

Deuteron $A(Q)$ at Low Q (E05-004)

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Hall-A Collaboration Meeting

In Short

- High Precision Measurement of Deuteron FF $A(Q)$ at Low Q (0.1 to 0.7 GeV/c)
- Better understanding of the deuteron, simplest interacting NN system
- Test relativistic corrections and χ PT
- Resolve discrepancy in the existing data set

Elastic e-D Scattering

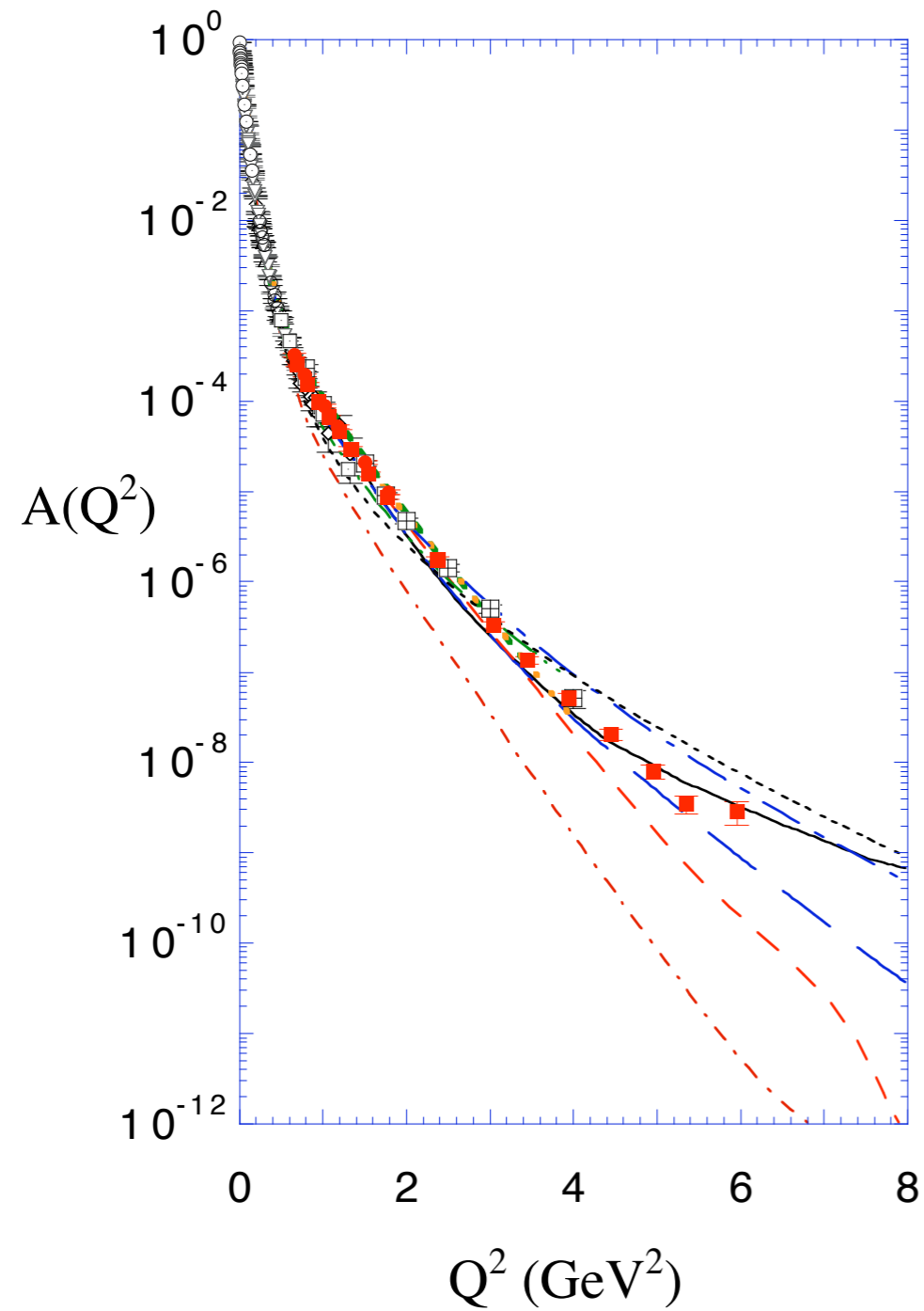
$$\frac{d\sigma}{d\Omega} = \frac{d\sigma}{d\Omega} \Big|_{NS} [A(Q) + B(Q) \tan^2(\theta/2)] \equiv \frac{d\sigma}{d\Omega} \Big|_{NS} S_d(Q, \theta)$$

$$\frac{d\sigma}{d\Omega} \Big|_{NS} = \frac{\alpha^2 E' \cos^2(\theta/2)}{4E^3 \sin^4(\theta/2)} = \sigma_M \frac{E'}{E} = \sigma_M \left(1 + \frac{2E}{m_d} \sin^2 \frac{\theta}{2}\right)^{-1}$$

