SANE

Spin Asymmetries of the Nucleon Experiment

(TJNAF E07-003)

Basics of experiment

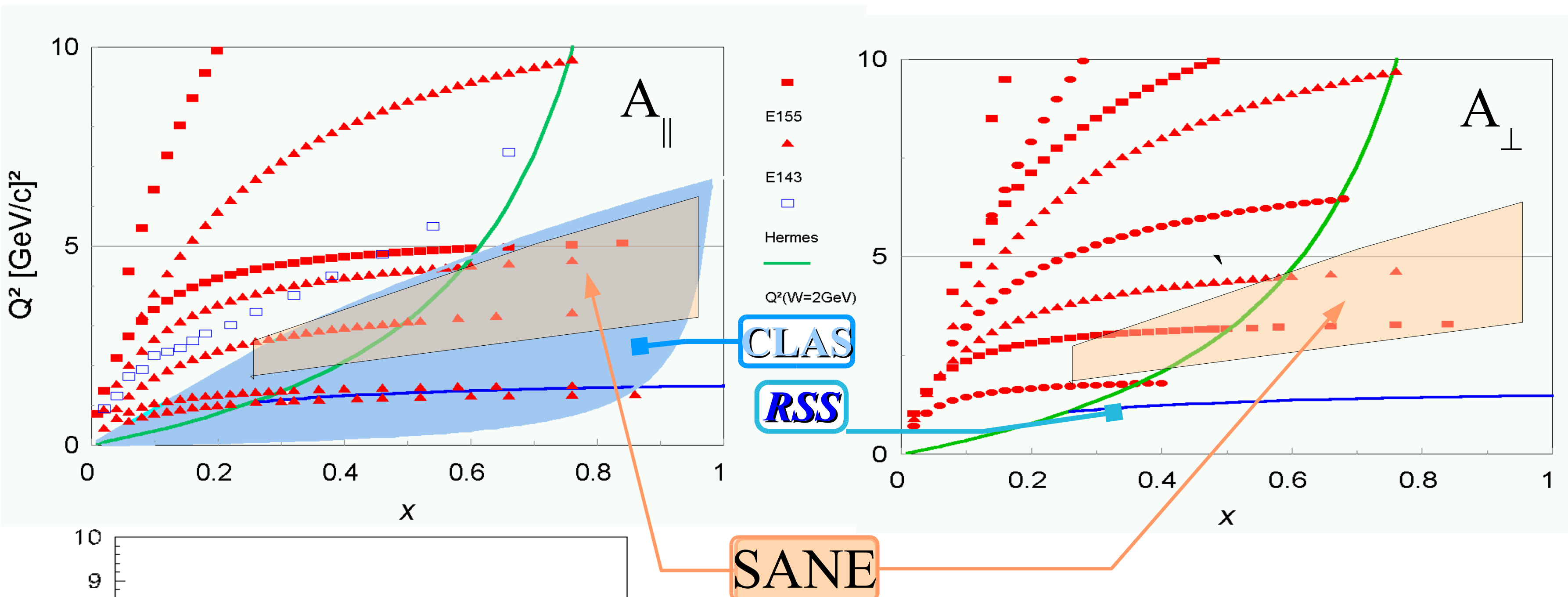
Measured polarized beam- polarized target asymmetries with target spin oriented 0^{o} and 80^{o} to the beam direction.

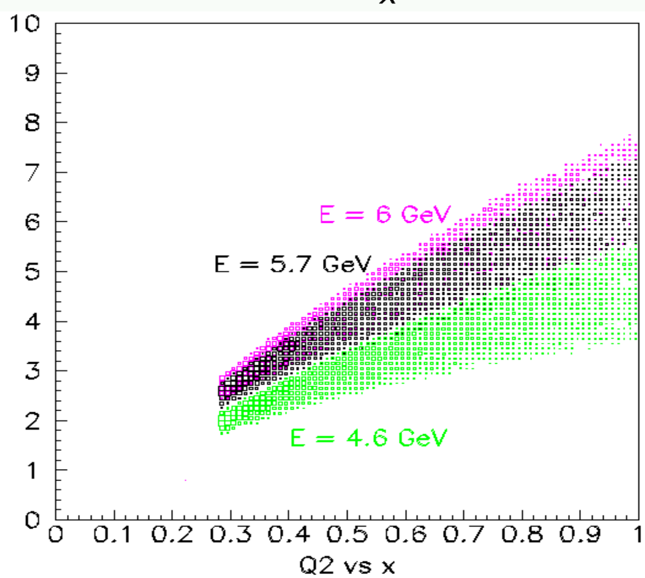
Experiment runs in both orientations at beam energies of 4.7 and 5.9 GeV . Calibration at 2.4 using 0^{o} orientation.

