

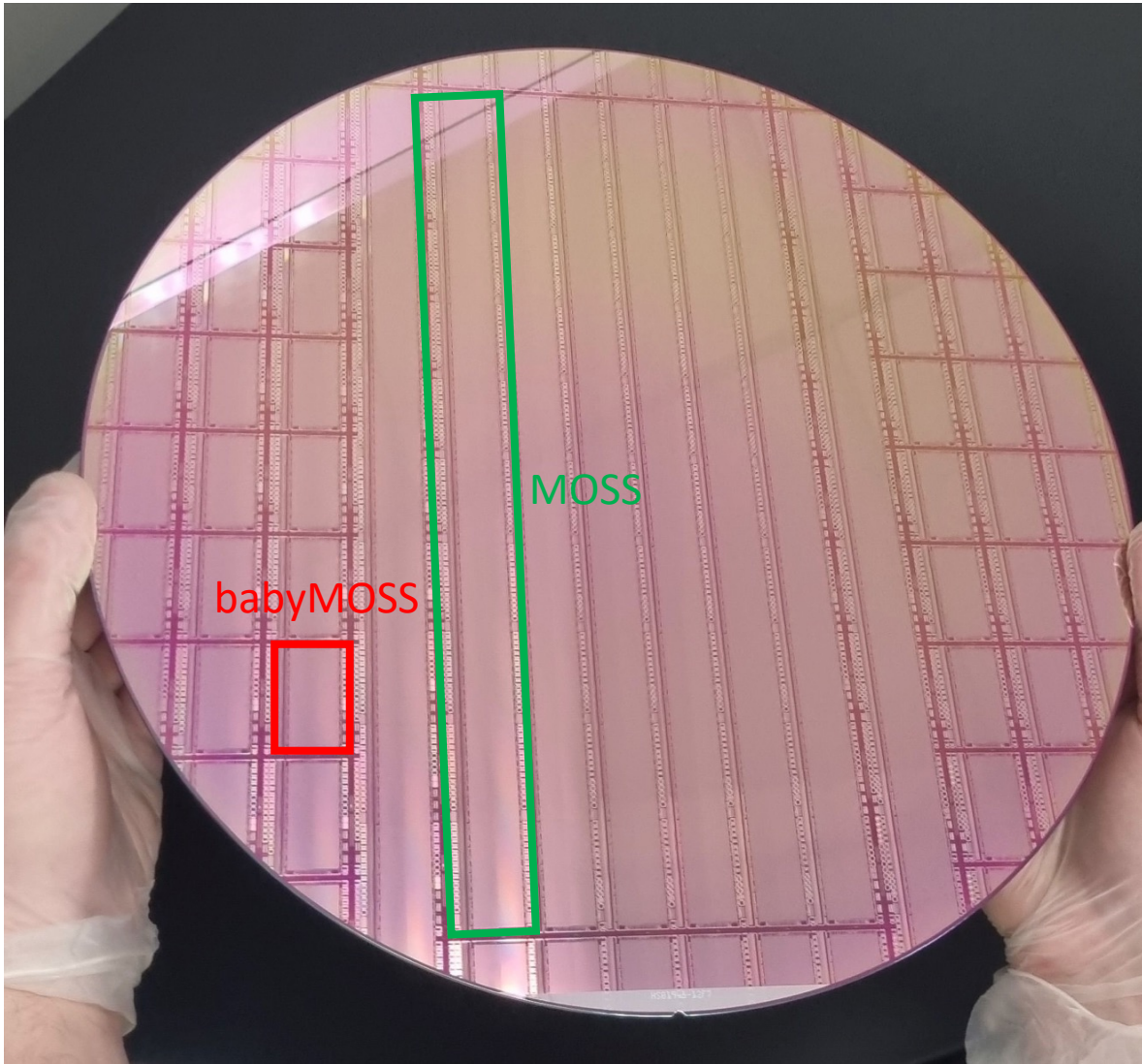


ER1 babyMOSS Tests at FTBF and BASE - updates -

Previous report given on June 17, 2024: <https://indico.bnl.gov/event/23845/>

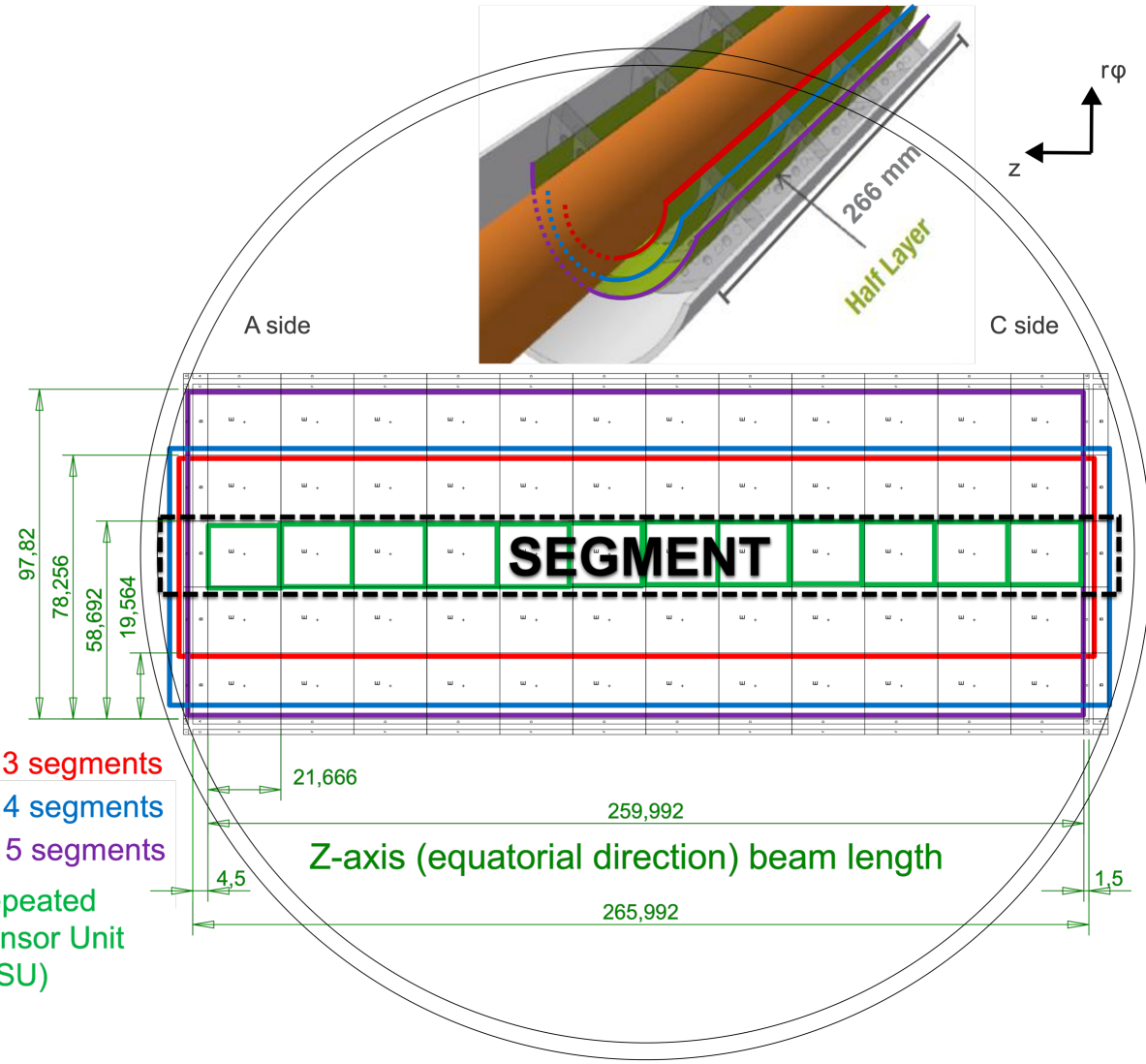
Zhenyu Ye
LBNL

ALICE ITS3 ER1 – MOSS and babyMOSS Sensors



$R\phi$ (azimuthal direction)
folded around beam-pipe

- Layer 0: 3 segments
- Layer 1: 4 segments
- Layer 2: 5 segments
- Repeated Sensor Unit (RSU)



