HINS collaboration activities at LBNL

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Overview

- LBNL has been working on HINS/Project X activities in FY07
  - RF controls
  - Buncher cavity design
- Other activities
  - Electron cloud studies (not reported here)

RF controls

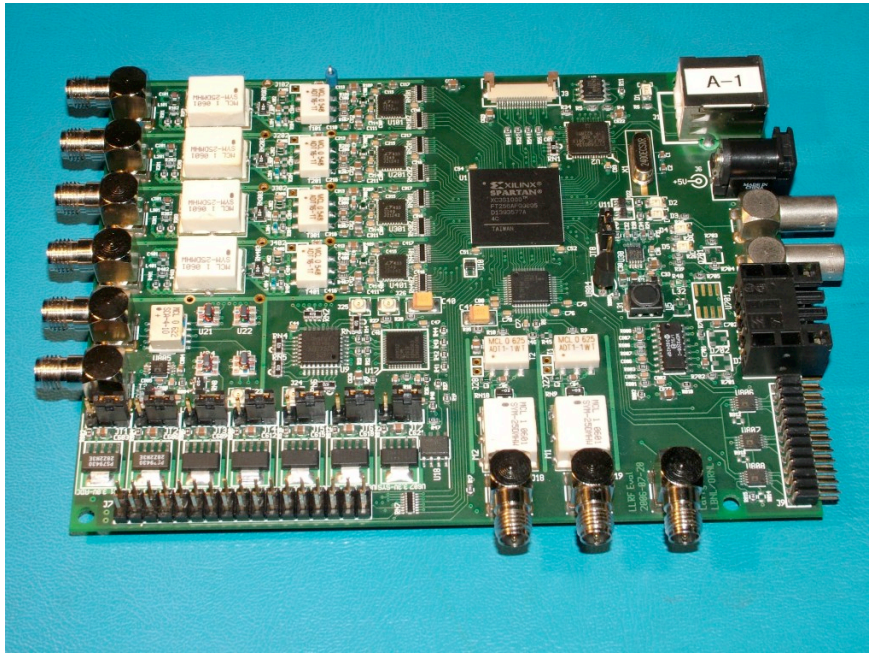
- Leveraging successful experience on SNS warm and cold linac controls
- Developed next generation hardware
- Expanding modeling capabilities to face new challenges
  - Single power source feeding multiple loads
- Developing existing SNS firmware release into new set of codes
  - Successful tests on the bench and on SRF cavity
  - Ready for more testing

Hardware Development

- Built next generation board
  - Extensively tested on bench
  - Demonstrated hi speed USB communication with host computer
    - Up to 32 MBy/s
- System tested at ANL on 345 MHz triple spoke resonator
  - With ANL, JLAB
- System now at FNAL for testing in HINS/PrX test stands
- Work done with significant contributions from the collaboration
  - FNAL, SNS

LLRF4 Hardware

- 4 – 14 bit, 80 MS/s digitizers
- 2 fast 14 bit ADCs
- Million gates class Xilinx FPGA
- Fast USB communications
- Multiple loads stability
- Flexible clocking
- Applicable to ILC
  - –Investigating low cost volume production options