SANE Physics

- Measure proton spin structure function $\boldsymbol{g_2}(x, Q^2)$ and spin asymmetry $\mathbf{A_1}(x, Q^2)$ at four-momentum transfer $2.5 \leq \boldsymbol{Q^2} \leq 6.5$ GeV^2 and Bjorken $\boldsymbol{x}$ $0.3 \leq \boldsymbol{x} \leq 0.8$
  - **Meets or Exceeds DOE 2011 Milestone for Proton Spin Structure**
- Goal is to learn all about proton SSF's from inclusive double polarization measurements of parallel and near-perpendicular spin asymmetries
  - twist-3 effects from third moments of $\boldsymbol{g_2}$ and $\boldsymbol{g_1}$:
    - $\boldsymbol{d_2}$ matrix element $= \int_0^1 x^2 (3\, \boldsymbol{g_2} + 2\, \boldsymbol{g_1})\, dx$
  - comparisons with Lattice QCD, QCD sum rules, bag models, chiral quarks
  - Study x dependence (test nucleon models) and Q^2 dependence (evolution)
  - Exploration of "high" $\boldsymbol{x}$ region: $\mathbf{A_1}$'s approach to $\boldsymbol{x} = 1$
  - Test polarized local duality for final state mass $W > 1.4$ GeV
- Detect electrons with novel large solid angle electron telescope **BETA**

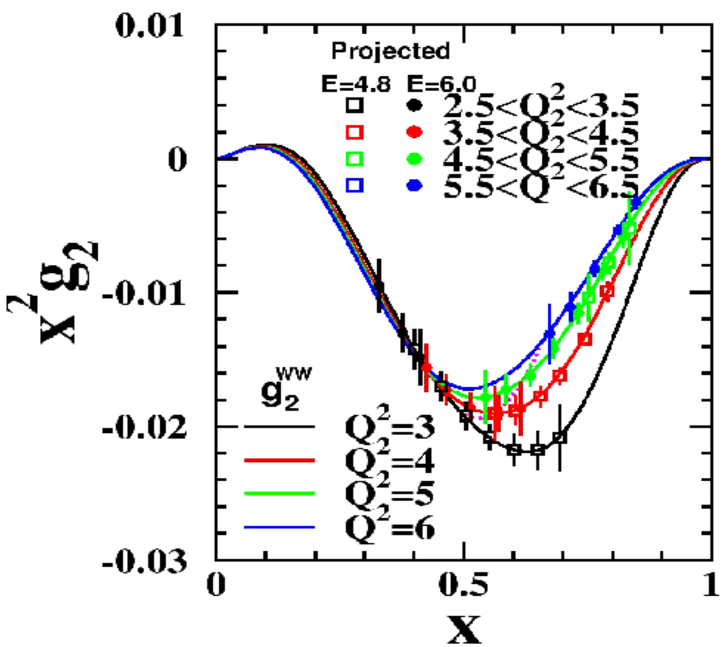
World data on $A_{\parallel}$, $A_{\perp}$ and SANE kinematics

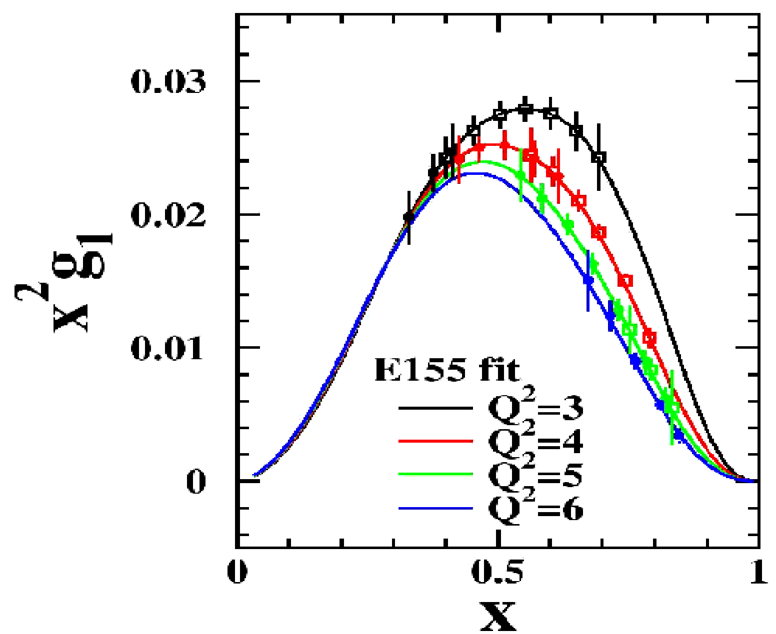




- Two beam energies: **5.9 GeV**, **4.7 GeV**
  - (small loss if **5.7 GeV**)
- Very good high ***x*** coverage with detector at 40° (plot from BETA's GEANT simulation)

