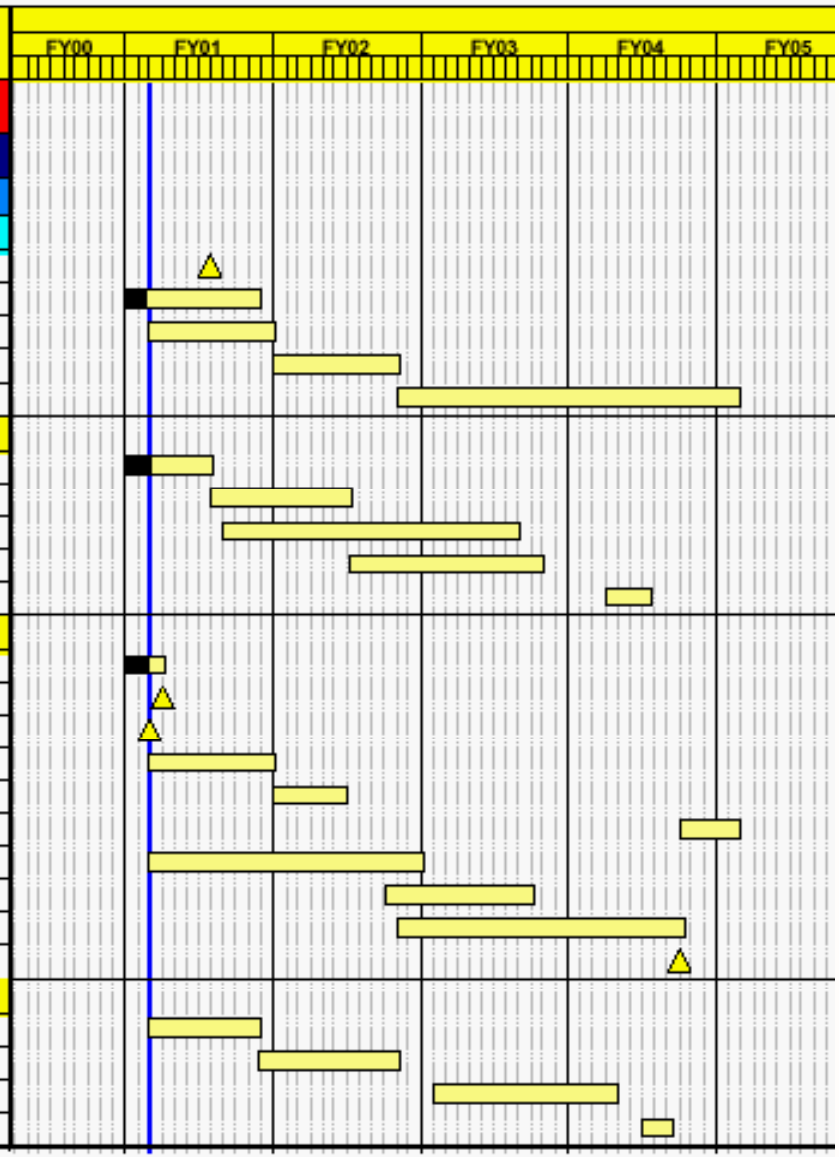
Baseband BPM - Peter Cameron

- Schedule
- System Specifications
- Level of Design
- Design Details
  - Shorted Stripline
  - Open Stripline
  - Tolerance Stackup
  - Feedthrus and Signal Cables
  - Beam-based Alignment
- Conclusions

