

Status Update on g_2^p (E08-027) and G_P^E/G_P^M (E08-007) Experiments

Kalyan Allada
Jefferson Lab

(for the Hall-A g2p/GEP Collaboration)

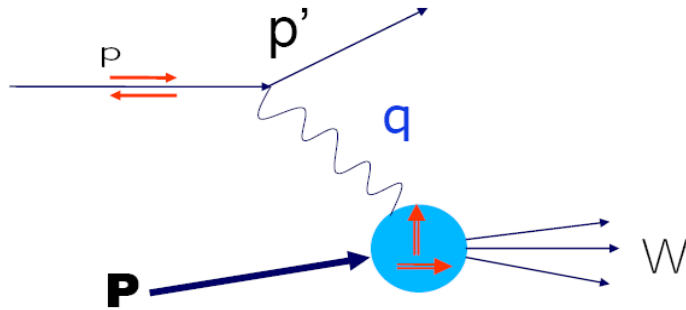
Hall-A Collaboration Meeting, Dec 9th 2010

E08-027 : Proton g_2 Structure Function

A⁺ rating by PAC33

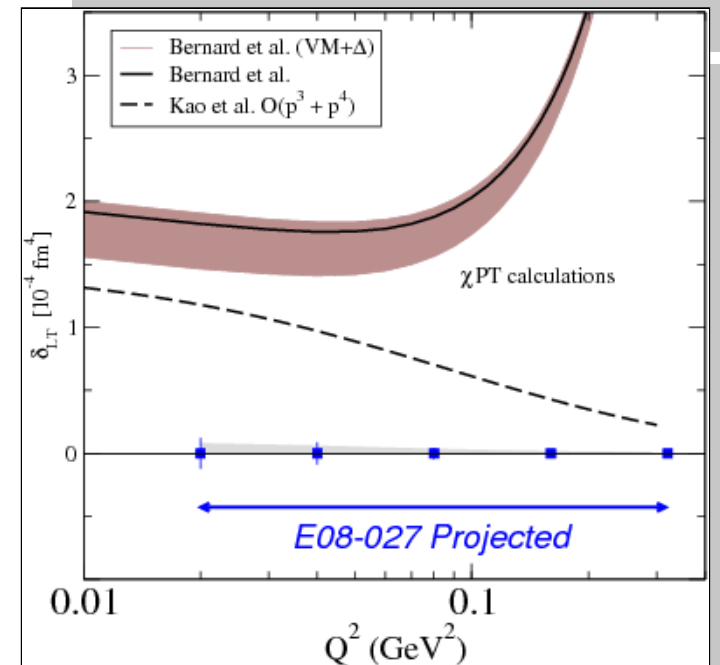
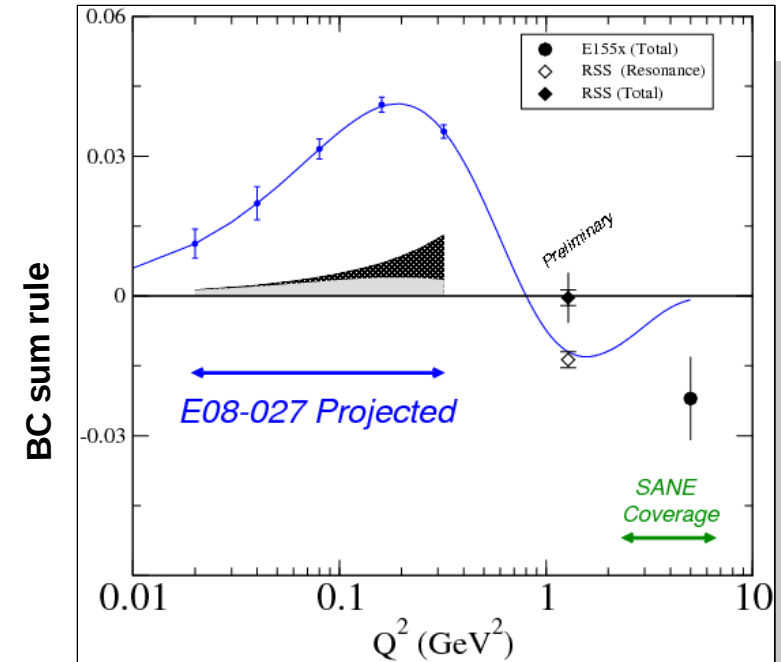
Spokespeople: A.Camsonne, JP.Chen, D. Crabb, K.Slifer

