# GEN-II ERR Report

*T. Averett, William and Mary*

*18-Feb-2021*

GEN-II, E12-09-016, Measurement of $G_E^n$ at large $Q^2$ using polarized $^3$He

Readiness Review occurred on 22-Oct-2020

Must satisfactorily answer all ERR committee questions before we can request beam time.

Target-related items covered by G. Cates:

- Timeline for cell production
- Cell performance specs
- Optics, fibers and lasers
- Magnetic shielding; field mapping
- Raster and cooling jets, S. Covrig-Dusa simulations

**Charge 1)** Does the polarized 3 He system impose changes to the SBS beamline, spectrometers, or detector configuration? If so, please define these, including ownership, maintenance and control during beam operations.

## RECOMMENDATIONS:

- Work with Center for Advanced Studies of Accelerator (CASA) to define the final upstream beamline configuration including raster.
  - As part of this work, it would be useful to develop a table of beam requirements necessary for E12-09-016. This would include:
    - intrinsic beam profile size, always ~150-250 um for pol3he
    - raster (max) size and shape, Silviu, All (Gordon, Todd, Bogdan, Flay)
    - desired beam translation envelope (i.e. what are expected beam translation limits in x and y needed to accommodate target ladder offsets, etc. Fay
- Clarify the complete detector configuration. Bogdan

**Overall Status:** Flay is developing beamline based on raster and beam halo requirements currently being established by All + Silviu

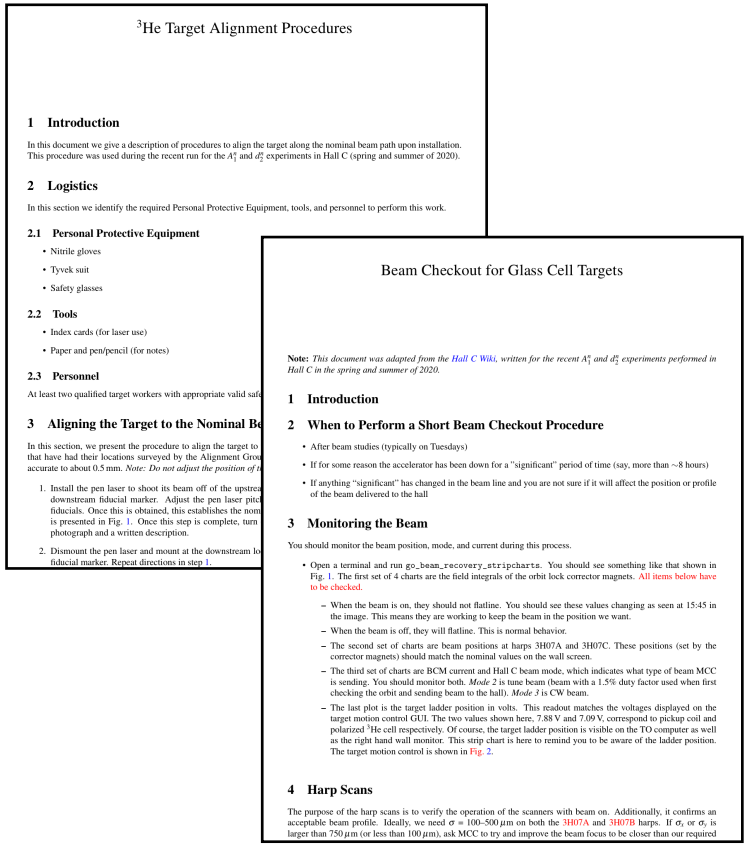
# Beam Line Items

## Recommendations

- The target alignment procedure with beam needs to be detailed in an OPS procedure. This also should include a description on how operations will ensure the beam alignment stays within tolerances during beam delivery
- Develop a solution allowing for centering the beam on target with the required raster pattern along with any specialized targets on the target ladder
- Desired beam translation envelope (i.e. what are expected beam translation limits in x and y needed to accommodate target ladder offsets, etc.)

## Work Towards Response

- Developing documents based on recent 3He target experience in A1n/d2n runs in Hall C
  - Target alignment procedure
  - Beam checkout (shifter documentation). Need to review and iterate on recently updated Accelerator procedures in Hall C



$^3$He Target Alignment Procedures

1 Introduction

In this document we give a description of procedures to align the target along the nominal beam path upon installation. This procedure was used during the recent run for the $A_1^n$ and $d_2^n$ experiments in Hall C (spring and summer of 2020).

