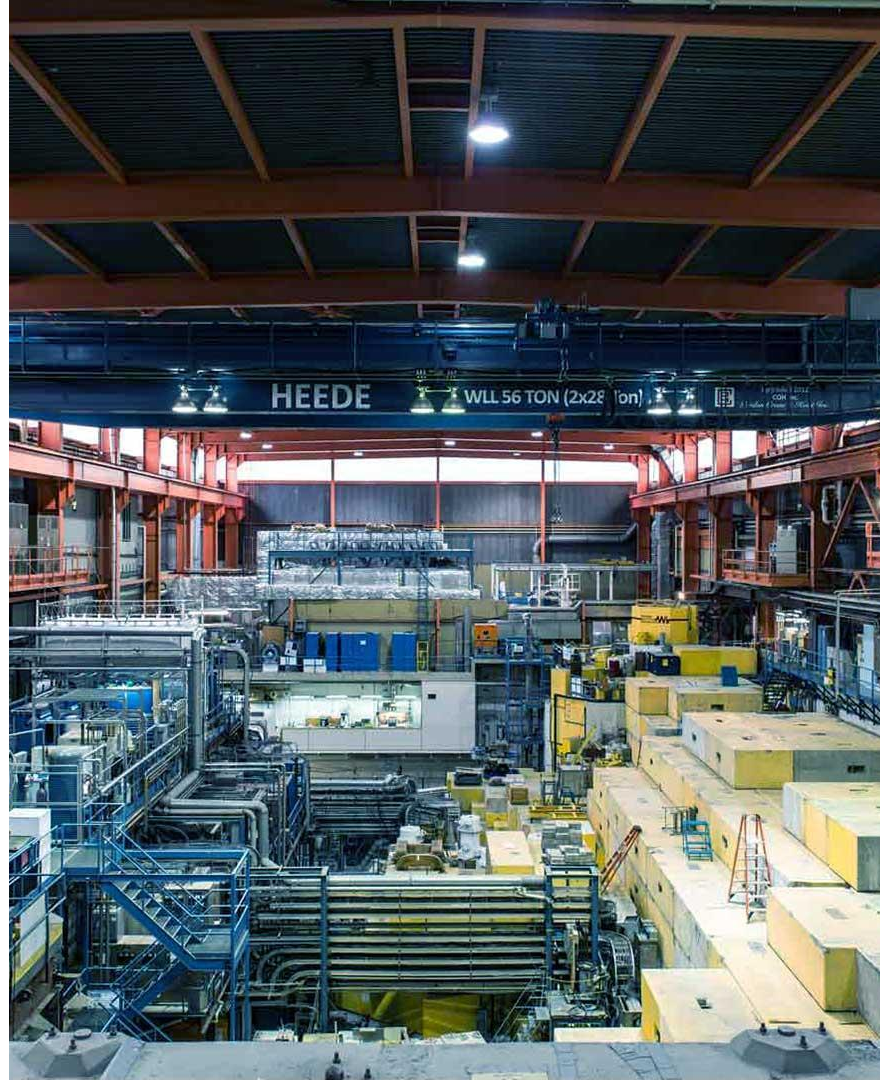


# BL1U Status & Readiness For Full Current

Dr. Pietro Giampa  
Physical Sciences Division

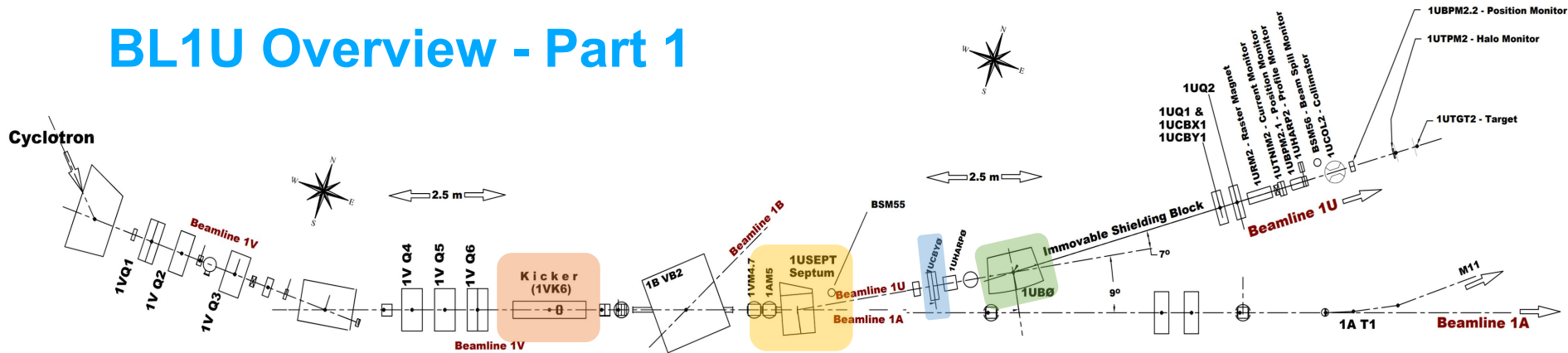
TUCAN EAC Review 2020



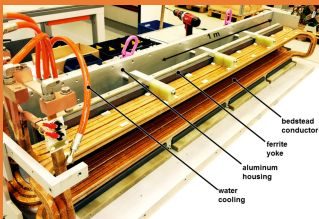
## Overview

- BL1U Overview
- Beamline Routine Operation
- Reaching 40  $\mu\text{A}$  in Beam-Current
- Beam-Position-Monitor (BPM) Status
- Outlook

# BL1U Overview - Part 1

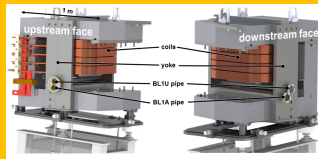


## Kicker Magnet



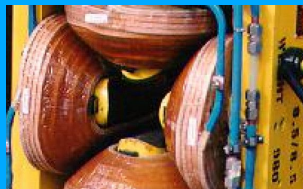
When ON, deflects proton upwards by 12 mrad (0.68°).

## Septum Magnet



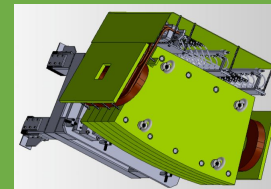
