

# Beam parameters for the Hall-B RG-D run period during fall of 2023

July 18, 2023

Hall-B Run Group D is scheduled to run in the fall of 2023 in experimental Hall B. The CLAS12 is a multipurpose detector system based on a toroidal (forward detector) and a solenoid (central detector) superconducting magnets. The detector system includes Cherenkov Counters, Drift Chambers, Scintillator Counters, Silicon-strip detectors, Micro-mega gas detectors, and Calorimeters. In this run period CLAS12 will be used in its standard detector and shielding configuration with the Forward tagger (FT) **off** and the Large Møller cone installed. RG-D run will use up to 11 GeV (5 passes) polarized electron beam, with currents up to 200 nA during the luminosity scans. This run will use several different targets ranging from cryogenic liquid targets, to heavy solid targets. Targets will be located inside the vacuum scattering chamber that is installed inside the central detector in the center of the 5 T solenoid magnet.

The target system used for RG-D is the new cryo-target. RG-D will use liquid H<sub>2</sub> and D<sub>2</sub>), and also solid targets (<sup>118</sup>Sn, <sup>63</sup>Cu, <sup>12</sup>C) mounted on the flag system. The targets are housed in a vacuum vessel along with the cryogenic system. A scattering chamber is installed around the target cell area. This is made from Rohacell foam with a wall thickness of 6.5 mm. Aluminum windows are used at the entrance and exit of the liquid cells, and at the exit of the scattering chamber. The schematic view of the RG-D target assembly is shown in Fig. 1.

The details of all components, such as windows and cells, are shown on the beam line drawing, including thicknesses and locations. The beam line layout is shown in Figures 2 - 6.

For initial beam tuning and after extended down time (>8 hours) the electron beam will be in the tagger yoke dump. After that the beam will be sent to the Faraday Cup and centered

Table 1: Target configurations that will be used in RG-D where liquid targets are denoted by "L" and solid targets are listed just as the chemical composition.

| Energy<br>(GeV) | Target                              | Thickness<br>(cm) | Density<br>(g cm <sup>-3</sup> ) | Areal<br>Density<br>(mg cm <sup>-2</sup> ) | T/X <sub>o</sub><br>(%) | Beam<br>Current (10 <sup>35</sup><br>(nA) | Luminosity<br>s <sup>-1</sup> cm <sup>-2</sup> ) |
|-----------------|-------------------------------------|-------------------|----------------------------------|--|-------------------------|---|--|
| ≤11             | LH <sub>2</sub>                     | 5                 | 0.071                            | 355  | 0.56                    | 100                                       | 1.3  |
|                 | LD <sub>2</sub>                     | 5                 | 0.164                            | 820  | 0.7                     | 50  | 1.5  |
|                 | <sup>12</sup> C                     | 2×0.2             | 2.20                             | 440  | 2×1.03                  | 50  | 1.7  |
|                 | <sup>63</sup> Cu/ <sup>118</sup> Sn | 0.009/0.018       | 8.96/7.31                        | 80.64/131.6                                | 0.63/1.49               | 150                                       | 1.2  |
|                 | Empty                               | —                 | —                                | —  | —                       | 165                                       | —  |