2 Logistics

In this section we identify the required Personal Protective Equipment, tools, and personnel to perform this work.

2.1 Personal Protective Equipment

- Nitrile gloves
- Tyvek suit
- Safety glasses

2.2 Tools

- Index cards (for laser use)
- Paper and pen/pencil (for notes)

2.3 Personnel

At least two qualified target workers with appropriate valid safe

3 Aligning the Target to the Nominal Be

In this section, we present the procedure to align the target to that have had their locations surveyed by the Alignment Grou accurate to about 0.5 mm. *Note: Do not adjust the position of t*

1. Install the pen laser to shoot its beam off of the upstrea downstream fiducial marker. Adjust the pen laser pitc fiducials. Once this is obtained, this establishes the nom is presented in Fig. 1. Once this step is complete, turn photograph and a written description.
2. Dismount the pen laser and mount at the downstream lo fiducial marker. Repeat directions in step 1.

Beam Checkout for Glass Cell Targets

**Note:** *This document was adapted from the Hall C Wiki, written for the recent $A_1^n$ and $d_2^n$ experiments performed in Hall C in the spring and summer of 2020.*

1 Introduction

2 When to Perform a Short Beam Checkout Procedure

- After beam studies (typically on Tuesdays)
- If for some reason the accelerator has been down for a "significant" period of time (say, more than ∼8 hours)
- If anything "significant" has changed in the beam line and you are not sure if it will affect the position or profile of the beam delivered to the hall

3 Monitoring the Beam

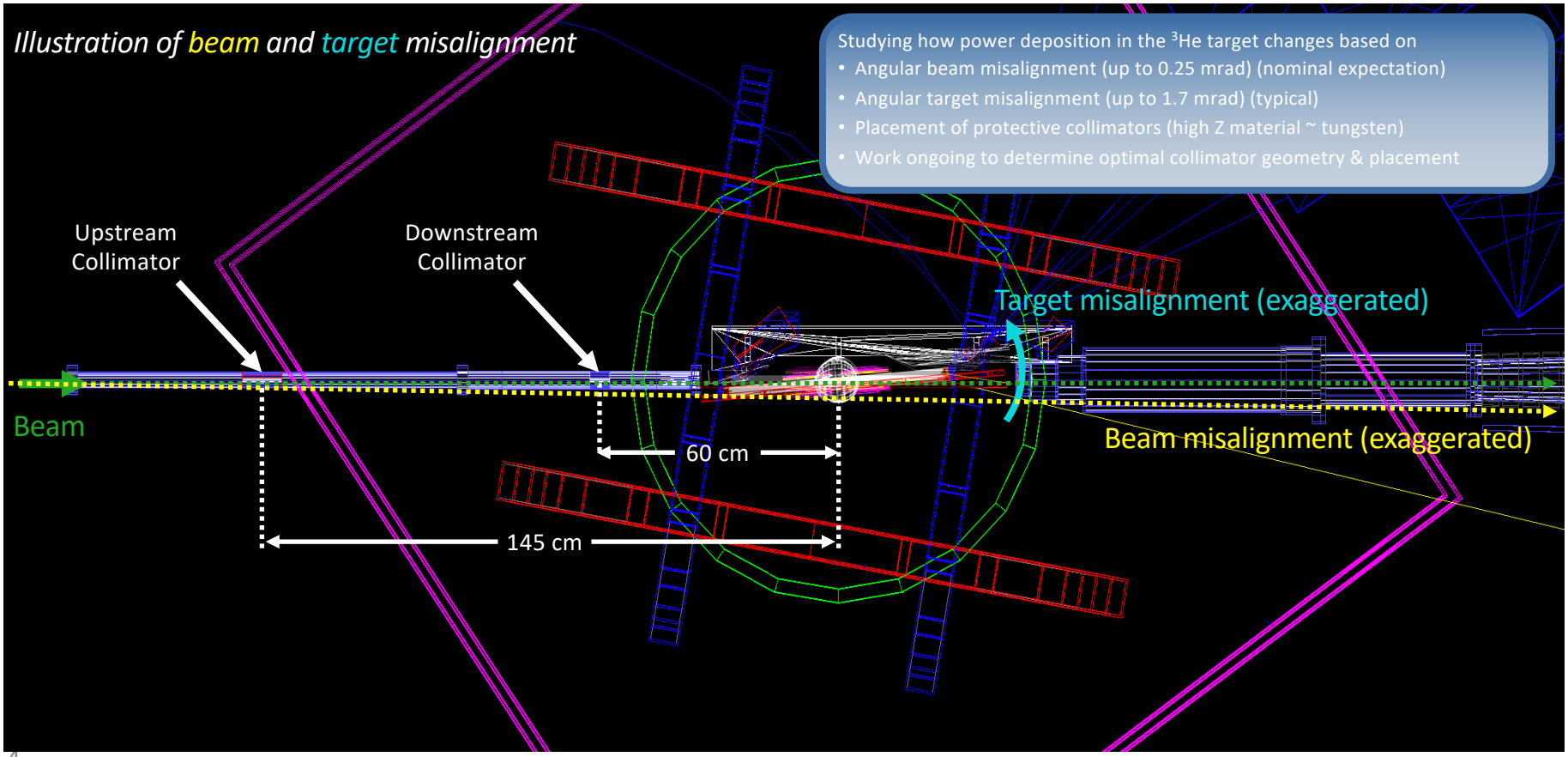
You should monitor the beam position, mode, and current during this process.

