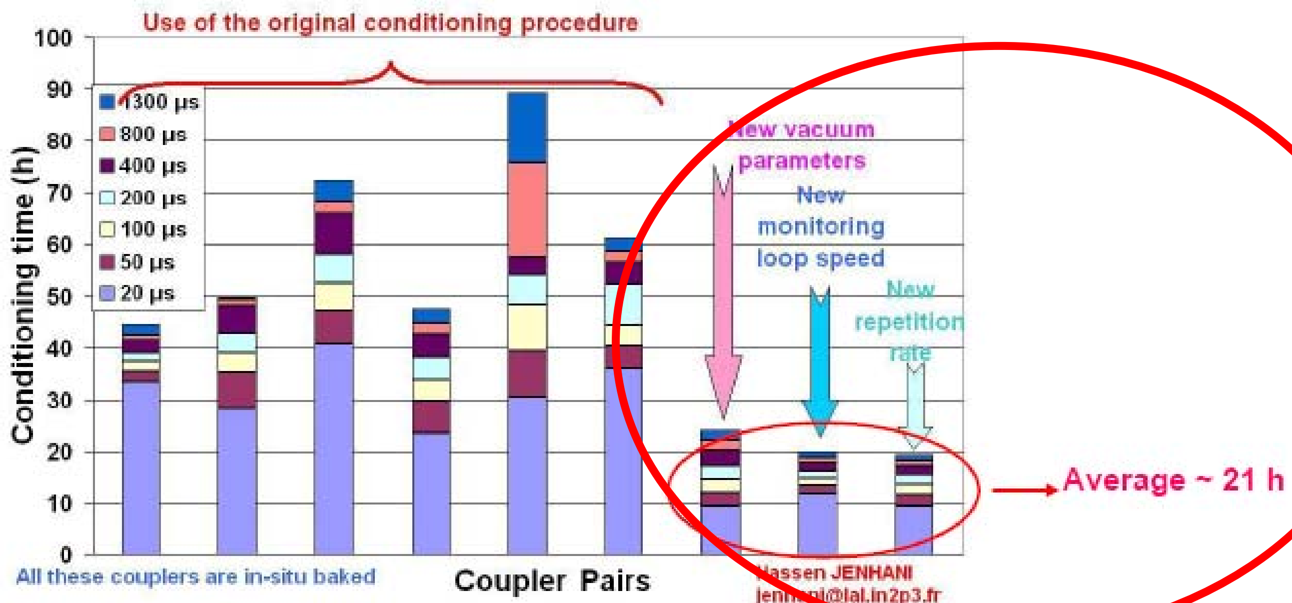
WG 4, Input & HOM Coupler Summary

TTC @ FNAL April 2007

RF CONDITIONING AND TESTS ON TTF-III POWER COUPLEURS AT LAL (Interlock thresholds)

W-D Moeller on behalf of H. Jenhani

Last conditioning time performances



		First values	Last values
Vacuum	1st threshold	2 x 10⁻⁷ mbar	6 x 10⁻⁷ mbar
	2nd threshold	4 x 10⁻⁷ mbar	1 x 10⁻⁶ mbar
	Vacuum interlock limit	1 x 10⁻⁶ mbar	5 x 10⁻⁶ mbar
e- current	Current interlock limit	5 mA	
Light	PM interlock limit	1 Lux	X
Temperature	I. R. detector limit	85 °C	
Arcs	If any		
Repetition rate	2 Hz		4 Hz ← Need more tests
Control loop	30 s		15 s

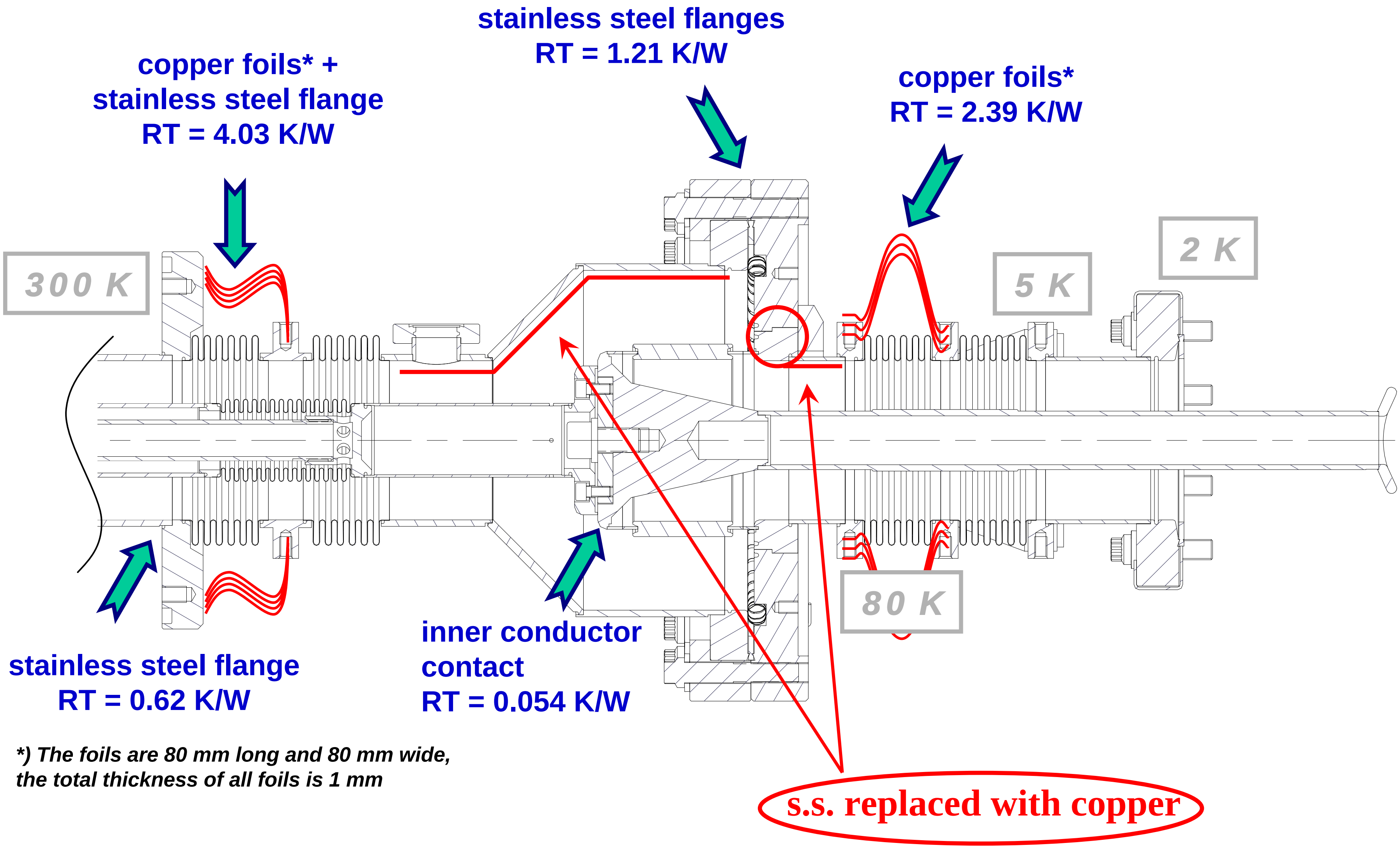
Conclusion

- New conditioning time performances : ~20 h
- 4.5 kV DC bias of the inner conductor seems to be efficient to stop e- activity on TTF-III coupler
- More tests are needed to find the best way to use the coupler inner conductor for e- current measurements

High power tests of the prototype input couplers for the Cornell ERL injector & RF system update

S. Belomestnykh
Cornell University

Design improvements



***) The foils are 80 mm long and 80 mm wide,**
the total thickness of all foils is 1 mm

Plans for the rest of 2007

- We have ordered ten more couplers of an updated design.
- We are closely following fabrication at CPI to ensure good quality.
- Recent RRR measurements of a copper sample produced good result:
- The first production pair of input couplers is expected to be delivered in June with the rest shortly after.
- As our installation schedule is very tight, we plan to do full testing of only the first two couplers.
- As we now have an operating high power klystron, it will be used for the coupler testing.
- As we have observed very little vacuum action in the cold parts of couplers (vacuum baked) and a lot of vacuum activity in the warm parts, we think that it is very important to implement *in situ* vacuum bake especially if we are to skip high power testing of input couplers.
- All input couplers will be *in situ* vacuum baked upon installation in the cryomodule and kept under vacuum after that. While it is already implemented for HTC, there are still some problems with the five-cavity cryomodule.
- Five more klystrons will be delivered between mid-May and mid-September and then tested at Cornell.
- While all cavities will be tested in a vertical dewar, only one will be tested in a specially design single-cavity HTC in late June / July. The prototype input couplers and HOM loads will be used in this test.
- Assembly of the five-cavity injector cryomodule is expected to be finished by the end of the year with installation starting early in 2008.

