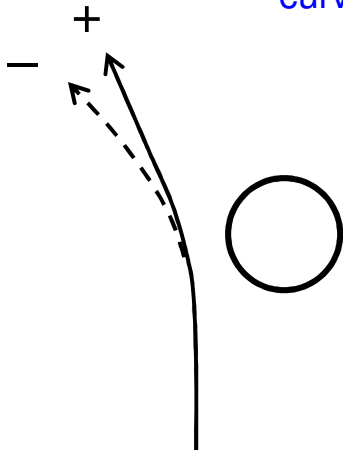
All targets are thick carbon slabs.

Except at highest energy, elastic scattering is separated by an absorber.

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IUCF – 11/12/3

Energies < 70 MeV
Coulomb rainbow scattering

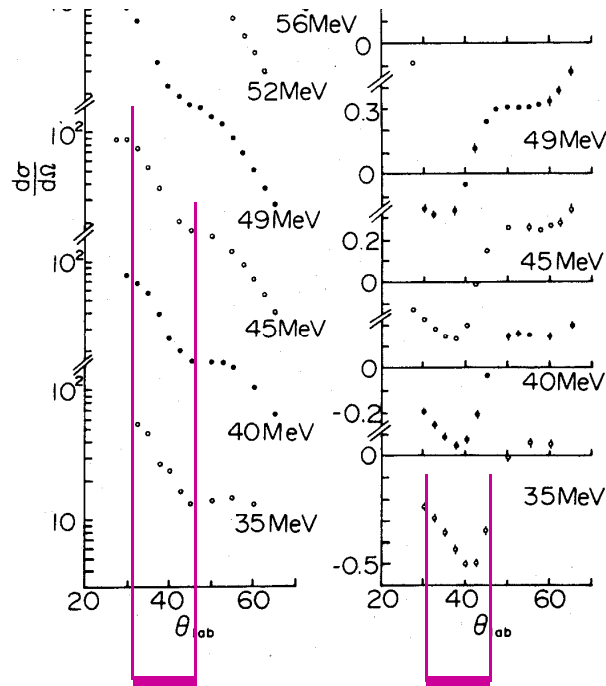
Forward-angle trajectories
curved in Coulomb field



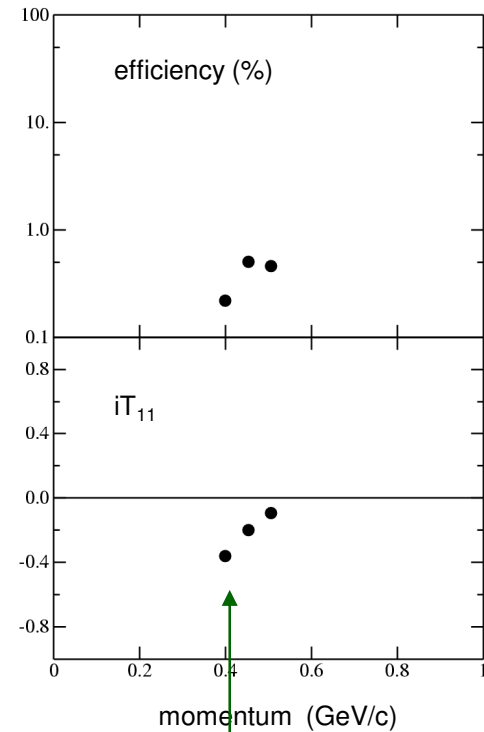
Spin-orbit force
causes (+) to
bend toward
smaller angles.

If the cross section
is FALLING
with
angle, then at any
angle, spin (-) will
dominate. This
makes $iT_{11} < 0$.

Work in this
region.