BPM Schedule

Activity Description	Early Start	Early Finish
1.0 Spallation Neutron Source Project		
1.5 Ring and Transport System		
1.5.7 Ring Systems Diagnostics Instrumentation		
1.5.7.1 Beam Position Monitor [BPM]		
B P M Final Design Review [FDR]	30APR01	
B P M Detail Design - Summary [FY01]	02OCT00A	29AUG01
B P M Procure, Fab & Assy - Summary [FY01]	01DEC00	28SEP01
B P M Procure, Fab & Assy - Summary [FY02]	01OCT01	06AUG02
B P M Install & Test - Summary	08AUG02	23NOV04
HEBT		
HEBT B P M Detail Design (FY01)	02OCT00A	30APR01
HEBT B P M Procure/Fab/Assy	01MAY01	05APR02
HEBT B P M Electronics Fab/Assy	31MAY01	30MAY03
HEBT B P M Elec Test	08APR02	30JUL03
HEBT B P M Elec Comp. Test @ Site	02JAN04	19APR04
RING		
B P M Detail Design (FY01)	02OCT00A	29DEC00
Ring BPM Detailed Design Complete		29DEC00
RING B P M Procurement Start	01DEC00	
B P M Procure/Fab/Assy (FY01)	01DEC00	28SEP01
B P M Procure/Fab/Assy (FY02)	01OCT01	29MAR02
RING B P M Component Test @ Site	05JUL04	23NOV04
B P M Electronics Design (FY01+)	01DEC00	30SEP02
B P M Electronics Procure/Fab/Assy	05JUL02	02JUL03
B P M Electronics Test	08AUG02	05JUL04
B P M Electronics Install & Test Compl	05JUL04	
RTBT		
RTBT BPM Detail Design (FY01)	01DEC00	29AUG01
RTBT BPM Detector Procure/Fab/Assy	30AUG01	06AUG02
RTBT BPM Test	06NOV02	30JAN04
RTBT BPM Comp. Test @ Site	01APR04	10JUN04



Baseband BPM - System Specifications

- AP Requirements
  - Range
    - HEBT +/- 0.5 * aperture?
    - Ring and RTBT +/- 20mm
  - Accuracy - 1mm - quad magnetic center to console
  - Resolution - 150μ
  - Rate to console - 5Hz
  - Data Structure
    - HEBT - within 600ns minipulse
    - Ring - turn by turn

Baseband BPM - Additional Requirements

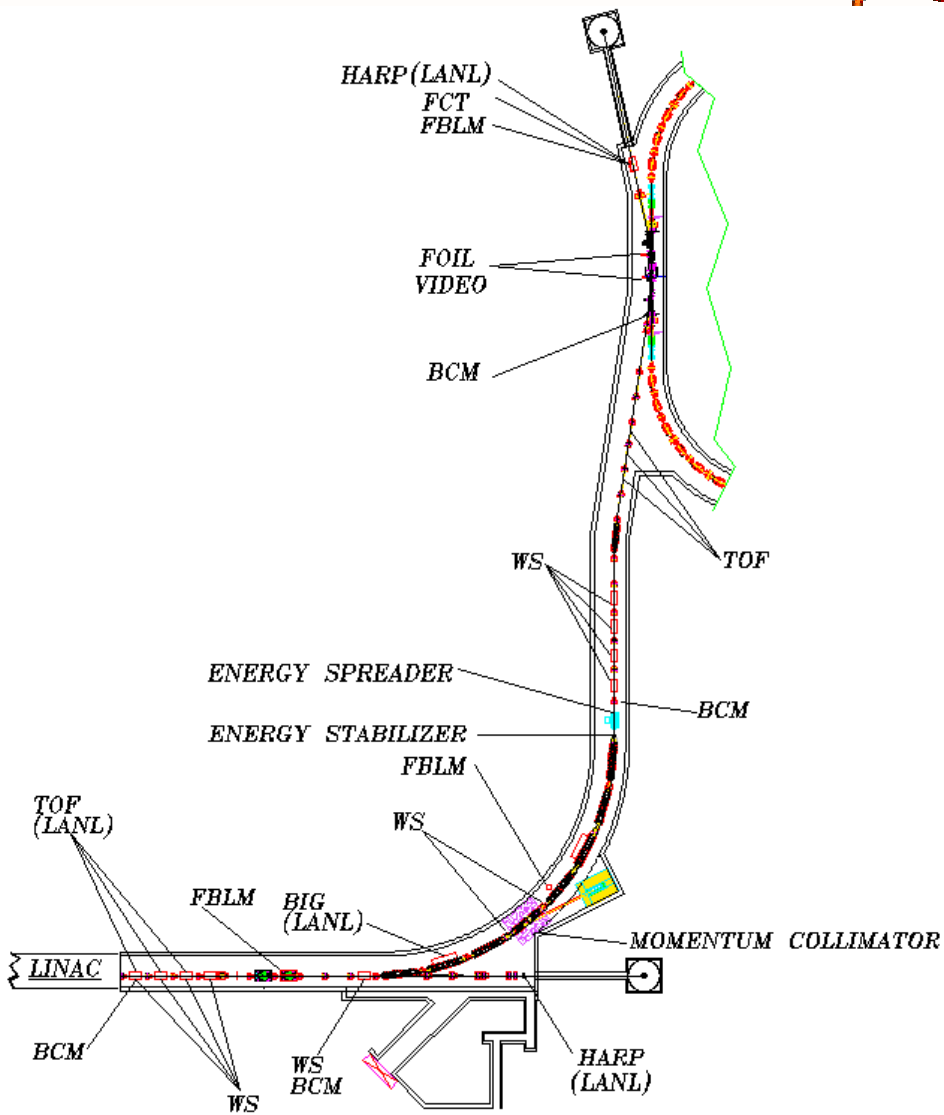
- Additional Requirements
  - Position along the mini-pulse is desirable, will be present in node as a result of oversampling, should be part of data structure
  - 400 MHz electronics at two locations (minimum) in Ring
- Comments
  - Accuracy and resolution requirements are not consistent with large variety of apertures