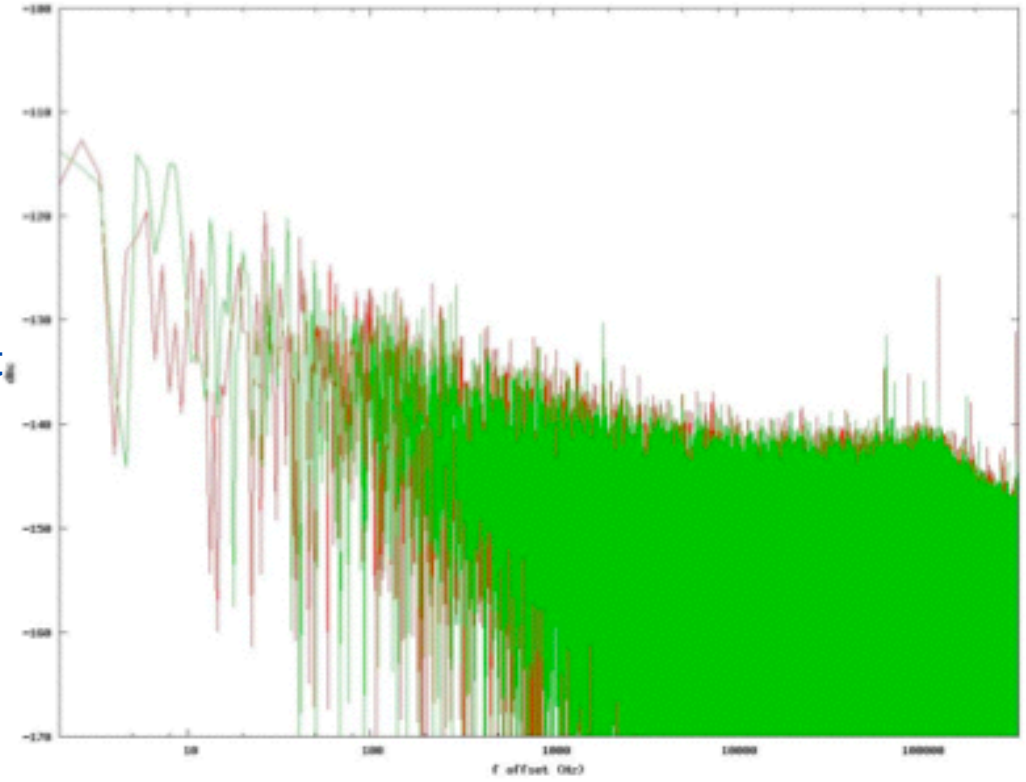


A batch of up to 30 boards going to production with applications at 8 accelerator labs worldwide

Noise Measurements

Results from bench testing

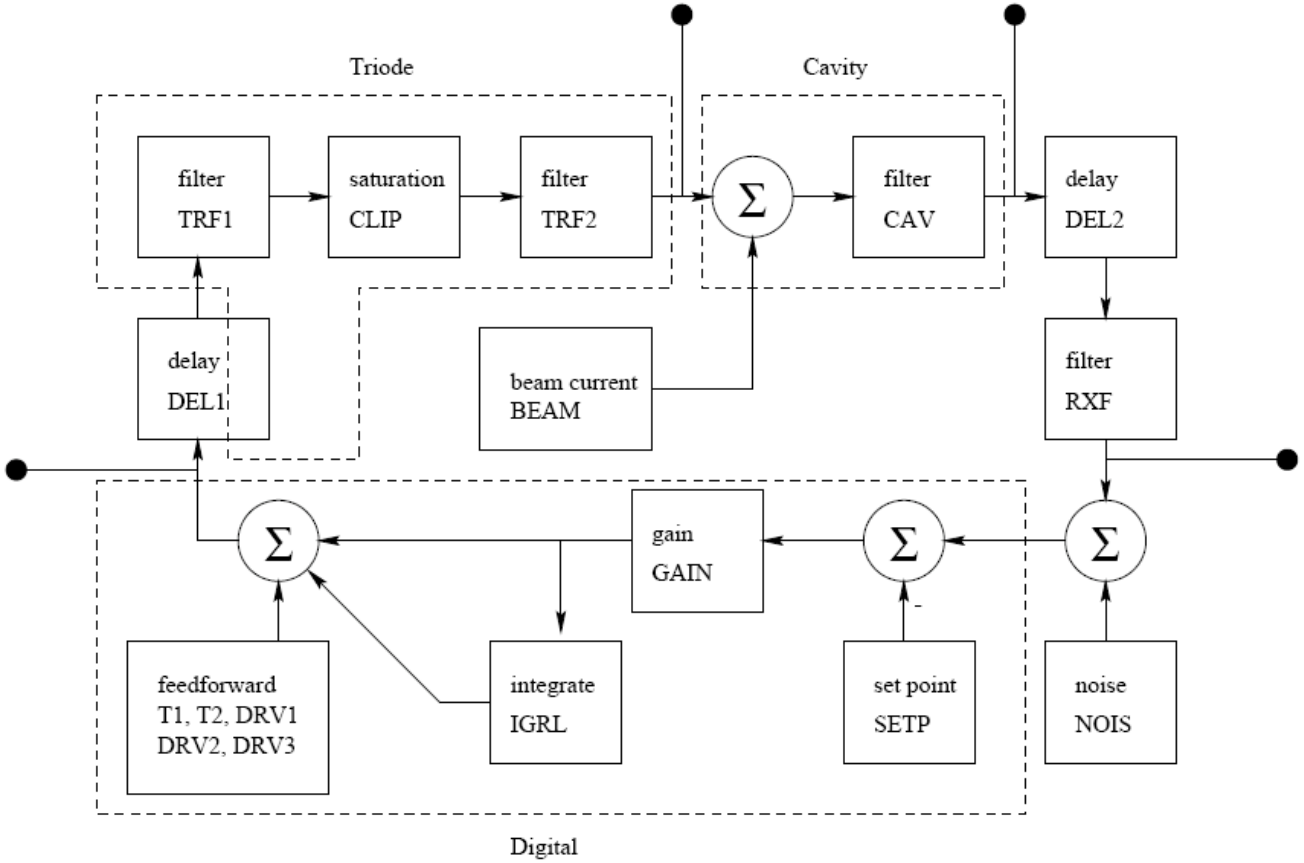
- Largest near spur at -126 dBc
- 1/f corner at 3 kHz
  - Possibly due to measurement hardware limitations



