Long Range PIT Summary and Plan

PIT Team

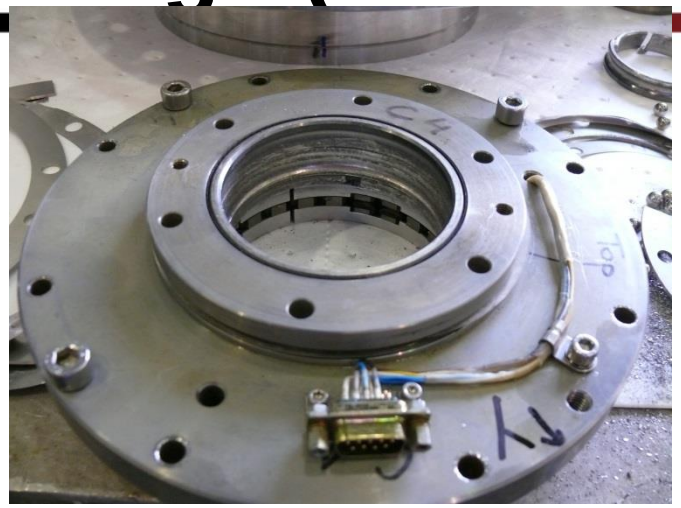
Long Range PIT Team Goals

- Investigate, understand, and improve long term SRF linac performance
  - Quantify/Summarize performance as built
  - Suggest and implement measurement plans to quantify performance changes
  - Work to understand any changes observed
  - Suggest improvements in operations processes and/or hardware and implement
- Understand better "accelerating system wide" problems
- Implement rational data management

Gradients in C100 During Commissioning (Rama)

Zone	Beam Measurement	During Commissioning
C100-1	104 MV	94.01 MV
C100-2	122	93.8
C100-3	108	76.58
C100-4	93	79.24
C100-5	121	100.31
C100-6	111	101.8
C100-7	104	103.81
C100-8	110	100.17
C100-9	105	101.15
C100-10	106	87.57
C100-0	104	82.3

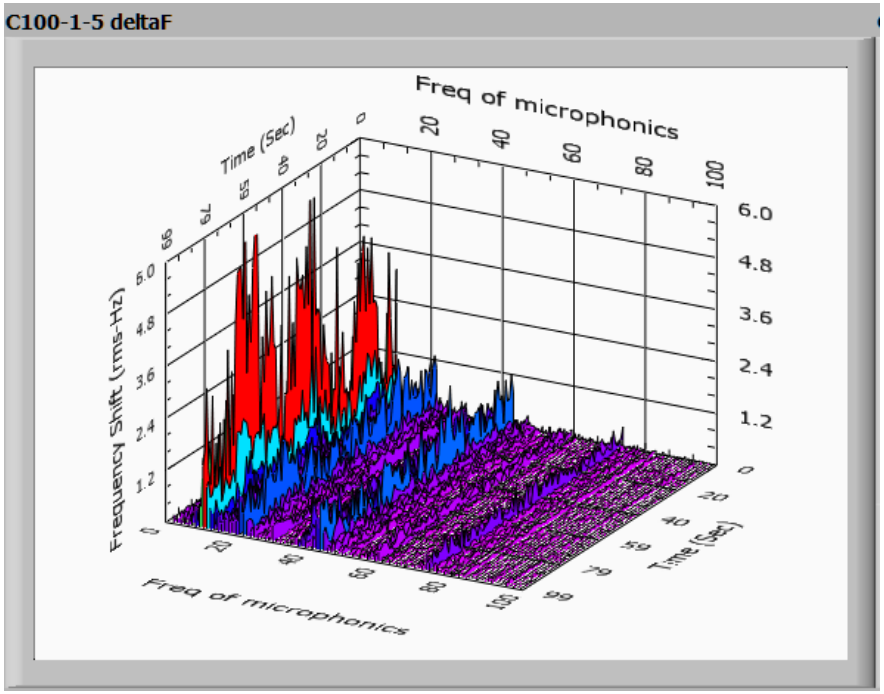
SC1 CC4 Findings (Jonathan)