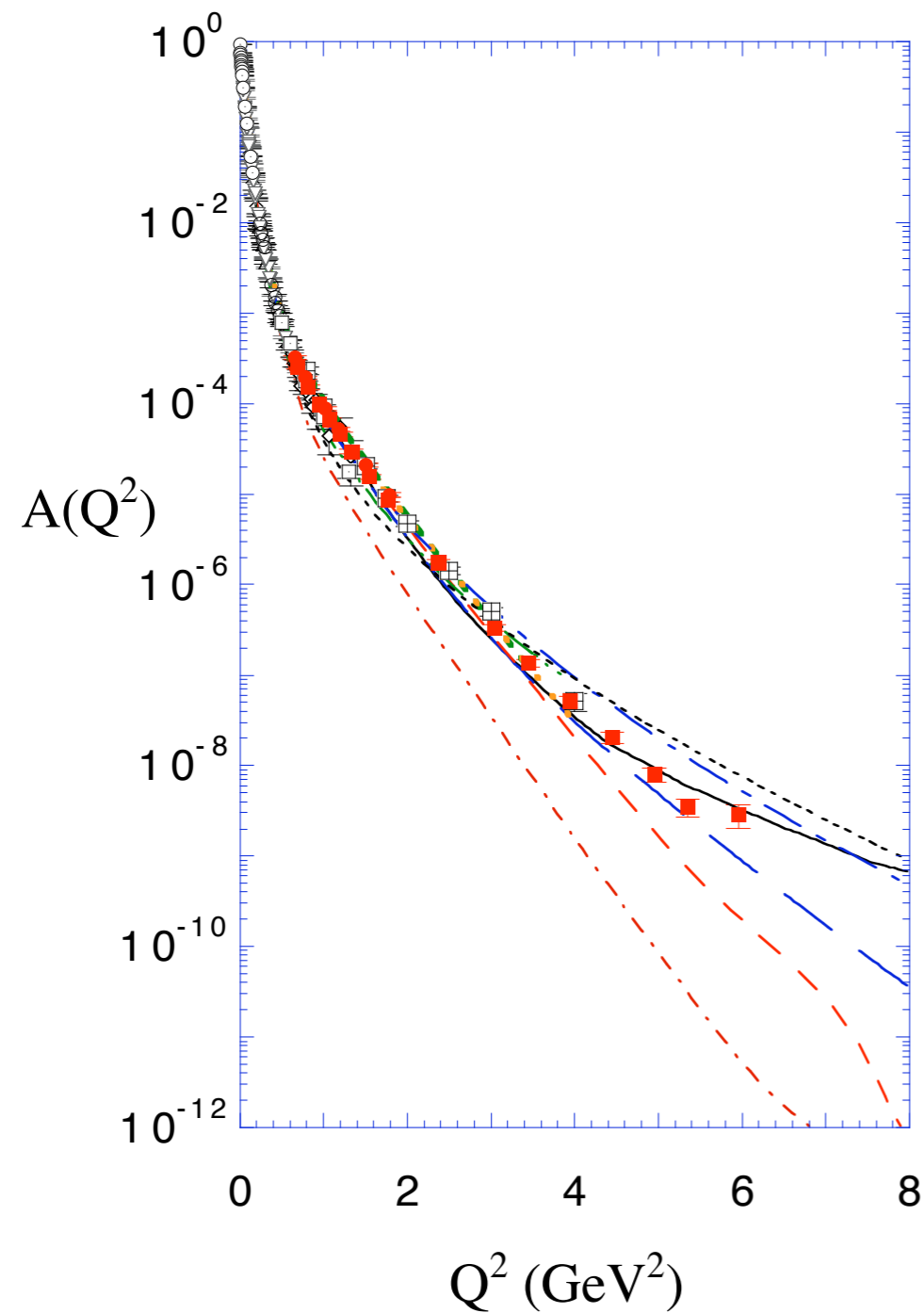
$$A(Q) = G_C^2(Q) + \frac{8}{9} \eta^2 G_Q^2(Q) + \frac{2}{3} \eta G_M^2(Q),$$