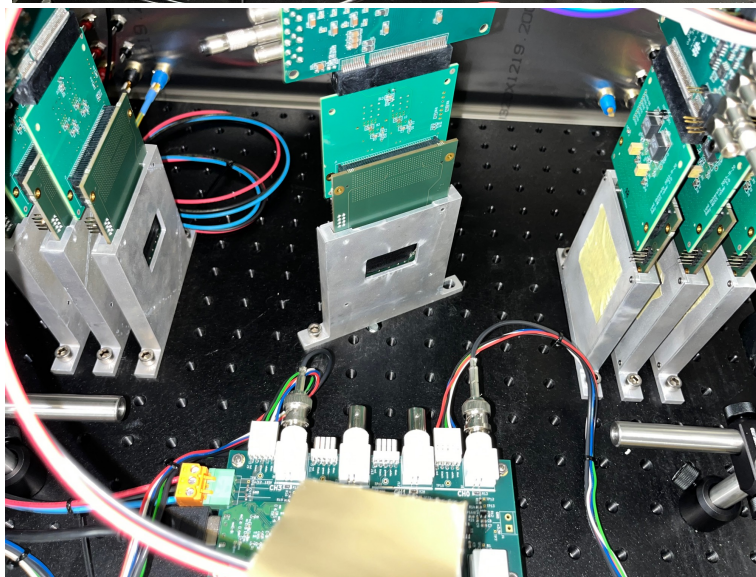
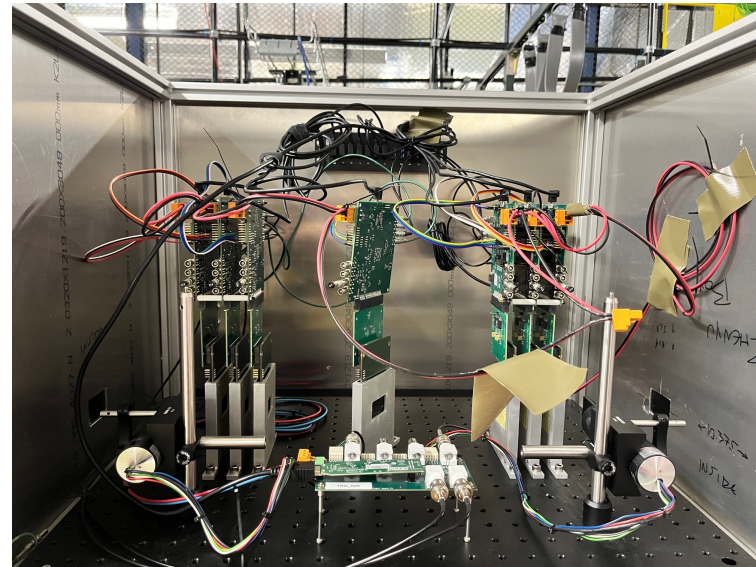
babyMOSS Beam Tests at FTBF

LBL/UCB: Tucker Hwang, Zhenyu Ye; **UIC:** Danush Shekar, (Abhishek Hingrajiya, Grigory Nigmatkolov)

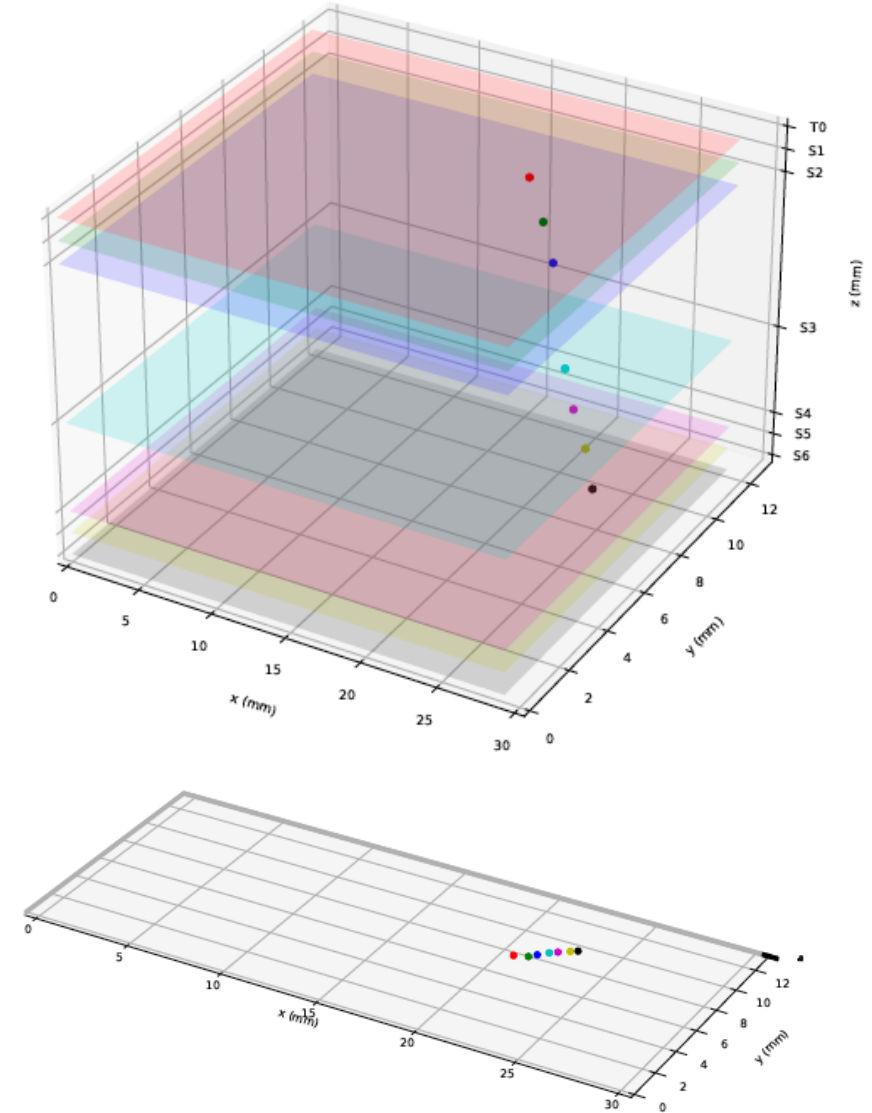
- May 22-June 4: commissioned a 7-plane babyMOSS telescope with 120 GeV protons
 - Took data to study the sensor performance with different incident angles between 0-75 degree
 - Issues:
 - Intermittent power loss that led to interruptions to data taking
 - Synchronization loss of the DUT that compromised the efficiency calculation
 - Significant secondary particles in the DUT holder at large incident angles that led to higher occupancy in the reference planes after the DUT
- June 26-July 12: took data with an improved setup at FTBF
 - Fixed the power cable connection that led to intermittent power losses
 - Reduced secondary particle production with modified babyMOSS holders
 - Got rid of synchronization losses with improved data taking and analysis procedures
 - Data analysis is nearly complete to extract efficiency, resolution, cluster size