Baseband BPM - Level of Design

- PDR Complete
- Detailed Design underway
- FDR Complete for 21cm Ring and HEBT PUEs
- First Articles of Ring and Transfer Line PUEs are in fabrication
- Feedthrus and standoffs are ordered

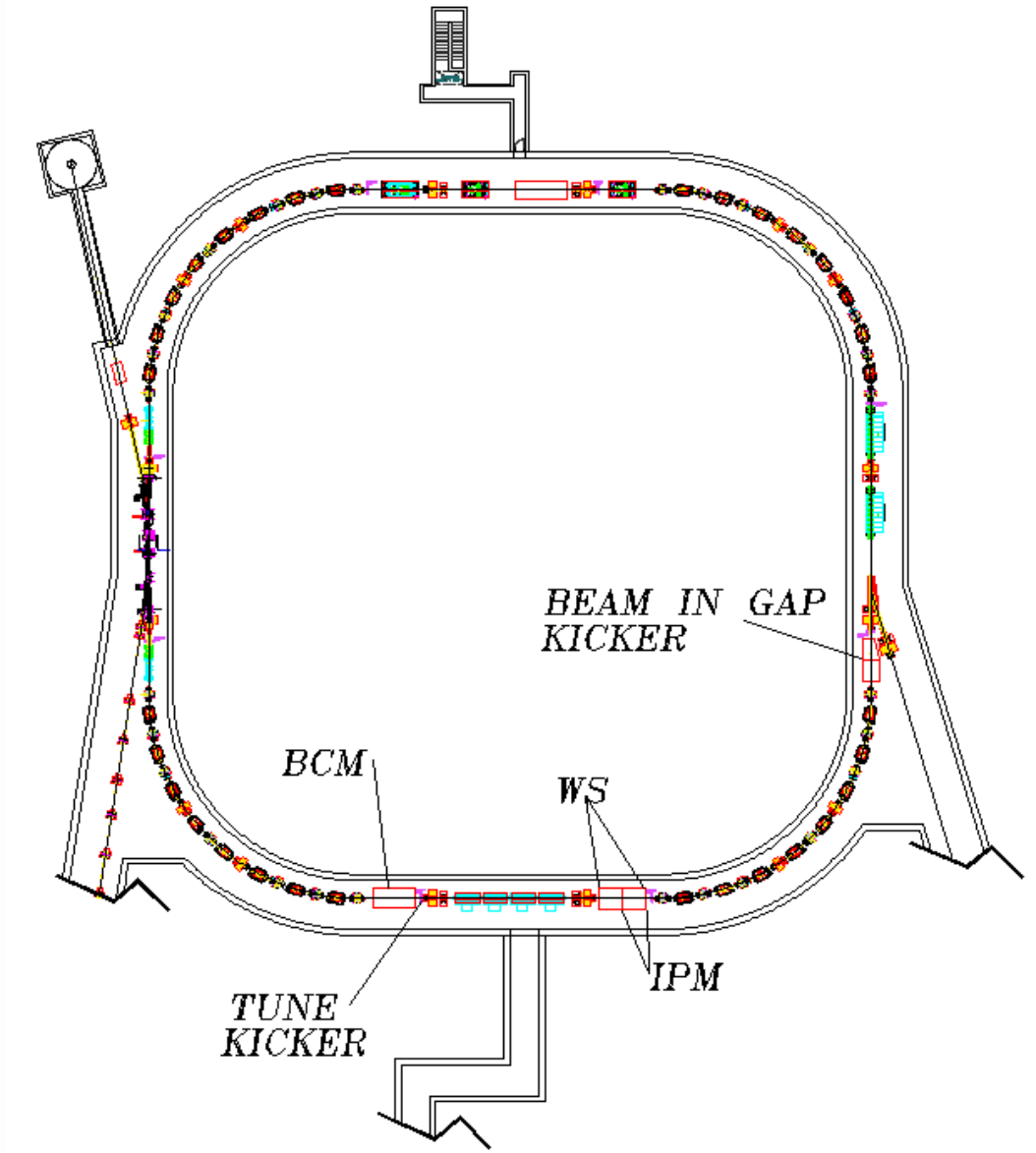
HEBT Beam Instrumentation