$$B(Q) = \frac{4}{3} \eta(1 + \eta) G_M^2(Q),$$

Previous Measurements

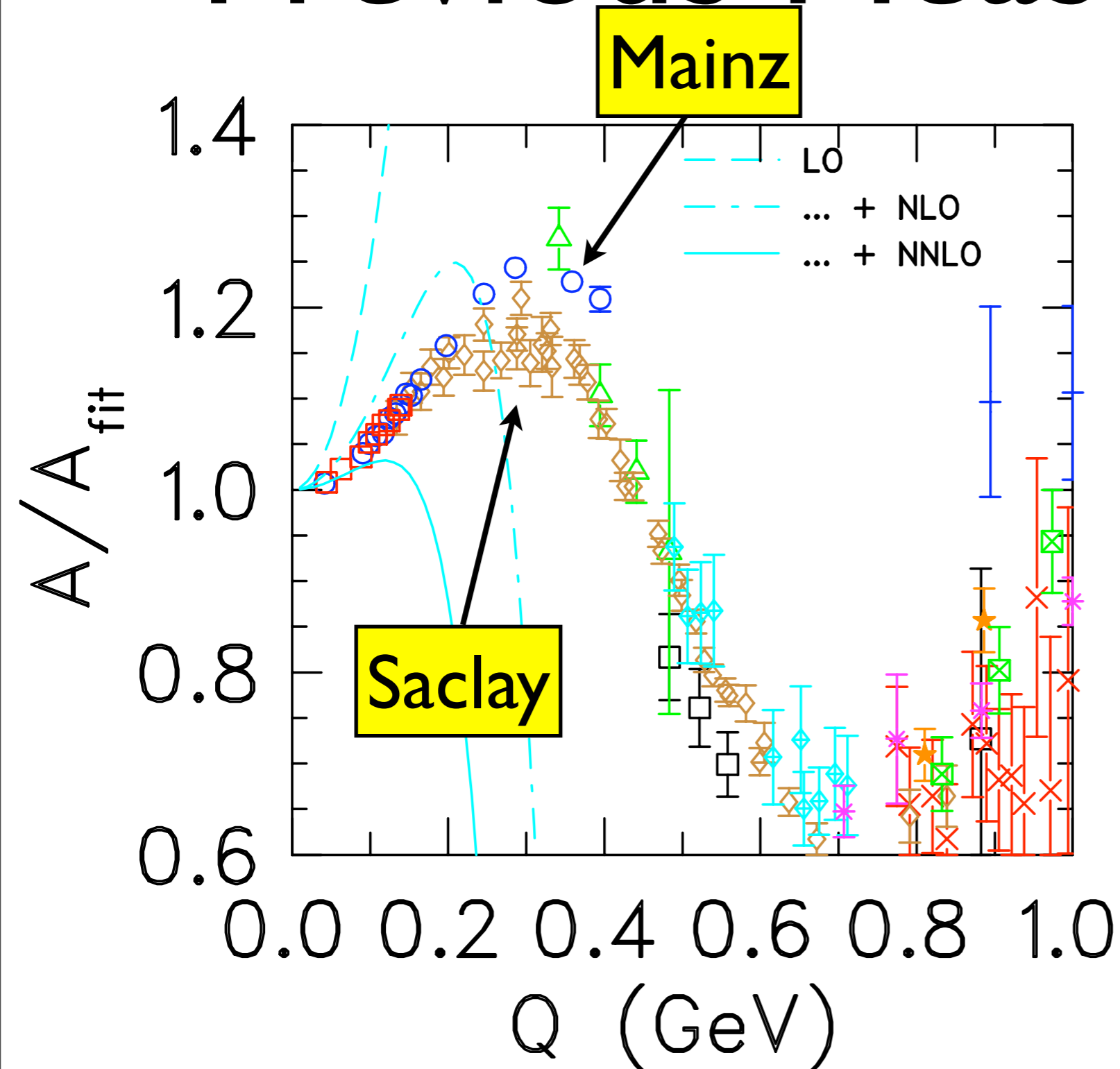


Previous Measurements



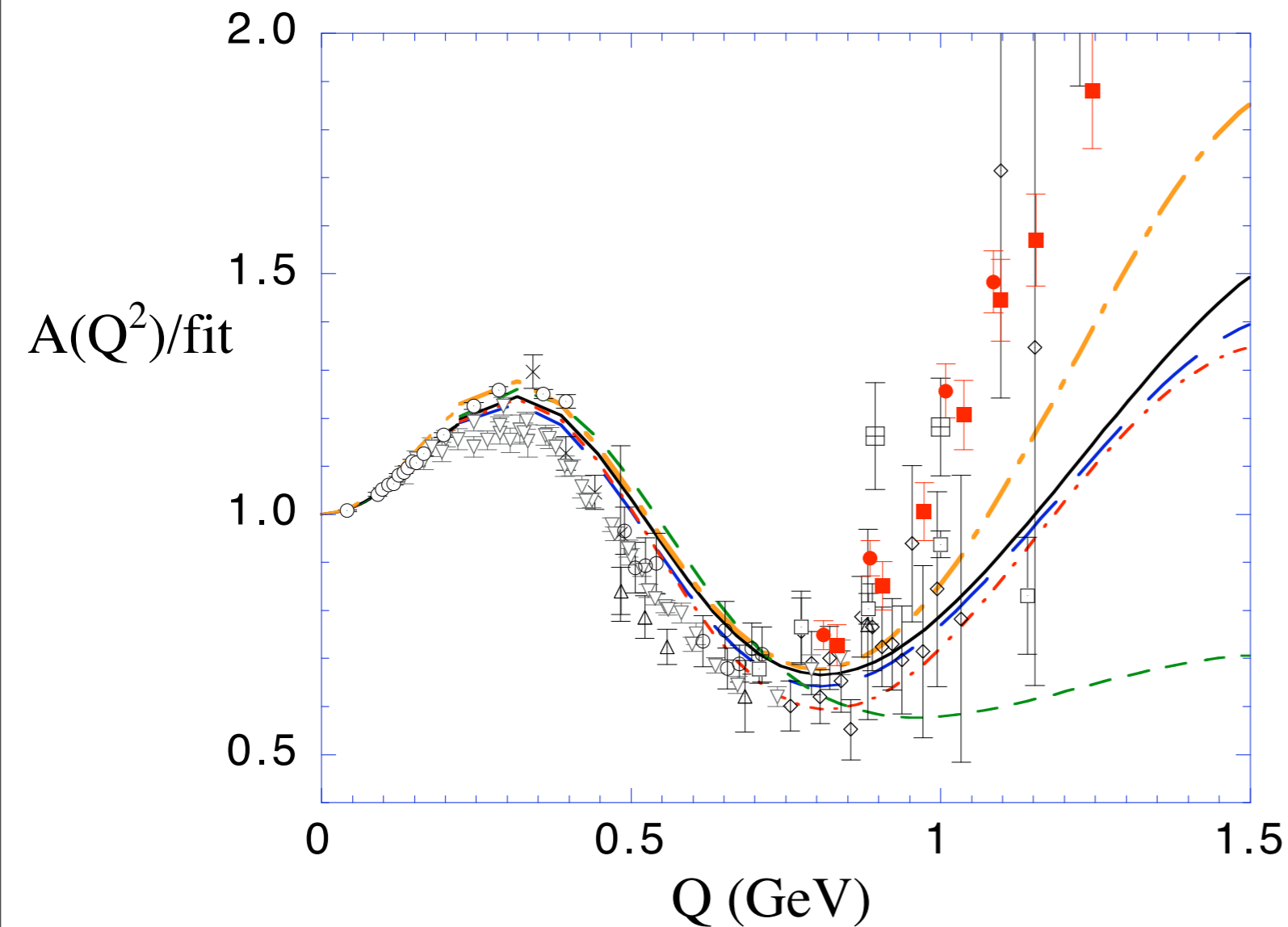
- In log scale, details are well hidden.