babyMOSS Beam Tests at FTBF

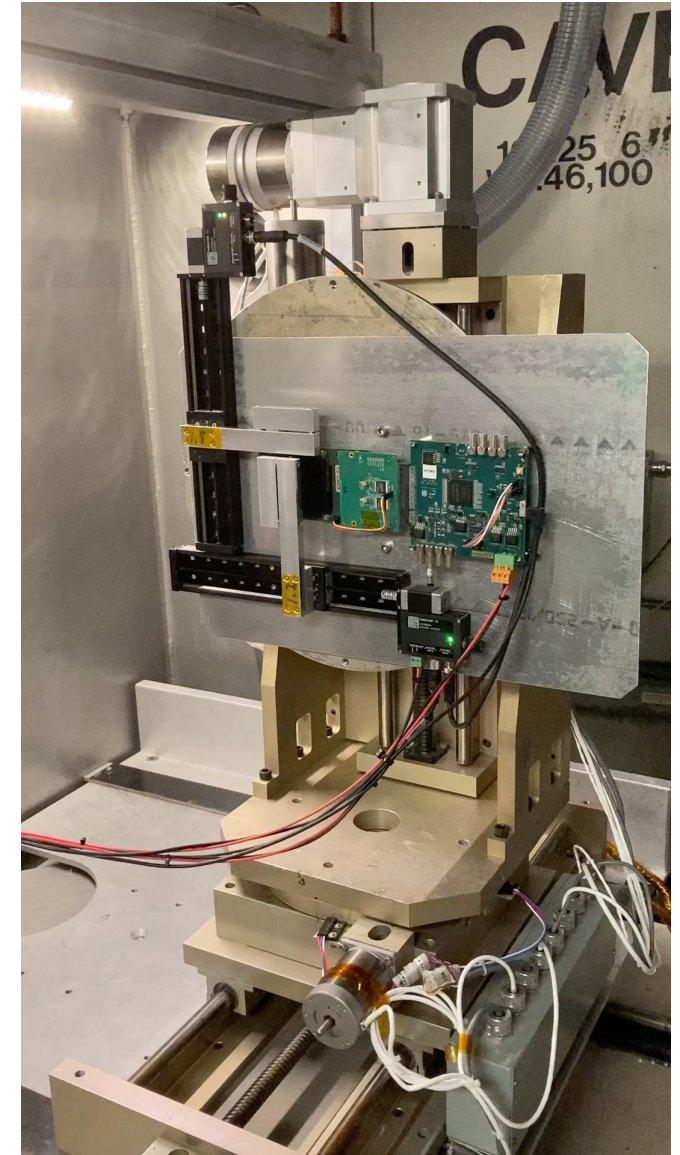
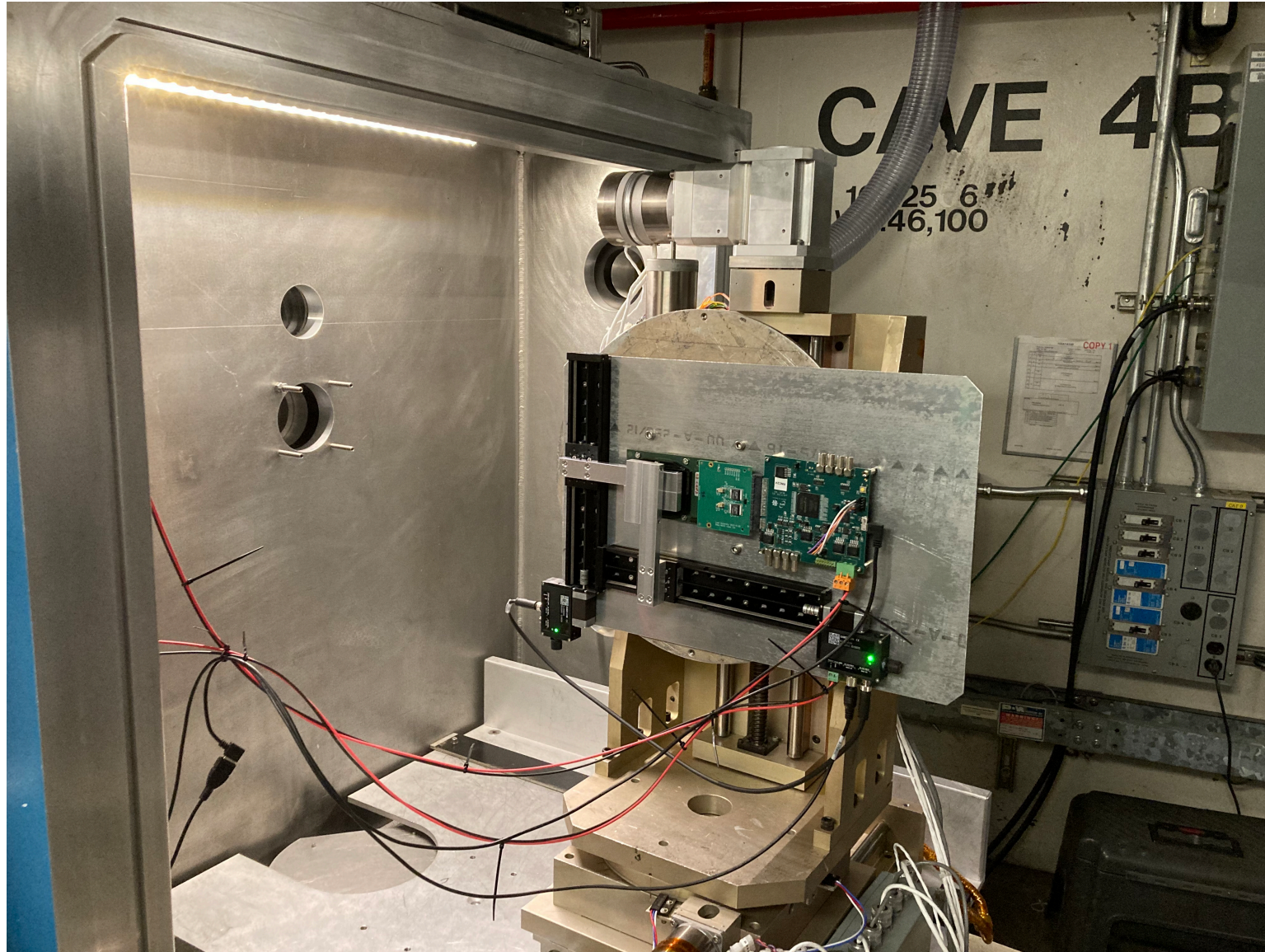
babyMOSS Telescope at Fermilab Test Beam Facility



A 120 GeV proton beam event



babyMOSS SEE Tests at BASE





babyMOSS SEL Tests at BASE



LBL/UCB: Yu Hu, Barbara Jacak, Beatrice Liang-Gilman, Shujie Li, Anjali Nambrath, Emma Yeats, Zhenyu Ye;

