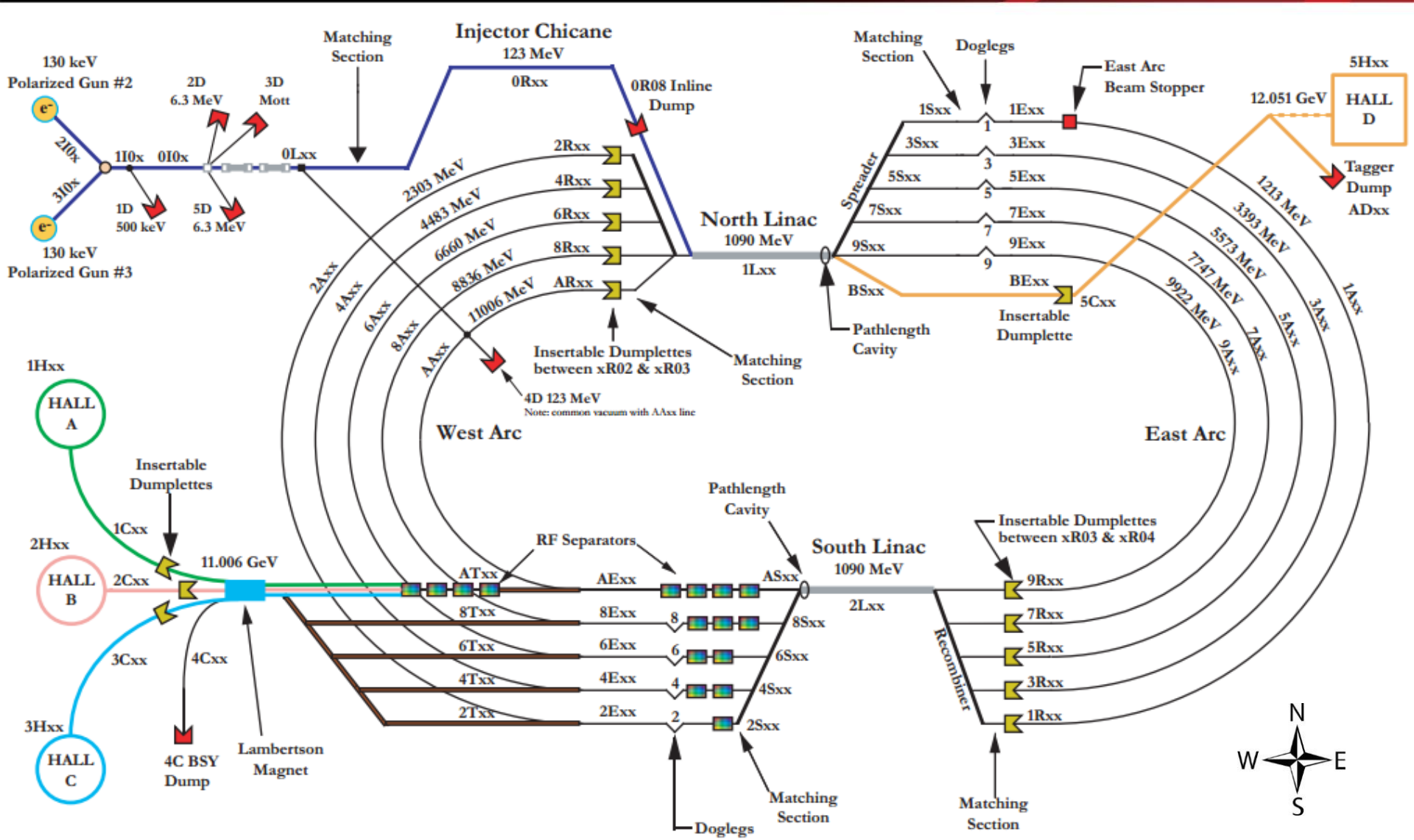
Extraction/Separator Setup

Michael Spata

Operations Stay Treat

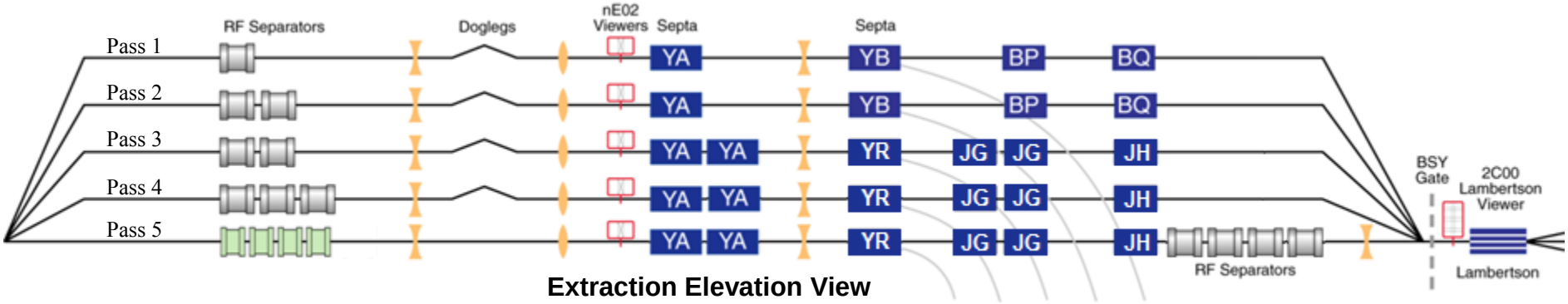
July 16, 2015

Accelerator Overview



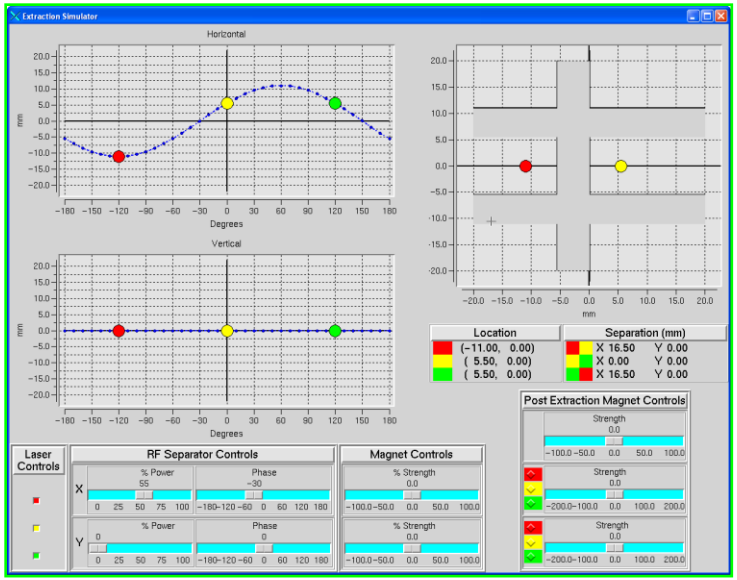
Extraction System

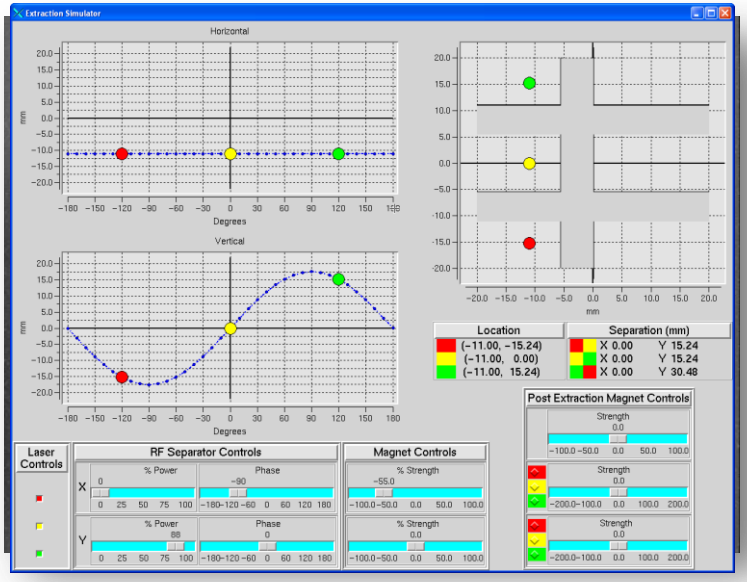
- Design settings for magnets and RF Separators come from CED
- All beamlines have been commissioned
- 750 MHz system needs to be recommissioned