HOM Damping and Coupler Mutipacting Simulations

<u>Z. Li</u>, L. Xiao, L. Ge

A. Candel, *A.Kabel,* C. Ng, K. Ko

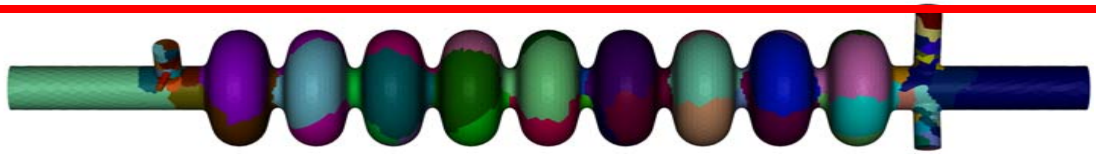
V. Akcelik, S. Chen, L. Lee, E. Prudencio, G. Schussman, R. Uplenchwar

SLAC-Advanced Computational Department

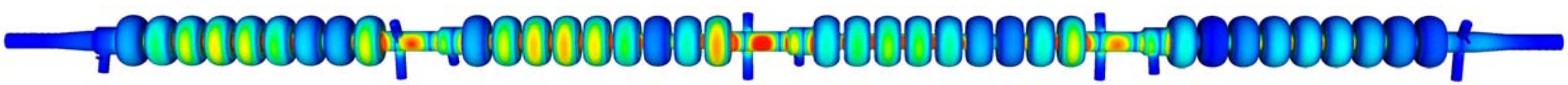
Work supported by U.S. DOE ASCR & HEP Divisions under contract DE-AC02-76SF00515

SLAC 3D Parallel FEM EM Codes

- Tetrahedral Mesh with Finite-Element
  - Up to 6th order basis for field accuracy
  - Unstructured grid for modeling geometry with large variation in dimensions
- Parallel implementation (10^2-10^3 processors, 10^2GB memory)
  - Modeling details with great realism



  - Simulating large systems such like multi-cavity cryomodule

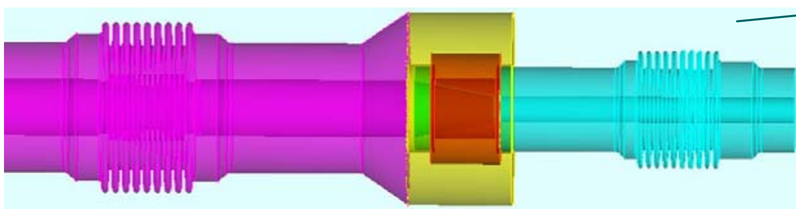


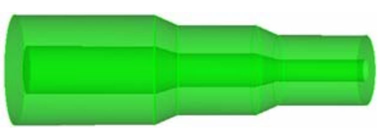
- A suite of solvers including frequency domain and time domain

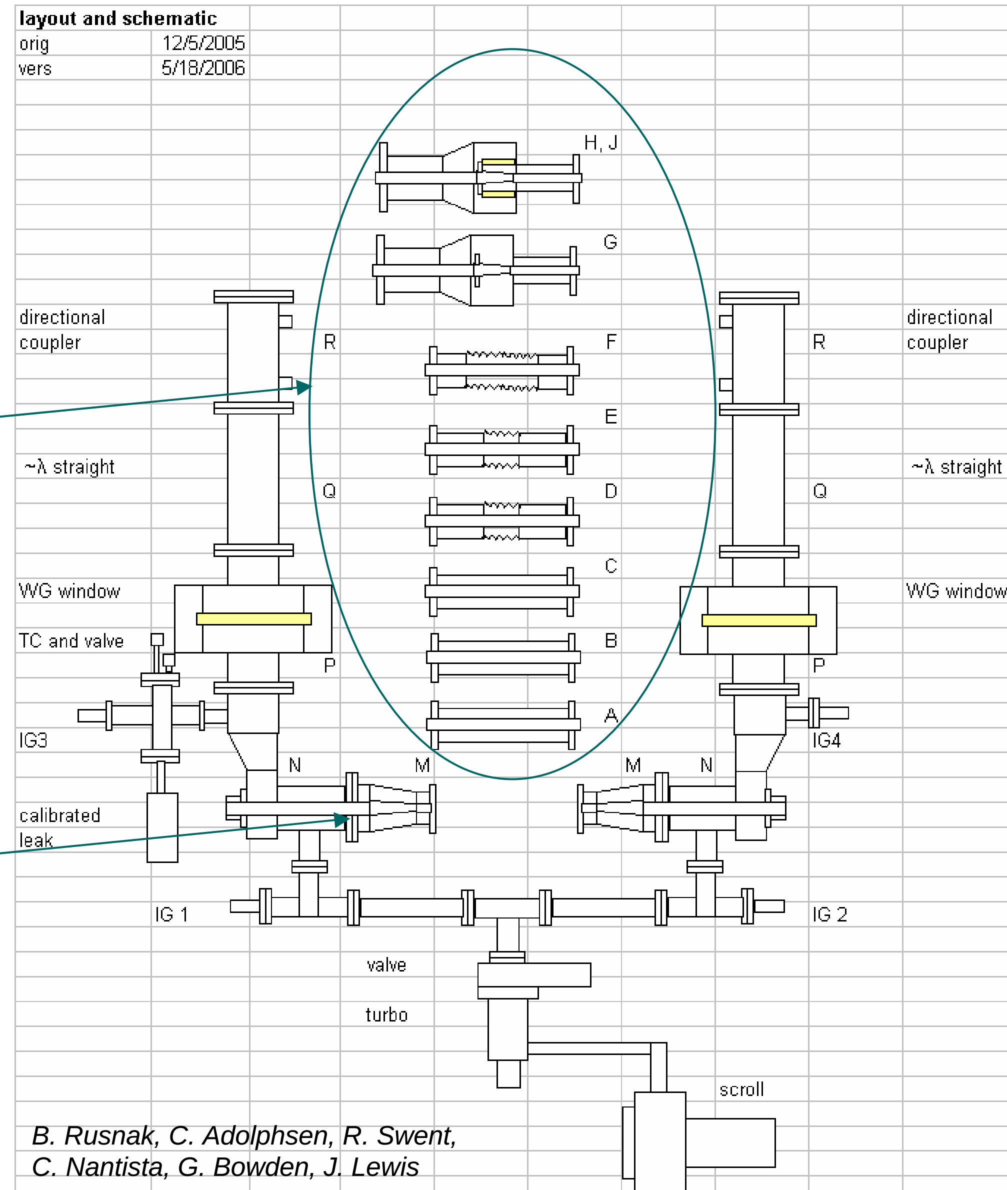
Omega3P	- Frequency Domain Mode Calculation
S3P	- S-parameter Computation
T3P	- Time Domain With Beam Excitation
Track3P	- Particle Tracking, MP and dark current
V3D	- Visualization
…	

Coupler Test Setup

Will simulate all the components to compare with and to help understand the HP test results







B. Rusnak, C. Adolphsen, R. Swent, C. Nantista, G. Bowden, J. Lewis

TTC meeting KEK

SLAC

First Results on a New 1.3 GHz Coupler Component Test Stand*

B. Rusnak (LLNL) (presenting), C. Adolphsen, F. Wang, G. Bowden, E. Doyle, L. Ge, K. Jobe, L. Laurent, B.D.McKee, C. Nantista, R. Swent, J. Tice, N. Yu (SLAC)

2007 TTC Meeting at Fermilab

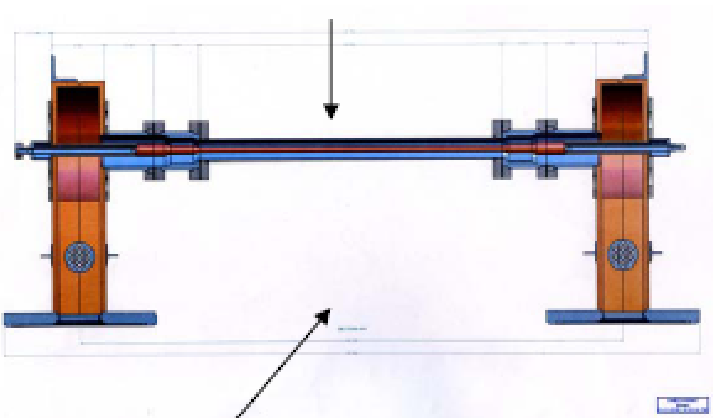
April 23-26, 2007

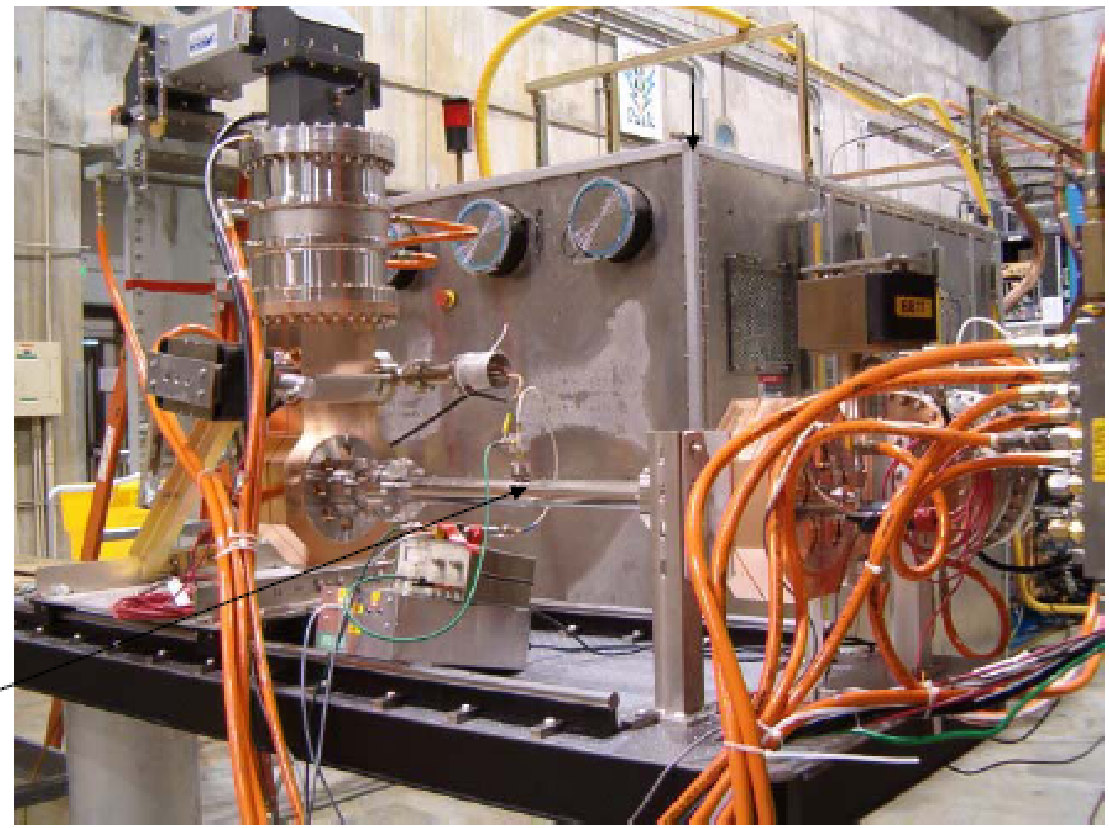
This work was performed under the auspices of the U. S. Department of Energy by the University of California, Lawrence Livermore National Laboratory under Contract No. W-7405-Eng-48.