Detector	BNL	LANL
BIG	0	1
BPM	40	0
TOF	0	2
FBLM	3	0
BLM	52	0
BCM/FCT	5	0
WS or PrM	11	0
FOIL VIDEO	2	0
HARP	0	2



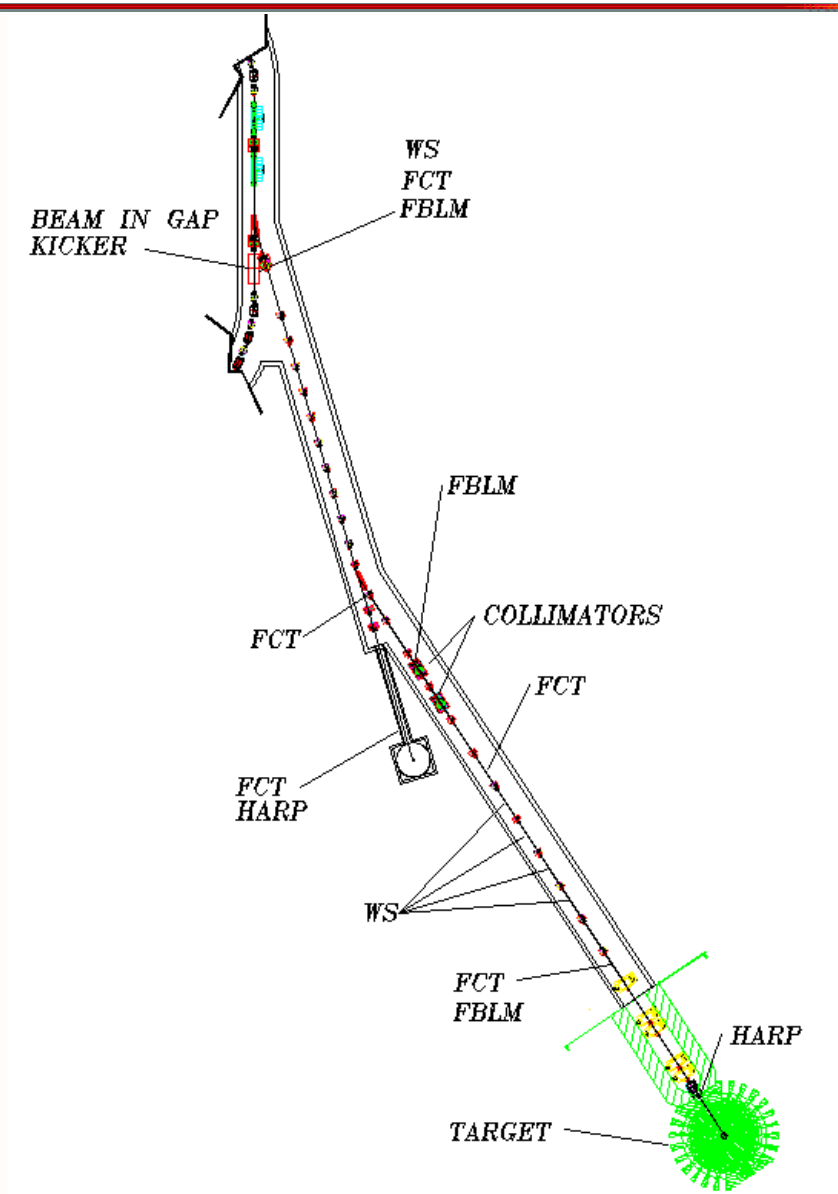
SNS Ring Instrumentation

Detector	Qty	Note
BPM	44	Dual Plane
BPM	2	RF radial loop
BLM	75	Ion Chamber
FBLM	12	Photomultiplier
BIG	1	Kicker+PMT