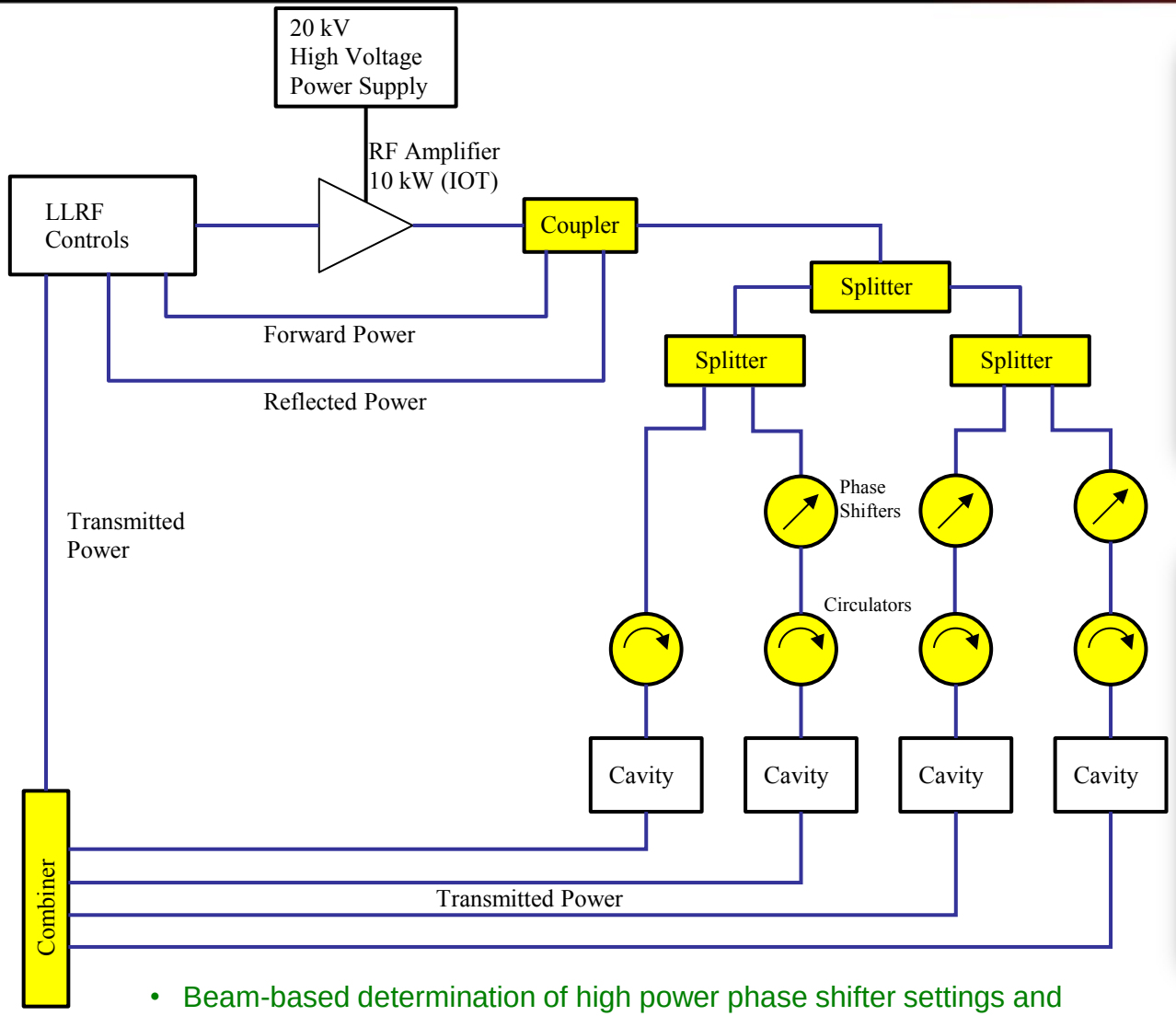
Extraction Elevation View

West Arc Beamlines





RF Components



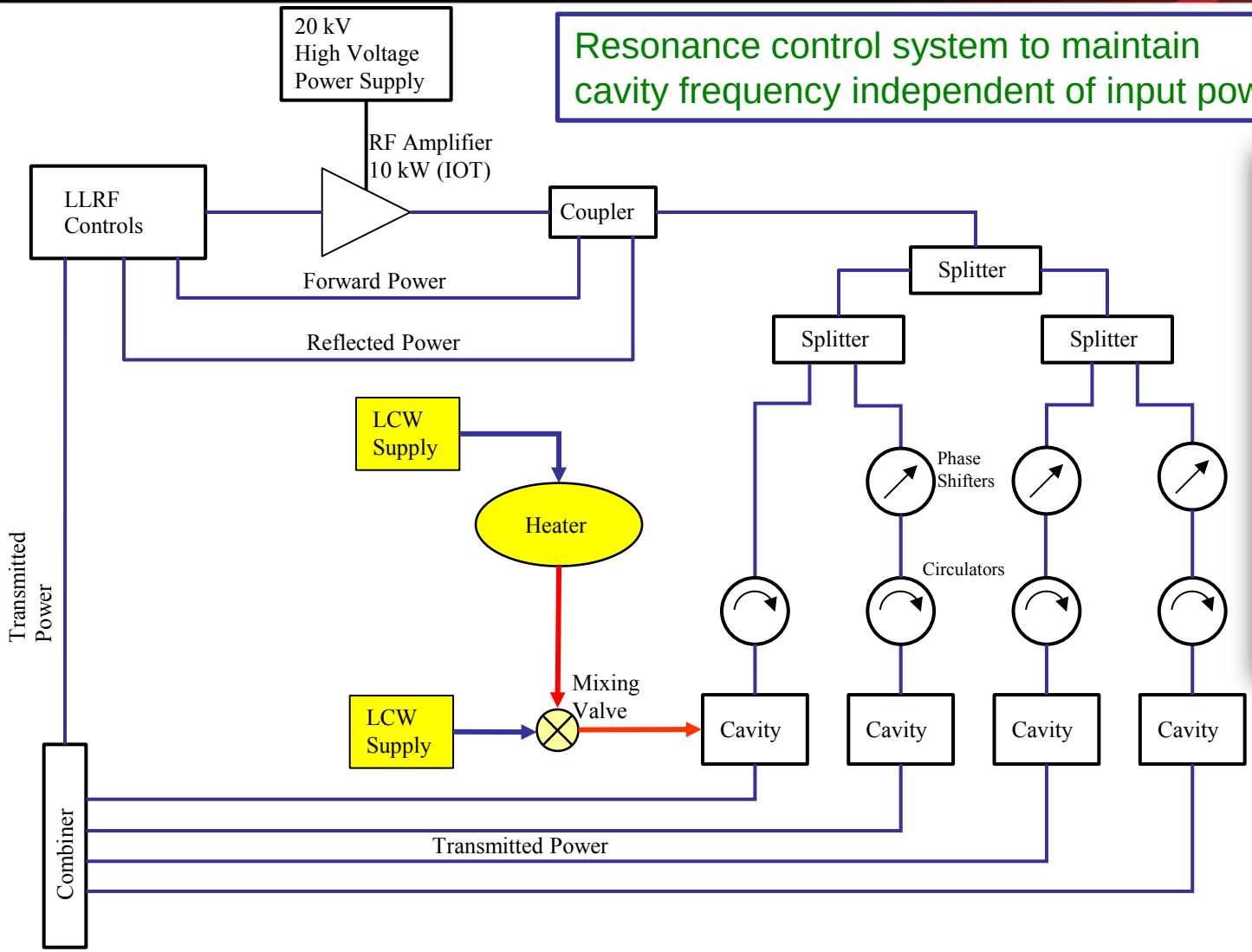
Existing HV Deck

RF IOT Layout

- Beam-based determination of high power phase shifter settings and cavity shunt impedance