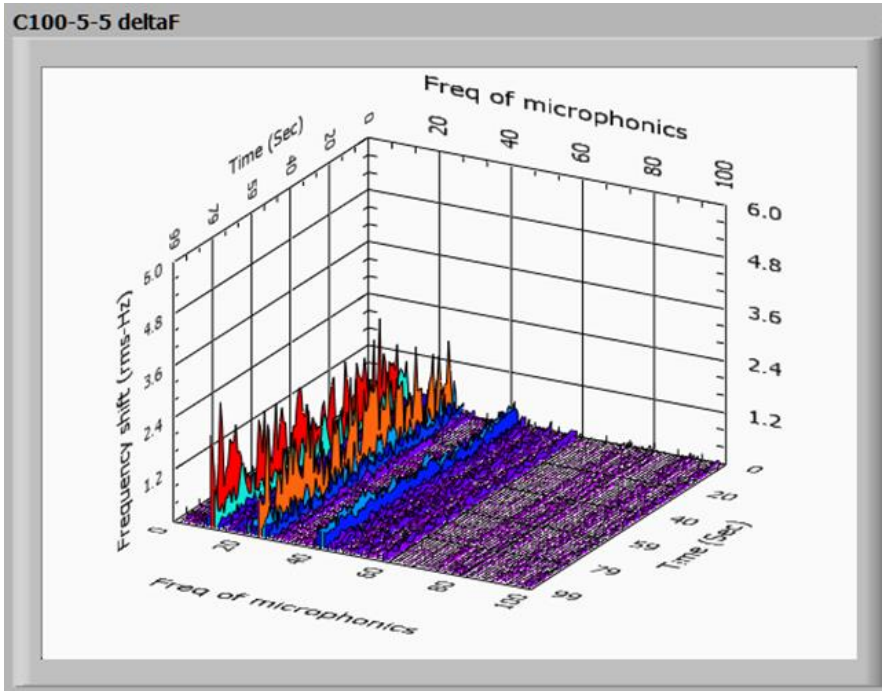
- Backup ball bearing failure
  - When rotor fell bearing 0 to 35,000 RPM instantly
  - Inner and outer races shattered
  - Balls damaged
  - Shaft scored
  - Position sensors damaged
  - Air Liquid and S2M working on estimates
    - CC4 repair
    - Balancing spare wheels
    - List of recommended future spare parts

Microphonics Spectra vs Time (Kirk)

