Studies of the Deuteron at High Q^2

(E01-020 Status)

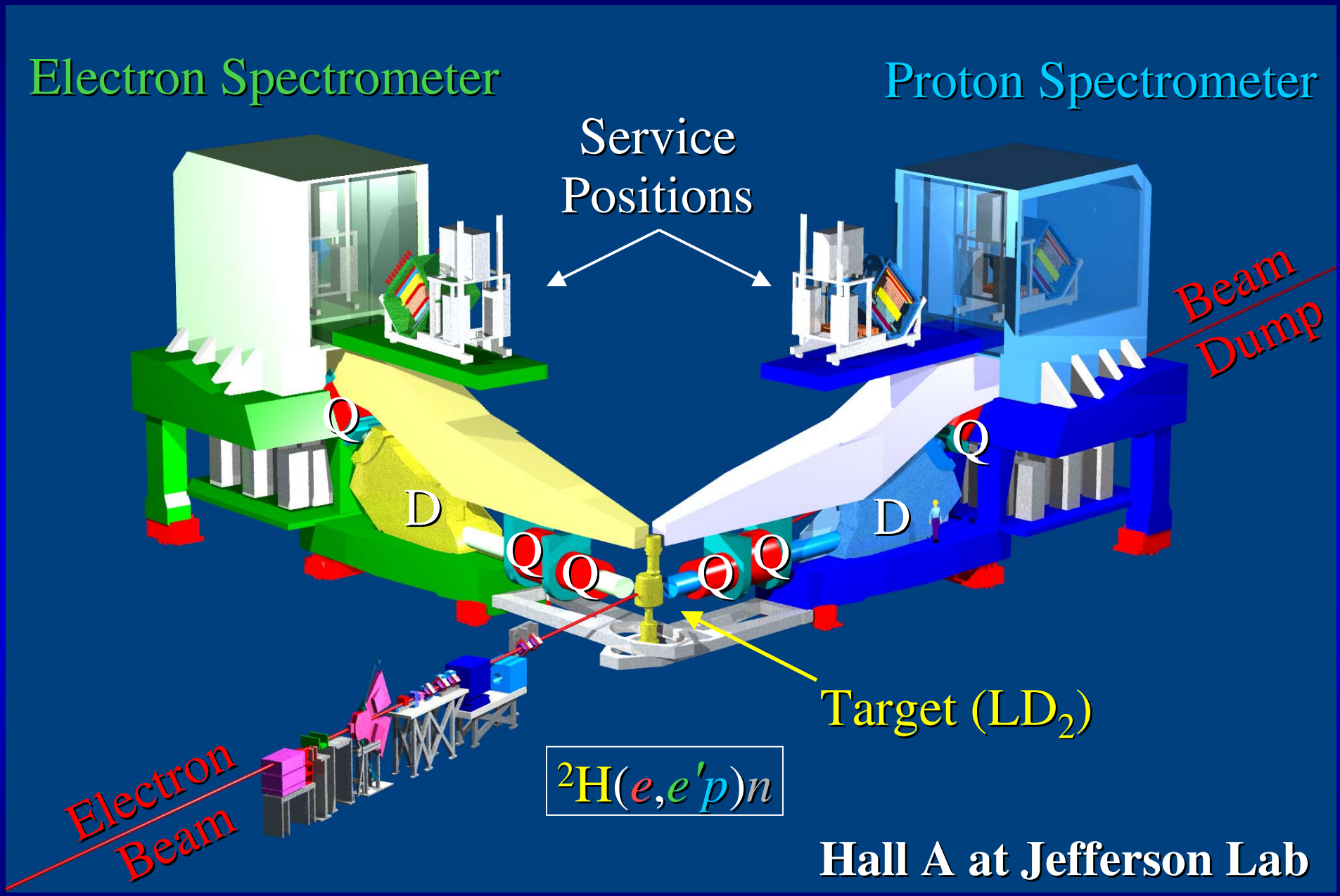
Hassan Ibrahim

Old Dominion University

(for the E01-020 Collaboration*)

Hall A Collaboration Meeting
June 23, 2005

* Spokespersons: W. Boeglin, M. Jones, A. Klein, P. Ulmer and E. Voutier
Graduate Students: L. Coman and H. Ibrahim


Electron Spectrometer
Proton Spectrometer
Service Positions
Beam Dump
Q
D
Q
Q
Q
Q
D
Q
Target (LD_2)
$^2H(e,e'p)n$
Electron Beam
Hall A at Jefferson Lab