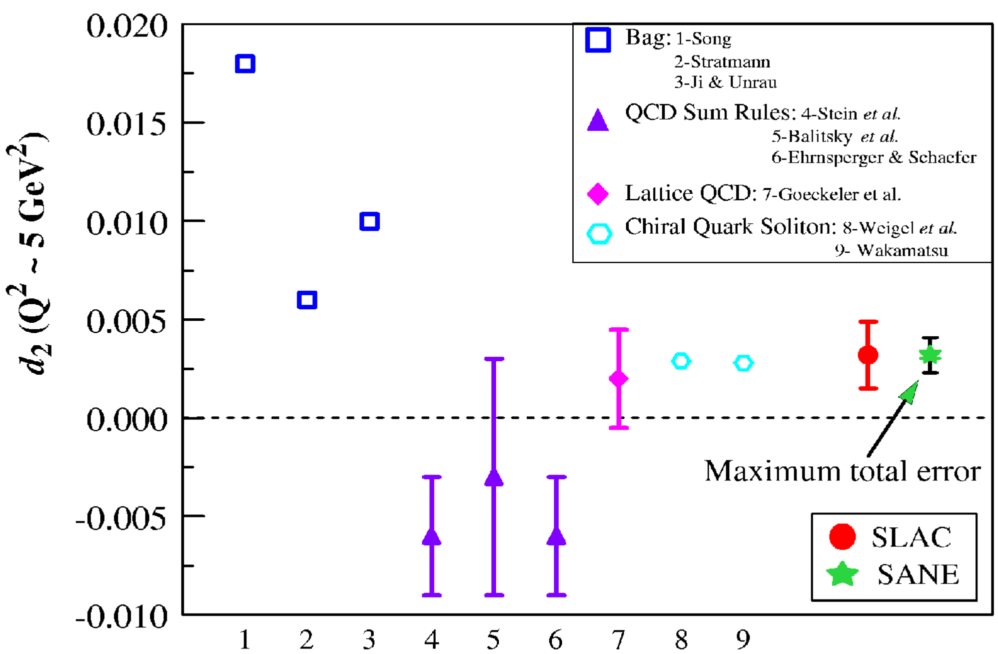
SANE Expected Results

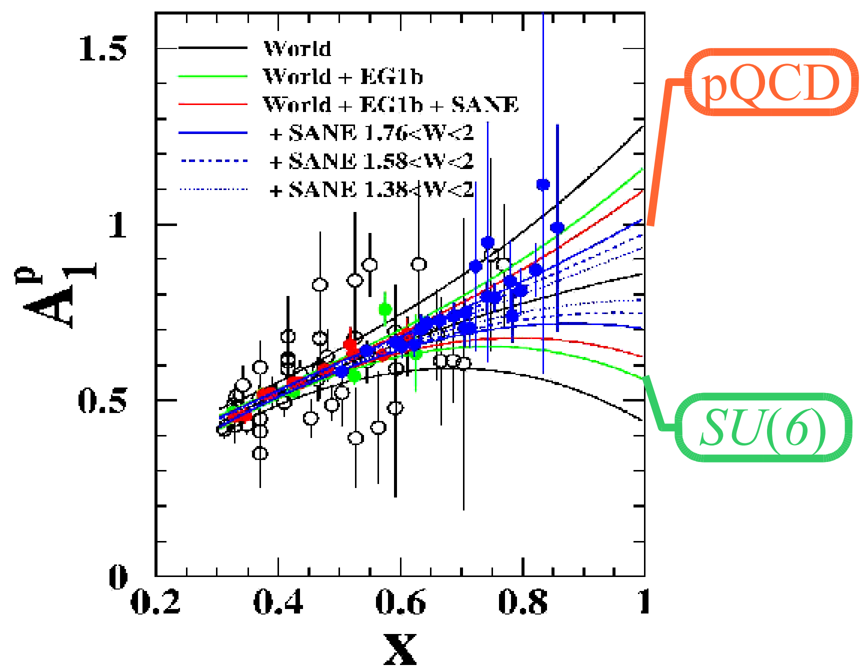




- x dependence at constant Q^2 and Q^2 dependence at fixed x (illustrative binning only)
- data are concentrated in the region most sensitive to $x^2 g_{2,1}$
  - (estimates based on 75% beam and target polarization, and 85 nA beam current)

SANE Expected Results (II)





- Improve total error on $d_2(Q^2 = 5\ \mathrm{GeV}^2)$ by factor < 0.5; systematics dominated
- Constrain extrapolations of $\mathbf{A}_1^{\mathbf{p}}$ to $x = 1$ within +/- 0.1 (using duality)
- SANE's measured $\mathbf{A}_2$ will improve world's $\mathbf{A}_1$ data set

