Module 6 Clean-up

July 2005

A project that involved many teams…

LANSCE-MDE Crew:
Jim O'Hara, Walt Barkley, Brandon Roller, Mike Perez, Felix Olivas, John Harrison, Jeff, Hannaford, Sunny Cordova, Jeff Casados, Fred Gorman, Mike Borden, Al Maestas, Victor Vigil

LANSCE-ABS Crew:
Jim Billen, Larry Rybarcyk

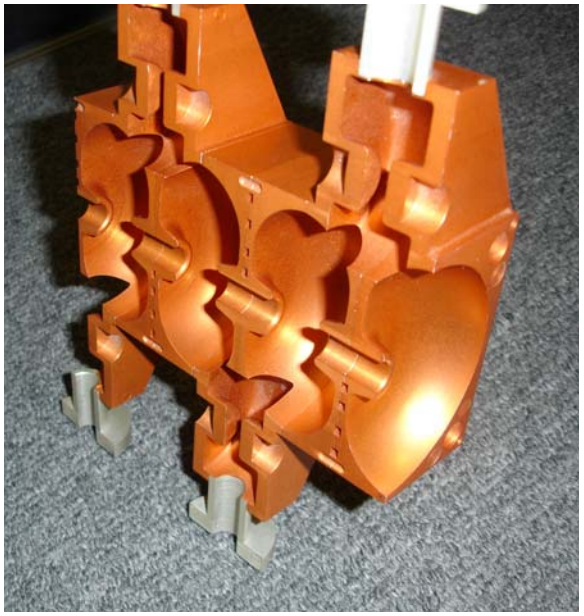
Consultant Crew:
Lloyd Young

LANSCE-RFE Crew:
Karen Young, Jerry Bolme, Alex Velasquez, Dave Keffeler, Dave Warner, Phil Torrez, Ed Partridge, Jillian Erickson, Brad Skidmore, Jerry Davis, Steve Ruggles

Outline

- Geometry of CCL Module 6
- Superfish Model of Module 6
- History of Module 6
- Inspection and Cleaning
- Bead Pull Set Up
- Bead Pull Results, Before and After the Cleaning
- X Ray Measurements
- Arc Rate Measurements
- Conclusions

Module 6 Geometry

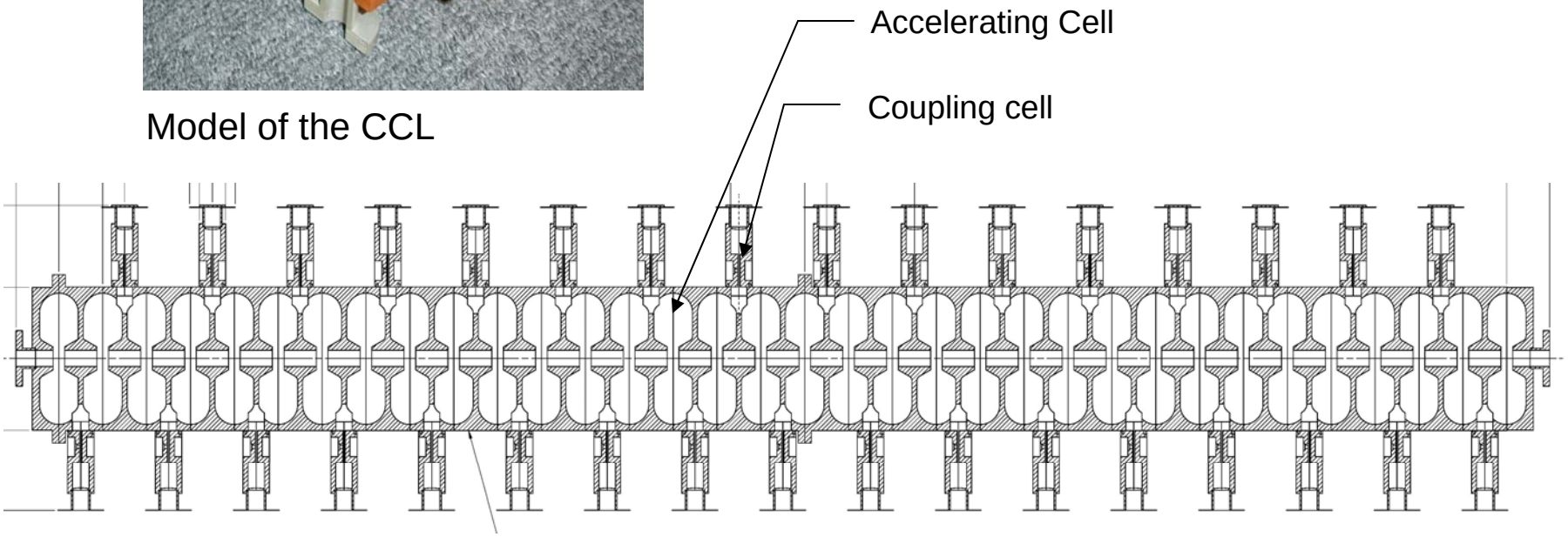


Model of the CCL

- Module 6 consists of 4 tanks connected with three bridge couplers.

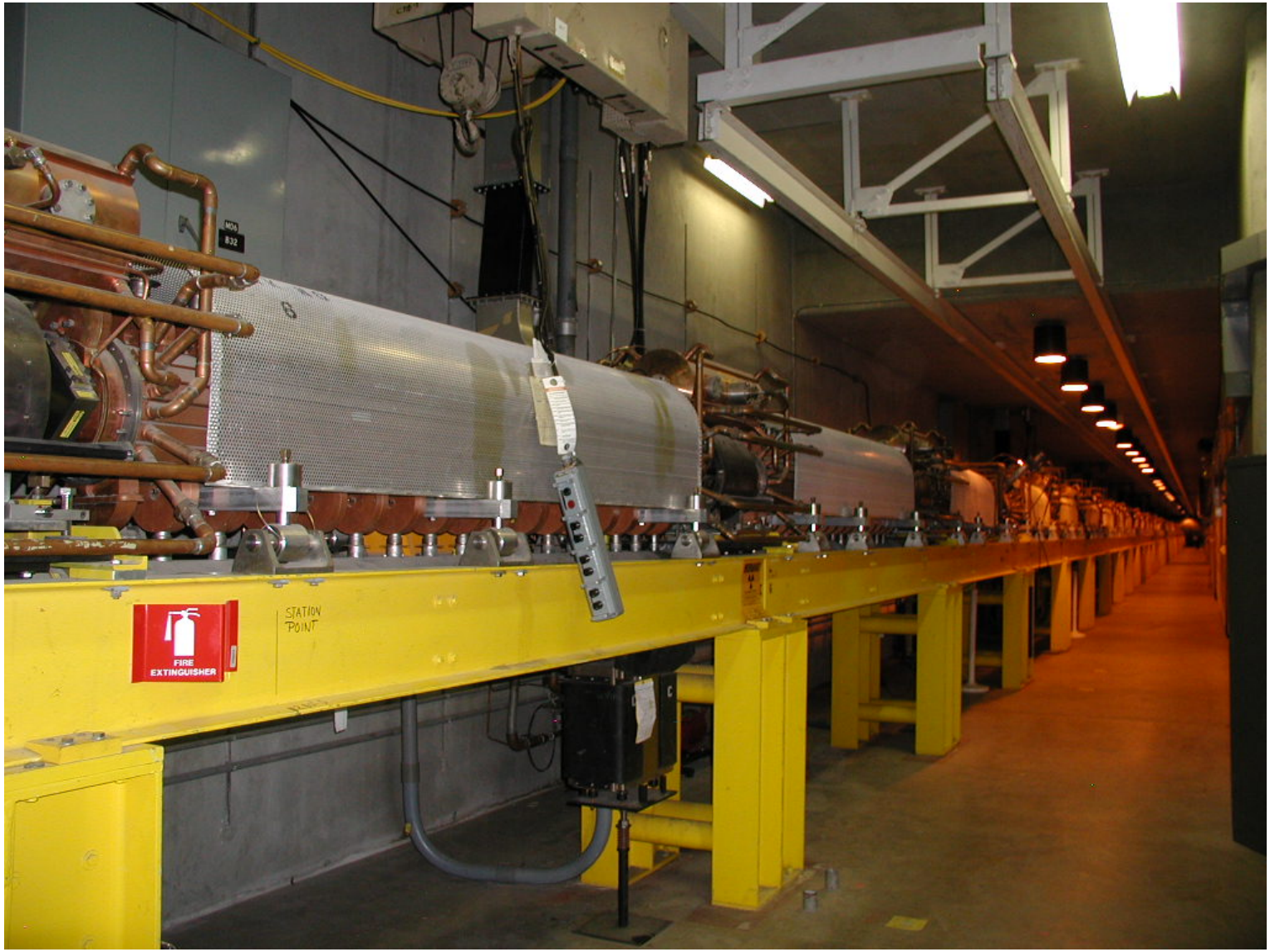
- RF is fed to all four tanks with one wave guide feed.

- Each tank has 34 accelerating cavities and 33 coupling cells.