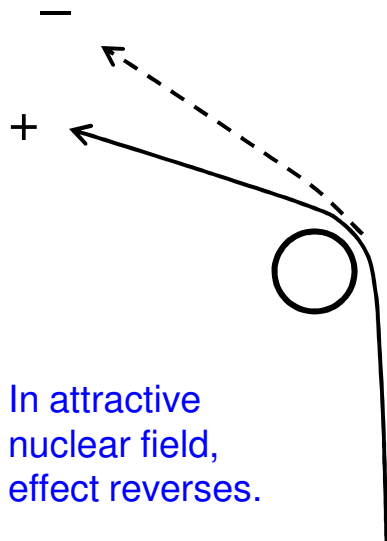


estimated operating
characteristics



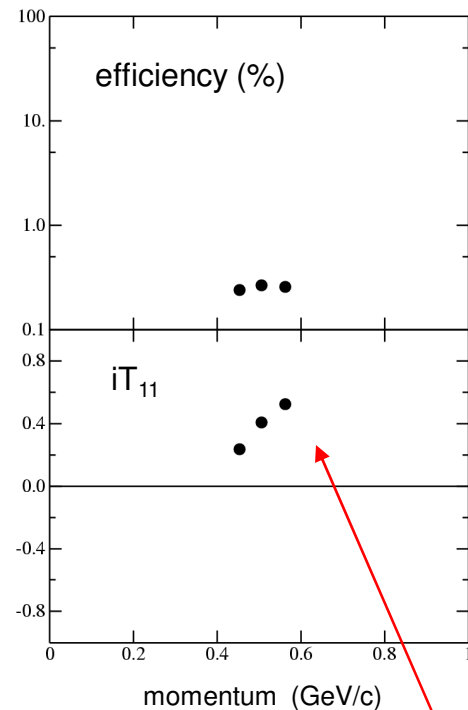
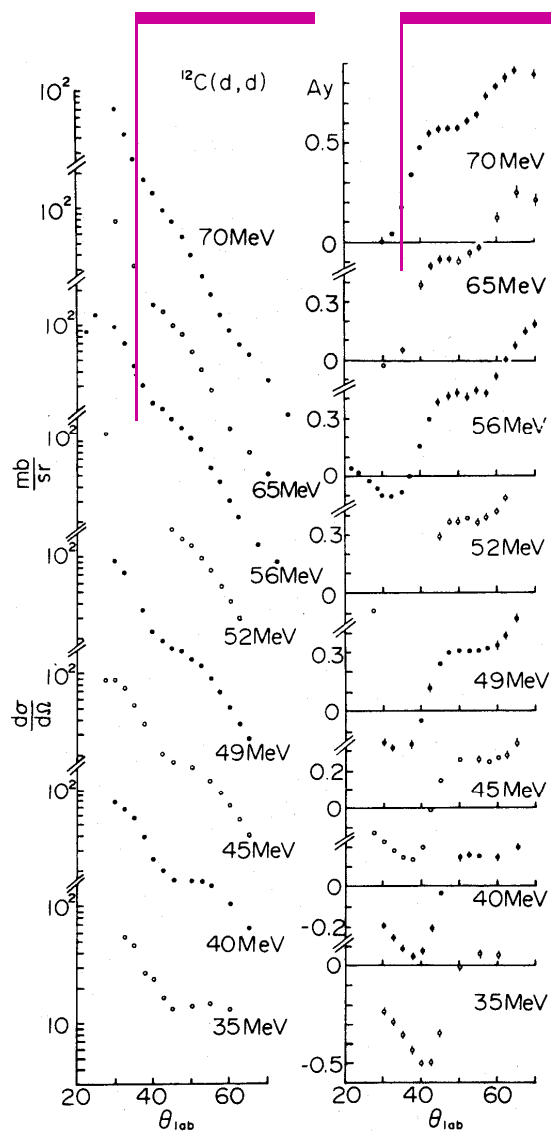
40 MeV design
was here.

