



BNB Target Scans – Start Up 2020/21

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BNB Operations Meeting

January 25, 2021

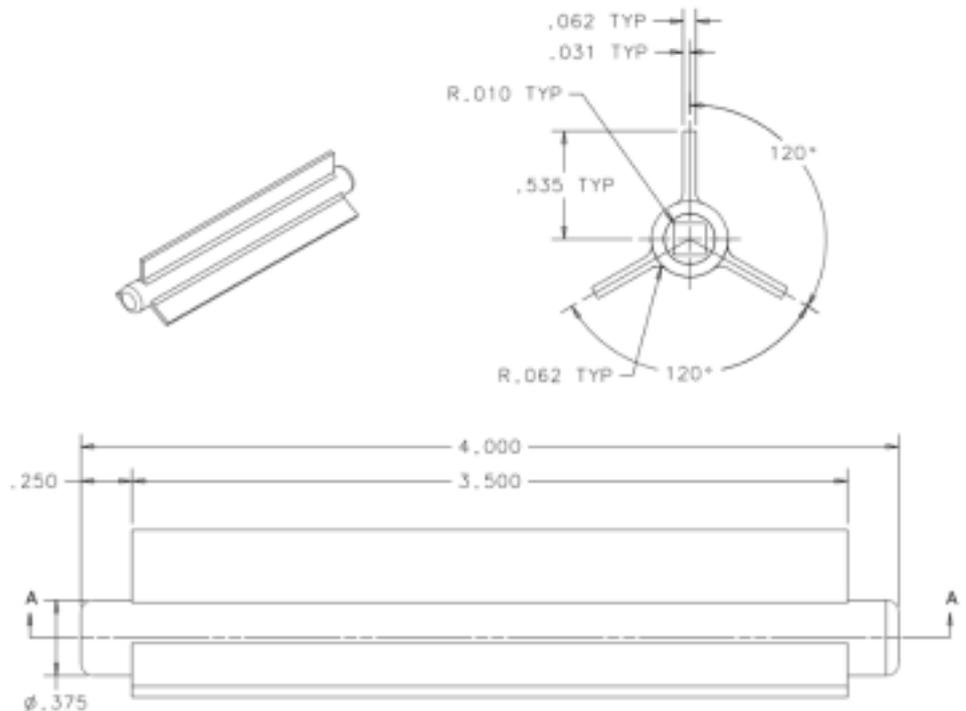
Target Scan Overview

We routinely perform target scans following the shutdown, which allow us to find the geometric center of the target.

In normal operation mode we steer the beam to the center of the target face using an autotune program.

Our autotune program needs to be told what the BPMs should read when beam is steered onto the center of the target face.

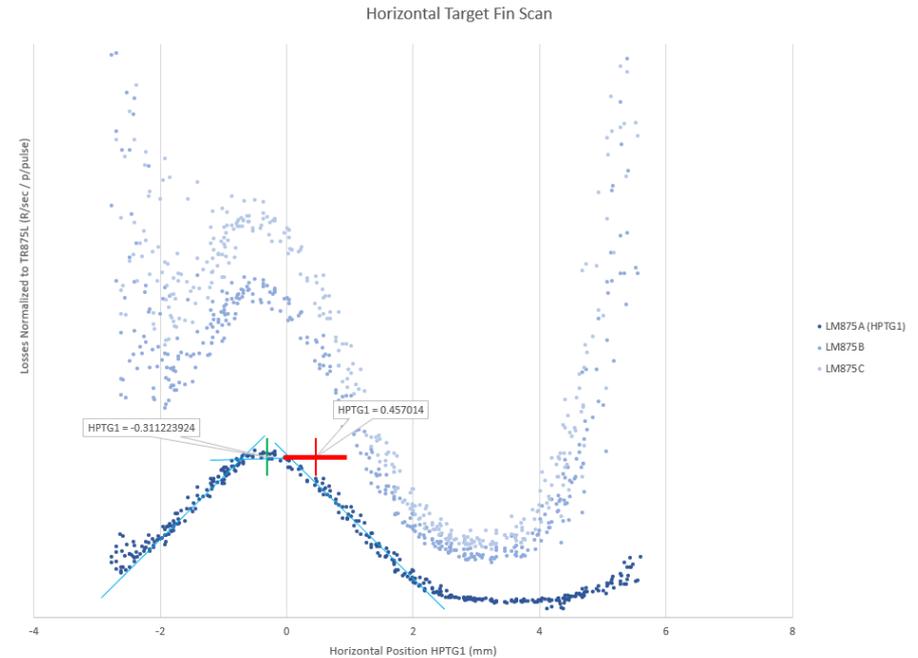
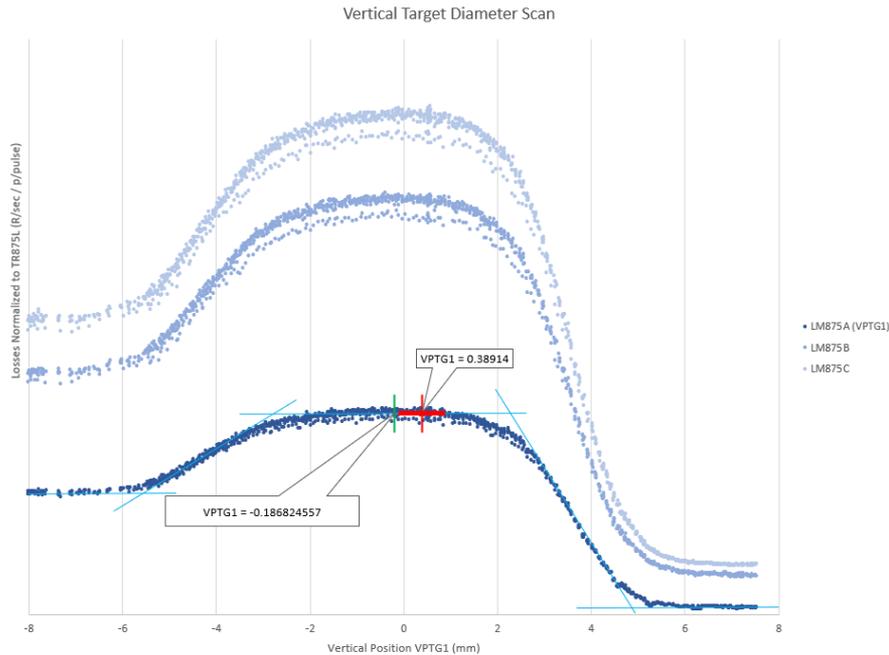
There are several reasons why these position readings are not necessarily “0 mm” and why their center readings would have changed.



Expectations

2018 start up scans

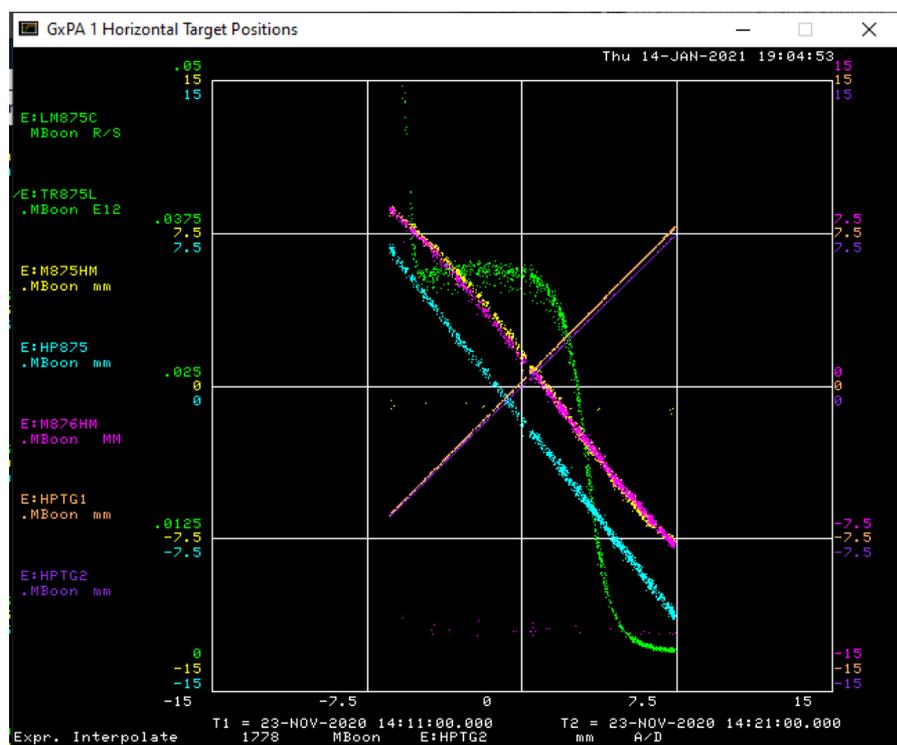
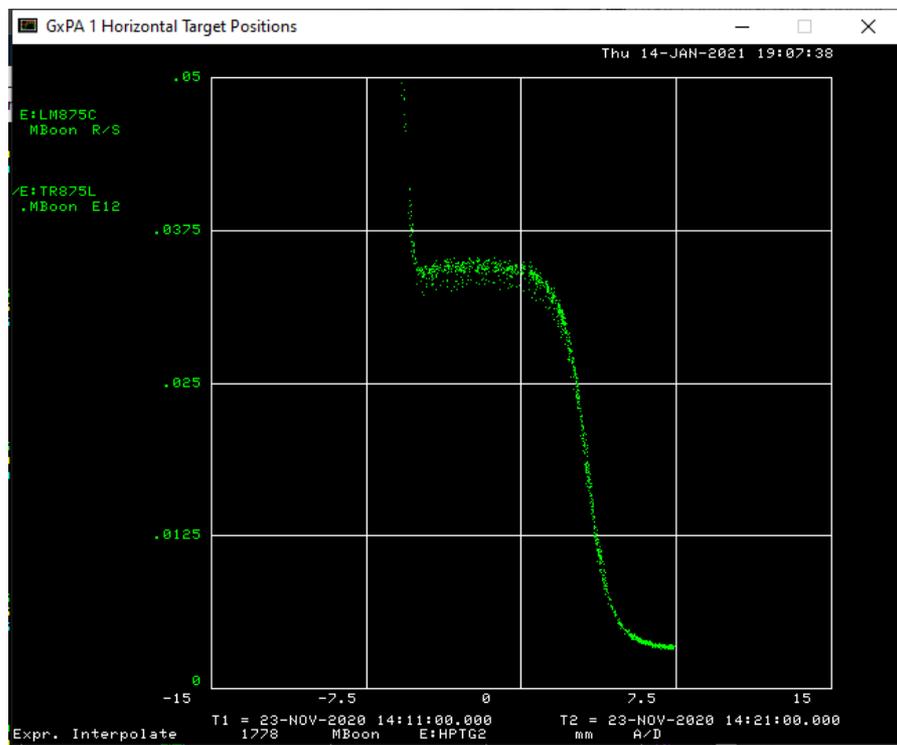
- We know the target geometry - BPM vs BLM trend indicates target center
- We give these new center readings to autotune