SLAC

To do these measurements, a novel L-band test stand was developed and installed at SLAC

Component Under Test



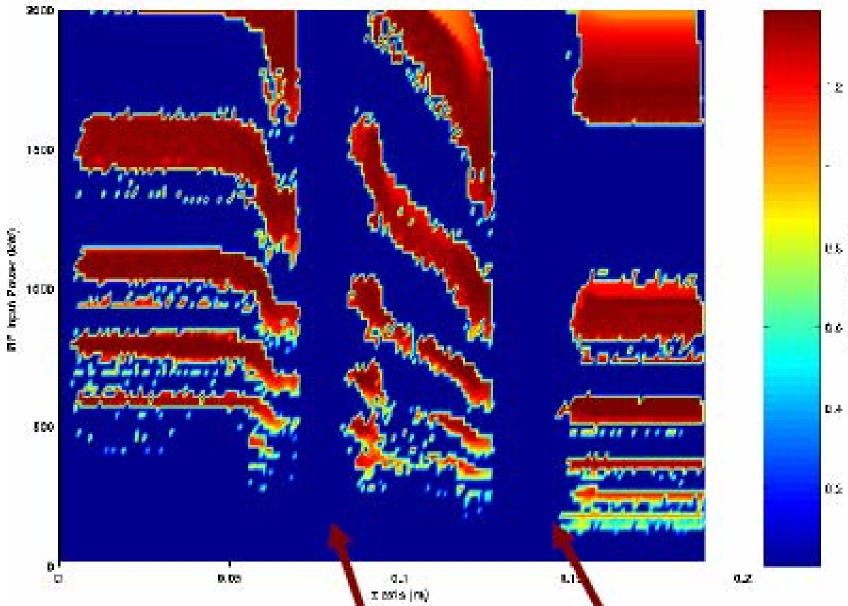


Concept and hardware of test set up for measuring components – first test component is a 40 mm straight tube

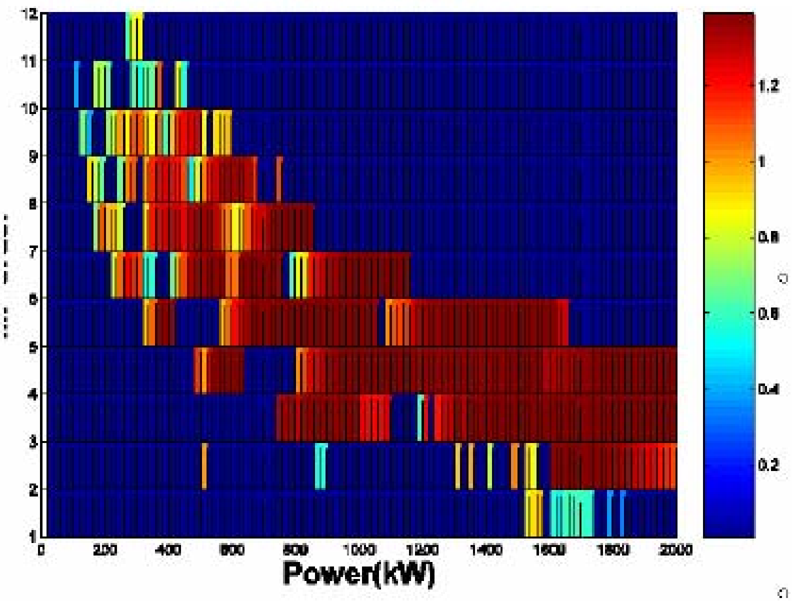
SLAC

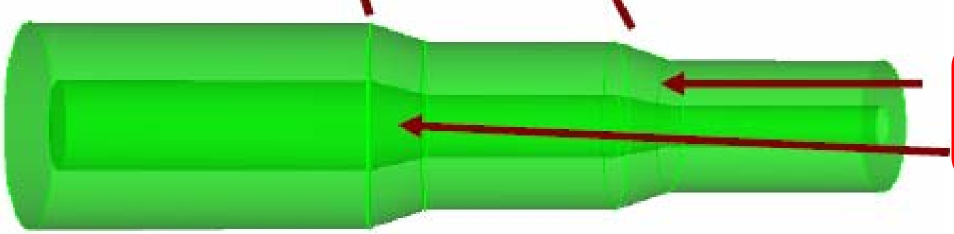
Taper Region Multipacting Modeling (Work by Lixin Ge)

Delta as a function of RF input power and z axis locations



Delta as a function of RF input power and MP order.





No Multipacting activities between coax pipe

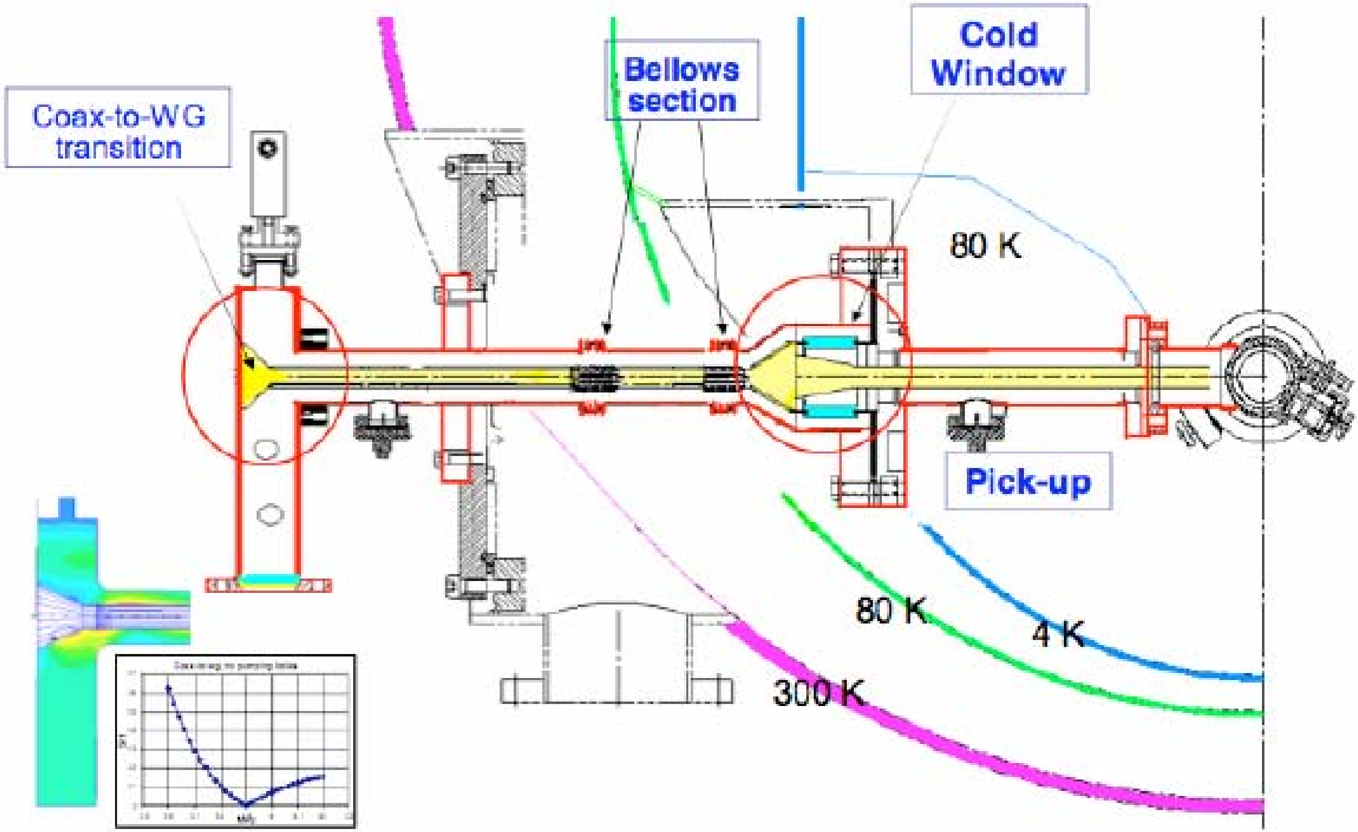
3.9 GHz Input Couplers at Fermilab

E. Harms

TTC Meeting

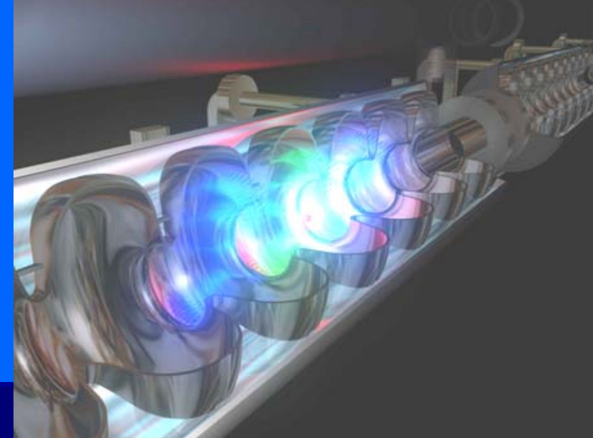
23-23 April 2007

Coupler Design & Specs



Conditioning Results to Date

- Maximum Power delivered - 71kW
  - 1.4 kW peak reflected
- Maximum Pulse Length - 1300 us/64kW
- Repetition Rate - 1/3 Hz, can now be adjusted to as fast as 2 Hz
- Temperature Rise - minimal
- Vacuum Activity - none
- Trips due to Arcing, etc. - none (expected)