Energy > 40 MeV
Nuclear rainbow scattering



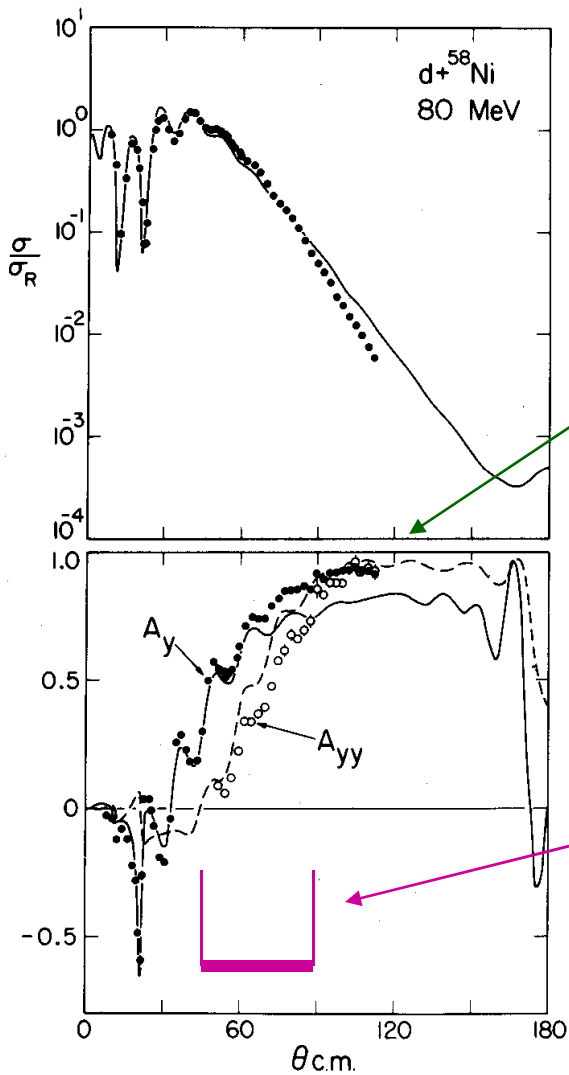
In attractive nuclear field, effect reverses.

These analyzing powers get very large while the cross section falls exponentially.



Data run out while spin sensitivity improves. Higher energy data are needed.

More about nuclear rainbow scattering...

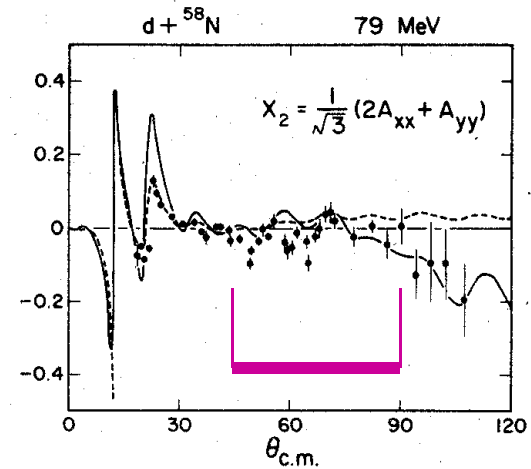


NOTE: Once analyzing power start to rise for elastic scattering, it rises for ALL inelastic and particle transfer channels. Thus an inclusive polarimeter will gain efficiency. (Estimates here consider only the elastic.)

Very large angle analyzing powers approach their limit, could be used for *in situ* calibration.