IPM	2	H + V
WS	2	H + V
Coherent Tune	1	Kicked
Incoherent Tune	2	PLL & QMM
BCM/FCT	1	
WCM	2	Including RF
Electron Detector	5	
Higher Moment	1	



RTBT Beam Instrumentation

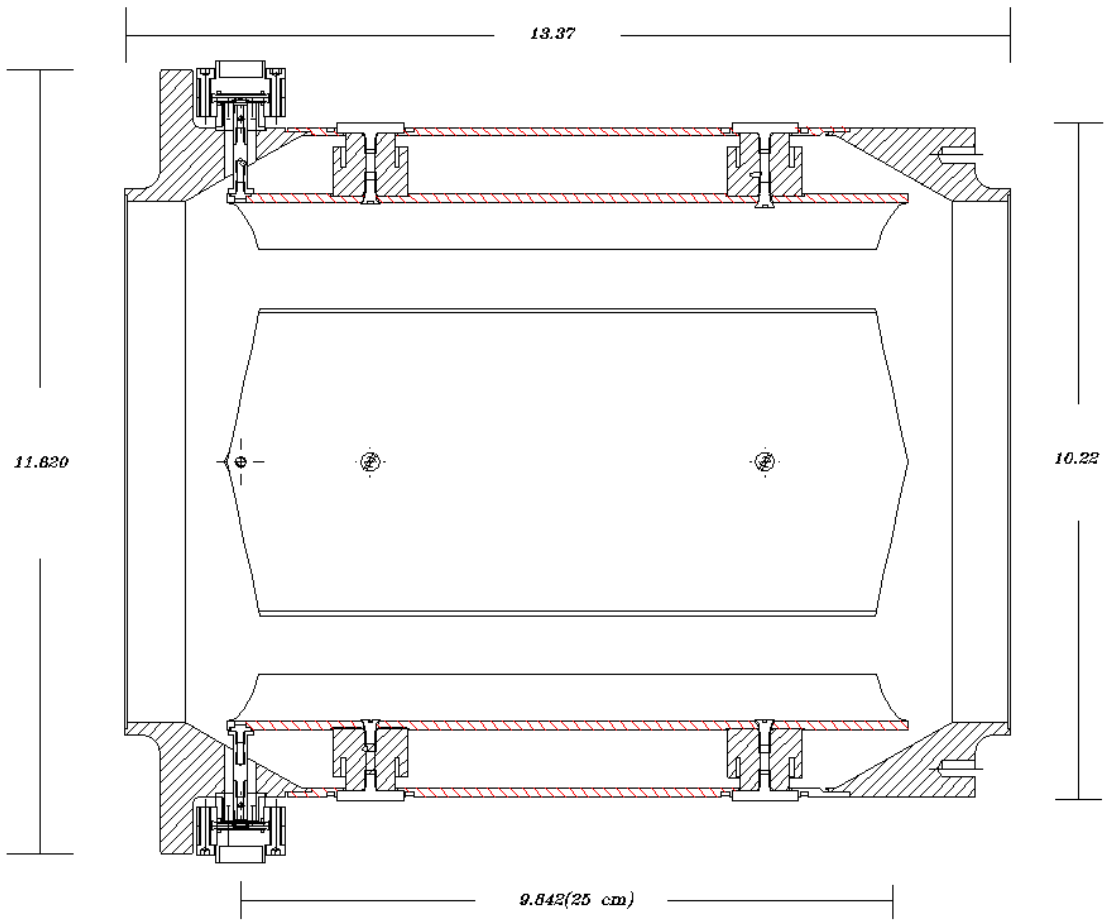
Detector	Qty
FBLM	3
BLM	40
BPM	32
DUMP HARP (LANL)	1
FCT	5
WS	5
TARGET HARP (LANL)	1