Reaction Kinematics

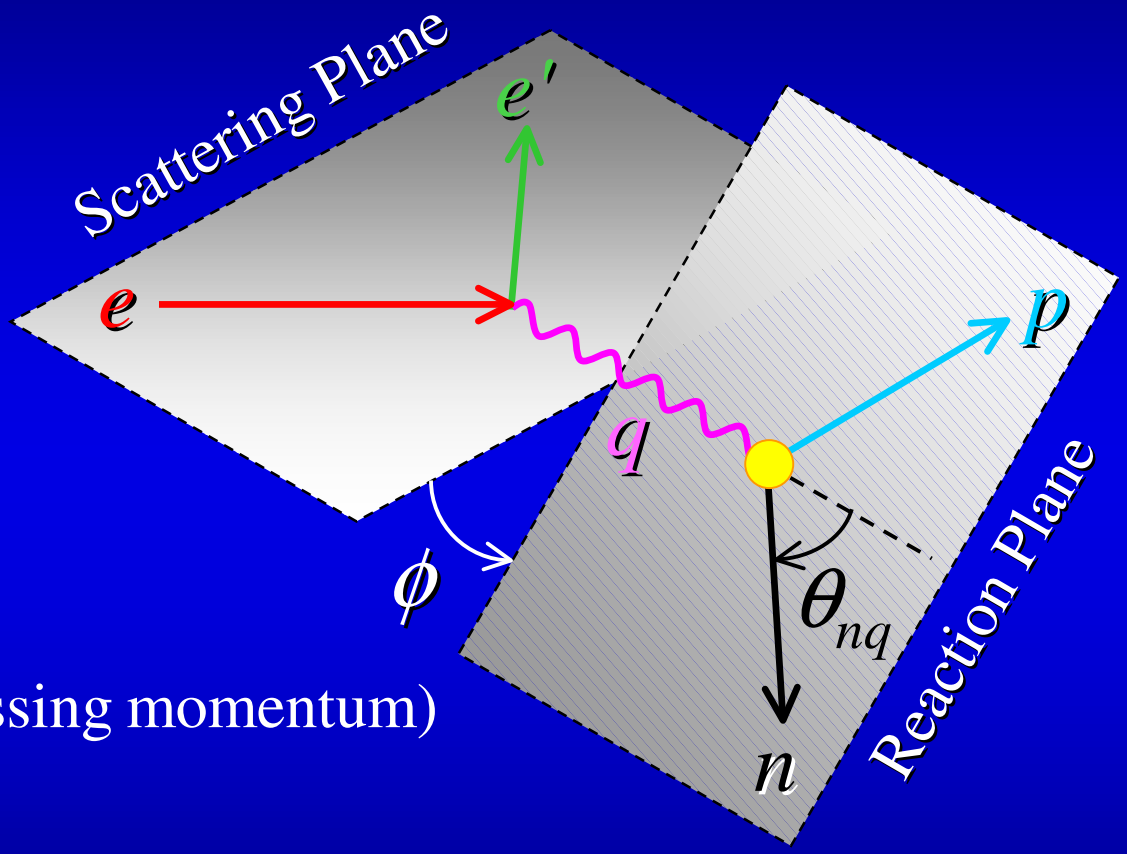
$$\omega = E - E'$$

$$q^{\mu} \equiv (\omega, \vec{q})$$

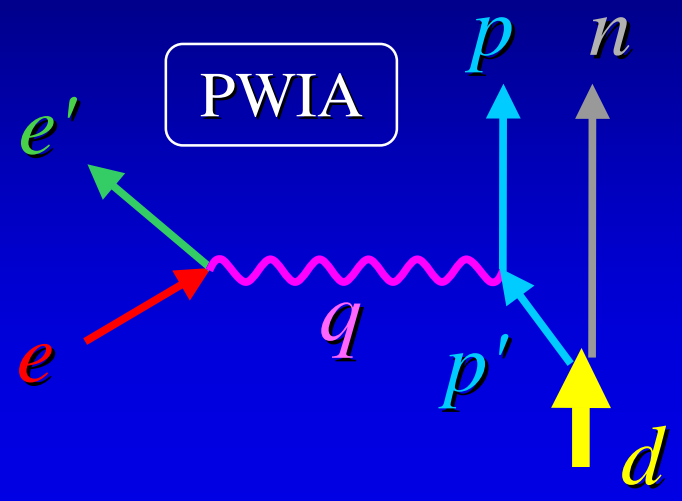
$$Q^2 = -q^{\mu} \cdot q_{\mu}$$

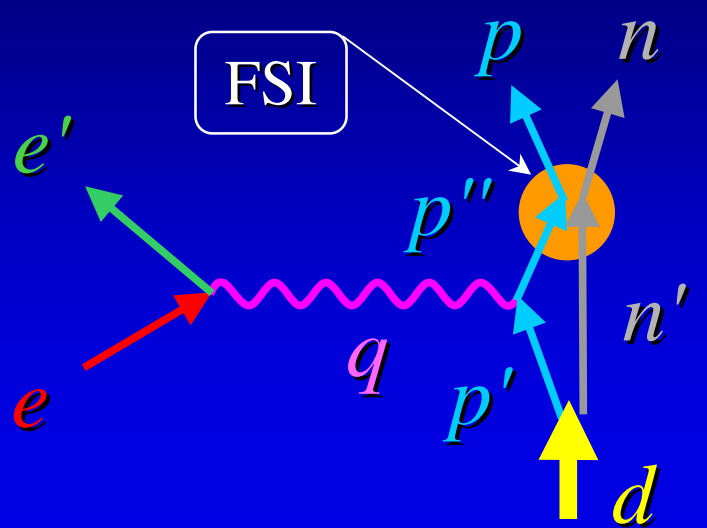
$$x_B = \frac{Q^2}{2M_p \omega}$$

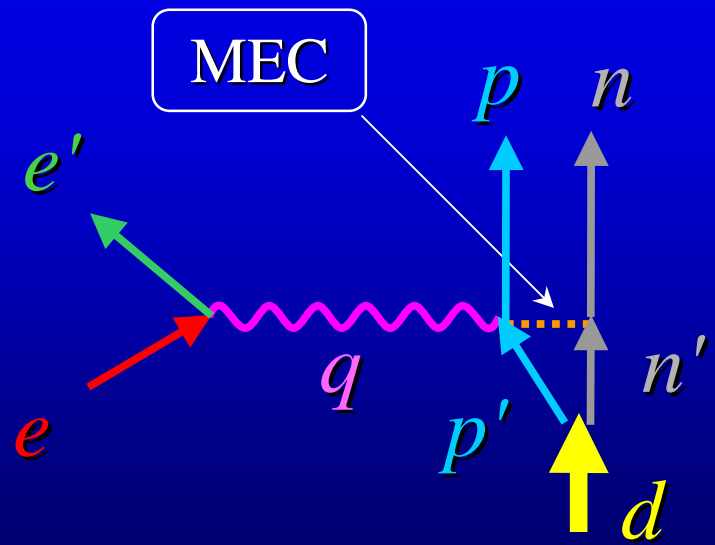
$$\vec{p}_m \equiv \vec{p}_n \equiv \vec{p}_r = \vec{q} - \vec{p} \quad \text{(missing momentum)}$$

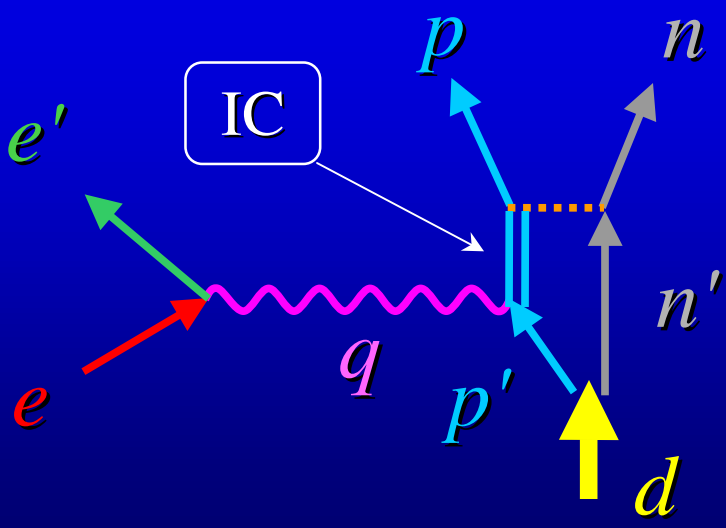


Plane Wave Impulse Approximation and Beyond









Reaction Cross Section

$$\frac{d^5\sigma}{d\omega d\Omega_e d\Omega_p} = Kf\sigma_{Mott}(v_L R_L + v_T R_T + v_{TT} R_{TT}\cos 2\phi + v_{LT} R_{LT}\cos\phi)$$

K is a kinematical factor,

f is a recoil factor,

σ_{Mott} is Mott Cross Section,

v_L, v_T, v_{TT} and v_{LT}, are leptonic factors and

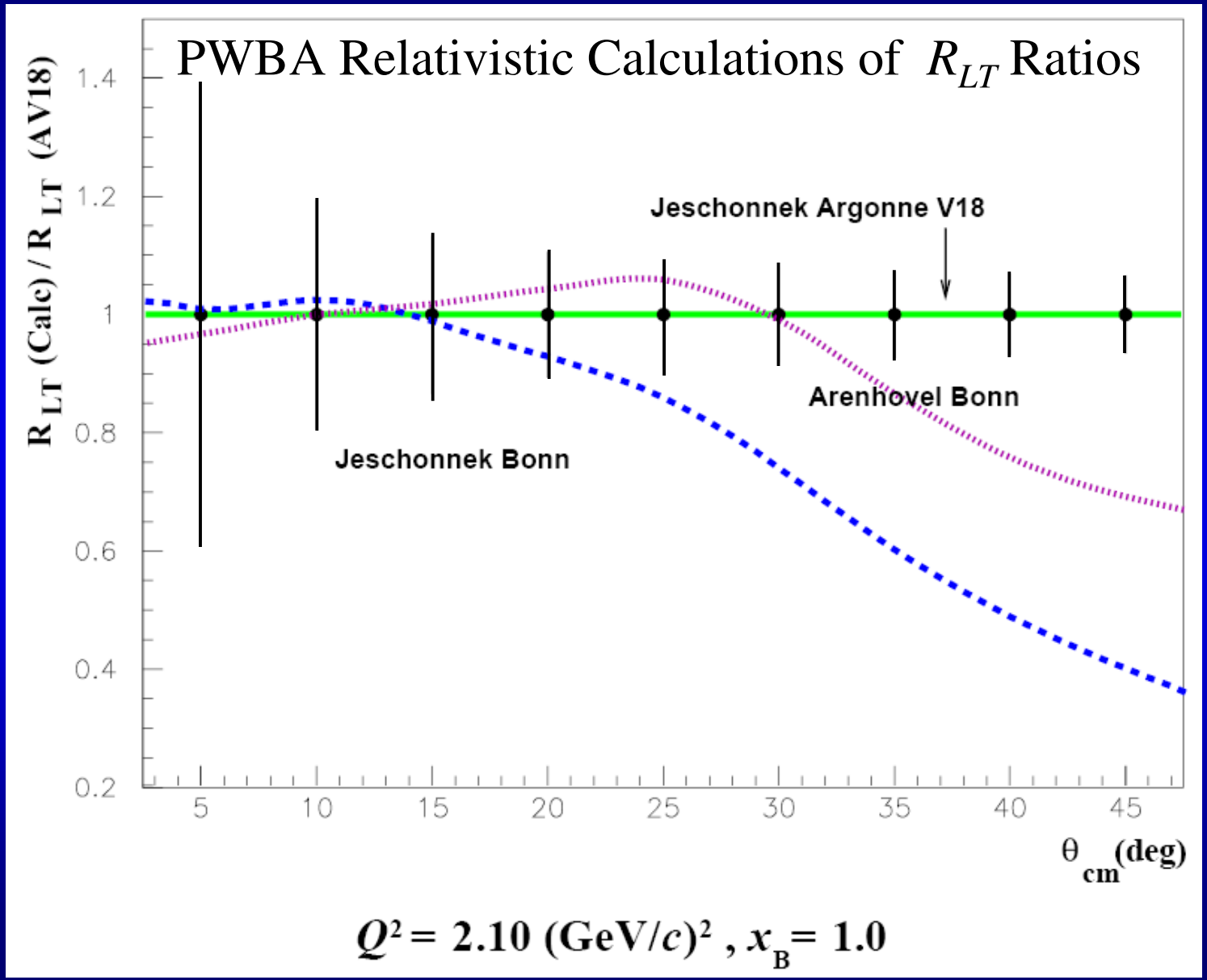
R_L, R_T, R_{TT} and R_{LT} are response functions.

