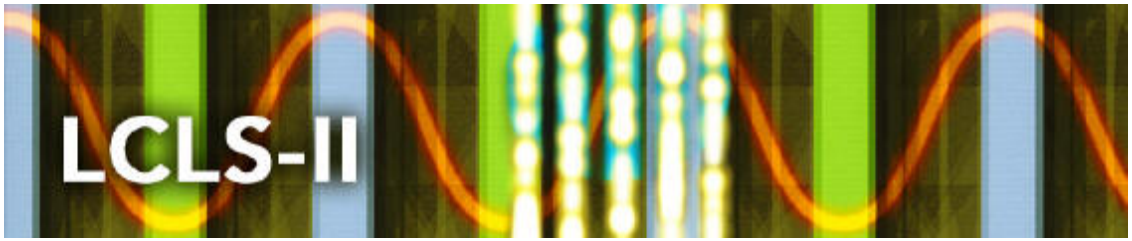


FNAL Cavities: QA/QC, qualification, work flow

Alex Melnychuk, Anna Grassellino, Chuck Grimm, Sebastian Aderhold, Damon Bice

September 13, 2016

SLAC NATIONAL ACCELERATOR LABORATORY

BERKELEY LAB Lawrence Berkeley National Laboratory

Argonne NATIONAL LABORATORY

CORNELL UNIVERSITY FOUNDED A.D. 1865

Fermilab

Jefferson Lab

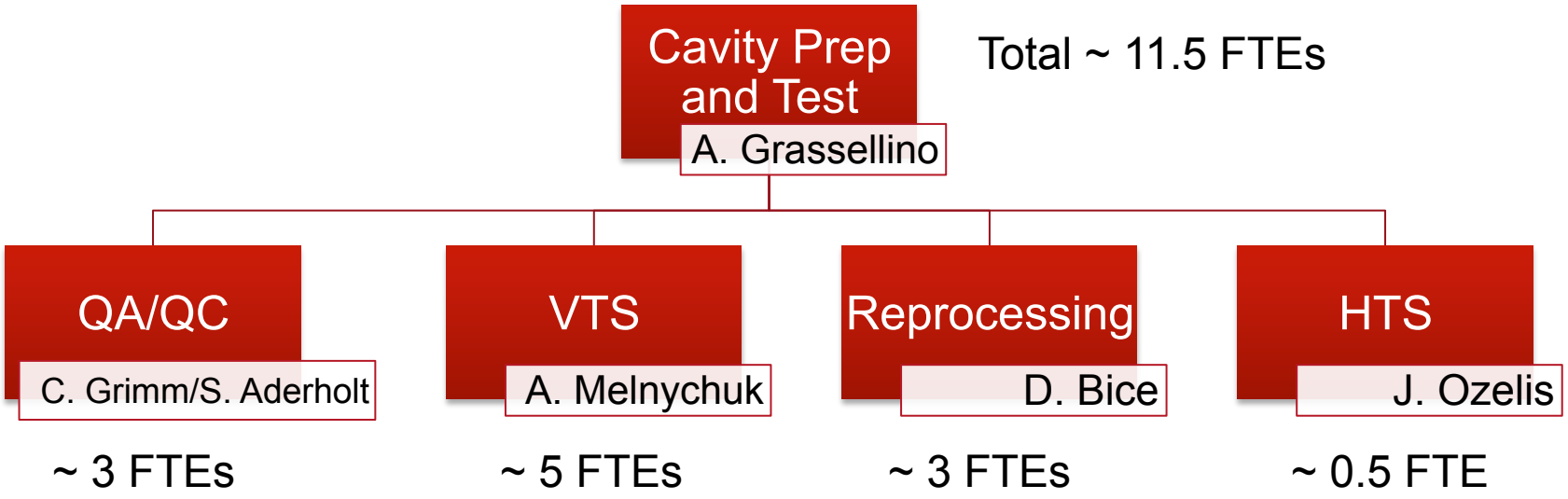
U.S. DEPARTMENT OF ENERGY Office of Science

Outline

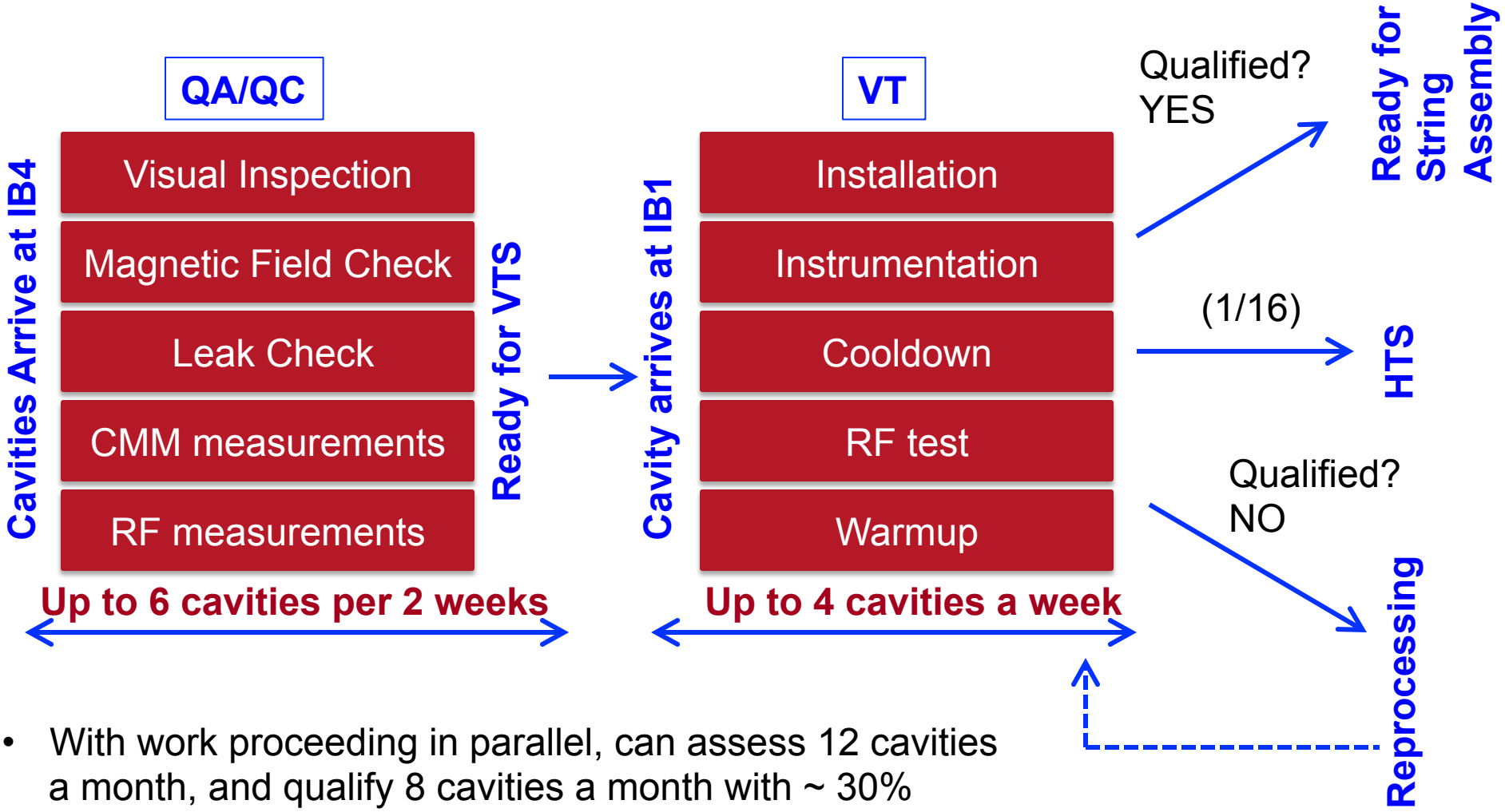
- Cavity “Prep and Test” scope of work
- Organization, manpower, workflow
- Subareas work examples, procedures, schedule, infrastructure:
  - QA/QC
  - Vertical Test
  - Re-processing
  - Horizontal Test
- Safety
- Travelers, DRs

Scope of work, organization

- Cavity prep and test covers all cavity qualification/performance assessment activities from the moment cavities arrive to “ready for string assembly”
- Main goal is qualification of ***8 cavities a month*** (from cavity arrival moment to delivery for string assembly) to keep CM assembly needed pace/supply
- All cavities undergo QA/QC and VTS qualification
- Assumption for reprocessing (HPR) is ~ 30%, small % can be lightly EP’d if needed
- Only 1 cavity in 16 (every two cryomodules) goes to HTS for couplers, tuners etc verification purposes



Work Flow, timeline of activities



- With work proceeding in parallel, can assess 12 cavities a month, and qualify 8 cavities a month with ~ 30% reprocessing rate

QA/QC

Steps of Incoming Inspection for LCLS-II cavities

- **Visual incoming inspection inspection**
  - Check for visible damage
  - Check presence of all components (screws, washers, feedthroughs,…)
  - Recording serial numbers of all parts in circulation

- **Leak check of Helium space**
  - Only Helium space of the Helium vessel is checked, no connection made to (clean) cavity vacuum

- **RF incoming inspection**
  - Measurement of cavity fundamental and HOM frequency spectrum
  - Measurement of external Q of all antennas

- **CMM measurement**
  - Check certain critical dimensions
  - Only performed on each cavity during early production
  - Might be fully waived or only extended to subset of cavities if no deviations from measurements at vendors are found

Cavity in IB4, incoming inspection

Incoming inspection documentation and results

- **All inspection steps guided by traveler**
- **Results of inspections documented in traveler**
- **No show-stoppers for qualifying cavities / no severe deviations from specifications found in any of the inspections so far**