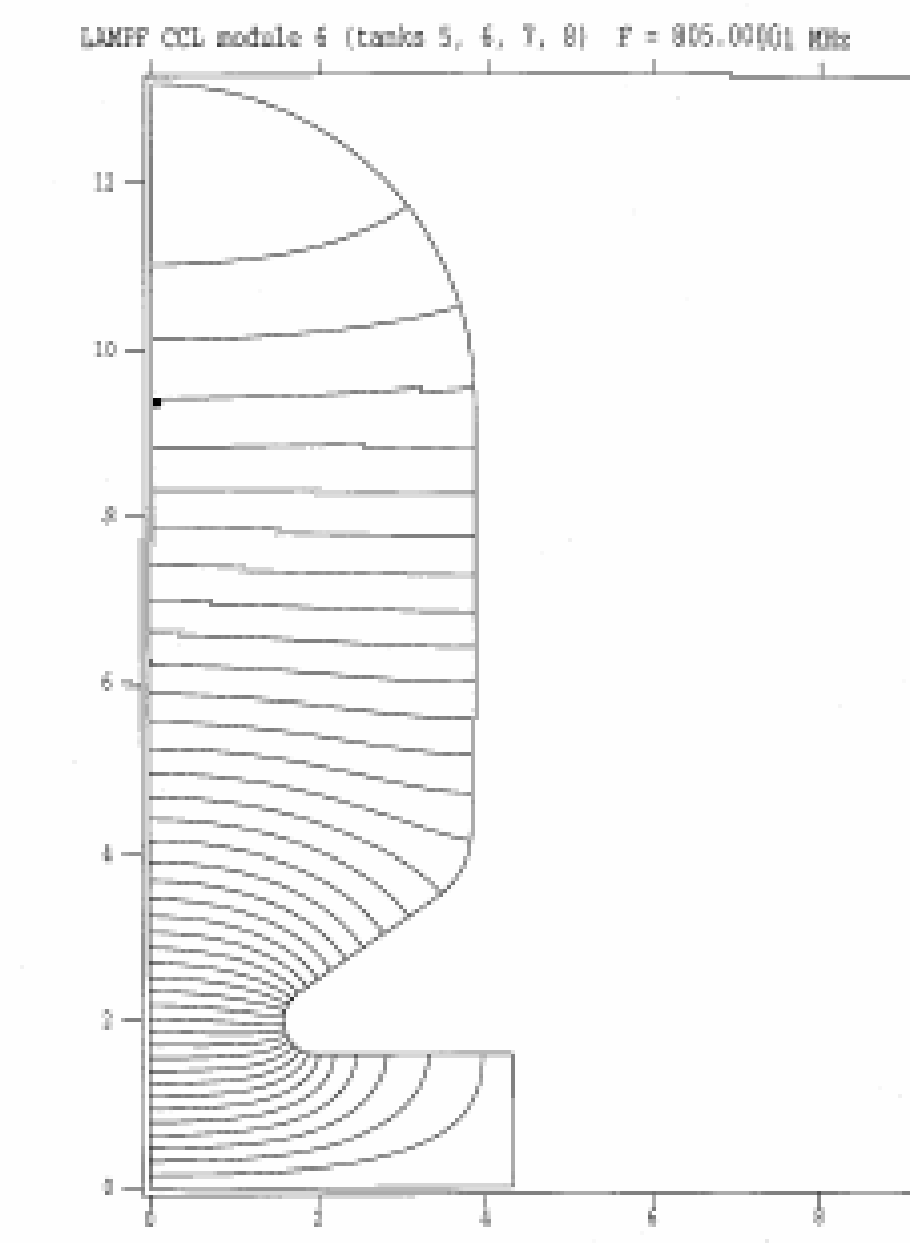


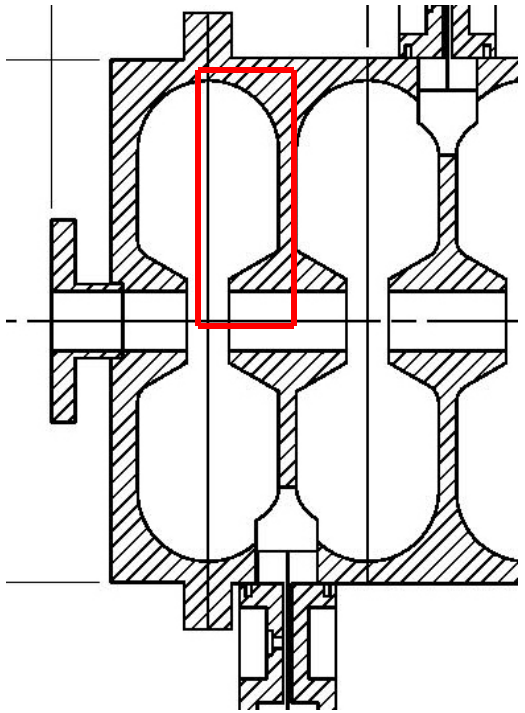
Cross sectional view of a tank on module 6

Module 6 Geometry



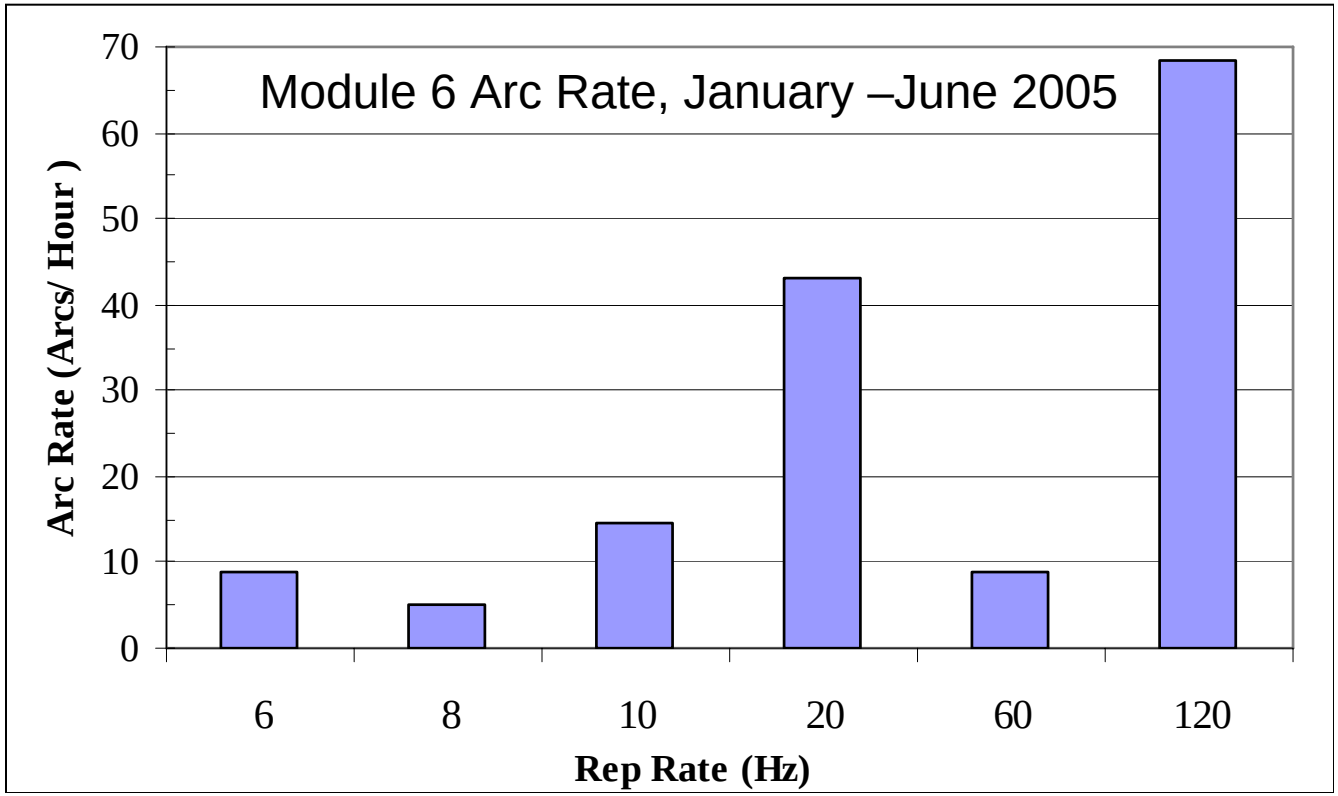
Super Fish Model





Module 6 History

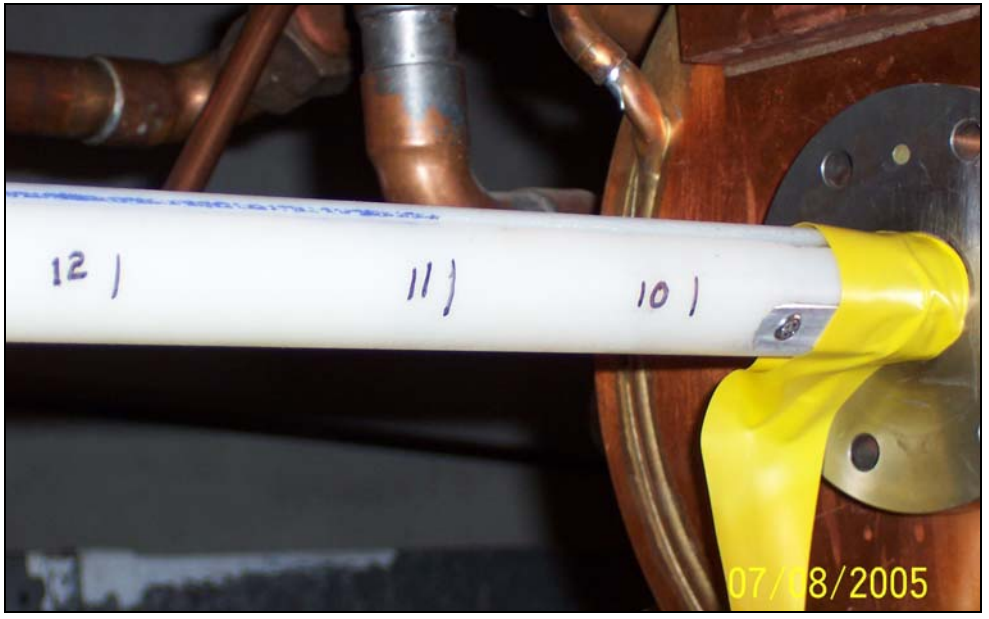
- After the shutdown, in January 2005, module 6 was turned on. It had been having vacuum problems. In Addition only 2 out of the 3 ion pumps were working. It was arcing and conditioning VERY slowly. After 5 days of conditioning, it was opened up for inspection.
- An O-ring was found between two nose cones in tank 8. It was vacuumed out.
- In March it de-conditioned. The tank was opened up and the noses were cleaned using a chamois cloth.
- It was run through June with a high arc rate.