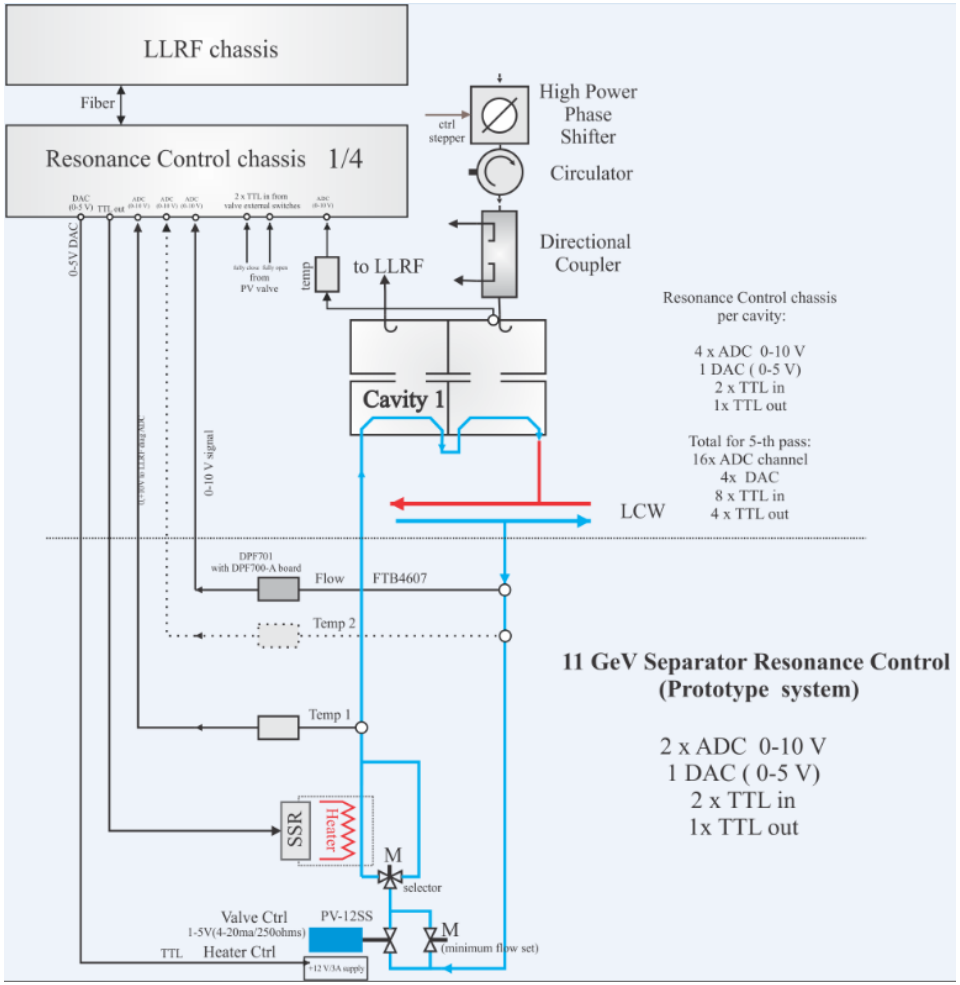
Resonance Control

Resonance control system to maintain cavity frequency independent of input power

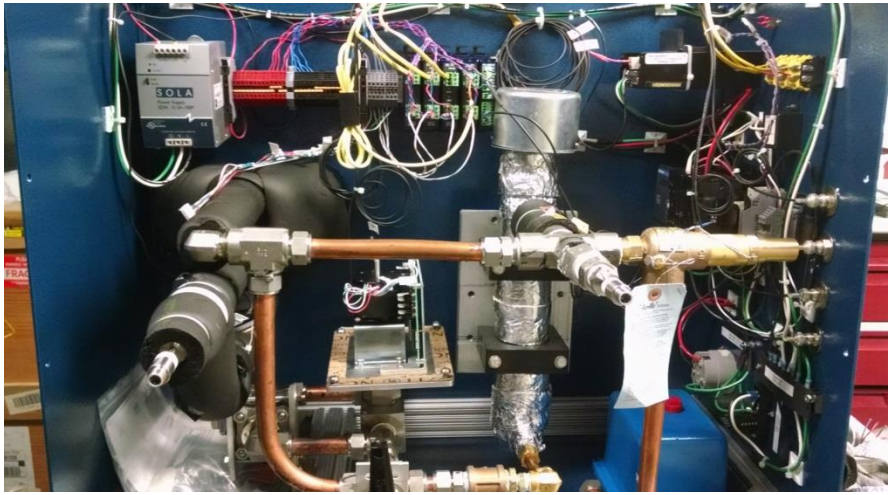


Rack Space for 5 Heaters

Resonance Control System

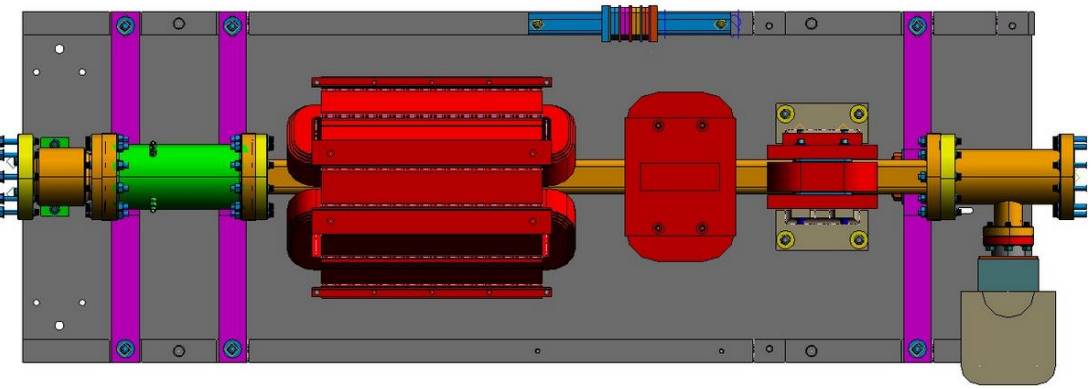


- Resonance control system under development for 750 MHz cavities
- One-button start-up software package will be provided to turn on the system

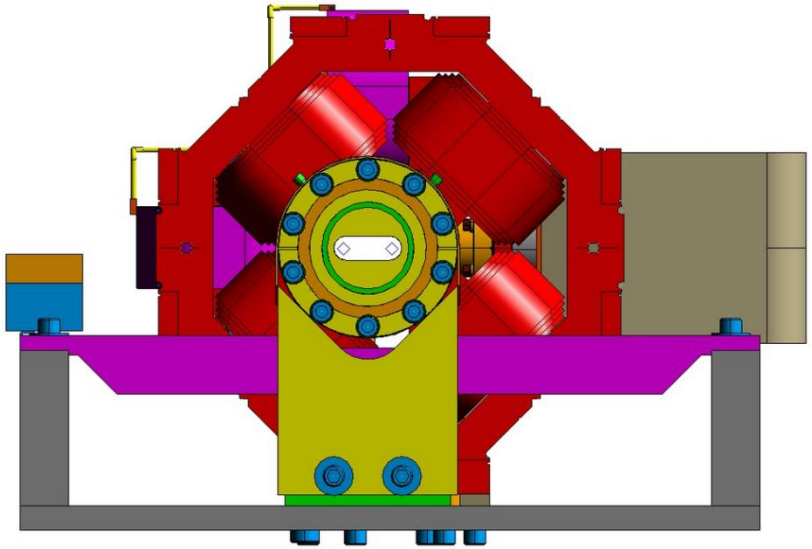


E03 Girder Aperture

- Beam separation at the E03 girder is sufficiently large to challenge the available aperture. The 6 GeV machine had less than 4 mm of clearance with the two beams on the nominal trajectory.
- Redesigned the E03 quad girders to accommodate the two beams.
- Need to correct for the nonlinearity of the BPM at large position offset.
- BPM shifted by half the beam separation.
- Beam separation on first and second pass is 2.524 cm.
- Beam separation on third through fifth pass is 3.192 cm.
- Need to correct for non-linearities