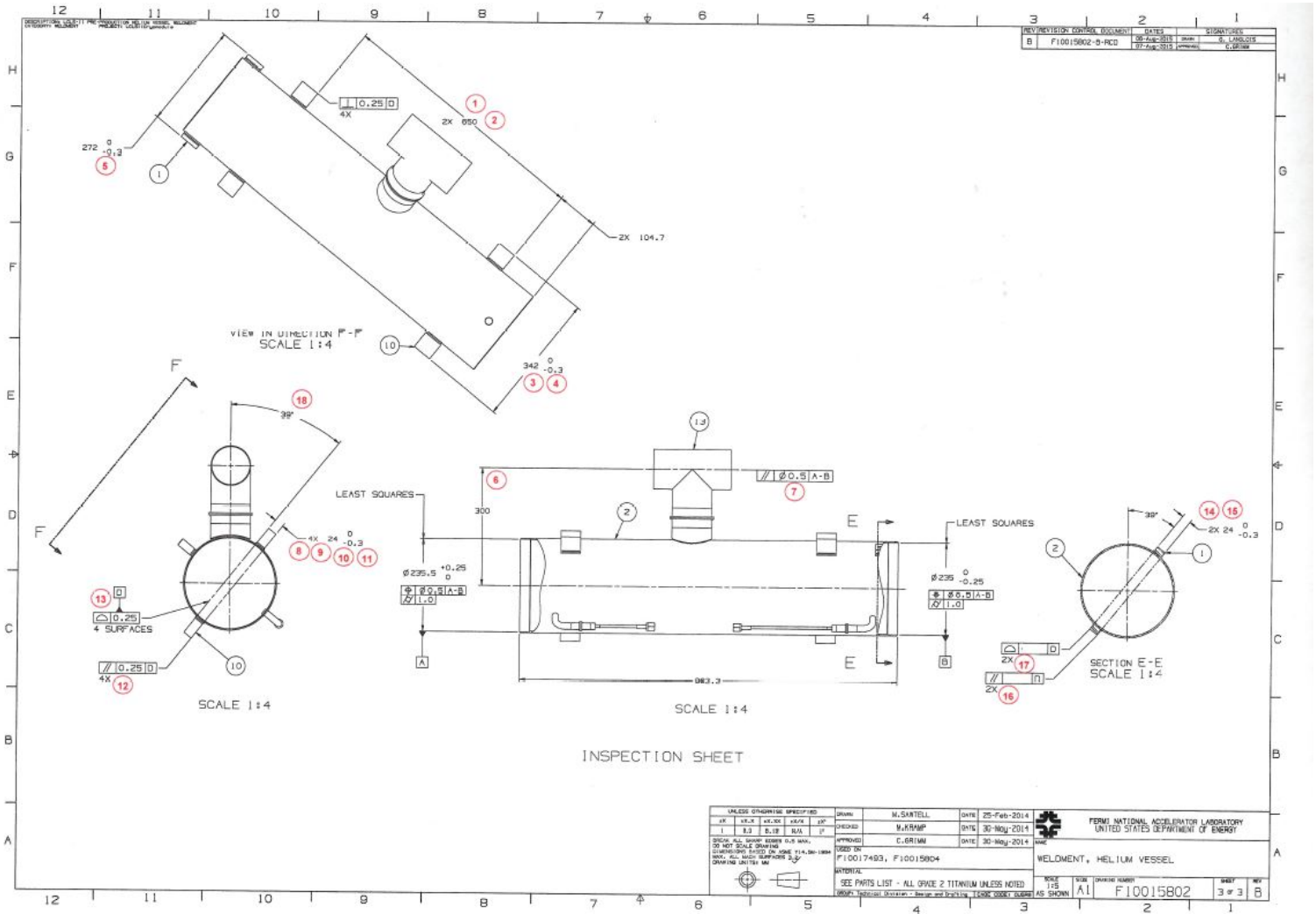
Incoming Inspections of the First Eight RI Cavities

- **Delivered RI Cavities**
  - **CAV0003**
  - **CAV0006**
  - **CAV0007**
  - **CAV0008**
  - **CAV0011**
  - **CAV0013**
  - **CAV0015**
  - **CAV0016**

- **Shock Log Data**
  - **All cavity data analyzed and at acceptable levels**
  - **CAV0003 example – Data captured in Incoming Inspection Traveler 464305**

CMM Measurements

- **CMM Measurement Map**



CMM Measurements

- **CMM Measurement CAV0008**
  - **All dimensions good, #4 is 60 microns (.002”) out-of-tolerance but still acceptable**
  - **FNAL data reveals the same slight deviation**

test number | test object | serial numbe | test instructic | test location | company nar | inspector nar | inspection da | remarks | result summary

Jefferson Lab — Thomas Jefferson National Accelerator Facility

Inspection Sheet Y M02

Dimension record

research instruments

	Dimensions [mm]										
	1	2	3	4	5	6	7	8	9	10	11
Max value	650.80	650.80	342.00	342.00	272.00	300.5	0.5	24.0	24	24.0	24
Min value	649.20	649.20	341.70	341.70	271.70	299.5	0	23.7	23.7	23.7	23.7
Measured value	650.31	650.15	341.80	341.64	271.70	299.84	0.49	23.87	23.88	23.88	23.86
Result	good	good	good	-0.06	good	good	good	good	good	good	good

	Dimensions [mm]						
	12	13	14	15	16	17	18
Max value	0.25	0.25	24	24.0	0.25	0.1	40
Min value	0.00	0.0	23.7	23.7	0	0.0	38
Measured value	0.08	0.07	23.84	23.84	0.03	0.03	38.99
Result	good	good	good	good	good	good	good

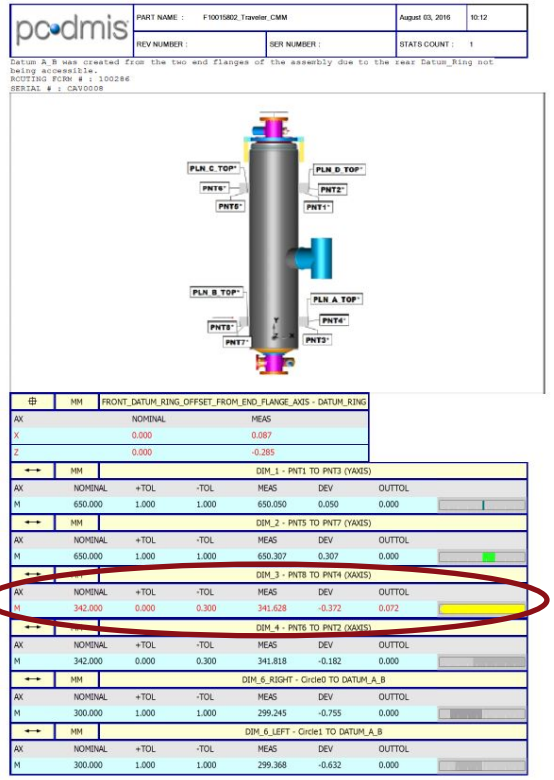
Remarks

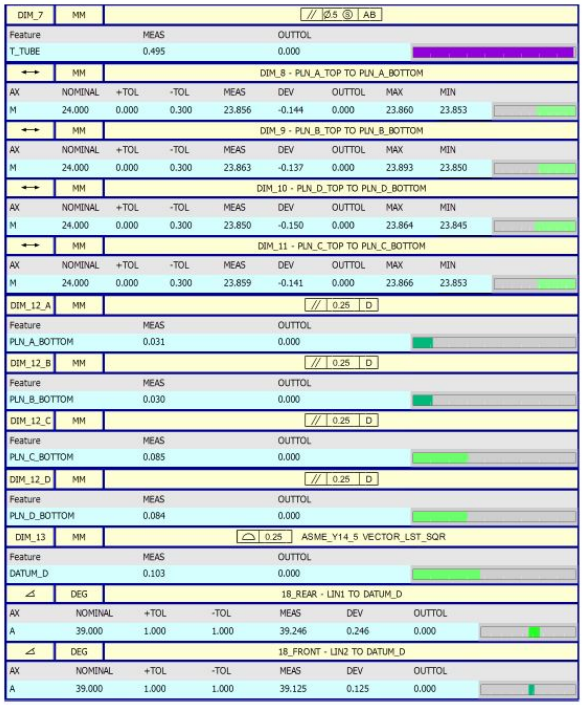
See NCR 3456-NCR-19-Q10502-0

* Dimension numbers see attachment to Y_M02

		Cavity in Helium Tank	CAV_HT0008
Inspection	7/1/2016	M. Friedrichs	
Description / Notes	*Date*	*Name*	*Serial-No.*