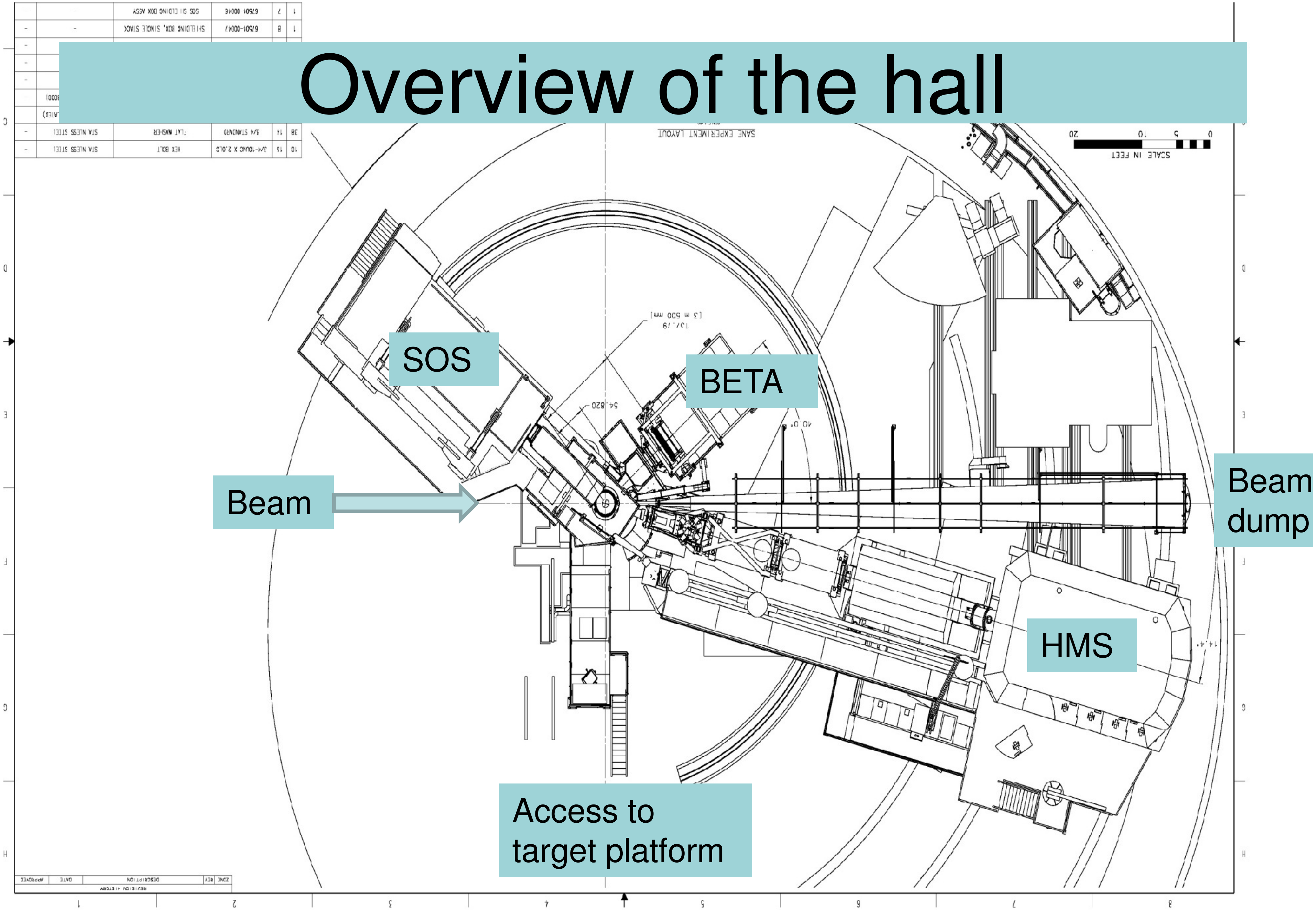
Overview of changes in Hall C

1. Polarized target
   - a. 5T field to polarized target with direction orienting spin
   - b. When 80^o to the beam direction need magnet chicane to direct beam upwards at angle before target field so beam parallel to vertical at target.
   - c. No vacuum connection between target chamber and beam line.
   - d. FSD triggered by loss of target field.
2. Exit beam line is a short aluminum snout attached to helium-filled bag.
   - a. When field at 0^o , beam into regular beam dump
   - b. When field at 80^o , beam deflected down (2.2 deg at 5.9 GeV and 2.8 deg at 4.7 GeV) into in-hall beam dump.
3. New girder directly upstream of target
   - a. Install SEM to measure beam position
4. Use slow raster (1cm radius) in addition to the fast raster. FSD on slow raster.
5. Average current will be 80-200nA (calibration at 2.4 GeV uses 1uA)
   - a. Need BPM sensitive to these low currents
   - b. Need upper limit for current
6. Use chicane for 80^o
   - a. Need magnet voltages in the FSD