Deflects the kicked beam by 150 mrad (9.0°). Magnet offset by 4.4° in x-axis to remove the beam rise from the kicker.

## Vertical Steerer



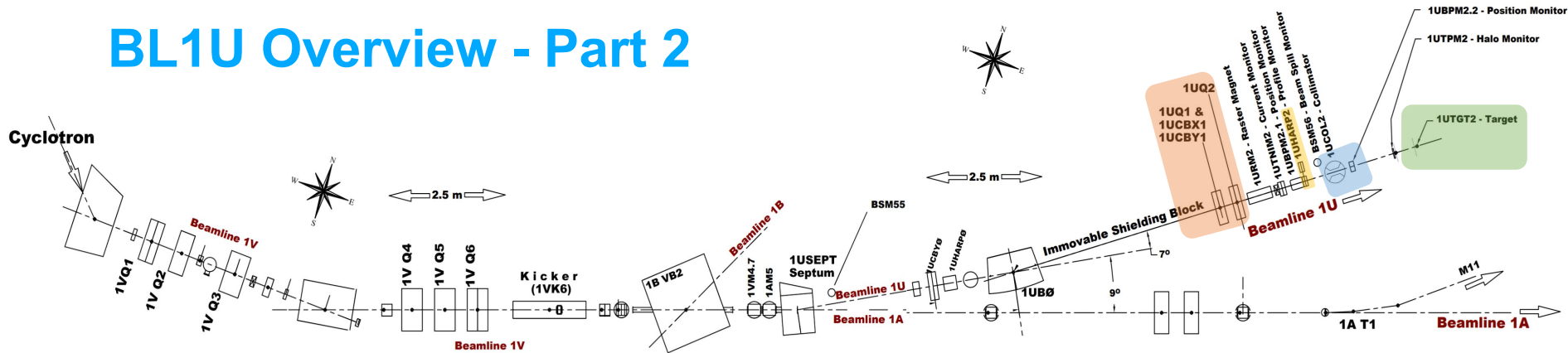
Corrects remaining vertical momentum in the 1U beam, after the Septum magnet.

## Bending Dipole

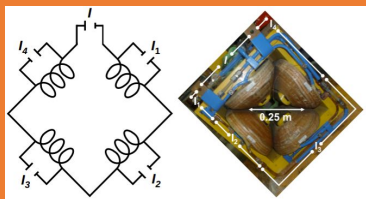


Adds another beam deflection of 120 mrad (7.0°) leftward, to further separate 1U and 1A.

# BL1U Overview - Part 2



## Quadrupole Magnets



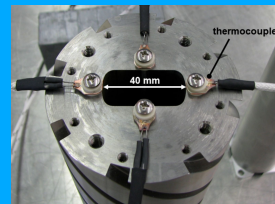
4Q8.5/8.5-type quadrupole magnets. Max field of 0.9 T.

## HARPs



Gas-filled wire chambers with 3 mm spacing.

## Tungsten Collimator



Cut into a single cylinder of W, 30 cm long. 20x40 mm opening..