RI CMM Data

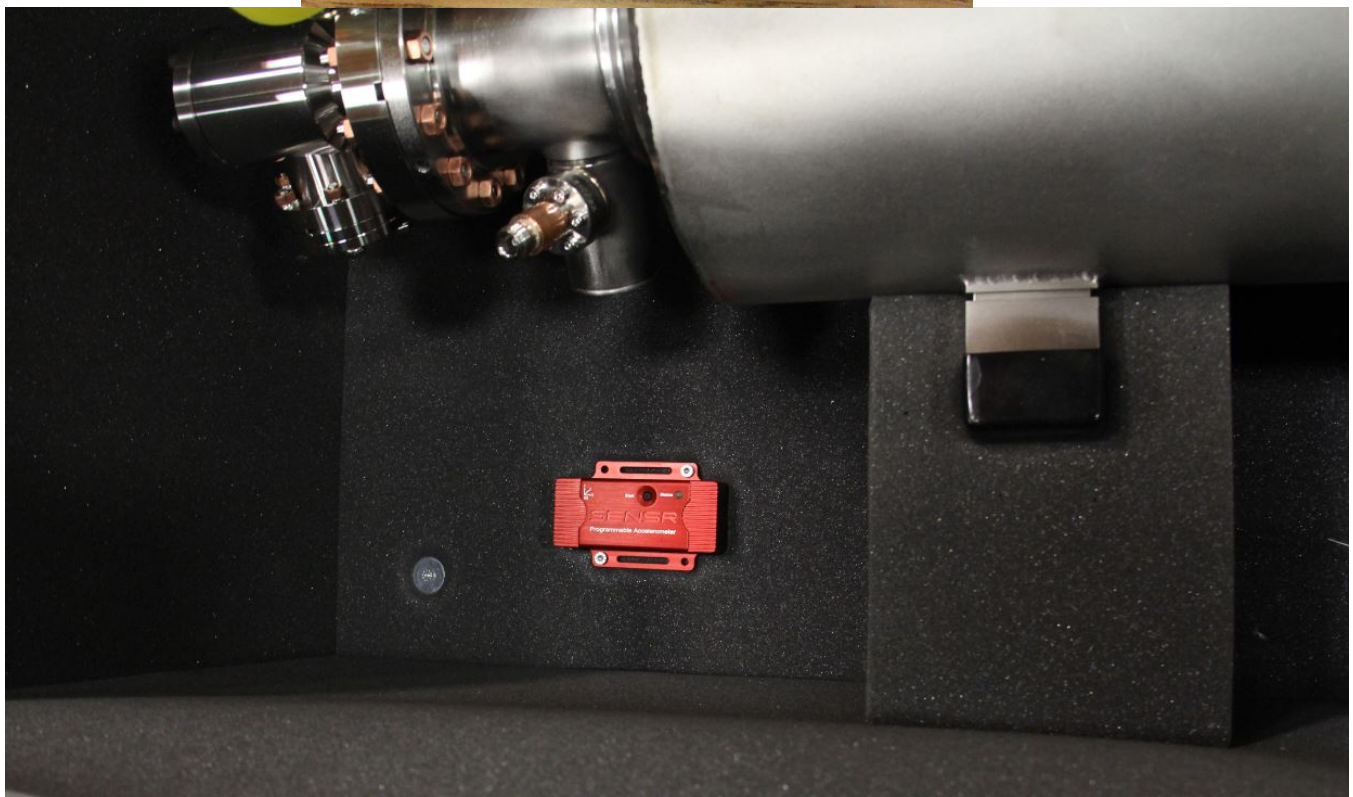




FNAL CMM Data

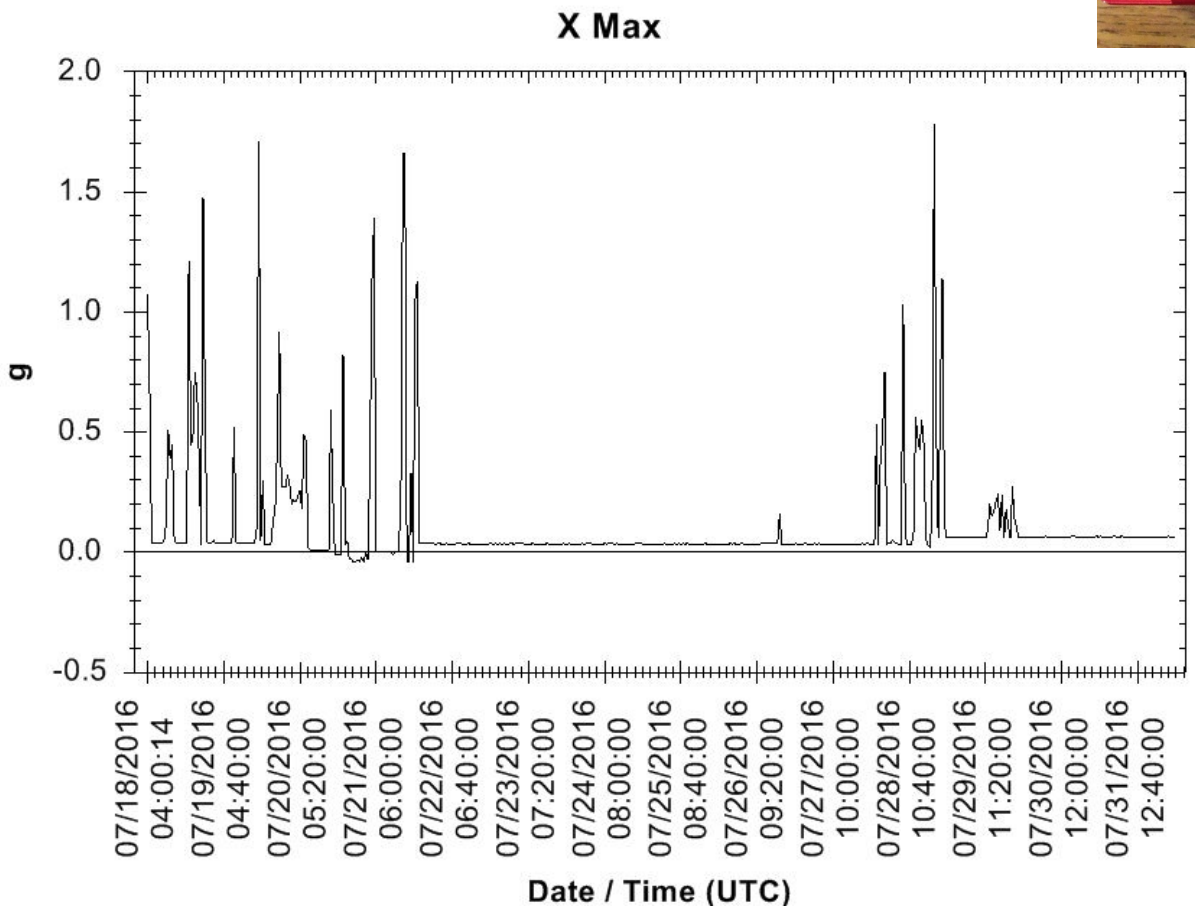
Shock Log Data

- **CAV0003**



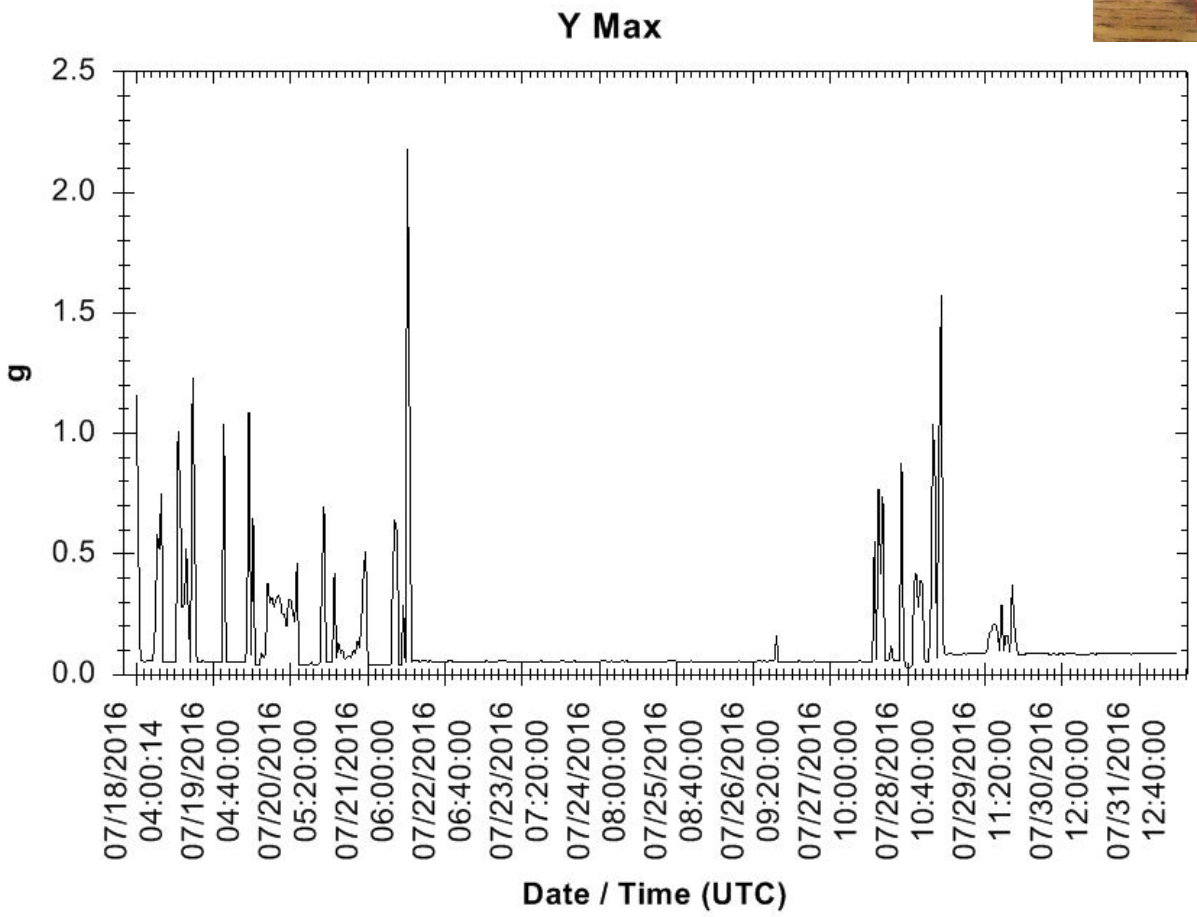
Shock Log Data

- **CAV0003 Shock Data**



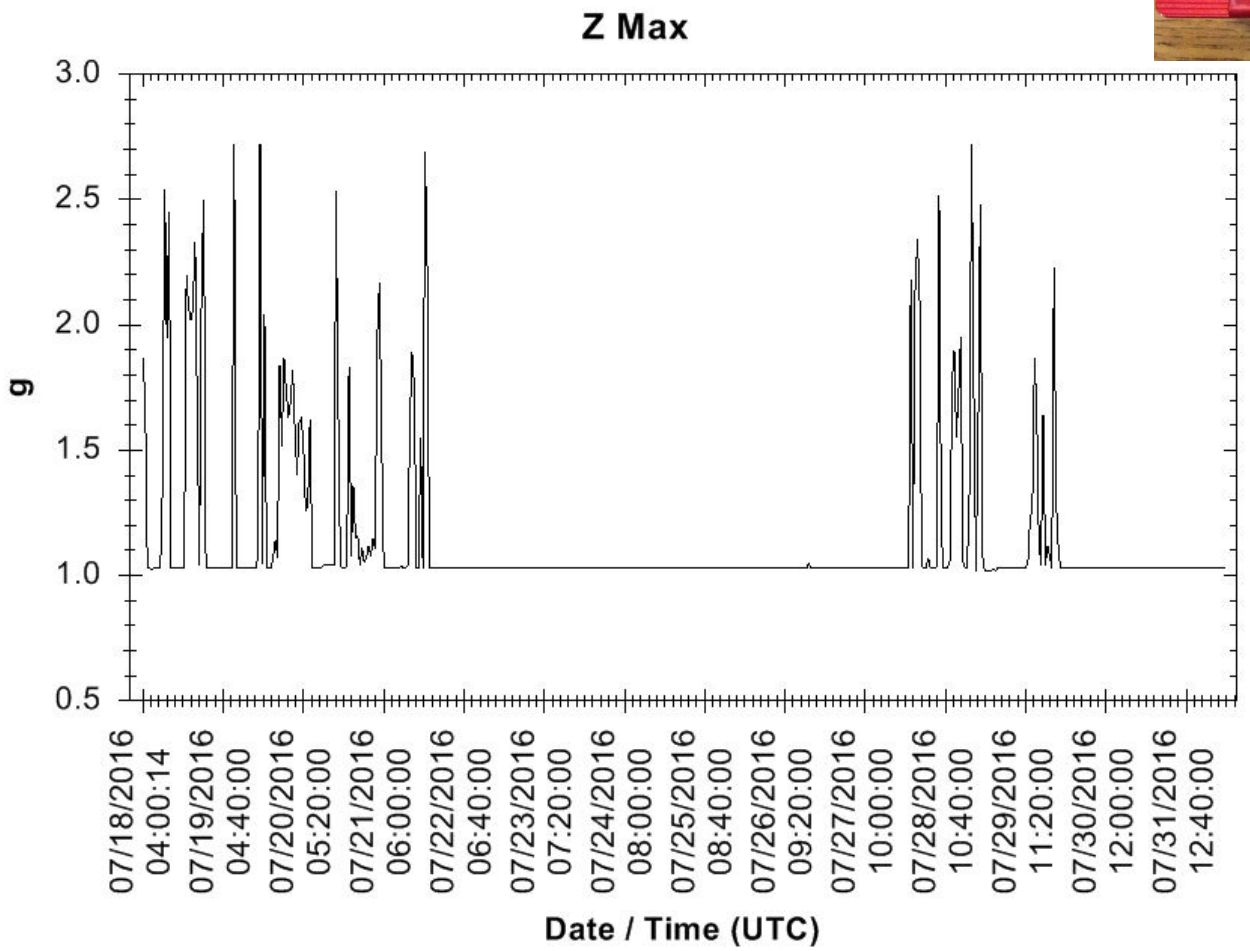
Shock Log Data

- **CAV0003 Shock Data**



Shock Log Data

- **CAV0003 Shock Data**
  - **Z axis is the up/down loads, the GP1 Accelerometer understands gravity, which is why the vertical axis starts at 1g**