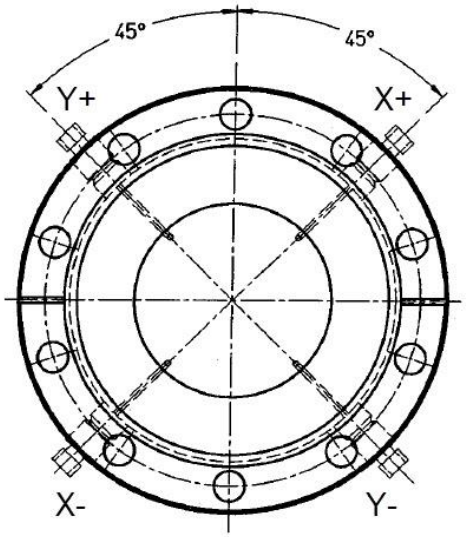


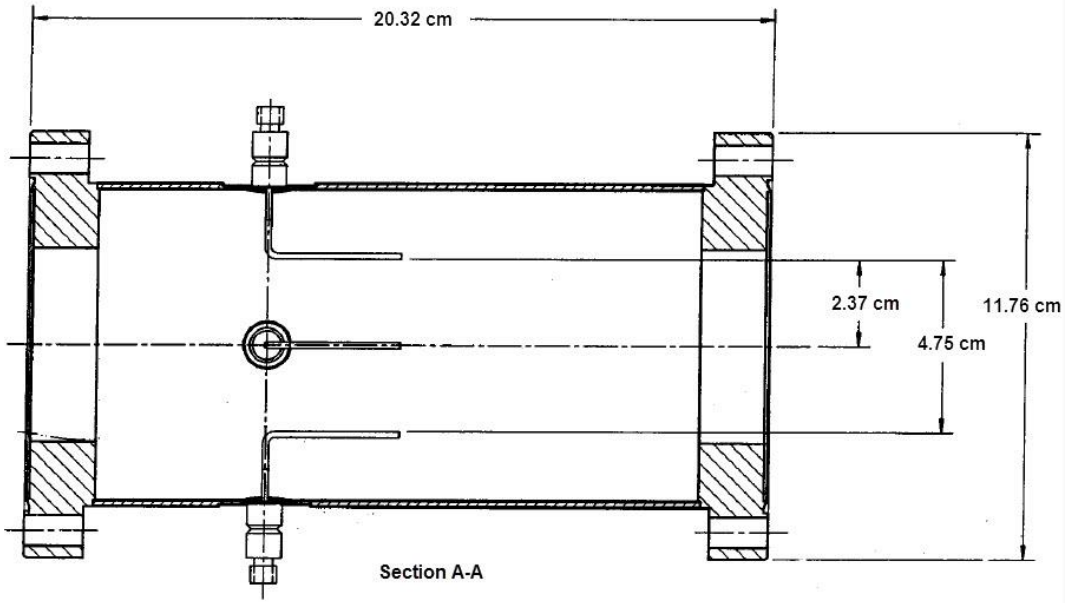
Offset Rectangular Beamline



Extracted and Recirculated Beams

Beam Position Monitor





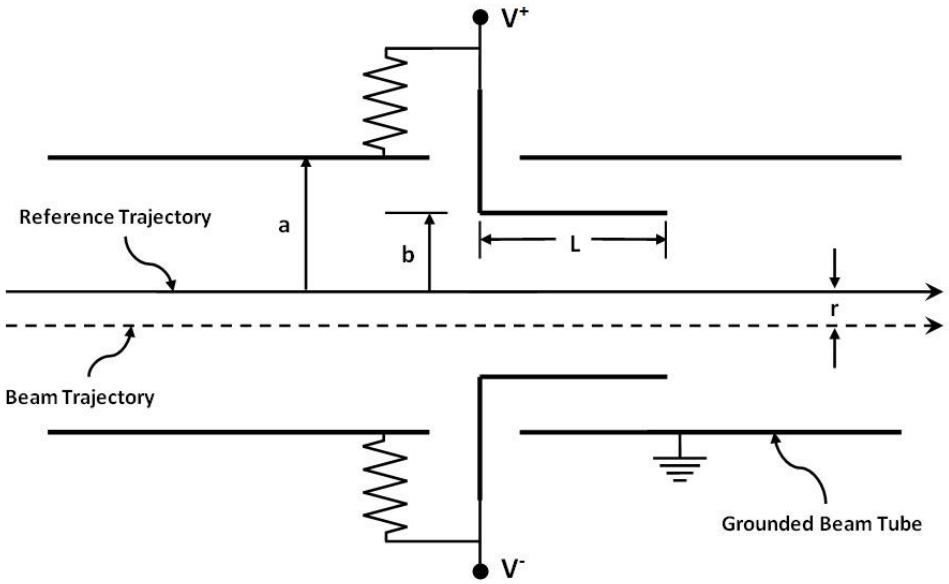
$$XROT = k\frac{X_+ - \alpha X_-}{X_+ + \alpha X_-}$$