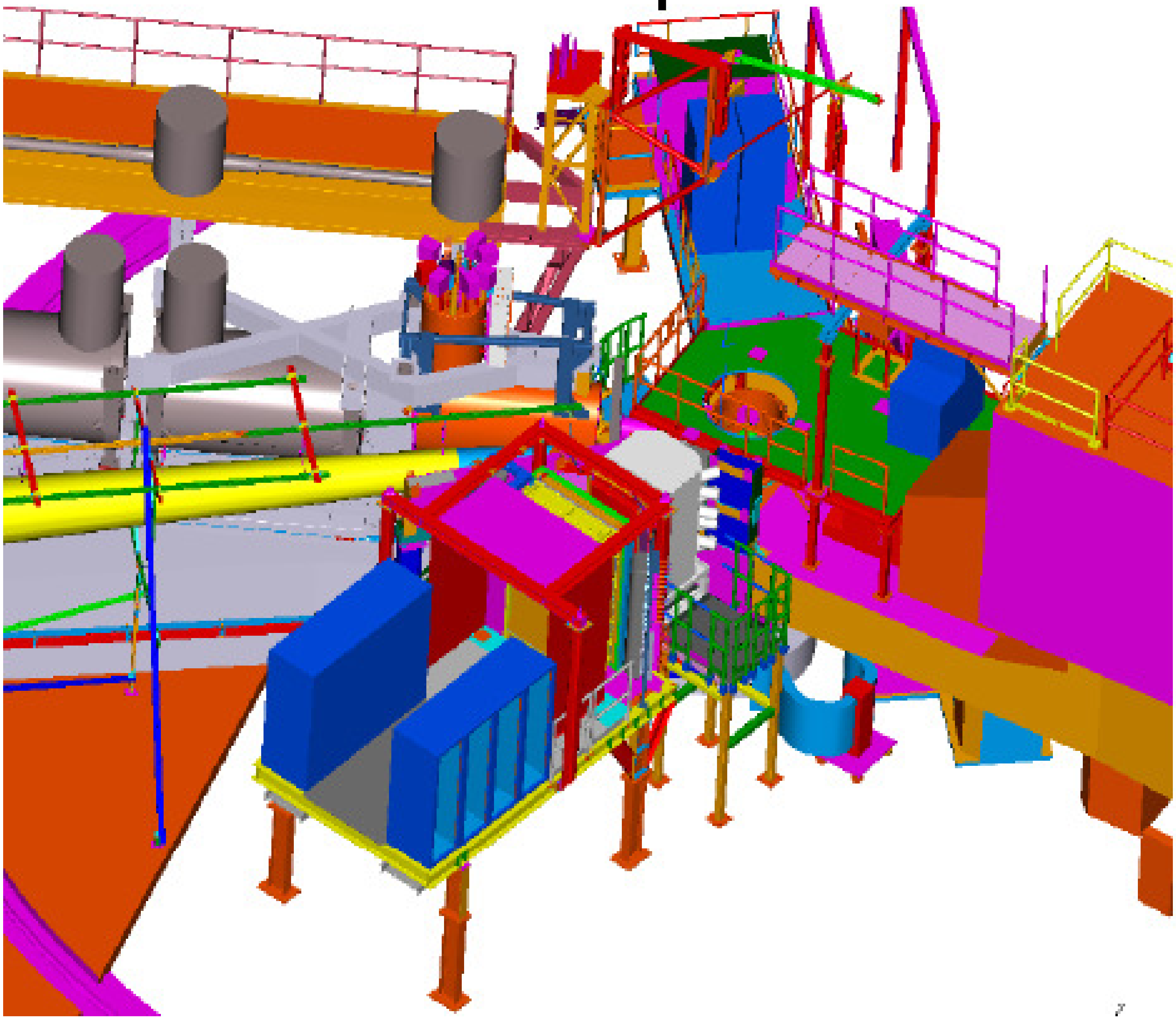
Experimental Schedule

1. Oct. 25-29 E=2.4 parallel target , commissioning.
2. Oct 30-Nov 2 E=4.7 parallel target, commissioning.
3. Nov 3-9 E=4.7 parallel target, production.
4. Nov 10 rotate target to perpendicular running. Modify chicane.
5. Nov 11-16 E=4.7 , perp target, commissioning. (Different backgrounds compared to parallel config)
6. Nov 17-Nov 30 E=4.7, perp target, production.
7. Dec 1 Change beam energy to 5.9, Modify chicane.
8. Dec 2-21 E=5.9, perp target, production
9. Jan 14-23 E=5.9 , parallel target, production. (Target rotated and chicane modified during down time)