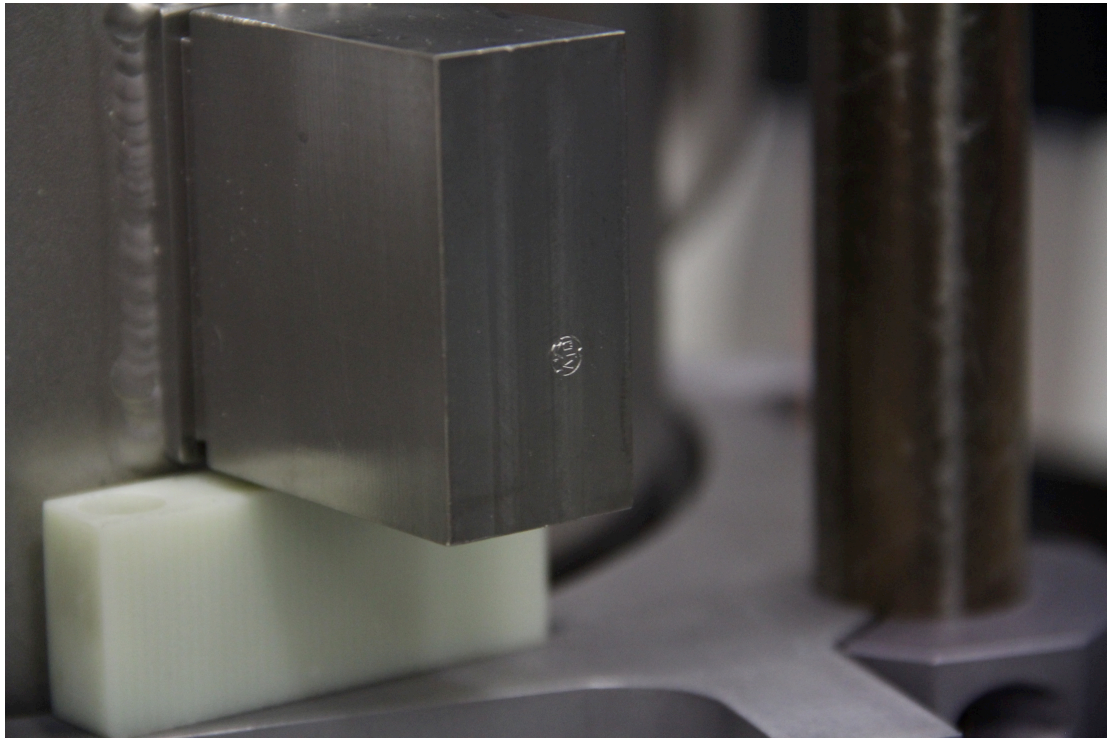


Minor Issues

- **Minor deviations found**
  - absence of plastic caps on RF connectors
  - absence of drilled holes on RF connectors in some of the cavities
  - QA mark placed on the support lug in an undesirable place/surface
  - Input coupler antenna too long (RF inspection indicated that Q1*Q2 was lower than expected, confirmed at VTS)
  - absence of VCR connector on RAV
  - All these were addressed, future cavities are not expected to have them

- **All these were addressed, future cavities are not expected to have these issues**

Minor Issue Example



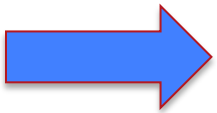
Vertical Test

IB1 Vertical Test Facility

- Three vertical test dewars for SRF cavities measurements
- Using two dewars VTS-2 and VTS-3 for LCLS-II Production (cavities do not fit in VT1), each dewar can safely host 2 LCLS-2 cavities simultaneously
- Cryogenics shared among several different programs – magnets and SRF testing
- Capability of adjusting cool-down rates, test T from 4.2K down to 1.4K
- Remnant magnetic fields < 5 mGauss (passive shielding), and < 2 mGauss (active compensation via coils)
- No active pumping – cavities will either be tested as received in static vacuum or after re-evacuation in clean room (half of cavities have been tested as received 1e-4Torr and half after re-evacuation 1e-6 Torr, no noticeable performance difference)

Standard LCLSII VTS Production Testing Schedule (VTS test 12 cavities per month)

- **Need to qualify 8 cavities per month**
- **Assume 30% re-HPR rate (based on XFEL experience)**
  - four more cavities to VTS-test per month
- **Test two cavities in one cryocycle**



Week 1:	**2 cryocycles × 2 cavities**	**= 4**
Week 2:	**2 cryocycles × 2 cavities**	**= 4**
Week 3:	**1 cryocycle × 2 cavities**	**= 2**
Week 4:	**1 cryocycle × 2 cavities**	**= 2**
		12

- **This scheme utilizes highest priority that LCLSII receives at lab level and still allows to run other programs (but at lower rate)**
- **Weekly prioritization of VTS test schedule done via SRF program/cavity coordinator (A. Grassellino) in accordance to lab and scientific priorities**
- **In case of schedule conflicts SRF/magnets TD Division Head (S.Belomestnykh) resolves conflicts determining priorities**

LCLSII VTS Schedule Risk Mitigation (VTS test 16 cavities/month)

- **Need to qualify 8 cavities per month**
- **Assume 30% re-HPR rate (based on XFEL experience)**
  - four more cavities to VTS-test per month
- **Test two cavities in one cryocycle**

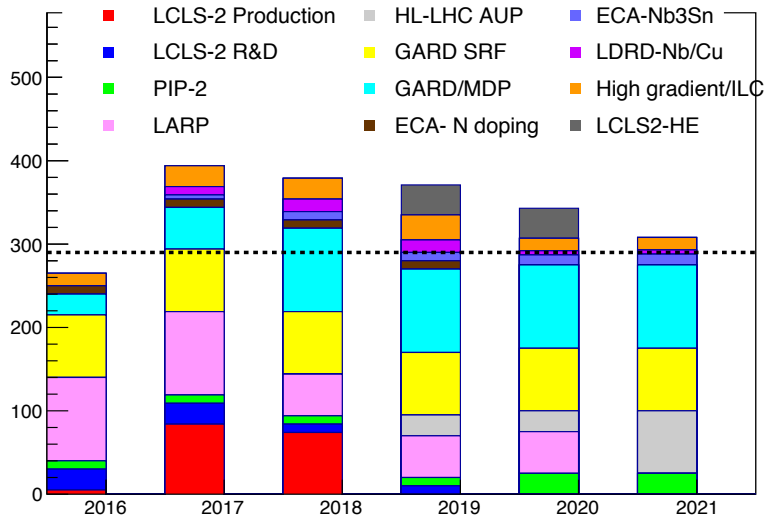
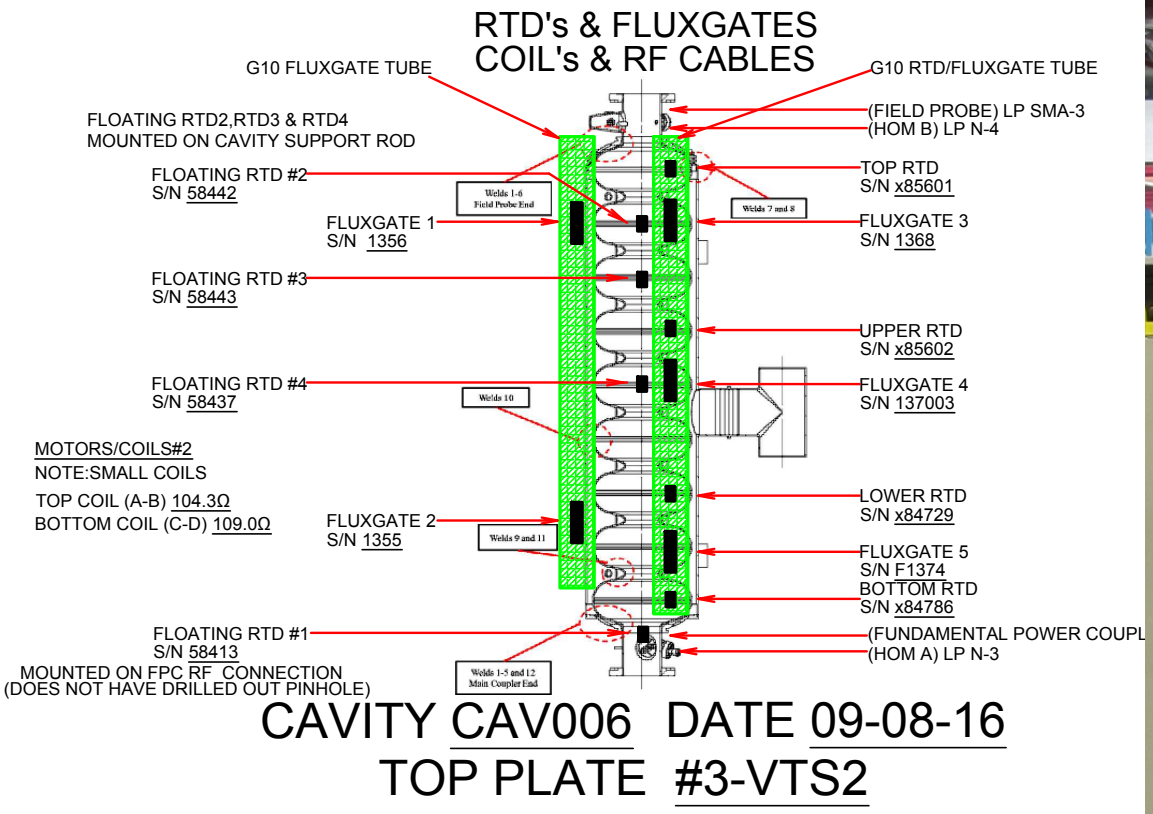


Figure 1. Projection for total number of test days (at cryogenic temperature ~ 2K), versus fiscal year. Dashed line indicates maximum number of days available at cryogenic temperature.