Original Tuner



Modified Tuner



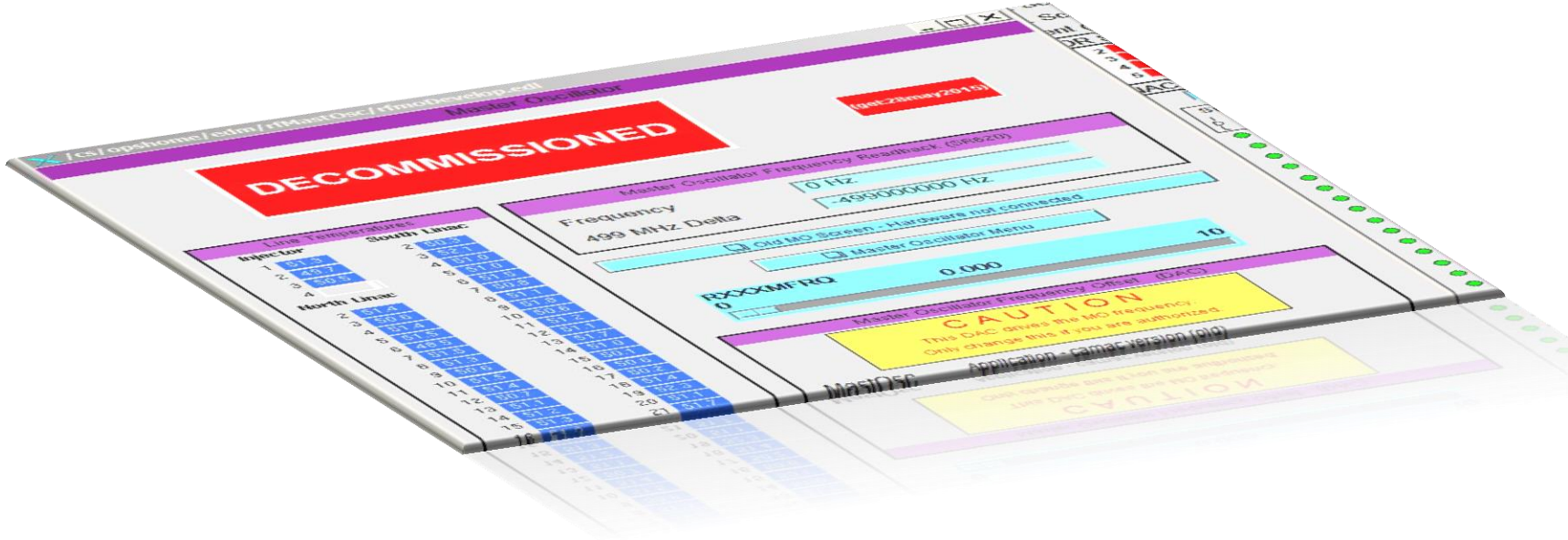
Suggestions for the Future (Kirk)

1. 24 Cavity (simultaneous?) measurement of baseline C100 vs modified C100 cryomodules in adjacent zones vs R100. (August, 2015)
2. Long-term accelerometer study of 0L04 (R100, late fall 2015):
   a) Trigger off of module trips, look at pre-trigger accelerometer data
   b) Trigger off of 6σ accelerometer events, look at LLRF data
3. Develop, install, test a helium pressure sensor with >50Hz bandwidth, fluid coupled to the LHe circuit.
4. Develop, install, and commission an accelerator-site continuous vibration monitoring system.