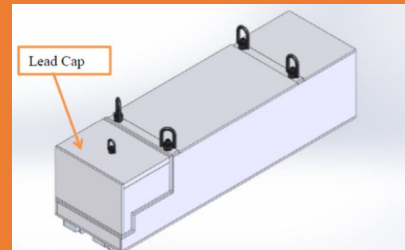
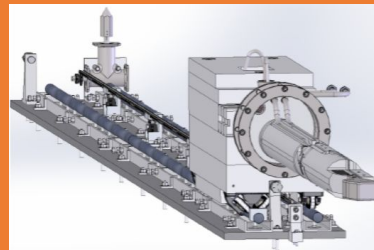
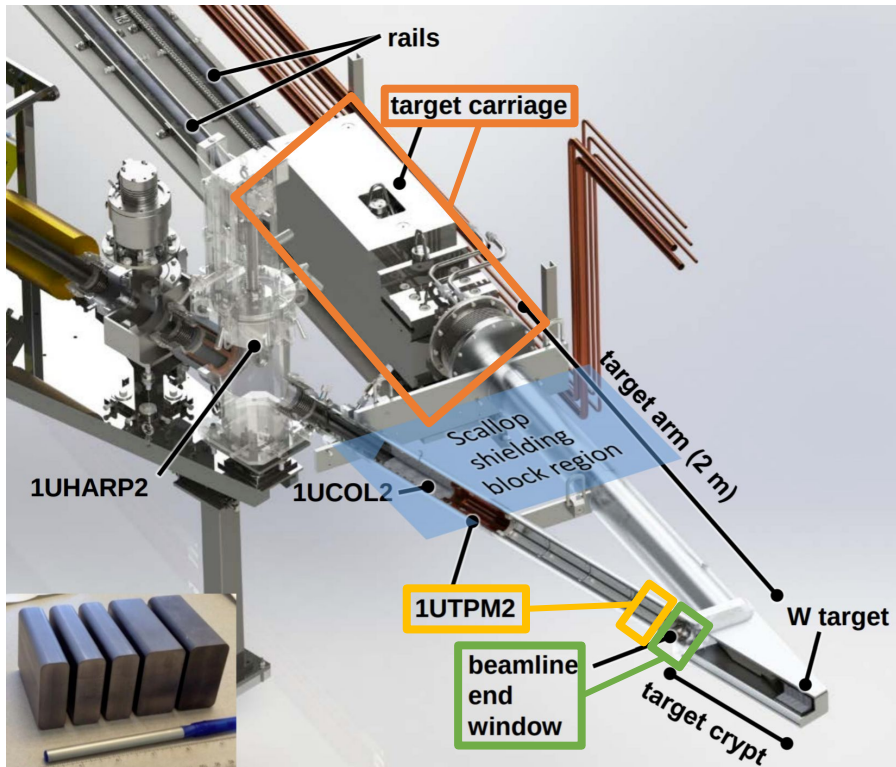
## Target



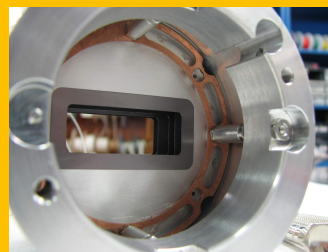
Five Tungsten blocks. 78x57 mm Cross-section.



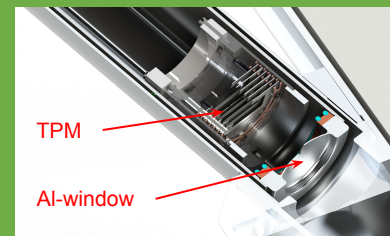
# BL1U Overview - Closer To The Target



Target casket design available, and a work request has been submitted. Goal is to install this during the next shutdown. (Requires assistance from Engineering and Accelerator Divisions).

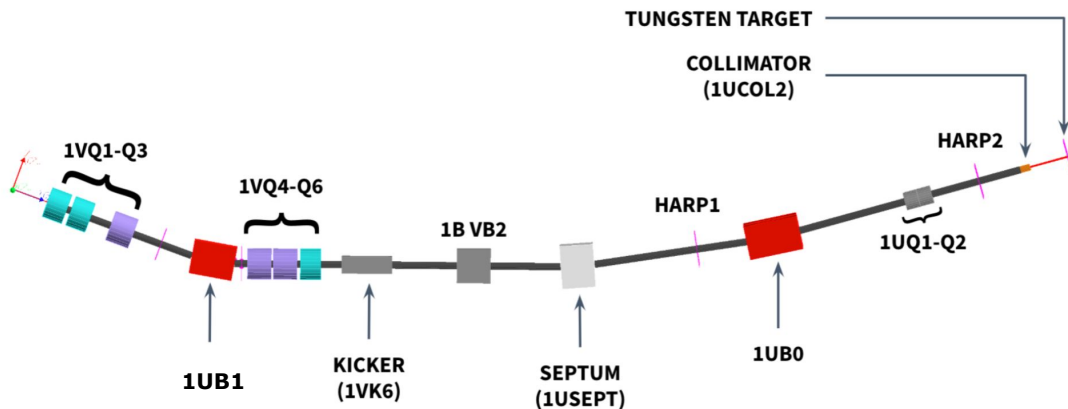


Picture of the TPM module. Six readout foils total.