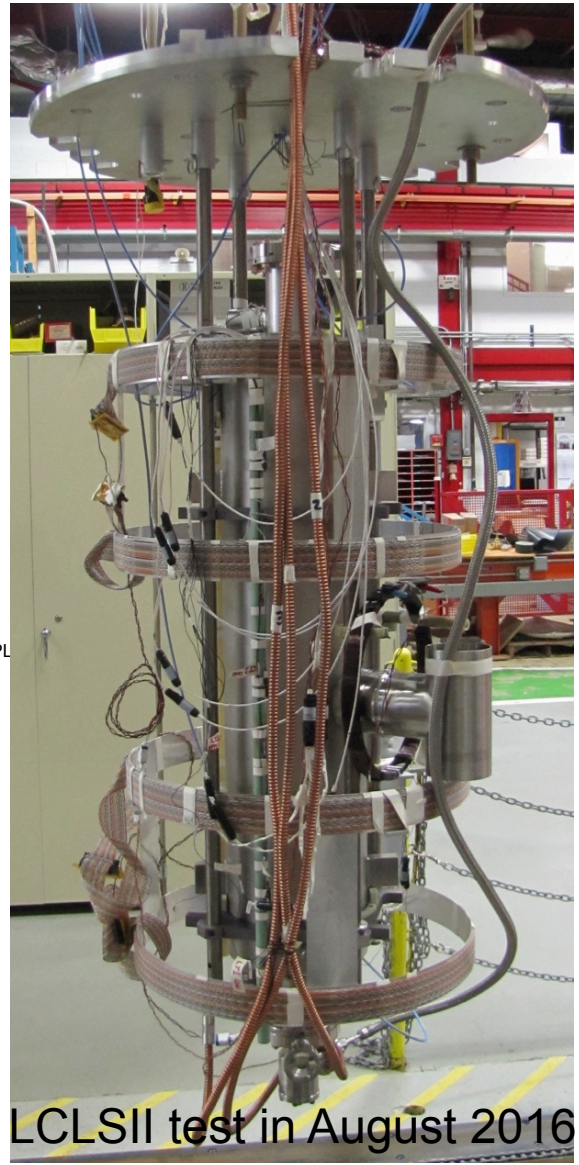
Week 1:	**2 cryocycles × 2 cavities**	**= 4**
Week 2:	**2 cryocycles × 2 cavities**	**= 4**
Week 3:	**2 ~~1~~ cryocycles × 2 cavities**	**= 2 ~~1~~**
Week 4:	**2 ~~1~~ cryocycles × 2 cavities**	**= 2 ~~1~~**
		16 ~~12~~

-- such scheme could be accommodated if needed (but impacting other projects)
-- increasing test rate beyond 16 cavities per month may be possible but will essentially delay/stop other programs/projects

Cavity Instrumentation in VTS Test

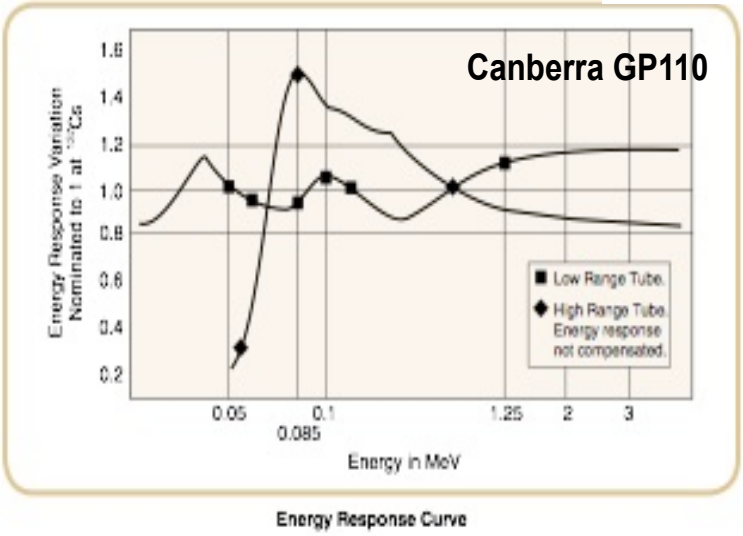


- Each Top Plate is instrumented with 4 or 8 T sensors and 5 or 6 fluxgates for careful monitoring (and active compensation) of fields and cooldown parameters, as it is crucial part of cavity qualification (Q)



LCLSII test in August 2016

Field Emission Detection

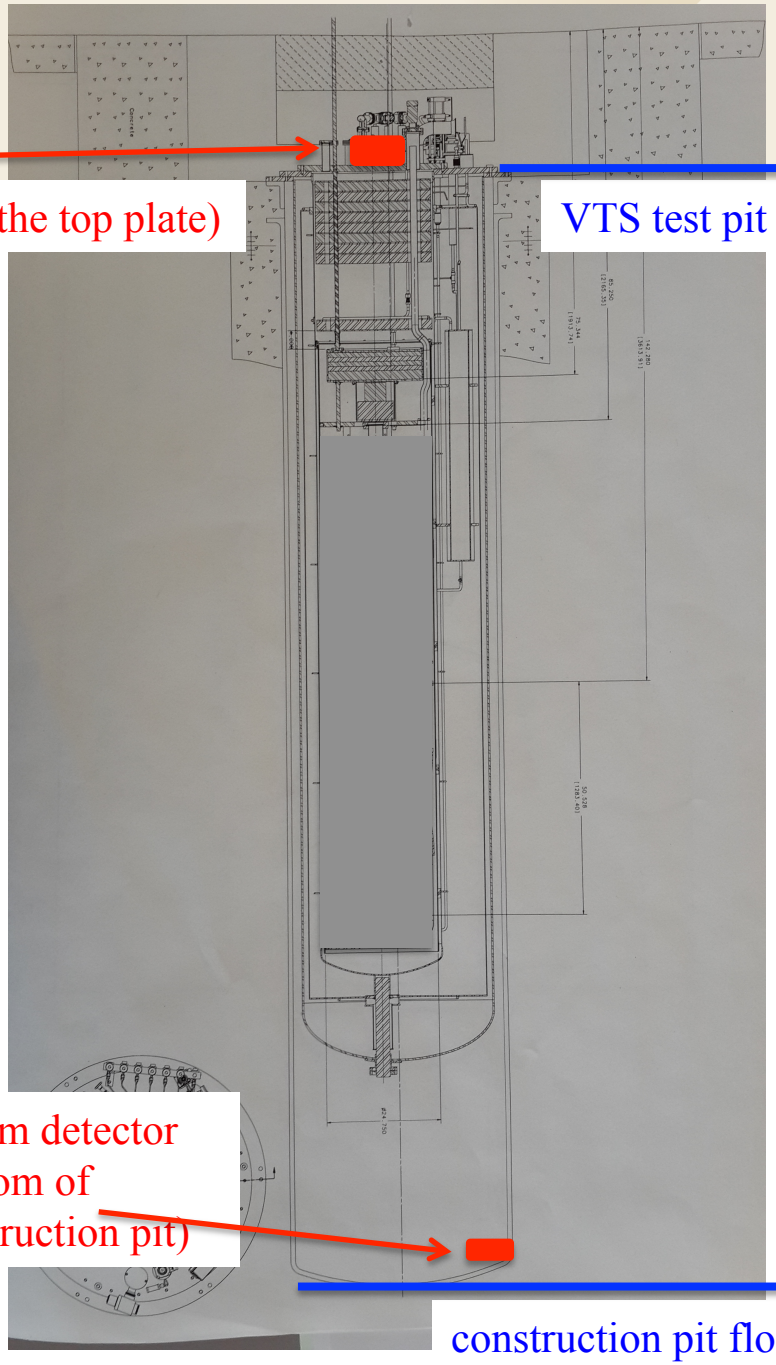


Energy Response Curve

-- Top detector Canberra GP110

-- Bottom detector very similar but smaller size to fit in the available space at the bottom of the dewar: Canberra GP100M

-- Installation and commissioning of bottom detector is on schedule

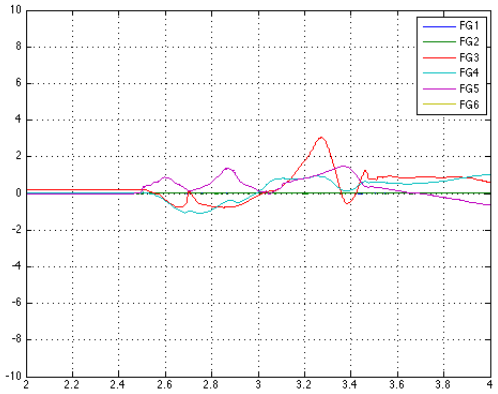


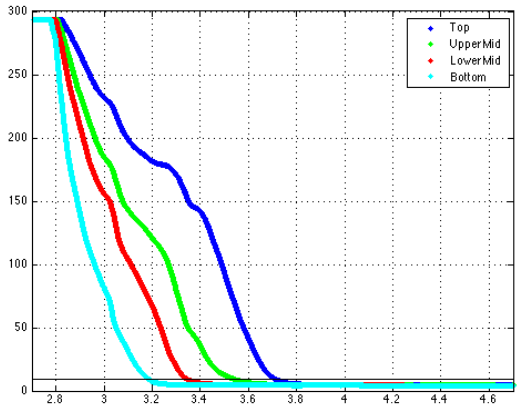
Vertical Test sequence and acceptance

- Warm RF checks, instrumentation and HOMs tuning
- Fast cooldown from 300K to 4.2K
- Active compensation of magnetic fields during cooldown
- No Q-disease test, overnight at 4.2K
- 2K pumping in the morning, Q vs E curve
- Administrative limit at 24 MV/m, or if excessive radiation observed
- Low T ~ 1.4K curve taken only in cases where Q assessment is needed
- If cavity meets specs proceeds to string assembly, if not DR is generated and disposed of (re-processing, etc)

Cavity acceptance criteria, LCLSII-4.5-EN-0590-R0

Parameters	Numbers	Unit
Min Gradient	19	MV/m
Q_0	2.5e10	
HOM Qext, operating mode	>2.7e11	
HOM power, at 16 MV/m	<1.0	W
Field emission Onset	> 17.5	MV/m
Field Emission at onset	<1	nA
Cavity center frequency	1.300	GHz
Cavity frequency range, tuned	+/- 20	kHz
Q_{ext2} (field probe)	2.5-7e11	





Magnetic fields at vessel during cooldown, example of fast cooldown

Performance summary nine cells –RI, pre-production series 5 cavities ready for string assembly, 3 awaiting re-HPR/test

Cavity S/N	Dewar N.	Qo at 16 MV/m @ 2K	Qo at 19 MV/m @ 2K	Max Gradient [MV/m]	Reason for Gradient Limit	FE onset at baseline test [MV/m]	FE onset after HPR test	STATUS
CAV003	3	2.22E+10	2.20E+10	>24	Admin	8 (14)	NONE	Qualified*
CAV007	2	2.40E+10	2.38E+10	>24	Admin	9 (9.6)	NONE	Qualified*
CAV008	2	2.46E+10	2.46E+10	>24	Admin	18 (12)	NONE	Qualified
CAV015	2	2.52E+10	2.5e10	>26	Admin	15 (11)	NONE (x-rays present in MP band, cleared)	Qualified
CAV006	2	2.4E+10	2.4E+10	>24	Admin	19 (11)	NONE	Qualified*
CAV011	2	2.27E+10	2.20E+10	>21	Admin (FE)	14 (12)		re-HPR/retest by Fri 16
CAV013	3	--- (issues with 2K pumping)	---	---	Admin (FE)	8		re-HPR/retest by Fri 16
CAV016	3	--- (issues with 2K pumping)	---	---	Admin (FE)	14		re-HPR/retest by Tue 20
Average		2.38E+10	2.36E+10	>24				

test today

- 8 cavities out of 8 required DR, reprocessing (re-HPR) and re-testing, which resulted in some schedule delays despite highest priority given (100% re-work)

Re-processing

Re-processing methodology

- If cavity does not meet FE requirements:
  - Re-HPR at FNAL or ANL facilities
  - If still FE present after two re-rinses then consider light EP (light EP ~ 5-7 microns of dressed cavities has already been successfully implemented on several pCM cavities)
- If cavity does not meet gradient spec
  - Consider on case by case
  - If quench field very low, may open and optically inspect for potential major issue (eg scratches etc)
  - Consider light EP in some cases
- If cavity does not meet Q spec
  - Examine cooldown and magnetic field data
  - Decide on case by case basis

