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NuMI Status

Jim Hylan / AD Target Systems Dept.

NoVA Collaboration Meeting

October 23, 2015

Outline

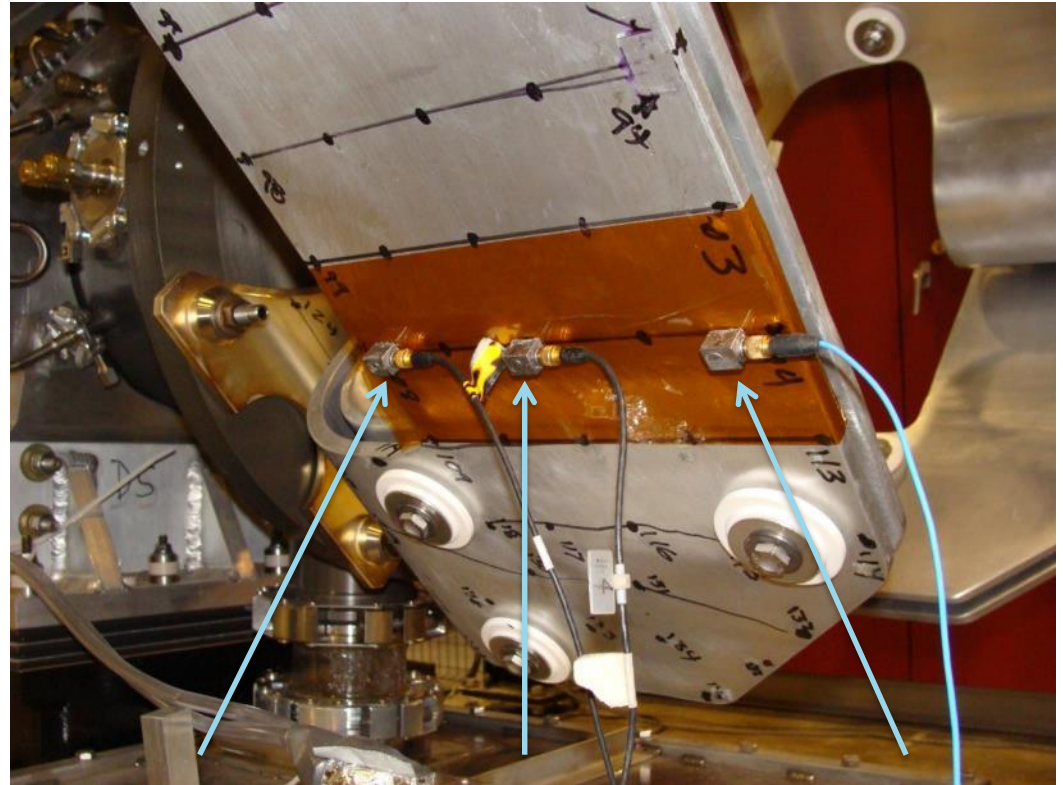
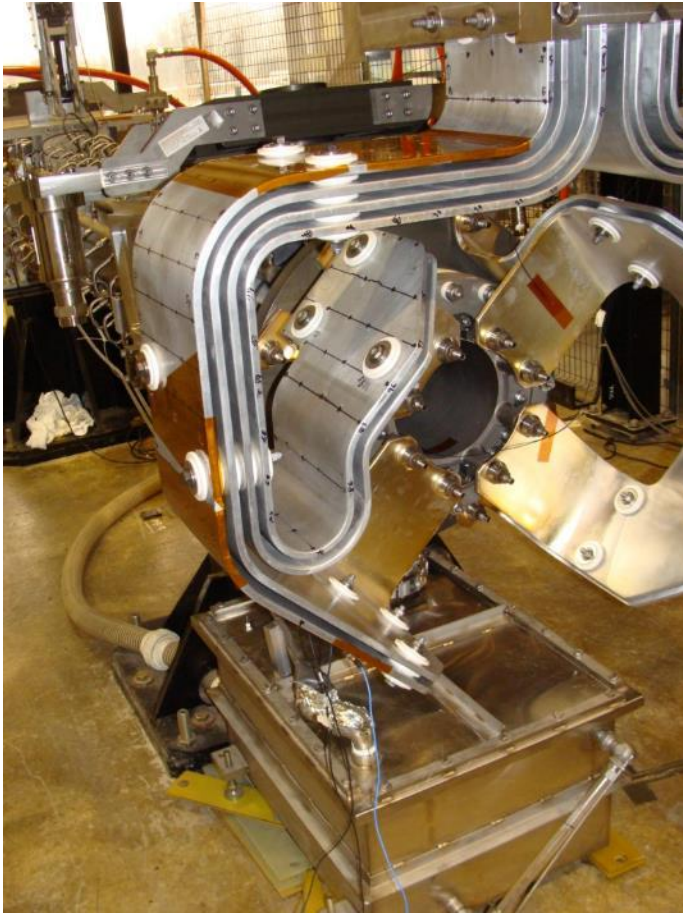
- Present Status:
 - All low power scans and alignment done
 - Hope for high power beam later today
 - One high power target scan left to do as cross-check
- Work done during shutdown
 - Major item is horn replacement
- Alignment summary
 - Everything is within TDR tolerance
- Spares Status
 - Have spare targets & horn 2
 - Want to replace strip-line on horn 1 spare, est. June 2016

Major work done during shutdown

- PH1-03 was tested, modified, and installed in place of failed horn PH1-04
- Target+baffle removed to allow beam scan of horn, then re-installed
- Profile monitors PM114, PM117, PMTGTL replaced
 - *PMTGT, used for normal beam monitoring, was NOT replaced*
- Leaking cooling coil in target pile air recirculation system replaced
- Dehumidifiers were refurbished, as done every shutdown
- Shielding at muon alcove 2 was upgraded
- New instrumentation added for air & water, aiding radiation containment
- Hole cored 11 feet to target hall under-drain, sump pump installed
- System installed to remotely inject vinegar into under-drain
 - doing weekly remote injection of 100 gal 12% vinegar to combat calcification