RF Controls - Firmware

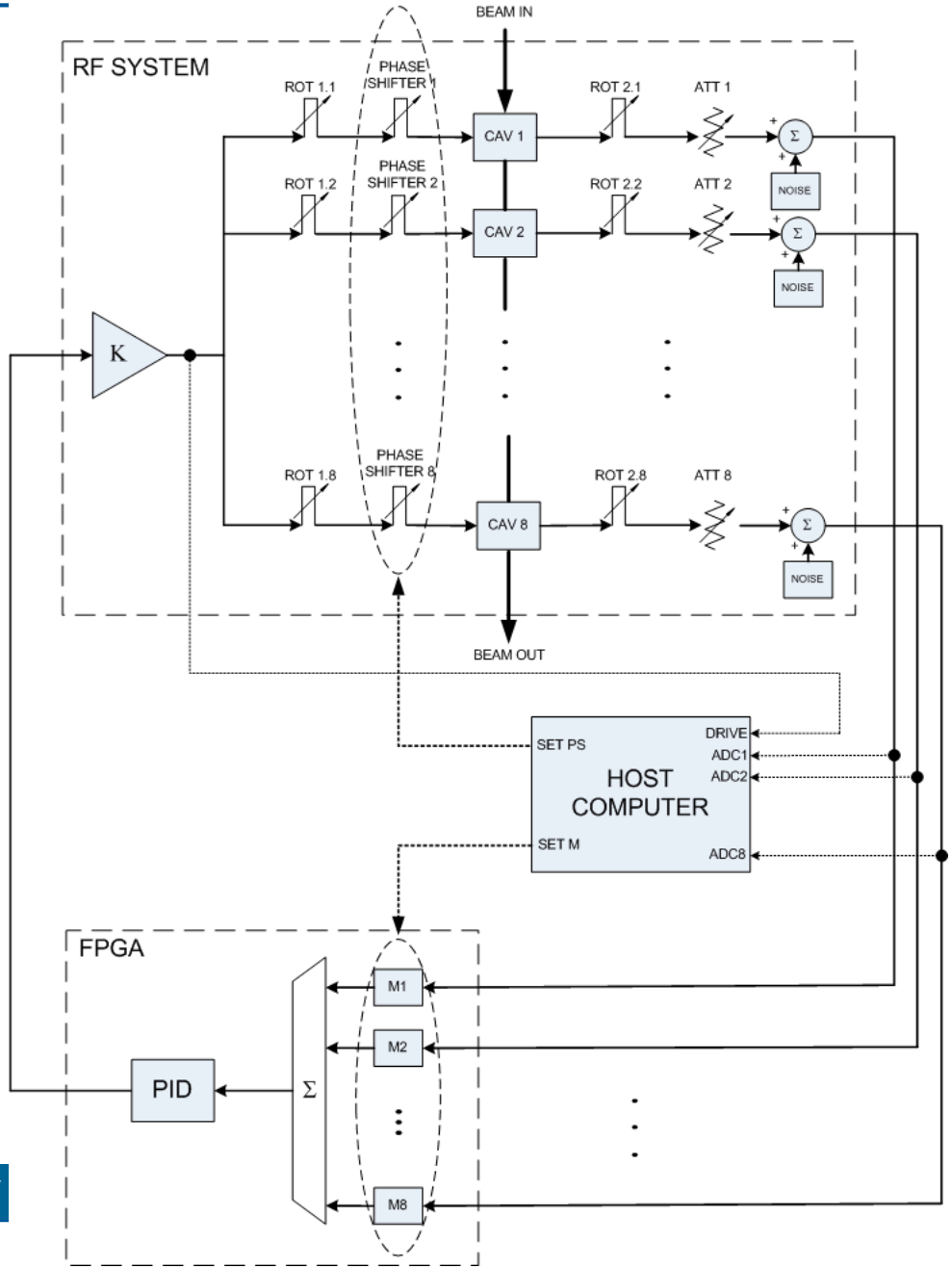
- Software-physics co-simulation
  - Expertise proved in SNS
    - llc-suite available online
  - Updated to handle ILC-like multiple cavities powered by a single klystron
    - including beam-loading based vector-sum calibration
    - Accounts for cavity to cavity relative phase changes
  - Inter-pulse calibration successfully tested in simulation
- Next step for HINS/Project-X
  - Add intra-pulse adjustment of ferrite phase shifters
  - In progress with input from collaborators at FNAL/SNS/JLAB…