Inclusive scattering



$$\frac{d^2\sigma}{d\Omega dE'} = \sigma_{Mott} \left[\frac{1}{2} F_2(x, Q^2) + \frac{2}{M} F_1(x, Q^2) \tan^2 \frac{\theta}{2} \right] + \gamma g_1(x, Q^2) + \delta g_2(x, Q^2)$$

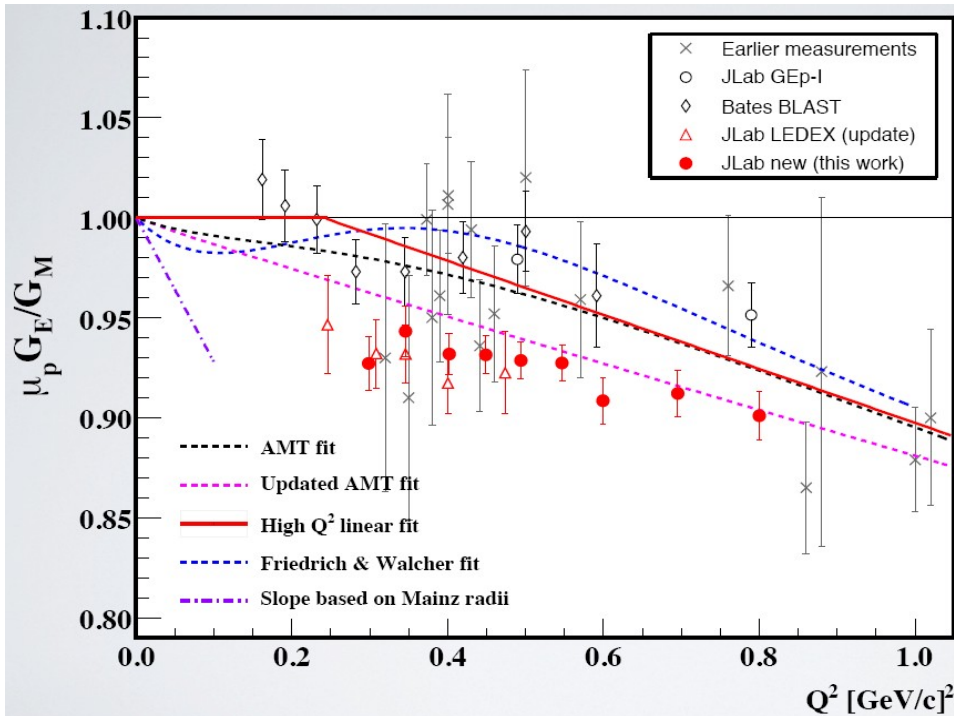
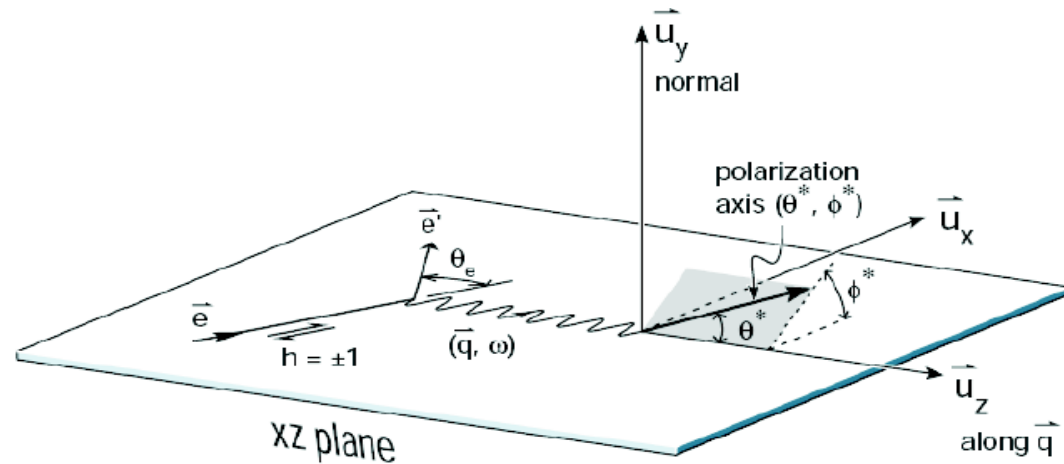
- Fundamental observable, never been measured in low and moderate Q^2 ($0.02 \text{ GeV}^2 < Q^2 < 0.4 \text{ GeV}^2$)
- g_1 is precisely measured in wide range of Q^2 ($0.015 \text{ GeV}^2 - 30 \text{ GeV}^2$), but g_2 not very well measured
- **BC Sum Rule:** violation suggested for proton at large Q^2 , but found to be satisfied for neutron and ^3He
- **Spin Polarizabilities:** fundamental observables, test of chiral perturbative calculations