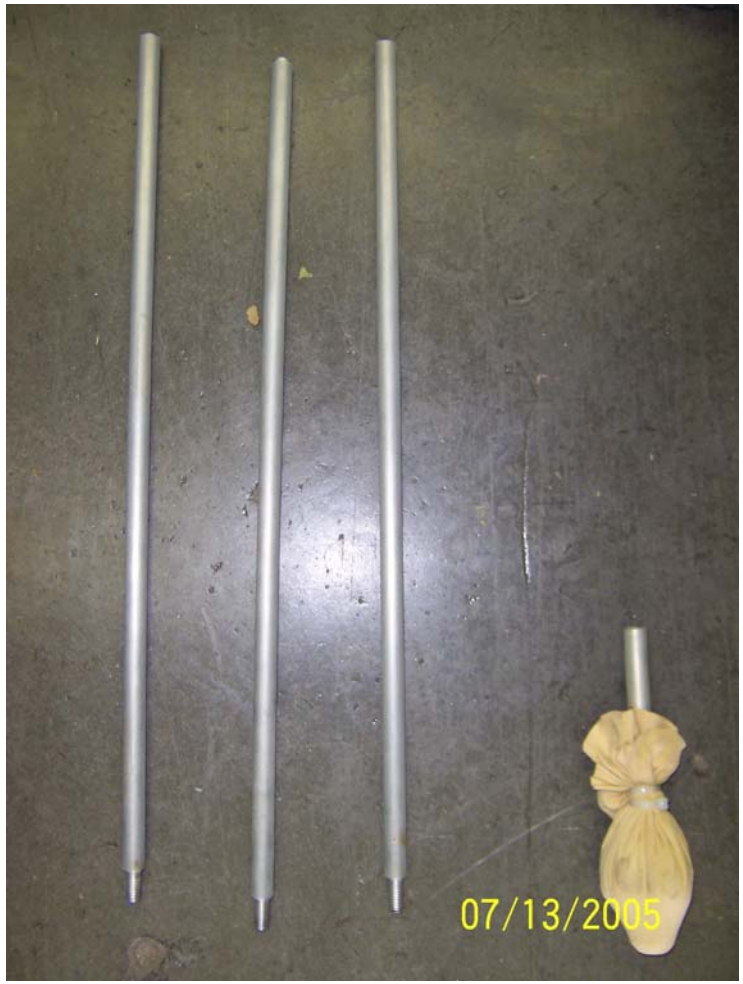
Initial Inspection

Initial inspection with the Bore-scope.

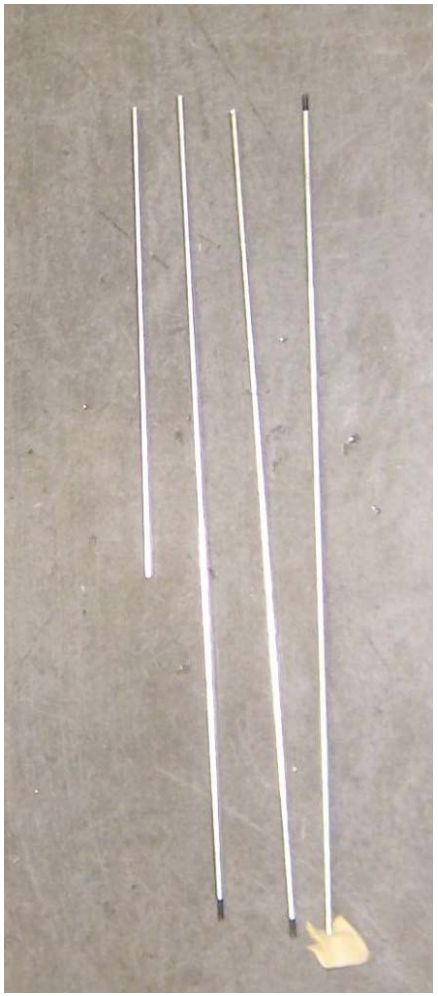
Nylon inspection/cleaning fixture. The numbers indicate which cells are being viewed.

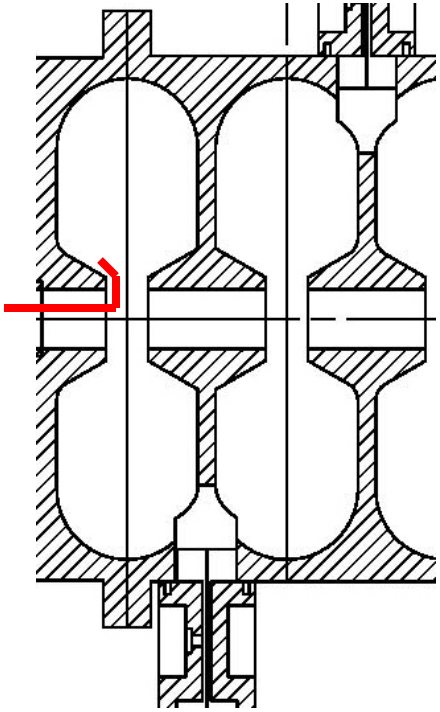


Cleaning Tools



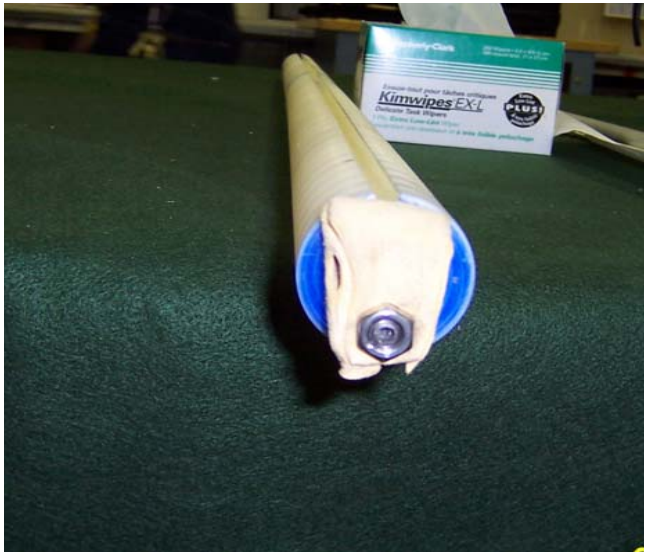
Q tip tool to clean the bore





Tool to clean surface of the noses

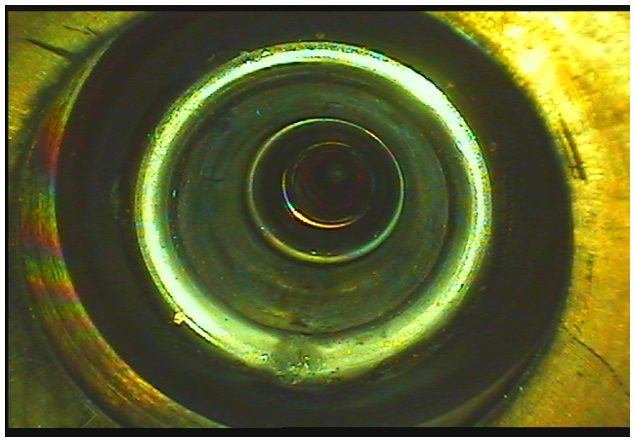
Cleaning Tools



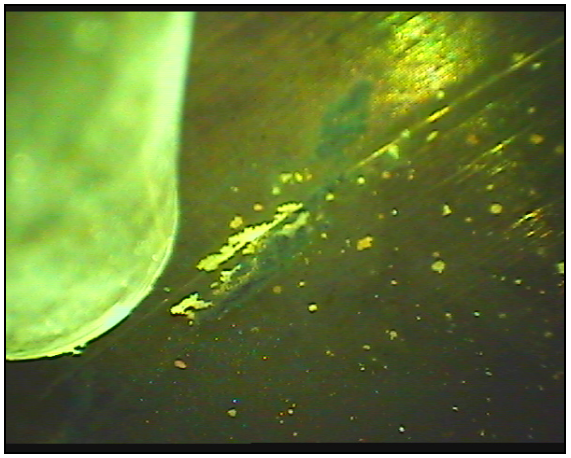
Cleaning tool with “cam-over” tip. The “key-hole” at the top is for the bore-scope

Q tip cleaning tool after the initial cleaning

Cell # 8



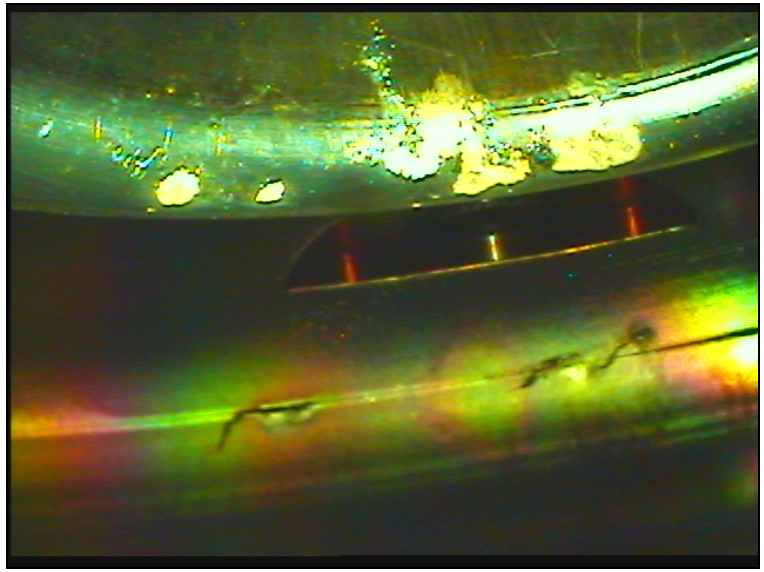
The nose of cell #8 before cleaning.
Note the arc damage at 6 O'clock position