- Open a terminal and run `go_bean_recovery_stripcharts`. You should see something like that shown in Fig. 1. The first set of 4 charts are the field integrals of the orbit lock corrector magnets. All items below have to be checked.
  - When the beam is on, they should not flatline. You should see these values changing as seen at 15:45 in the image. This means they are working to keep the beam in the position we want.
  - When the beam is off, they will flatline. This is normal behavior.
  - The second set of charts are beam positions at harps 3H07A and 3H07C. These positions (set by the corrector magnets) should match the nominal values on the wall screen.
  - The third set of charts are BCM current and Hall C beam mode, which indicates what type of beam MCC is sending. You should monitor both. *Mode 2* is tune beam (beam with a 1.5% duty factor used when first checking the orbit and sending beam to the hall). *Mode 3* is CW beam.
  - The last plot is the target ladder position in volts. This readout matches the voltages displayed on the target motion control GUI. The two values shown here, 7.88 V and 7.09 V, correspond to pickup coil and polarized $^3$He cell respectively. Of course, the target ladder position is visible on the TO computer as well as the right hand wall monitor. This strip chart is here to remind you to be aware of the ladder position. The target motion control is shown in Fig. 2.

4 Harp Scans

The purpose of the harp scans is to verify the operation of the scanners with beam on. Additionally, it confirms an acceptable beam profile. Ideally, we need $\sigma = 100$–$500\,\mu$m on both the 3H07A and 3H07B harps. If $\sigma_x$ or $\sigma_y$ is larger than 750 $\mu$m (or less than 100 $\mu$m), ask MCC to try and improve the beam focus to be closer than our required

# Using g4sbs to Study Beam & Target Misalignment



**Charge 2)** What is the status of the equipment required for this experiment towards operation? What is the completion/commissioning schedule and tasks? In particular, provide detailed information on the high-luminosity 3He target system,

- The target(s) configuration needed, performance requirements and status.
- The laser system configuration needed, its operation and safety (including documentation) and status.
- The integrated system (target holders, motion mechanics, optics, enclosures, …) as expected to be used during the experiment.

RECOMMENDATIONS:

- Provide more specific overall target development milestone timeline to judge progress.
  - What are the guidelines for the determination of the cell types to be chosen and a timeline in which this will be done. Cates
  - What tests will be done, on what types of cell, and by when? Cates, Averett
  - What determines the success of a cell design (what polarization or additional relaxation time is sufficient)? June 2021 is mentioned as a decision point in a rough timeline given in the slides, but a more formal set of milestones would be useful. Cates, Averett
  - Include milestones for production cell creation.
    - How many beam-ready cells will be needed, at what lab-measured polarization, and when will they be ready? Cates, Averett
- Demonstrate the GEn-II experiment-required-performance full 3He target on the bench that is production ready, prior to the submission of beam request. Cates, Chen, Averett
- Complete the in-progress thermal and structural analysis of the target beam entrance and exit windows at the anticipated beam currents for the chosen cell type. Silviu + Engineering
- Define final optics specifications including lasers and fibers into the hall. Complete laser fiber studies by May 15, 2021. Cates, Averett, Chen
- Fully define target ladder configuration. All
- Complete the in-progress analysis of local density reduction in the path of the beam. Silviu
- Exercise full readout chain with final detectors, cables, DAQ as early as possible. Will be done during installation of GMn.