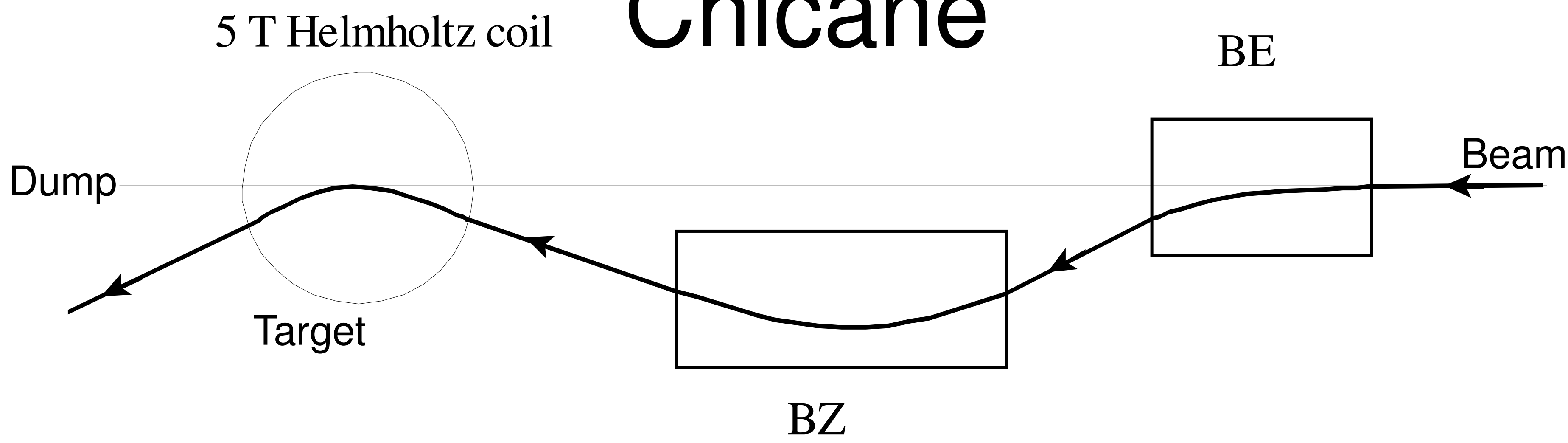
Overview of the hall



Close up view

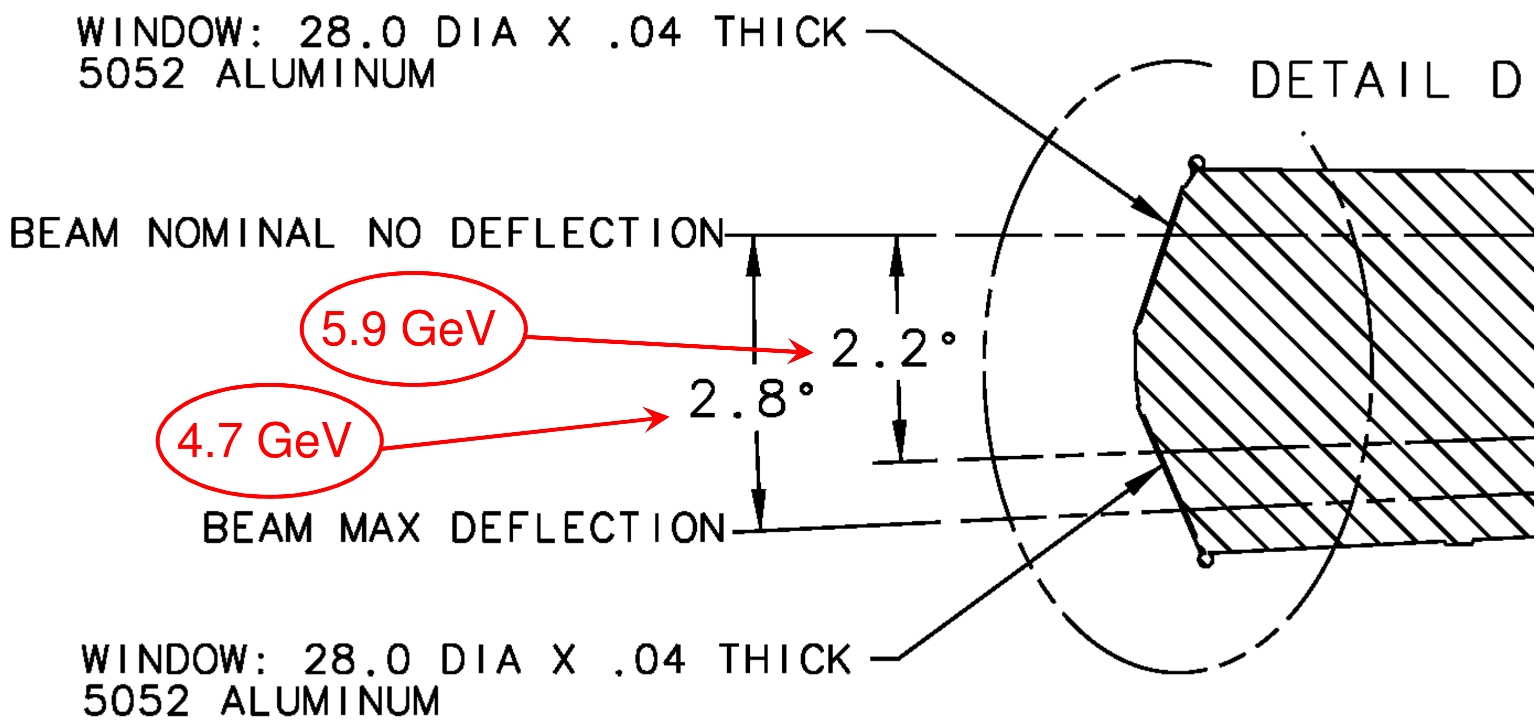


Chicane



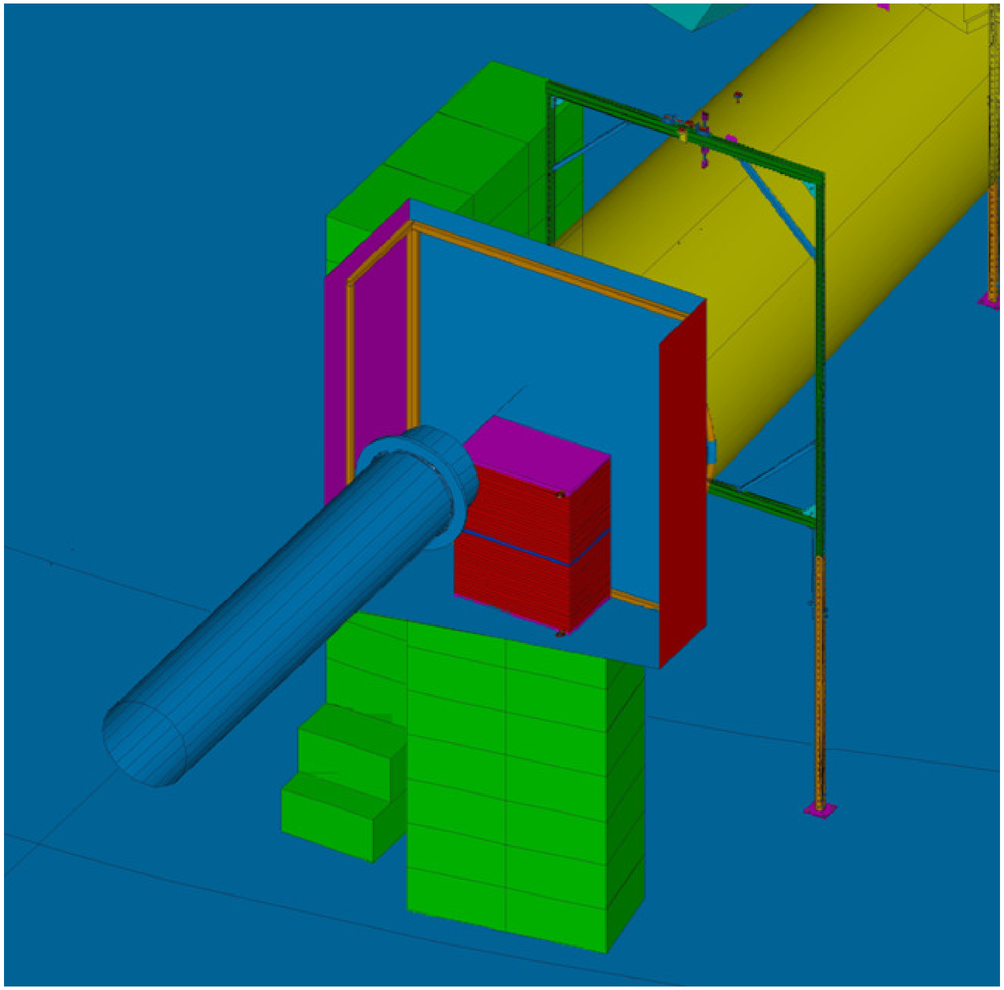
- BZ dipole magnet
  - Max. current: 500 A
  - Eff. Length: ~ 2 m
  - Gap: 3.81 cm
  - Power Supply: 40V/500A
- BE dipole magnet
  - Max. current: 300 A
  - Eff. Length: ~ 1 m
  - Gap: 2.54 cm
  - Power Supply: 40V/320A