$$YROT = k\frac{Y_+ - \alpha Y_-}{Y_+ + \alpha Y_-}$$

$$X = XROT\cos(45^\circ) - YROT\sin(45^\circ)$$

$$Y = YROT\cos(45^\circ) + XROT\sin(45^\circ)$$

Beam Position Monitor



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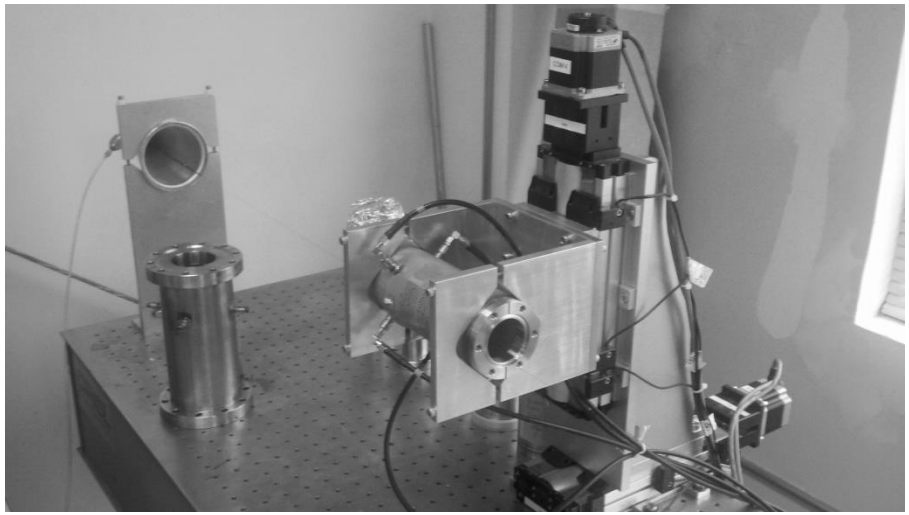
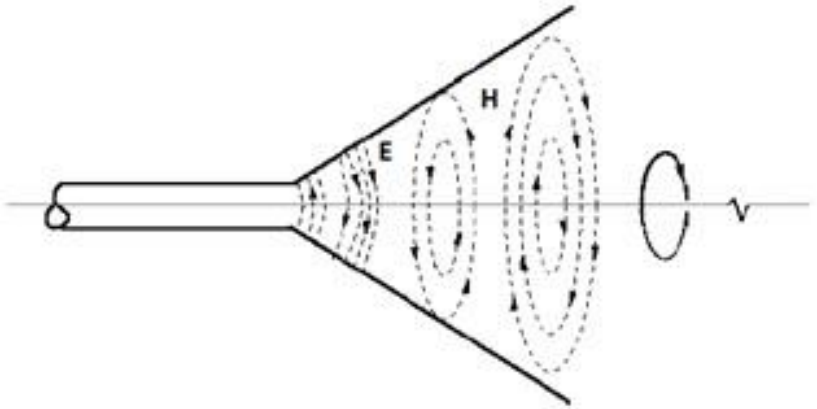
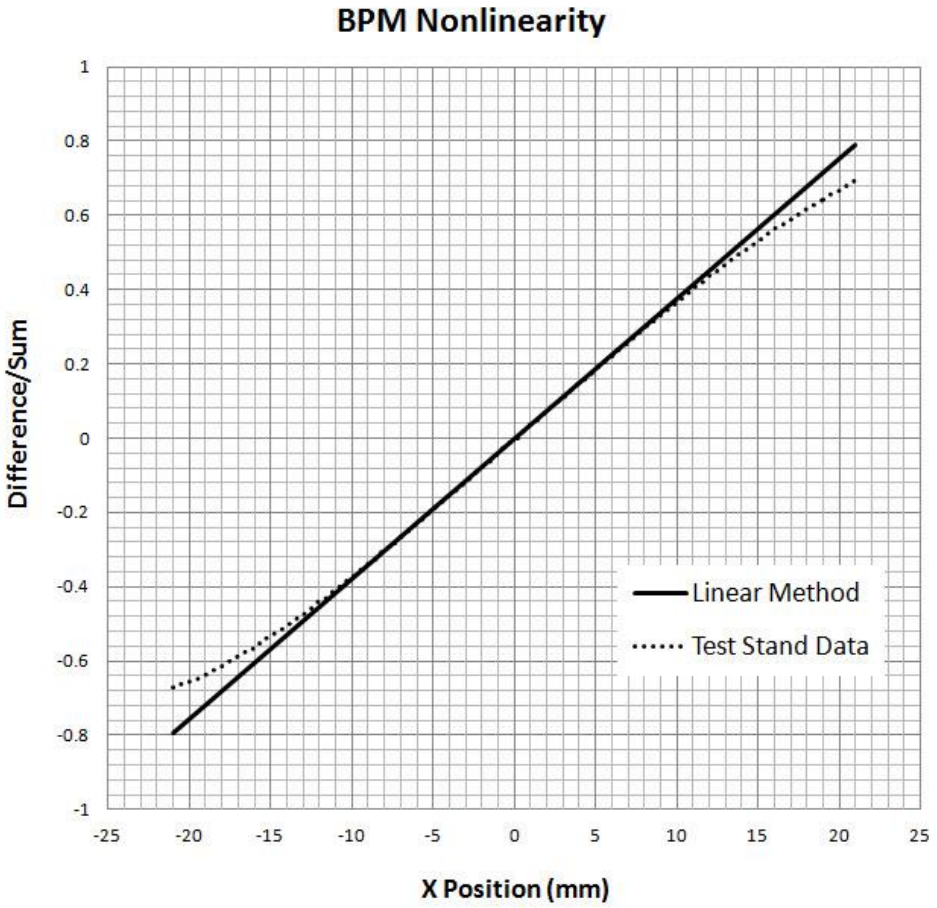
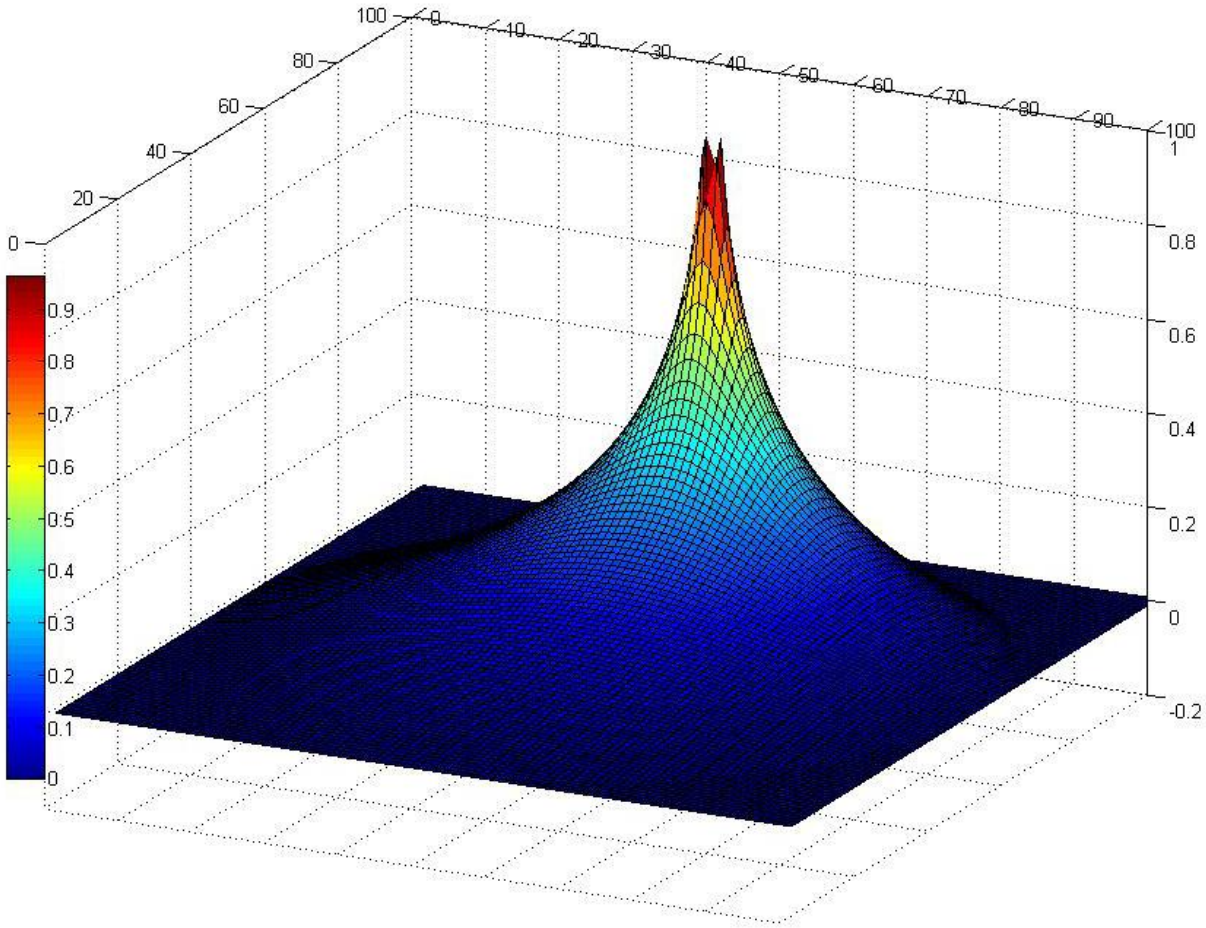
BPM Non-Linearity