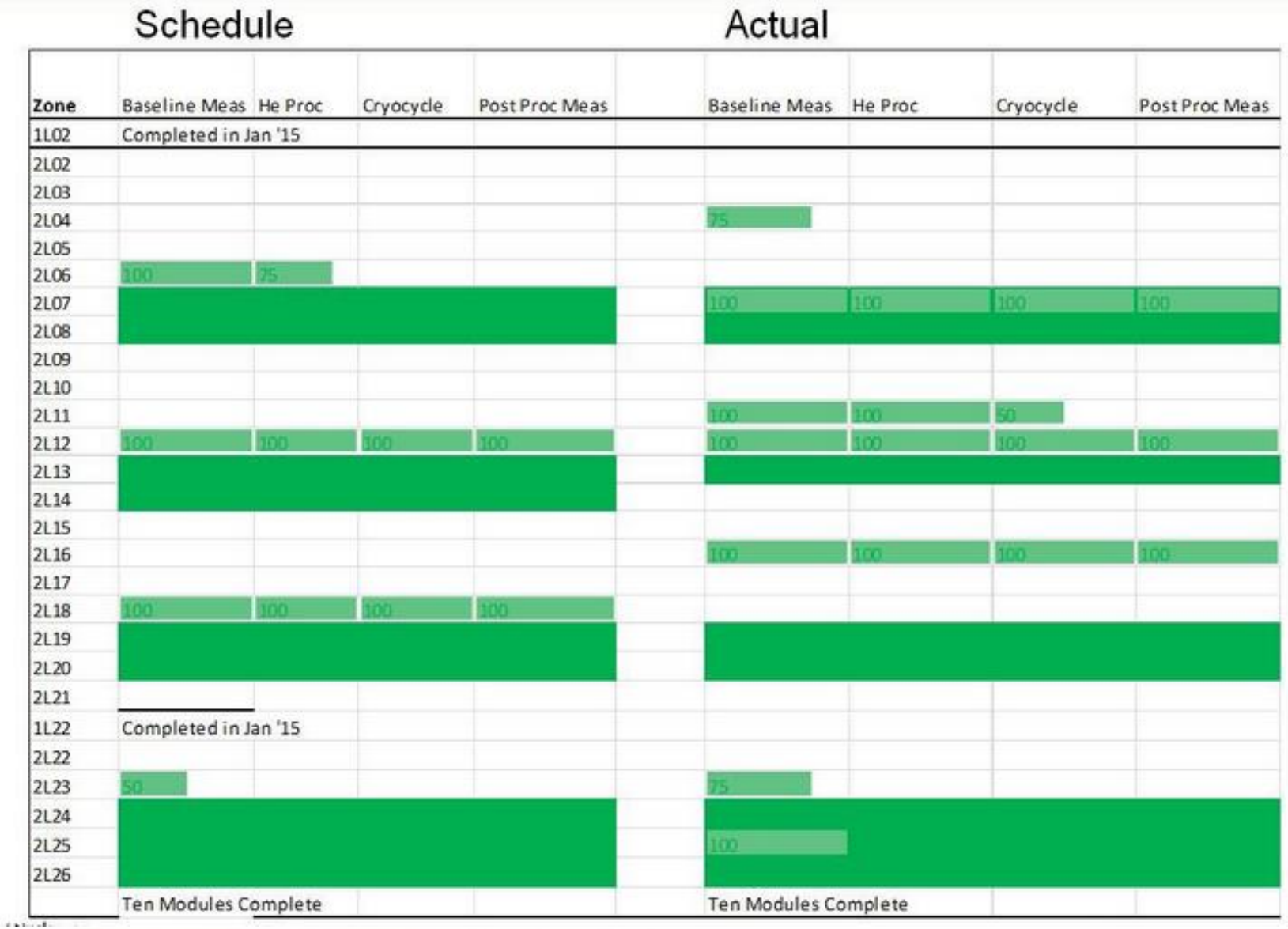
Future Plans (Tomasz)

- LCW 19” Rack Mount Water Chiller (temp. stability ± 0.1 ° C) - 4 local MO racks

- Remove obsolete EIPCS Screens



Schedule vs. Actual (Mike)