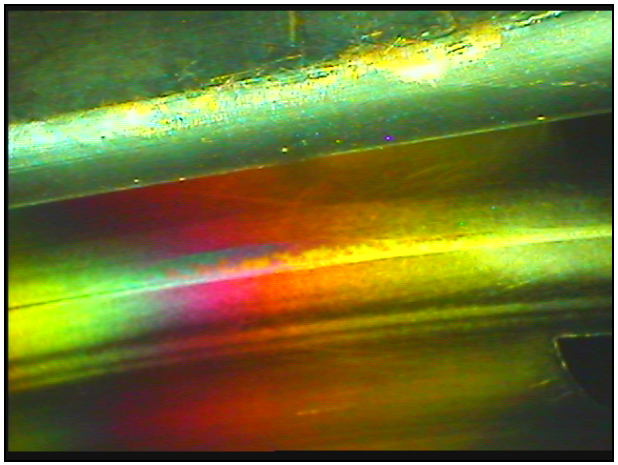
Debris and the remnants of the O-ring were found at the bottom of cell #8.

Tygon tubing with poly-flow working tool working at the bottom of cell #8

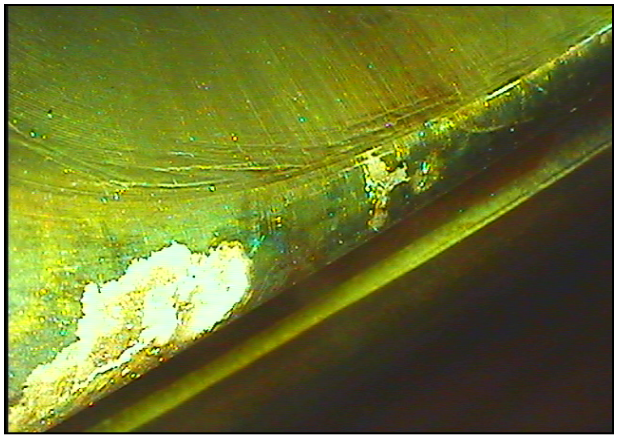
Picture showing both the damage on the nose and the O ring remnants



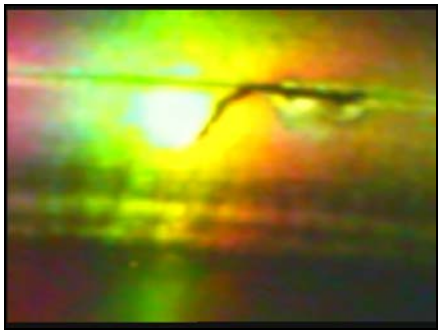
Cell # 8



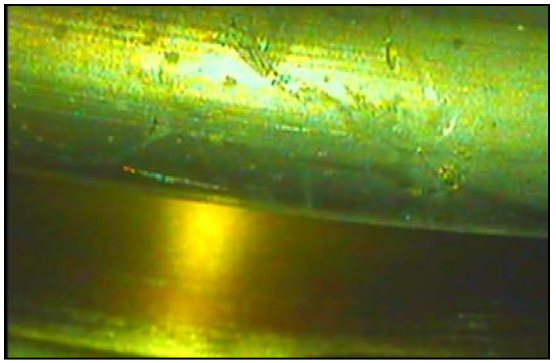
Discoloration on the wall of cell # 8



Upstream nose of cell #8

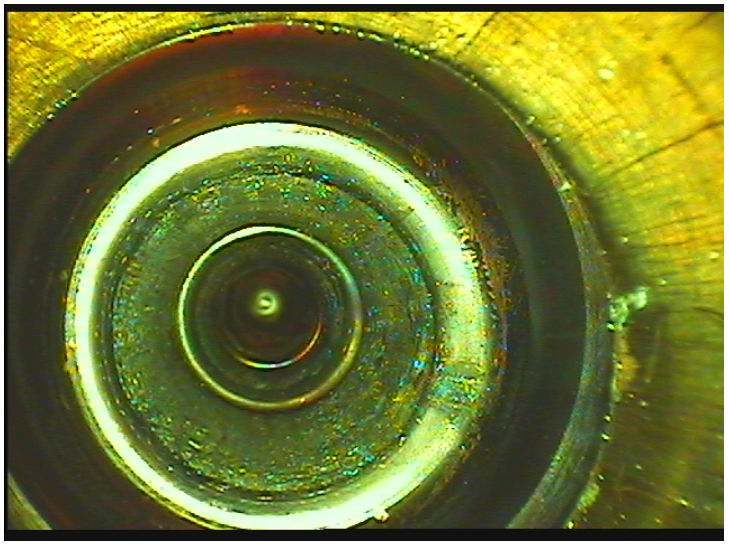


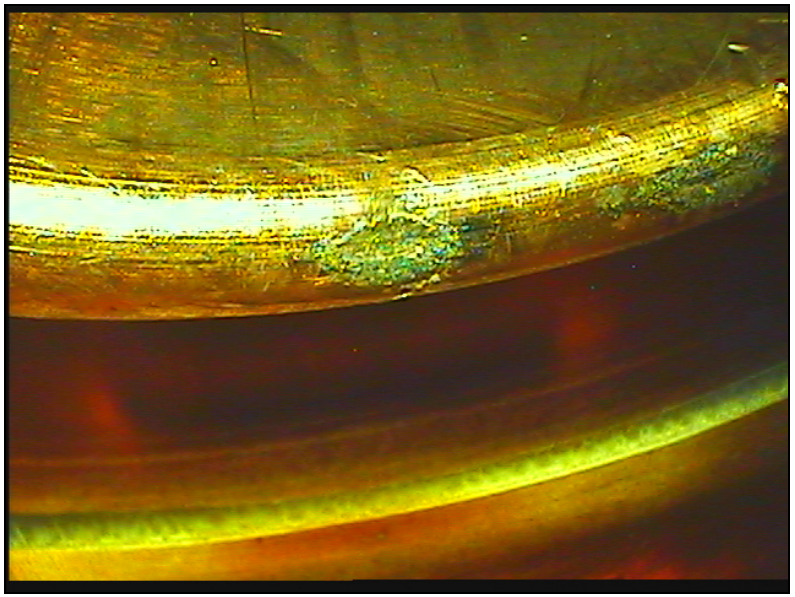
Debris in cell # 8 as seen from the bore

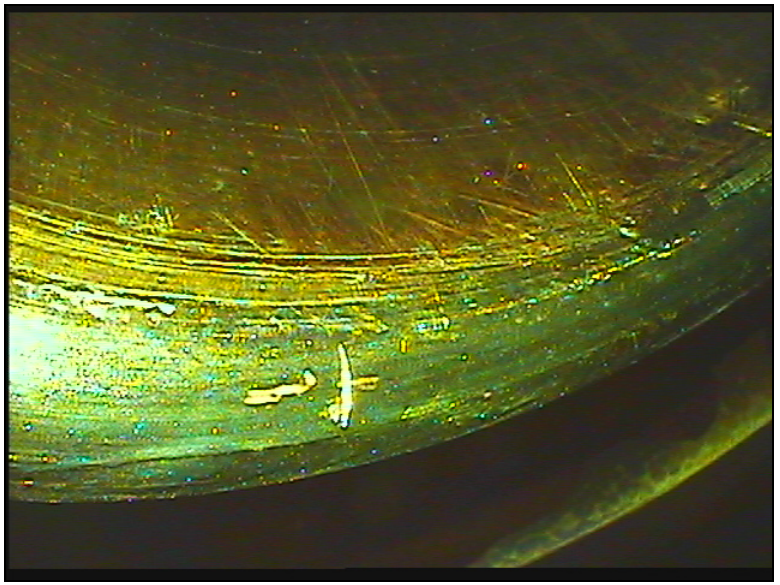


Abrasions located on Cell #8 upstream nose (3 O'clock).

Cell # 8 After cleaning







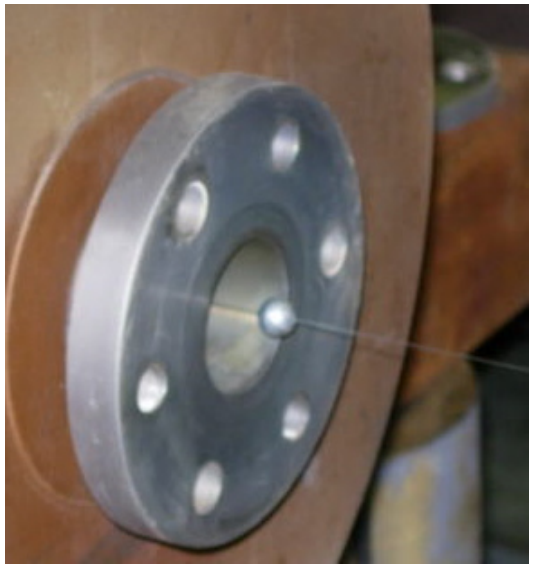
Bead Pull

- Practice runs were done using the lawn ornament south of building 6!