$$R_{LT} \equiv \frac{1}{Kf\sigma_{Mott}}[\sigma(\phi = 0) - \sigma(\phi = 180^\circ)] \quad \rightarrow \text{ Separation of } R_{LT}$$

R_{LT} and Relativity

- The longitudinal component of the relativistic electromagnetic nuclear current contains additional spin-orbit term.
- This additional term can interfere with the spin-flip magnetization term in the transverse current component.
- But, non-relativistically, there is no such additional term since *L* reflects charge only and can not interfere with the spin-flip part of *T*.
- Therefore, we can test relativistic models by separating R_{LT}.

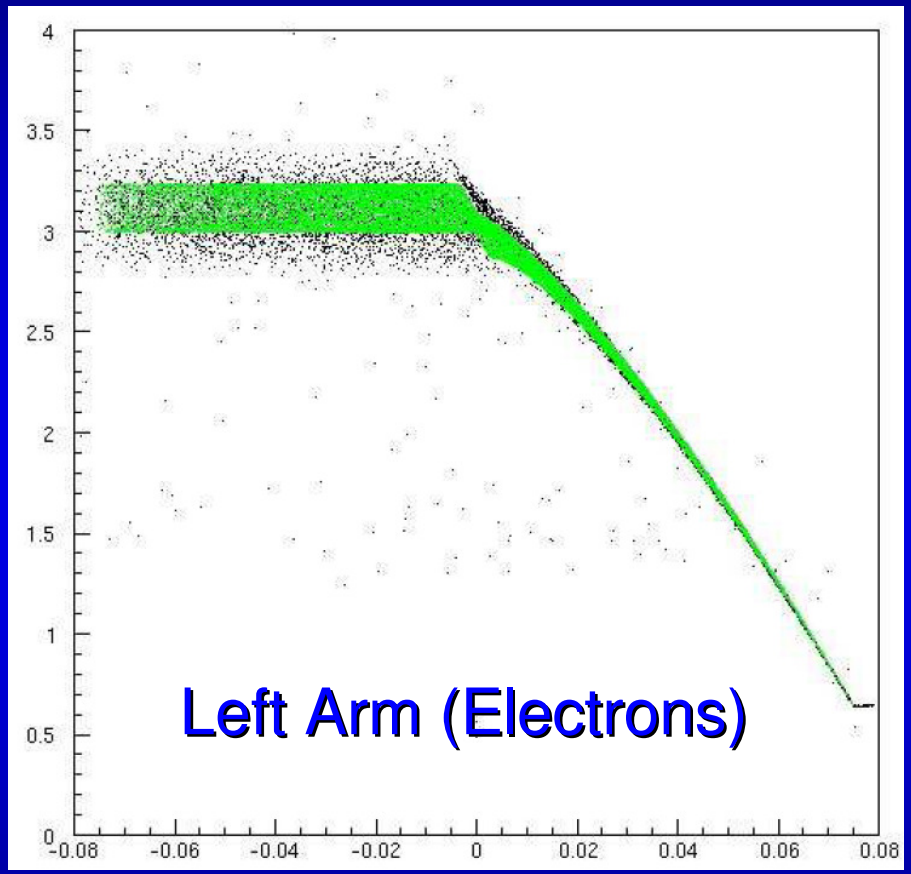
Anticipated Uncertainties

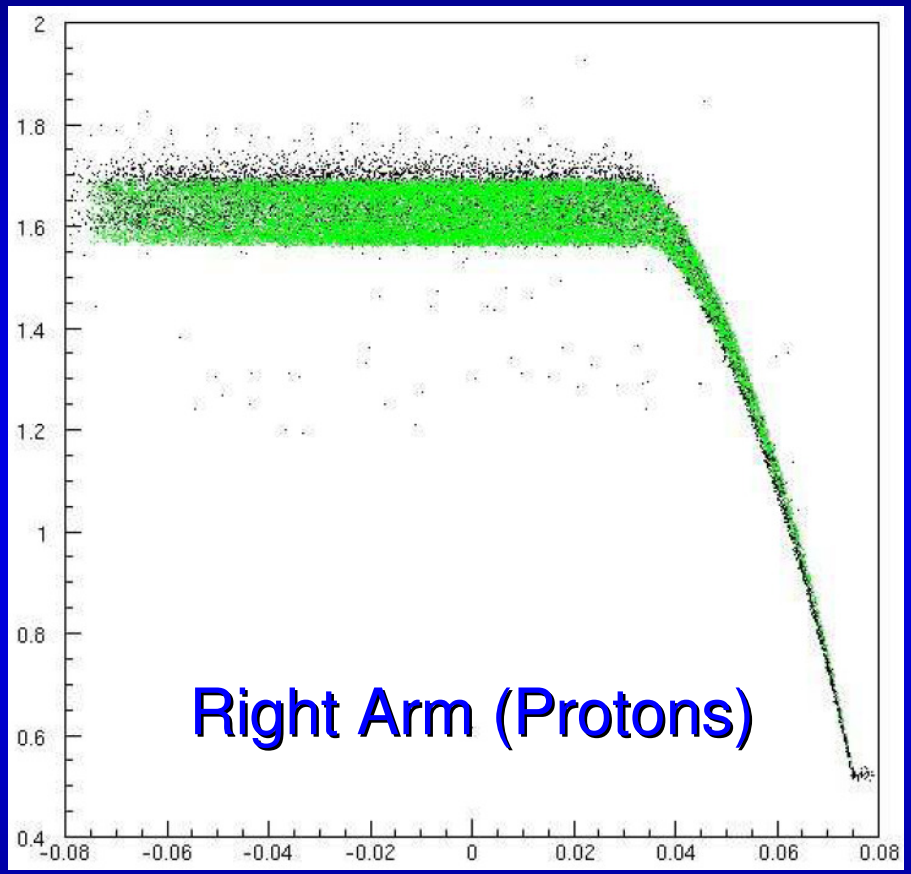


Run Summary

Neutron Direction	Q^2 $(GeV/c)^2$	P_m (MeV/c)	x_B	FSI	MEC / IC	Motivation
Parallel ($p_m \parallel q$)	2.1	100, 200, 300, 400 and 500	< 1	Minimum	Maximum	Emphasize MEC / IC
Anti-Parallel ($p_m \parallel -q$)	2.1	100, 200, 300, 400 and 500	> 1	Minimum	Minimum	Study Deuteron Short-range Structure
Perpendicular ($p_m \perp q$)	0.8 2.1 3.5	0, 100, 200, 300, 400 and 500	1	Variable	Minimum	Test Relativistic Models (R_{LT})
Neutron Angular Distribution	0.8 2.1 3.5	0, 100, 200, 300, 400 and 500	Variable	Variable	Variable	Study FSI