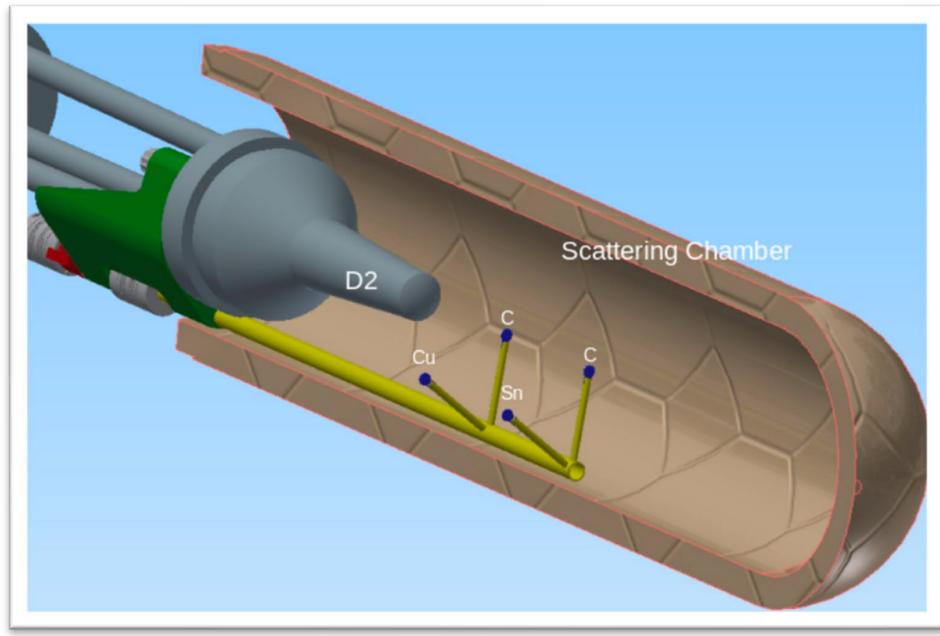


Figure 1: Schematic view of the target assembly. The flag design sowing foils 5 cm apart mounted on the same shaft with 60 degree opening between their holding needles that rotate via stepper motor.

on the target. The electron beam polarization will be measured periodically using Møller polarimeter. During Moøller runs the beam will be in the tagger yoke dump. For beam currents for which beam power exceeds 1 kW on the Faraday Cup (90 nA at 11 GeV) the beam blocker will be inserted upstream of the Faraday Cup.

During RG-D run the fast machine shutdown (FSD) system will be as follows:

1. Solenoid magnet current, with the exception of zero field alignment runs
2. Upstream, midstream and downstream halo counters and BOM

FSD masking must not be changed without the Hall permission.

The HPS halo counters and raster are not used in this run and should be always masked.

The requirements for beam parameters for RG-D run are summarized in Table 2

Table 2: Required beam parameters.

| Parameter  | Requirement             | Comments   |
|--|-------------------------|--|
| Energy (GeV)   | $\leq 11$               | 5 pass   |
| $\delta p/p$   | $\sim 2 \times 10^{-4}$ |  |
| Current (nA)   | $\leq 200$              |  |
| $\sigma_{xy}$ ( $\mu\text{m}$ )                          | $< 200$                 | As measured by 2H01 harp                                   |
| Position stability ( $\mu\text{m}$ )                     | $< 100$                 | On 2H01 and 2H00 ( $> 30\text{nA}$ )<br>BPMs with feedback |
| Divergence ( $\mu\text{rad}$ )                           | $< 100$                 |  |
| Beam Halo ( $> \pm 5\sigma$ )                            | $< 10^{-5}$             | As measured by 2H01 harp                                   |
| Long term current stability                              | $< 5 \%$                | For $> 30 \text{nA}$ , integrated<br>over minutes          |
| Short term beam intensity<br>stability (60 Hz harmonics) | $< 10\%$                | of the total power, measured<br>with SLM and halo rates    |
| Bunch charge fluctuations                                | $< 10 \%$               | Measured with DAQ  |
| Beam polarization  | $\geq 85\%$             | Measured with Møller polarimeter                           |