Lawn Ornament before

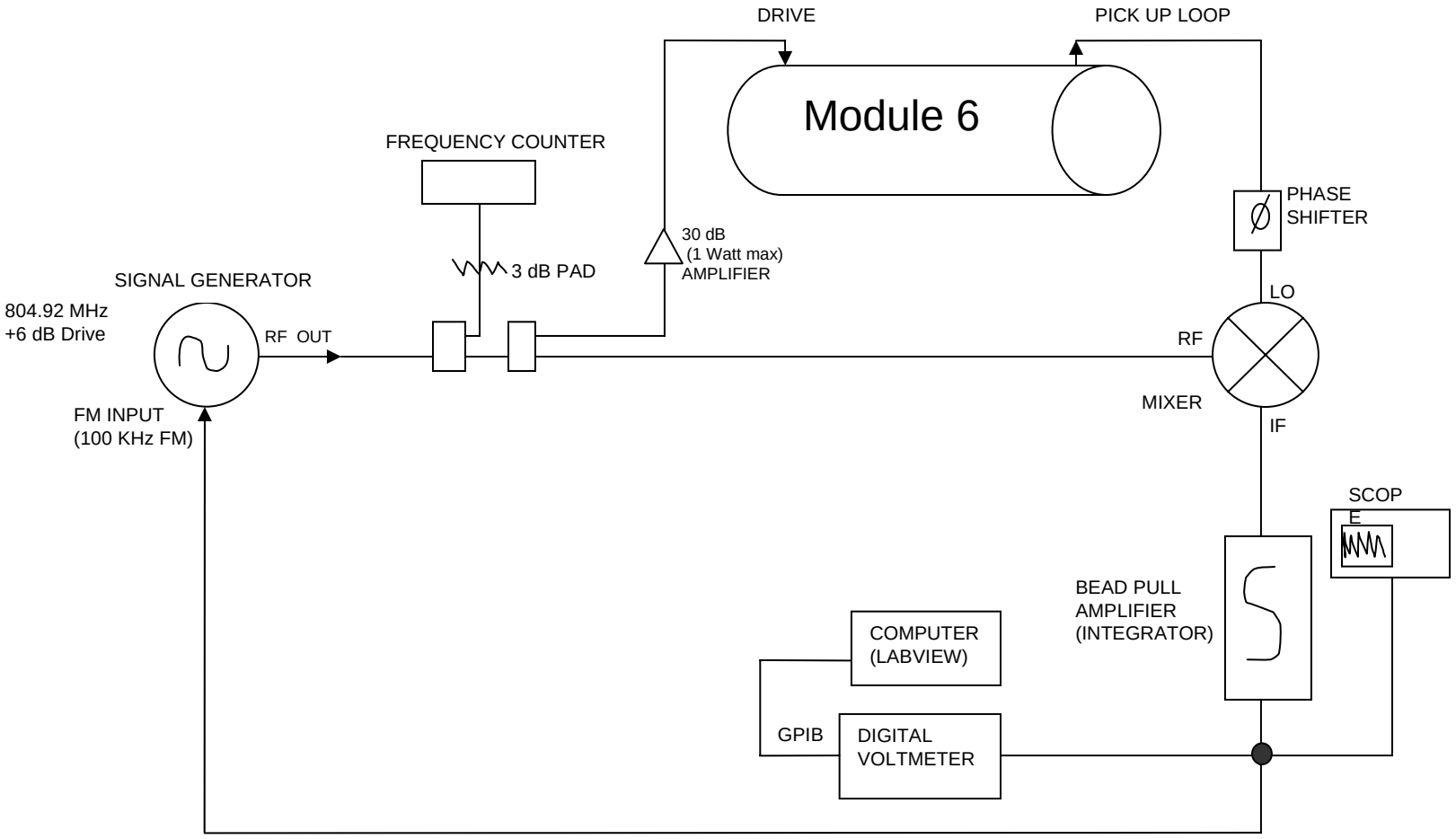
Lawn Ornament after module 6 cleaning

Bead Pull

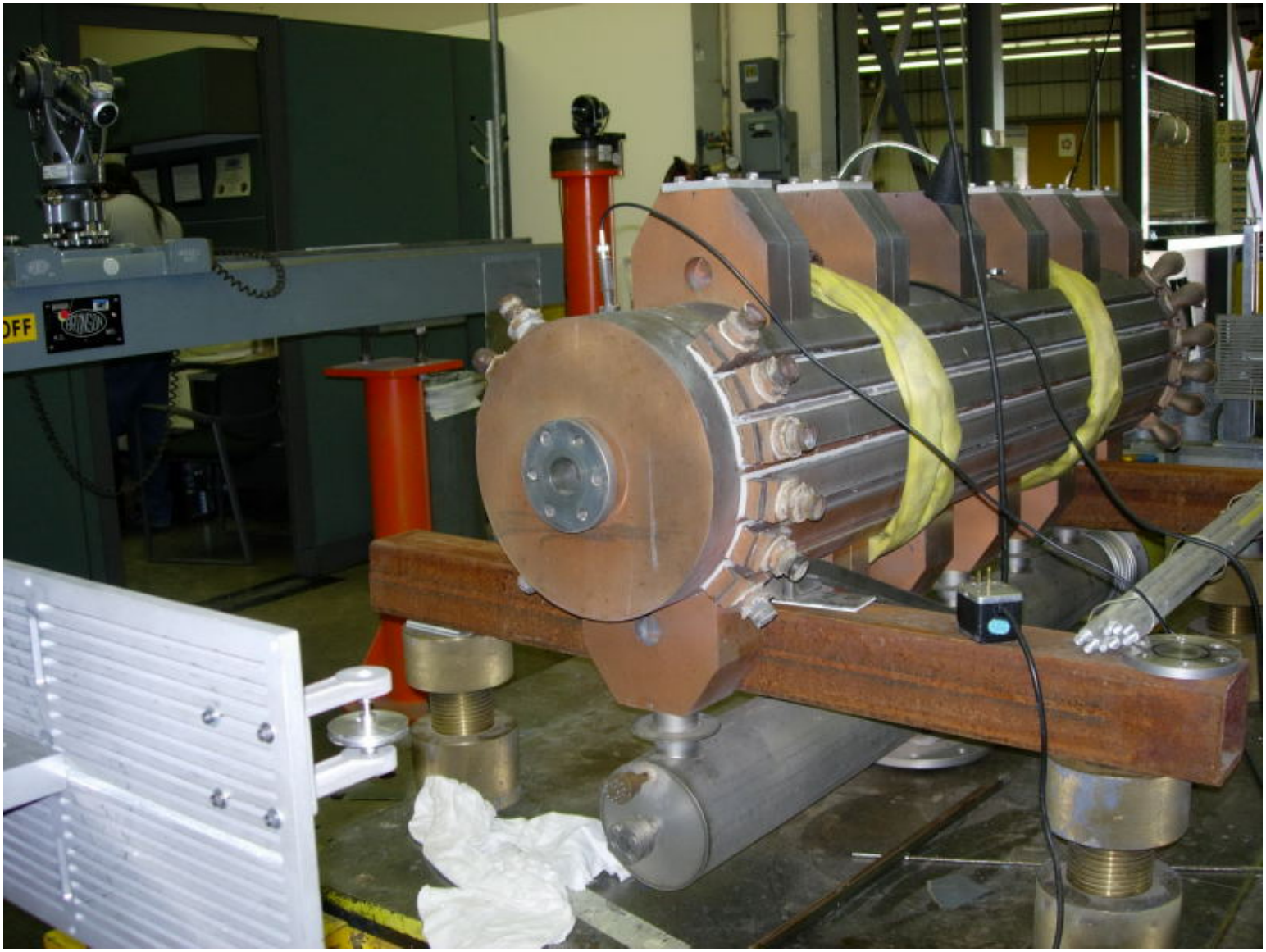


- The bead is pulled through the CCL using a fishing line.
- It displaces electromagnetic energy thus causes a frequency shift while in the high field region.
- A phase lock loop is used to adjust the frequency to maintain resonance.
- Using this frequency shift and a Superfish module of module 6, the electric fields can be calculated.

