A High Precision Measurement of the Deuteron Spin-Structure Function Ratio g_1/F_1

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- **Experiment**
- **Differences from SANE**

$\Delta G(x)$

Experimental Setup

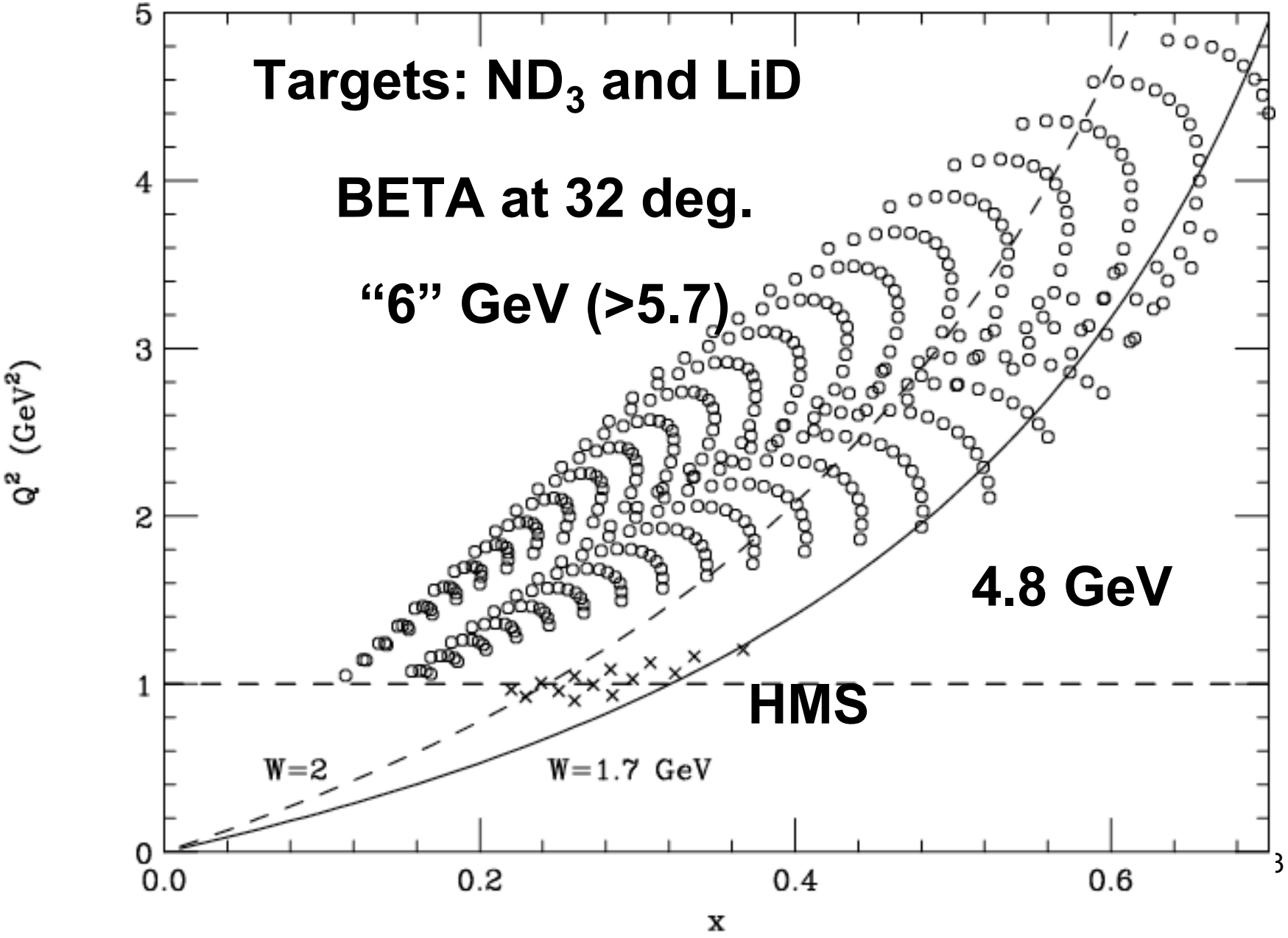
- **Longitudinally polarized beam 4-pass and 5-pass (>5.7 GeV), 100 nA (same as SANE)**

- **ND_3 and ^6LiD, longitudinal polarization only (SANE uses NH_3, perpendicular polarization too)**

- **Inclusive electrons detected in BETA at 32 degrees (and HMS). SANE uses 40 degrees.**

- **5.7 GeV part identical to deuteron part of Semi-SANE experiment except for trigger (single-arm instead of coincidence) and using ND_3 for half of time (original experiment all ^6LiD).**