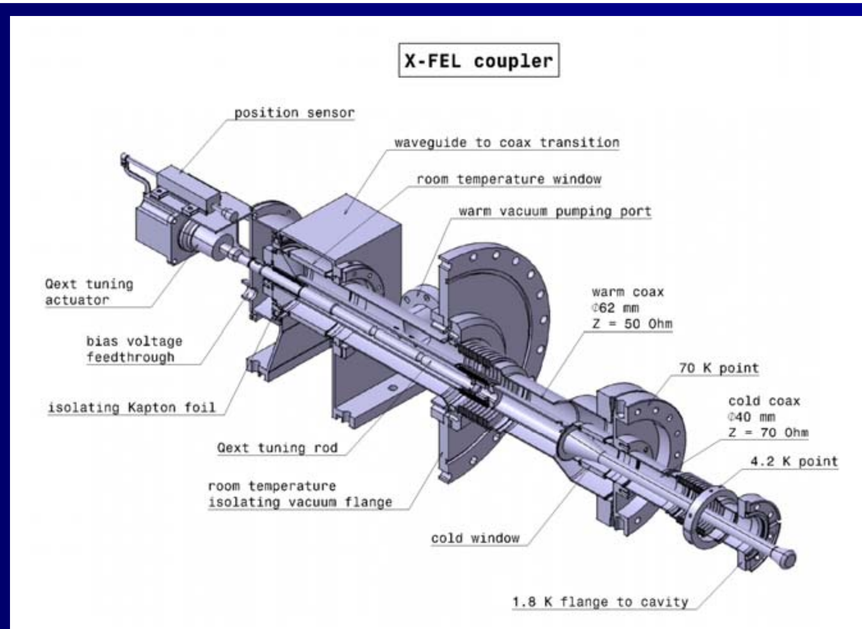


XFEL
X-Ray Free-Electron Laser

Industrialization process for XFEL Power couplers and Volume manufacturing

TTC meeting at Fermi lab, April 2007

Serge Prat / LAL - Orsay



Scope of delivery

Manufacturing parts and sub-assemblies

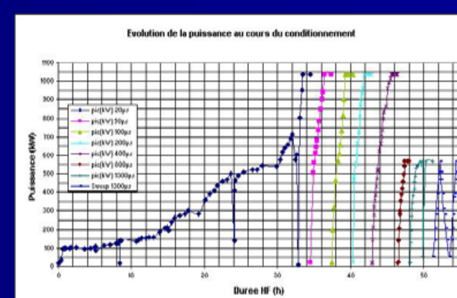
In ISO 6 and ISO 4 clean room:

- Cleaning
- pre-assembly
- Vacuum oven outgassing
- Final assembly on test stand

Final assembly

1 000 couplers are needed for XFEL

- Vacuum pumping
- In situ baking
- Connect to RF power

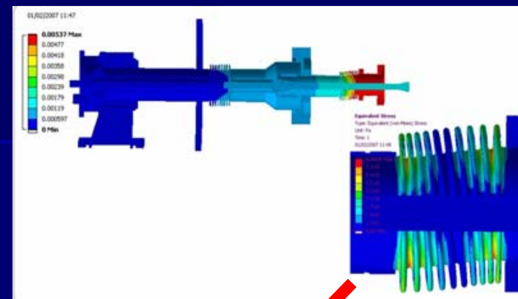


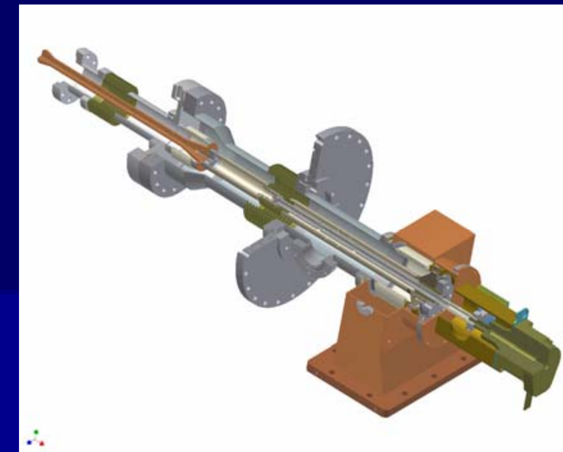
RF conditioning

- Dismount
- Pack
- Transport

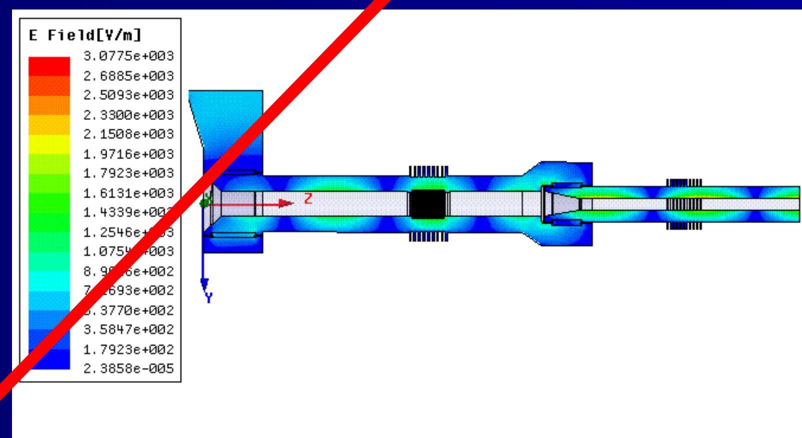
Deliver 2 by 2

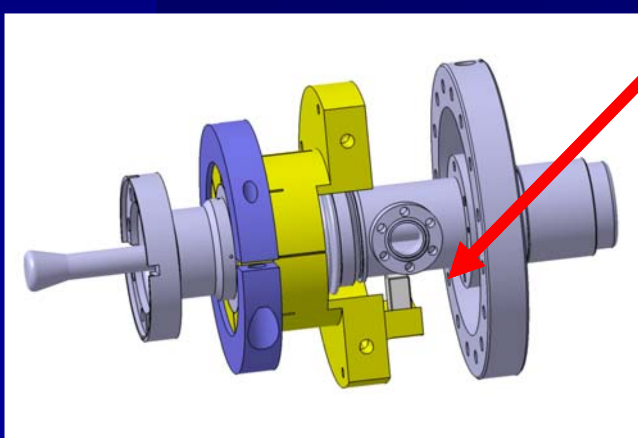
Some work results



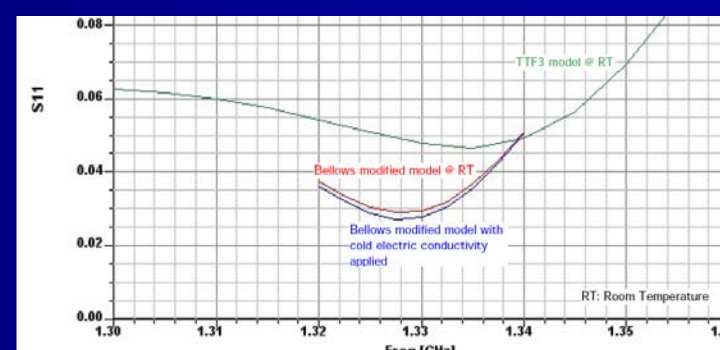


Warm window sample





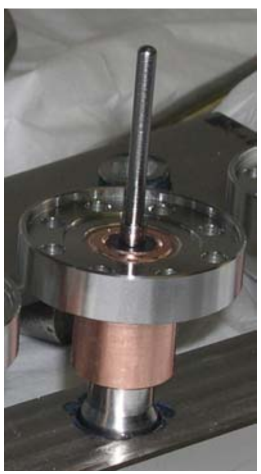
Sliding support

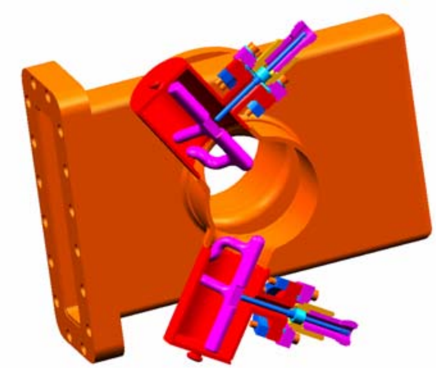


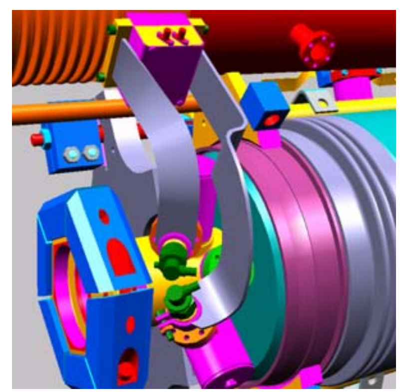
Measurements on the New HOM Feedthrough and Heat Station for the HOM Coupler at CW Operation