## Overall Status: See Cates Talk

**Charge 3)** Are the polarized target running configurations affected by the spectrometer fields? If yes, have the fringe field effects been properly mitigated?

RECOMMENDATIONS:

- Please provide TOSCA field maps over the critical target regions (pumping chamber, transfer tubes, target cell) using up-to-date models and representative SBS and BB fields (including field clamps, accurate iron shield box model, etc). Vladimir Nelyubin, Cates
  - Plots showing the full scale of Bx, By, Bz in the regions of interest.
  - Plots showing the difference from the average for Bx, By, Bz over the same regions. (These will make it easier to evaluate the gradient and general field homogeneity.)
- Please describe the target field measurement equipment (MFS system) and operational procedures/plans. Bogdan, Gordon, Vladimir
  - Provide a summary table of the magnetic field requirements and tolerances needed for target operation. Vladimir, Cates, Averett
  - Describe how the necessary field measurements will be made and how long they will take, and demonstrate that the measurement tolerances will match the experimental needs in the prior table. Vladimir, Metzger
- Determine if field-tuning ('field spoiler') coils may be needed. If it is a possibility, then define the requirements and add needed power supplies, controls and cabling requirements to the target plan. Vladimir

**Overall Status:** See Cates Talk

**Charge 4)** Are the responsibilities for carrying out each job identified, and are the people-power and other resources necessary to complete them on time in place?

RECOMMENDATIONS:

- Create an overall spreadsheet that lists the equipment/detectors and work out detailed activities. Include resources committed for these activities and generate start-to-end [milestone] dates for these activities. Averett, Wines, Butler
- Create a detailed detector and beamline installation plans with key milestones. Averett, Wines, Butler

**Overall Status:** Preliminary schedule in place. Timeline depends on GMn

**Big Items:** Move BB, SBS and HCAL, Install Pol3he target. No new detectors to install or commission - thanks to GMn

# Example: Page 1 of Jessie's Schedule

| ID | Task Mode | Task Name | Duration | Start | Finish |
|---|---|---|---|---|---|
| 1 | | **GEN Installation Plan** | **75 days** | **Mon 1/3** | **Fri 4/15** |
| 2 | | Post-Beam Checklist / Radiation Hold | 2 days | Mon 1/3 | Tue 1/4 |
| 3 | | Warm Up Target | 3 days | Wed 1/5 | Fri 1/7 |
| 4 | | Transport Equipment to Hall | 5 days | Mon 1/3 | Fri 1/7 |
| 5 | | Bleed Up Vacuum and Open Chamber | 1 day | Mon 1/10 | Mon 1/10 |
| 6 | | Complete As-Found Surveys | 2 days | Tue 1/11 | Wed 1/12 |
| 7 | | Remove Target and Instrumentation From Chamber | 2 days | Thu 1/13 | Fri 1/14 |
| 8 | | Remove Cu Radiator | 1 day | Mon 1/17 | Mon 1/17 |
| 9 | | Disassemble and Remove Target Chamber From Pivot | 2 days | Tue 1/18 | Wed 1/19 |
| 10 | | Move LHRS Out to a Large Angle | 1 day | Thu 1/20 | Thu 1/20 |
| 11 | | Remove Exit Beamline | 1 day | Fri 1/21 | Fri 1/21 |
| 12 | | Reconfigure Exit Beamline and Correctors | 5 days | Mon 1/24 | Fri 1/28 |
| 13 | | Reinstall Exit Beamline | 1 day | Mon 1/31 | Mon 1/31 |
| 14 | | Install Carriage and Big Bite Magnet on Pivot | 4 days | Tue 2/1 | Fri 2/4 |
| 15 | | Install BB Electronics' Hut | 2 days | Mon 2/7 | Tue 2/8 |
| 16 | | Move LHRS to Start Position | 1 day | Wed 2/9 | Wed 2/9 |
| 17 | | Install Lower Work Platforms on Beam Right and Left | 2 days | Thu 2/10 | Fri 2/11 |
| 18 | | Install Helmholtz Coils and Base on Pivot | 3 days | Mon 2/14 | Wed 2/16 |
| 19 | | Install Target System and Connect Beamline | 2 days | Thu 2/17 | Fri 2/18 |
| 20 | | Survey and Align Helmholtz Coils and Target System pt.1 | 3 days | Mon 2/21 | Wed 2/23 |
| 21 | | Install Support Structure for Shielding Box Around Coils | 2 days | Thu 2/24 | Fri 2/25 |
| 22 | | Install Upper Work Platform | 1 day | Mon 2/28 | Mon 2/28 |
| 23 | | Install Laser/Optics Box | 1 day | Tue 3/1 | Tue 3/1 |