Basic model (used for SNS)



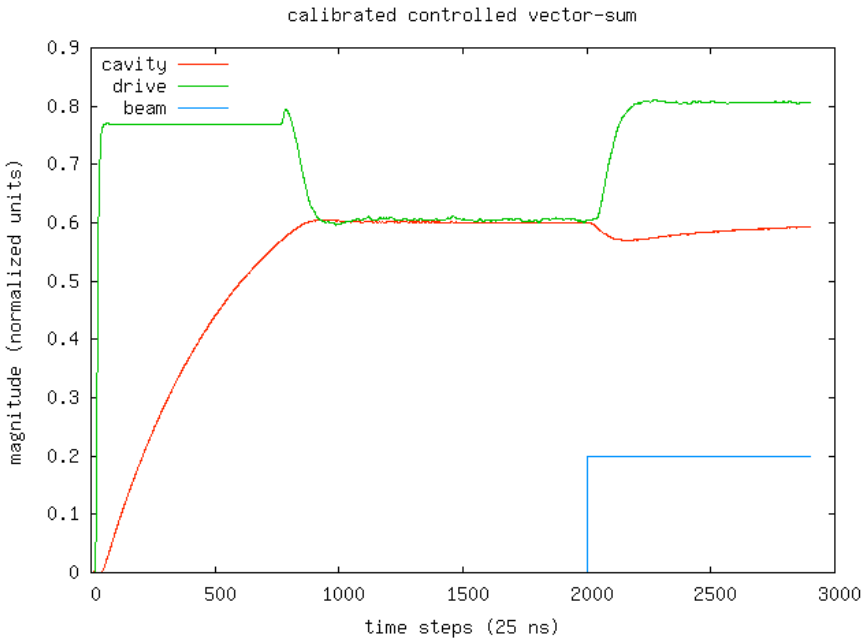
Expanded Model

- From single cavity to multiple loads with single source
- Configuration
  - Number of cavities set to up to 99
  - Every element in the system defined in a configuration file and loaded into the model at runtime
    - filters, delays, cavities, phase shifts