Initial target position scan

Horizontal target face scan

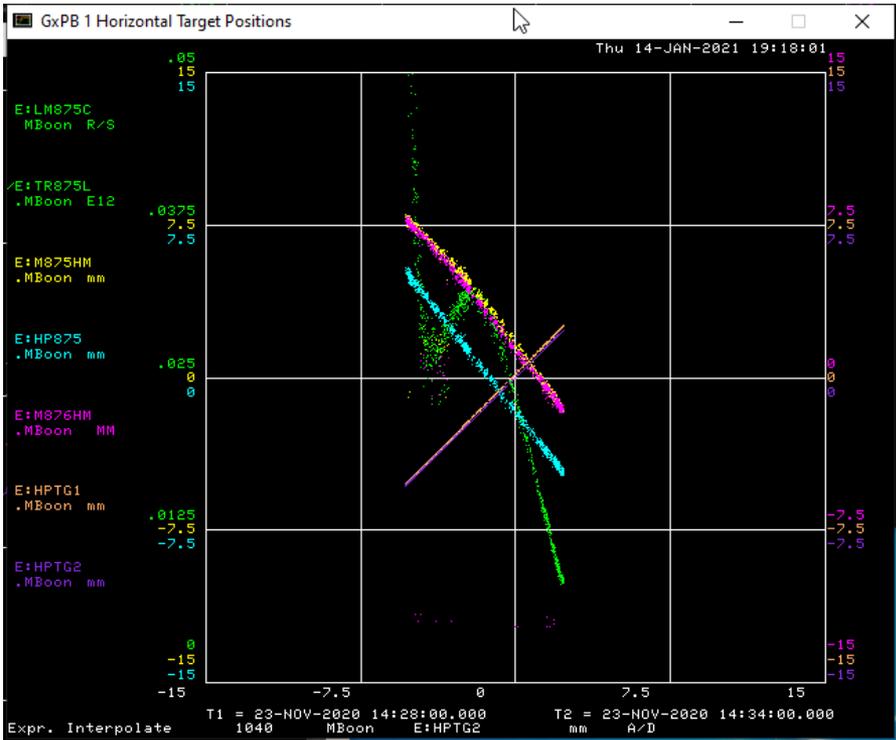
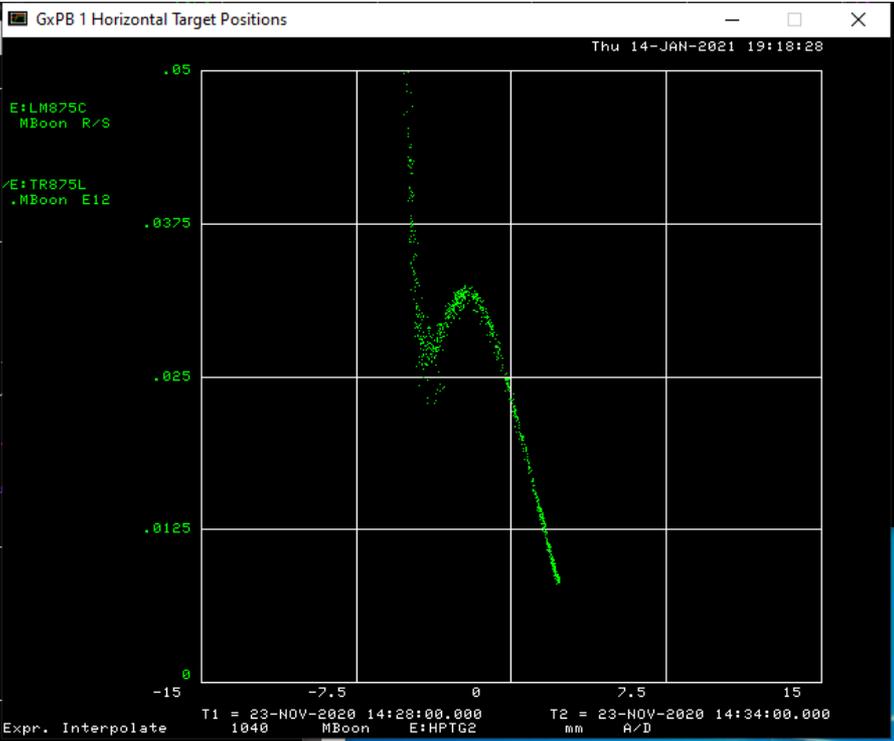
- Unexpectedly scraping the donut collimator
- Alarming, can't trust a target center derived from this scan



Initial target position scan

Vertical fin scan

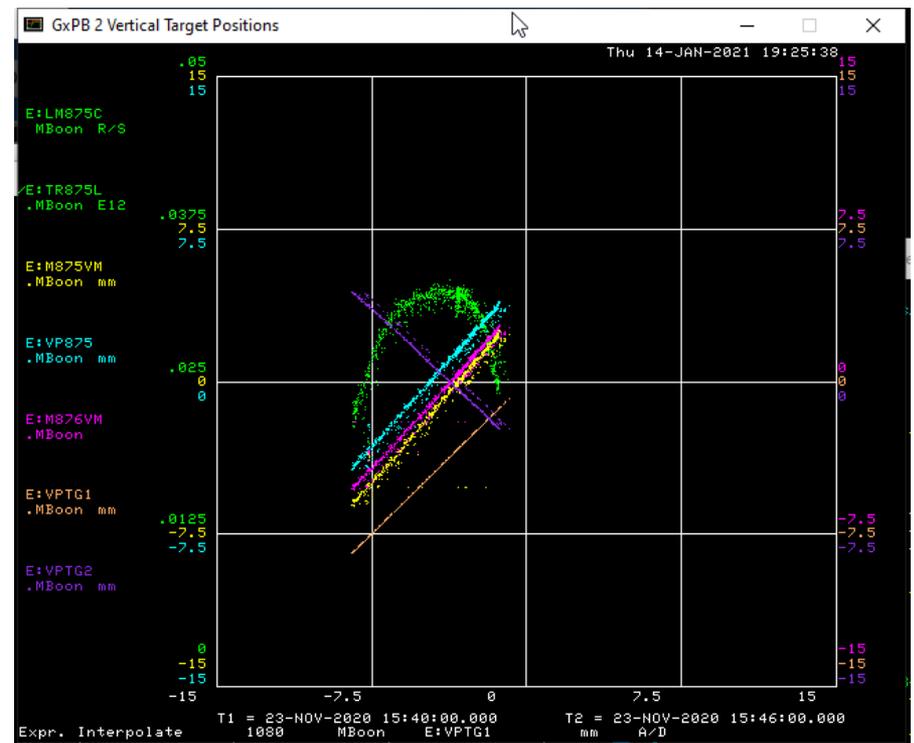
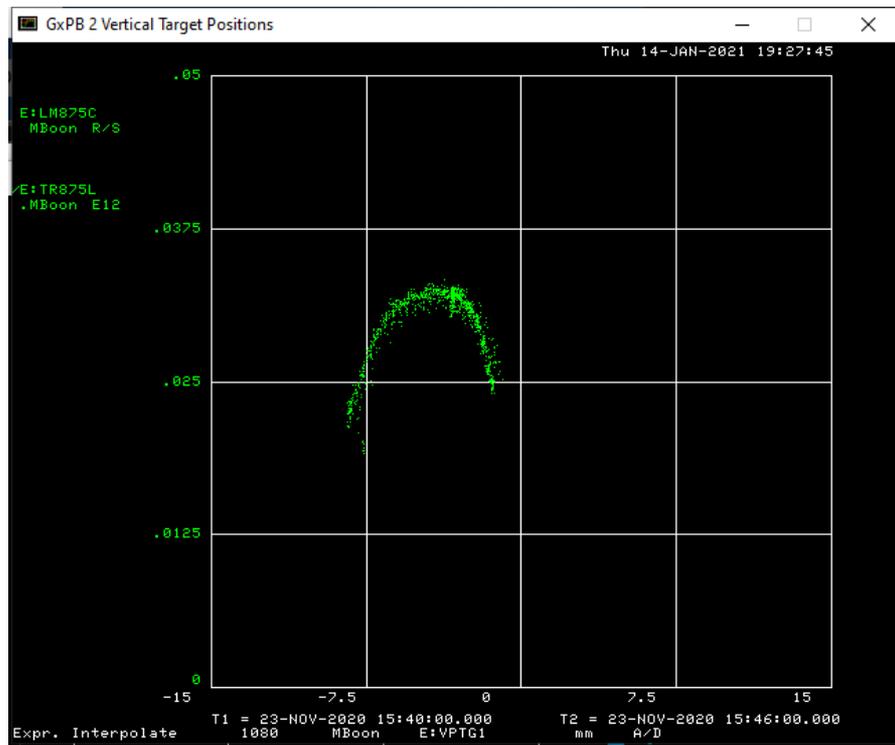
- Checks out for the most part
- Still scraping



Initial target position scan

Vertical face scan

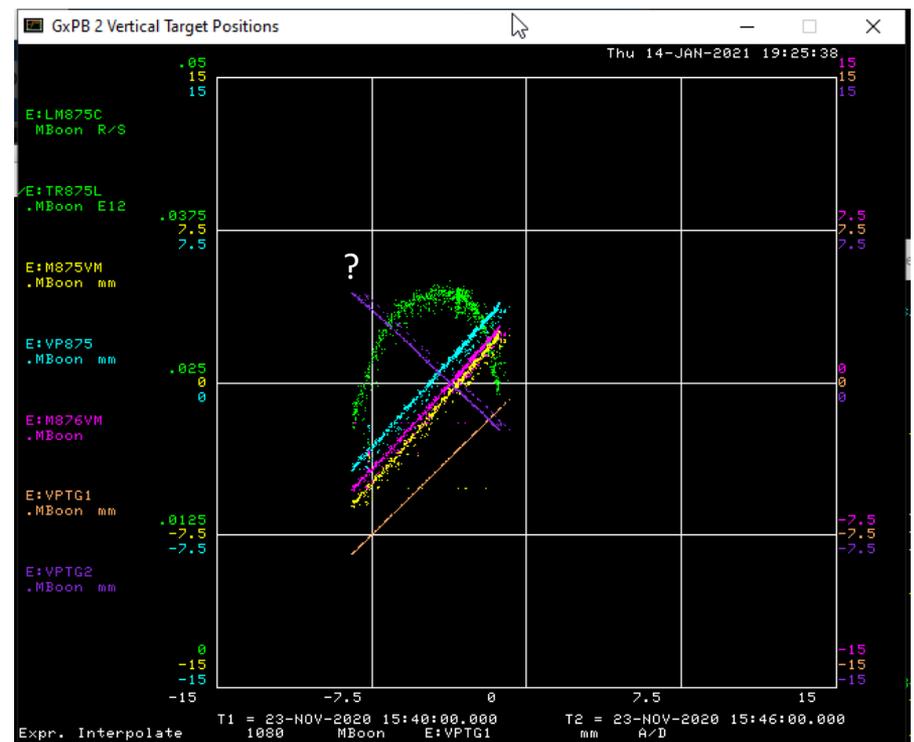
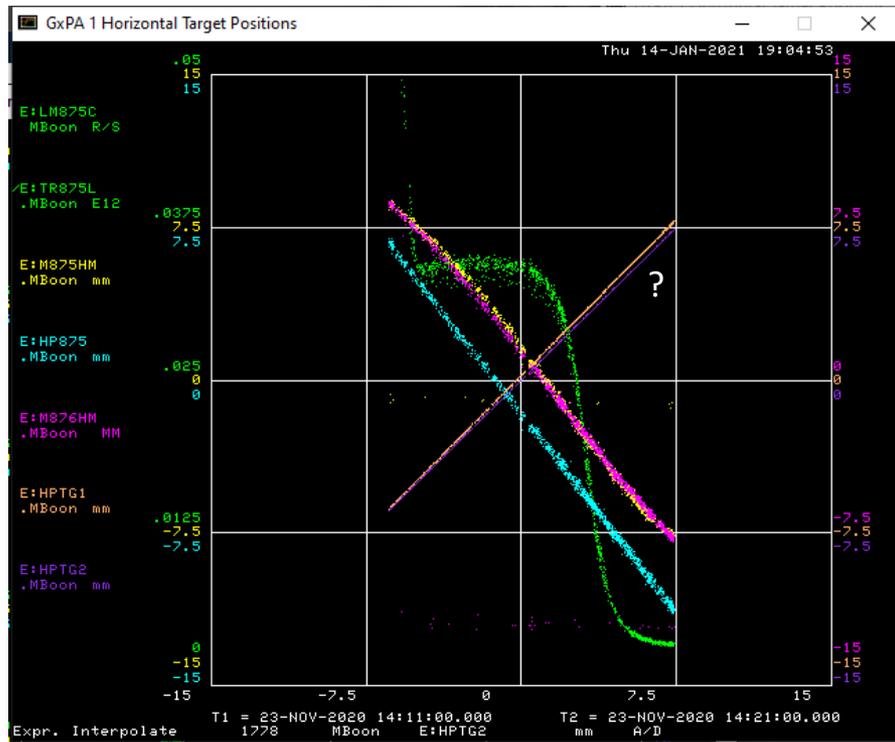
- Relatively clear peak