Horn replacement

Horn strip-line vibration measurements



PH1-04 style strip-line has larger motion,
longer ring-down than PH1-03 style

Horn replacement

Horn wind tunnel heat transfer coefficient measurements



Horn replacement

PH1-03 Modifications for higher beam power

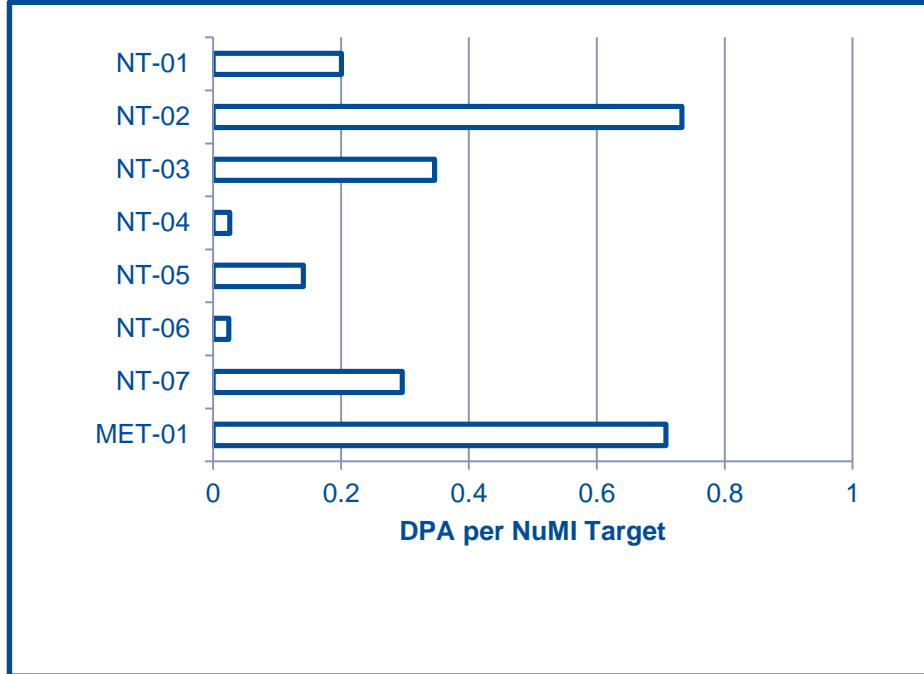
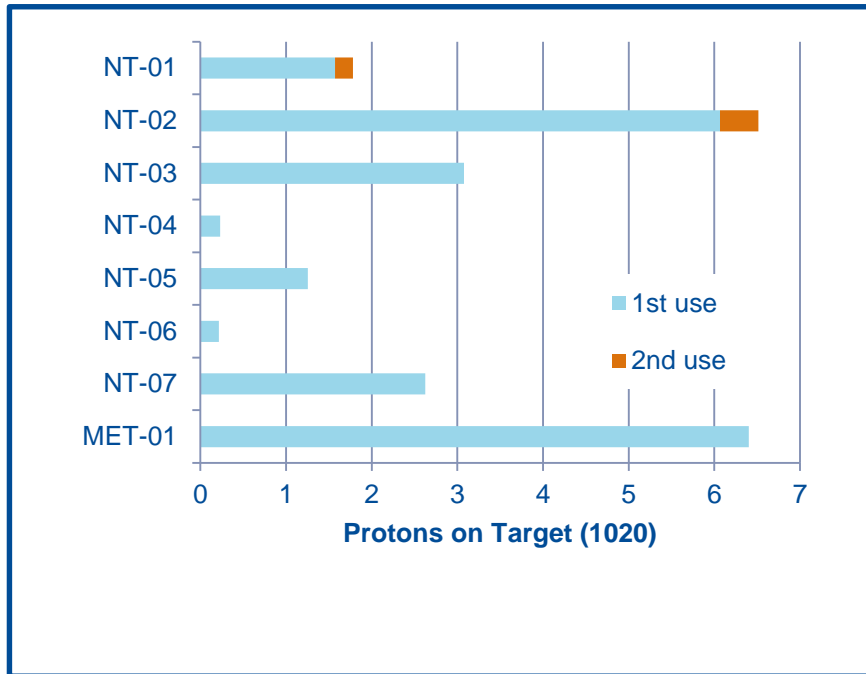
- Air duct added (wind tunnel result)
- Al cross-hair replaced with Be
- Water cooling of DS flange added
- Bdot coils removed



PH1-03 analysis

- Based on modifications, wind tunnel tests, vibration tests:
 - *PRELIMINARY: May have some safety factor for 50 million pulses at 200 kA current and 700 kW beam power*
- Work is on-going, will be finalizing analysis this fall

Target status: MET-01 is two years old



- MET-01 Exhibits No Sign of Neutrino Yield Degradation
- For Graphite, Significant Changes in Material Properties With $DPA > 1$

New sump pump system for cored hole



Sucks water from drain
through sediment settlement system
with pneumatic diaphragm pump.

Pump can be turned off remotely for vinegar injection.