High Pressure Rinsing Facilities

Two facilities in use by FNAL for High Pressure Rinsing

SCSPF

- **S**uperconducting **C**avity **S**urface **P**rocessing **F**acility
- Built as part of the joint ANL / SCSPF facility
- Utilizes self contained apparatus
- Located in Class 10 Cleanroom

CPL

- **C**avity **P**rocessing **L**ab
- Tool isolated from room by doors
- Located in Class 10 Cleanroom

- Both Facilities use identical recipes for LCLS-II Cavities
- Both Facilities are severely overbooked and represent the bottleneck in cavity processing
- 30% reprocessing rate planned, anything larger requires re-prioritization and impacts severely other projects/programs, and can result in schedule delays for LCLS-2
- By-Weekly scheduling/prioritization of tool usage done via SRF Program/Facilities meeting

Facility Tools

SCSPF HPR TOOL

CPL HPR Tool

LCLS-2 High Pressure rinse recipes

Two Recipes Have Been Used for Re-Processing

- **Complete Disassembly (~ 5 days)**
  - All cavity peripherals are removed
  - Cavity receives 1 pass of HPR
    - Rinsing begins with the wand at the top of the cavity and cavity moves in the upward direction
  - Both HOM Feedthroughs, field probe, beamline flange blank, and fundamental power coupler are installed
  - Cavity receives 3 more passes of HPR
    - Rinsing begins with the wand at the top of the cavity, cavity moves in the upward direction, cavity then moves downward for the 2nd pass, and completes with the cavity moving upward with the wand ending in the lower beamtube
- **Field Emission Mitigation (~3.5 days)**
  - Lower beamline flange assembly removed
  - Cavity receives 3 passes of HPR
    - Rinsing begins with the wand at the top of the cavity, cavity moves in the upward direction, cavity then moves downward for the 2nd pass, and completes with the cavity moving upward with the wand ending in the lower beamtube.

HTS

Scope and goals of HTS testing

1. **Current scope includes ~1 cavity every two cryomodules, to address:**

- QA of processes, procedures, and parts
  - Are the processes, procedures, tooling, and staffing yielding the required performance of the combined SYSTEM when assembled from qualified individual components
  - Are the vendor-supplied components conforming (or still conforming) to required performance specifications when used/operated under conditions similar to those encountered during cryomodule operation (and which cannot be duplicated “on the bench”).
- Investigate critical problems/issues in production, on an as-needed basis
  - Detailed (limited scope) investigation of problem and/or mitigation
- Long-term reliability or stability testing (tuners, coupler, LLRF systems)
- **At this level of scope no clear bottlenecks are envisioned**

Travelers

Incoming inspection Traveller Example

LCLS-II 1.3 GHz Dressed Cavity Incoming Inspection Traveler (RFCG)

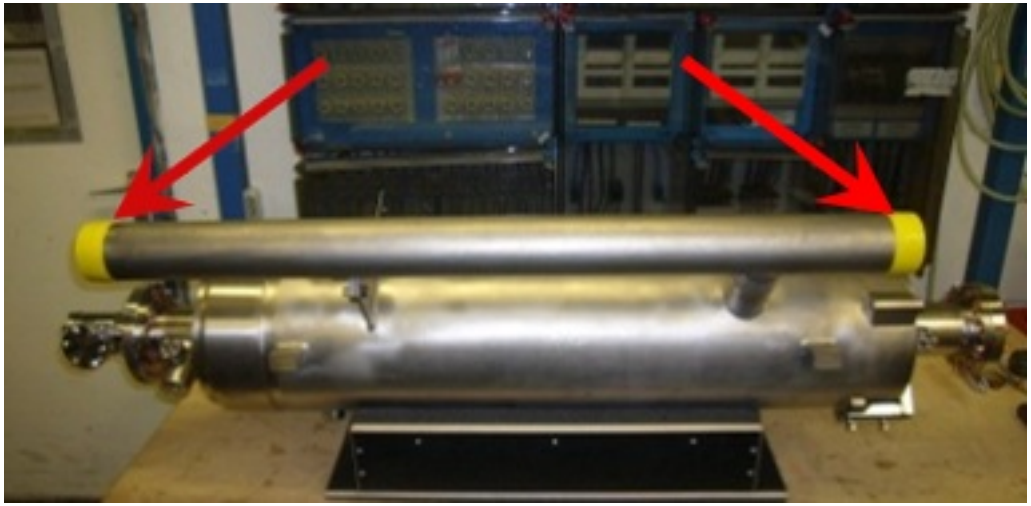
464305 Rev. NONE

by Timothy McKenna

Series	Serial No.	Job No.	Task No.	Released By	Released Date	Status
RFCG	CAV0003-0	584	n/a	Timothy McKenna	7/28/2016 4:57:22 PM	Closed

5.3.10 Check for the presence of caps on helium service pipe (caps made of PE-LD on both ends of the 2-phase pipe).

◉ *Pass* ○ *Fail*



Minor Issues

- **Minor deviations found**
  - absence of plastic caps on RF connectors
  - absence of drilled holes on RF connectors in some of the cavities
  - QA mark placed on the support lug in an undesirable place/surface
  - Input coupler antenna too long (RF inspection indicated that Q1*Q2 was lower than expected, confirmed at VTS)
  - absence of VCR connector on RAV
  - All these were addressed, future cavities are not expected to have them

- **All these were addressed, future cavities are not expected to have these issues**

Noting Minor Issue in Incoming inspection Traveller

LCLS-II 1.3 GHz Dressed Cavity Incoming Inspection Traveler (RFCG)

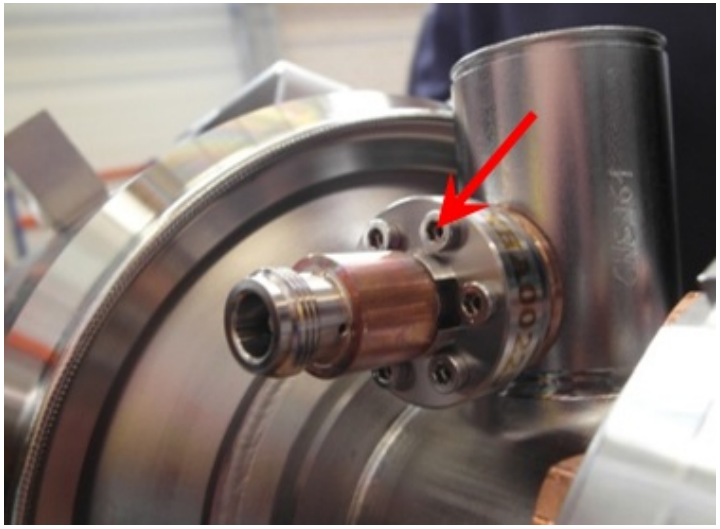
464305 Rev. NONE

by Timothy McKenna

Series	Serial No.	Job No.	Task No.	Released By	Released Date	Status
RFCG	CAV0003-0	584	n/a	Timothy McKenna	7/28/2016 4:57:22 PM	Closed

5.3.24 Check to make sure there are 6 bolts with washers.

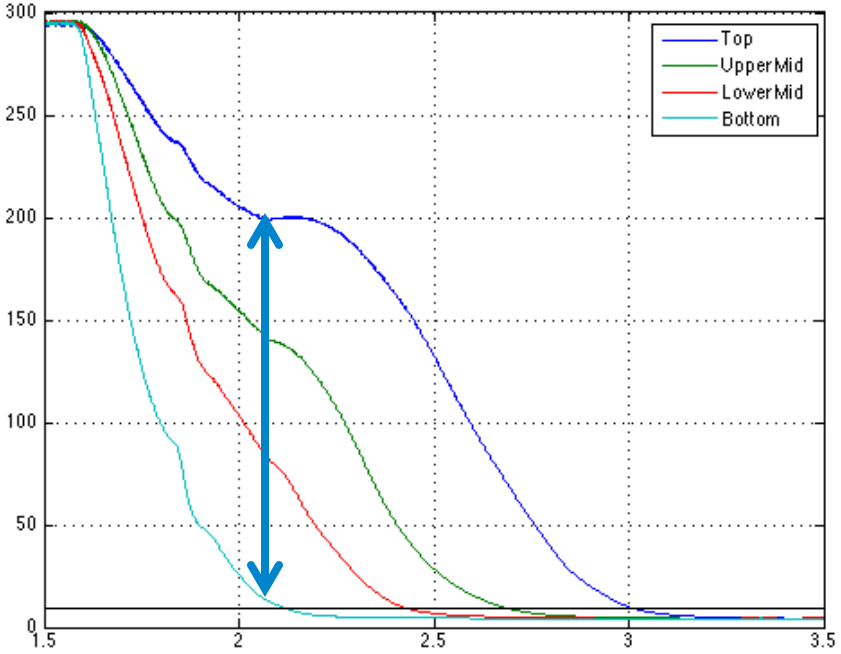
◉ *Pass* ○ *Fail*



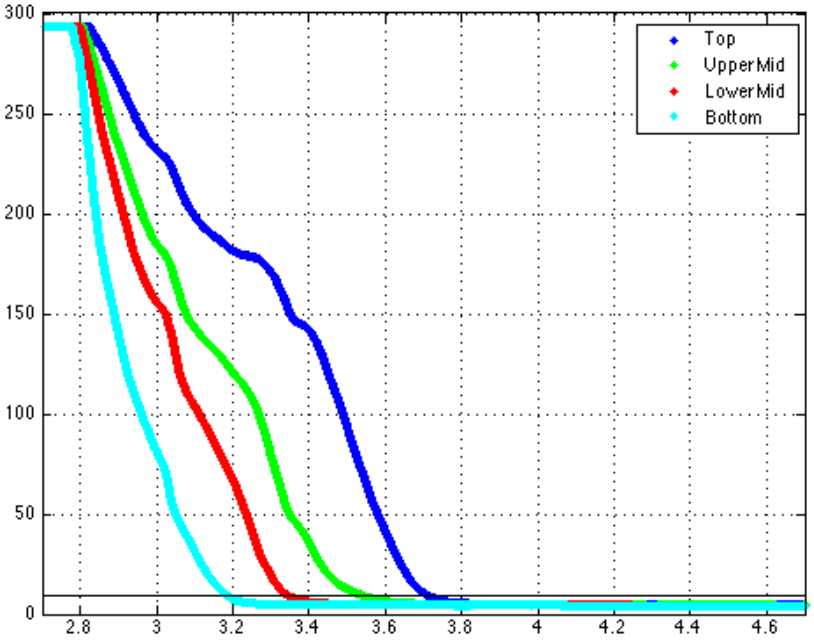
Comments: ***No Protective cap***

Cooldown rates (Examples)

VTS-2 filled from VTS-3



VTS-3 filled from cryoplant main storage dewar



Cooldown rates (Examples)

LCLS-II 1.3 GHz Nine Cell Dressed Cavity 2K VTS Testing (RFCG)
464170 Rev. A
by Jan Szal

Series	Serial No.	Job No.	Task No.	Released By	Released Date	Status
RFCG	CAV0003-0	584	n/a	Oleksandr Melnychuk	8/1/2016 4:47:16 PM	Closed

5.0 Testing and Results

5.1 Test Operator, and Date.

Principal Test Operator: ***Oleksandr Melnychuk***

Test Date: ***8/2/2016***

5.2 Cool down Parameters.

Enter the temperature gradient between top and bottom when bottom transitions trough Tc.