Instrumentation discrepancy

Wanted a clear understanding of beam positions, instrumentation readings don't all act as expected

- We will use the MW means as a constant



Instrumentation discrepancy

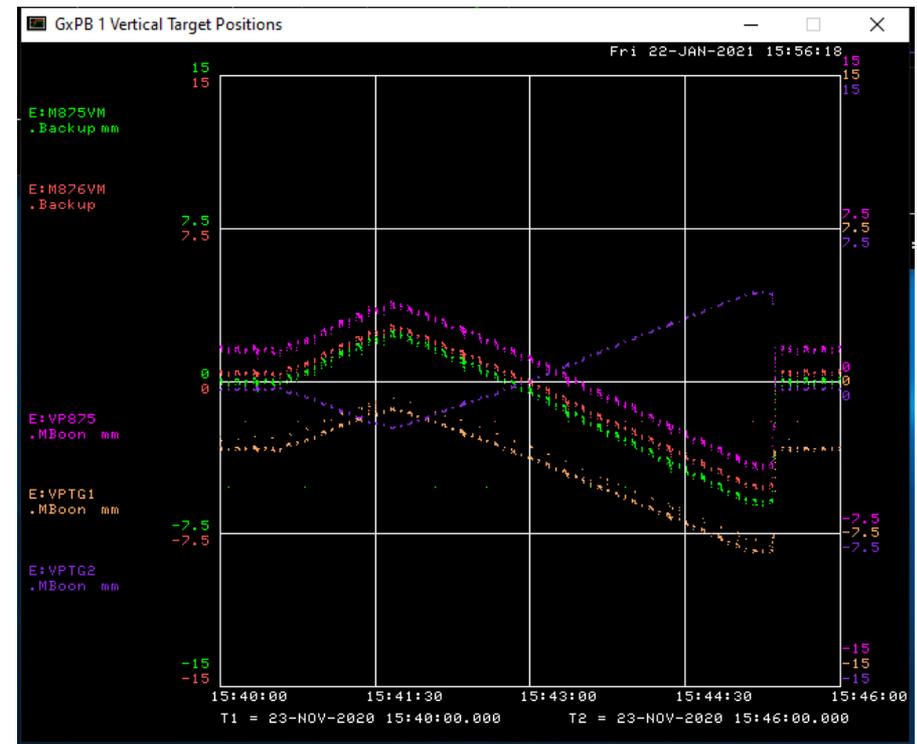
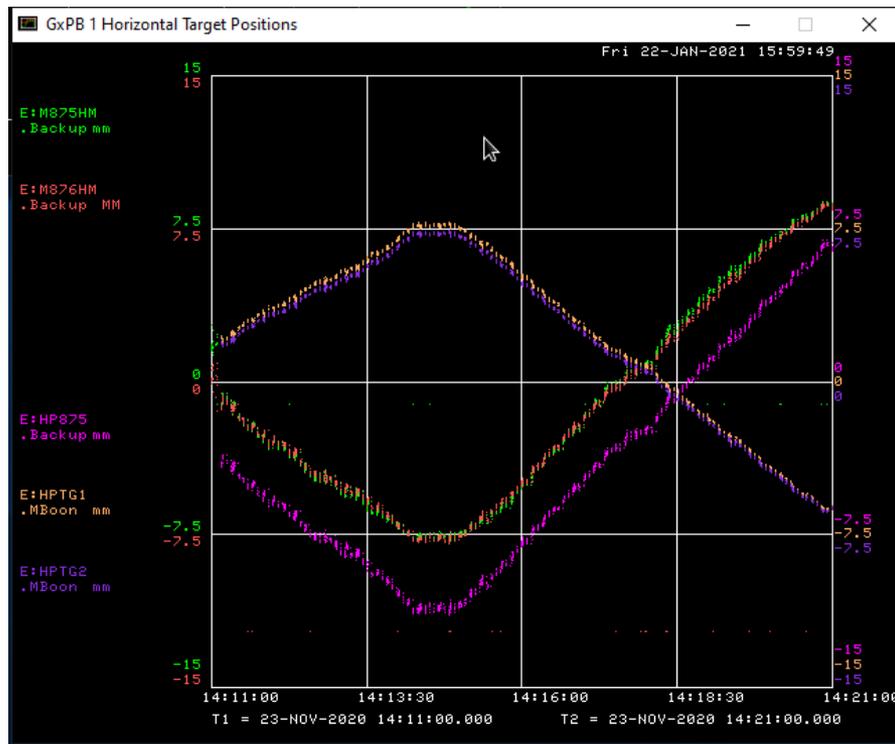
Horizontal behavior:

- ✓ HP875 tracks
- × HPTG1, HPTG2 “backward”

Vertical behavior:

- ✓ VP875, VPTG1 track
- × VPTG2 “backward”

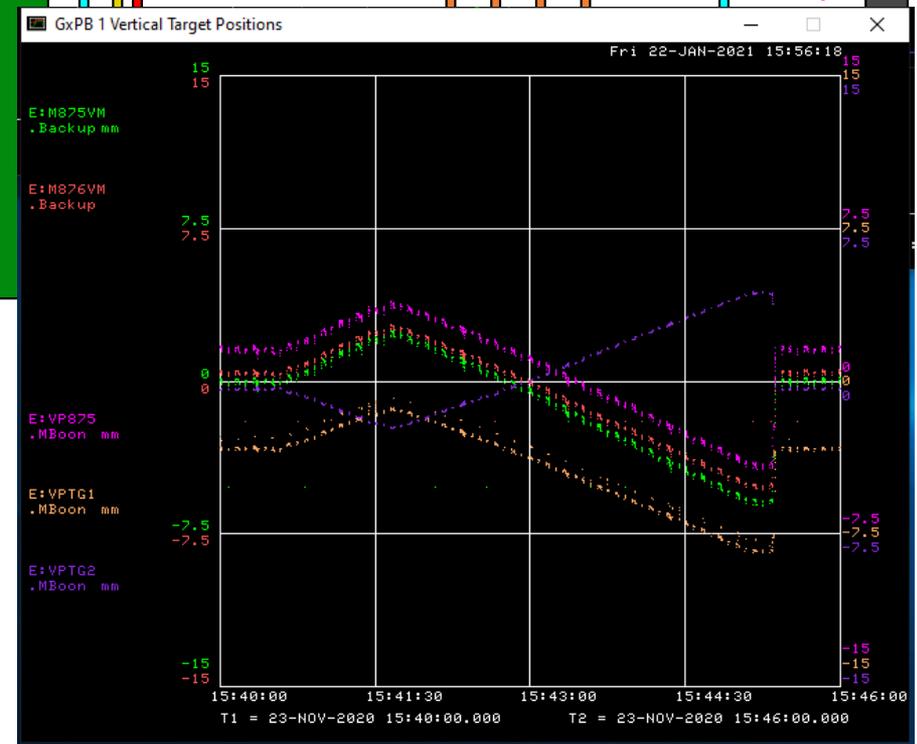
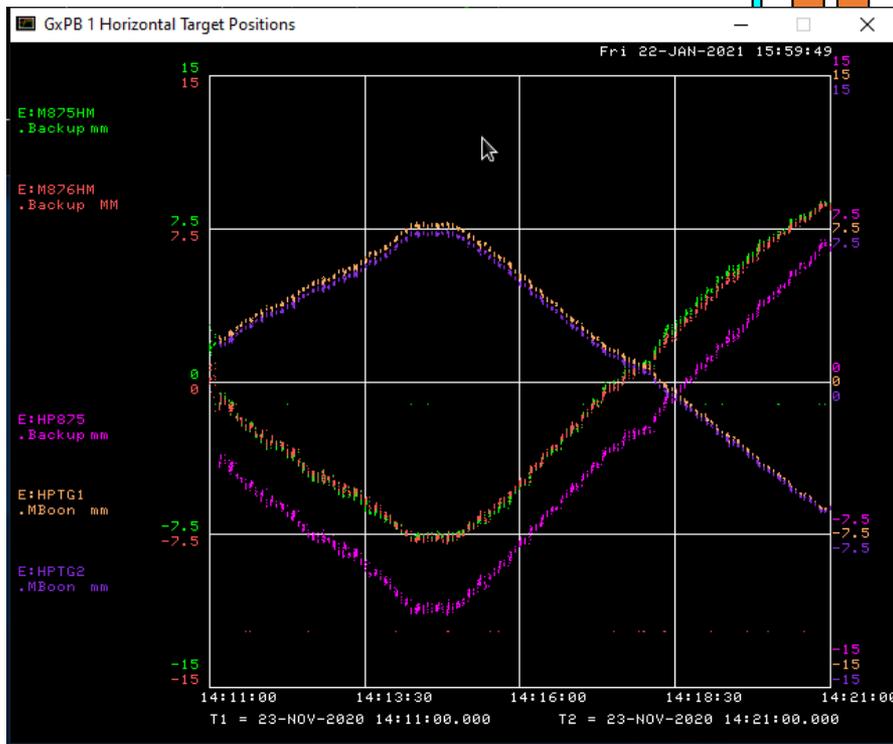
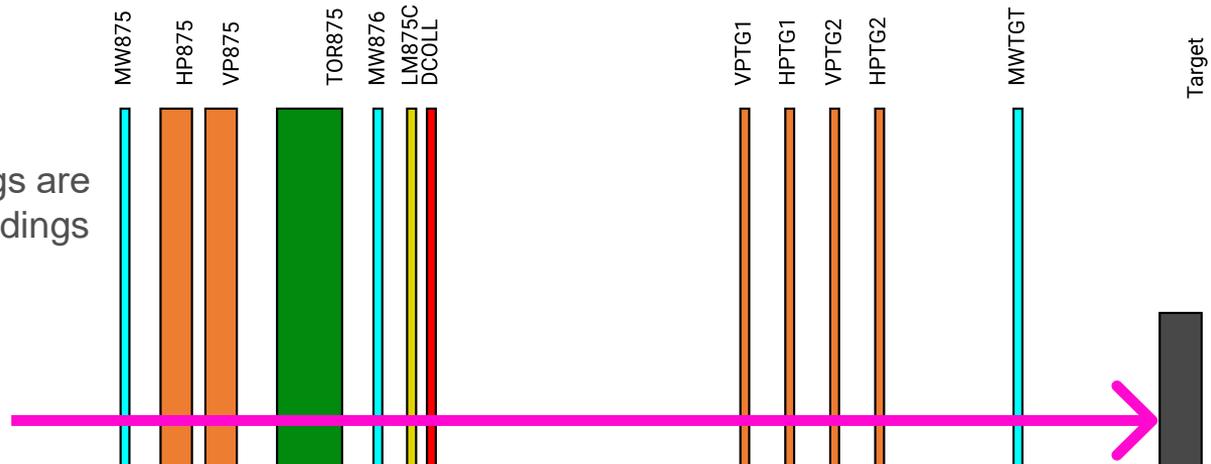
Also some offsets in both planes... *