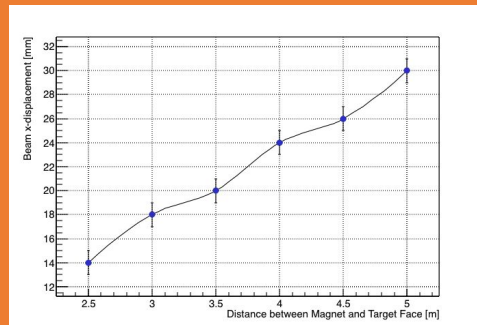
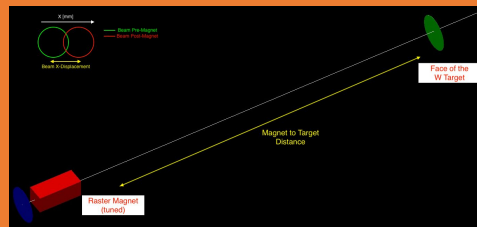


1 mm Al beamline-end window. Vacuum to ~20 PSIA He Gas.

# BL1U Overview: Simulation Model



Developed a Geant4beamline Simulation Model for BL1U. All current components have been implemented in the model. This will allow us to validate and test any possible modifications to the system.



Example: Using G4beamline to predict the x-displacement from a possible Raster Magnet.

# Beamline Routine Operation

**TRIUMF** Document-157217

## Beamline 1U - Procedures for 520 MeV Operations

Document Type: Operating Procedure  
 Release: 2 Release Date: 2019-10-09  
 Author(s): W. Schreyer

|              |             |                                 |
|--------------|-------------|---------------------------------|
|              | Name:       |                                 |
| Author:      | W. Schreyer |                                 |
| Reviewed By: | E. Chapman  | <a href="#">Approval Record</a> |
|              | C. Davis    |                                 |
|              | K. Genge    |                                 |
|              | C. Marshall |                                 |
|              | T. Lindner  |                                 |
|              | R. Picker   |                                 |
| Approved By: | V. Toma     |                                 |

Note: Before using a copy (electronic or printed) of this document you must ensure that your copy is identical to the released document, which is stored on TRIUMF's document server.

|   |               |                           |
|---|---------------|---------------------------|
| Beamline 1U - Procedures for 520 MeV Operations |               |                           |
| Document-157217                                 | Release No. 2 | Release Date.: 2019-10-09 |

### 1 Purpose and Scope

The purpose of this document is to provide instructions for setting up beamline 1U and delivering beam to the UCN target. An overview of the facility is provided.

This document only covers routine operation and basic troubleshooting of beamline 1U. Any operation not covered by the procedures in this document will be supported in person by experts from Accelerator Division with possible support from the UCN Group.

### 2 Referenced documents

- [TRI-DN-16-34 - Safety Analysis for UCN Commissioning to 1 Microampere](#)
- [BL1U Beam Commissioning Plan for up to 1uA operation and kicking](#)
- [Design Note TRI-DN-16-11 UCN Kicker Control and Diagnostics](#)
- [TRI-DN-17-08 - BL1U Current Interlock Requirements](#)
- [UCN Beamline Interlocks](#)
- [Air monitor warning response](#)
- [Nuclear Ventilation Alarms Response](#)

### 3 Responsibilities

The Driver Operations Group is responsible for beam delivery to the UCN target and for monitoring the state of beamline 1U and the UCN target.

The UCN shift crew is responsible for operation of the UCN source and for requesting beam parameters from Operations Group via Beam Property Request forms.

Accelerator Division and the Beamlines Group are responsible for all equipment described in section 4.2. Control of most of the elements is provided through PLC and EPICS. Controls support is provided by the Controls Group. The kicker sequencer and 1VM4 use custom hardware supported by the DAQ Group.

Mechanical Services is responsible for the air extraction fan.

|   |               |                           |
|---|---------------|---------------------------|
| Beamline 1U - Procedures for 520 MeV Operations |               |                           |
| Document-157217                                 | Release No. 2 | Release Date.: 2019-10-09 |

### 5 Procedures

#### 5.1 Beam trips

##### 5.1.1 Interlocks

Three summary bits are transmitted to the Central Safety System (CSS) and will trip the beam when interlocked. The status of these 1U summary bits can be checked on the CSS vertical safety panel SJV page in the MCR. To view page SJV, select "1U" from the Index page on the DIS01 touch screen.