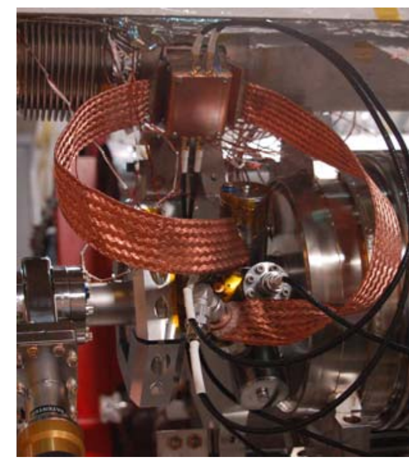
Ed Daly

for the SRF Institute



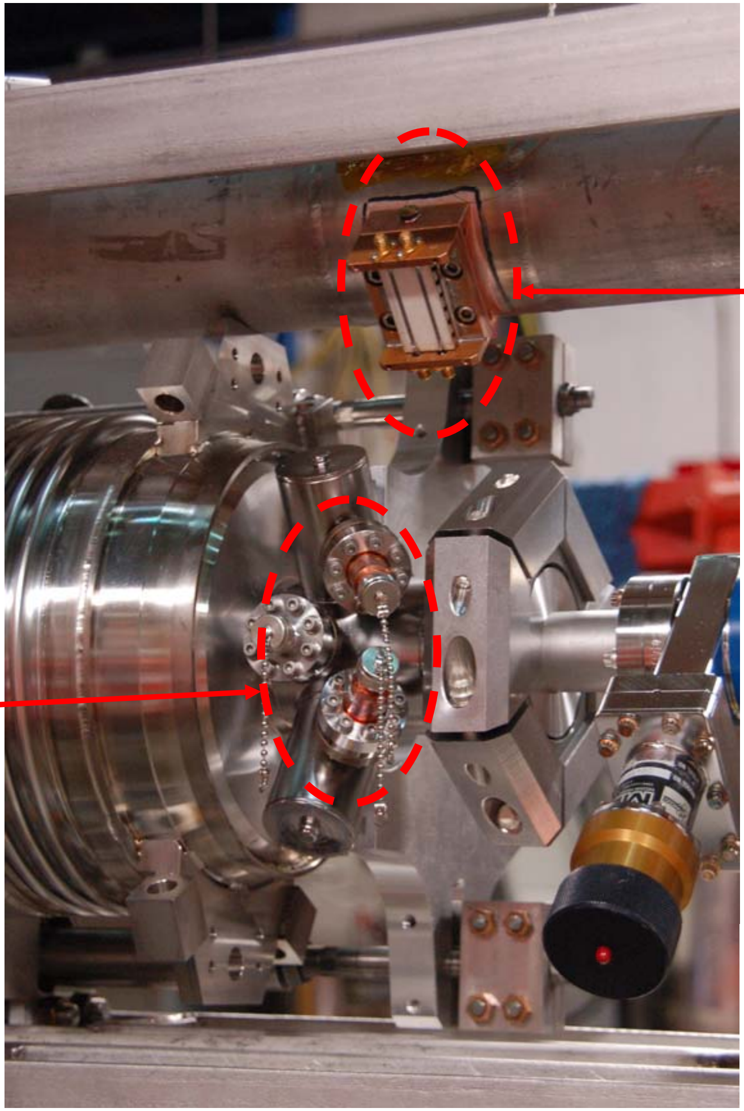






Heat Station and HOM Feedthroughs

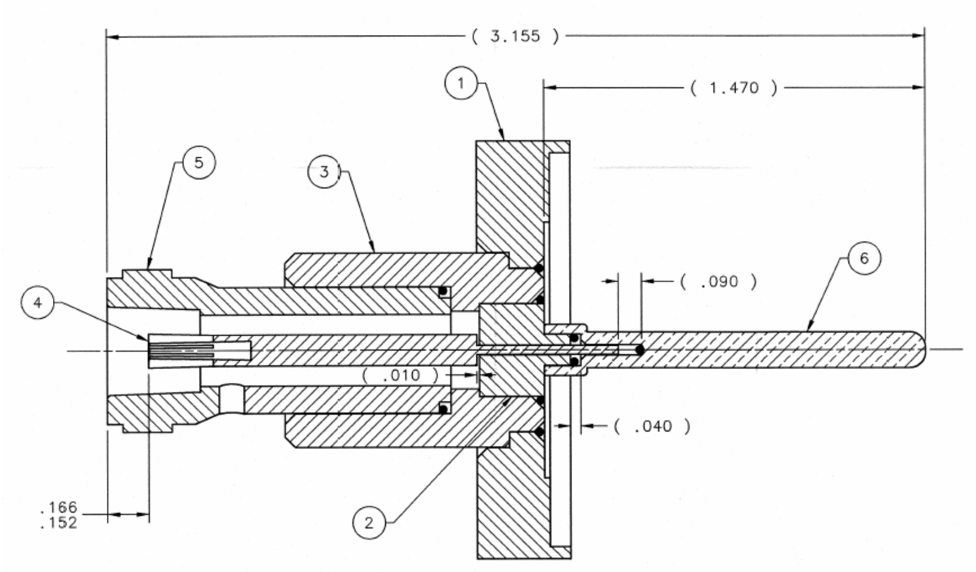
Two HOM feedthroughs installed on C100 HTB test cavities.



Heat station bolted onto Return Header.

Cu mounting block is brazed onto the SST pipe.

High Conductivity RF Feedthru



- Heat from Nb probe (item 6) is conducted through sapphire (item 2) to the copper sleeve (item 3).
- Heat is removed from copper sleeve via thermal strap to copper block on 2 K return header.

Prototype parts for Tesla-style cavity

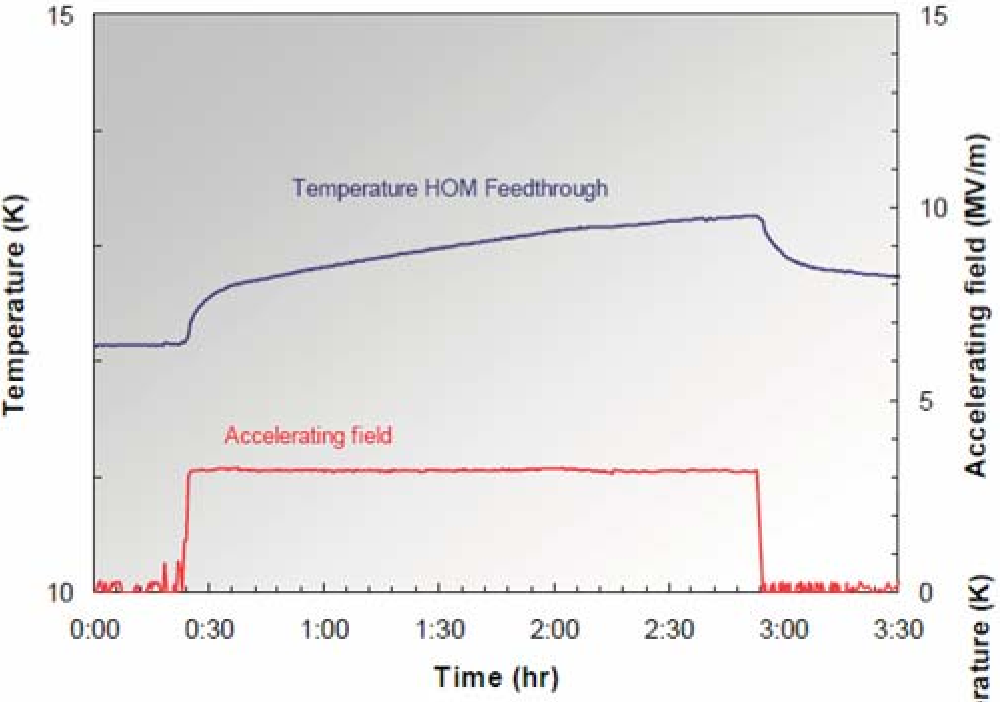
Conclusions / Future Work

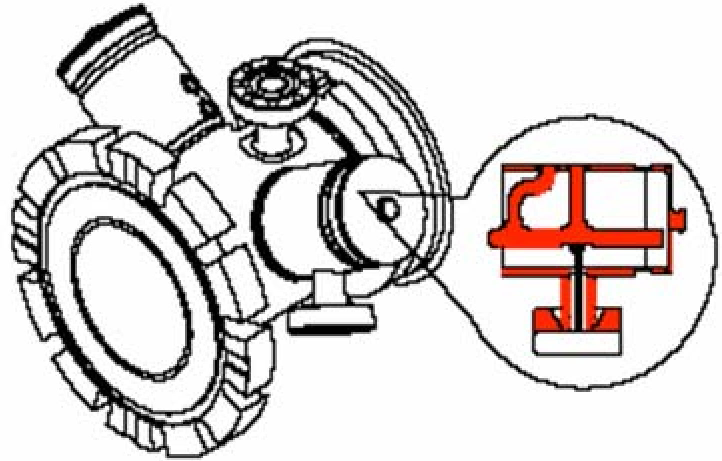
- Conclusions
  - Stripline heat station isolates cable inner conductor heating from HOM feedthrough
  - Feedthrough performs well; maintains SC Nb probe tip
  - Very conservative thermal anchoring scheme
- Future Work
  - Test REN with improved heat stationing
    - Fields not reduced…
  - Quantify component performance limits – what simplifications can be made (impact on 12 GeV)
  - Understand dynamic losses in RF cables – better specifications