Device stationing

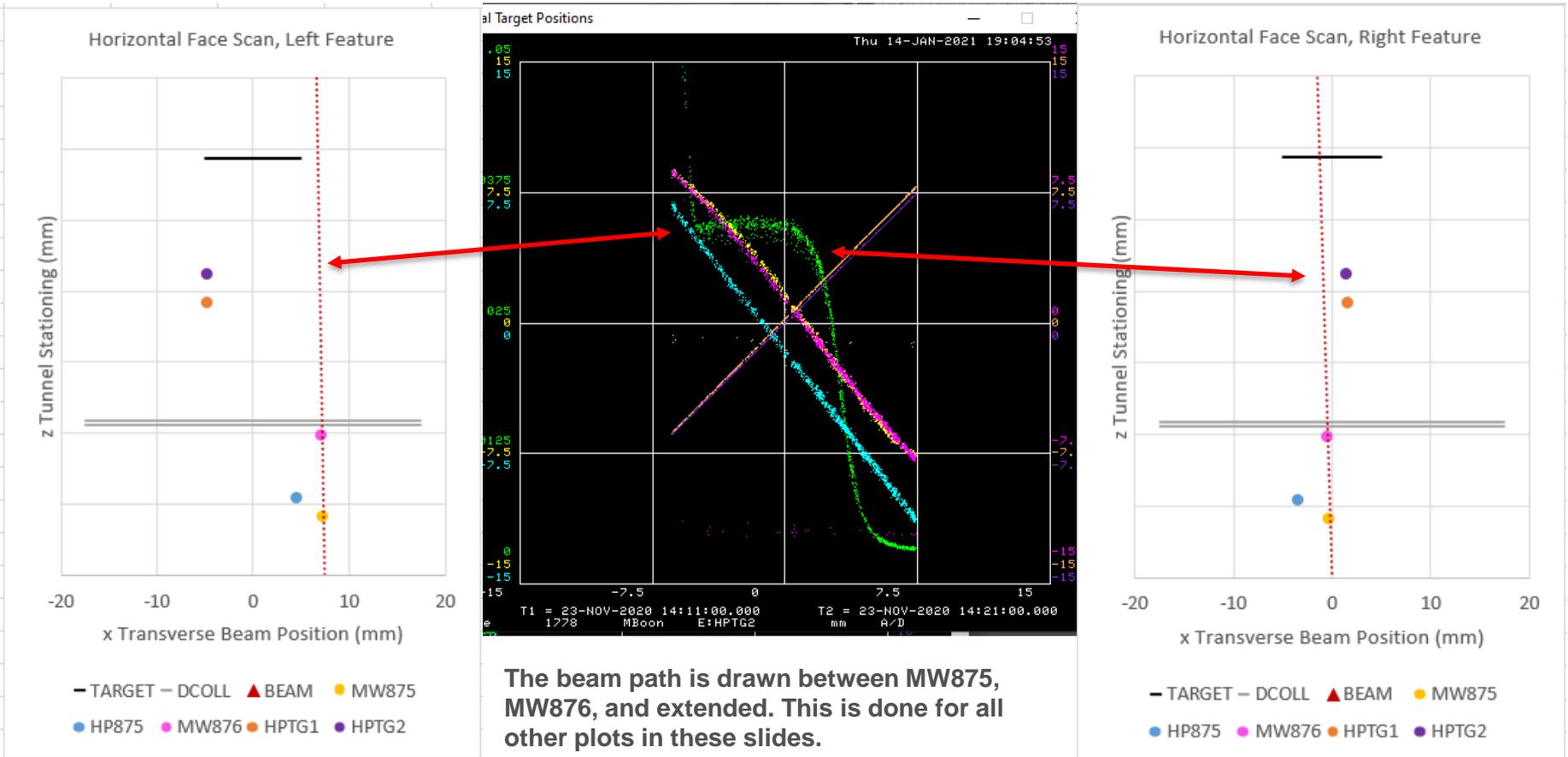
We don't think the "backward" readings are reflecting reality (although vertical readings did get fixed later)

Stationing depiction built from BNB TRANSPORT deck data



Horizontal beam path

A depiction of horizontal beam path according to the MW means, compared to the “backward” BPMs:



*A note about offsets

Specifically looking at this scraping, the beam seems pretty far from the inside aperture of the donut collimator (labeled DCOLL on the left plot – two lines show the upstream and downstream faces).

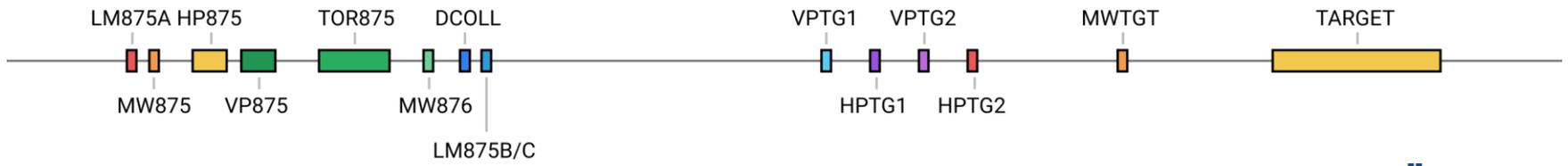
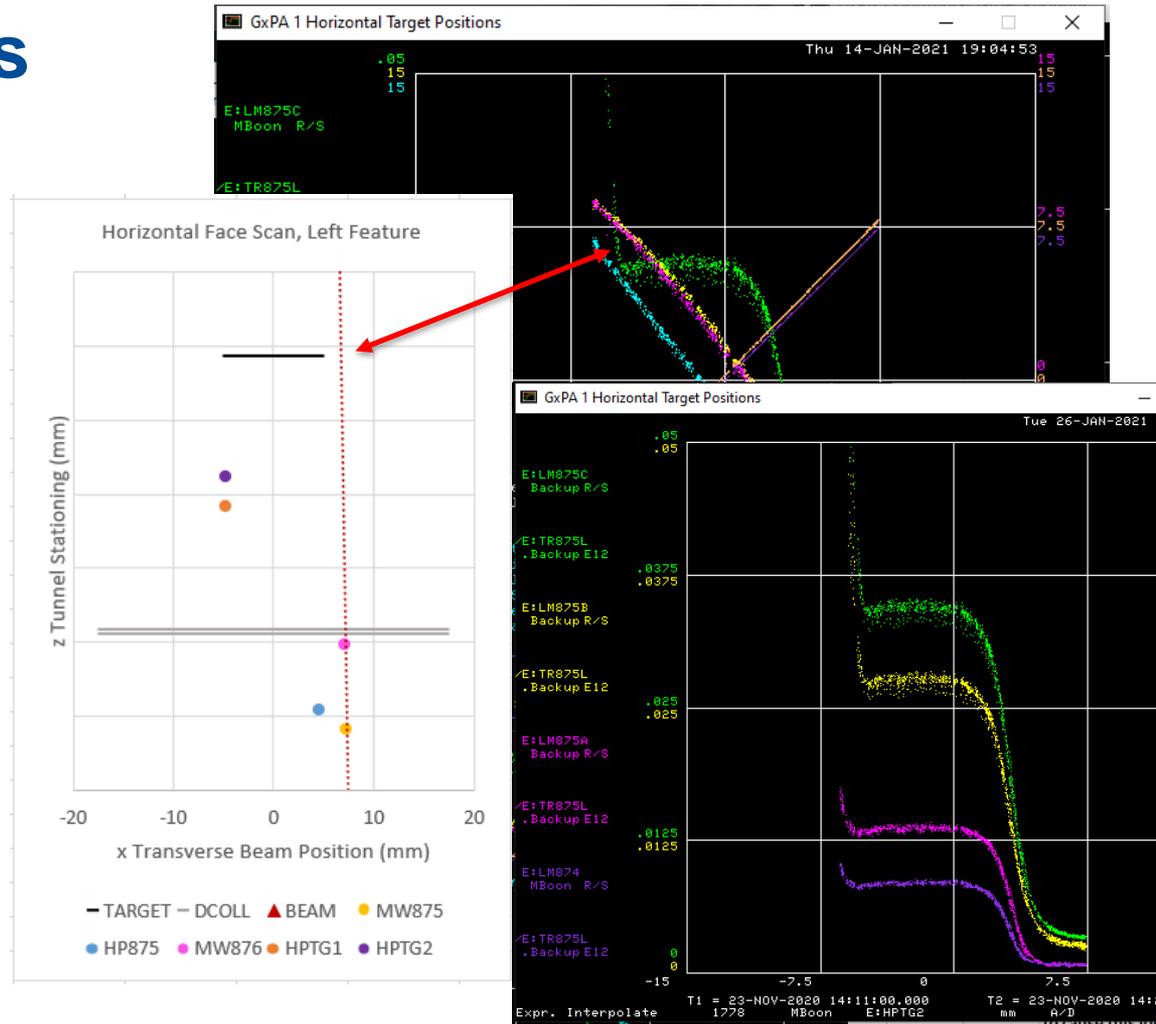
We trust that the MWs show a beam path on target-right, about to roll off the edge (the left plot shows it should already be off the target at that point, but I assume some beam width and imperfections in reading and physical alignment).

Even if the MWs are close to reality, beam would still have about 10 mm to travel before scraping the inside aperture of the donut collimator.

I am not sure how to interpret that distance. I could be wrong about where beam is scraping. I would need to verify the positions of the loss monitors relative to the collimator by checking in the tunnel (TRANSPORT may not reflect reality).

The loss pattern here which indicates scraping is exhibited furthest upstream on LM874, getting more intense as beam travels downstream to LM875C.

The graphic below shows TRANSPORT tunnel stationing of relevant devices, for reference. The scale is reasonably close to reality.



Instrumentation tests, reading confirmation

Instrumentation personnel, made aware of the perceived polarity differences and offsets, tested the devices themselves.

- Tested HPTG1, HPTG2, VPTG1, VPTG2
 - Not HP875, VP875

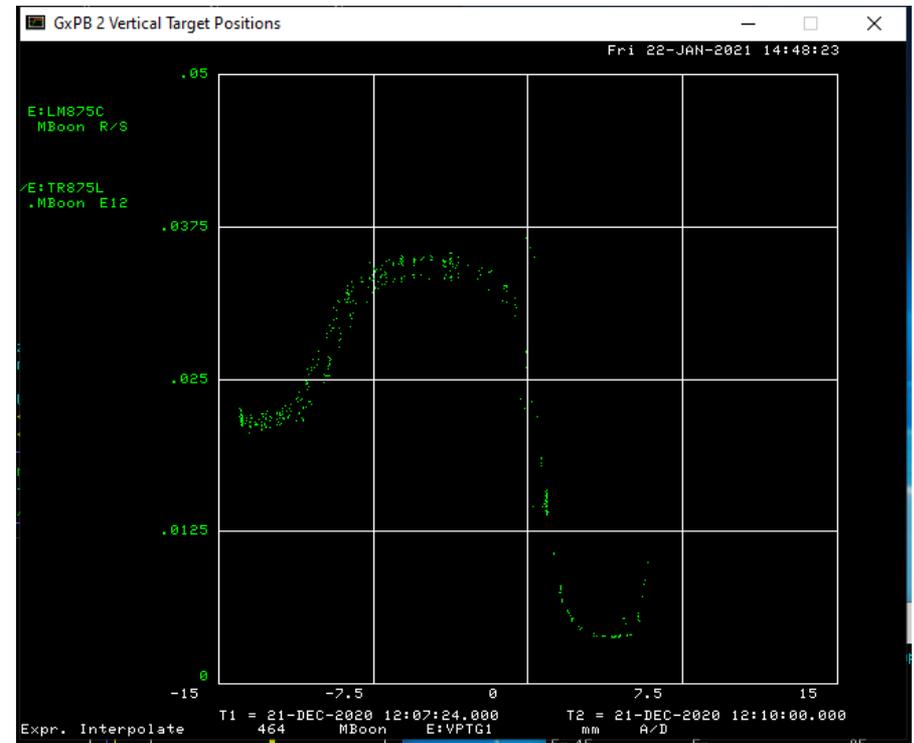
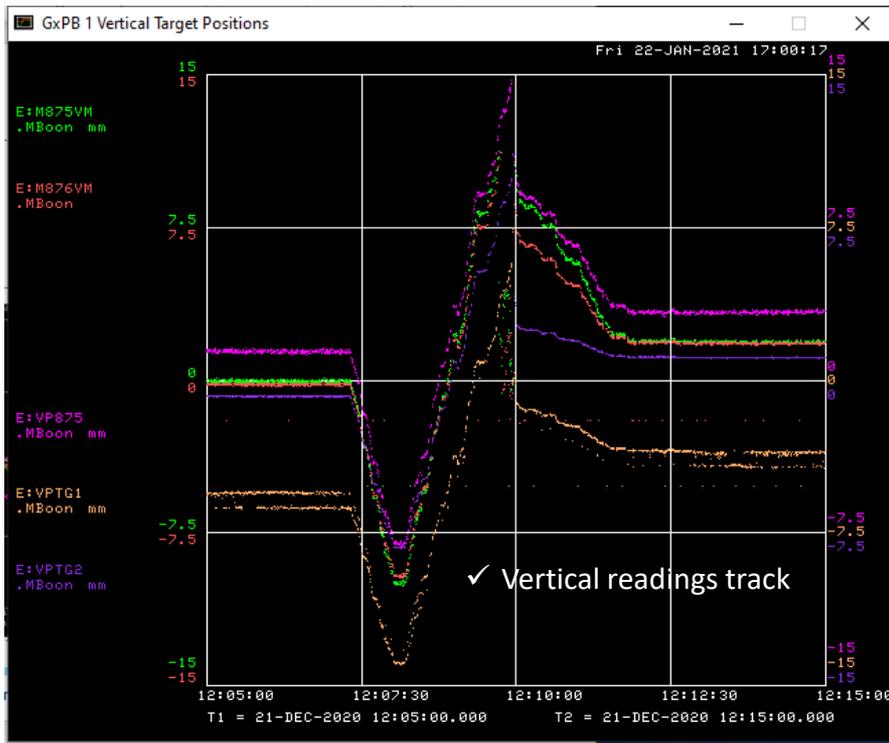
They were determined to be cabled and reading correctly. Some calculated deviations from center were included in the BPM engineering program.