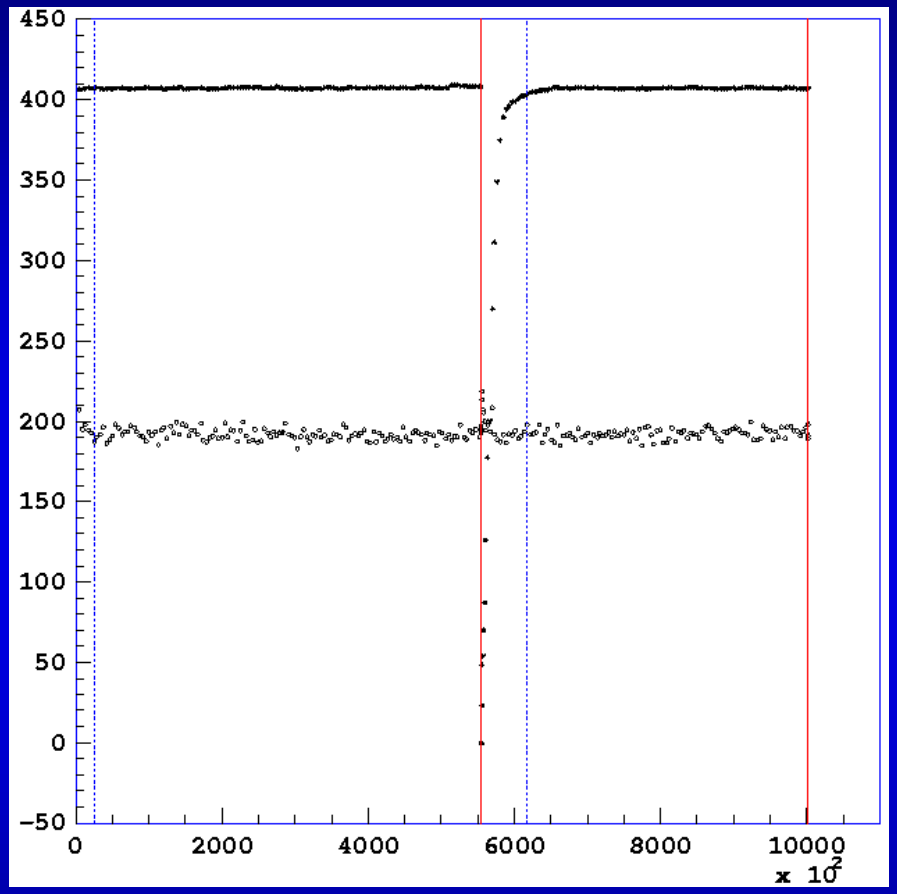
Energy Loss (Data vs. MCEEP)