HEBT, Ring and RTBT BPMs

- HEBT - 40 dual plane, one at each Quad
  - 31 each 12cm diameter
  - 9 each 21cm diameter
- Ring - 44 Dual Plane, one at each Quad in arcs, one per doublet in straights
  - 28 each 21cm diameter
  - 8 each 26cm diameter
  - 8 each 30cm diameter
- RTBT - 32 Dual Plane, one at each Quad
  - 28 each 21cm diameter
  - 4 each 30cm diameter
  - 5 each 36cm diameter
- TOTAL 116

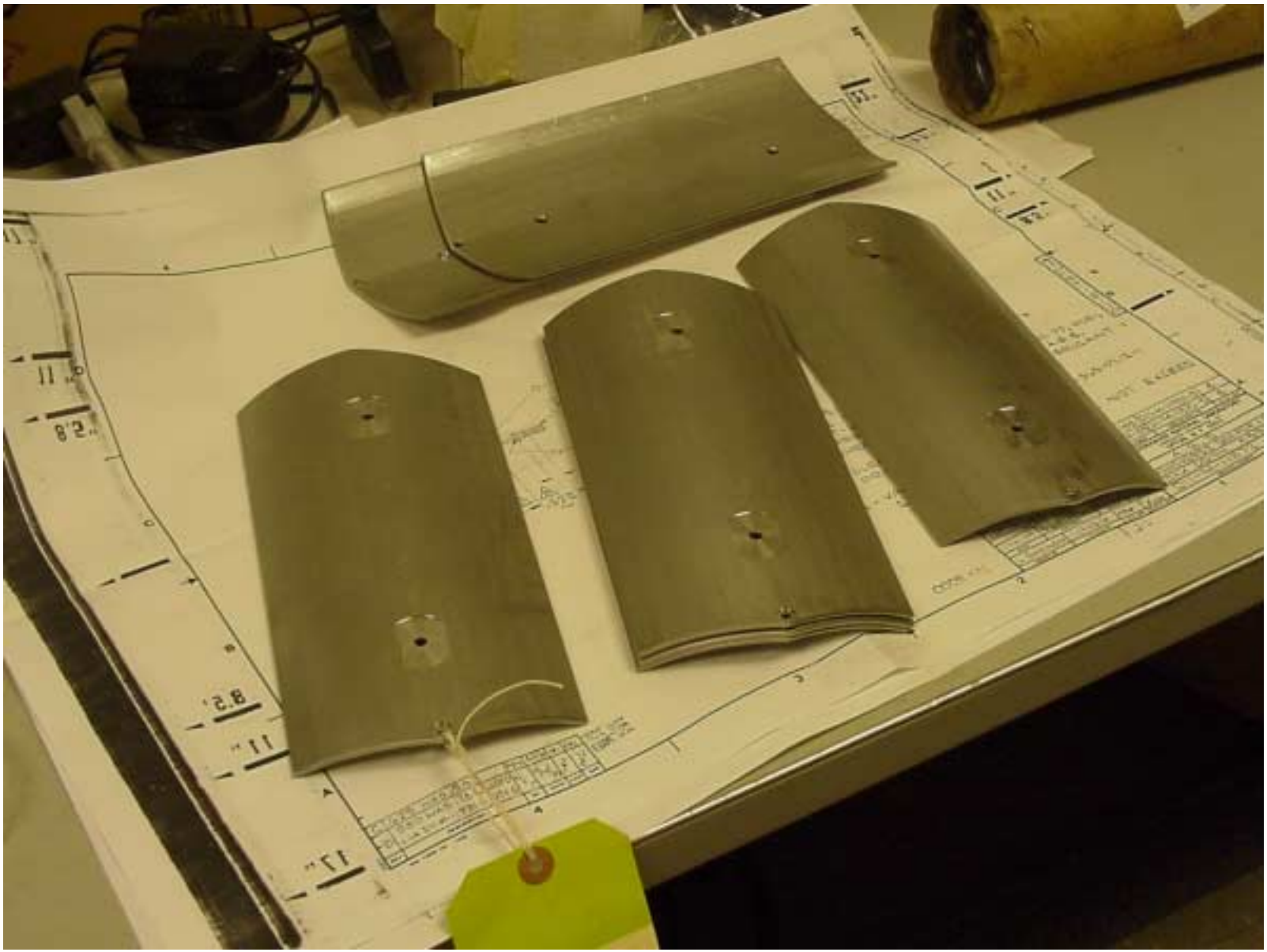
Ring BPM PUE



Ring BPM PUE

Ring BPM PUE

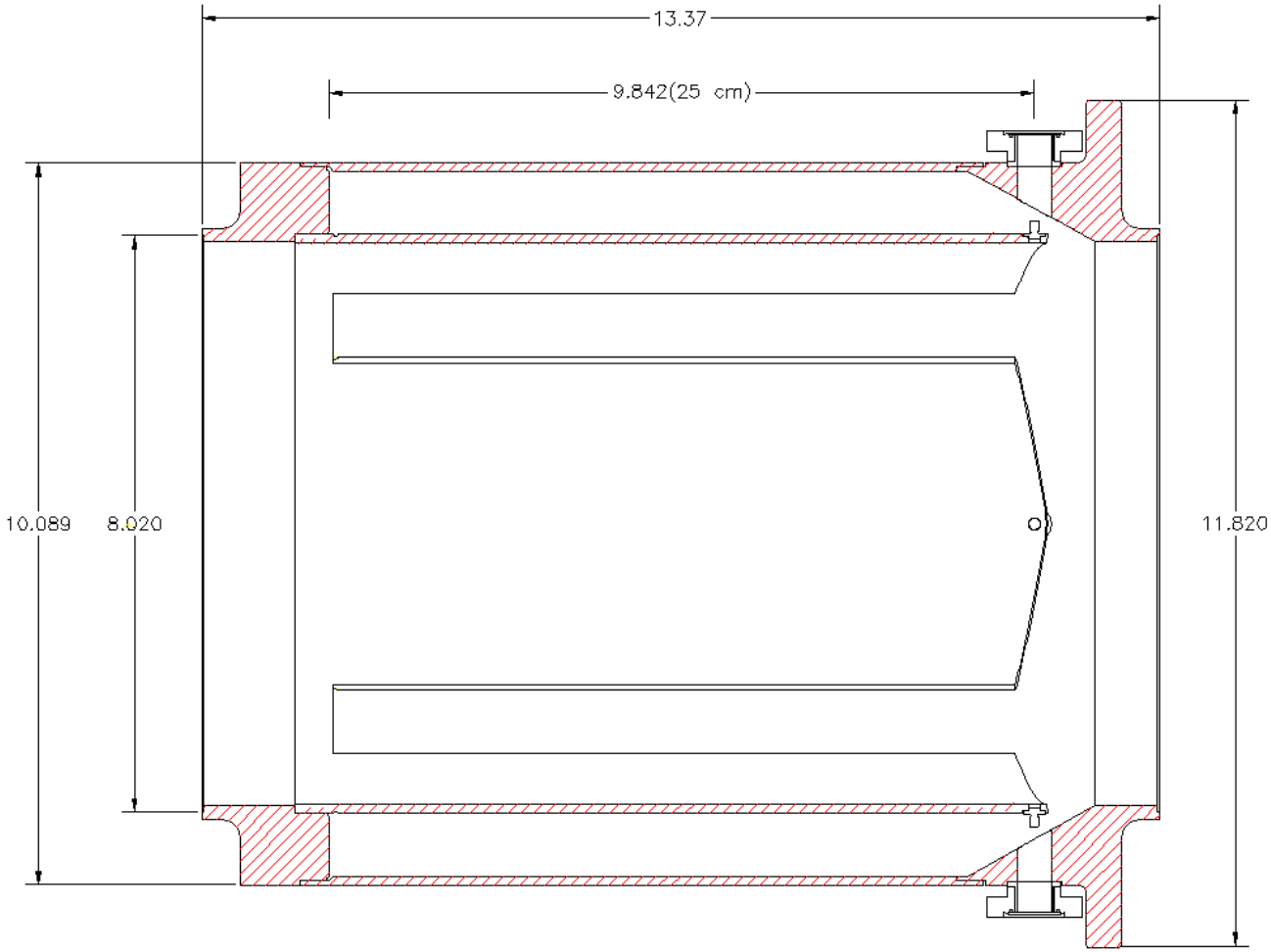
Ring BPM PUE



Ring 21cm BPM PUE Tolerance Stackup

Items	Rad. Accuracy to the center of quad.
1. Shoulder screw location	.0075"
2. Brazing surface on the outer shell	.005"
3. Rad. clearance for the brazing	.001"
4. Weld post on the outer shell	.005"
5. Length of ceramic standoff	.005"