- Instrumentation measurements were made 2020.12.15
- Offsets (included below) were changed 2020.12.21, 11:30am
 - HPTG1: -0.050 mm HPTG2: -0.693 mm
 - VPTG1: 0.279 mm VPTG2: 0.323 mm
- Another target scan was performed following this change

Latest vertical target scan** (2020.12.21)

Vertical face scan center points (autotune inputs):

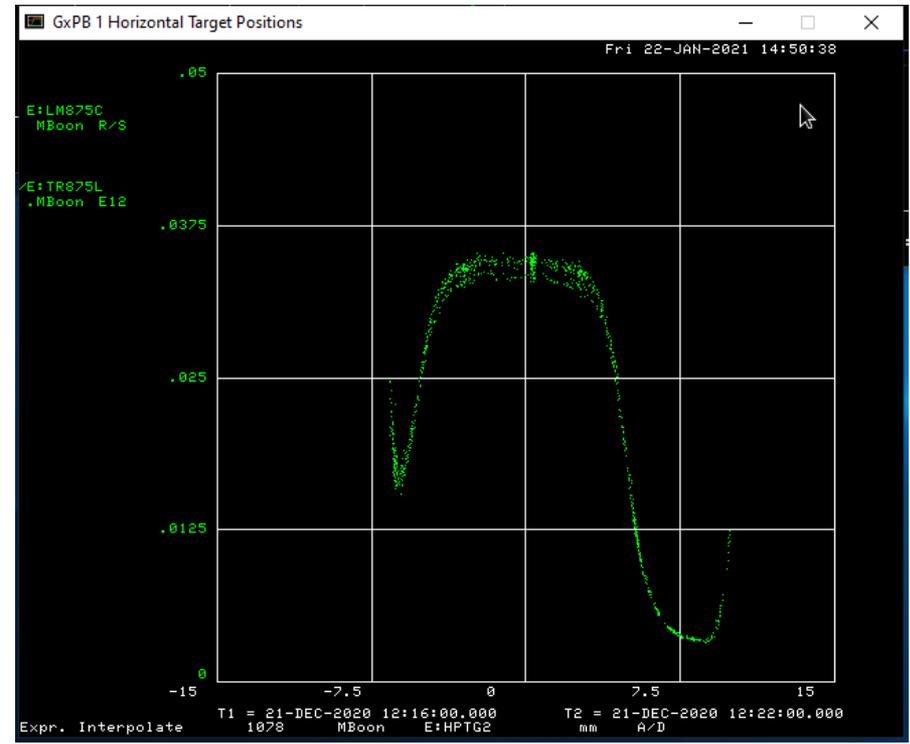
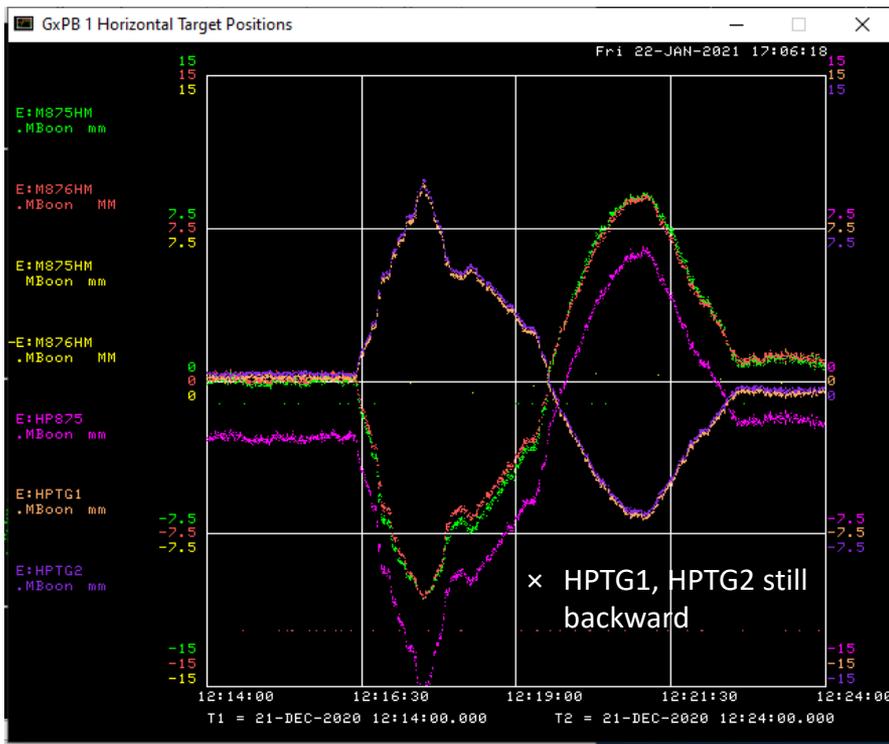
- E:VPTG1S -4.7 +/- 0.5 mm E:M875VM 1.0 mm
- E:VPTG2S 0.0 +/- 0.5 mm E:M876VM 0.8 mm
- E:VP875S 2.4 +/- 0.5 mm



Latest horizontal target scan*** (2020.12.21)

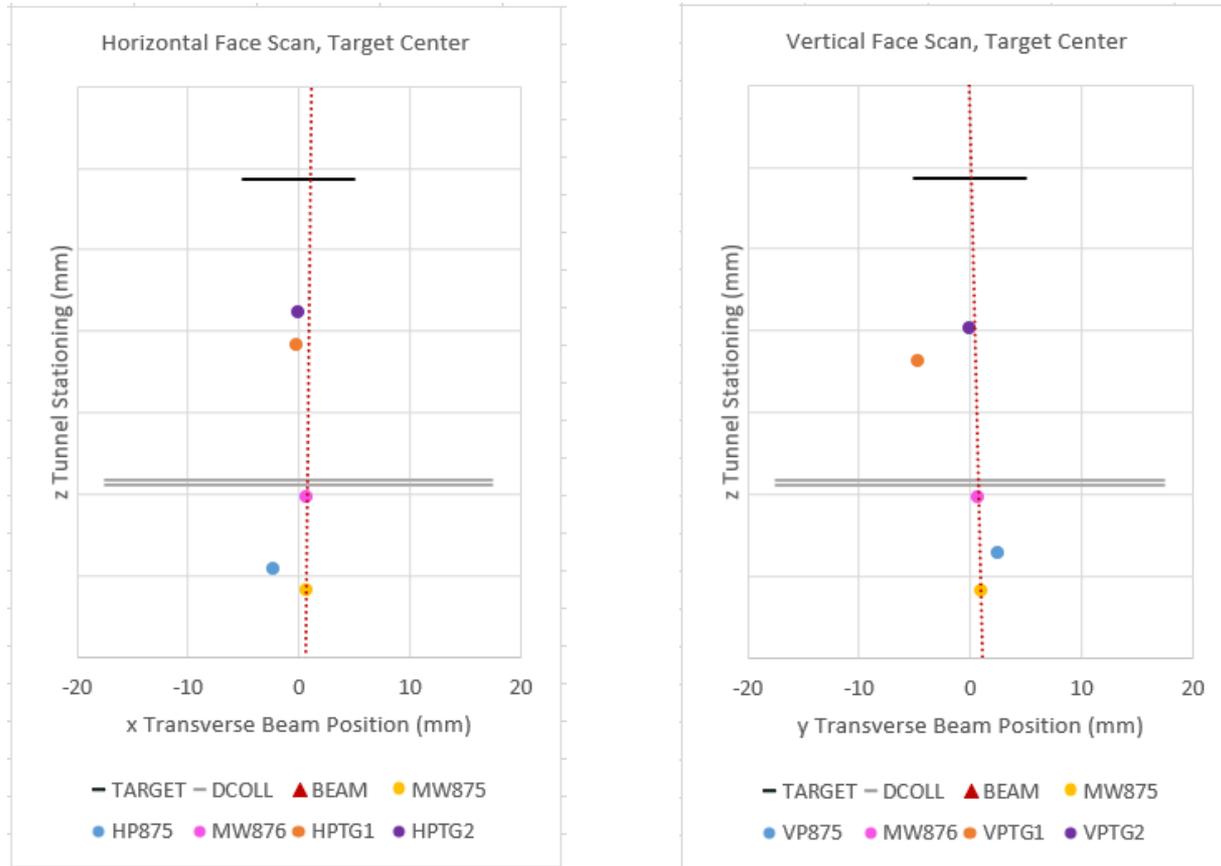
Horizontal face scan center points (autotune inputs):

- E:HPTG1S -0.2 +/- 0.5 mm
- E:HPTG2S 0.0 +/- 0.5 mm
- E:HP875S -2.4 +/- 0.5 mm
- E:M875HM 0.7 mm
- E:M876HM 0.7 mm



Beam paths on target center

A comparison of the center readings taken from the latest target scan to show why the path shown from the MW readings is trustworthy.



Beam path angle

After performing several of these scans beam was found to be approaching the target with an angle indicating its path was not horizontally or vertically perpendicular to the target face (we expect a parallel path from the pre-set parallel trim current mult).