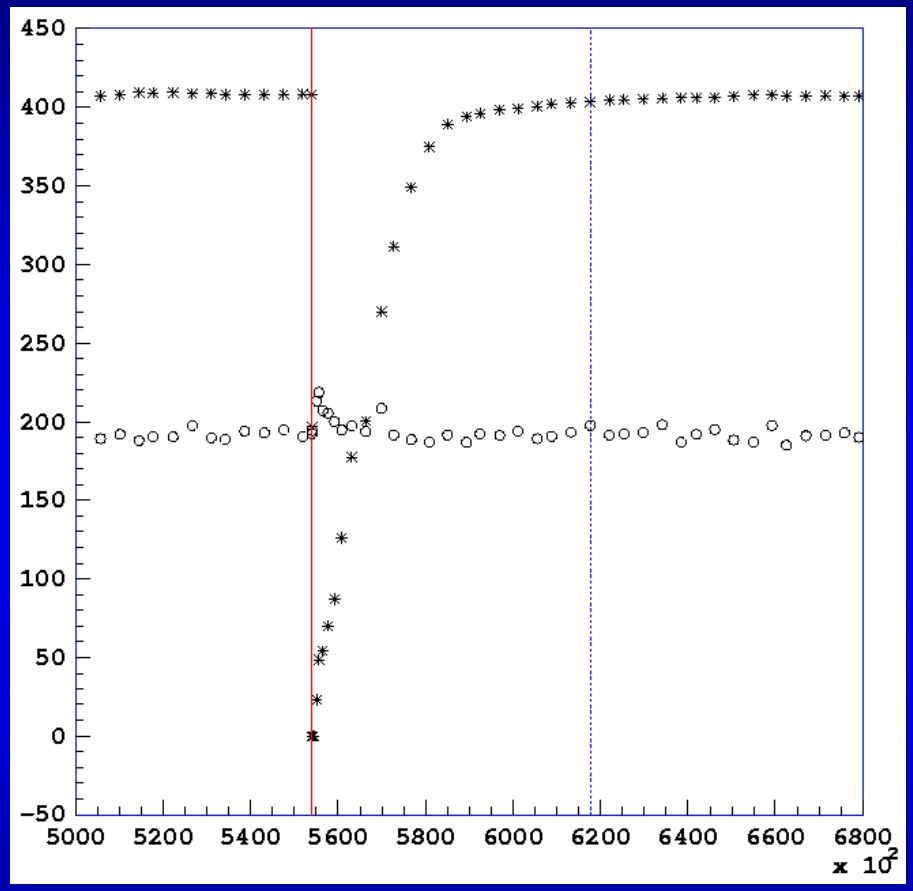


Data : Black
MCEEP : Green

Current Stability for Run # 1876



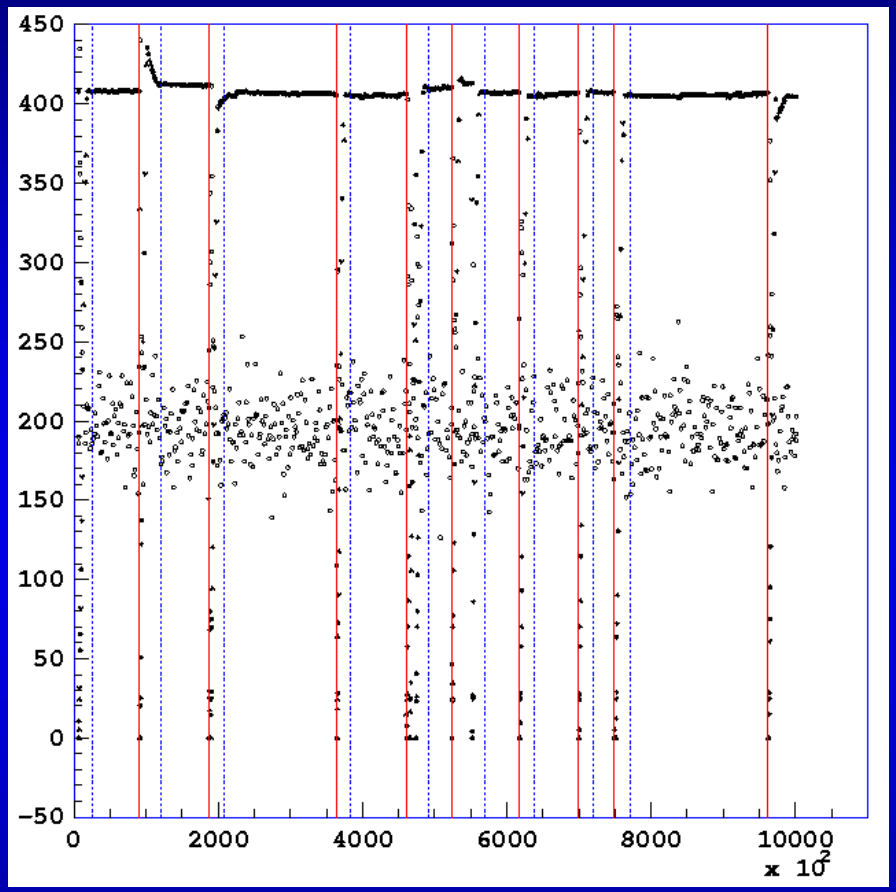
Event #



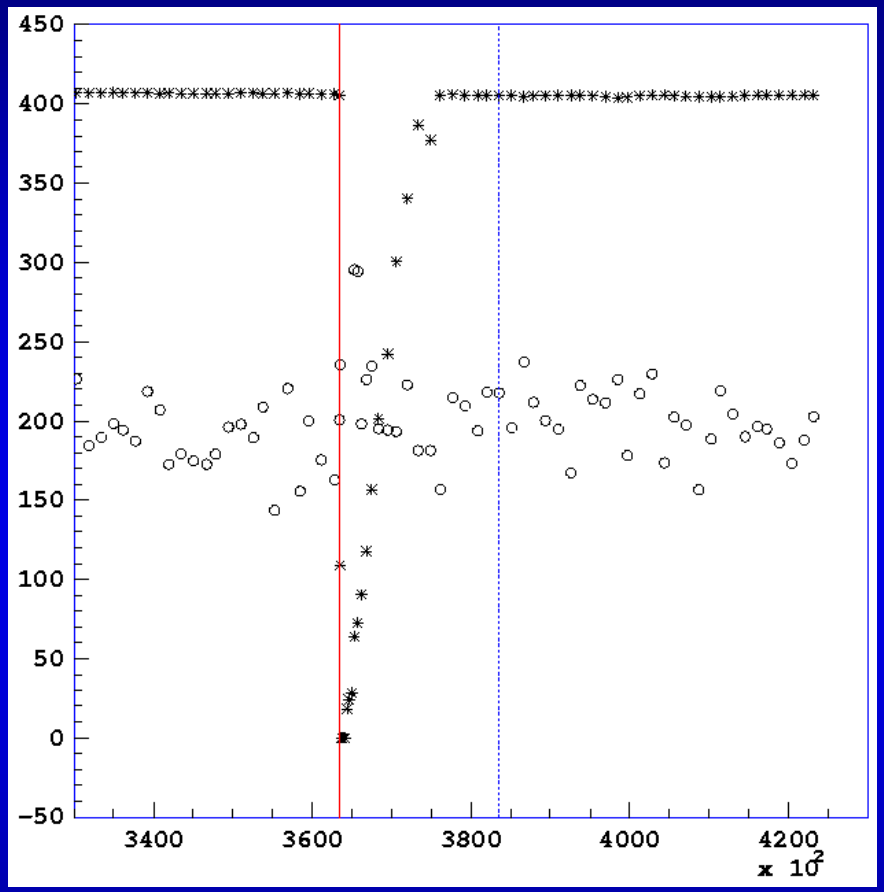
Event #

Current (*) and Normalized T5 (o) in Arbitrary Units

Current Stability for Run # 2745



Event #

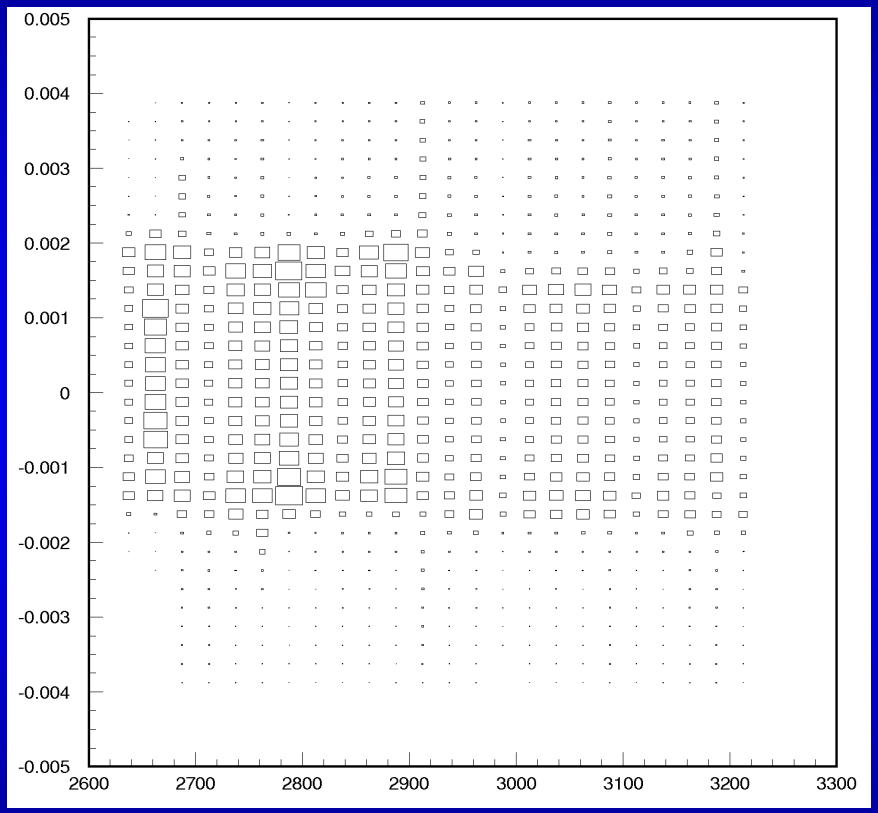


Event #

Current (*) and Normalized T5 (o) in Arbitrary Units

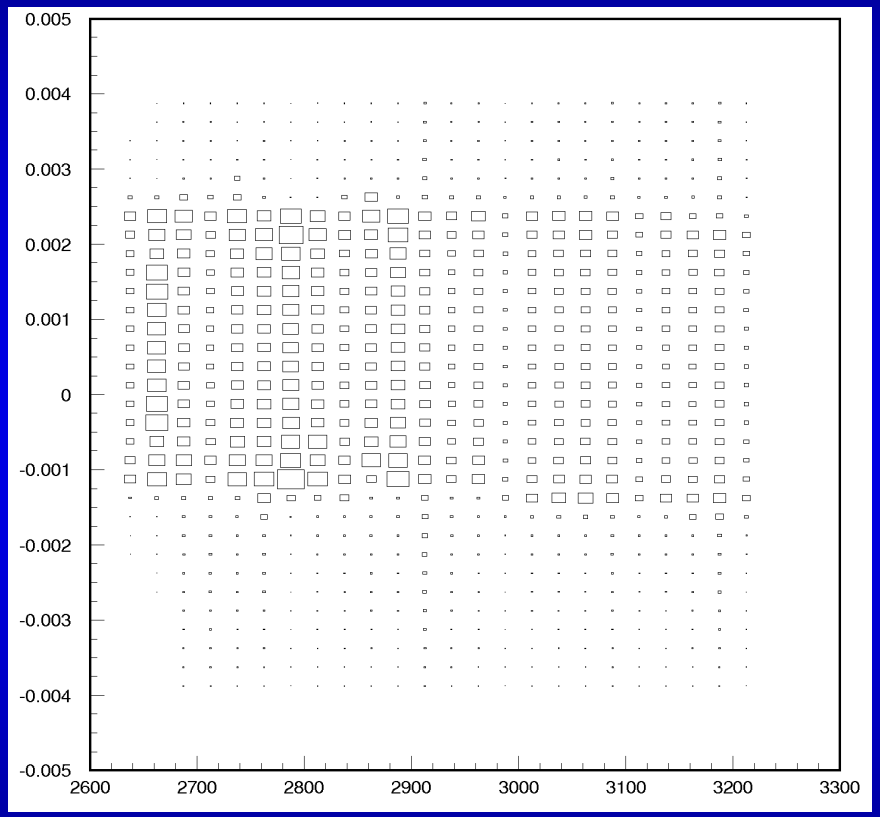
Beam Raster for the 2nd Run Period

X_{Beam} (m)