CERN: Hartmut Hillemanns; **KU:** Nicola Minafra; **UC Riverside:** Barak Schmookler

- May 22-23:
 - Initial commission of the setup with motion-controlled collimators
 - Scan in X and Y to search for SEL-sensitive circuits with 1.5 (1.2) mm gap collimator in X (Y)
 - Scan in X and Y to search for SEL-sensitive circuits with 0.2 mm gap collimators
- July 1:
 - Measure the SEL and DAC SEU cross-section as a function of LET
 - Scan in Y to search for SEL-sensitive circuits with 0.2 mm gap collimator
- Data analysis is nearly complete to extract cross-sections and locations of sensitive circuits on babyMOSS

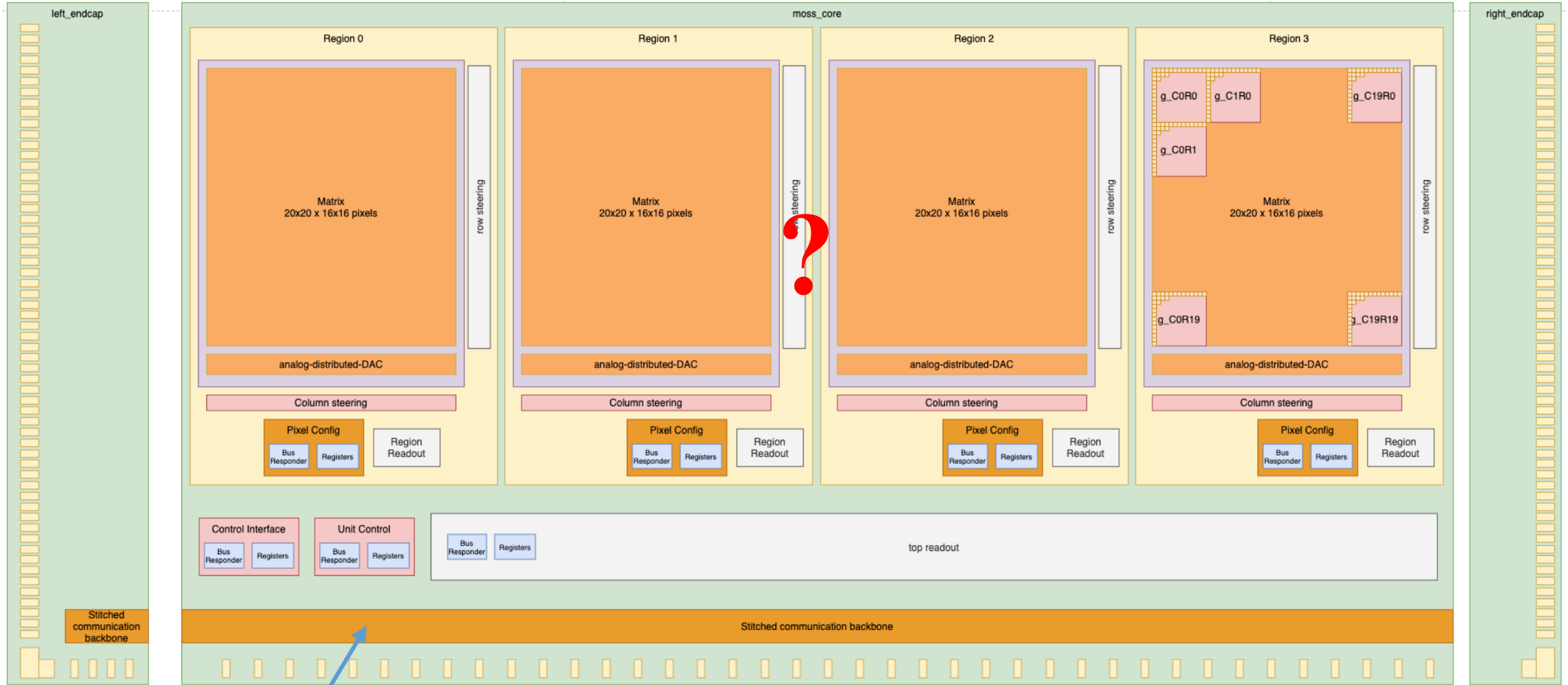
Berkeley Accelerator Radiation Facility

- Berkeley Accelerator Space Effects Facility, LBNL <https://cyclotron.lbl.gov/base-rad-effects>
 - Heavy ions with fluxes up to $10^7 \text{ cm}^{-2}\text{s}^{-1}$ and LET between 1-100 MeV/(mg/cm²)