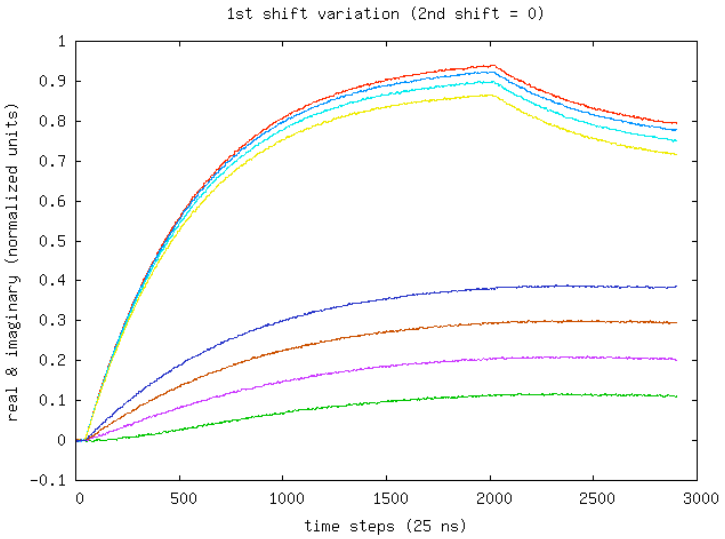
Modeling Results - Cavity Control

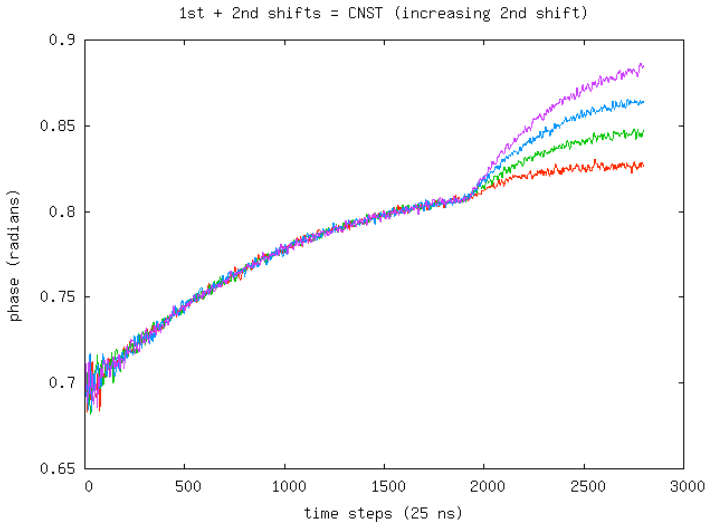
- Vector sum control
- Example of a 2900 cycles
  - 25 ns each
- Control applied at 750 cycles
- Beam hits at 2000 cycles



Effects of Phase Errors

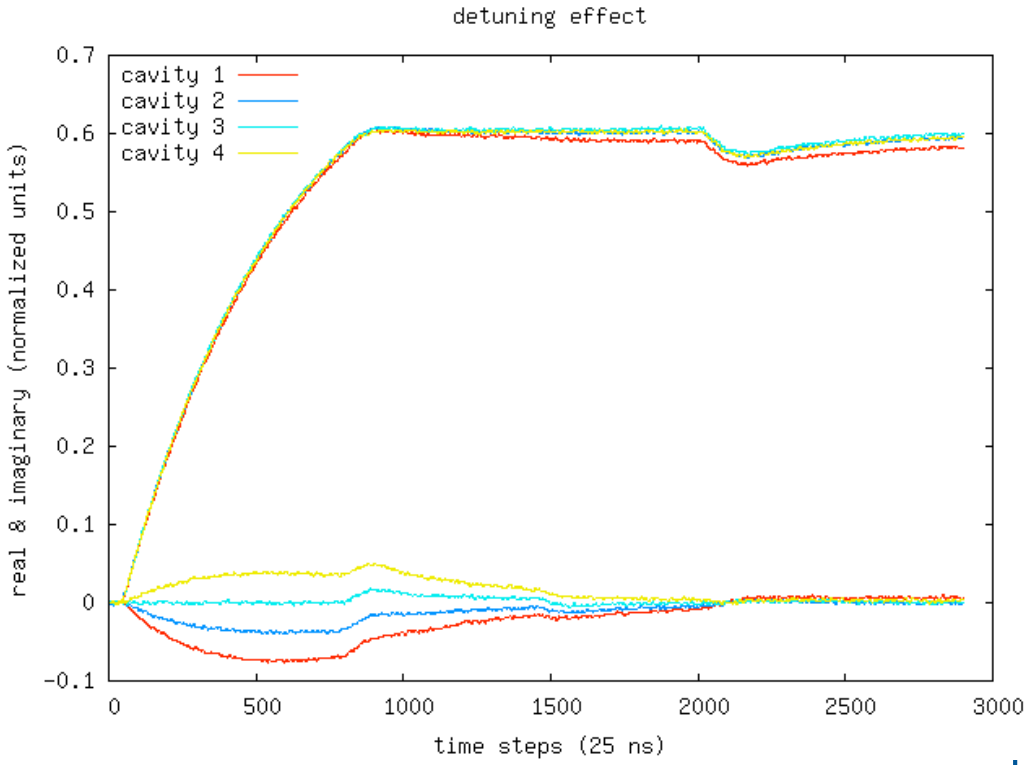
- Error in first phase --->
  - Cavity transient
- Error in second phase V
  - Beam transient