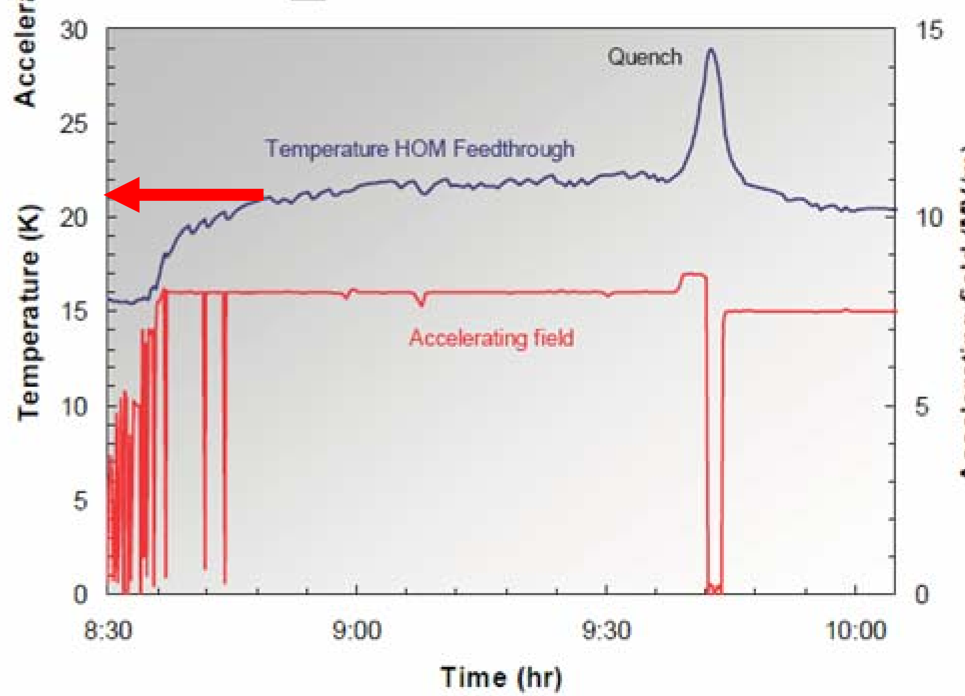
CW Operation of TESLA HOM Loop Couplers

J. Knobloch, BESSY

Heating at the HOM Picku



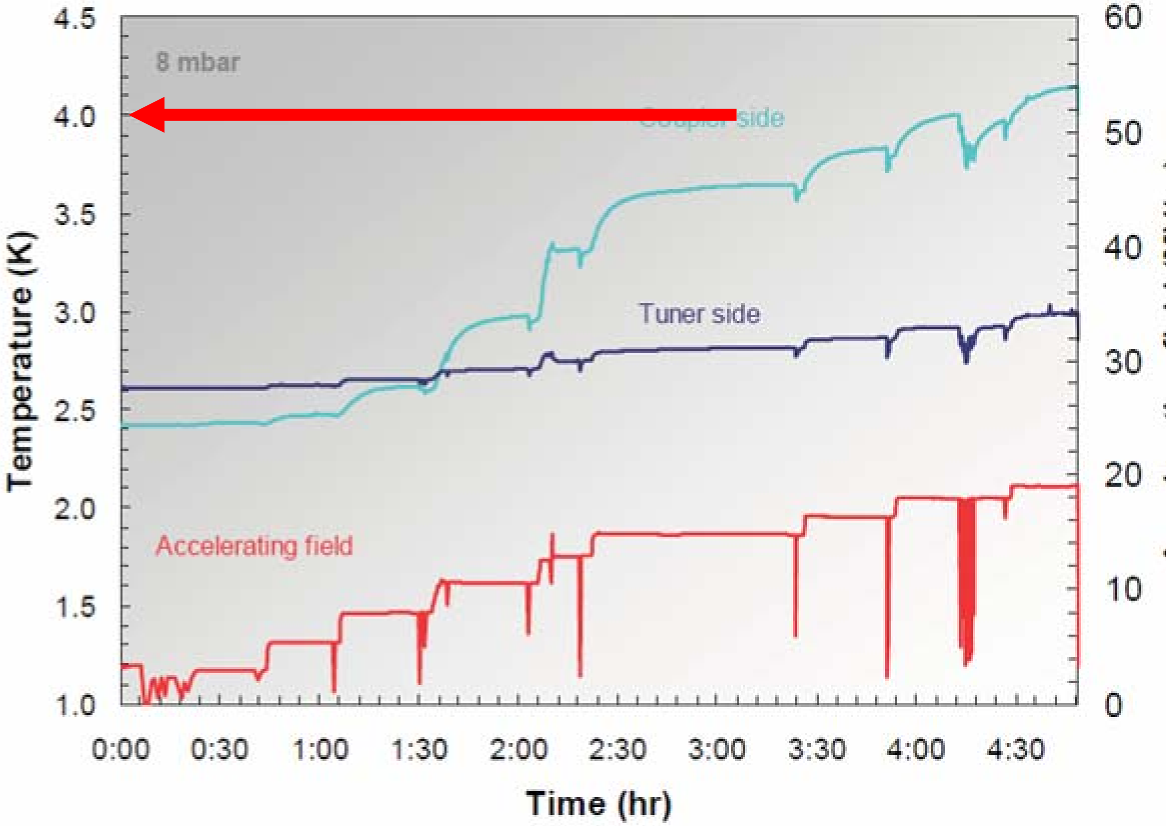




Effect of the HOM Pickup cable

isconnected the HOM Pickup cables

- Zero-field temperatures drop significantly (nearly 4 K)
- Temperature rise on tuner side very small & time constant short
- Larger time constant and temperature rise on coupler side.