Temperature Gradient ***199 K***

Traveler Status

- **Traveler Status**
  - **464305 – Incoming Inspection – Passed all travelers closed**
  - **464282 – Incoming Leak Check – Passed all travelers closed**
  - **464314 – Incoming CMM – Passed all travelers closed**
    - **CAV0008 example**
  - **464224 – Incoming RF Measurements – Passed all travelers closed**
  - **464189 – Reprocessing –** All closed
  - **464240 - Preparation and Installation of a Cavity in the Vertical Test Stand** -- All closed except for re-tests that did not happen yet
  - **464170 - LCLS-II 1.3 GHz Nine Cell Dressed Cavity 2K VTS Testing** -- All closed except for re-tests that did not happen yet

Vector Traveler Status

All Inspection, Reprosessing, Prepration and VTS testing travelers that should be closed at this point are closed !

Serial Number	464305 - LCLS-II 1.3 GHz Dressed Cavity Incoming Inspection Traveler (RFCG)	464282 - LCLS-II 1.3 GHz Dressed Cavity Incoming Inspection Leak Check Traveler (RFCG)	464224 - LCLS-II 1.3 GHz Dressed Cavity RF Incoming Inspection Traveler (RFCG)	464314 - LCLS-II 1.3 GHz Dressed Cavity Incoming Inspection CMM Traveler (RFCG)	464189 - LCLS-II Vertical Test (VTS) Preparation of 1.3GHz Dressed Cavities	464240 - Preparation and Installation of a Cavity in the Vertical Test Stand (VTS)	464170 - LCLS-II 1.3 GHz Nine Cell Dressed Cavity 2K VTS Testing (RFCG)
CAV0003 - 0	Closed	Closed	Closed	Closed	Closed	Closed	Closed
CAV0003 - 1						Closed	Closed
CAV0006 - 0	Closed	Closed	Closed	Closed		Closed	Closed
CAV0006 - 1						Closed	Closed
CAV0007 - 0	Closed	Closed	Closed	Closed		Closed	Closed
CAV0007 - 1						Closed	Closed
CAV0007 - 2						Closed	Closed
CAV0008 - 0	Closed	Closed	Closed	Closed		Closed	Closed
CAV0008 - 1						Closed	Closed
CAV0011 - 0	Closed	Closed	Closed	Closed		Closed	Open - 63/85 (74%) Done
CAV0011 - 1							Open - 0/85 (0%) Done
CAV0013 - 0	Closed	Closed	Closed	Closed	Closed	Closed	Open - 59/85 (69%) Done
CAV0013 - 1						Open - 19/69 (27%) Done	Open - 0/85 (0%) Done
CAV0015 - 0	Closed	Closed	Closed	Closed	Closed	Closed	Closed
CAV0015 - 1						Closed	Closed
CAV0016 - 0	Closed	Closed	Closed	Closed	Closed	Closed	Open - 59/85 (69%) Done
CAV0016 - 1							Open - 0/85 (0%) Done
TB9ACC015							

Discrepancy Reports (Field Emission in VTS tests)

Vector Home Reports

Vector - Select Discrepancy Report - Read Only

DR Number	Document	DR Status
10900	CAV0003-0--464170--LCLS-II 1.3 GHz Nine Cell Dressed Cavity 2K VTS Testing (RFCG)	Closed
10901	CAV0006-0--464170--LCLS-II 1.3 GHz Nine Cell Dressed Cavity 2K VTS Testing (RFCG)	Closed
10902	CAV0007-0--464170--LCLS-II 1.3 GHz Nine Cell Dressed Cavity 2K VTS Testing (RFCG)	Closed
10903	CAV0007-1--464170--LCLS-II 1.3 GHz Nine Cell Dressed Cavity 2K VTS Testing (RFCG)	Closed
10904	CAV0008-0--464170--LCLS-II 1.3 GHz Nine Cell Dressed Cavity 2K VTS Testing (RFCG)	Closed
10905	CAV0011-0--464170--LCLS-II 1.3 GHz Nine Cell Dressed Cavity 2K VTS Testing (RFCG) **- Awaiting Disposition Verification (Oleksandr Melnychuk)**	Dispositioned
10906	CAV0015-0--464170--LCLS-II 1.3 GHz Nine Cell Dressed Cavity 2K VTS Testing (RFCG)	Closed
10912	CAV0013-0--464170--LCLS-II 1.3 GHz Nine Cell Dressed Cavity 2K VTS Testing (RFCG) **- Awaiting Disposition Verification (Oleksandr Melnychuk)**	Dispositioned
10913	CAV0016-0--464170--LCLS-II 1.3 GHz Nine Cell Dressed Cavity 2K VTS Testing (RFCG) **- Awaiting Disposition Verification (Oleksandr Melnychuk)**	Dispositioned

464170 - 1.3 GHz Cavity VTS Performance and Acceptance Status (JS)

Serial Number	Rework ID	5.6 Qext1 464170 (Rev. B)	5.6 Qext2 464170 (Rev. B)	5.6 Q HOM A 464170 (Rev. B)	5.6 Q HOM B 464170 (Rev. B)	5.7 Eacc at Maximum Q0 464170 (Rev. B)	5.7 At E_{acc} of 16MV/m : 464170 (Rev. B)	5.8 Rad_{max}: 464170 (Rev. B) - **mR/hr**	6.1 Qualified 464170 (Rev. B)	6.1 Need reproccessing 464170 (Rev. B)	6.1 Rejected 464170 (Rev. B)
CAV0003	0					10.7	1.98	7400	○	◉	○
CAV0003	1	1.7E10	3.55E11	1.5E13	1.3E12	16	2.22	0	◉	○	○
CAV0006	0	5.5E9	3.46E11	8.5E12	2.4E12	15	2.42	200	○	◉	○
CAV0006	1	5.1E9	4.63E11	4.4E12	1.7E12	18	2.38	0.06	◉	○	○
CAV0007	0					11.9	2.13	7210	○	◉	○
CAV0007	1		2.27E11			11	2.3	385	○	◉	○
CAV0007	2	1.5E10	2.95E11	2.3E13	8.4E11	14	2.4	0	◉	○	○
CAV0008	0	5.5E9	2.82E11	1.4E12	6.8E11	16.3	2.46	450	○	◉	○
CAV0008	1	5.7E9	4.11E11	9.6E12	7.4E11	16	2.46	0	◉	○	○
CAV0011	0	4.2E9	1.58E11	1.3E15	1.2E12	14	2.2	608	○	◉	○
CAV0011	1								○	○	○
CAV0013	0	5.4E9	2.76E11	8.3E12	1.1E12			12	○	◉	○
CAV0013	1								○	○	○
CAV0015	0	4.3E9	3.36E11	5E12	7E11	12.5	2.23	495	○	◉	○
CAV0015	1	1.5E10	3.61E11	8.5E13	9.7E11	16.1	2.52	16.9	◉	○	○
CAV0016	0	4.5E10	3.07E11	1.5E12	7.7E11			130	○	◉	○
CAV0016	1								○	○	○

Safety

Safety

464045 - NONE - Procedure for SRF Cavity Handling in the IB4 CPL Cleanroom Area

464044 - NONE - Procedure to Authorize Personnel to Handle SRF Cavities in the CPL Cleanroom Area

333960 - NONE - Procedures for SRF Cavity Handling at IB4 RF Laboratory

333959 - NONE - Procedure to Authorize Personnel for SRF Cavity Handling at IB4 RF Laboratory

Safety (IB4, Cont'd)

333957 - NONE - Procedures for SRF Cavity Handling at ANL/FNAL SCSPF

333956 - NONE - Procedure to Authorize Personnel for SRF Cavity Handling at ANL/FNAL SCSPF

333955 - NONE - Procedures for SRF Cavity Handling at CAF

333954 - NONE - Procedure to Authorize Personnel for SRF Cavity Handling at CAF

333953 - NONE - Quality and Materials Department Cavity-related Work Authorization Process

333952 - A - Procedure for Inter-Facility Transport of 1.3 GHz Nine-Cell SRF Cavities

333951 - A - Radio Frequency Cavity Handling Guidelines

TD-7050 Procedures for Working in Industrial Building #4

Safety Cont'd (VTS specific)

- Have been well prepared for LCLSII production testing
- VTS-2 and VTS-3 test stands were granted ORC by Dave Harding on 11/18/2014
- Test stand cryogenic systems were signed off by the cryo safety subcommittee in mid-October 2014
- Developed a method for establishing relief calculations for "new" devices.
- Conducted radiation verification tests before final ORC was granted
- Relevant building safety and cavity handling procedures in place

Summary

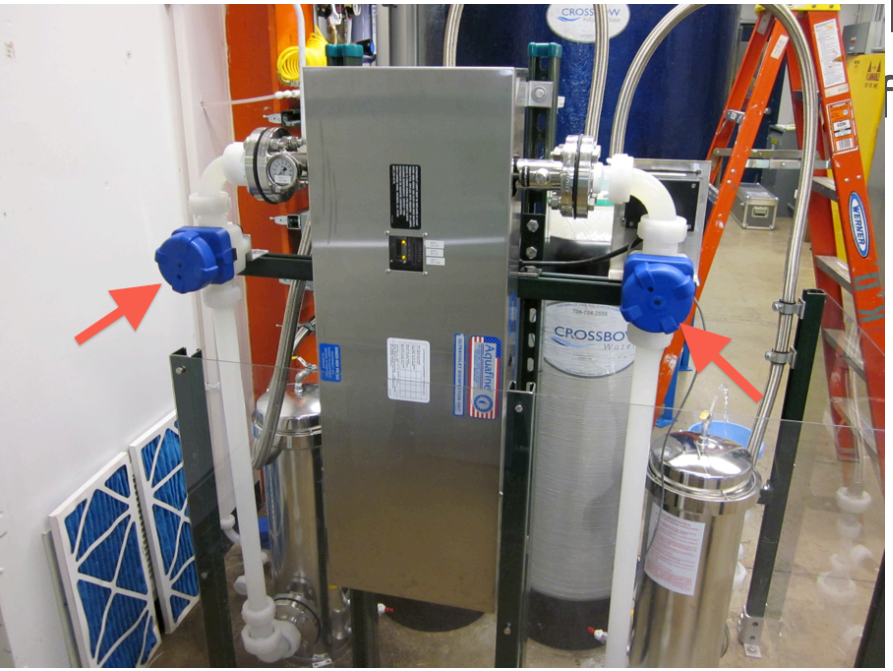
- Cavity prep and test has adequate resources to meet the goal of qualifying 8 cavities a month, under the 30% XFEL reprocessing rate experience
- Well qualified teams in place, for processing and testing
- Procedures, travellers in place and successfully implemented on trial run with pre-production series from RI
- Re-work > 30% (re-HPR, re-test) could cause schedule delays due to large number of other project/programs ongoing at FNAL (conflicts for cryo-usage and processing tools)