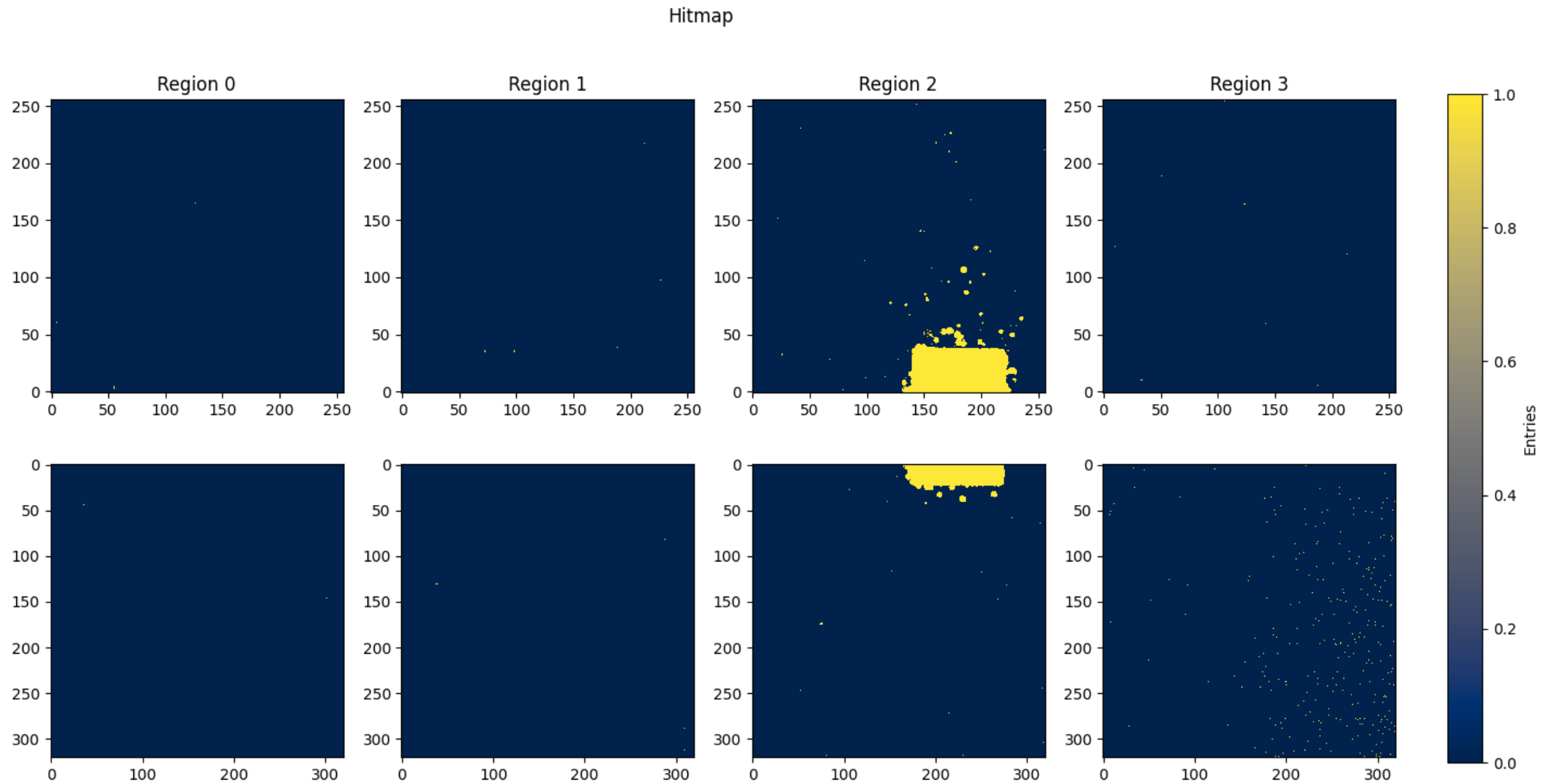
| Ion | Cocktail (AMeV) | Energy (MeV) | Z | A | LET (Entrance) (MeV/mg/cm ²) | Range in Si (Max) (μm) |
|------------|-----------------|--------------|----|-----|--|------------------------|
| B | 10 | 108.01 | 5 | 11 | 0.89 | 307.2 |
| O | 10 | 183.47 | 8 | 18 | 2.19 | 222.2 |
| Ne | 10 | 216.28 | 10 | 22 | 3.49 | 166.1 |
| Si | 10 | 291.77 | 14 | 29 | 6.09 | 132.1 |
| Ar | 10 | 400.00 | 18 | 40 | 9.74 | 116.6 |
| V | 10 | 508.27 | 23 | 51 | 14.59 | 93.9 |
| Cu | 10 | 659.19 | 29 | 65 | 21.17 | 84.6 |
| Kr | 10 | 885.59 | 36 | 86 | 30.86 | 84.1 |
| Y | 10 | 928.49 | 39 | 89 | 34.73 | 68.9 |
| Ag | 10 | 1111.92 | 47 | 107 | 46.92 | 60.5 |
| Xe | 10 | 1232.55 | 54 | 124 | 58.78 | 49.0 |
| Au* | 10 | 1955.87 | 79 | 197 | 86.38 | 54.8 |