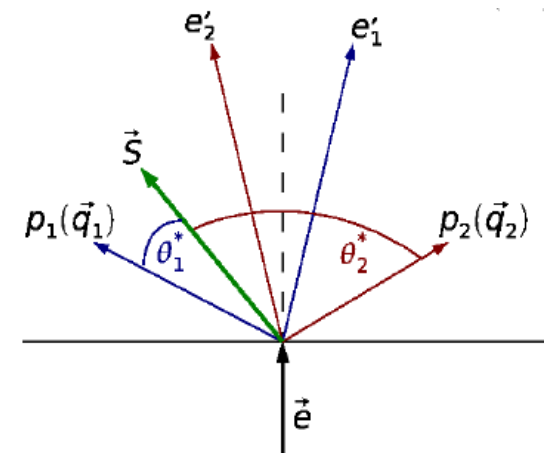
E08-007: G_P^E/G_P^M at Low Q^2 (Part II)

Spokespeople: J.Arrington, R. Gilman, A. Sarty, G.Ron, D. Higinbotham

- Part-I (using recoil polarimetry method) finished in Summer 2008 ($0.25 \text{ GeV}^2 < Q^2 < 0.7 \text{ GeV}^2$)
- Part-II will use double spin asymmetry method ($0.015 \text{ GeV}^2 < Q^2 < 0.4 \text{ GeV}^2$)
- Measure asymmetry in both HRS at the same time (equal acceptance)
- Ratio of asymmetries gives G_P^E/G_P^M



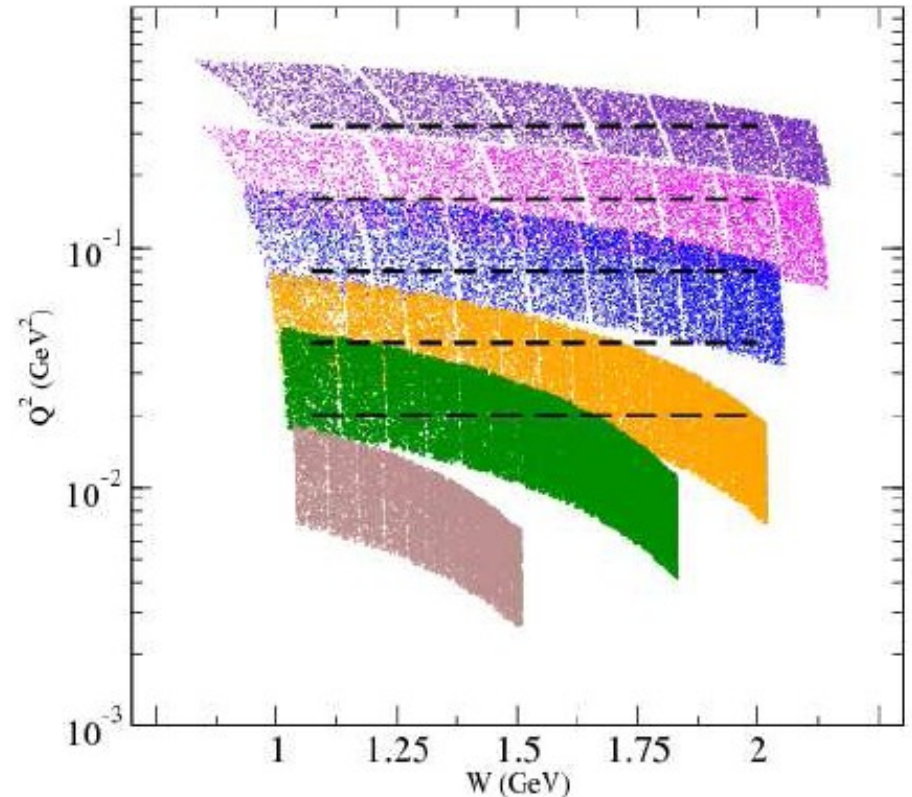
$$\mu_p \frac{G_E}{G_M} = -\mu_p \frac{a(\tau, \theta) \cos \theta_1^* - \frac{f_2}{f_1} \frac{A_1}{A_2} a(\tau, \theta) \cos \theta_2^*}{\cos \phi_1^* \sin \theta_1^* - \frac{f_2}{f_1} \frac{A_1}{A_2} \cos \phi_2^* \sin \theta_2^*}$$