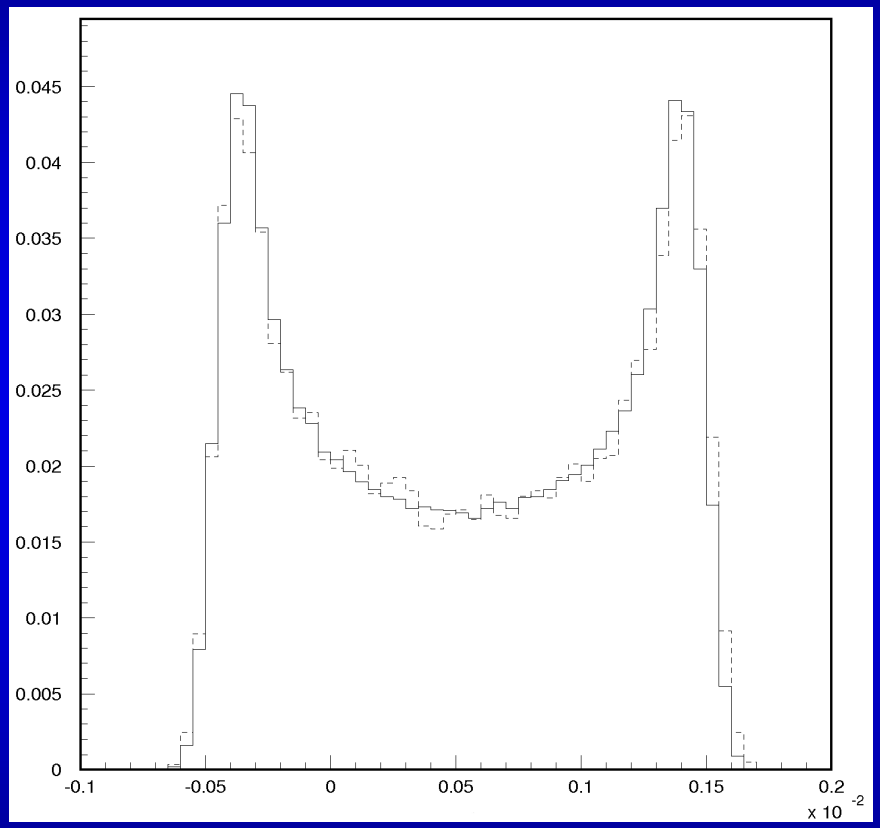
Run #

Y_{Beam} (m)

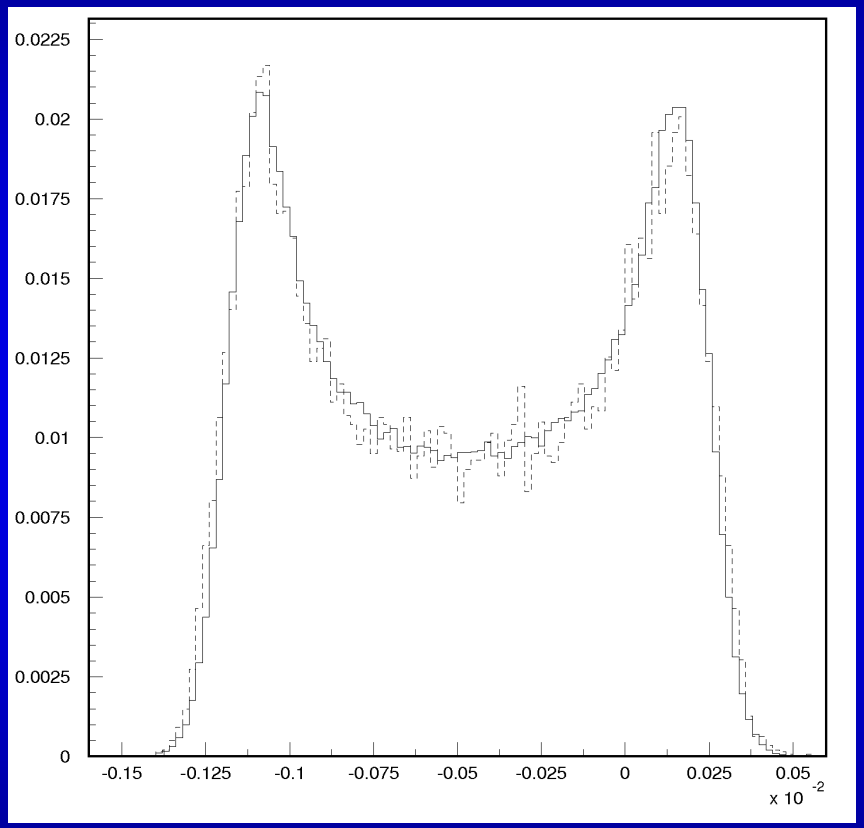


Run #

Beam Raster (Data vs. MCEEP)



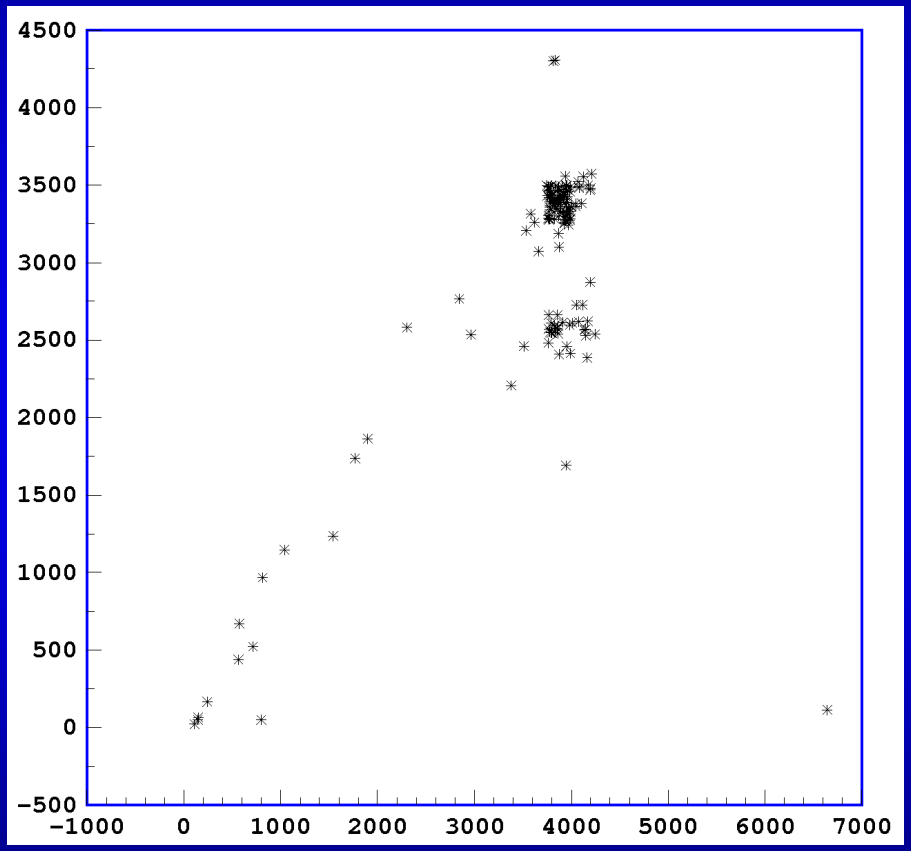
X_{Beam} (m)