- This may have been causing excessive scraping

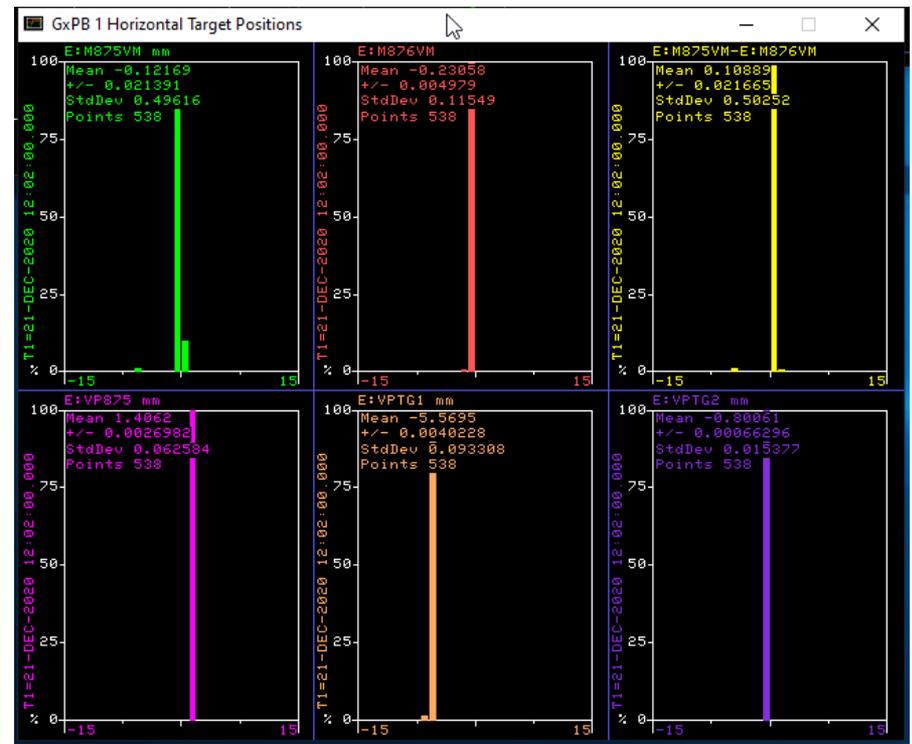
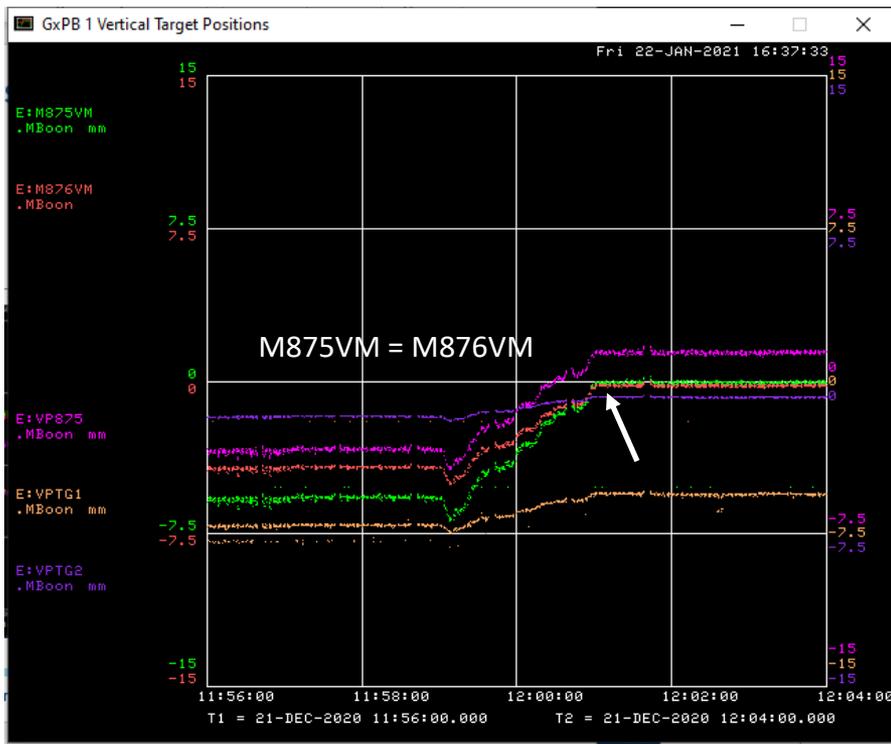
Beam was straightened out before performing the target scans shown in the last couple slides.

- Many thanks to Ops for the help

Angle on the approach

Vertical face scan

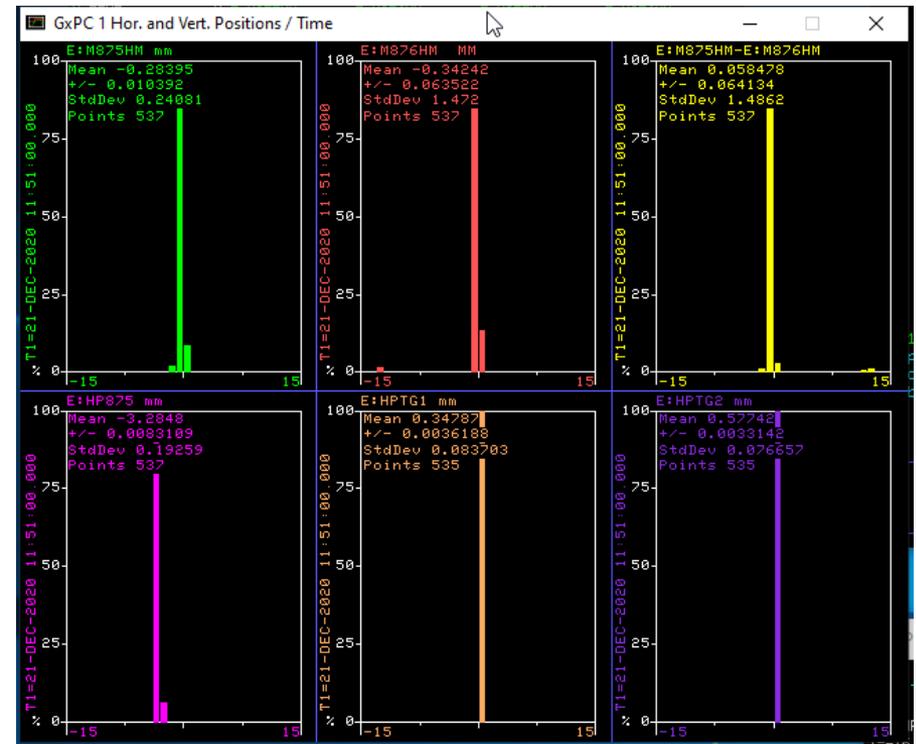
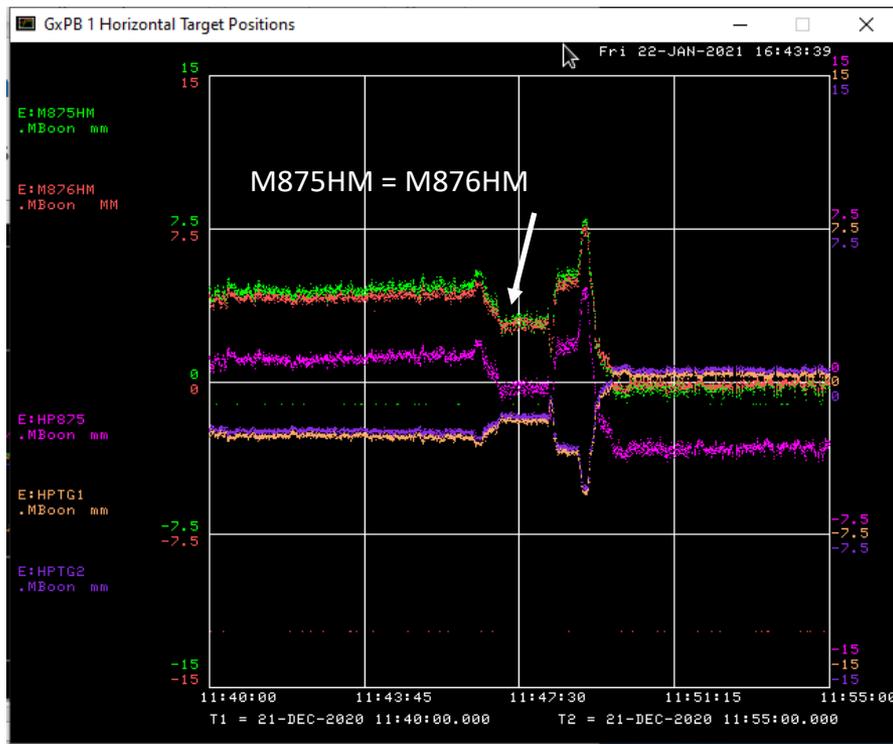
- Beam is moved so the MW means read the same value (zero angle between them), then move that reading to 0 mm (ideally the center value)
- Beam sat at this position for a few supercycles to check noise