Beam based alignment of NuMI

Beam Position Monitors (BPMs) upstream of target

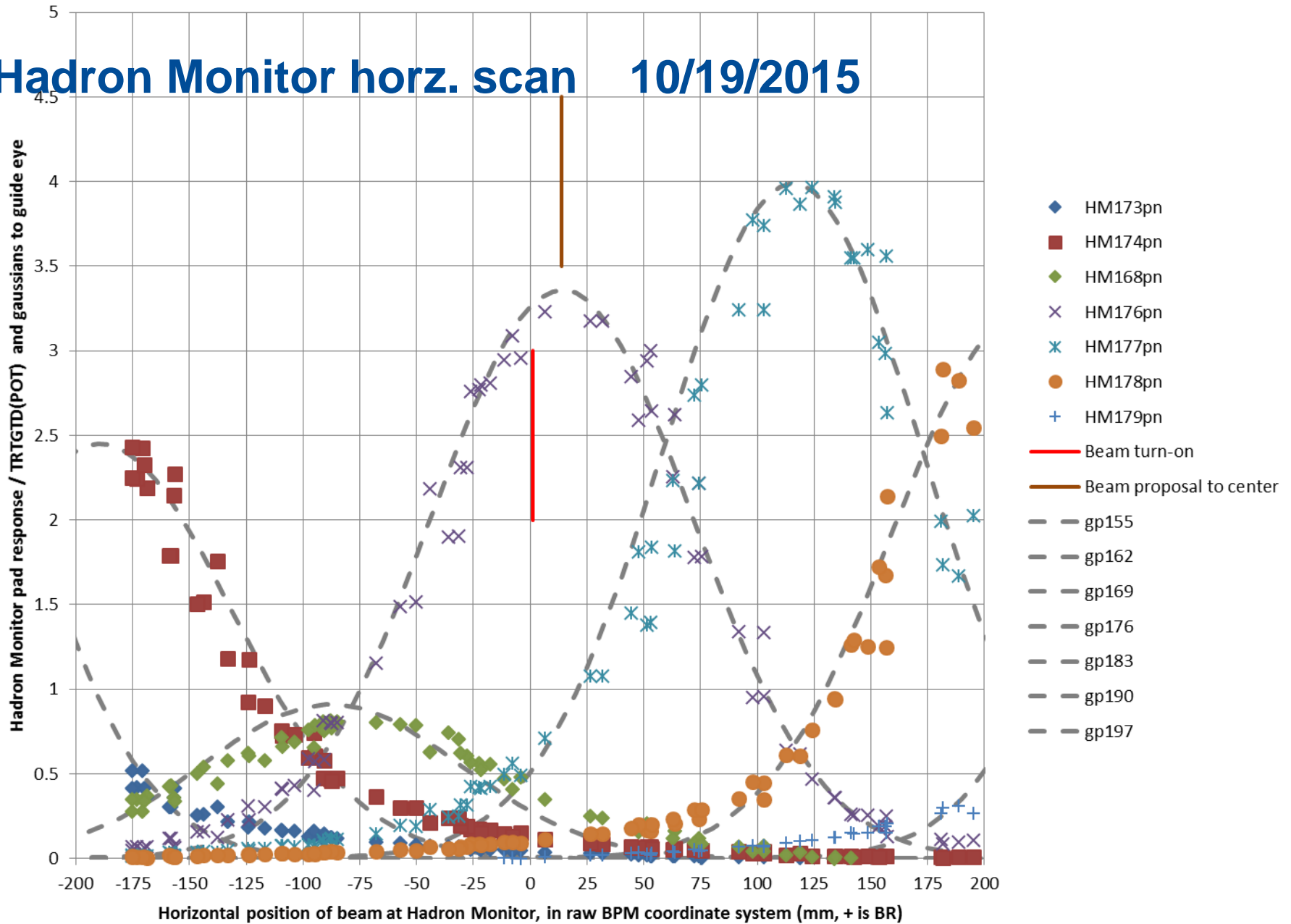
measure proton beam position and angle

- will present everything in coordinate system defined by BPMs

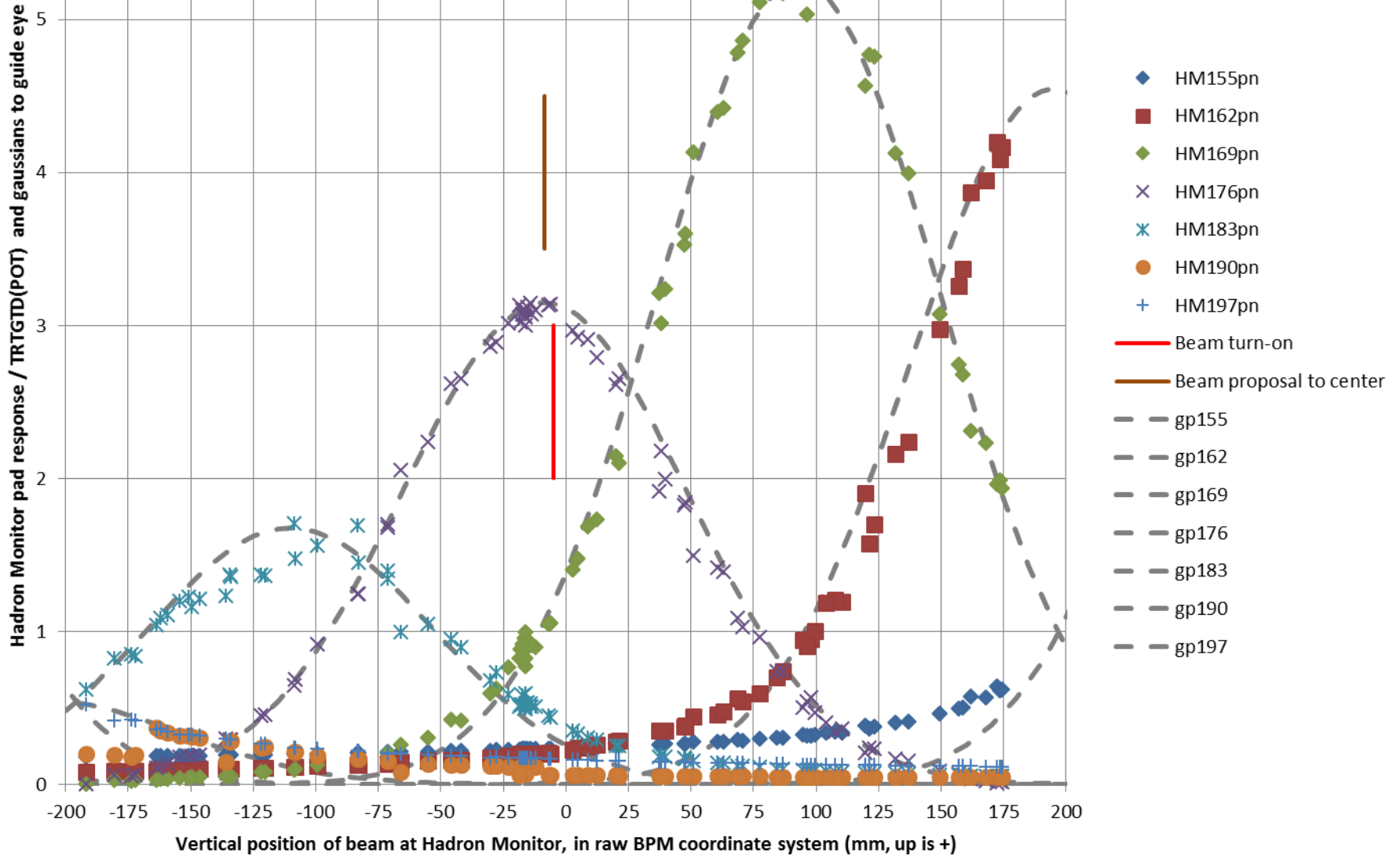
Beam scans done in four steps:

- Target out, scan beam across hadron monitor at end of decay pipe
 - Point beam at center of hadron monitor, defines beam angle to Soudan
- Target out, scan horn 1 neck and horn 1&2 cross hairs (signal in loss monitors)
 - If necessary, adjust horn 1 position.
- Target in, scan beam across baffle and target (signal in hadron monitor)
 - If necessary, adjust target + baffle position
- Cross-check beam height on target with high power vertical scan (signal in TVPT)
 - If necessary, adjust beam position on target or target position

Hadron Monitor horz. scan 10/19/2015



Hadron Monitor vert. scan 10/19/2015

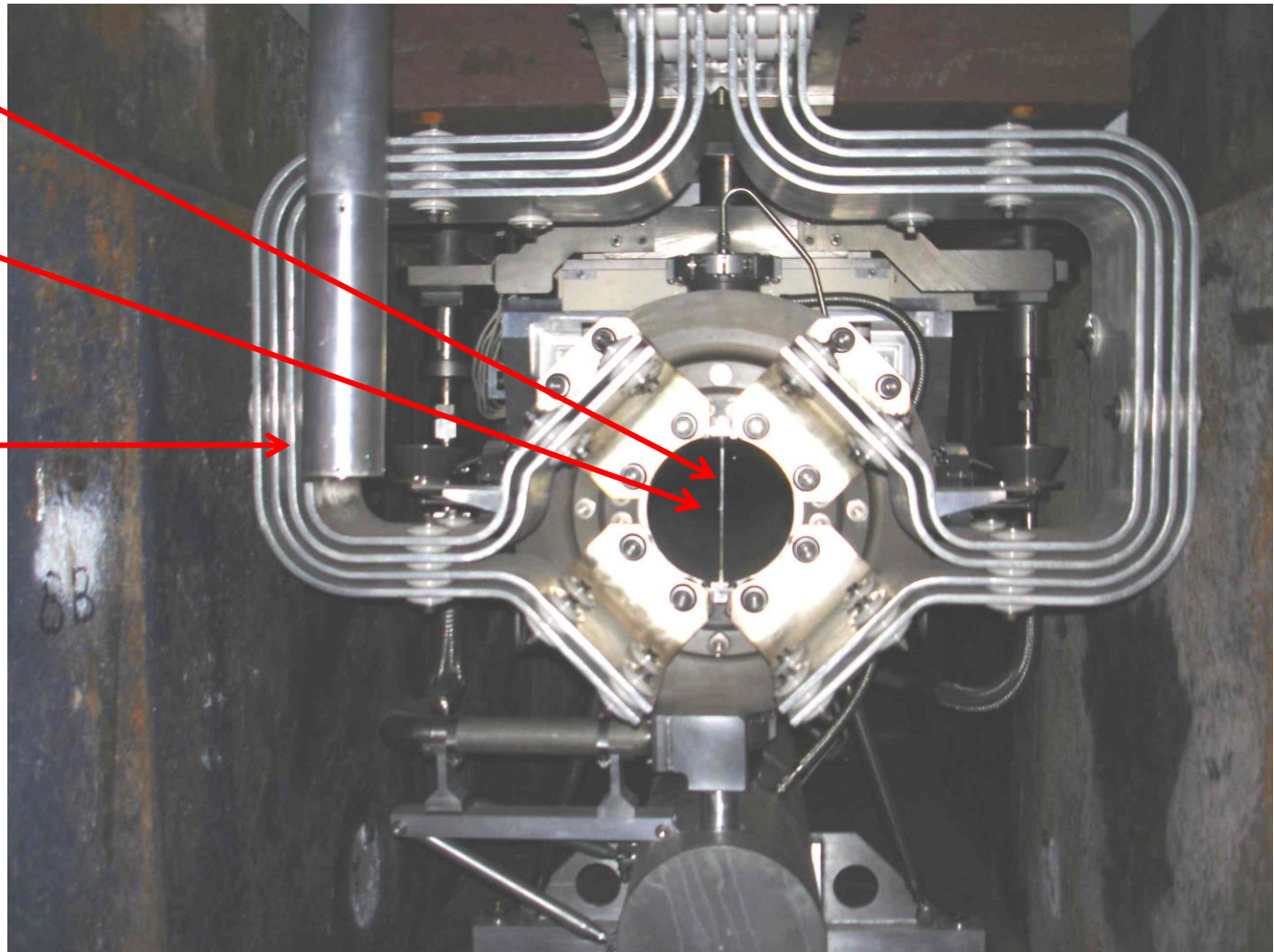


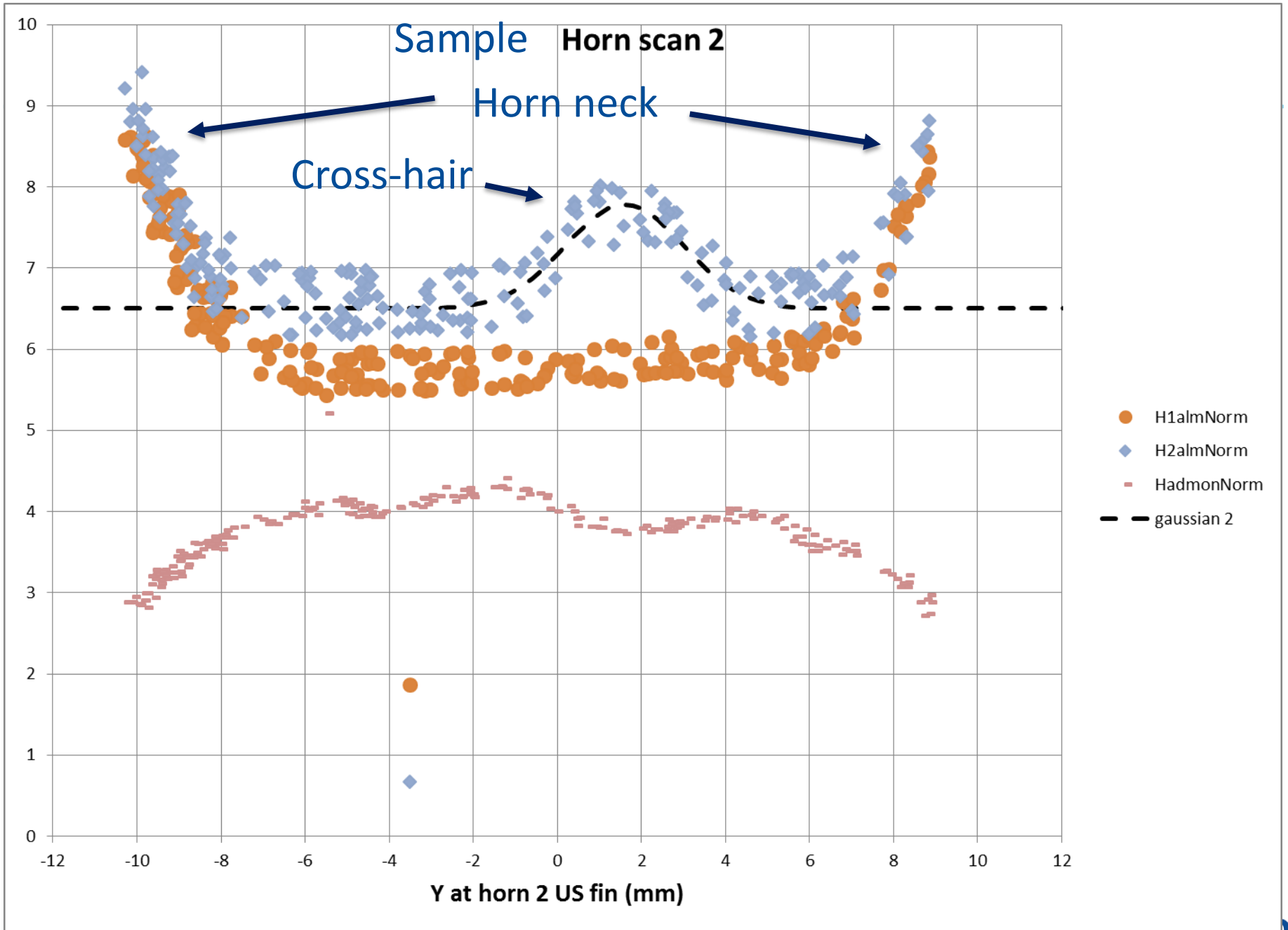
Horn cross-hair

Fin for beam
horz. alignment

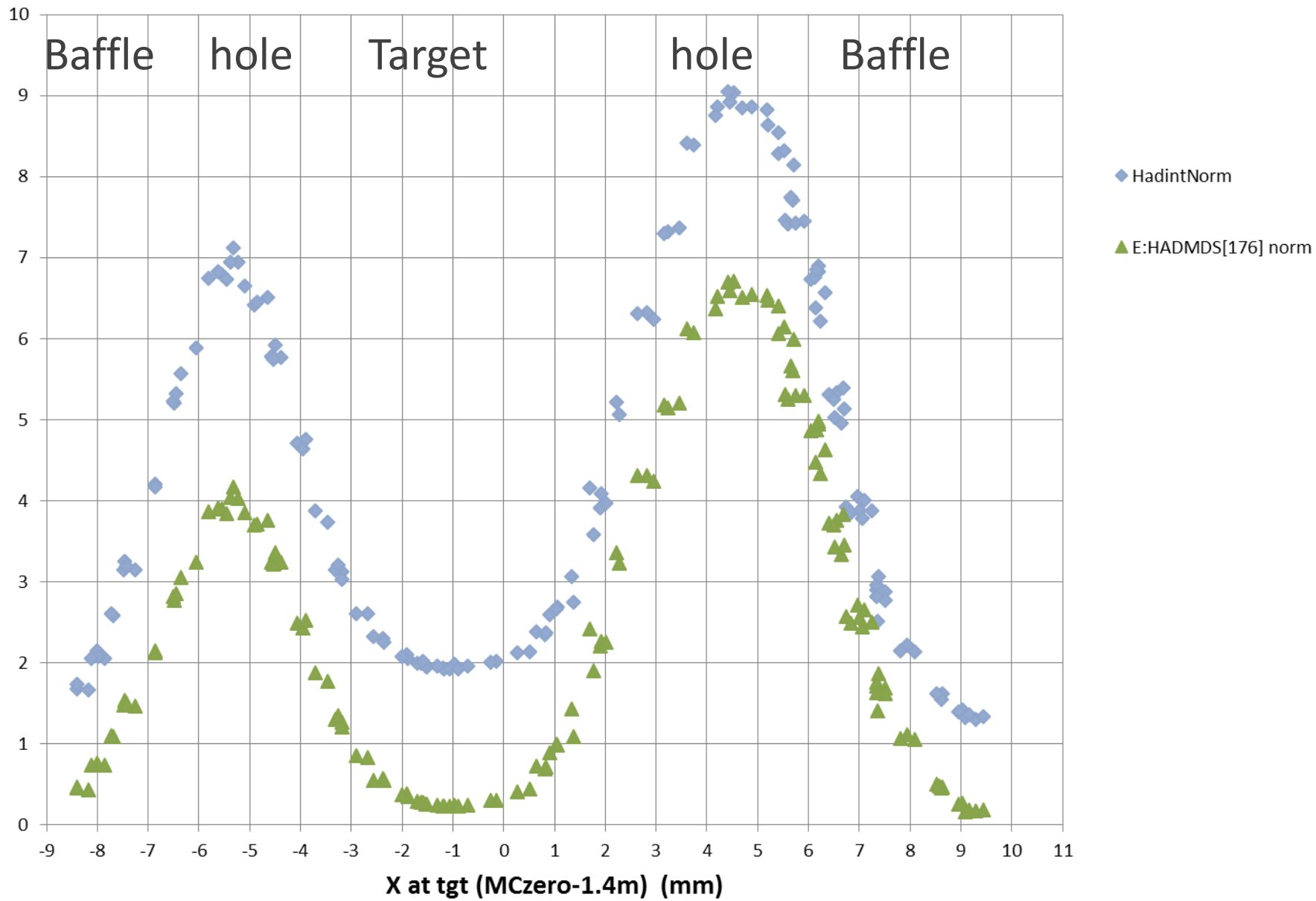
Nub for beam
vert. align

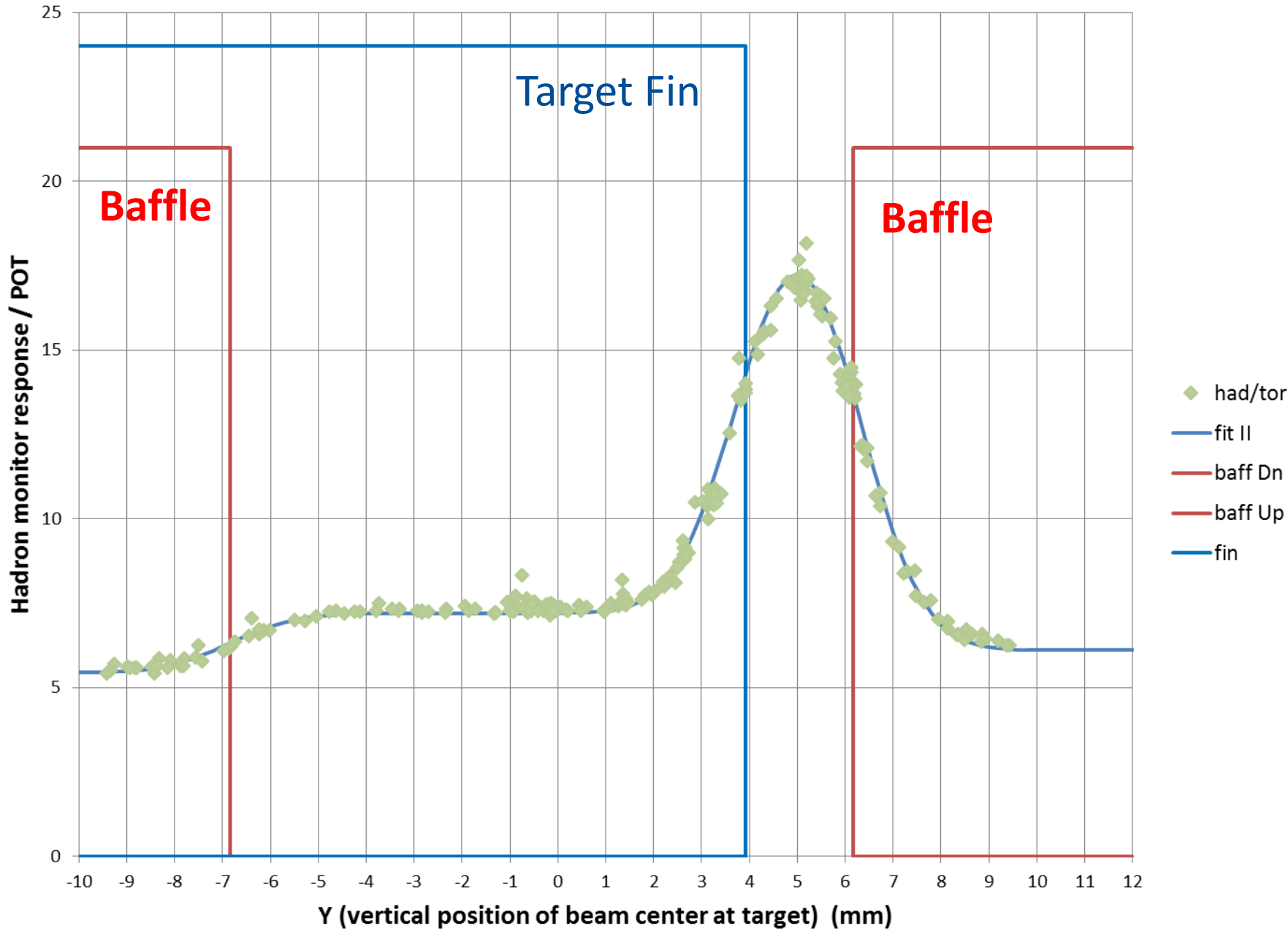
Beam loss mon.
to detect beam
scatter from fin