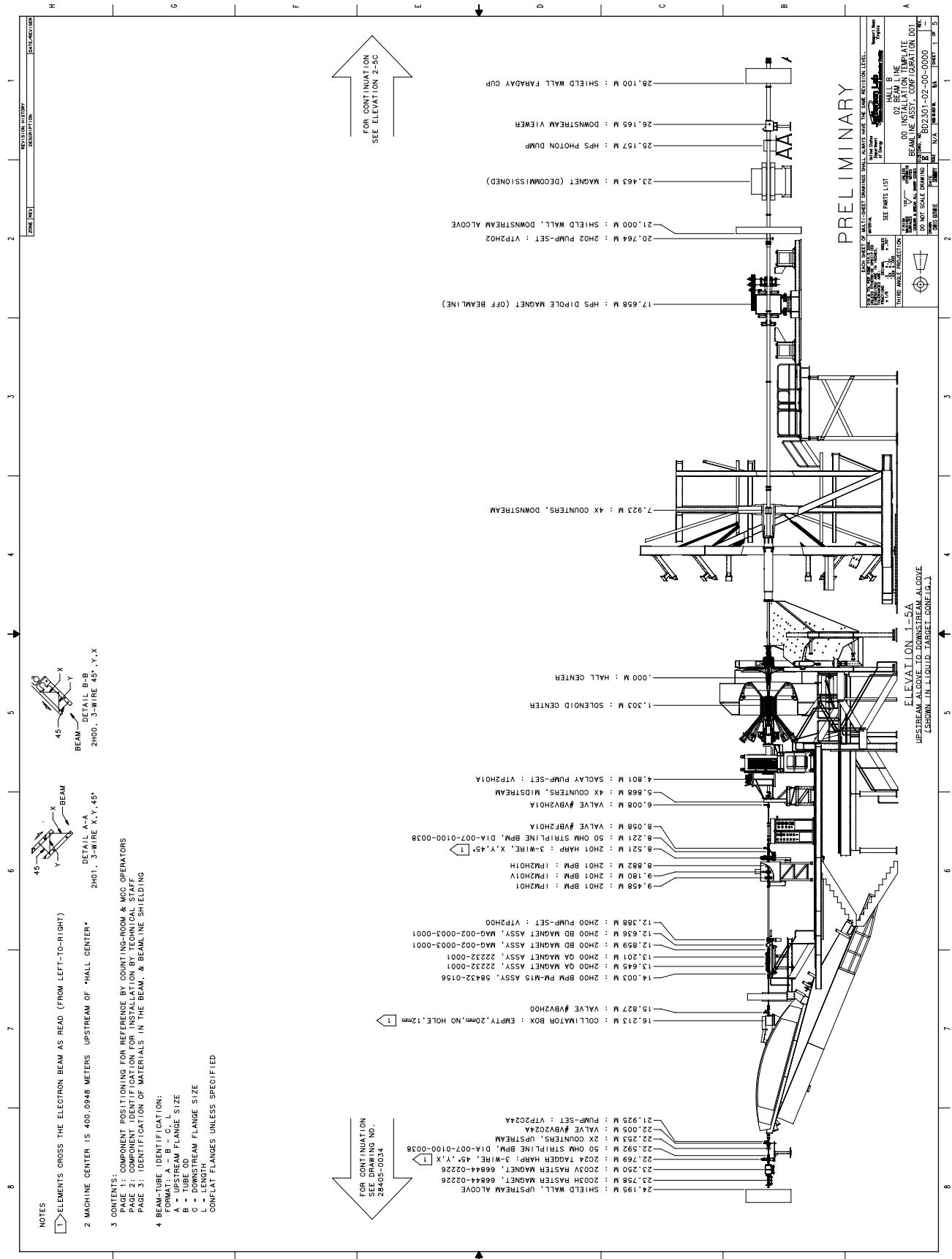


Figure 2: The layout of tHe RGD beamline.