Project: GEn_InstallationPlan_ER
Date: Thu 12/17

| | | |
|---|---|---|
| Task | Inactive Summary | External Tasks |
| Split | Manual Task | External Milestone |
| Milestone | Duration-only | Deadline |
| Summary | Manual Summary Rollup | Progress |
| Project Summary | Manual Summary | Manual Progress |
| Inactive Task | Start-only | |
| Inactive Milestone | Finish-only | |

**Charge 5)** What is the simulation and data analysis software status for the experiment? Has readiness for expedient analysis of the data been demonstrated? What is the projected timeline for the first publication? Please provide a documented track record from previous experiments.

RECOMMENDATIONS:

- Demonstrate sufficient neutron-photon separation in HCAL, especially important for the highest Q2 point where neutrons beta » 1. {TDA Do they mean neutron proton

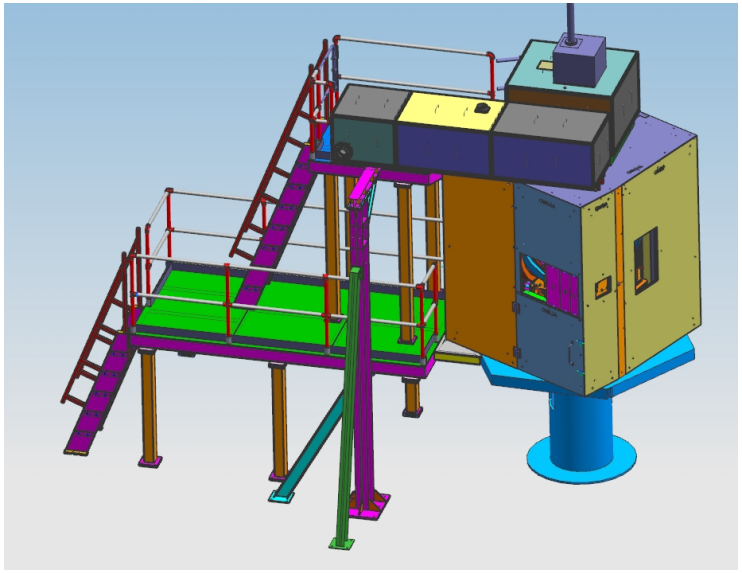
**Overall Status:** In Progress. See talk by Porovakar Datta, UConn

**Charge 6)** Are the radiation levels expected to be generated in the hall acceptable? Is any local shielding required to minimize the effects of radiation in the hall equipment?

RECOMMENDATIONS:

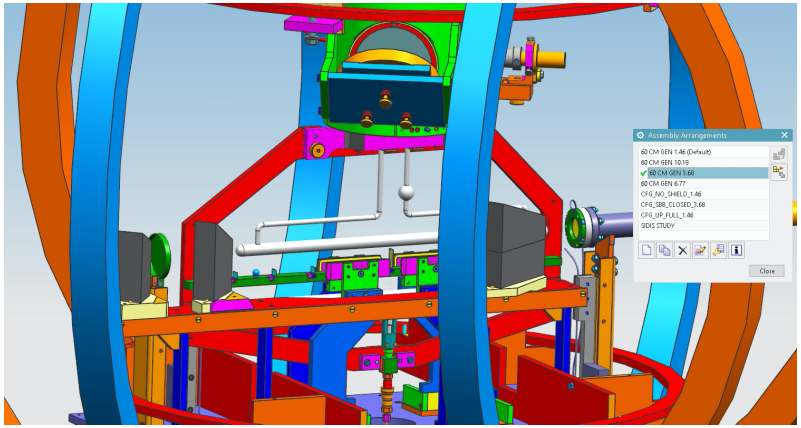
- Extend the recent GMn ALARA studies, as applicable to this Experiment, to evaluate the material activation in the vicinity of the target and around the beam line. Attention should be paid to the target surroundings and the vacuum windows. All needed planned work around the target should be scheduled in accordance with the expected radiation levels. Have a plan to address these issues. Averett, Pavel, RADCON, Luminosity 10x lower than GMn-RADCONl to confirm activation is 10x lower than for GMn
- Use the lessons learned from the previous experiments to try to understand the sources of radioactive contamination around the target enclosure, and ways to control it. Have a plan to address this issue. Averett, Meekins