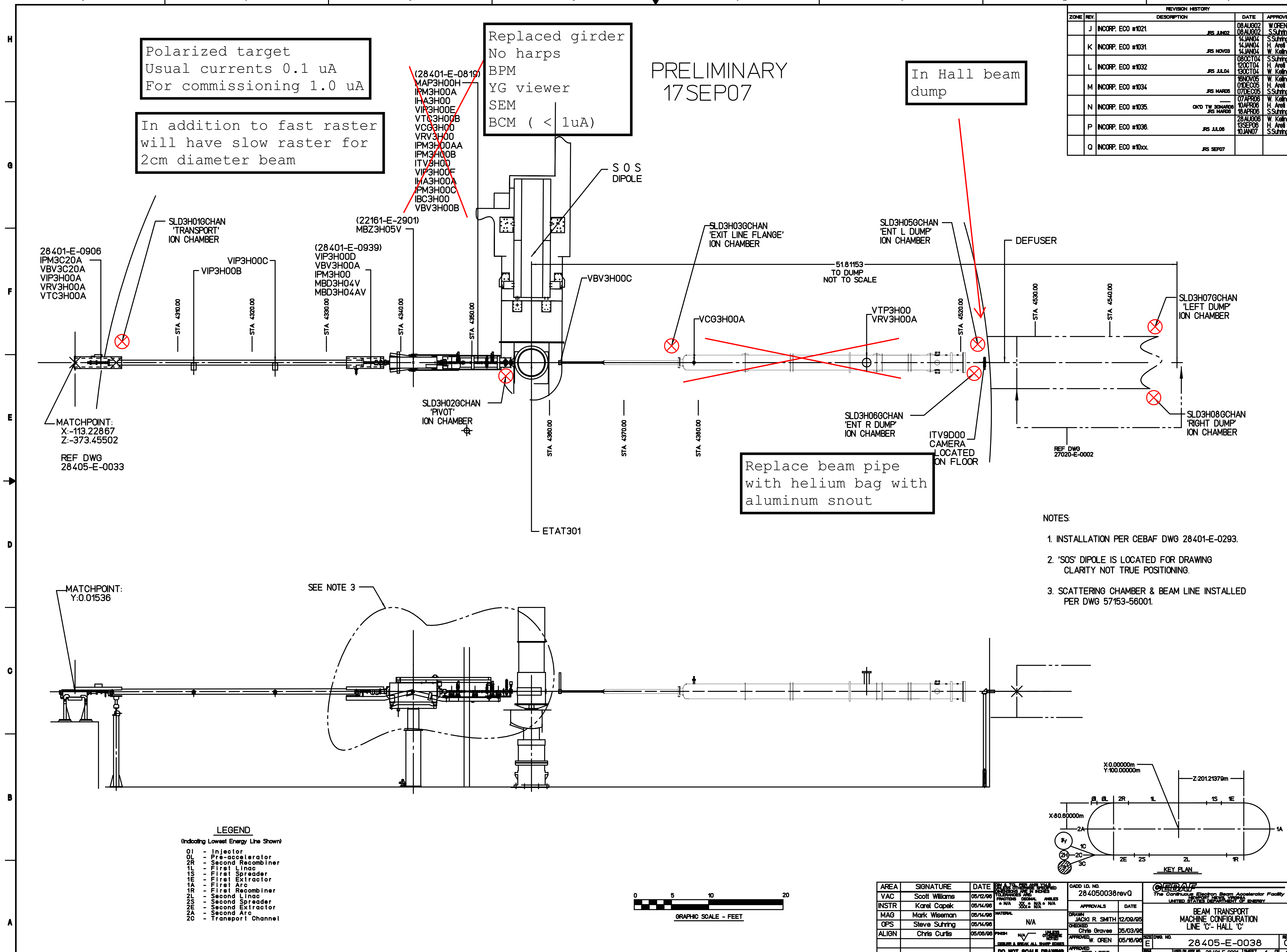
Rear Windows of Helium Bag



Beam Dump

Walter has drawings for dump, will be installed after the G0 magnet is removed.