Previous Measurements



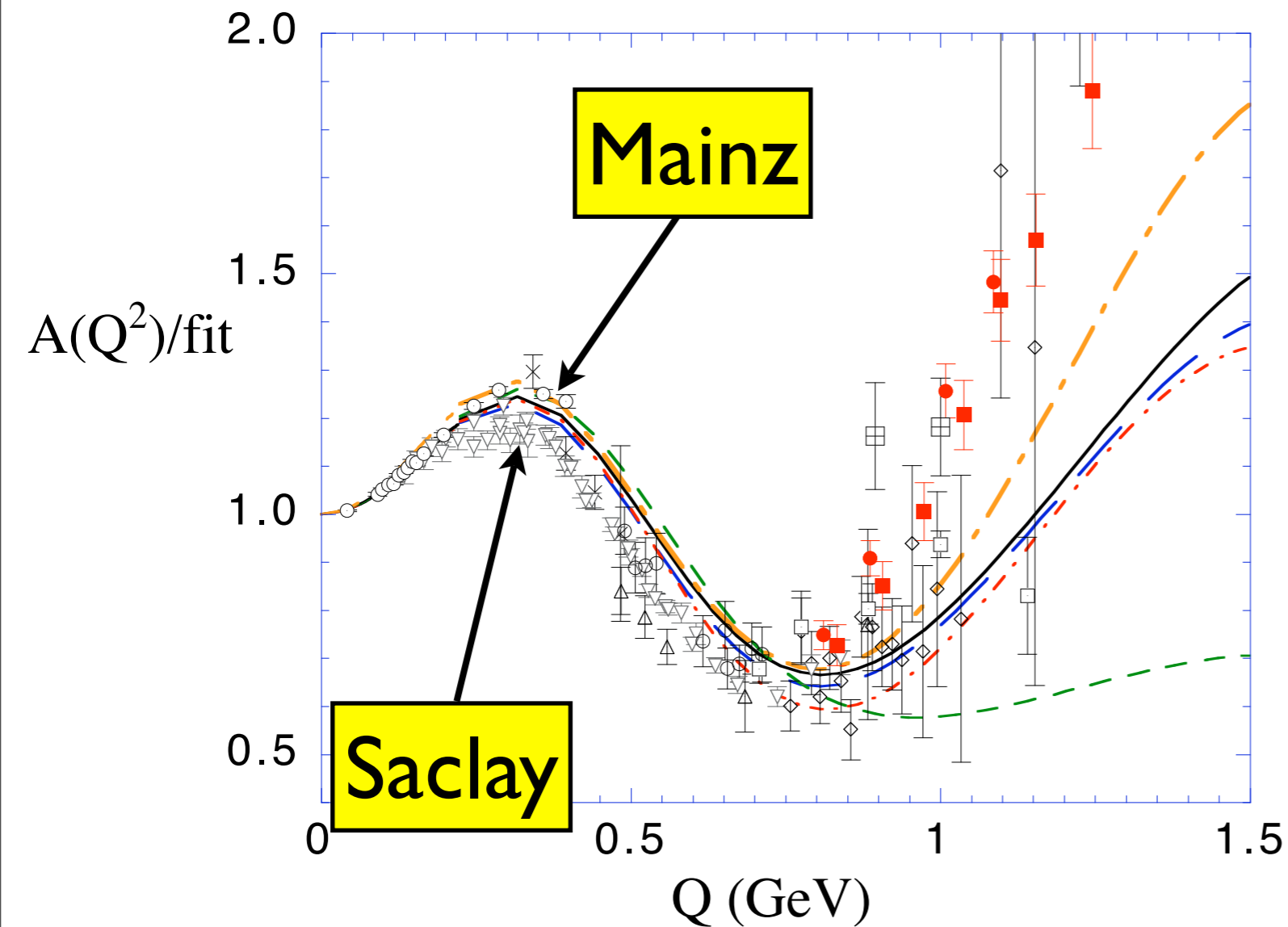
- In log scale, details are well hidden.
- Disagreement between Saclay and Mainz measurements

Theories



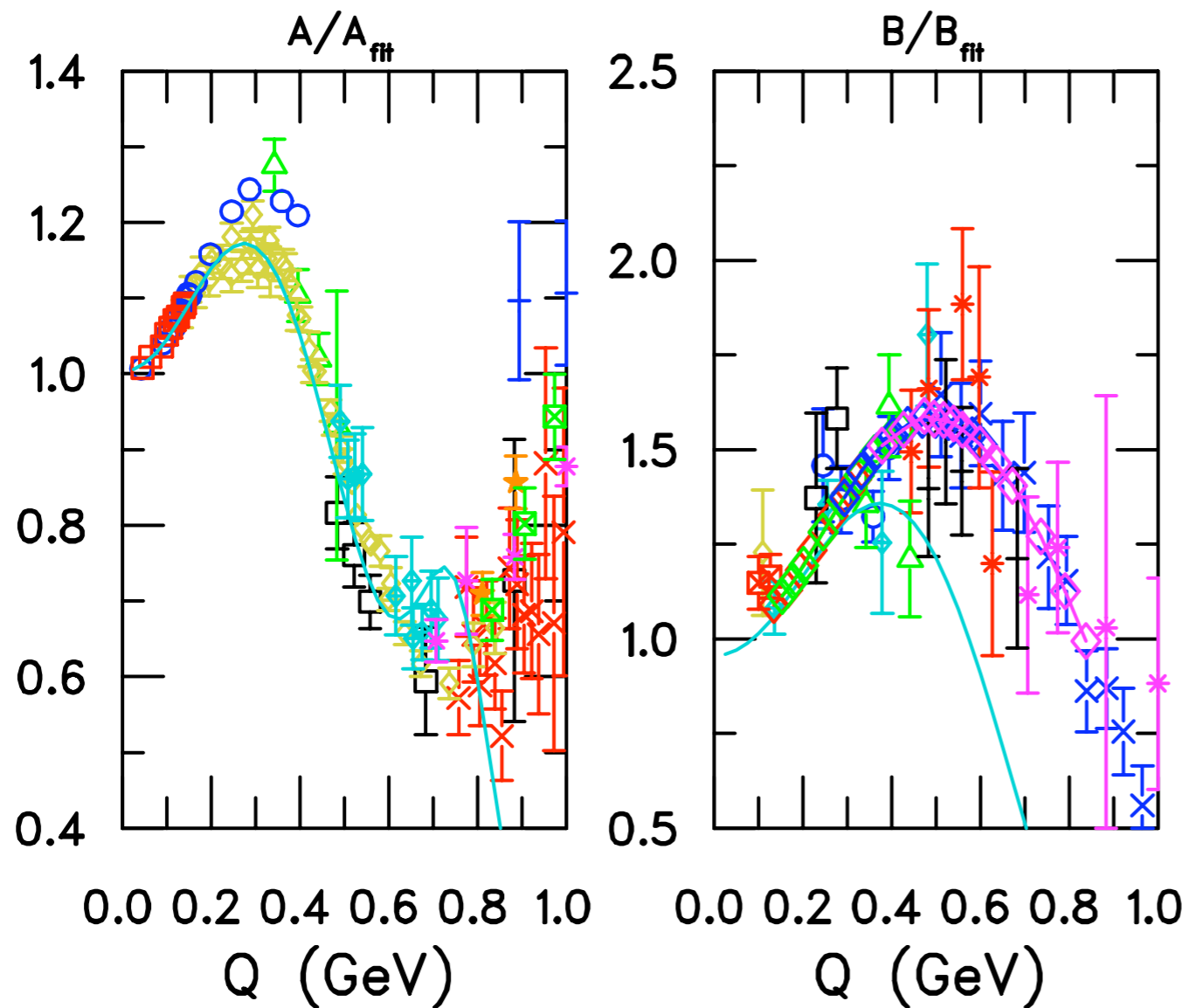
- Non-relativistic calculations agree within 2% at low Q
- The curves are in between Mainz and Saclay data
- The new measurement can confirm the sign of the relativistic corrections.