Overview


Targets: ND_3 and LiD
BETA at 32 deg.
"6" GeV (>5.7)
4.8 GeV
HMS
W=2
W=1.7 GeV
Q^2 (GeV^2)
x
0
1
2
3
4
5
0.0
0.2
0.4
0.6

Transition from SANE

- **Move BigCal to 32 degrees (requires reducing beam line shielding: will preplan).**

- **Change target insert to ND_3 and ^6LiD. UVa has material needed. Keep longitudinal field (no rotation needed). Perform TE measurements.**

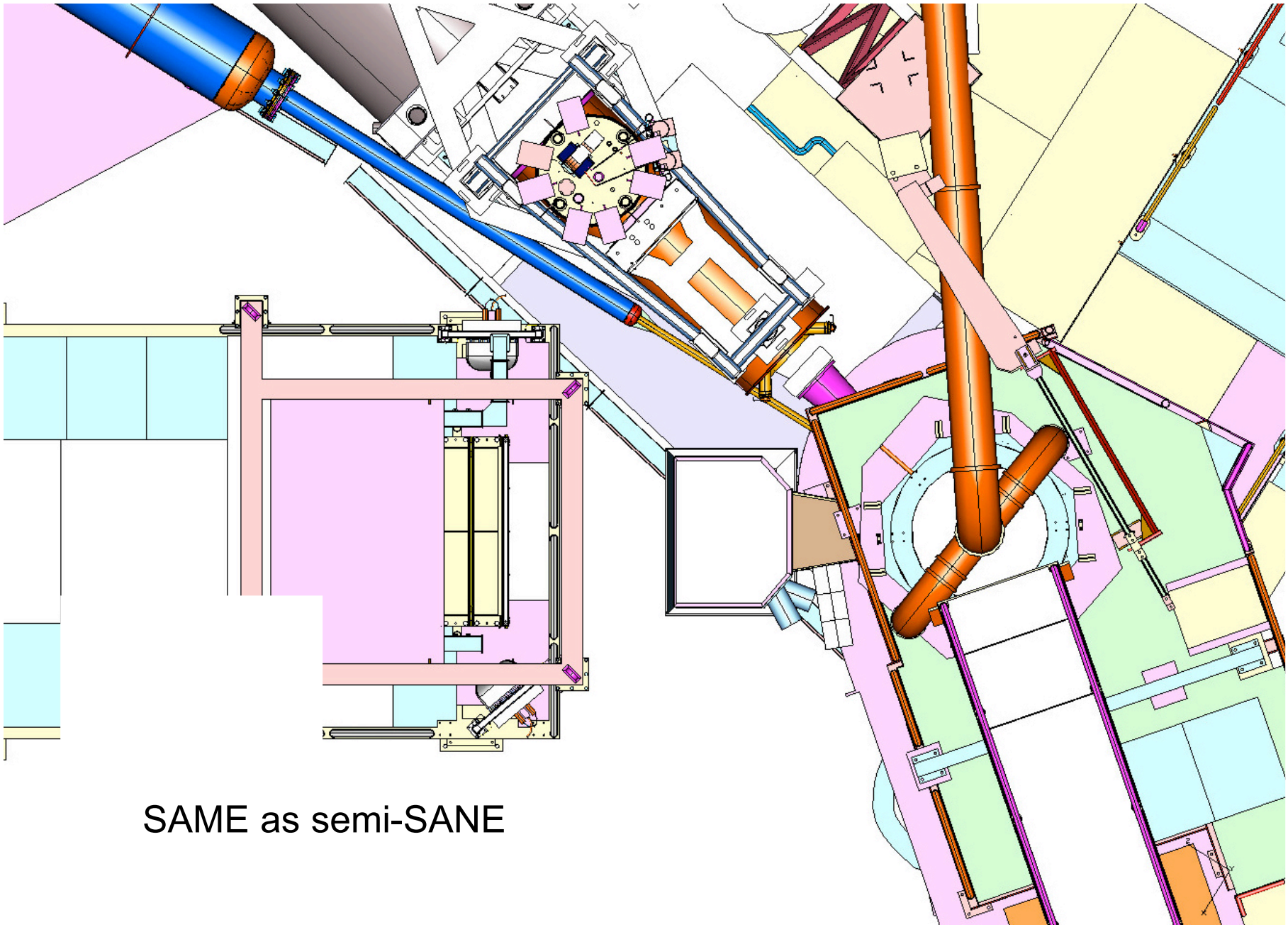
- **Change He bag to standard beam pipe.**