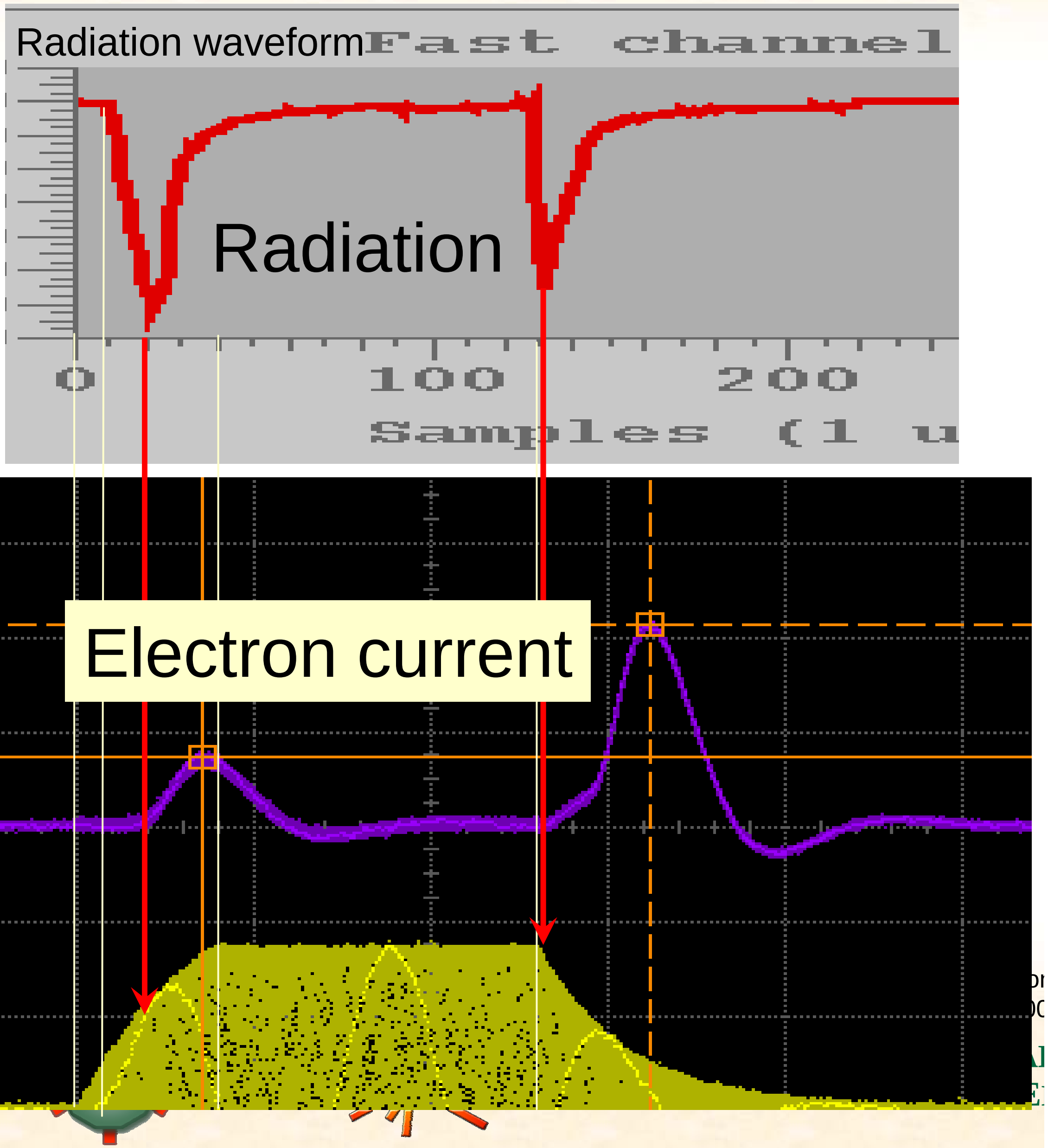


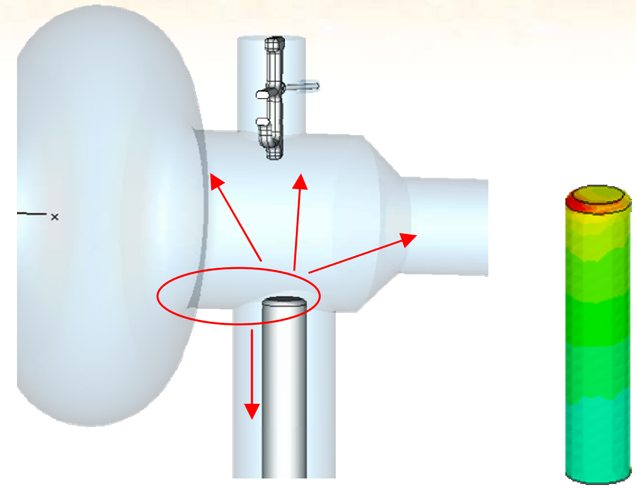
SRF Operations at SNS

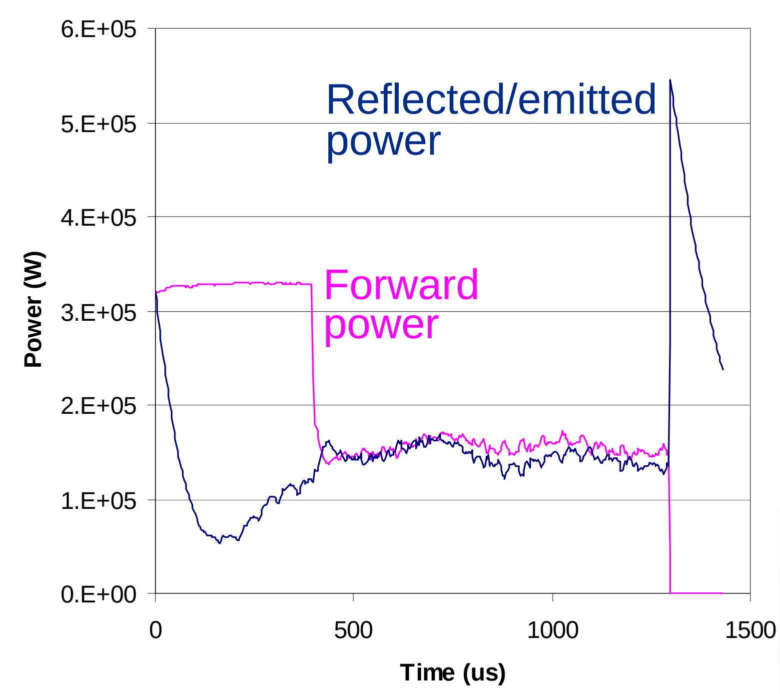
Isidoro Campisi and Sang-Ho Kim

For the SNS SRF Task Force

FPC interaction with cavity field







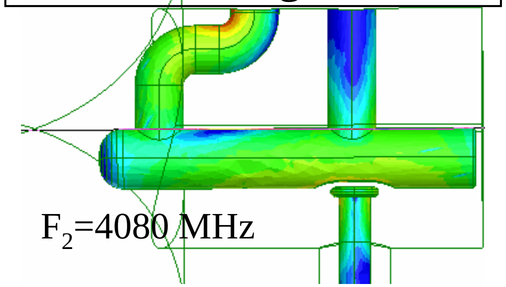
Conclusion

- **HOM filters are not needed for SNS and will be phased out (blanked off for now and later removed)**
- **CCG's cannot provide interlock protection for FPC windows and will be replaced by electron current monitors**
- **Piezo tuners may be needed for only a handful of cavities and will be eliminated in the cryomodules being repaired**
- **Field emission (not necessarily from contamination) needs to be understood and brought under control**
- **Many failure modes are lurking to make the operation of even a modest number of cavities difficult**
- **Some failure modes are peculiar to pulse operation (e.g. one can afford to operate more deeply into field emission and be vulnerable to HOM problems, cryogenics overload etc.)**

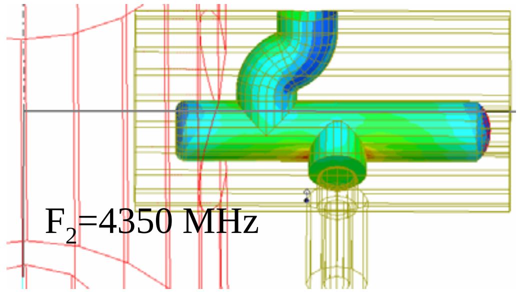
Designs of the HOM coupler, T. Khabiboulline, FNAL

3rd harmonic cavities for FLASH

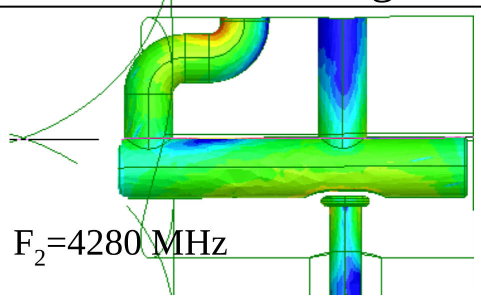
Initial design No.1



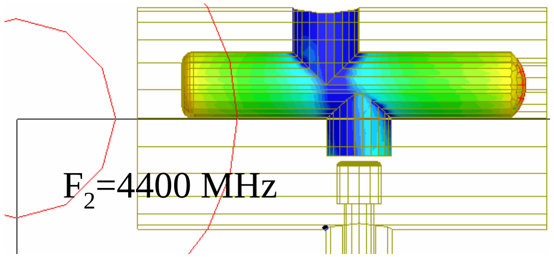
1-post design #3



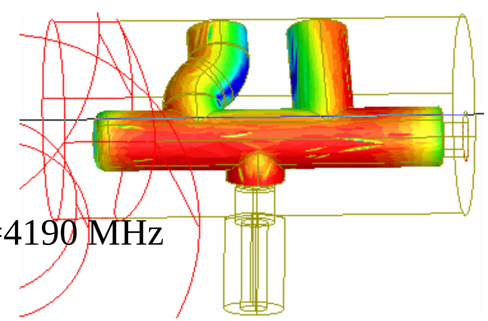
Trimmed Initial design -1a



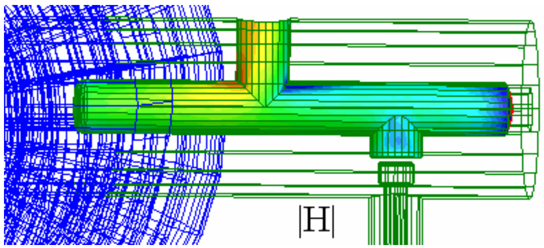
1-post design #4



Modified 2-post design #2



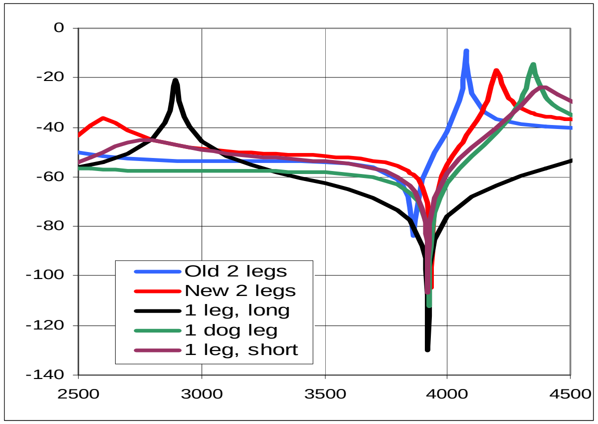
1-post Long design #5



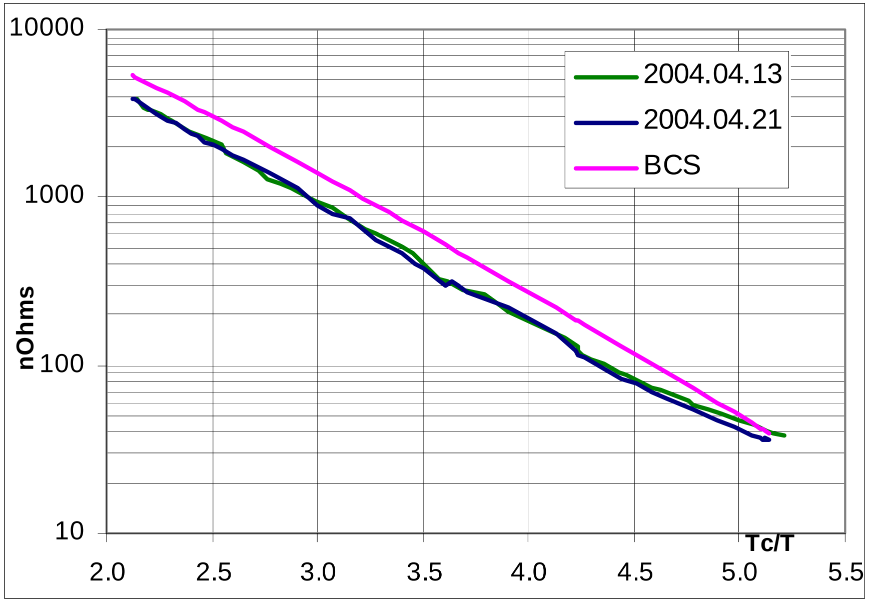
F_2=2900 MHz

HOM Comparison

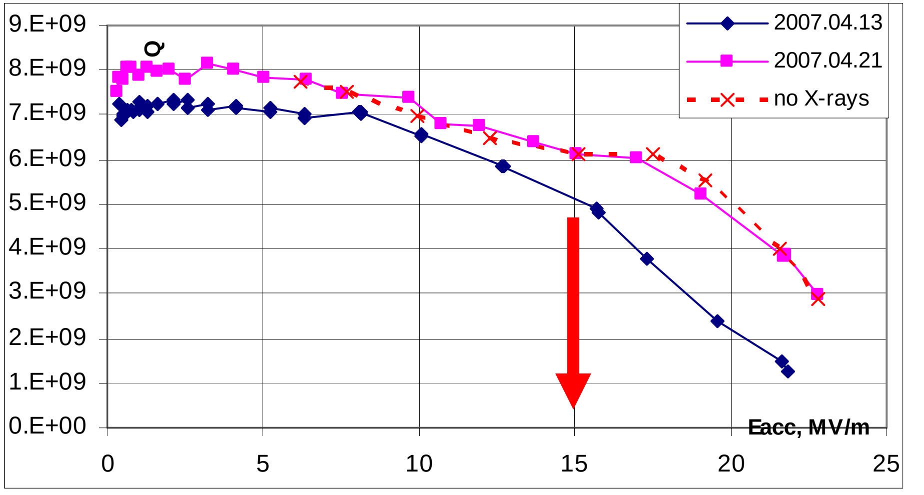
	Hp/H#1	Ep/E#1
HOM #1	1	1
HOM #1a	**0.4**	**0.4**
HOM #2	0.76	0.45
HOM #3	0.77	0.48
HOM #4	**0.67**	**0.31**
HOM #5	0.57	0.098
cavity	**7.4**	**3.5**