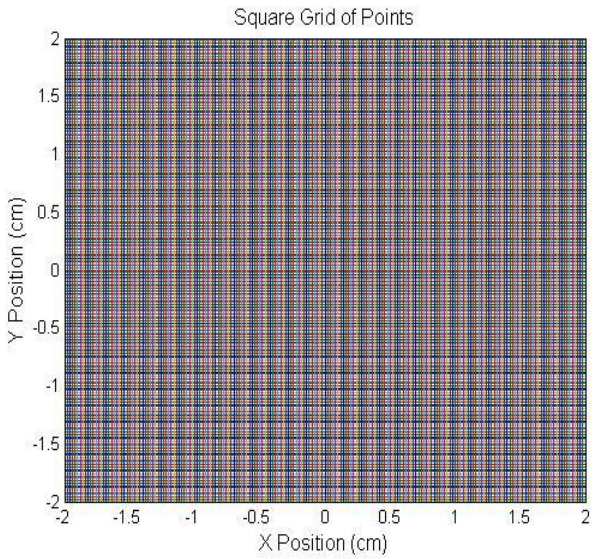




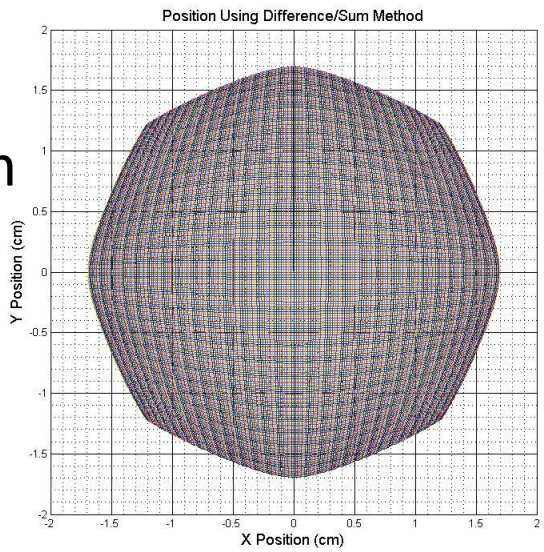
Poisson Model of BPM Electrode



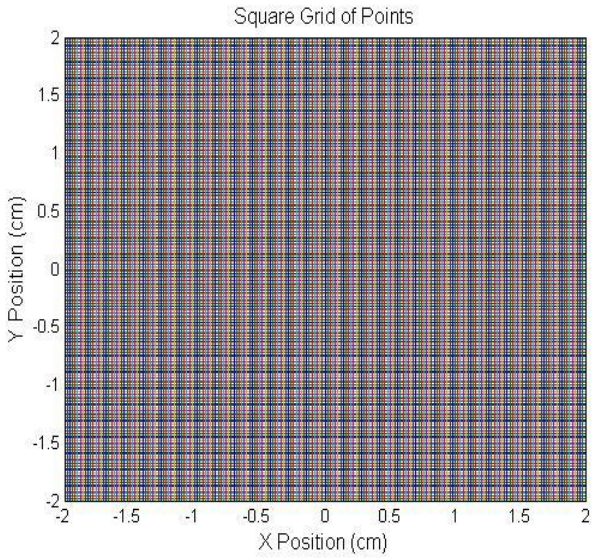
BPM Nonlinearity Correction



Difference/Sum Method →



BPM Nonlinearity Correction



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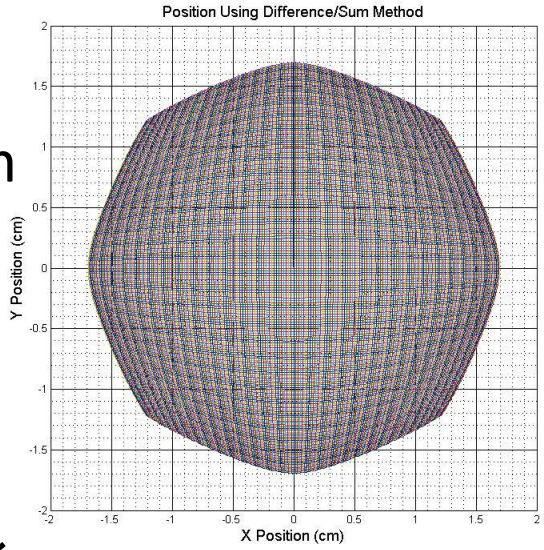
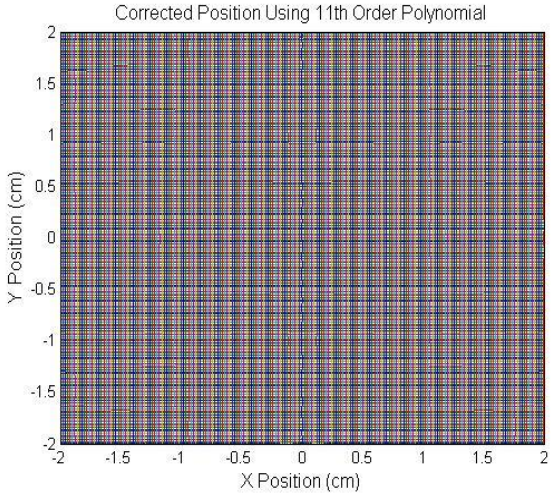
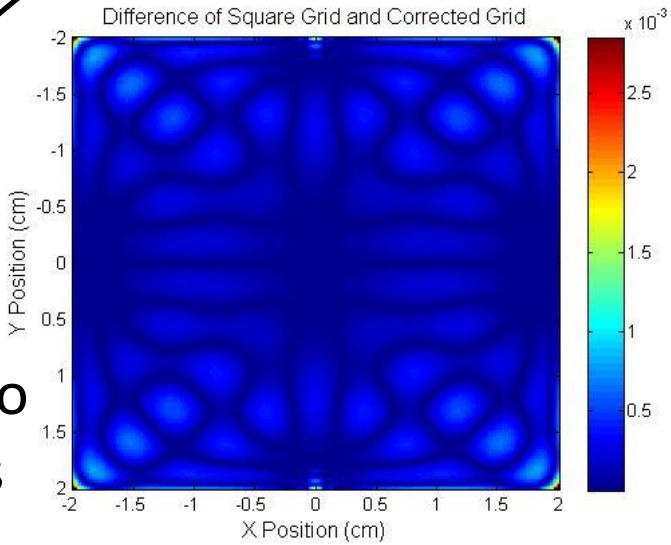


11th Order Polynomial

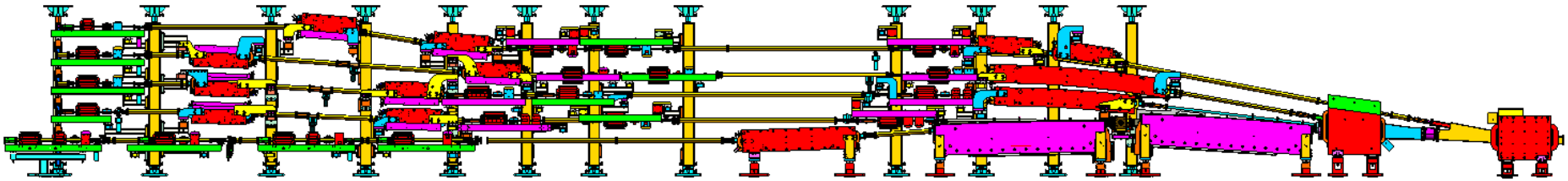


Correction to 100 microns



Lambertson Elevation Control

- Down beam of the Lambertson magnet the beamline elevation for hall A is 2.2 cm above Hall B. The Hall C beamline is 2.2 cm below Hall B.
- The original 6 GeV layout used transport channel correctors and quad kicks to change the elevation of the beam and set that pass to the proper Hall.
- This technique often resulted in aperture limitations.
- The new layout uses dedicated correctors at 2T09, 4T09, 6T09, 8T09 and AT04 to control the beam elevation at the entrance of the Lambertson magnet



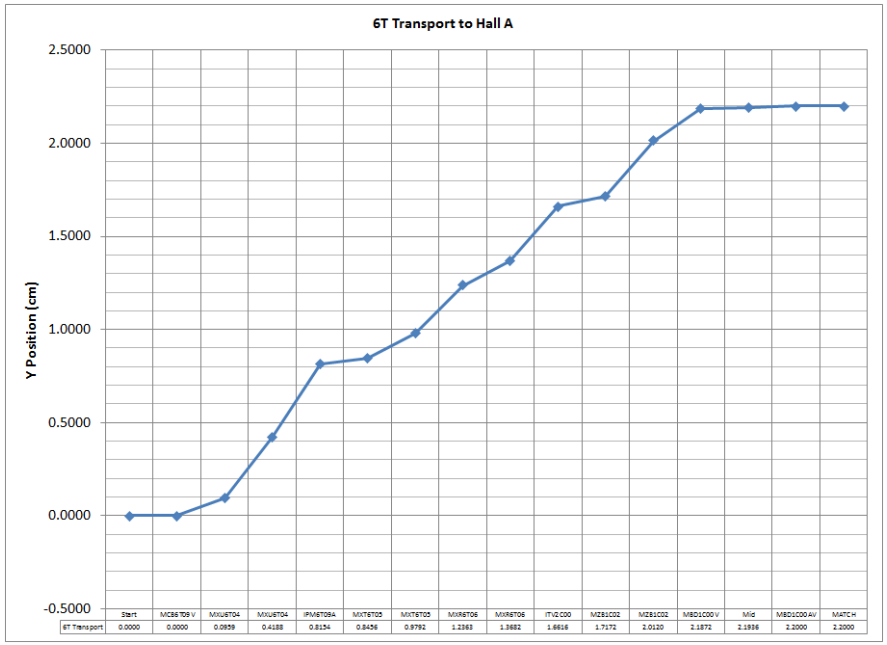
Transport Recombiner

Lambertson Elevation Control

- First pass uses a single BC corrector on a 10 Amp trim.
- Second pass uses two BC magnets on 10 Amp trims for the nominally doubled beam energy.
- Third pass uses a CB corrector which is a new design used in the Reinjection Chicane. Its powered by a 20 Amp trim.
- Fourth Pass uses two BD magnets on 12 Amp trims.
- Fifth pass uses a BD magnet on a 10 Amp trim.
- The 1C and 3C vertical correctors take the vertical pitch out of the beam and set the final elevation. They have been upgraded to 12 Amp trims.