Phase Lock Loop

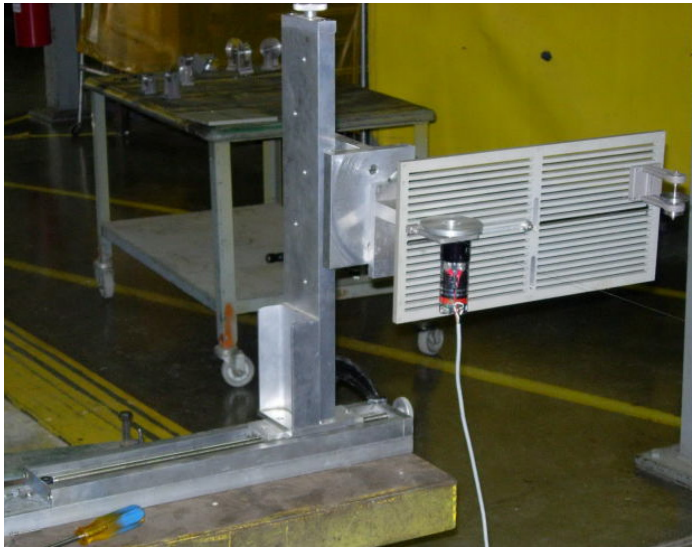


Bead Pull at ETL



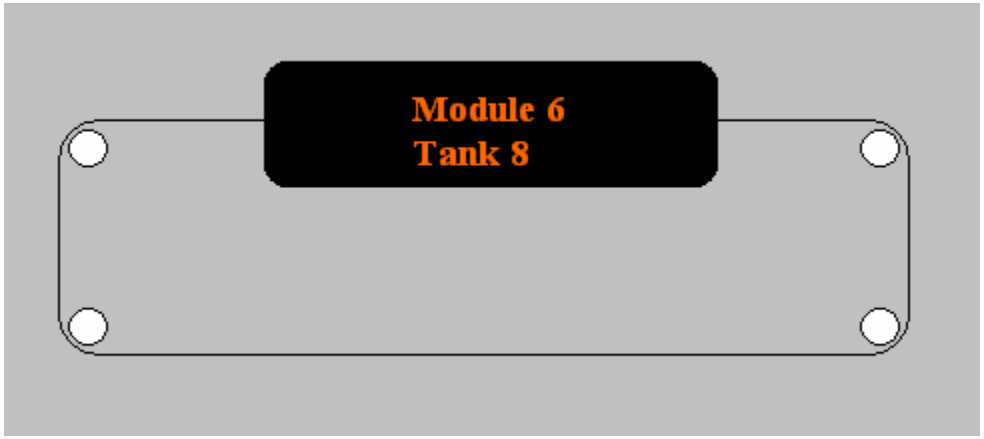
Bead Drive System

Motor Controller



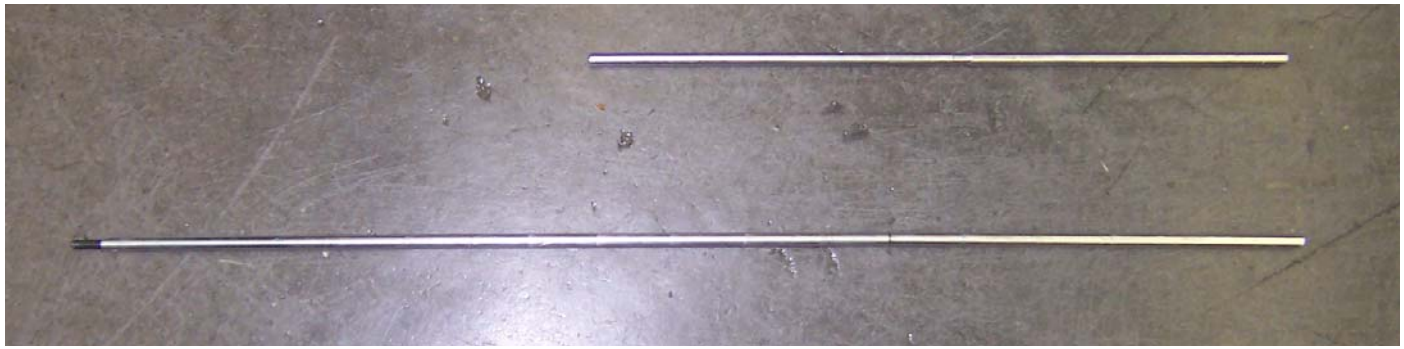
Pulleys on tower

- Four pulleys, with motor on one pulley to drive it.
- Pulleys were mounted on towers with worm gears to provide horizontal and vertical adjustment.
- 10 lb test fishing line.
- String tension was estimated to be .5 to 1 lb.
- 3/8 inch hollow aluminum bead.



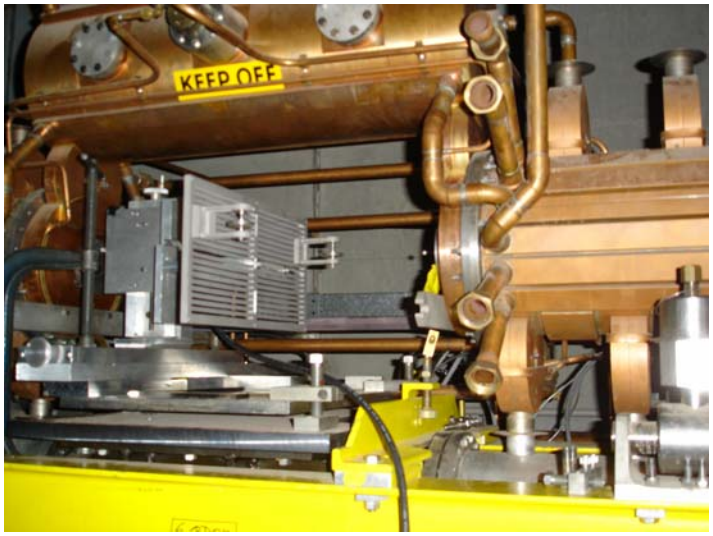
Bead Pull

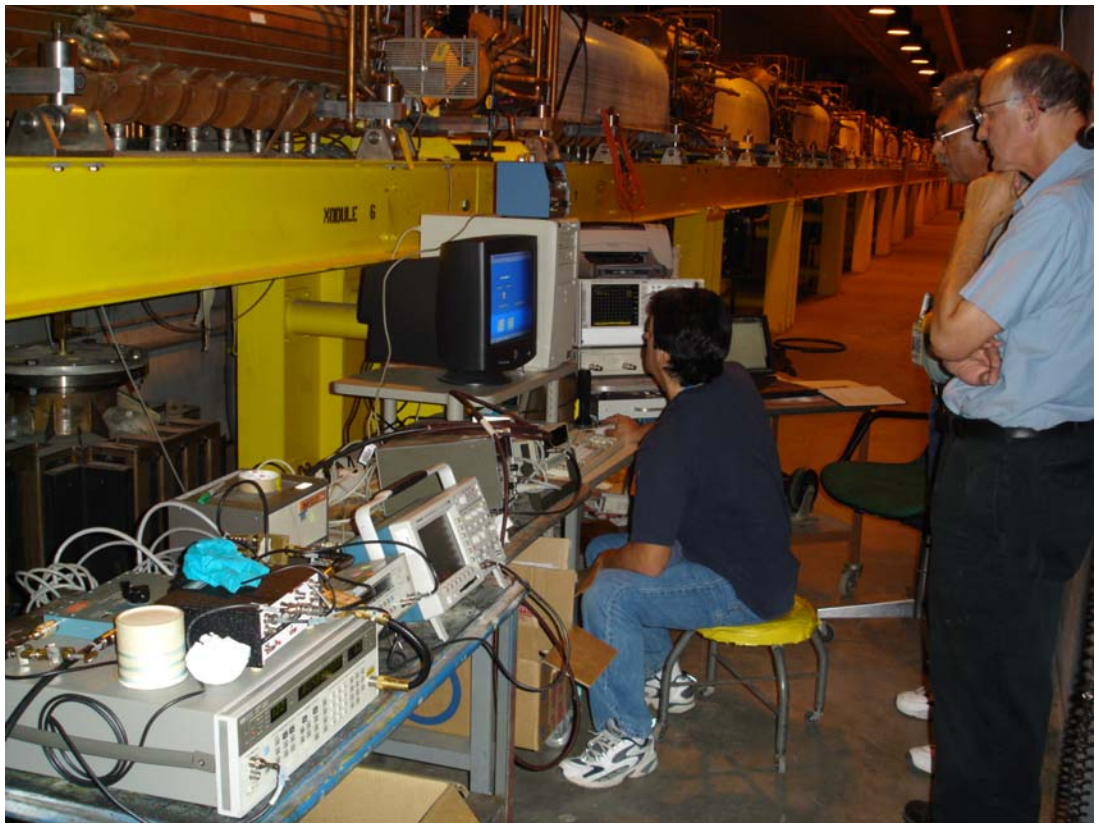
Alex… tying the knot



Six 20” rods were used to thread the bead through the tank

Bead Pull





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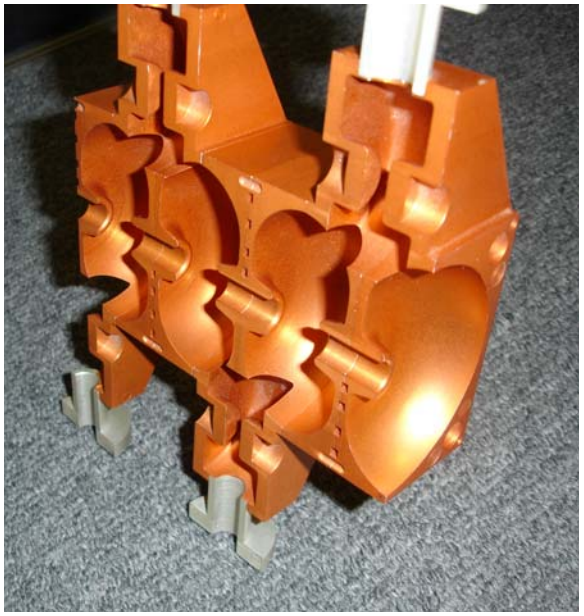
Module 6 Geometry