Theories



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χ^2 PT



- For $A(Q)$, better agreement with Saclay Data
- Depending on the confirmation by the new measurement
- Either next order contribution is significant or negligible

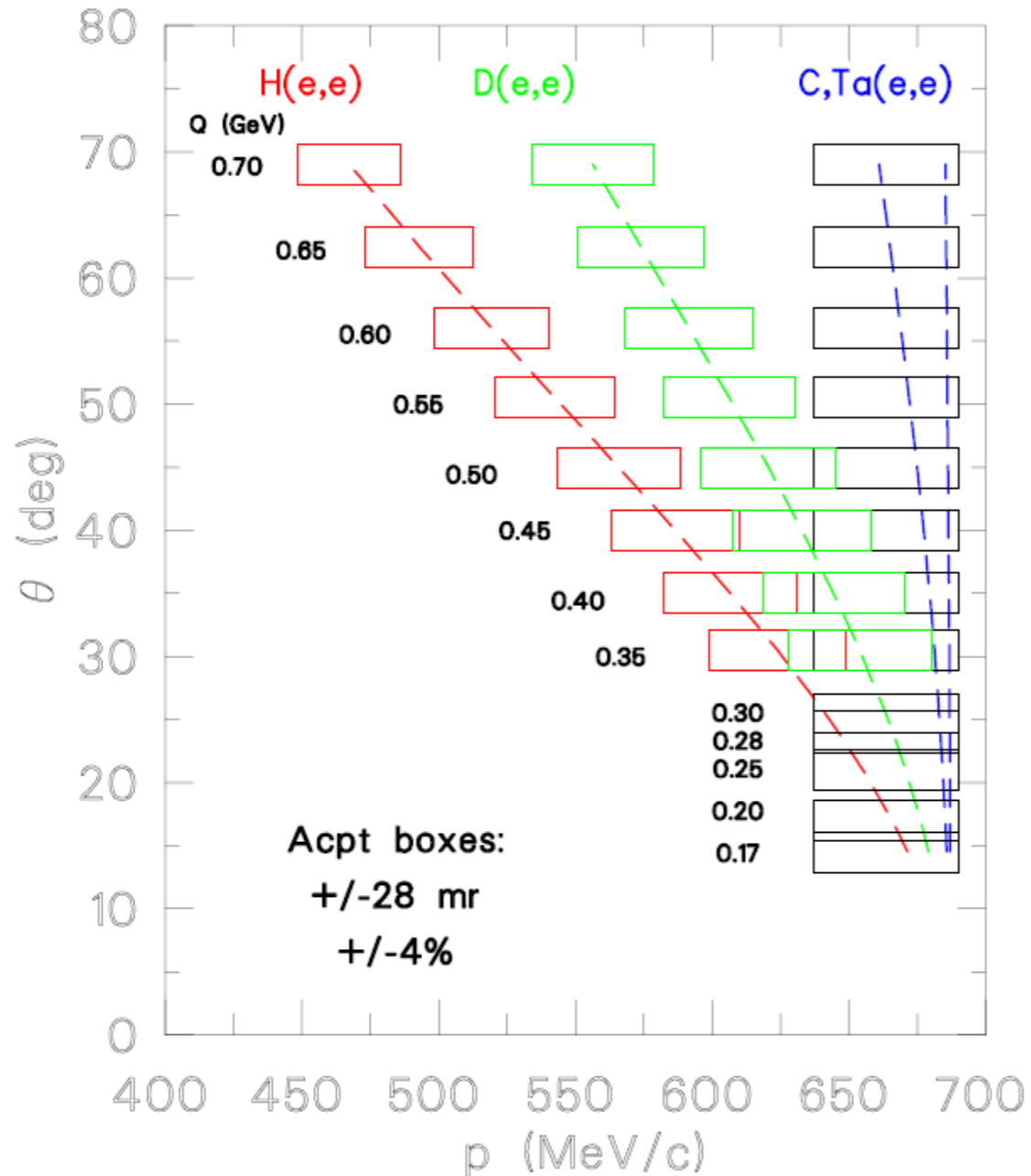
Experiment

- Measurement of $A(Q)$ with 2-3% absolute and less than 1% relative
- Several cross checks
 - Carbon elastic cross section
 - Proton elastic cross section
 - Beam energy calibration with Ta

People

- Spokespersons
R. Gilman, D. Higinbotham, Xiaodong Jiang
- Student
Byungwuek Lee
- Hall-A Collaboration