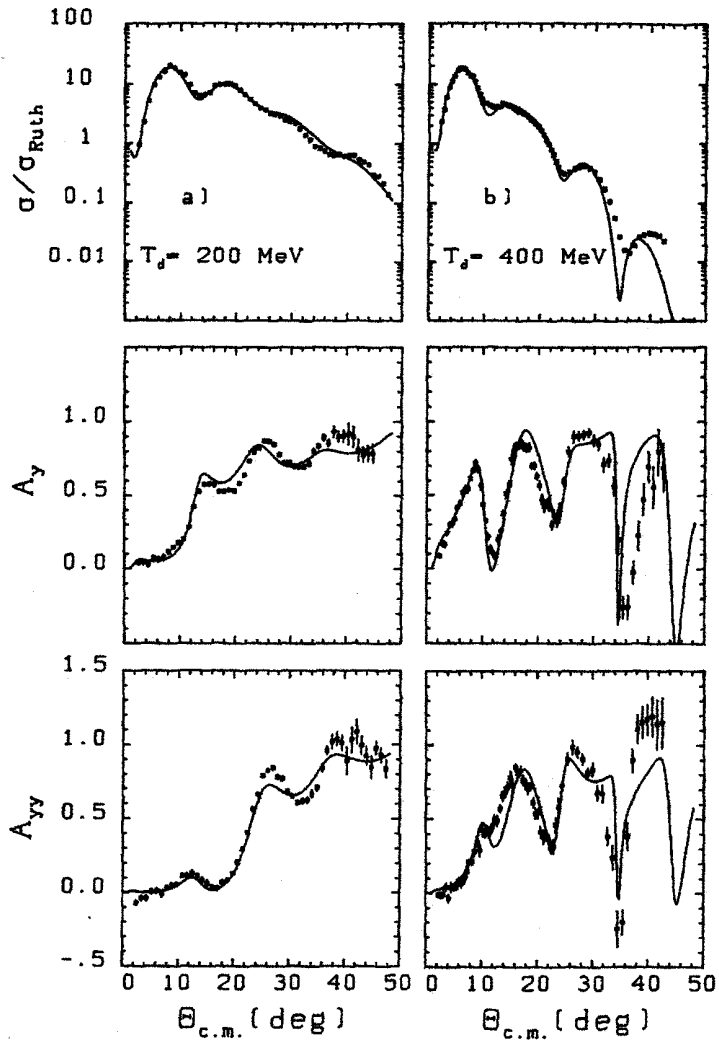
Most useful where analyzing power starts to rise and cross section is still large.

Sensitive to inner angle cut.



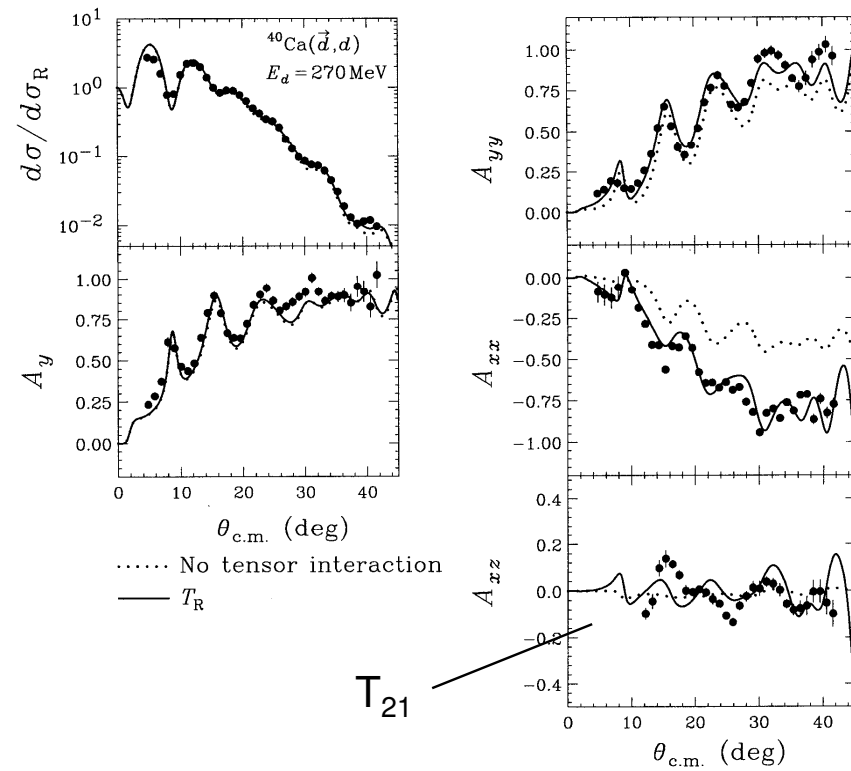
Non-spin-orbit observables such as T_{21} or X_2 are small.