- If the BL1U vacuum interlocks are in the error state, check their status on B1U controls – CSS – Vacuum summary
  - o Follow procedure 5.3 to restore vacuum if necessary
  - o Fault report any issues with vacuum equipment to the Vacuum Group
- If the BL1U magnet interlocks are not ok, check their status on B1U controls – CSS – Magnet summary
  - o If B1U magnet temperatures or water flows are not ok, confirm that Cu-ALCW water system is on and that system pressures are nominal
  - o Contact Beamlines Group to investigate
  - o If both temperatures and flows not ok, there may be a controls issue. Contact Controls Group to investigate.
- If the UCN target is in the error state, check its status on B1U control – CSS – Target summary
  - o If B1U target temperatures, B1UT:WFB2 FM50 water flow, B1U:WFB1 WNDW water flow, or B1UT:TS50 water temp are not ok:
    - Check target water expansion and cooling, see procedure 5.2
    - Contact Cam Marshall or Beamlines Group if not fixed
  - o If B1U:TNIM2 not ok:
    - Reset latches in B1U controls – B1U:TNIM2
    - Check that B1U control – Optics – B1V:KICK settings are ok and predicted current is 1uA or lower.
    - Contact Diagnostics or Controls Group if not fixed
  - o If B1UT:PS01 air flow not ok:
    - Check the fan breaker in panel P-079 (east of Meson Hall loading bay)
    - Cycle the breaker and check if B1UT:PS01 air flow restores
    - If breaker trips twice leave it off

# Reaching 40 $\mu\text{A}$ in Beam-Current

## Goal:

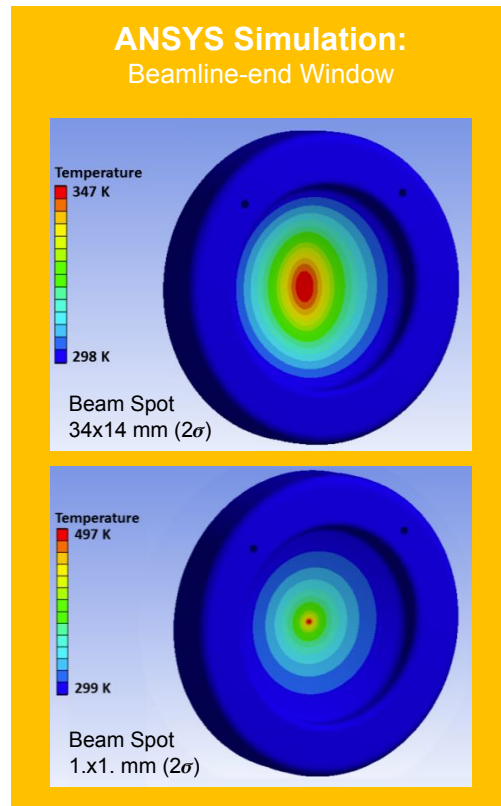
Safe, and stable, delivery of 40  $\mu\text{A}$  beam-current to the BL1U target.

## What is Needed:

- Understanding the beam-envelope on target. If the beam is too focused on the target, it could permanently damage the beamline-end window.
- Determine if extra diagnostic elements (or a raster magnet) are required. The beam-envelope has to be monitored very carefully.