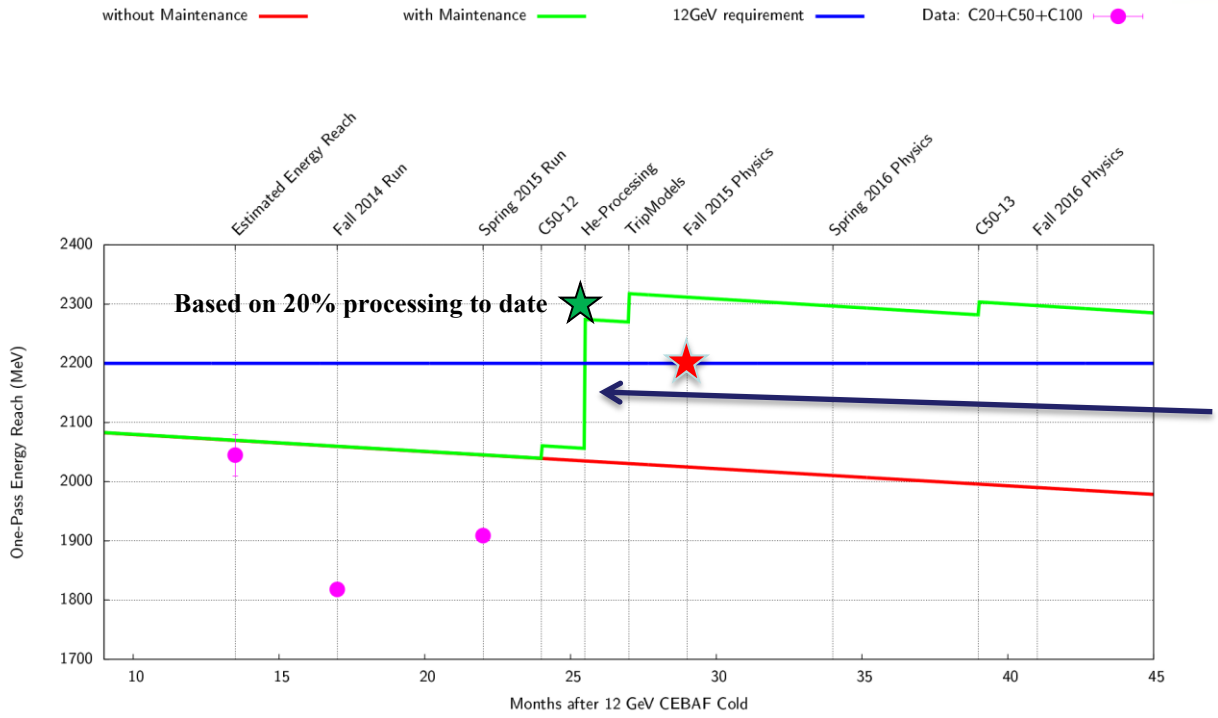


Gain in Field Emission Free Voltage (MV) (Mike)

Zone	Integrated Change FE Gradient (MV)
1L02	5.7
2L02	
2L03	
2L04	
2L05	
2L06	
2L07	5.3
2L08	5.0
2L09	
2L10	
2L11	
2L12	3.9
2L13	3.4
2L14	
2L15	
2L16	
2L17	2.5
2L18	
2L19	
2L20	1.6
2L21	
1L22	7.14
2L22	
2L23	
2L24	
2L25	11.3
2L26	6.2

C20 /C50 Average Gain	3.9
C100 Average Gain	8.2
Overall Average Gain	5.2

Energy Reach: Past and Future



Helium processing of all cavities planned for Summer 2015

- C20/C50 performance degradation:
  - 0.21 MV/m – year (~34 MeV/pass - year).
  - Cause of degradation is unknown, actively being investigated.
- C100 insufficient data to date to reliably estimate degradation, if any.

Collecting Particulates (Rongli)

Individual Heater Controls (Tom)

- When SL21 was installed in the FEL we needed to get all of the energy out of the cryomodule as possible.
- One of the problems that we found when we had 8 heaters powered off of one supply is that if one or more cavities was below the maximum gradient, the heaters on all of the cavities were turned on to compensate. This meant that we would have the RF heat (which was pushing the limits) plus the heater heat which pushed us over the threshold and we had boiling. **Enables Modulation Experiments!**
- The fix for FEL3.
  - Implemented individual heater controls for each cavity
  - Operated with expected RF Heat set about 20% below the drive high RF heat.
  - Disabled swing heater function for that zone.

Proposal for New Studies and Tests (Rongli)

- Further evaluation of nitrogen-doping for raising Q_0 5-cell cavities, including possible re-doping after barrel polishing.
  - Two cavites in hand:
    - IA008 (N-doping completed)
    - IA011
  - A clear conclusion on N-doping is useful
    - Positive answer sets solid ground for possible future path of Nb_3Sn re-treatment.
    - Negative answer sets solid ground for possible future path of “LG cell transplant”
- Fundamental studies of defects in IA009
  - Dissect cavity, make 5 each 1-cell cavities, test with T-mapping, cut out quench area for material studies.
  - Recycle end groups for “C75” cavities

CEBAF energy maintenance options (Bob)