- Proton and neutron beams are also available for SEE, TID, and NIEL studies

babyMOSS SEL Tests at BASE



Hitmap for 1.5/1.2mm-Collimator Calibration



Hitmap for 0.2/0.2mm-Collimator Calibration

| Beam | Comment | Collimator (x,y) | Sensor (region, col, row) | Transformed Collimator (x,y) in mm | Sensor (x,y) in mm | Collimator-Sensor (x,y) Difference in mm |
|-----------|---------|------------------|------------------------------|------------------------------------|--------------------|--|
| Xe, 2.5E5 | | 0, 0 | T2: [11,21], [27,41] | 15.3437, 7.82855 | 15.3635, 7.82775 | -0.0197487, 0.00080297 |
| Xe, 2.5E5 | | 0, 0 | T2: [8,21], [27,41] | 15.3437, 7.82855 | 15.3297, 7.82775 | 0.0140013, 0.00080297 |
| Xe, 2.5E5 | | 0, 0 | T2: [9,21], [27,41] | 15.3437, 7.82855 | 15.341, 7.82775 | 0.0027513, 0.00080297 |
| Xe, 2.5E5 | | -10, 0 | T0: [118,129], [33,47] | 5.34458, 7.96128 | 5.3172, 7.96275 | 0.0273821 , -0.00146978 |
| Xe, 2.5E5 | | -5.0, 0 | T1: [63,75], [30,44] | 10.3441, 7.89492 | 10.3235, 7.89525 | 0.0206917, -0.00033341 |
| Xe, 2.5E5 | | +2.5, 0 | T2: [120,133], [26,39] | 17.8435, 7.79537 | 17.8497, 7.794 | -0.0062189, 0.00137116 |
| Xe, 2.5E5 | | +5.0, 0 | T2: [231,243], [24,38] | 20.3433, 7.76219 | 20.336, 7.76025 | 0.00731084, 0.00193935 |
| Xe, 2.5E5 | | +5.0, 0 | T2: [231,244], [24,38] | 20.3433, 7.76219 | 20.3472, 7.76025 | -0.0039392, 0.00193935 |
| Xe, 2.5E5 | | +10, 0 | T3: [177,190], [22,35] | 25.3428, 7.69583 | 25.3647, 7.704 | -0.0218796, -0.00817427 |
| Xe, 2.5E5 | | 0, -2.5 | T2: [11,24], [138,152] | 15.3769, 10.3283 | 15.3972, 10.3253 | -0.0203169, 0.00308276 |
| | | rotation | -0.00132731 +/- 0.0595656 | | | |
| | | xshift | -15.2384 +/- 0.585944 | | | Max Dev= (27, 8) um |
| | | yshift | 8.03152 +/-1.00349 | | | |



Summary and Outlook

- **Beam Tests at Fermilab Test Beam Facility on May 22-June 4 and June 26- July 12, 2024**
 - Assembled and commissioned a 7-plane babyMOSS telescope with 120 GeV protons
 - Studied the dependence of sensor performance on incident angle
 - Data analysis is nearly completed to extract efficiency, resolution, cluster size
- **SEE Tests at Berkeley Accelerator Space Effects Facility on May 22-23 and July 1, 2024**
 - Measured babyMOSS SEL and DAC register SEU cross-sections as a function of LET
 - Searched for SEL-sensitive circuits on babyMOSS with motion-controlled collimators
 - Data analysis is nearly completed to extract cross-sections and locations of sensitive circuits
- **Plan for Winter 2024/Spring 2025:** irradiate babyMOSS sensors and study the temperature dependence of pre- and irradiated sensor performance in the lab and with beam