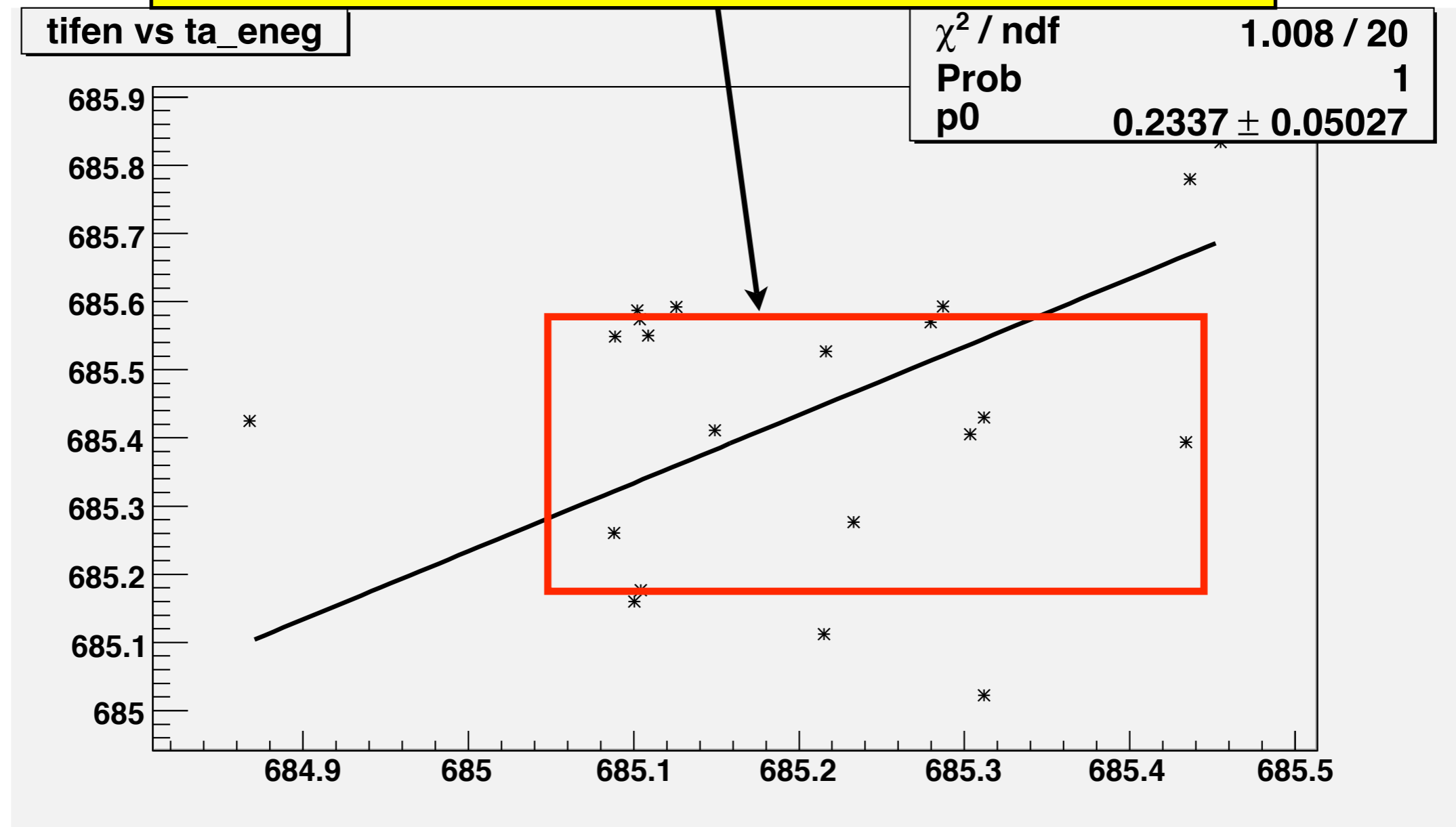
Kinematics



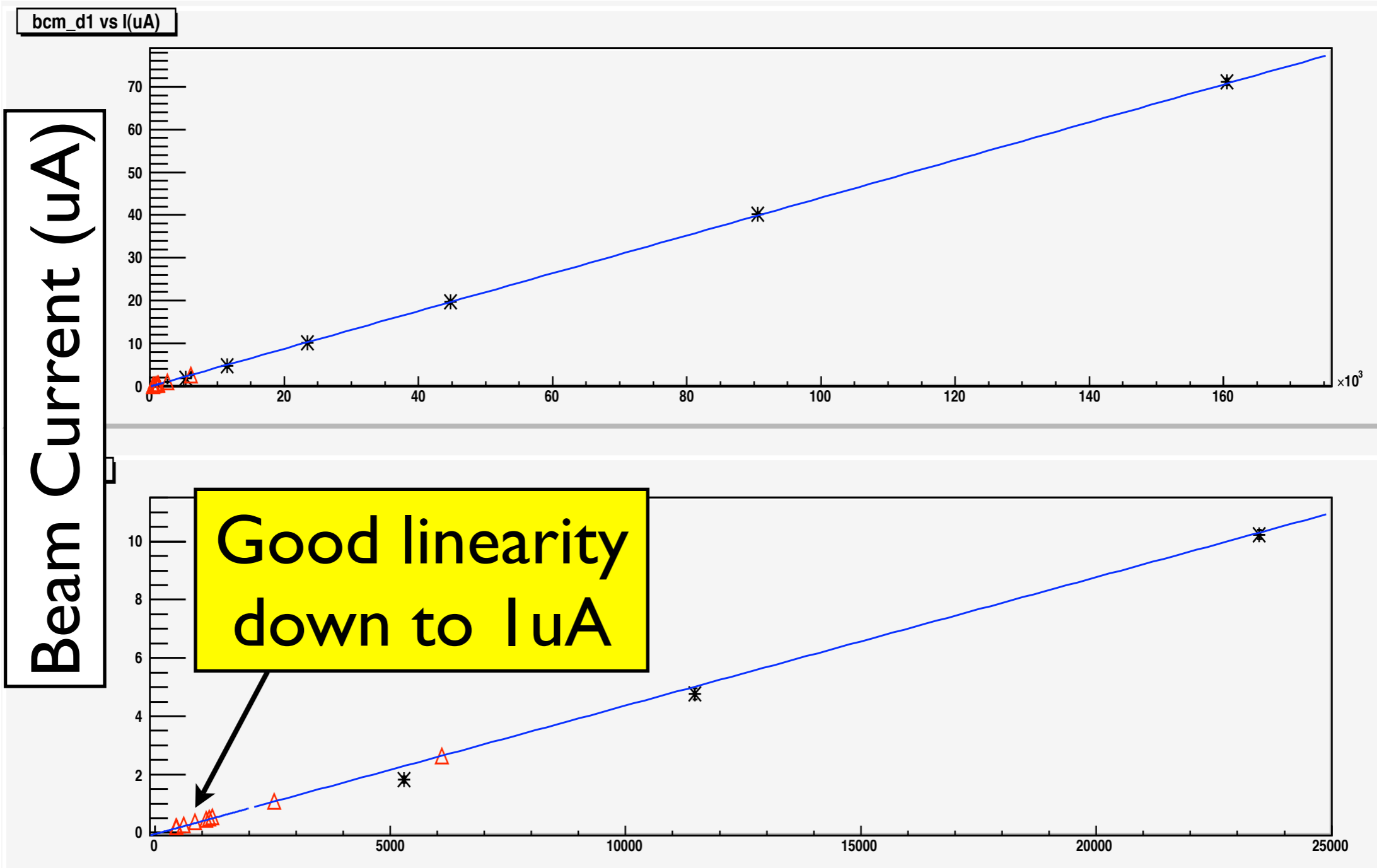
- Q range: 0.1 ~ 0.7 GeV/c
- Two beam energies: 680 and 360 MeV
- Targets: D, H, C and Ta
- Small collimator (~ 2 msr)
- Silver calorimeter for low beam current