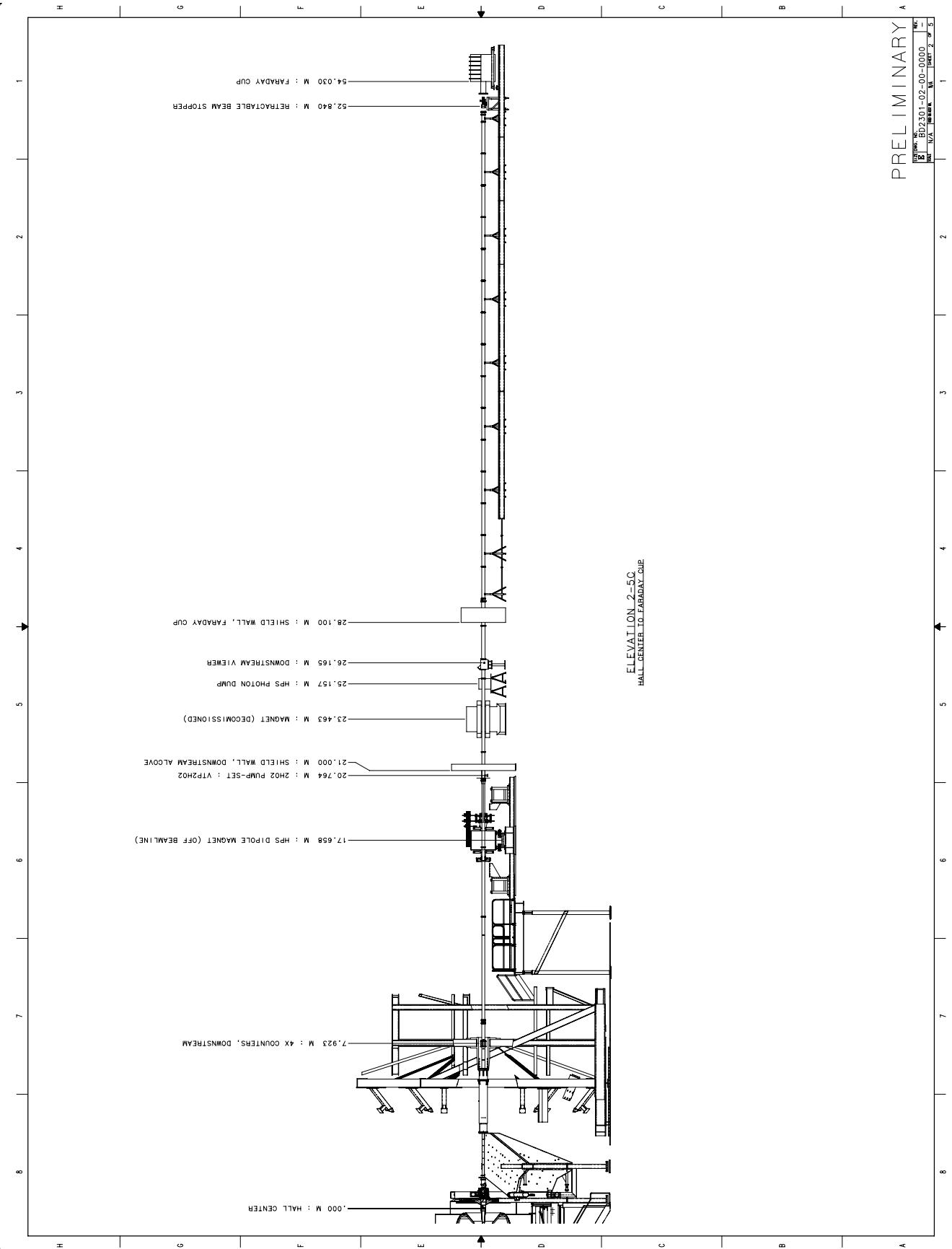


Figure 3: The layout of the RG-D beamline.