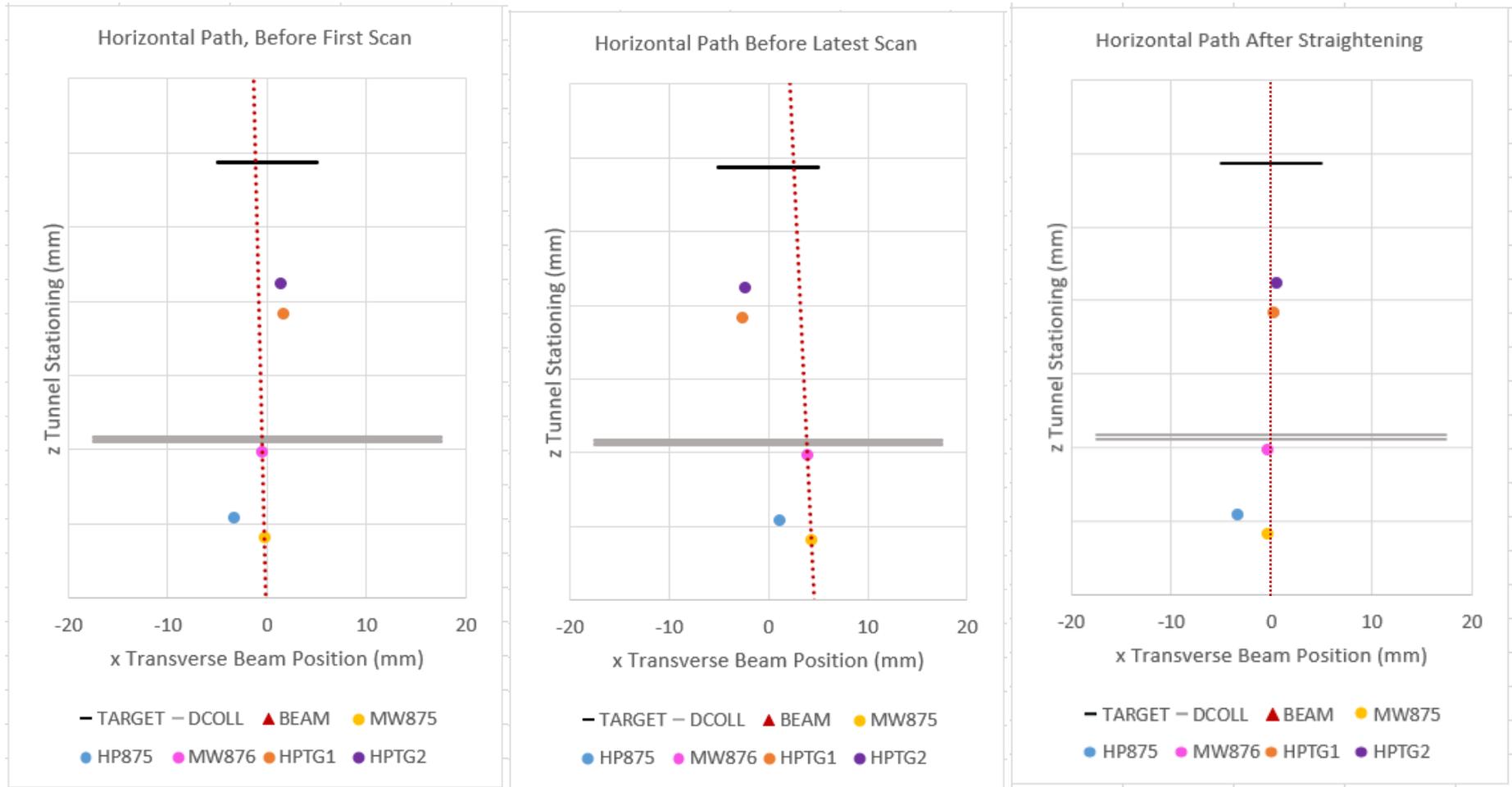
Angle on the approach

Horizontal face scan

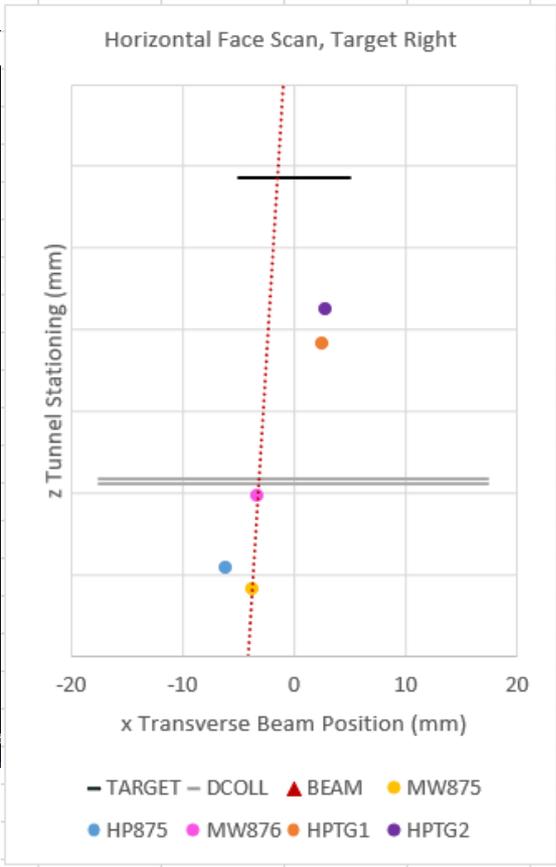
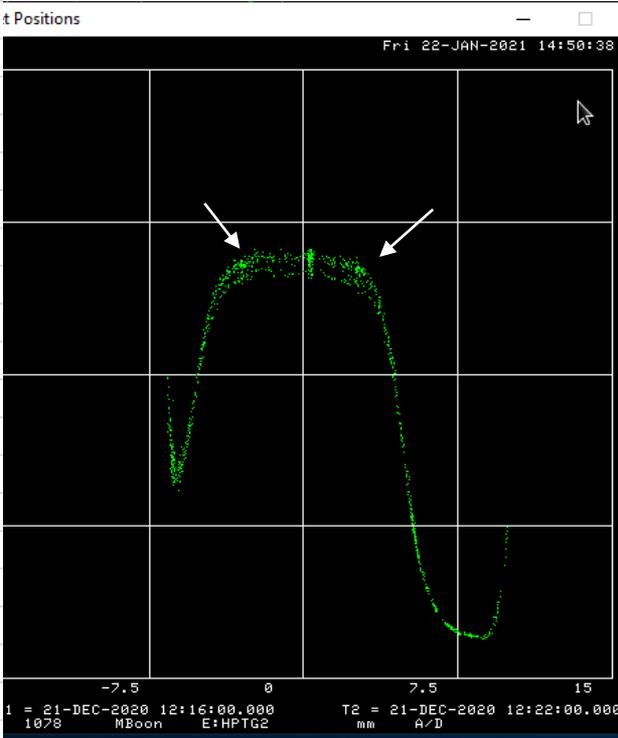
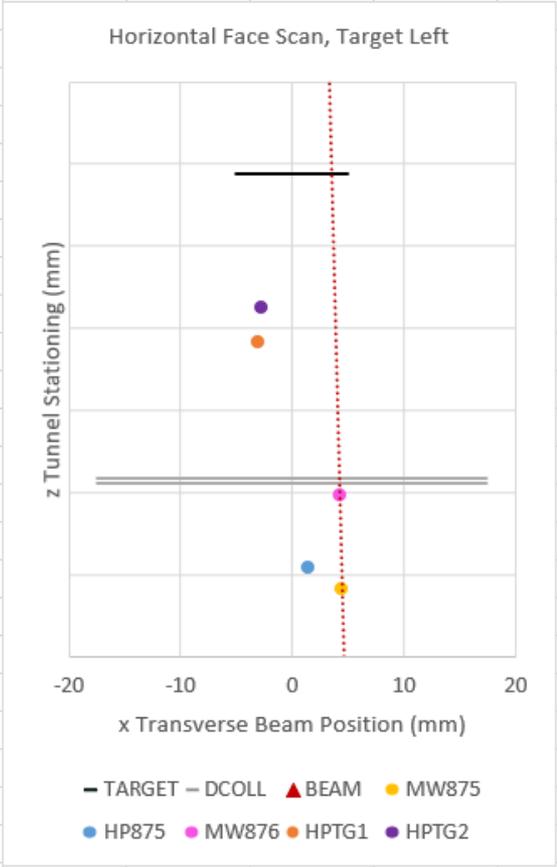
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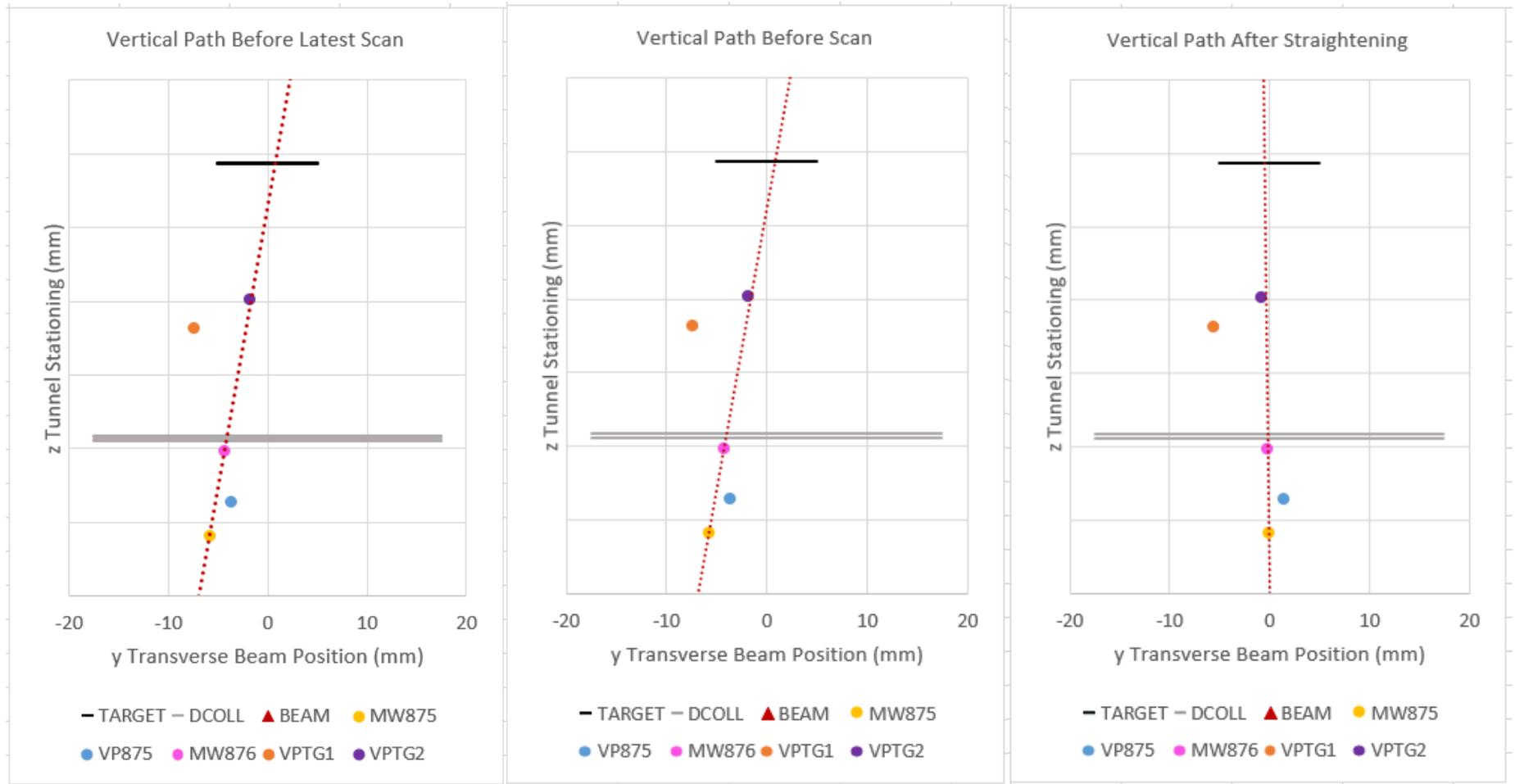
Horizontal angle fix, early scan comparison



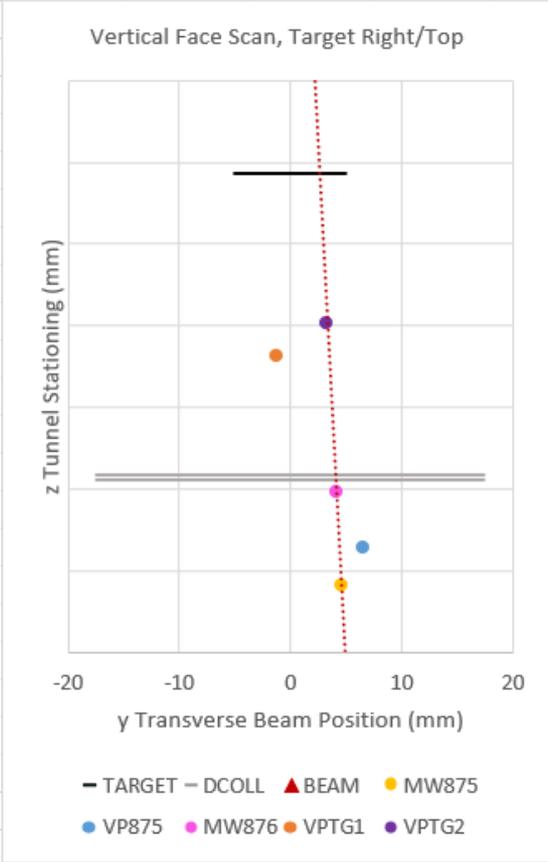
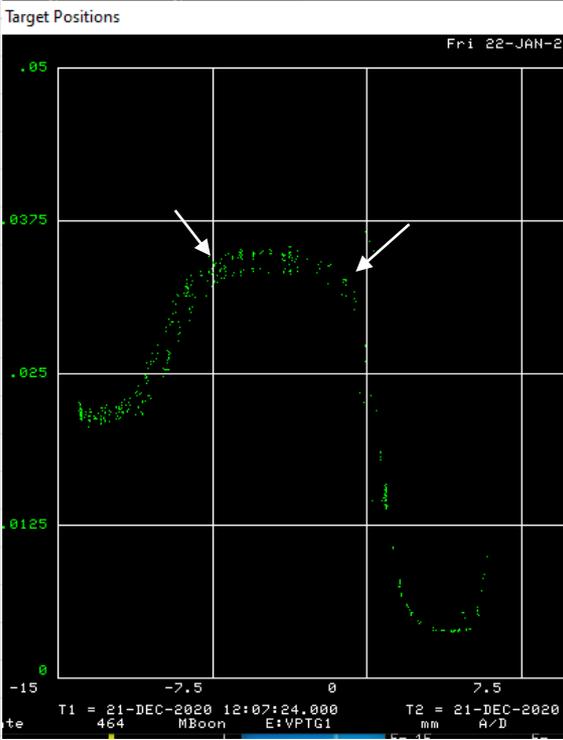
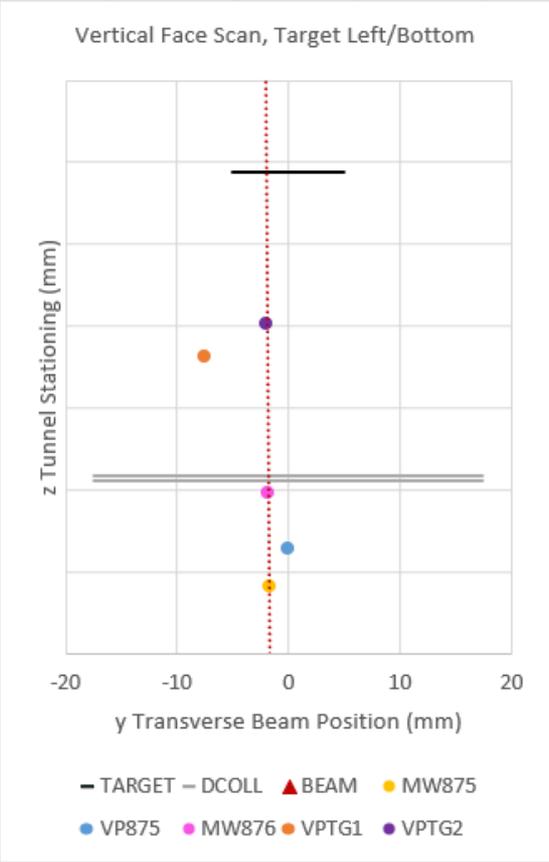
Horizontal face scan path