- **Adjust BigCal threshold to keep trigger rate below 4 to 5 kHz.**

- **Need about 1 week for transition.**

Backup Slides

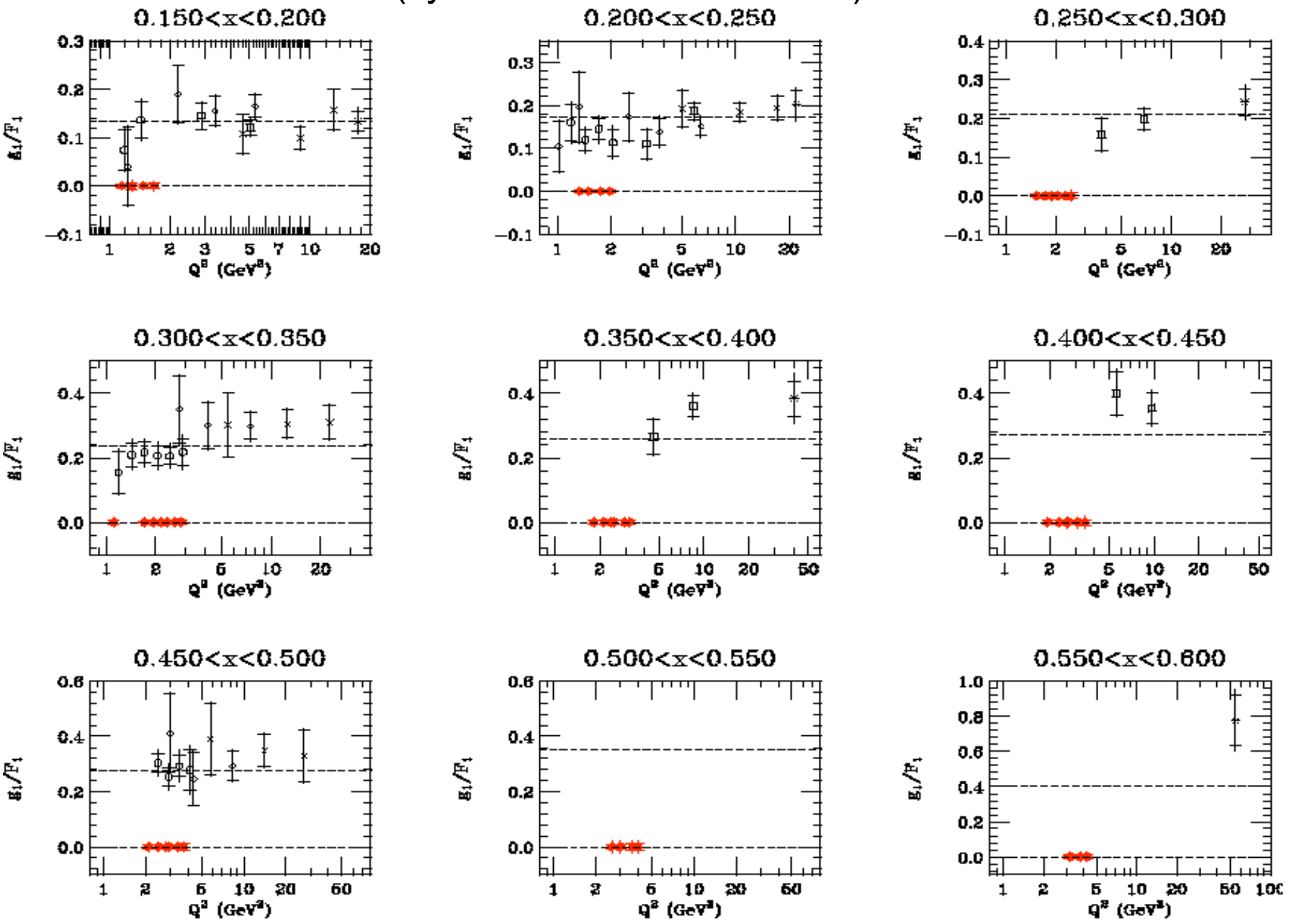
Experimental Setup



SAME as semi-SANE

Proposed data shown in red

(systematic errors included)