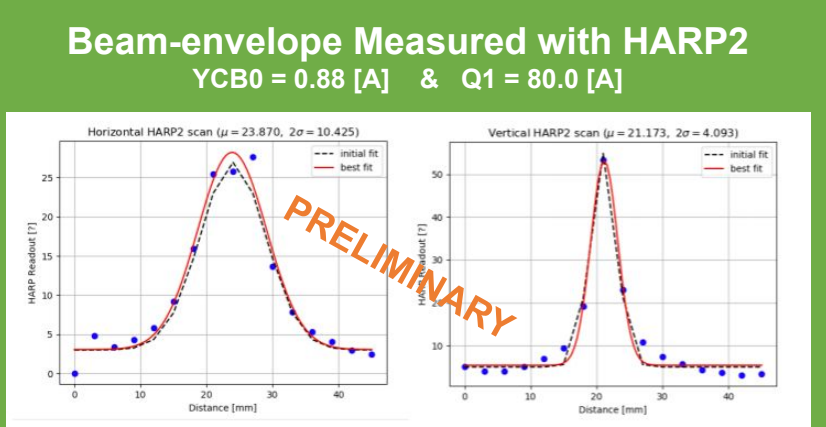
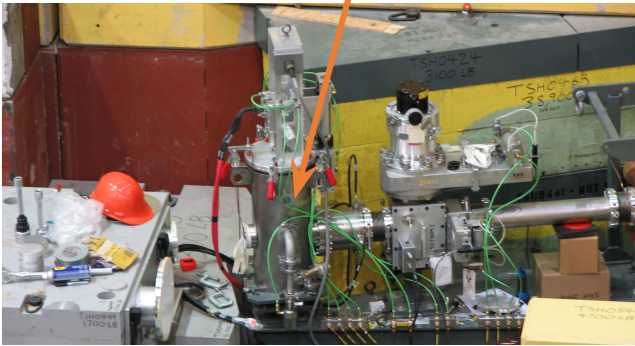
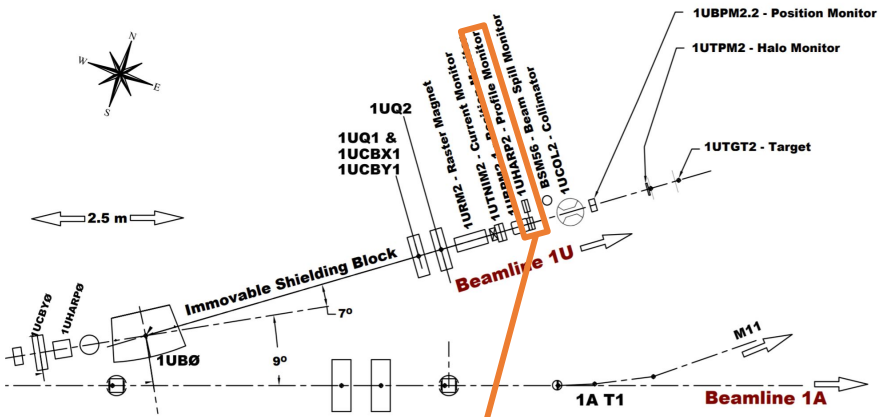
## Challenges:

- Use of diagnostic elements designed for other purposes.
- Rely on calculations/simulations, which require validation.



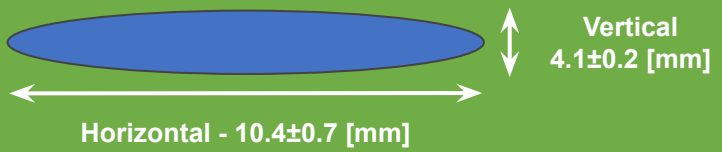


# Reaching 40 $\mu\text{A}$ in Beam-Current - HARP2



The HARP readout (15 wires, 3 mm spaced, in each direction) is model with a gaussian distributions (beam-envelope) plus a flat background corresponding to the intrinsic noise in each wire.

### 2 Sigma Beam-Envelope at HARP2



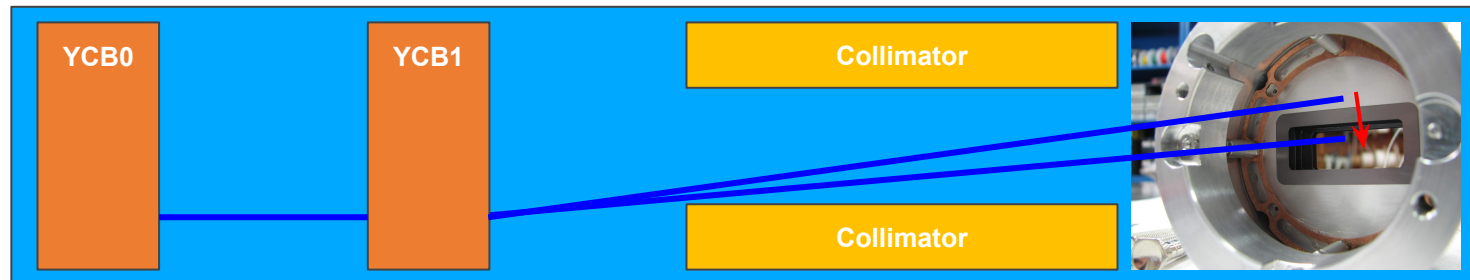
# Reaching 40 $\mu\text{A}$ in Beam-Current - Beam-envelope

## Why is HARP2 Not Enough:

- HARP2 is several meters away from the target, while it helps tuning the simulations, a more precise direct measurement near the target is needed.