Vertical angle fix, early scan comparison



Vertical face scan path



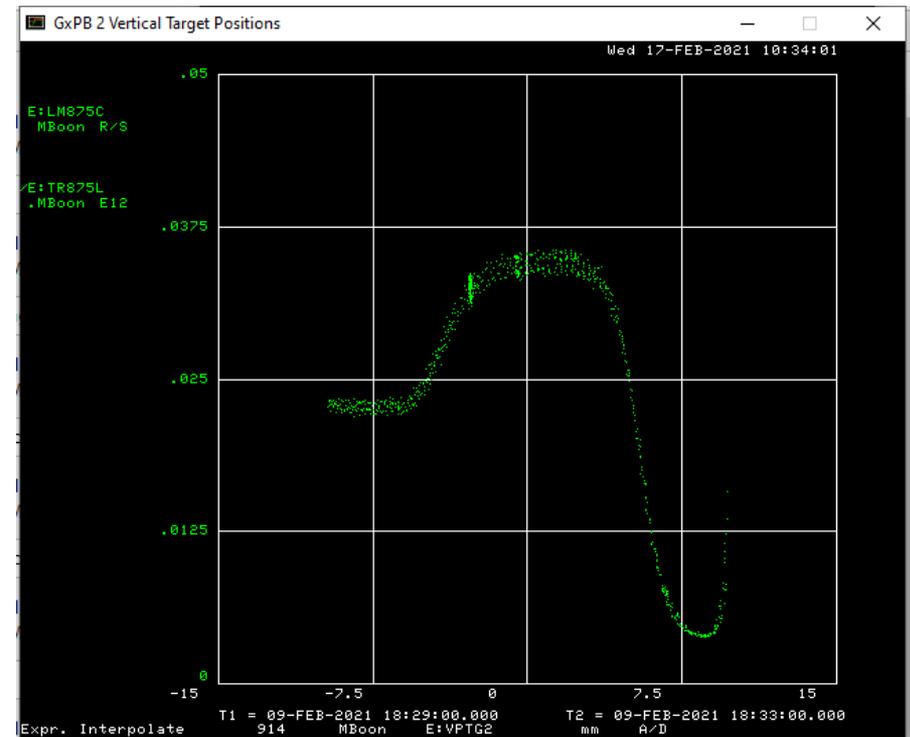
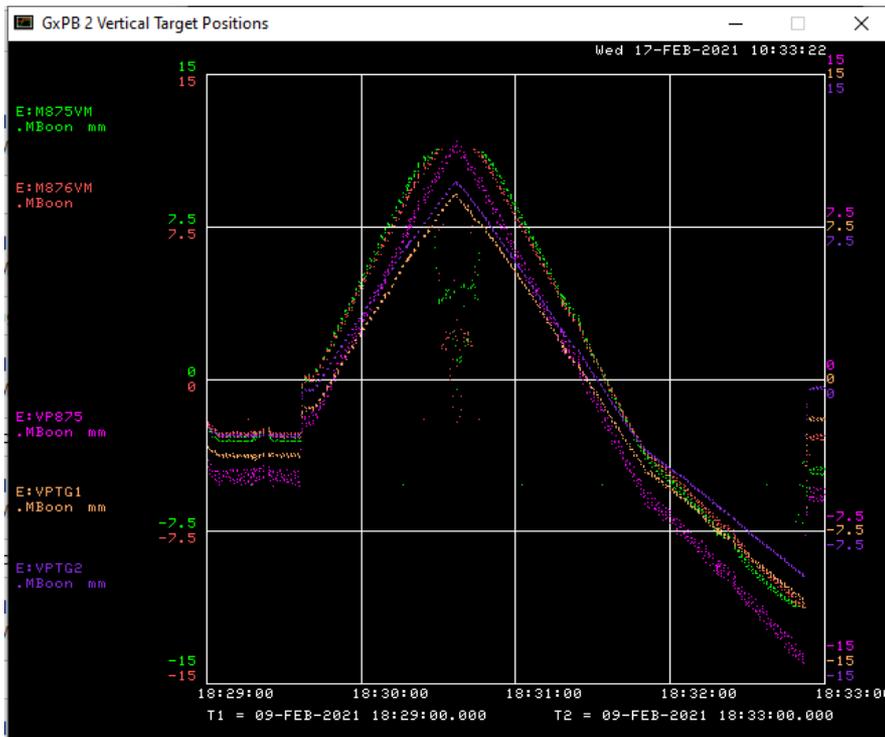
What to do next

- We can do a test to verify the MW movement
 - Change current on H866, see which direction beam moves
 - Lower current should move beam left*
 - *If we are facing the same direction as beam is traveling
 - *MW wire numbering may complicate this expectation
 - Could also maybe just do this in TRANSPORT
- We would like to consider what to do for HPTG1, HPTG2*
 - Goal: have all instrumentation used for determining beam movement read consistent directions
 - Much easier to analyze more complicated studies in the future
 - *Could change HPTG1 and HPTG2 reading polarities somewhere
 - Engineering page, ACNET, ...
 - *Could also change MW875, MW876 and HP875 instead
 - May need to understand how this change propagates in other systems first
 - TRANSPORT would not reflect reality
 - Does it now?
 - ***Could just use one set of instruments for analysis (only need two points to draw a line)**
 - **Other instruments were being used as a secondary check on beam behavior**
 - We need to do another target position scan if we make horizontal reading changes
- Angle scans – where is the pivot point of the beam (using trusted pre-set trim mults)
 - Some have already been done, not analyzed as thoroughly, waiting until we sort out the instrumentation readings
- Verify tunnel device stationing in TRANSPORT – visit the tunnel

**2021.02.09 vertical update

Vertical face scan center points (new):

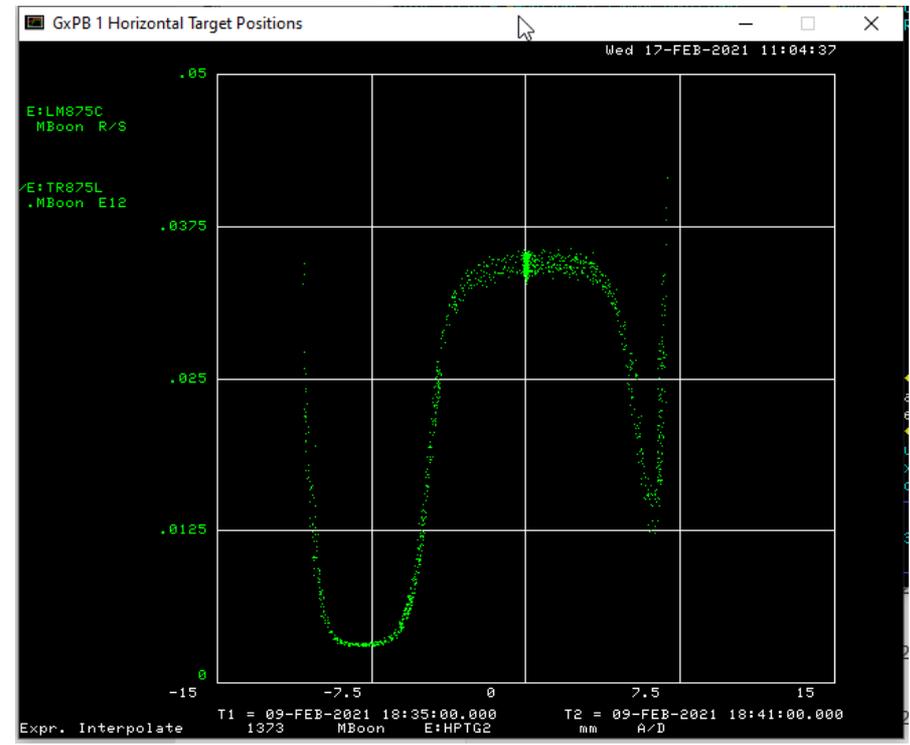
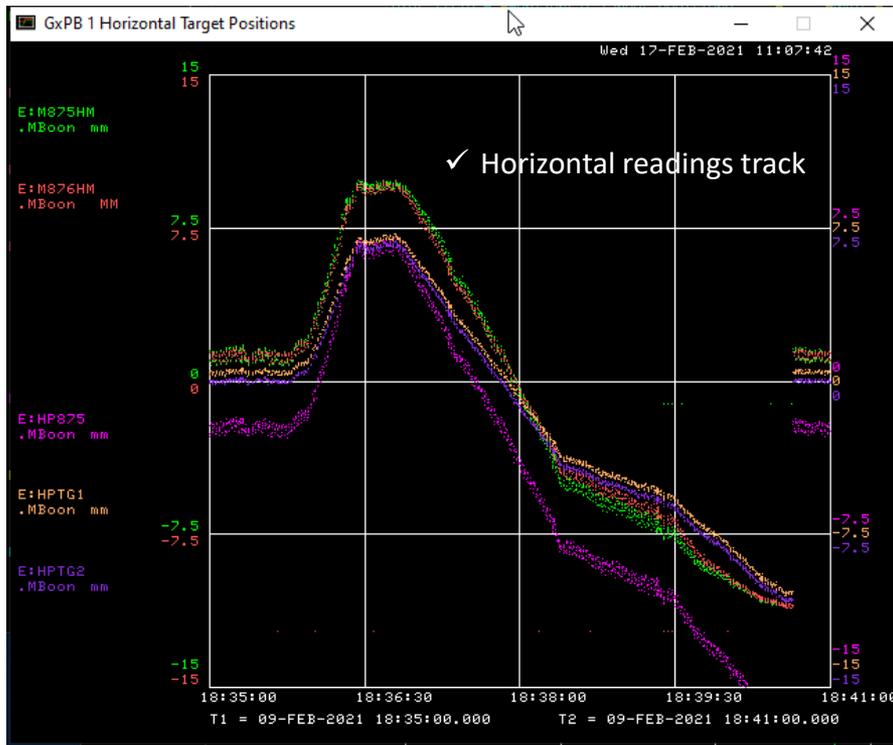
- E:VP875S -0.7 +/- 0.5 mm
- E:VPTG2S 0.8 +/- 0.5 mm
 - E:VPTG2S is now used in place of E:VPTG1S due to a failure at the BPM itself



***2021.02.09 horizontal update

Horizontal face scan center points are unchanged.

- HPTG2 flipped its sign seemingly without cause following an access to verify BPM plate readings. The autotune matrix was updated to accommodate this change.
- HPTG1 readout scale factor sign was flipped to match HPTG2 in the BPM engineering program. This BPM is not currently used in the autotune program.



What to do next (2021.02.17 update)

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- Verify tunnel device stationing in TRANSPORT – visit the tunnel