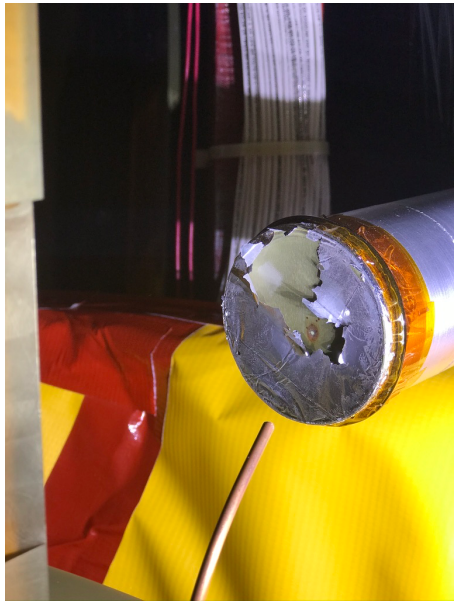
**Overall Status:** Not much done on bullet 1. Contacted RADCON
Bullet 2: Next page



- Previous Pol3he targets
  - Used N2 gas jets to preserve integrity of Be beamline windows (and target windows)
  - “open” to air, no ODH hazard
  - Activated $^{22}$Na dust produced from Al covering Be

- GEN-II target is in an enclosure
  - Will use air for target cooling
  - Attempt to use Au-plated Be without inert gas jets
  - Must test window concept during GMn





**Charge 7)** Are the beam commissioning procedures and machine protection systems sufficiently defined for this stage?

RECOMMENDATIONS:

- The choice of the raster pattern needs to be motivated. Whether one has to use a circular or square raster will affect the optics configuration of the beamline. Likewise, there is an upper limit on the raster size beyond which it may become difficult to deliver beam without scraping on the long 3 He target. Silviu, Cates
- The target alignment procedure with beam needs to be detailed in an OPS procedure. This also should include a description on how operations will ensure the beam alignment stays within tolerances during beam delivery. Flay, Averett, Metzger, Chen, Cates
- The experimenters have a plan for commissioning the SBS correctors and studying the effect of the stray field on beam delivery. A formal procedure needs to be developed with operations to eliminate ambiguities and miscommunications between MCC and the Hall A control rooms. Flay-will be done for GMn
- Develop a solution allowing for centering the beam on target with the required raster pattern along with any specialized targets on the target ladder. Flay, Averett, Metzger, Chen, Cates

**Overall Status:** Deep into raster studies with All+Silviu. See Cates talk. Nothing on beam/target alignment

**Charge 8)** What is the status of the specific documentation and procedures (COO, ESAD, RSAD, ERG, OSP's, operation manuals, etc.) to run the experiments?

RECOMMENDATIONS:

- Have a physics liaison assigned (JP Chen) and complete full set of safety documents (COO, ERG, ESAD, RSAD) for E12-09-016. Averett-Will use GMn documents for all but target-Quinn/Folts. Averett, Chen, Cates-Develop SOP, LSOP for target
- Identify necessary work control documents required (Operational Safety Procedure), using the laboratory's format found in: Averett
  - Chapter 3310 Operational Safety Procedure (OSP) https://www.jlab.org/ehs/ehsmanual/manual/3310.htmChapter 6410 Appendix T1
  - Laser Operational Safety Procedure (LOSP) https://www.jlab.org/ehs/ehsmanual/6410T1.htm Chen

**Overall Status:** GMn documents in progress. Working on safety issues for Pol3he target and enclosure - ODH, RW-II, Laser safety. Chen-LSOP for EEL target lab complete: basis for LSOP in Hall.

GMn safety documents website:

https://hallaweb.jlab.org/experiment/SBS/GMn/GMn_Website.html#gmnsafety

GMn Conduction of Operations – COO

Emergy Response Guidelines - ERG

ERG Chart

Equipment Safety Assessment Documets - ESAD

Radiation Budget Form

Safety Procedures (OSP) for GEM detectors

Safety Procedures (OSP) for BigBite magnet

Safety Procedures (OSP) for BigBite rotation

Safety Procedures (OSP) for GRINCH Cherenkov detector

Safety Procedures (OSP) for BigBite timing hodoscope

Safety Procedures (OSP) for Hadron Calorimeter, HCal-J