6. Groove depth on the stripline	.005"
7. Quad. surface flatness	.020"
Total (RSS):	.0236" (or 0.6 mm)
	<1 mm design req.

HEBT 21cm BPM PUE



Stripline and Capacitive PUEs

- Capacitive
  - Sensitive to bunch middle
  - Larger impedance possible - not matched
  - linear design possible
  - less accurate mechanically
  - Can be biased for electron clearing
- Stripline
  - Sensitive to bunch ends
  - Impedance matched
  - Not linear
  - More accurate mechanically
- Compromise - open stripline

Feedthrus, Cables, and Standoffs

- Feedthrus
  - Lithium silicate glass/ceramic
  - Thermal expansion matched to stainless steel
  - Ultra-reliable mechanically
  - Very good electrically
- Cables
  - PUE to tray - flexible coaxial
  - Tray to service building - 1/4” low loss heliax
- Standoffs
  - All ring components to be titanium nitride coated
  - Results in shielded standoff design to avoid shorting

Beam-based Alignment

- K-modulation - for Ring
  - Use trim coil to modulate quad - 1%, 10 Hz
  - Use correctors to sweep beam across quad
  - Narrow band detect deflections
  - Scaling from LEP and HERA suggests ~100μ rms
- Swept bump - for transfer lines
  - No trims on quads
  - Sweep bump thru a quad, adjust currents to avoid propagating a wave.
  - Difference current measures quad offset contribution
  - Under consideration for RHIC alignment
  - A few hundred microns?

Conclusions

- BPM mechanical design is mature and well tested
- A significant portion of tolerance stackup is beyond our control
- Calibration is simplified and improved with beam-based alignment, overcomes this stackup problem.