Oxygen target



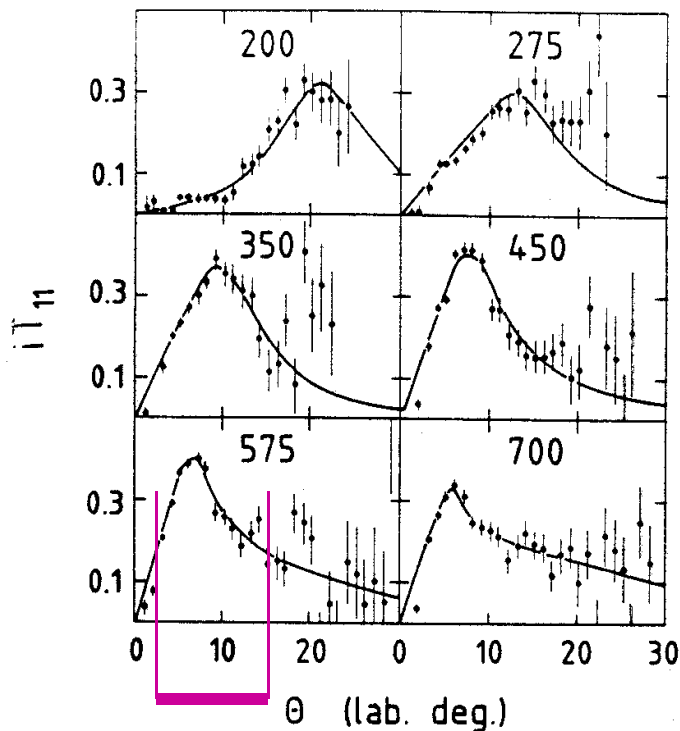
... rainbow at higher energy

Calcium target



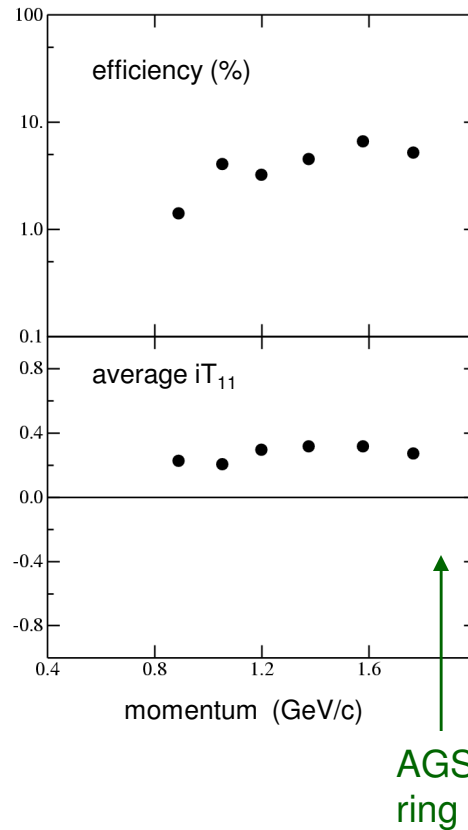
Energy > 200 MeV
Absorptive spin-orbit

Absorption eventually reduces nuclear rainbow. But forward-angle spin-orbit effect grows in.



Work here.

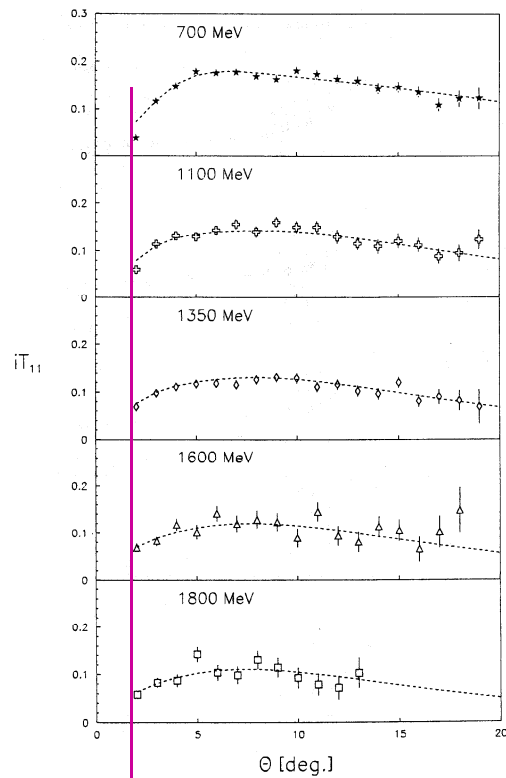
Forward-angle cross sections are large!