PRELIMINARY
17SEP07
Polarized target
Usual currents 0.1 uA
For commissioning 1.0 uA
In addition to fast raster
will have slow raster for
2cm diameter beam
Replaced girder
No harps
BPM
YG viewer
SEM
BCM (< 1uA)
In Hall beam
dump
Replace beam pipe
with helium bag with
aluminum snout
(28401-E-0819)
MAP3H00H
IPM3H00A
IHA3H00
VIP3H00E
VTC3H00B
VCG3H00
VRV3H00
IPM3H00AA
IPM3H00B
ITV3H00
VIP3H00F
IHA3H00A
IPM3H00C
IBC3H00
VBV3H00B
S O S
DIPOLE
28401-E-0906
IPM3C20A
VBV3C20A
VIP3H00A
VRV3H00A
VTC3H00A
SLD3H01GCHAN
'TRANSPORT'
ION CHAMBER
VIP3H00B
VIP3H00C
(22161-E-2901)
MBZ3H05V
(28401-E-0939)
VIP3H00D
VBV3H00A
IPM3H00
MBD3H04V
MBD3H04AV
VBV3H00C
SLD3H03GCHAN
'EXIT LINE FLANGE'
ION CHAMBER
VCG3H00A
51.81153
TO DUMP
NOT TO SCALE
SLD3H05GCHAN
'ENT L DUMP'
ION CHAMBER
VTP3H00
VRV3H00A
DEFUSER
SLD3H07GCHAN
'LEFT DUMP'
ION CHAMBER
SLD3H08GCHAN
'RIGHT DUMP'
ION CHAMBER
SLD3H06GCHAN
'ENT R DUMP'
ION CHAMBER
ITV9D00
CAMERA
LOCATED
ON FLOOR
REF DWG
27020-E-0002
SLD3H02GCHAN
'PIVOT'
ION CHAMBER
ETAT301
STA 4310.00
STA 4320.00
STA 4330.00
STA 4340.00
STA 4350.00
STA 4360.00
STA 4370.00
STA 4380.00
STA 4520.00
STA 4530.00
STA 4540.00
MATCHPOINT:
X:-113.22867
Z:-373.45502
REF DWG
28405-E-0033
MATCHPOINT:
Y:0.01536
SEE NOTE 3
NOTES:
1. INSTALLATION PER CEBAF DWG 28401-E-0293.
2. 'SOS' DIPOLE IS LOCATED FOR DRAWING CLARITY NOT TRUE POSITIONING.
3. SCATTERING CHAMBER & BEAM LINE INSTALLED PER DWG 57153-56001.
LEGEND
(Indicating Lowest Energy Line Shown)
0I - Injector
0L - Pre-accelerator
2R - Second Recombiner
1L - First Linac
1S - First Spreader
1E - First Extractor
1A - First Arc
1R - First Recombiner
2L - Second Linac
2S - Second Spreader
2E - Second Extractor
2A - Second Arc
2C - Transport Channel
0 5 10 20
GRAPHIC SCALE - FEET
X:0.00000m
Y:100.00000m
Z:201.21379m
X:80.60000m
KEY PLAN
REVISION HISTORY
ZONE REV. DESCRIPTION DATE APPROVED
J INCORP. ECO #1021
K INCORP. ECO #1031
L INCORP. ECO #1032
M INCORP. ECO #1034
N INCORP. ECO #1035
P INCORP. ECO #1036
Q INCORP. ECO #10xx
AREA SIGNATURE DATE
VAC Scott Williams 05/12/96
INSTR Karel Capek 05/14/96
MAG Mark Wiseman 05/14/96
OPS Steve Suhring 05/14/96
ALIGN Chris Curtis 05/06/96
DIM & TOL PER ANSI Y14.5 UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ARE: FRACTIONS ± N/A DECIMAL .XX ± N/A .XXX ± N/A ANGLES ± N/A
MATERIAL N/A
FINISH N/A UNLESS OTHERWISE NOTED
DEBURR & BREAK ALL SHARP EDGES
DO NOT SCALE DRAWING
CADD I.D. NO. 284050038revQ
APPROVALS DATE
DRAWN JACKI R. SMITH 12/09/95
CHECKED Chris Graves 05/03/96
APPROVED W. OREN 05/16/96
APPROVED SEE LEFT ---
CEBAF The Continuous Electron Beam Accelerator Facility
NEWPORT NEWS, VIRGINIA
UNITED STATES DEPARTMENT OF ENERGY
BEAM TRANSPORT
MACHINE CONFIGURATION
LINE 'C'- HALL 'C'
SIZE E
DWG. NO. 28405-E-0038
REV. Q
SCALE 1/48
USED ON ASSY NO. 28401-E-0001
SHEET 1 OF 1