- Summary of options and estimated costs

	cavities	cells/ cav	cav length m	Act. length m	fill factor %	voltage (MV)	volts/ cav (MV)	gradient (MV/m)	klystron power	unit cost (FY16 M$)	voltage gain (MV)	V/$
C50	8	5	0.5	4	48.1	50	6.25	12.5	6	1.51	20	13.3
C100	8	7	0.7	5.6	64.4	100	12.5	17.9‡	13	4.77	70	14.7
C75†	8	5	0.5	4	48.1	75	9.4	18.8‡	8	1.91	45	23.6
C75†*	8	6	0.6	4.8	57.8	75	9.4	15.6	8	2.31*	45	19.5
J100*	6	9	0.9	5.4	65.0	100	16.7	18.5‡	~17	???	70	???
J75*	6	9	0.9	5.4	65.0	75	12.5	13.9	13	???	45	???

†New cells or new processing required to achieve higher Q's and gradients

*Engineering required at additional cost (not included)

‡Digital LLRF required

Current Plans (Rama)

- Helium Processing in progress
- Installation of Individual Cryomodule Heater Control System (Exercise these!)
- Microphonics Detuning analysis, Piezo Algorithm studies and Implementation
- Pressure sensor sensitive to He fluctuations
- Control Loop Optimization
  - Investigate the loop phase mismatch between SEL and GDR
- Klystron Drive Cables
  - Detect the source of crosstalk

- I'm quite happy with general progress and activity; except in the documentation theme (inadequate leadership!)

New CEBAF QCM (Tony)

General Scope

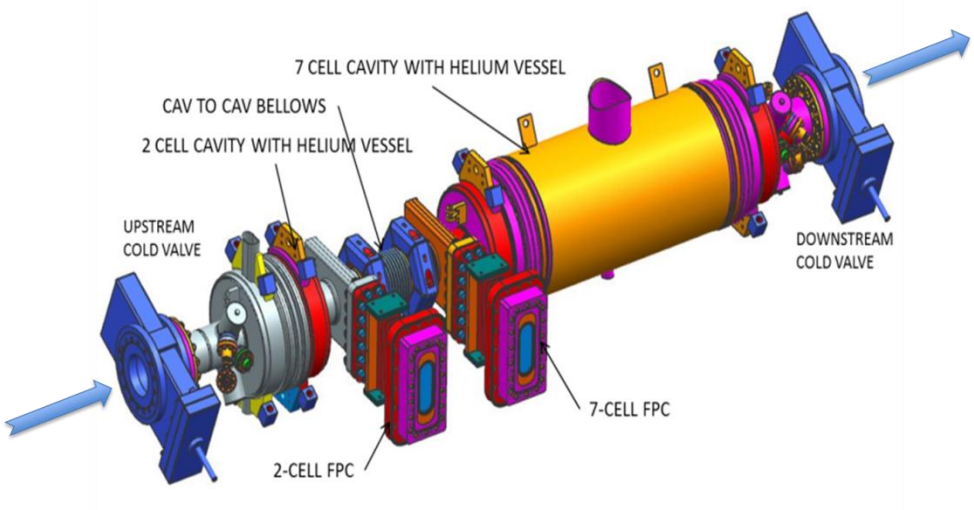
- Design and build a new quarter cryomodule (QCM) for CEBAF utilizing a new 2-cell elliptical and a modified elliptical 7-cell cavity

FY15 Scope

- Complete cavity qualification
- Procure components
- Assemble cavity string
- Complete cryomodule design

FY16 Scope

- Close out CM procurements
- Cryomodule assembly
- Cryomodule acceptance test
- Cryomodule install and commission
- **C50-12 too!**



H. Wang et al. *"Injector Cavities Fabrication, Vertical Test Performance and Primary Cryomodule Design"*

Present “Vision”

- If we would like to write a PRSTAB paper of the 12 GeV performance need
  - Main parameters data for every cavity and summaries (Q0, QL, Emax, Emax(ops), …
  - Descriptions of ancilliary equipment (RF sources, couplers and probes, LLRF, cryogenic systems, …
  - Summary data on these items for publication
  - Reliability Descriptions (main phenomena of interest) and data
  - Can help get “over the hump” for Task 1