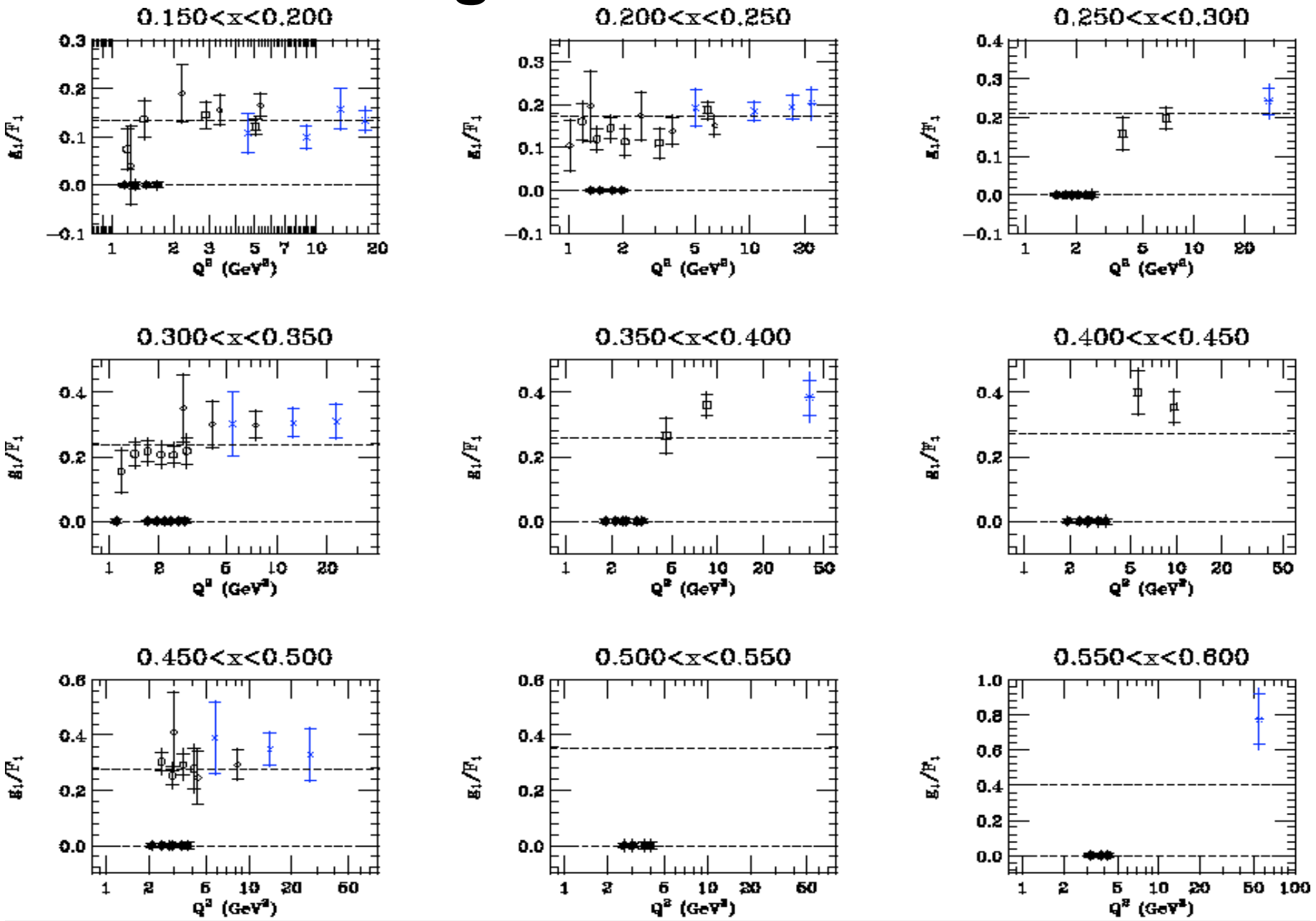
^{6}Li as Polarized Deuteron

- Most high Q^2 experiments used (SLAC) or are using (COMPASS) ^{6}LiD as target (blue points on next slide).