Backup slides

High Pressure Rinse Water Source

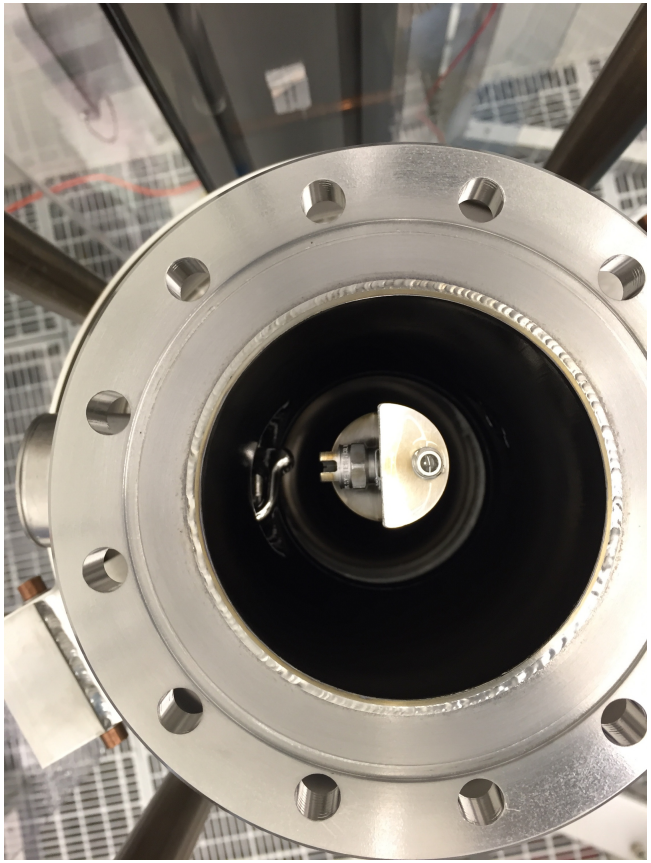
Ultra Pure Water

- Resistivity monitored for >/=18 MegaOhm quality
- Total Organic Compounds monitored for quality



High Pressure Rinse Water Delivery

- Lewa Diagphram Pump
- Electropolished S.S. high pressure delivery manifold
- 1200 p.s.i water delivered from two 45 degree fanjet nozzles
- Each nozzle delivers approximately 2 GPM



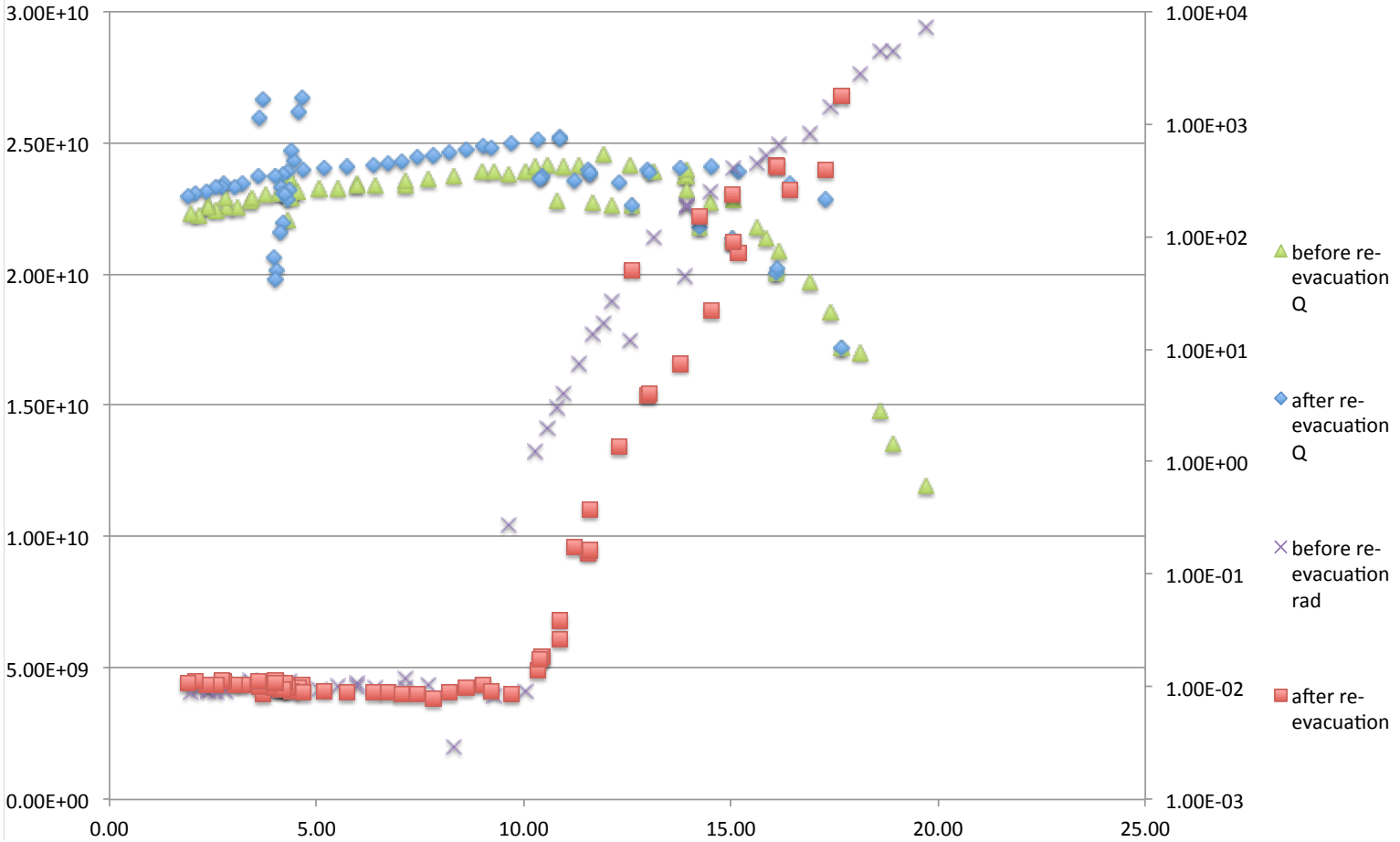
Mechanical Translation

- Wand rotates inside cavity
  - Speed is approximately 3 RPM
- Cavity moves longitudinally
  - Speed is approximately .2” per minute
- Each longitudinal pass takes approximately 4 hours

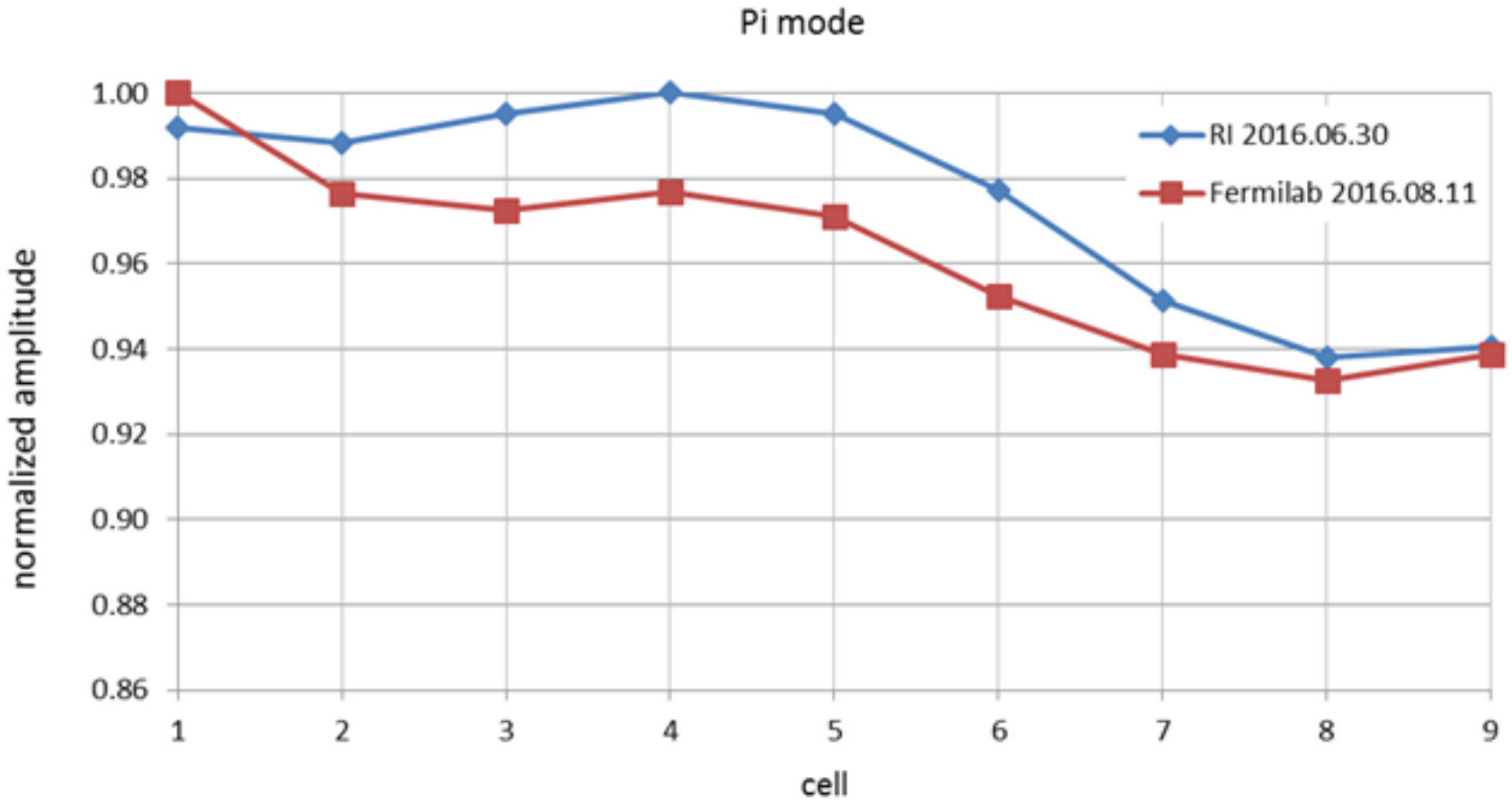
CAV008 before – after re-evac

At receipt/Vertical test pressure 2e-4 Torr

Cavity was then brought to clean room, re-evacuated overnight to ~1e-7 Torr, retested



FF measurements CAV003



Optical inspection – CAV003

No major features revealed (no scratches, etc)

But very strange surface appearance – bumpy and wrinkly – not sure why?