(plot from G.Ron's talk)

g_2^p Kinematics and Hall-A Setup

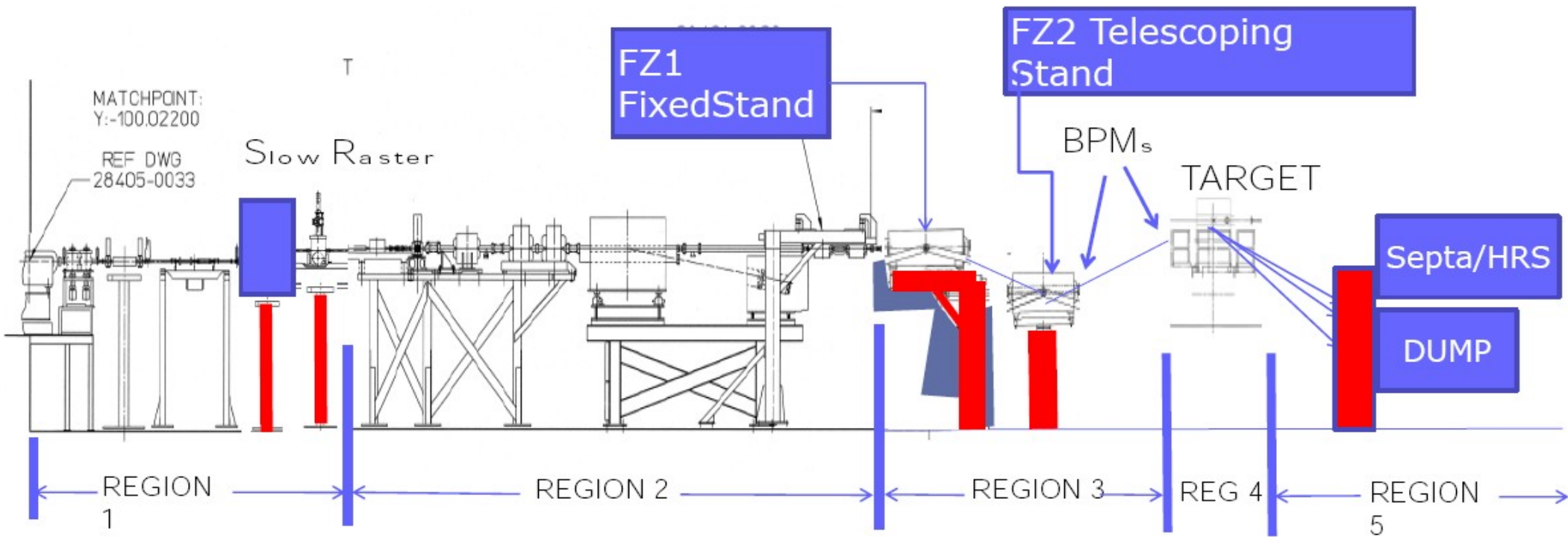
- Polarized beam : 50 - 130nA
- Polarized NH_3 target (5T field)
- Target polarization at 90° (transverse) for all settings
- At 0° (longitudinal) for 3.3 GeV (cross-check with existing data)
- G_E^p require target pol. direction to be 80°
- Two configurations :
 - with septa (6°) and target at 87cm upstream of the pivot
 - without septa (12.5° and 15°) and target at the pivot
- G_E^p configuration is same as g_2^p at elastic setting