Oct 21, 2015, tgt H scan, before tgt realign





From NuMI TDR - *tolerances*

	PH2me	Medium	Energy	Beam
	A	B	C	D
	estimated accuracy (mm)	Will cause 2% error (mm)	error in worst energy bin (%)	error squared (%)
At Fermilab				
Position of Beam on Target	0.38	1.20	0.201	0.040
Angle of Beam on Target [18.13m]	0.71	8.16	0.015	0.000
Target X	0.50	-	0.000	0.000
Target Angle [1.0m]	0.71	1.67	0.362	0.131
Horn 1 X &	0.50	0.89	0.645	0.416
Horn 1 Angle [3.0m]	0.71	1.69	0.353	0.125
Horn 2 X	1.00	4.28	0.109	0.012
Horn 2 Angle [3.0m]	0.71	23.00	0.002	0.000
Decay Pipe [675m]	25.00	270.00	0.017	0.000
Downstream End				
Near Detector	25.00	209.00	0.029	<u>0.001</u>
Sum			0.851	0.724
Times root 2, since two transverse planes			1.204	1.449

Preliminary alignment Horizontal

Beam setting for running



TDR error est.



(mm)				HM scan as found	parallel as found	angled as found	average X (mm)	residual (mm)	Wes est (mm)	resid/est
H bp		station (m)	X (mm)	X scan 1	X scan 4					
-0.5	set	bpm121	-22							
-0.25	set	bpmtgt	-10							
-0.02		tgt	-1.4							
-0.02		MCZERO	0							
-0.02	extrap	neck	1.232		-0.3	0	-0.15	-0.13	0.5	-0.27
0.037	extrap	H1 DS fin	3.788		0.4	0	0.2	0.16	0.7	0.23
0.37	extrap	H2 US fin	19.76		1.4	1.1	1.2	0.83	1	0.83
14.73	extrap	HM	709	14			14	-0.73	27	-0.03

Preliminary alignment Vertical

Beam setting for running



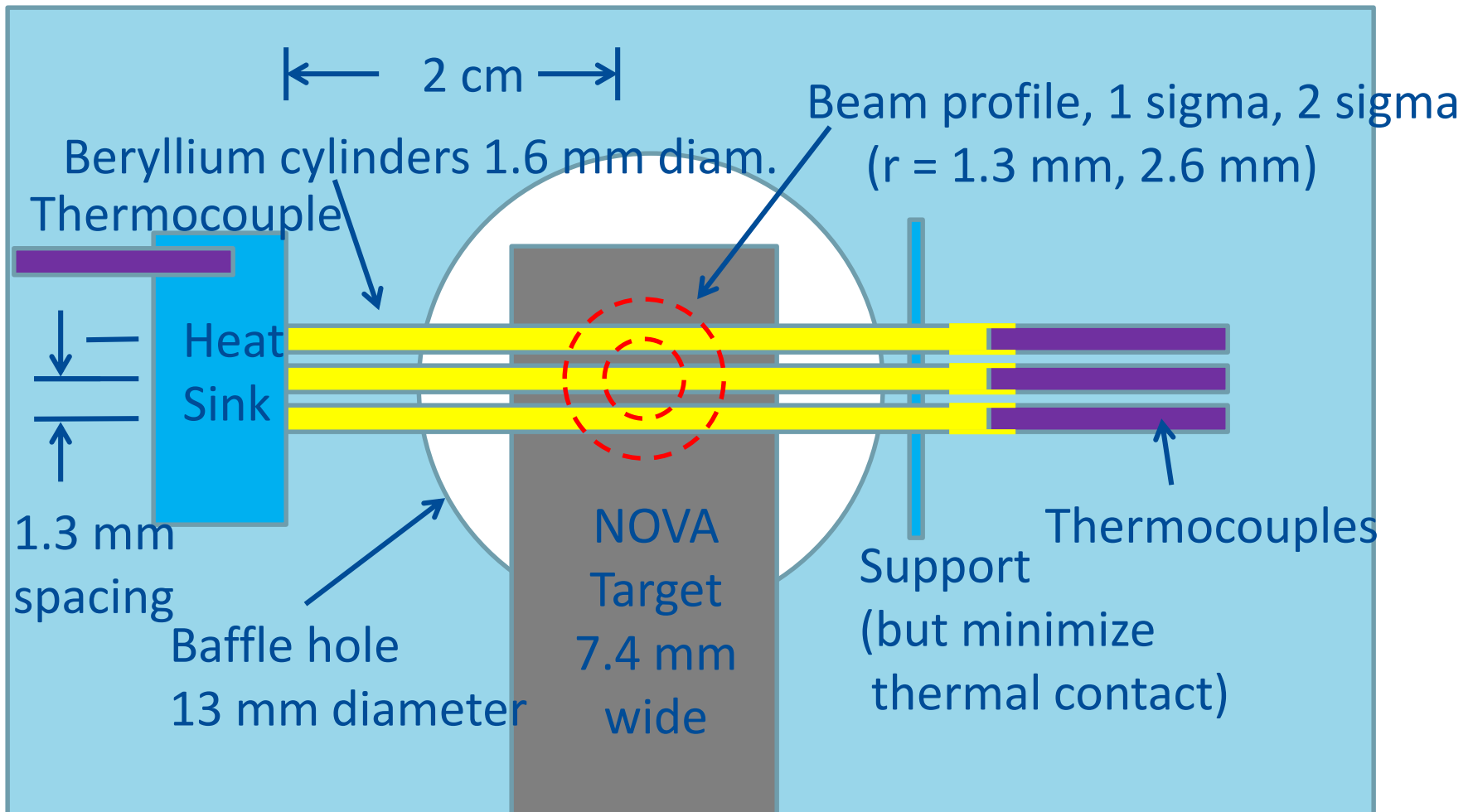
TDR error est.