Model of the CCL

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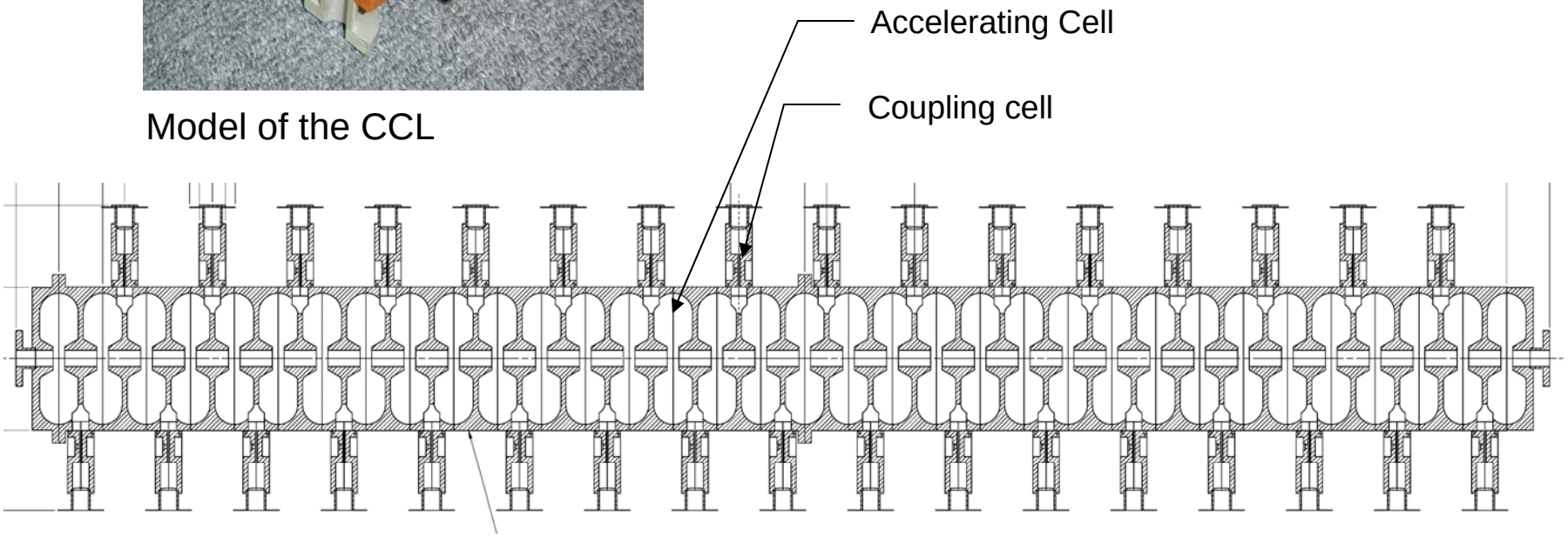
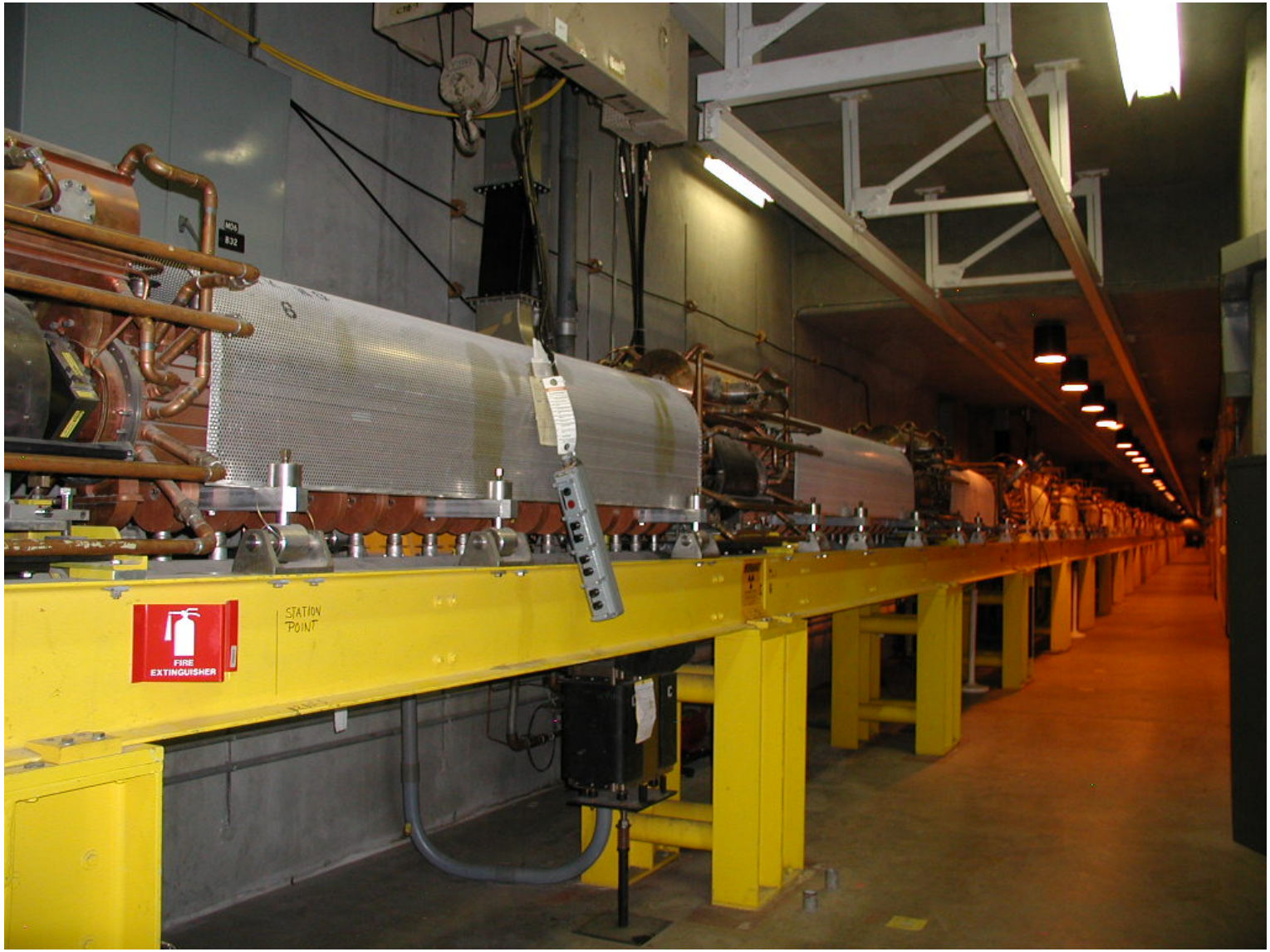
- RF is fed to all four tanks with one wave guide feed.

- Each tank has 34 accelerating cavities and 33 coupling cells.

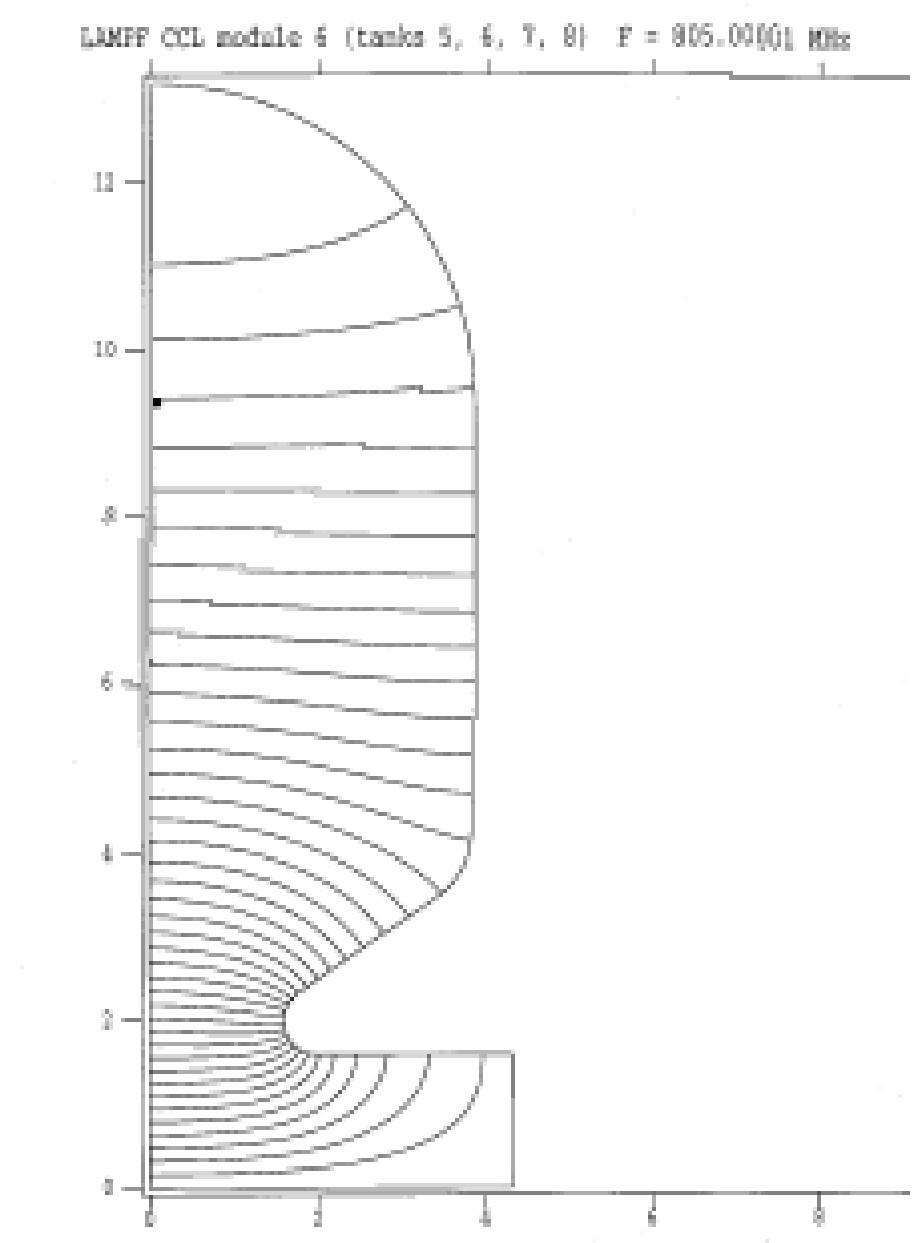


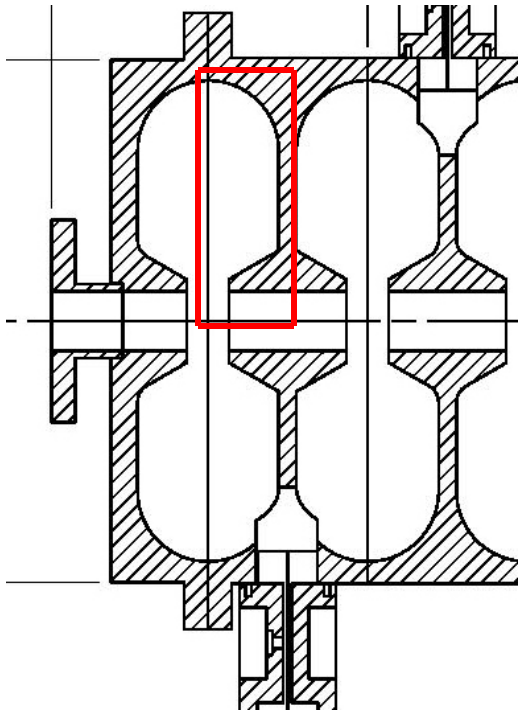
Cross sectional view of a tank on module 6