HRS angle (degrees)	Beam Energy (GeV)
6 (septa)	1.1, 1.6, 2.2 and 3.3
12.5	3.3
15	2.2

Major Equipment Required

- Polarized solid NH_3 target (UVa/Hall-C)
 - Some changes to Hall-C scattering chamber (entrance/exit windows etc..)
- Beamline Modifications
 - Add magnetic chicane
 - Electronics modifications for BPM/HARP/BCM for low current running
 - Add of slow raster (25mm diameter)
- Local beam dump close to the target
- Use modified PREX septum magnet for 6° running
 - Add high field coils



Update on Polarized NH₃ Target

(Chris Keith et al.)

- Bi-weekly meetings on Thu. 1.30PM in room A110
- **Magnet status:**
 - Sent for repairs, still at Oxford company, expected to be on-site in Feb 2011
- **Mostly in design stage:**
 - Working on drawings for a new 1K refrigerator
 - New pumps
 - New target inserts
 - Buffer dewar, new cryo lines etc ..
 - Electronics mount in the Hall
- **Target Irradiation:** NIST, FEL and ISU (NIST is convenient and inexpensive)
- Target cool down at UVA (Jan 2011 ?)
- Target polarization
 - NMR
 - Monitor elastic asymmetry from NH₃ (gives $P_T P_b$)
 - Looking into detecting recoil proton with a third arm at large angles (70° to 80° ?)

Beamline Update

Coordination:

- Tim Michalski (Engineering division)
- Weekly meetings on Tue 8.30am at MCC

Engineering/Design

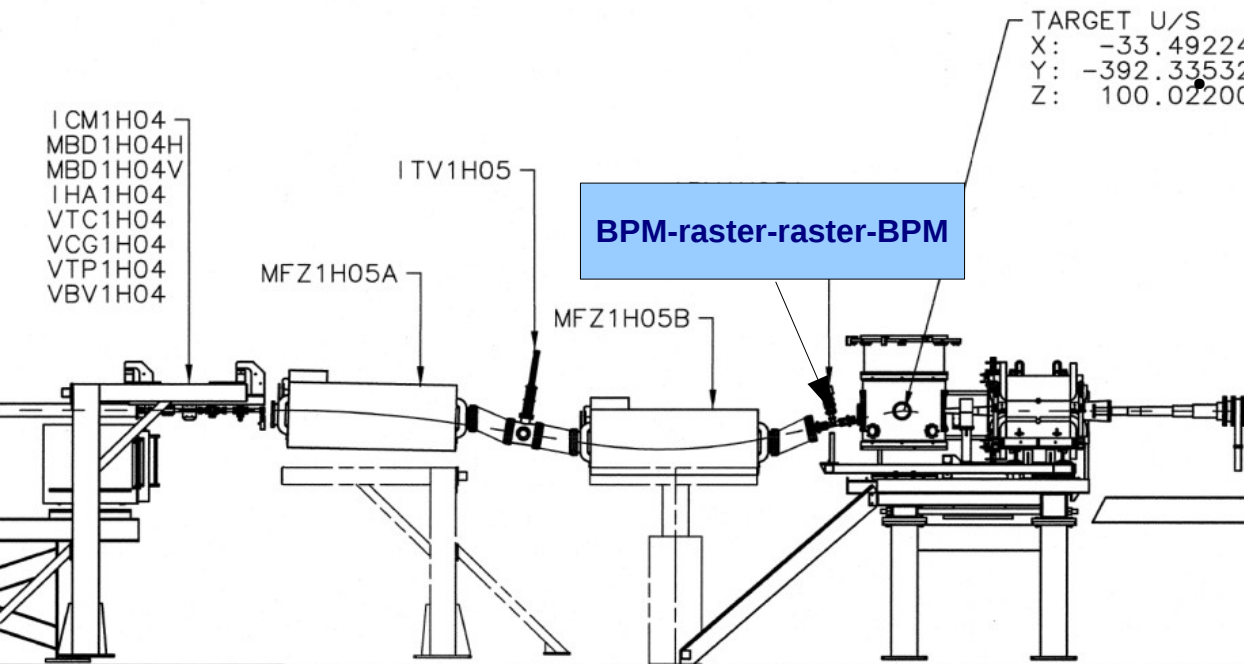
- Design layout is almost final (sent out for signatures)
- Chicane:
 - Existing FZ1 and FZ2 magnets need some modification
 - Power supplies from Hall-C