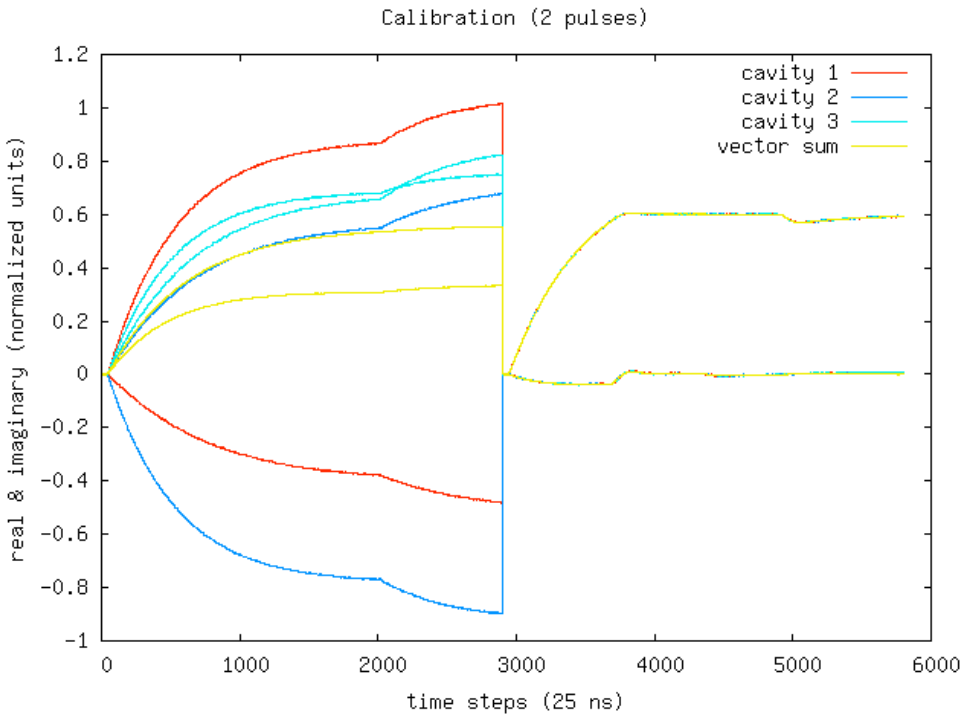


Detuning Effects

- 4 cavity example
- Detuning is measured and reflected in the vector sum
- Correction not implemented yet



Multiple Pulses



First pulse operated open loop

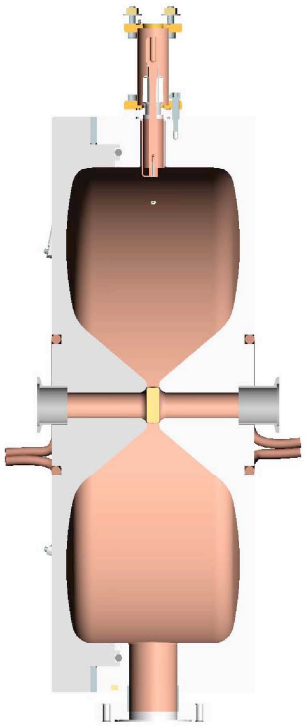
- Random phases for each cavity

All cavities are aligned by the second pulse

Considerations for Project X

- Developing and updating model to simulate the many conditions required by project X
  - Flexibility makes modeling simpler
  - Modeling is essential to face the challenging conditions of Project X
    - Many different loads (time constants, beam loading) with single source
- Existing and planned hardware installations at FNAL are ideal to develop and improve RF controls
- Leverages existing and ongoing activities
  - S-band for FEL
  - ILC for SRF
- Look forward to continuing the collaboration

HINS Buncher Cavity



Feature	HINS	SNS	Units
Frequency	325.0	402.5	MHz
Outer diameter	571.5	571.5	mm
Outer length	200	129.76	mm
Inner diameter	472.53	472.53	mm
Inner length	172	101.09	mm
Outer wall thickness	49.48	49.48	mm
End wall thickness	14.0	14.33	mm
Beam aperture	25.4	30	mm
Nose angle	40	45.19	degrees
Nose radius	7	4	mm
Gap	11.92	12.42	mm
Bolt size	1/2	1/2	inch UNC
Number of bolts	24	24	each

HINS Buncher Cavity Design

- Scaled from SNS buncher cavity
- Same Cu plated steel approach
- In collaboration with industry (JPAW)
  - Includes tuner and drive loop
- Ready to build