(mm)				HM scan				Wes	
				as found	as found	summary	residual	est	
V bp		station (m)		Y (mm)	Y scan 2	Y	(mm)	(mm)	resid/est
-0.25	set	bpm121	-22						
-0.4	set	bpmtgt	-10						
-0.54		tgt	-1.4						
-0.5		MCZERO	0						
-0.5	extrap	neck	1.232		-0.4	-0.4	0.1	0.5	0.28
-0.6	extrap	H1 DS fin	3.788		-0.5	-0.5	0.1	0.7	0.10
-0.8	extrap	H2 US fin	19.76		-0.9	-0.9	-0.1	1	-0.13
-9.4	extrap	HM	709	-8.5		-8.5	0.9	27	0.03

Concept of Target Vertical Position Thermometer

(not to scale; note baffle drawn behind target, although it is actually in front)



700kW Medium Energy Target Status

Target	Status	Location
TA-01	Operation	Beamline 6.4E20 POT
TA-02	Ready Spare, 3 Be Fins	MI-8
TA-03	98% Complete	MI-8
TA-04	40% Complete Finish FY2016	MI-8
TA-05	40% Complete Finish FY2016	MI-8
TA-06	Started Procurement	MI-8
TA-07	Started Procurement	MI-8

FY16 Priority
FY16 Priority
FY16 Priority

- Expect Consumption of one target
- Make-up spare inventory (100% through TA-05)
- Delay later targets

From Bob Zwaska

NuMI Horn 1 Status

<u>Horns</u>	<u>Status</u>	<u># Pulses</u>	<u>Location</u>	<u>Comments</u>
PH1-01	Very Used, Water Leak	24.2M	C0 Bay	9 R/hr @ 1 ft. on 5/12/14
PH1-02	Used, Still Operational 400kW "Spare"	45.9M	C0 Bay	35 R/hr @ 1 ft. on 9/10/14
PH1-03	400kW Spare, Upgraded Cooling for higher beam power	0	MI-8	
PH1-04	700 kW Horn Stripline Fracture	27M	NuMI Target Pile	Must be replaced Very Radioactive
PH1-05	'Ready' 700 kW Spare; Same stripline as PH1-04	0	MI-8	Under construction vibratic measurements
PH1-06	In process, Complete FY 2017			<u>Need to Complete Work Remains</u>
PH1-07	Just started procurement			IC Parts on Order Much work remains

FY16 Priority
FY16 Priority

From Bob Zwaska



NuMI Horn 2 Status

<u>Horns</u>	<u>Status</u>	<u># Pulses</u>	<u>Location</u>	<u>Comments</u>
PH2-01	Used, Stripline Fracture	28.1M	C0 Bay	Intend to ship off-site FY16
PH2-02	In operation	69M Pulses 4/13/2015	NuMI TH Beamline	
PH2-03	Ready 700kW Spare	Test Stand Qualified	MI-8	
PH2-04	Ready for MI-8 Test Stand	0	MI-8	<div style="position: absolute; top: 10px; right: 10px; color: orange; font-weight: bold; font-size: 1.2em;">FY16 Priority</div> Expected completion FY16
PH2-05	Completion late FY2017			<u><i>Need to CNC TIG IC, Much Work Remains</i></u>

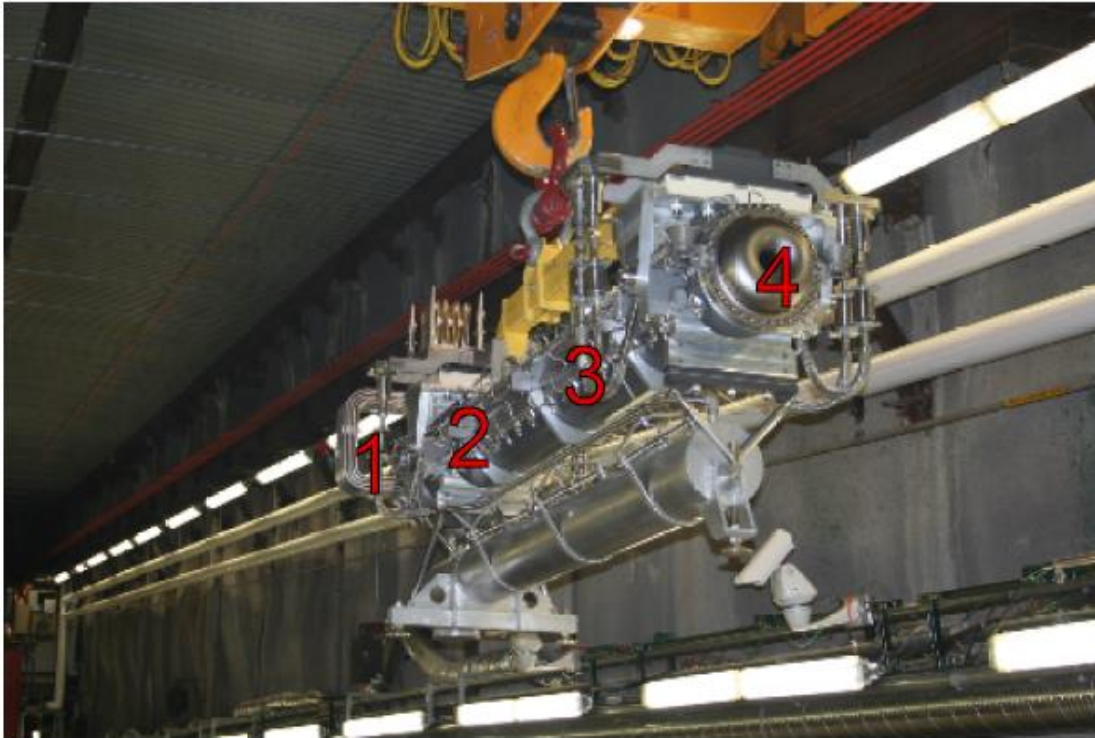
From Bob Zwaska



Residual radiation getting high



DATE: 9/3/15 TIME: 1000 PURPOSE: replacement survey RWP # _____



NuMI Horn PH1-04

Point	Doserate @ 1 foot (mr/hour)
1	50000
2	100000
3	110000
4	80000



- Worker would accumulate weekly dose limit in 2 seconds