Beam Diagnostics

- **BPM / HARP:** (John Musson et al.)
 - **Will not use stripline BPM** (dropped by 12GeV upgrade project due to low S/N)
 - Use M15/M20 type with new electronics for low currents (ready by Sept 2011)
 - **BPM requirements: 0.1mm resolution**
- **BCM:** Use existing BCM with upgraded electronics
- **Slow raster** (30Hz) and standard fast raster (Chris Cuevas et al.)
- **Tungsten calorimeter:** for absolute beam position measurement, need more work !

Beam polarization:

- Moller
- Compton (not likely due to high current requirement for Compton)



Monte Carlo Simulations

(J. Zhang and M. Huang)

- Understand HRS acceptance due to addition of target field + septum (new configuration in Hall-A)
- Starting point : Use Hall-A SAMC + SNAKE
 - Modify SNAKE to add target field + septum magnet (done, J. Leroise)
 - Generate both forward and backward transport functions
 - Use these in SAMC for the simulations
 - Add energy loss for the target region (done)
- Optics:
 - Sieve slit design (standard HRS one will work?)
 - Rates from carbon foil target (100nA)
 - At 6° setting: rates are good for all beam energies (1.1, 1.6, 2.2 3.3 GeV)
 - At 12.5° and 15° setting: not enough rates (will need simulation)
- Software:
 - Source code available on svn repository :
 - <https://jlabsvn.jlab.org/svnroot/halla/groups/g2p>

Timeline

- Engineering/Design/Manufacture: 5/2011
 - most of the engineering/design will be done by 2/2011
- Installation: 5/2010-11/2011
- Commissioning: 11/2011
- Data taking: 11/2011-3/2012
- Remove septa and move target location: 1/2012

Manpower

- **PhD Students:**
 - Pengjia Zhu (USTC, advisor: Yunxiu Ye), 3rd year, onsite
 - Min Huang (Duke, Haiyan Gao), 3rd year, onsite
 - Chai Gu (UVa, Nilanga Liyanaga), 2nd year, onsite from 1/2011
 - Melissa Cummings (W&M, Todd Averett), 2nd year, onsite from 5/2011
- **Postdocs:**
 - Kalyan Allada (Hall A) (Beamline, detectors etc..)
 - Jixie Zhang (Hall A) (MC simulations)
 - Narbe Kalantarians (UVa)
 - Hovhannes Baghdasaryan (UVa)
 - Xiaohui Zhan (Argonne)
- **Physicists:**
 - Jian-ping Chen (Hall A) (Project Manager and point of contact)
 - Alexandre Camsonne (Hall A)
 - Doug Higinbotham(Hall A)
 - Karl Slifer (New Hampshire)
 - Guy Ron (LBNL)
- **More people are expected to join as we make progress...**

Summary

- **Beamline:** Making good progress, immediate issue to address:
 - new electronics for BPM/BCM (ready by Sept 2011?)
 - given all the constraints, how well we can get to 0.1mm position resolution?
- **Target** is mostly in the design/repair stage, lot more action is expected early next year
- **Analysis/Software:**
 - students have started modifying the existing MC code
 - building a framework for the experiment to address any questions related to the acceptance, optics/sieve etc..

Thank You!