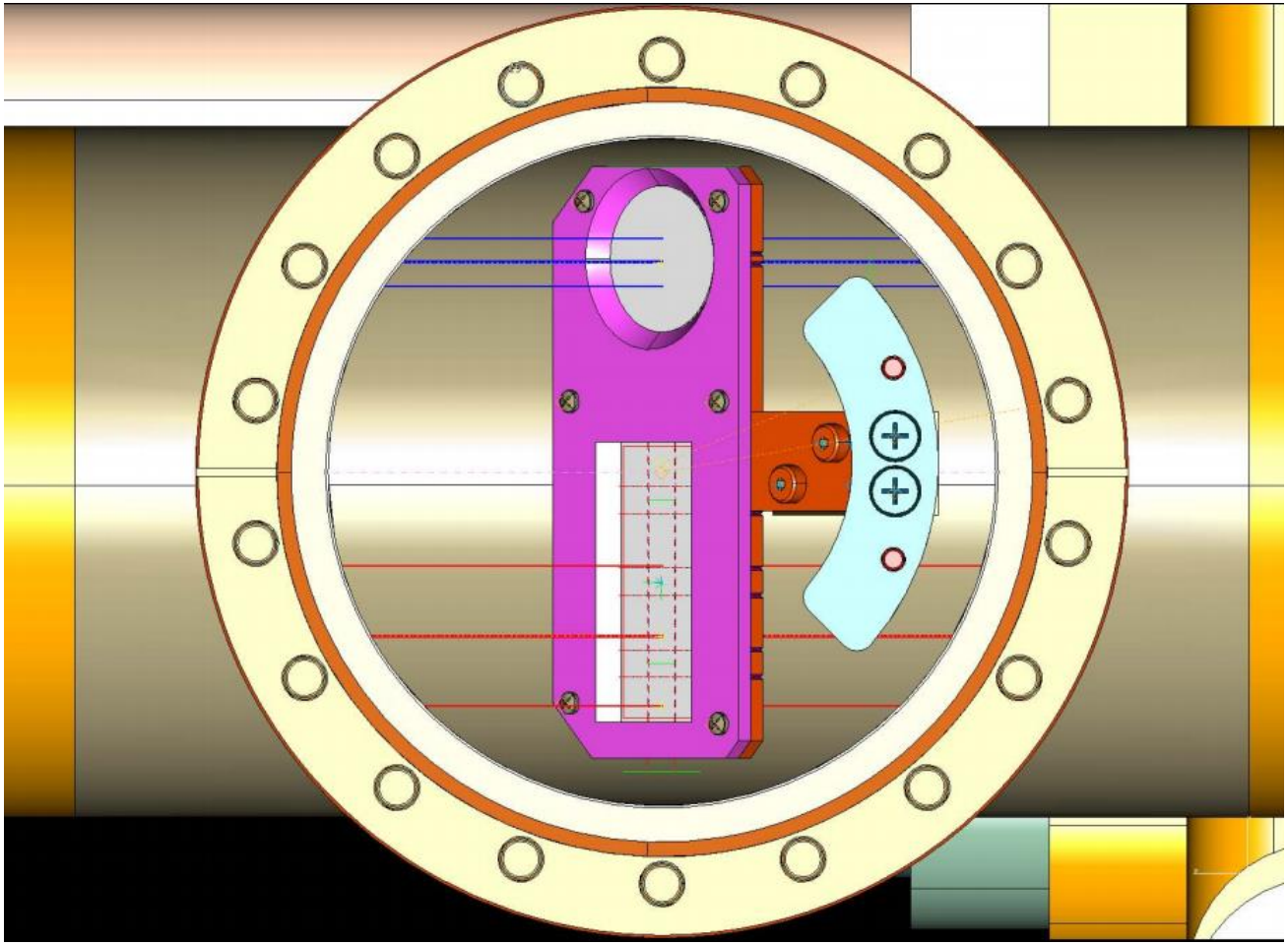
	Kicker	Required B-dl (G-cm)	Limit (G-cm)	Headroom (%)	Limits	
					Type	B-dL (G-cm)
2T	MBC2T09V.BDL	9923.890	10647.421	6.795		
	MBD1C00V.BDL	5314.100	18308.547	70.975	BT	2940.271
	MBD1C00AV.BDL	5314.100	18308.547	70.975	BC	10647.421
4T	MBC4T09V.BDL	9295.500	10647.421	12.697	BM	10291.358
	MBC4T09AV.BDL	9295.500	10647.421	12.697	BD-H	18456.096
	MBD1C00V.BDL	10456.600	18308.547	42.887	BD-V	18308.547
	MBD1C00AV.BDL	10456.600	18308.547	42.887	CB	30000.000
6T	MCB6T09V.BDL	28394.800	30000.000	5.351		
	MBD1C00V.BDL	14538.000	21970.256	33.829		
	MBD1C00AV.BDL	14538.000	21970.256	33.829		
8T	MBD8T09V.BDL	17821.200	21970.256	18.885		
	MBD8T09AV.BDL	17821.200	21970.256	18.885		
	MBD1C00V.BDL	19002.200	21970.256	13.509		
	MBD1C00AV.BDL	19002.200	21970.256	13.509		
AT	MBDAT04V.BDL	10657.000	18456.096	42.258		
	MBD1C00V.BDL	13519.900	21970.256	38.463		
	MBD1C00AV.BDL	13519.900	21970.256	38.463		

Ideal Corrector Settings



8T09/AT09 Viewer

- Beam trajectories through ZA magnets different than YR magnets
- Viewer frame machined for new 12 GeV elevations
- New frame will be installed during this downtime



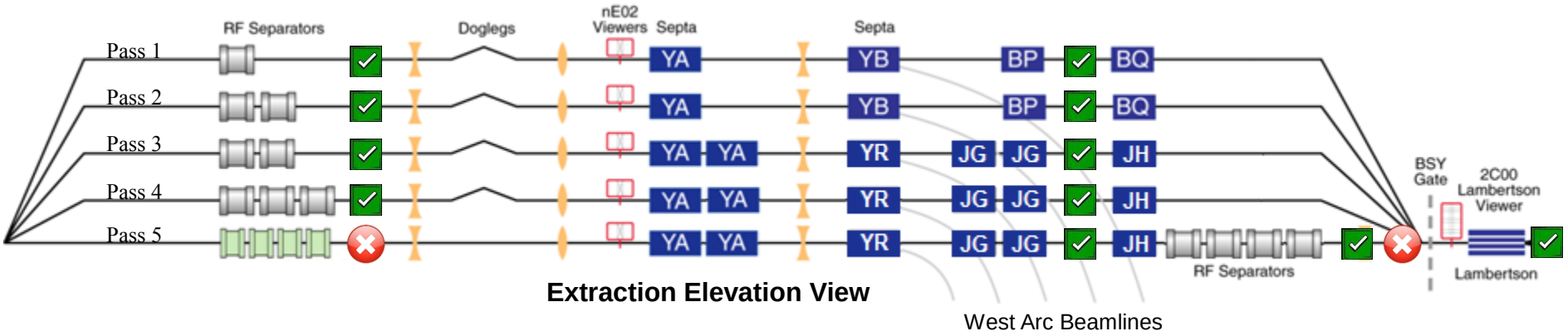
Extraction Procedure

- **RF Separator procedure being modified to include magnetic transport through Extraction dipoles, into BSY recombiner and through to Hall A,B,C dumplets.**

Excerpt from test plan steps for inclusion in procedure…..

- Find quad center for 6S10, 6E01, 6E02, 6E03 and 6A01 BPMs and update SOF values.
- Run tune beam to the 6R dump and let the extraction and arc orbit locks reach their targets.
- Record value of IPM6E03.XPOS.
- Insert 6E02 viewer and document image of recirculated beam.
- Remove viewer and let orbit locks converge.
- Change MBC6S10H to move the beam from +5.5 mm to -11.0 mm at 6E02.
- Insert 6E02 viewer and document image of recirculated beam.
- Adjust MYA6T01/MYA6T01A to tune beam to mirror-symmetric position at 6E03 recorded in step 3 above.
- Adjust MXSEP6T (MYR6T02) to get beam to zero horizontal position at IPM6T00A.
- Adjust MJG6T03 to get beam to zero horizontal position at IPM6T00B.
- Adjust MJH6T04 to zero entrance into 6T region.
- Thread beam through 6T beamline to the IPM6T06 BPM.
- Adjust MXB6T01/MXB6T02 step dipole to optimize transport along IPM6T07, IPM6T08 and IPM6T09 girders.
- Insert Lambertson viewer and adjust MXU6T04 to center the beam on the Hall B aperture.
- Remove viewer and thread tune beam to the Hall B dumplet.
- Adjust MCB6T09V to center the beam on the Hall A aperture or Hall C aperture. Record values for each.