Beam Energy Calibration

Uncertainty ~ 0.4 MeV (or 6×10^{-3})

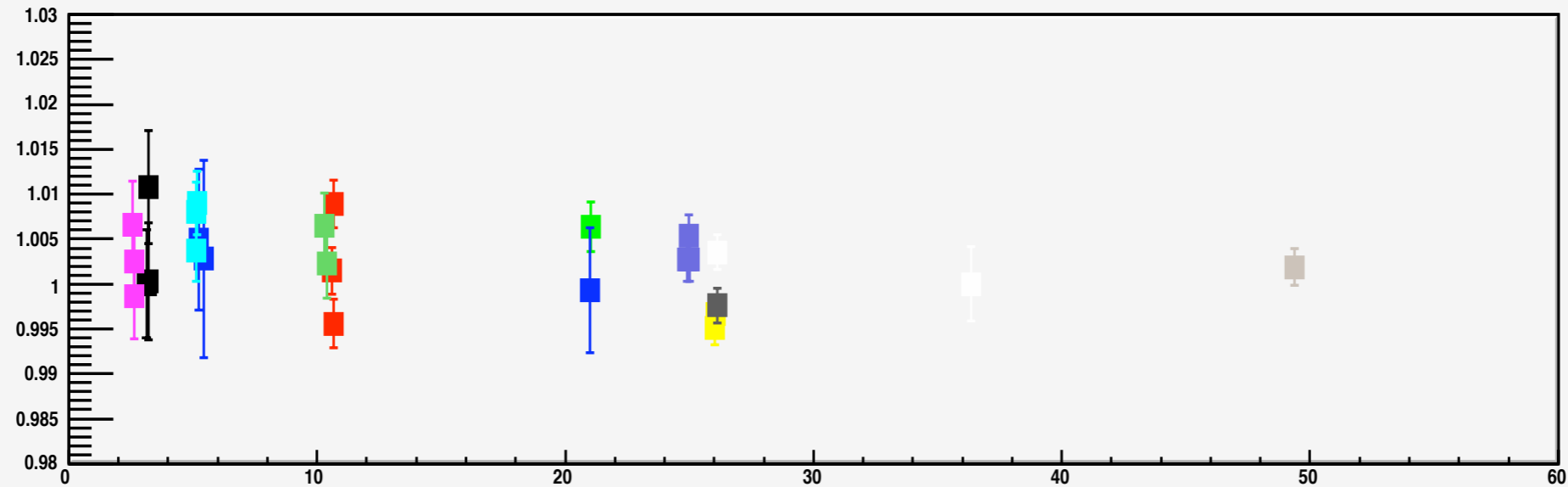


BCM Calibration

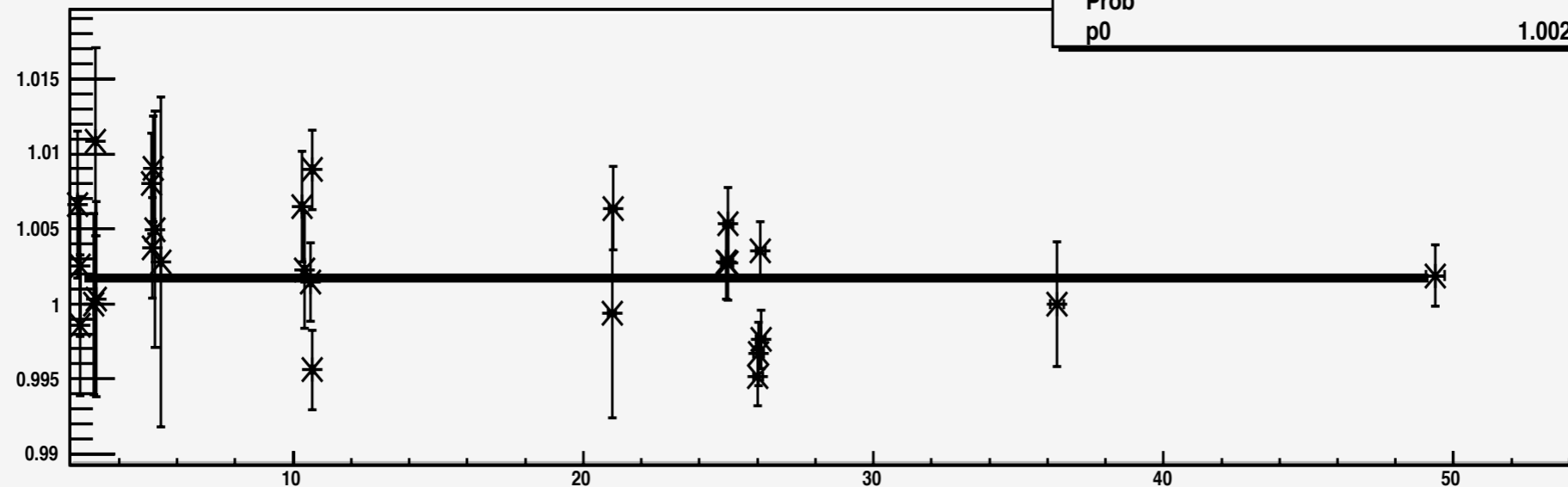


^{12}C yield vs Current

current vs cross section for carbon



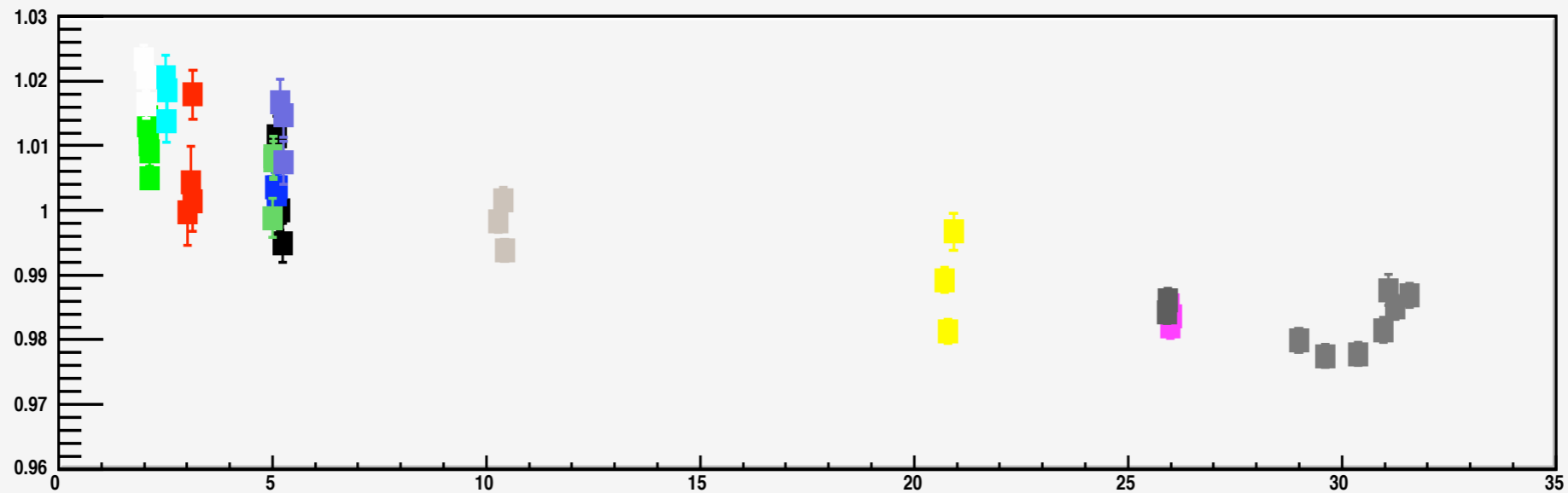
Graph



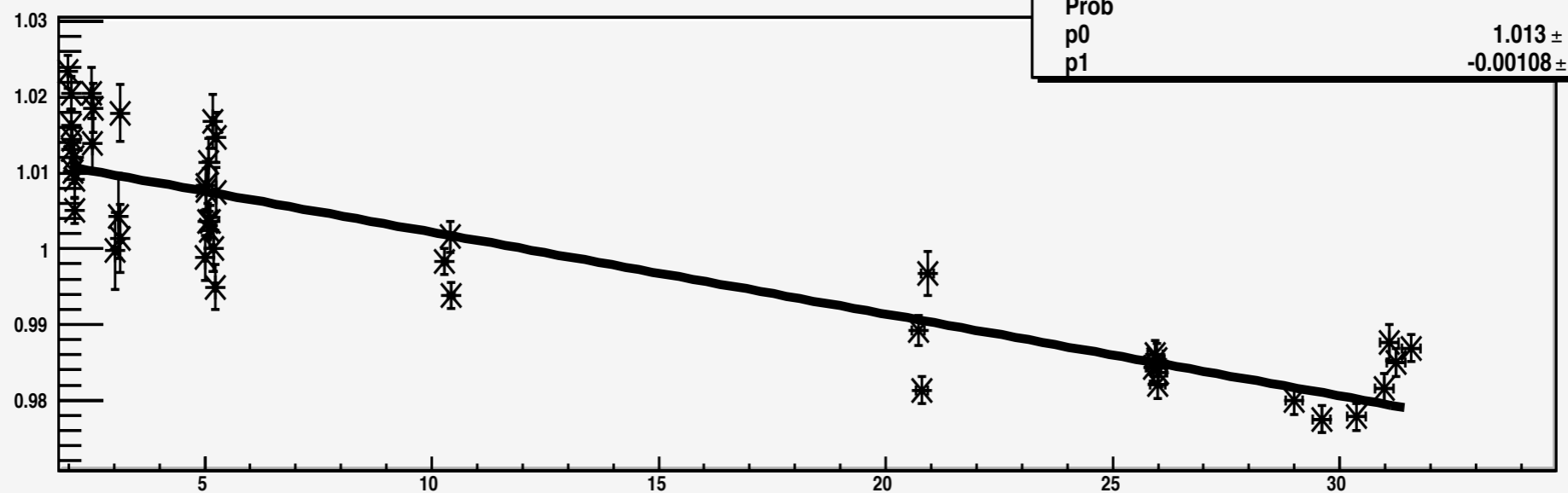
χ^2 / ndf 54.71 / 26
Prob 0.0008244
p0 1.002 \pm 0.0005732

^2D yield vs Current

current vs cross_section for deuteron



Graph



χ^2 / ndf	275.5 / 44
Prob	0
p0	1.013 ± 0.0005153
p1	$-0.00108 \pm 2.765e-05$

Summary

- Carbon yield analysis finished
- LH₂, LD₂ yield analysis in the final stage
 - Finding and fixing small corrections: BCM and BPM variations etc
- Next step
 - Analysis of low energy data
 - Radiative corrections