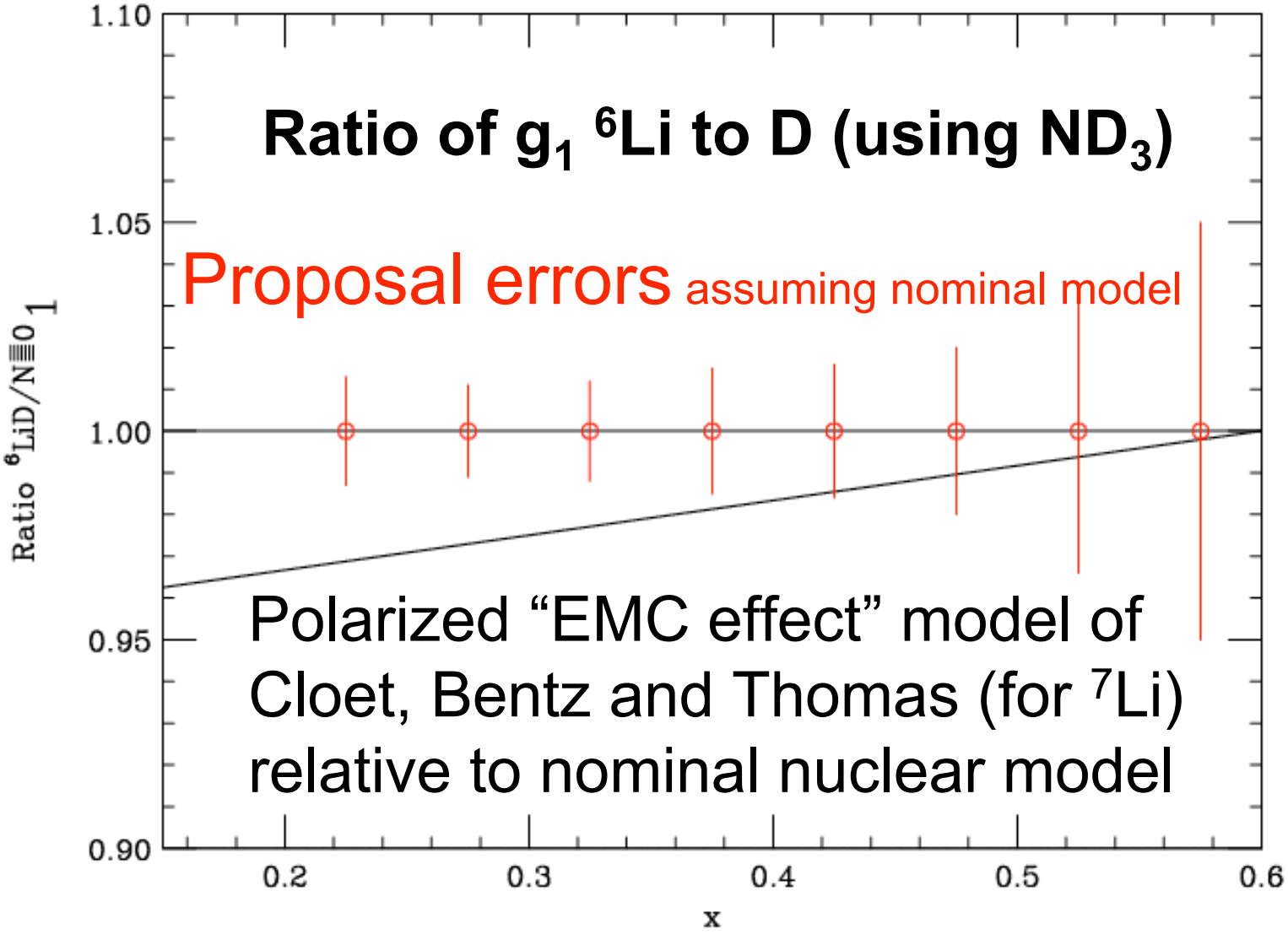
- ^{6}Li treated as unpolarized alpha particle plus deuteron with polarization 87% that of the free proton.

- If this wrong, will bias Q^2 dependence of g_1 and hence extracted gluon polarization. **Global problem we can solve.**

Existing ^{6}LiD data in Blue



Nuclear effects in ^{6}Li



Quasi-elastic Measurement

- At low Q^2, deuteron quasi-elastic peak clearly visible in HMS spectrometer (see next slide).

- Use absolute cross sections to measure D content of the ND_3 target . Cross check of ratio of ND_3 to C rates in BETA and HMS.

- Use double-spin asymmetry to obtain product of beam and target polarization (compare with full calculation of Arenhoevel including MEC and FSI). Cross check with beam Moller and target NMR (two methods).

Differences from Semi-SANE

- **Some running at 4.8 GeV in addition to 5.7 GeV running. Gas change from C4F10 to CO2 in HMS for 4.8 GeV electron running.**

- **Split 5.7 GeV time between LiD and ND_3 .**

- **Use single-arm BETA trigger as in SANE. Trigger rate expected to be of order 4 kHz. Need faster DAQ to not introduce signficant computer dead time.**

Collaboration

- 79 collaborators from 22 institutions.
- Strong overlap with SANE, Semi-SANE, polarized Compton experiments
- Expertise in BigCal, BETA, HMS, polarized target, polarimetry, data analysis.
- Two young enthusiastic spokespersons (one did thesis on g_{1d}) that can carry polarized target physics into 12 GeV era.

Summary

- **Experiment approved January 2007 with rating of "A".**
- **Compelling and timely physics: would very much like to do before 12 GeV upgrade.**
- **Only significant addition to semi-SANE is need to higher trigger rate capability (but still well below present Hall B capability)**