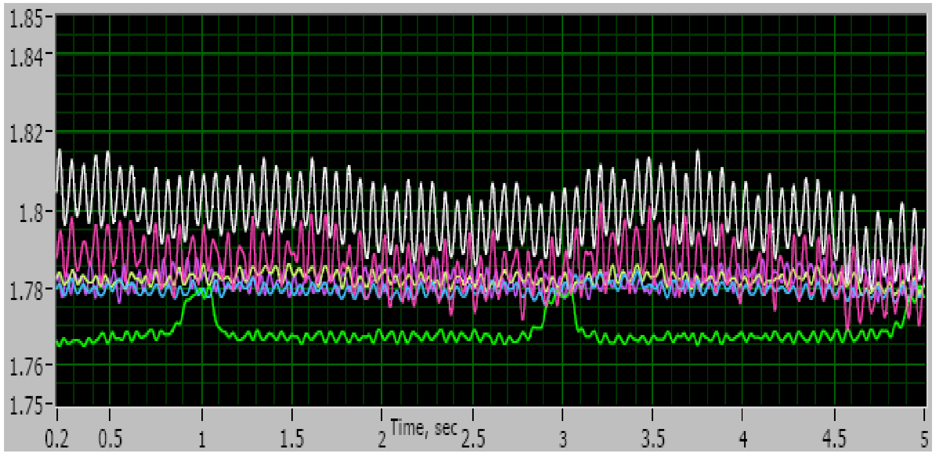
Nb 9 cell cavity N4. 2nd cold test after HPR. 2007.04.21.



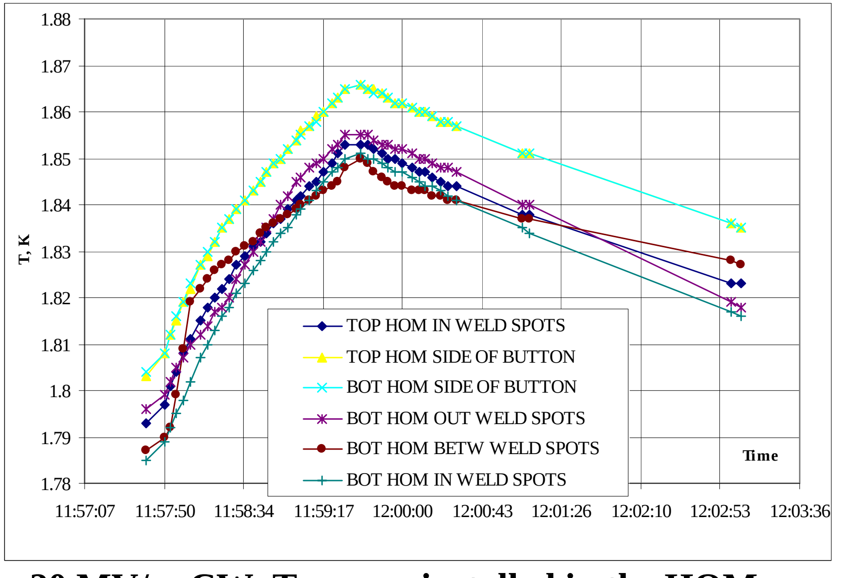
QvsT. Surface resistance Rs 36 nOhms.



QvsE. Eacc=23 MV/m. Limitation quench in the cavity. It was high x-rays at 15 MV/m. Then something happened and x-ray dropped ~1000 times.



Temperature sensor installed in the bottom end cell shows some heating during RF pulse.



~ 20 MV/m CW. T-sensor installed in the HOMs.

Conclusions:

- The source of the heating of the HOM found.

- Multipactor calculations and measurement results are in a good agreement.

- Several new designs of the HOM developed for dumping of the multipactoring.

- Modified (trimmed) old design HOM coupler allows reduce fields in coupler by factor of ~2.5. It shifts MP threshold to ~27 MV/m. Test results (~23MV/m, no MP) are in a good agreement with expectations. Cavities #3-6 will have trimmed design.

- Prototype of a new one leg design is tested and approved for next Nb cavities. End groups with this design under production.

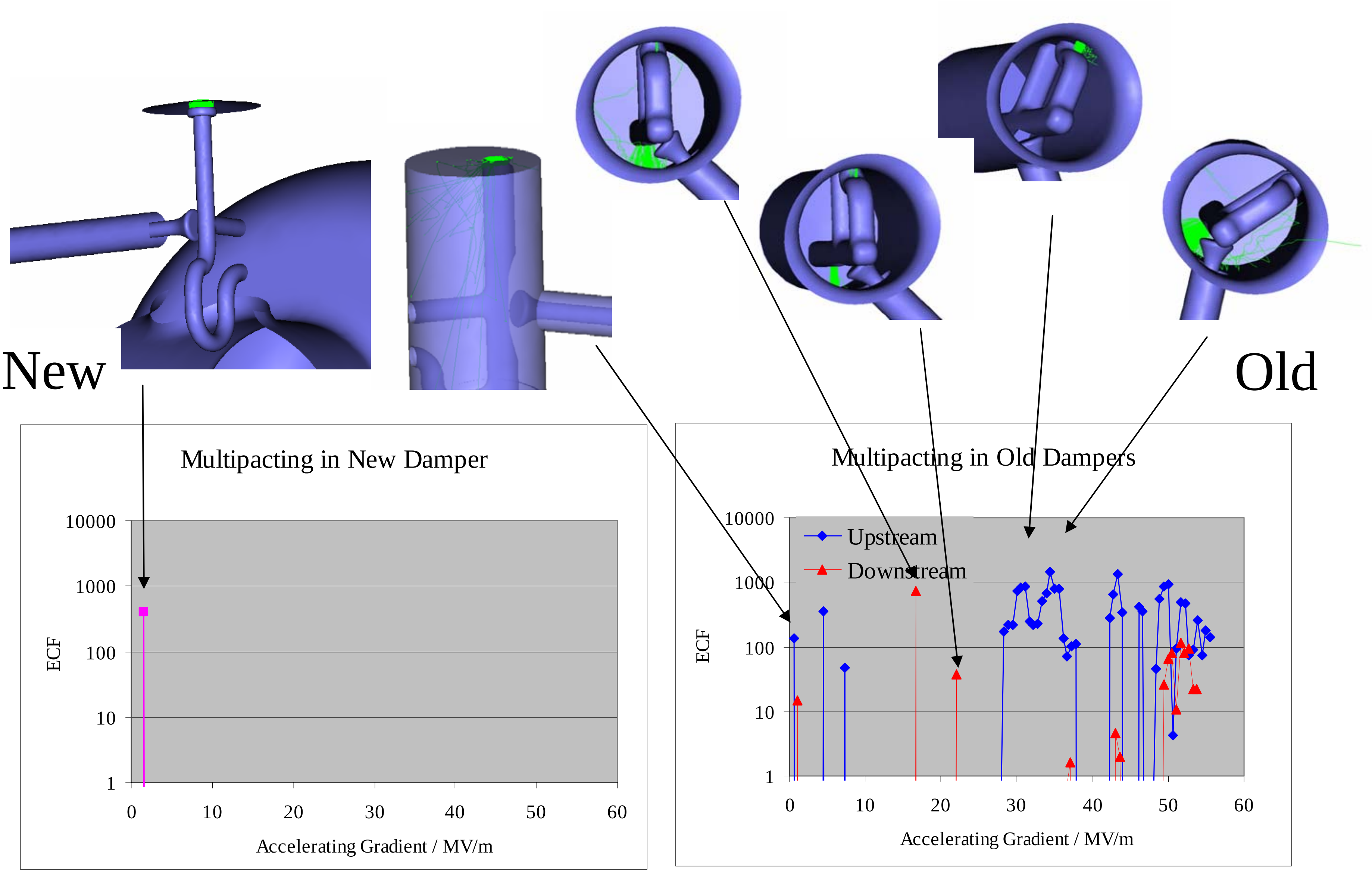
New HOM Dampers for KEK 45 MV/m 9-Cell Structures

- Part of Revision of End Structures –

Morozumi Yuichi

High Gradient SRF Development
KEK

Suppression of Multipacting in HOM Damper



Summary

HOM Damper – Newly Designed for Improved Cavity Characteristics and Performance

Multipacting – Highly Reduced

HOM Damping – Improved or Acceptable (under Evaluation for Higher Frequency HOMs)

Accelerating Mode Decoupling – Checked

High lights WP4

- very powerful simulation tools are available for new developments and investigation of problems
- together with this simulations there is a test stand available
- CW solution for the HOM coupler is available now