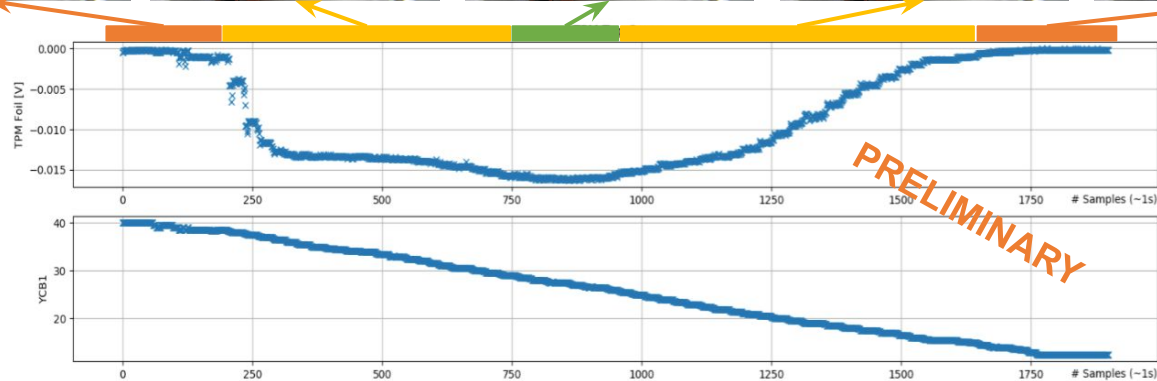
## Using the TPM To Measure the Beam-Envelope on Target:

- Fix the magnet YCB0 and use the steering quadrupole YCB1 to guide the beam in the desired direction.
- Move the beam until you get to a specific TPM foil.
- Use the TPM readout to determine the Beam-Envelope near the target.



# Reaching 40 $\mu\text{A}$ in Beam-Current - TPM Measurement

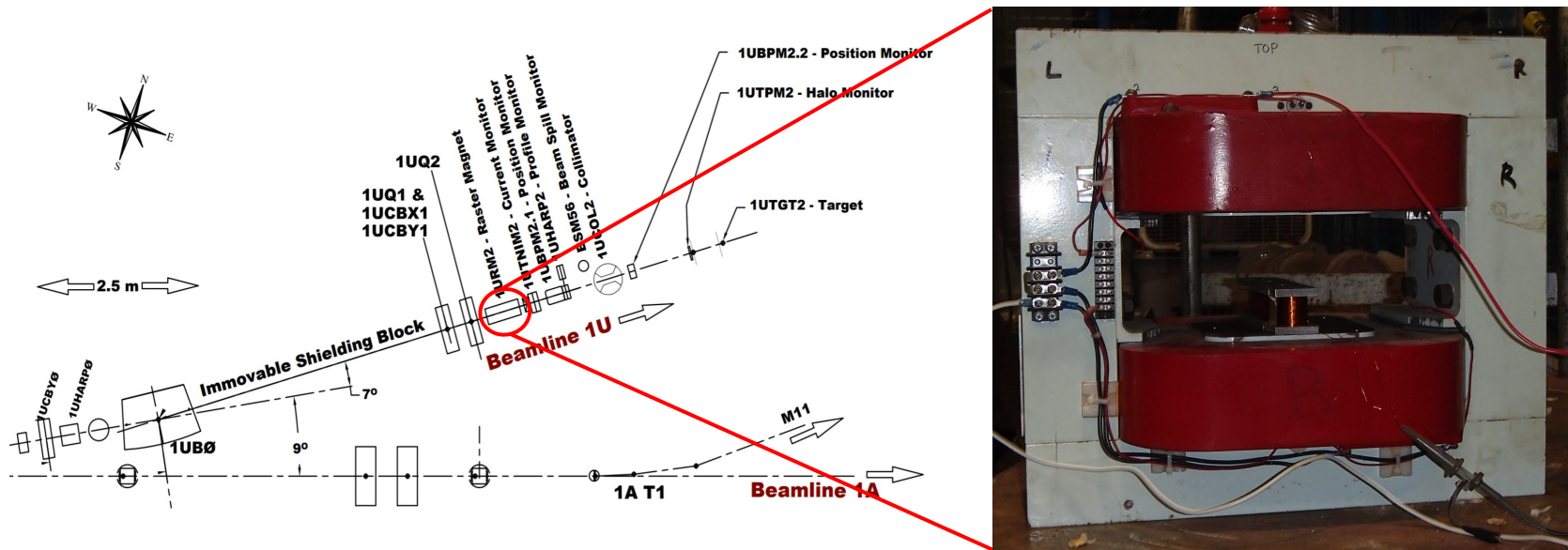
● Simplistic representation of the Beam Envelope