Y_{Beam} (m)

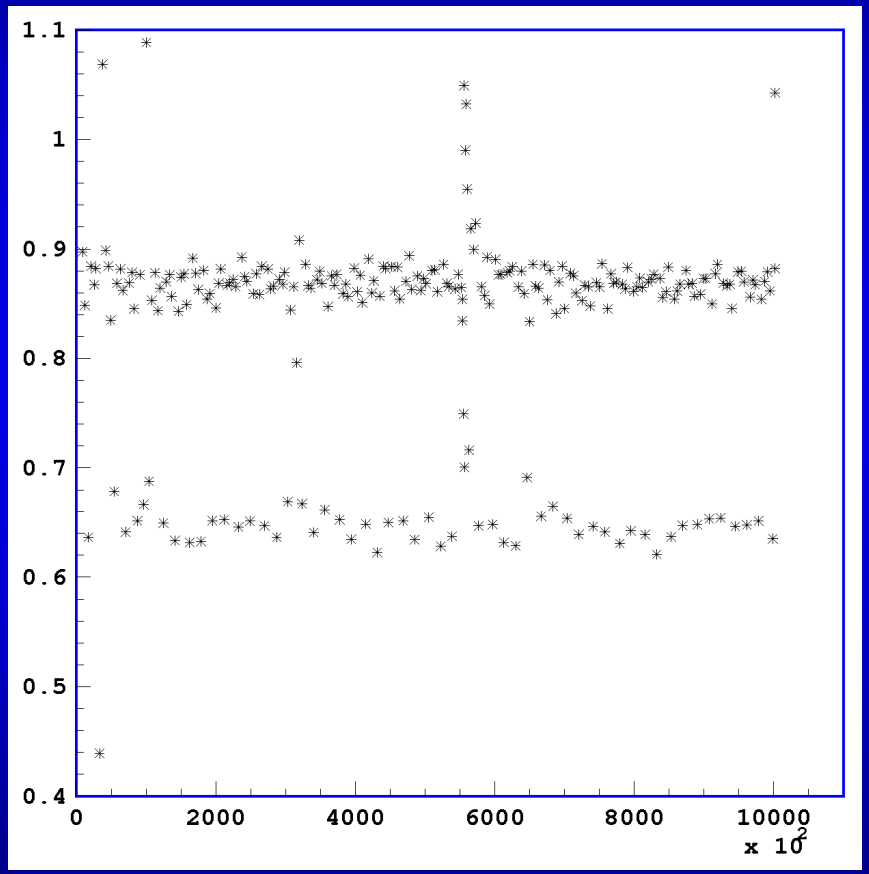
Data (E5) vs. Scaler (T5) Events

E5



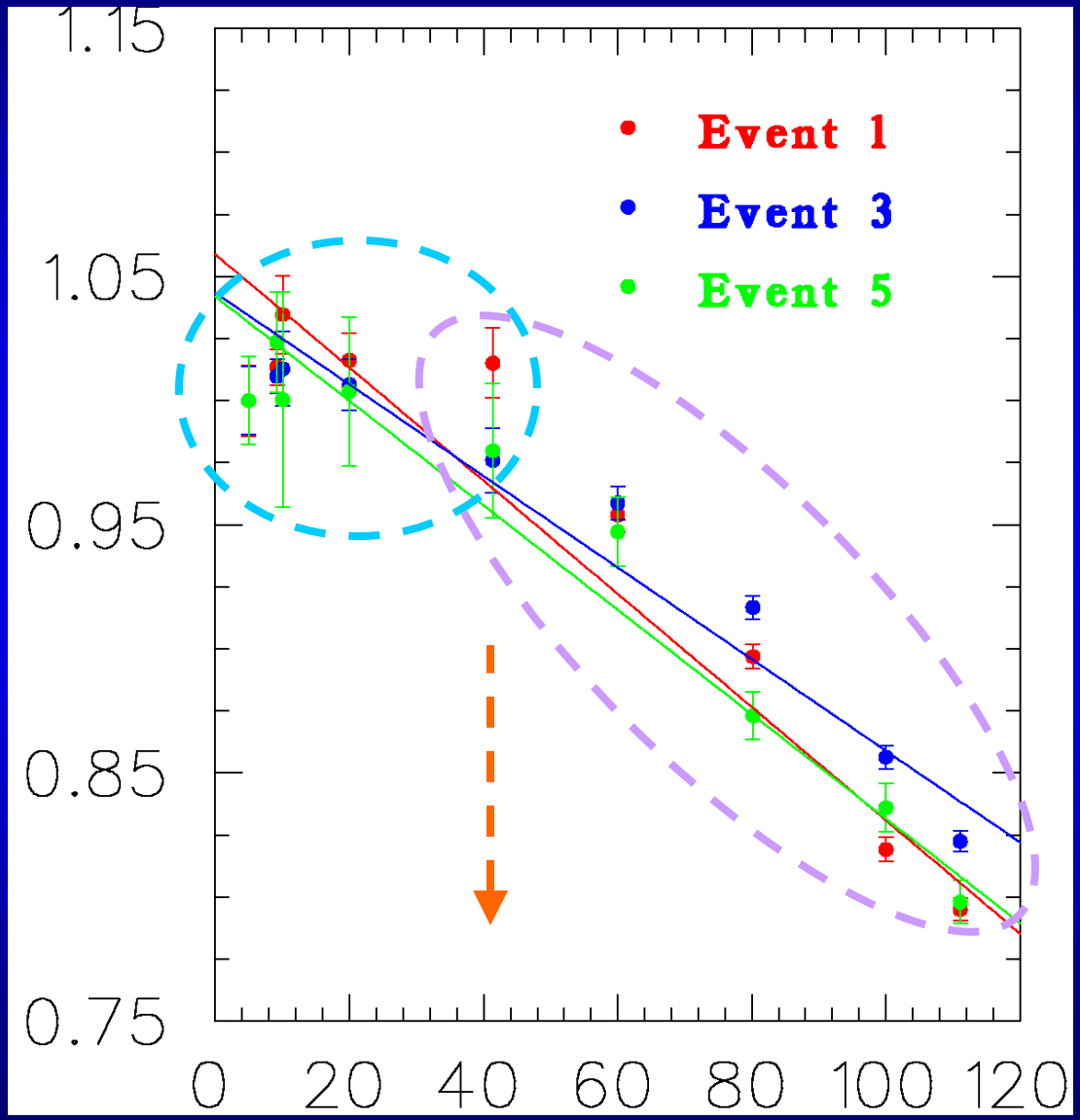
T5

CLT = E5 / T5

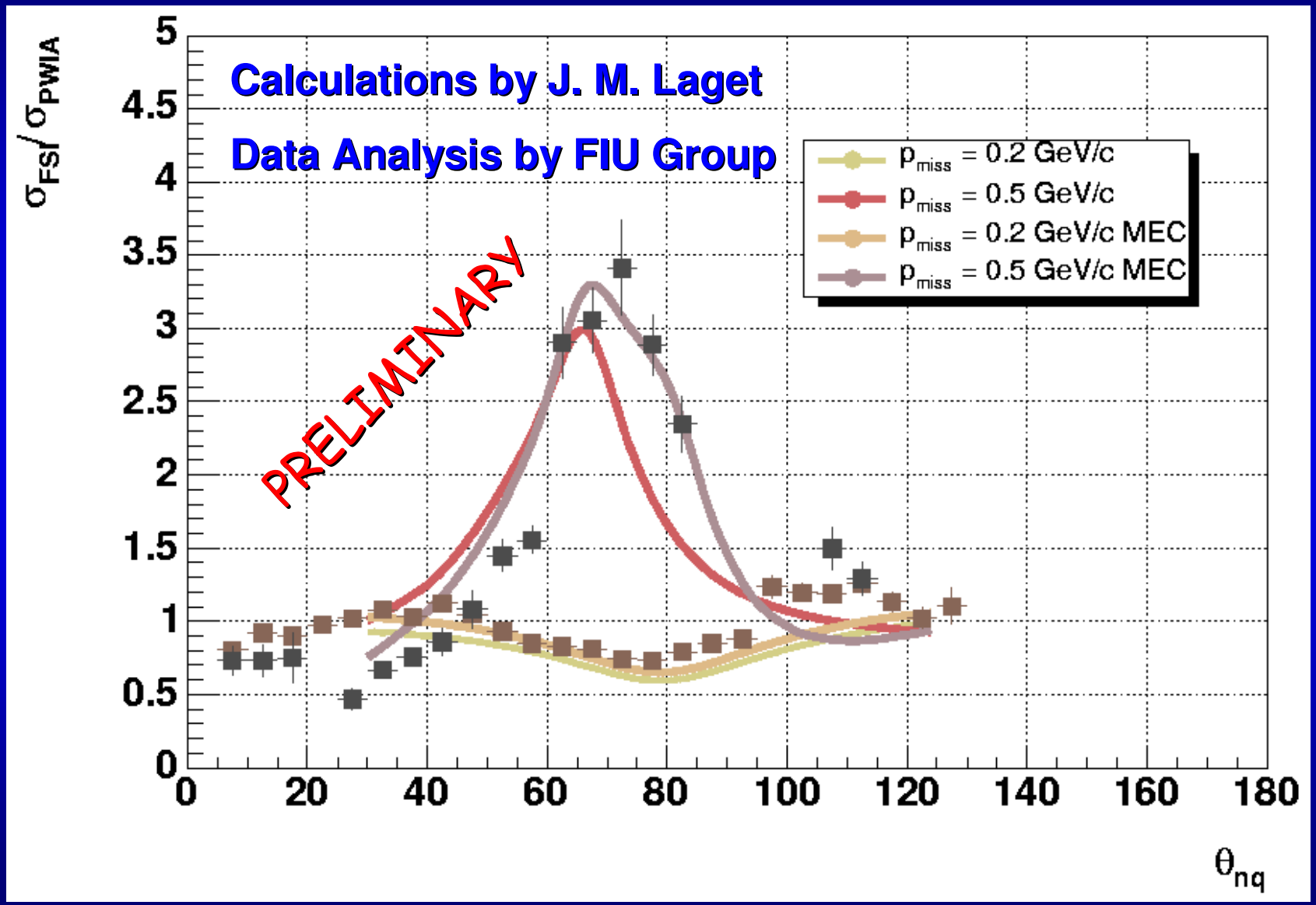


Event #

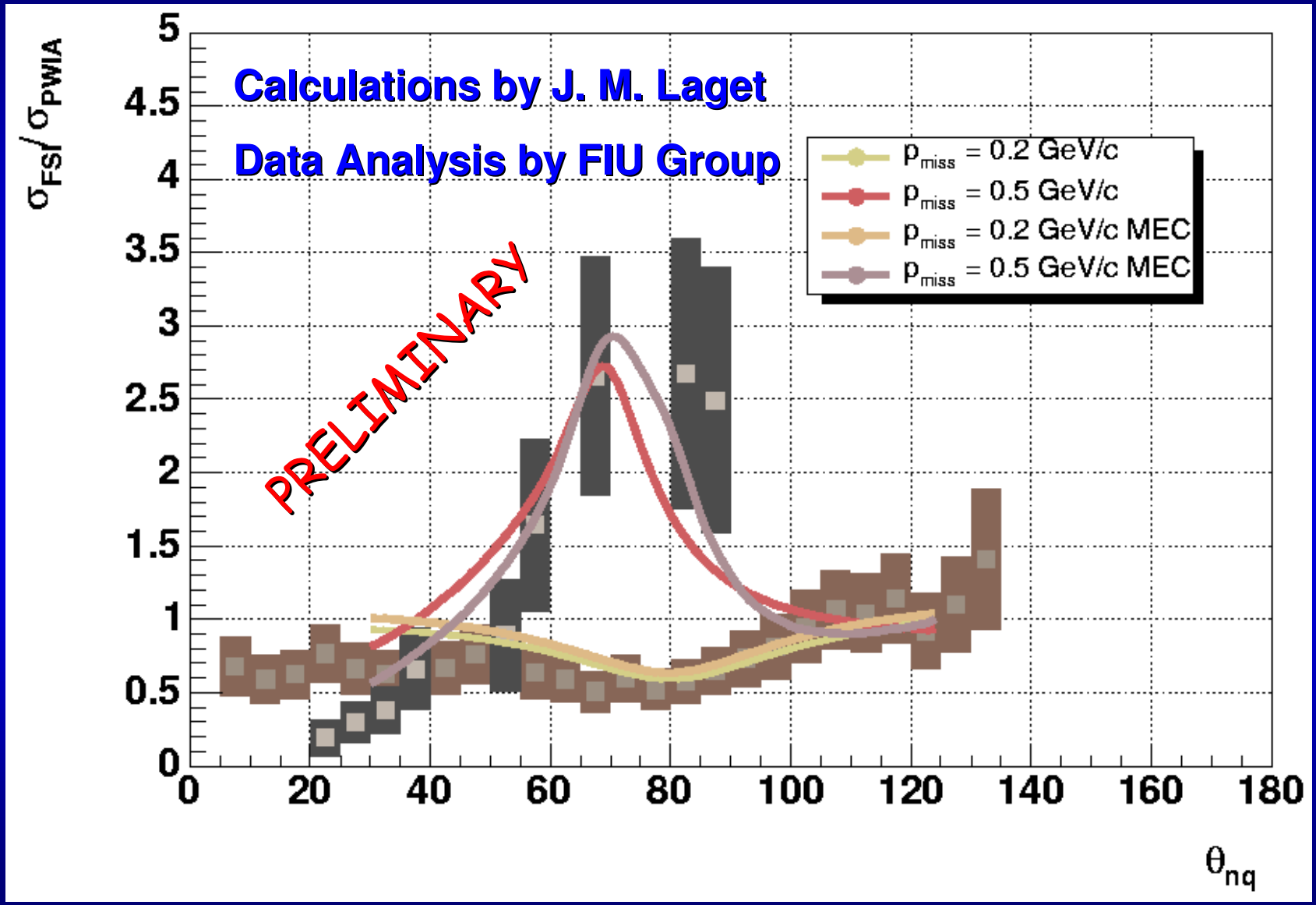
^{1}H Target Boiling



Cross Section Ratios for $Q^2 = 2.1$ (GeV/c)^2



Cross Section Ratios for $Q^2 = 3.5$ (GeV/c)^2



Summary

- The experiment ran in 2002 for 2 months and collected about 2 TB of data for more than 120 different kinematics.
- Most optimizations and calibrations of the two spectrometers have been completed.
- Extensive software improvements have been made in *ESPACE* and *MCEEP*.
- Many new computer codes and scripts were written to display and optimize the different aspects of the data.
- Several passes through the data were done to filter the coincidence events and to extract the good current periods.
- Some preliminary results were obtained.