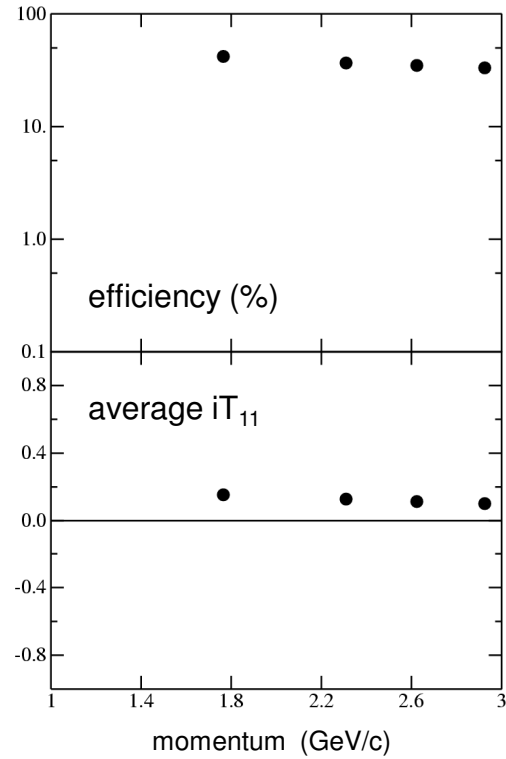
Efficiency rises while average iT_{11} falls.

At about 700 MeV, the use of an iron absorber to separate the elastic scattering loses its effectiveness. Then iT_{11} starts to decline.

Energy > 700 MeV
Absorptive spin-orbit
no particle identification



All angles past
1.5° are kept.