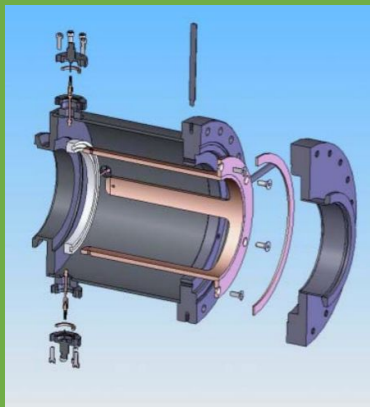
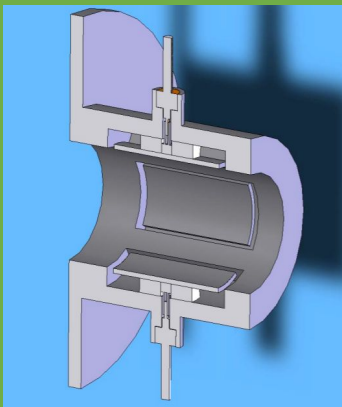
We can use the rising edge to determine the beam-spot (tomography exercise). You can repeat for top-bottom foils to determine the vertical envelope and left-right to determine the horizontal envelope.

# Reaching 40 $\mu\text{A}$ in Beam-Current - Raster Magnet

If the beam-envelope is too focused (or if it can not be determined with enough precision) the current plan would be to install a Raster magnet to sweep the beam 6.4 mm left and right lowering the time averaged beam intensity ( $\sim 3.5$  [m] distance from the Target).




# Beam-Position-Monitor (BPM) Status



The BPM has been built (TRI-DN-10-06).  
The core of the beam-profile monitor are four rectangular capacitive pickups.

Juan Pon (Engineering Division) is assisting with the completion of this task (crucial diagnostic component).

|  |                   |   |   |                                     |
|--|-------------------|---|---|-------------------------------------|
| <b>TRIUMF - Work Request</b><br>Released   |                   |  | <b>Request No.</b><br>4818                      |                                     |
| <b>Assessment Stage:</b><br>Accepted   |                   |   | <b>Date Submitted</b><br>2018-03-16             |                                     |
| <b>Title of Request:</b><br>Provide EPICS readout of B1U Beam Position Monitors          |                   |   | <b>Related Work Requests:</b>                   |                                     |
| <b>Requestor Name:</b><br><a href="#">Lindner, Thomas</a>                                |                   |   | <b>Requestor Division:</b><br>Physical Sciences |                                     |
| <b>Commitment Tracking Number:</b><br>Ultracold Neutron Source (2009 CFI project) (F118) | <b>CCS:</b><br>No | <b>Labour Account:</b><br>7413 - LABOUR   | <b>Material Account:</b><br>7413 - EQUIP        | <b>Date Required:</b><br>2018-08-15 |
| <b>Experiment Number:</b>  |                   |   |   |                                     |

**Request Summary:**  
I'd request that we get EPICS readout of the B1U BPMs. The diagnostics group is providing a BPM electronics card (NIM form factor) that digitizes the BPM signals and creates analog outputs based on those measurements. Specifically it creates four analog outputs:  
1) +10V signal indicating X position  
2) +10V signal indicating Y position  
3) 0-10V signal indicating total current  
4) 0-10V signal indicating position error  
(Contact person for this module: Shengli Liu)

There are two of these BPMs in B1U (B1U-BPM2A and B1U-BPM2B).

I believe that the plan is to digitize these analog signals with the VME VADC8 board which controls group uses. This can go in the B1U VME crate.

**Deliverables:**

| Title       | Quantity | Description                                       | Required Date |
|-------------|----------|---|---------------|
| see request | 1        | Provide EPICS readout of B1U-BPM2A and B1U-BPM2B. | 2018-08-15    |

**Hazard Analysis:**

| Category  | Description | Source | When it will occur | Who will be exposed | Consequence | Regulation and Policies | Control |
|-----------|-------------|--------|--------------------|---------------------|-------------|-------------------------|---------|
| Assessed: |             |        |                    |                     |             |                         |         |

**Assessed:**

| Service Group Name       | Assessed By       | Assessment Comment            | Date Assessed | Closed | Closed By |
|--------------------------|-------------------|-------------------------------|---------------|--------|-----------|
| <a href="#">Controls</a> | Nussbaumer, Rod B | <a href="#">View Comments</a> | 2018-05-24    | No     |           |

[View Request History](#)



## Conclusions & Outlook

- We now have a first Geant4beamline simulation model for BL1U (*although more work is required*).
- We developed a new operation procedure for BL1U (*currently valid for  $1\mu\text{A}$  only*).
- Focusing on getting BL1U ready for full current ( $40\ \mu\text{A}$ ).
- Understanding the beam-envelope on target is of the high-priority. Once we know the beam-envelope we can construct a plan going forward to deliver  $40\ \mu\text{A}$  to the target. (*Acceleration Division support crucial for this task*).
- If necessary, we have plans to install a Raster magnet to assist, if the beam is too focused.
- Goal to make the BPM operational during the next long shutdown. (*Engineering Division support crucial for this task*).
- Necessary transition from UCN group to Accelerator group.