Extraction System Status

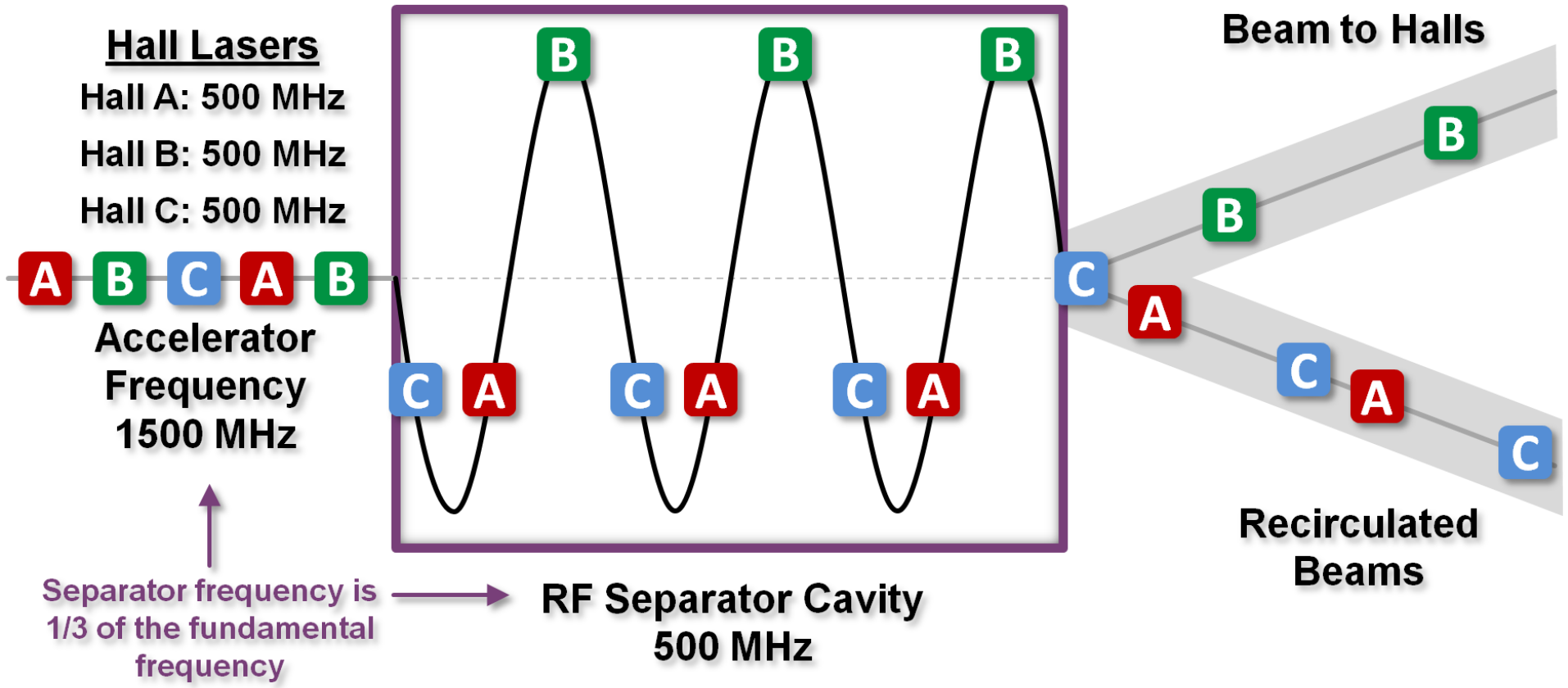


- What remains to be done
  - Recommission 750 MHz cavities
    - Measure shunt impedance for each cavity
    - Find high power phase shifter settings
  - Checkout new 8T09/AT09 viewer
  - Build and commission the resonance control system
  - Complete and checkout one button start-up for 750 MHz cavities
  - Implement non-linear correction for BPMs
  - Finalize procedure with Anna and give it to Tom

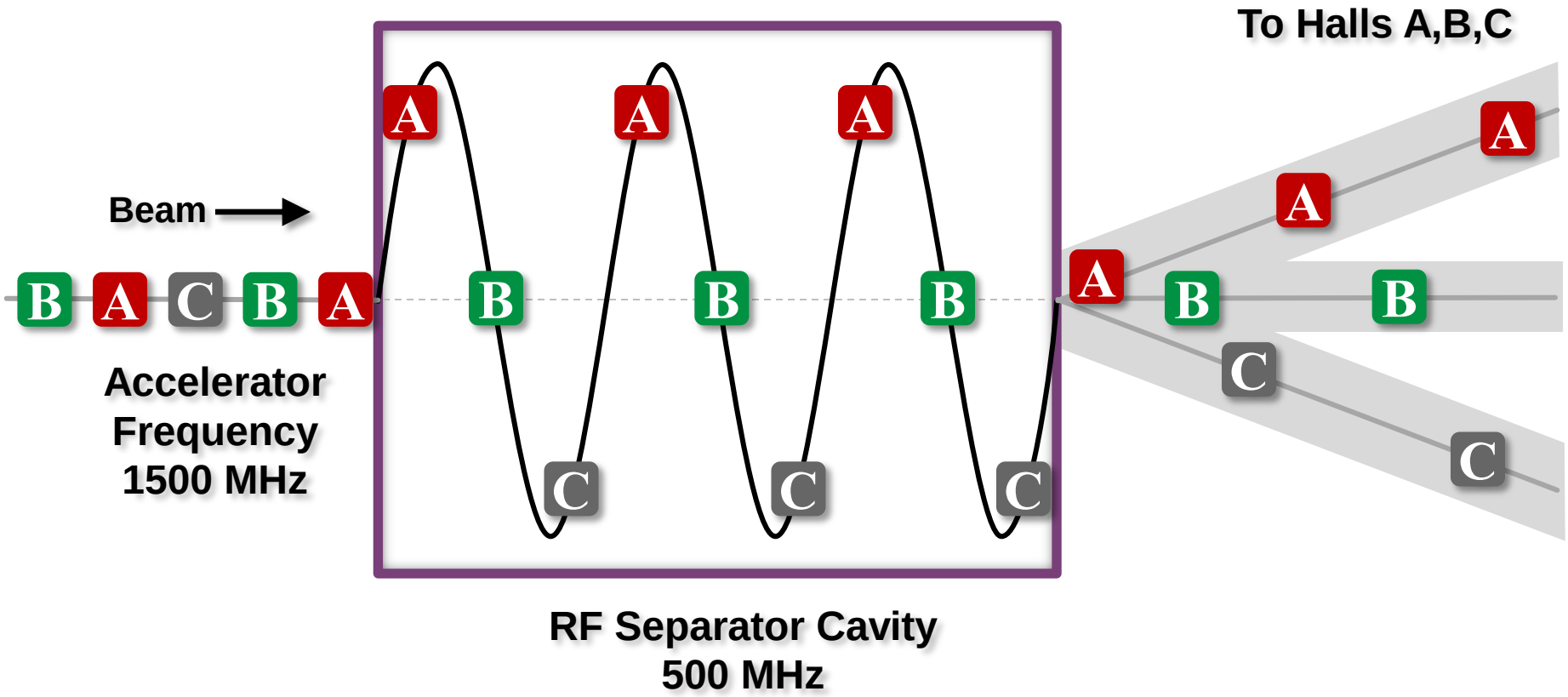
Thanks

Questions?

Existing Horizontal RF Separation (500 MHz)



Halls A,B,C 5th Pass Vertical Separation (500 MHz)



5th Pass Horizontal RF Separation (750 MHz)