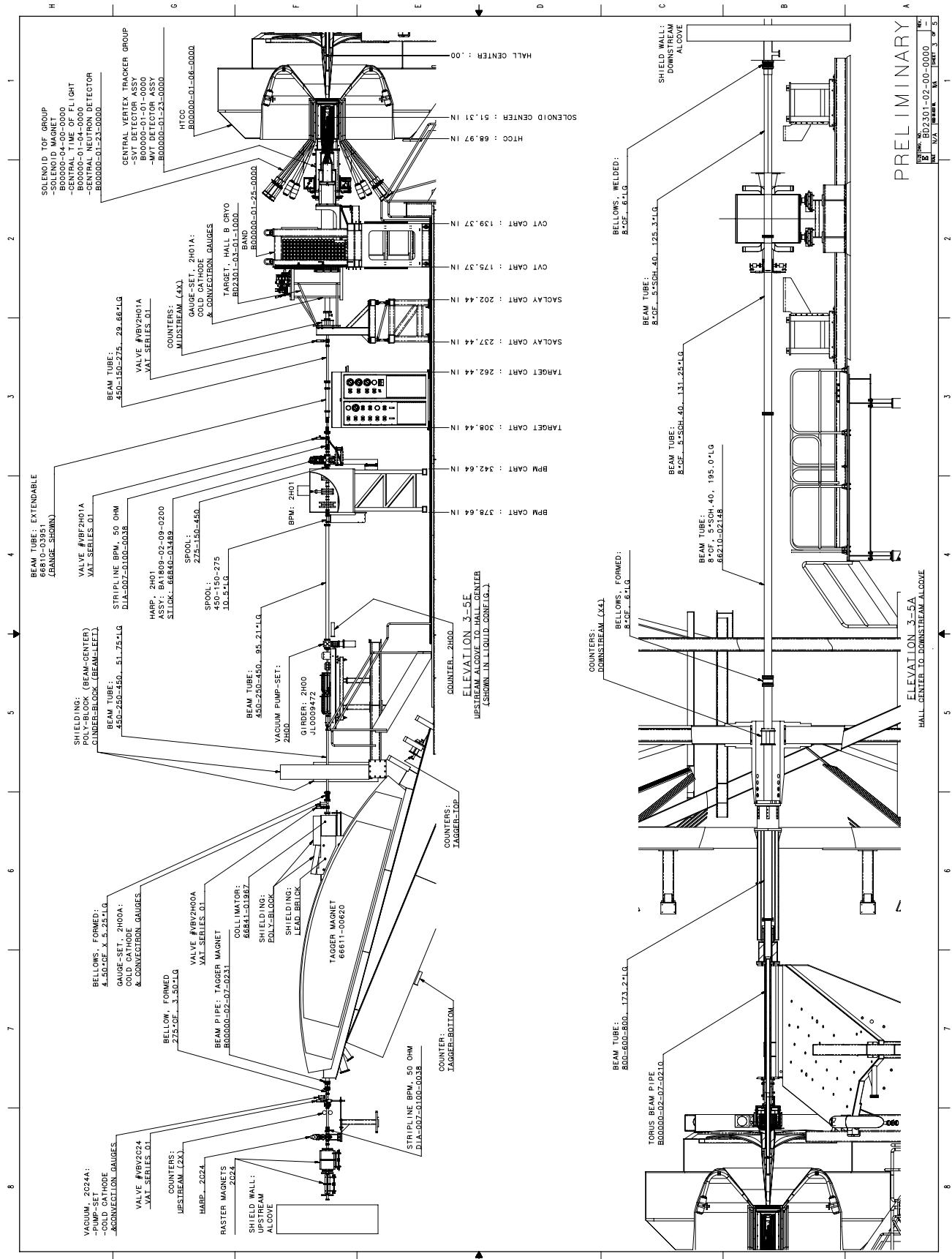


Figure 4: The layout of the RG-D beamline.

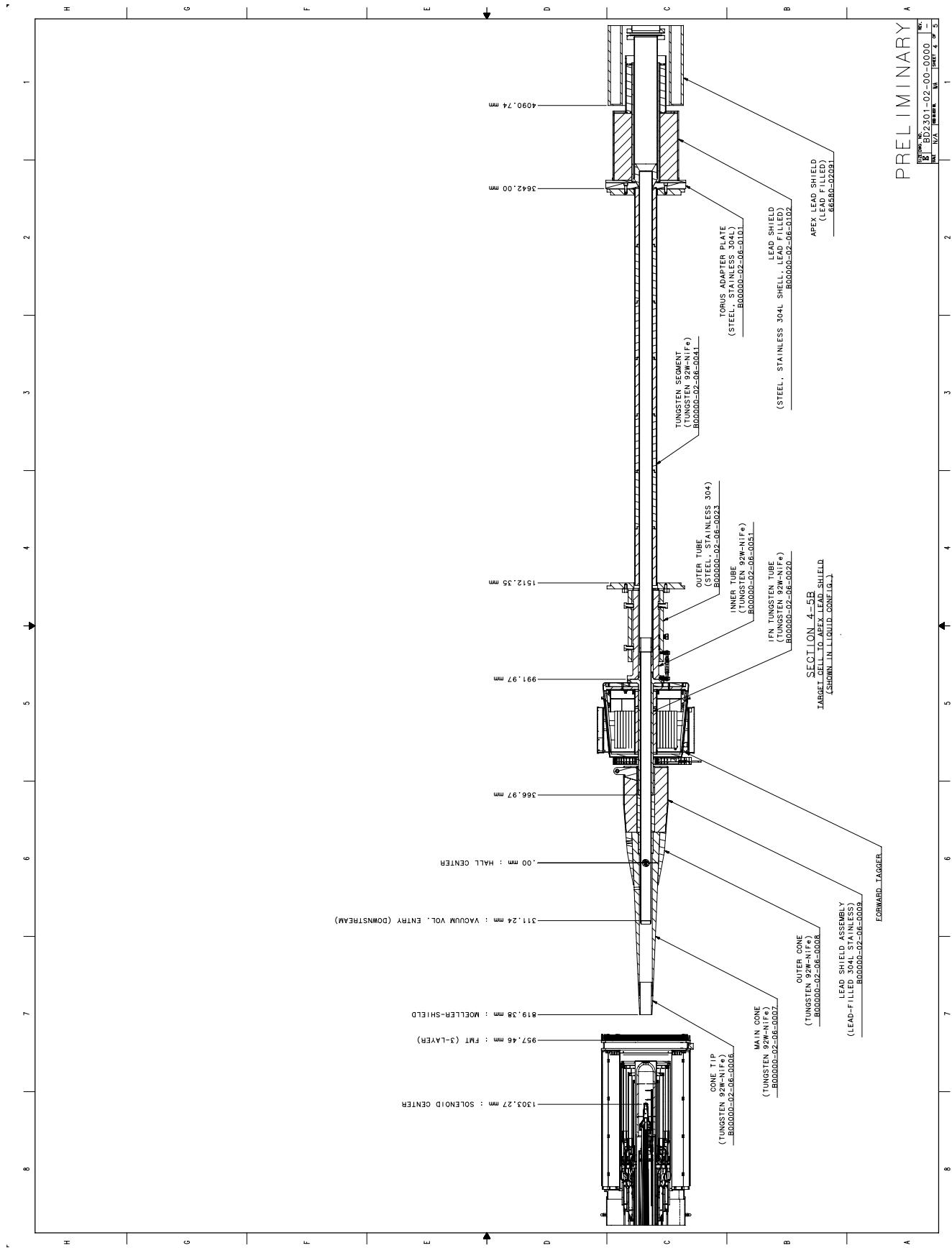


Figure 5: The layout of the RG-D beamline.