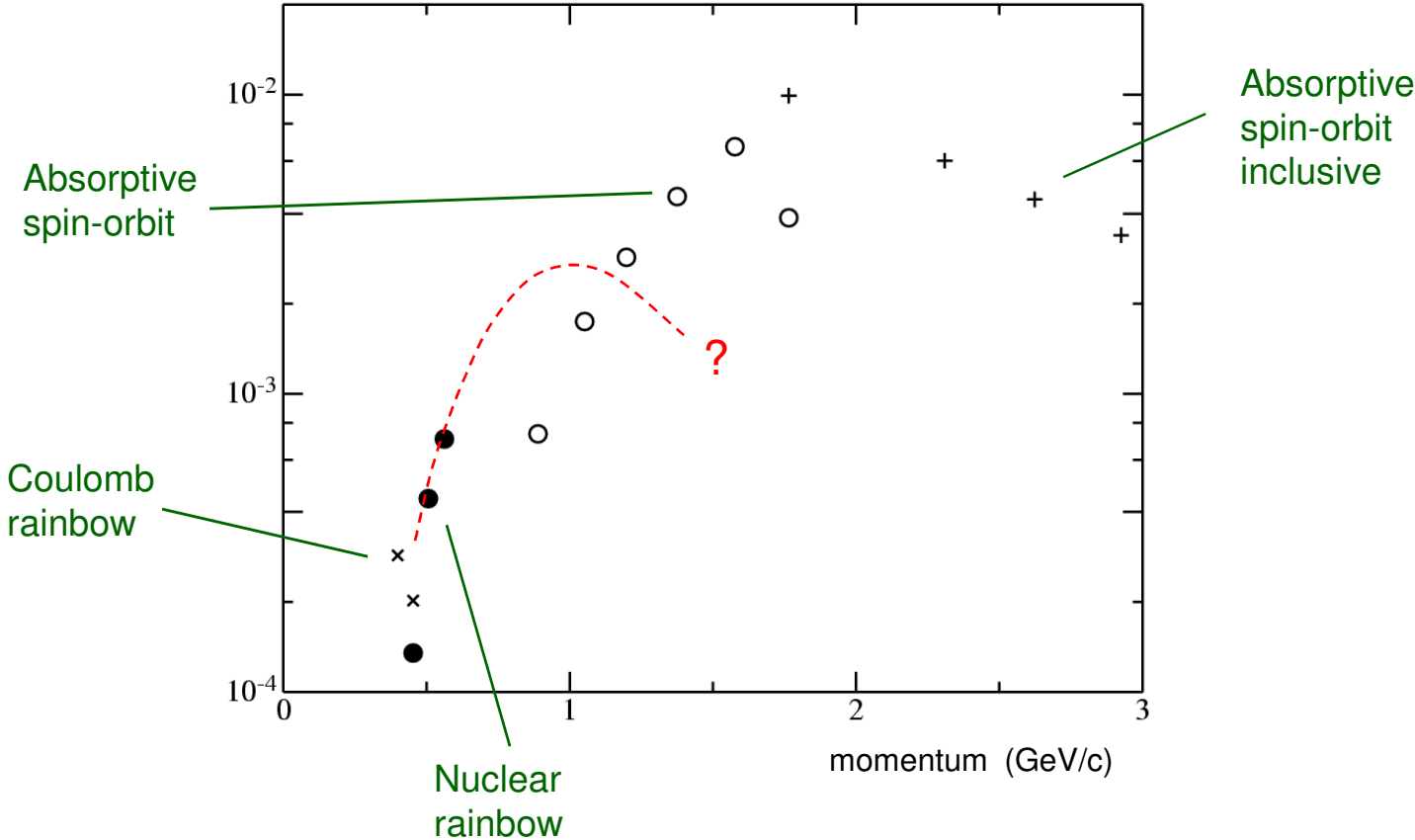


Higher efficiency but
smaller analyzing
power.

For these cases the
carbon target
thickness was held
fixed at 30 cm.

Summary

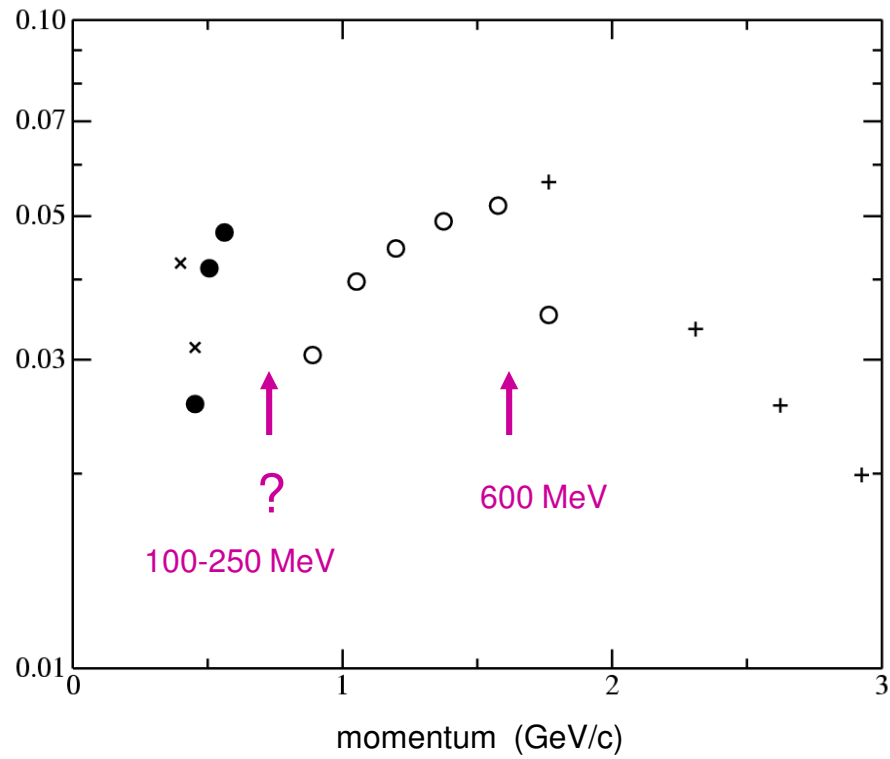
Figure of merit = efficiency $\times \langle iT_{11} \rangle^2$



Extrapolation of nuclear rainbow effect is not known.

Can this information be useful for planning?

Consider: $\frac{\text{precision}}{\text{cost}} = \frac{\sqrt{FOM}}{p}$



possible optimum polarimeter points