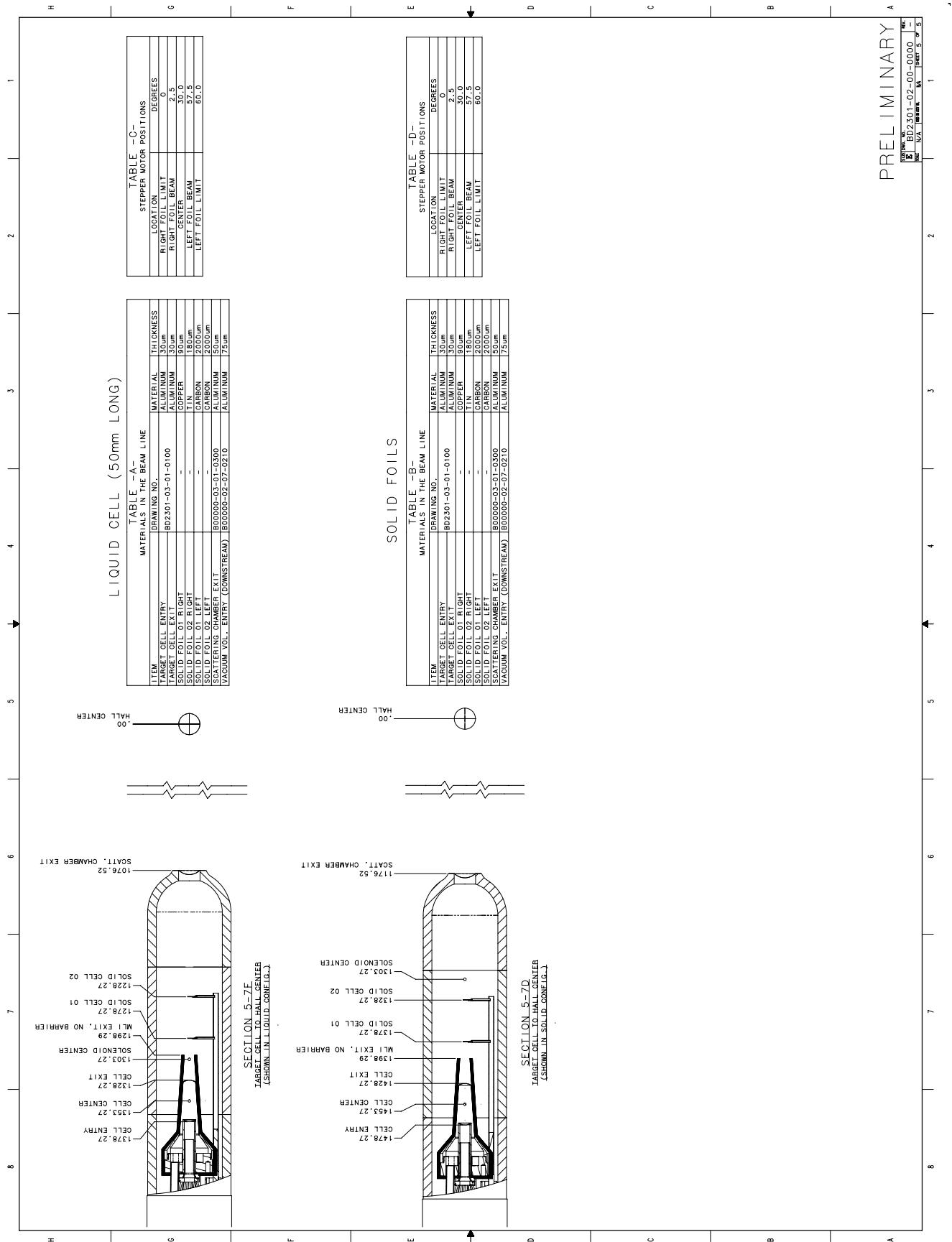


Figure 6: The layout of the RG-D beamline.