Module 6 Geometry



Super Fish Model

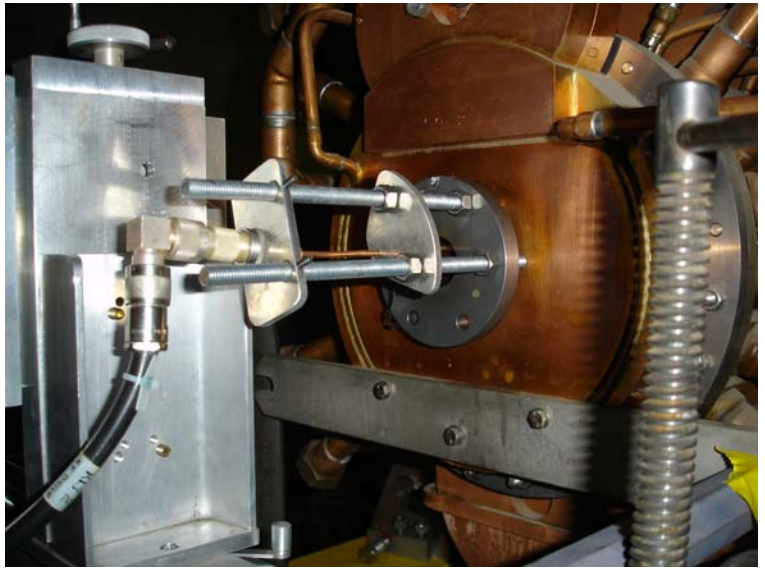




Bead Pull

Drive through type N transition on waveguide

Electric Field Probe

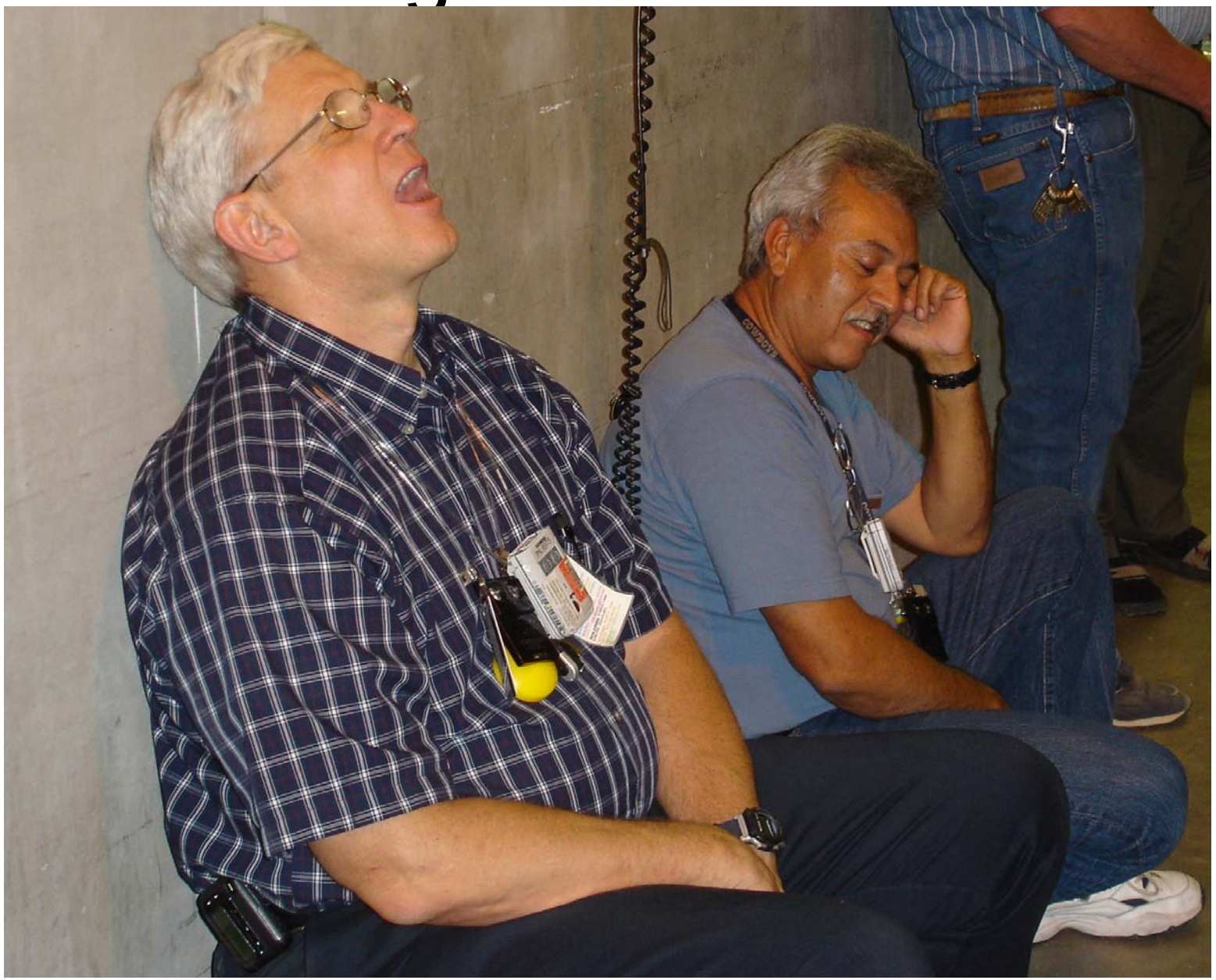


Pick Up using an electric field probe in the last cell on Tank 7

Waiting for the bead…

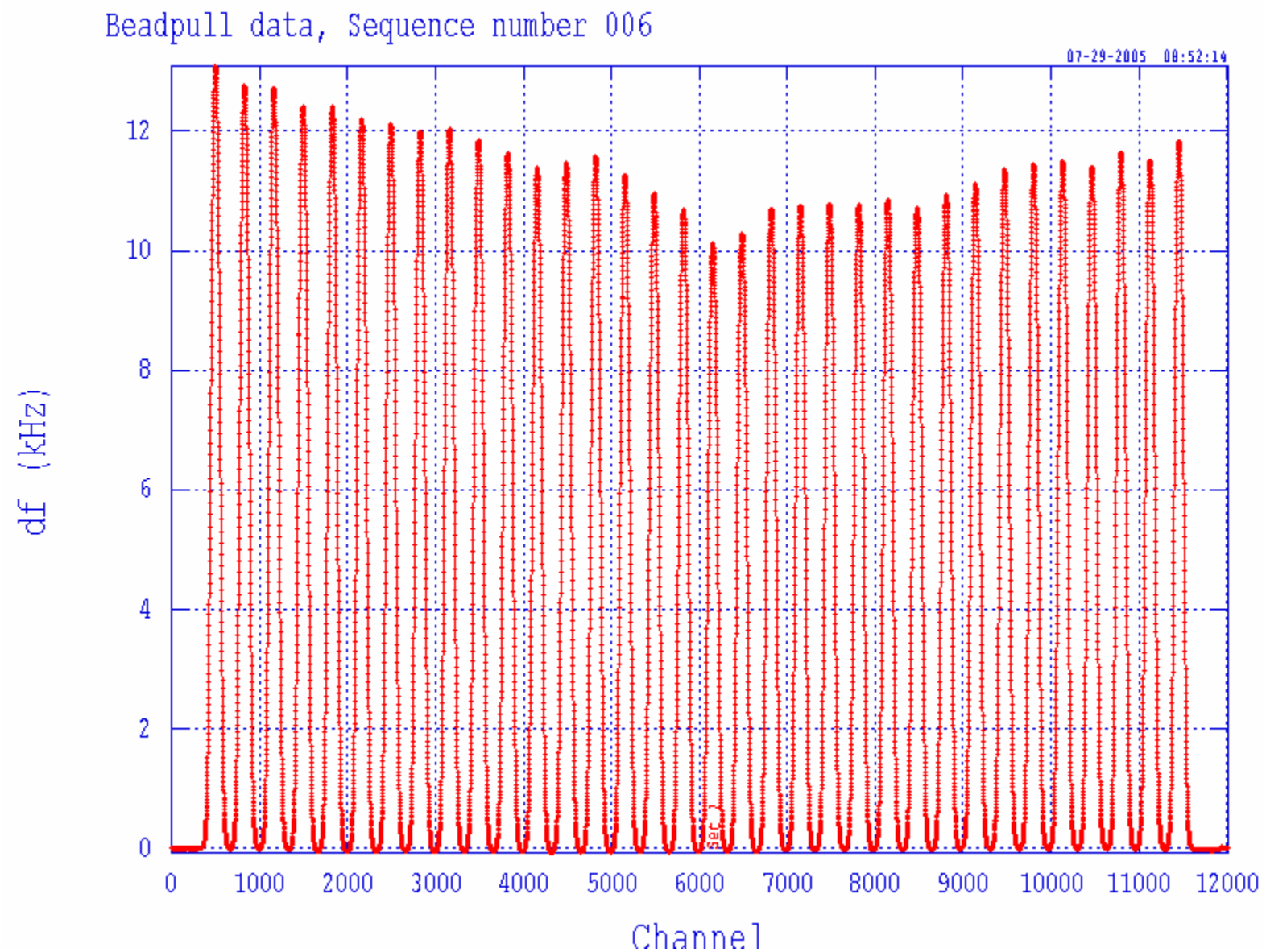
To get 10,000 data points, it took the bead about 11 minutes for the bead to go through the tank.

Waiting for the bead….

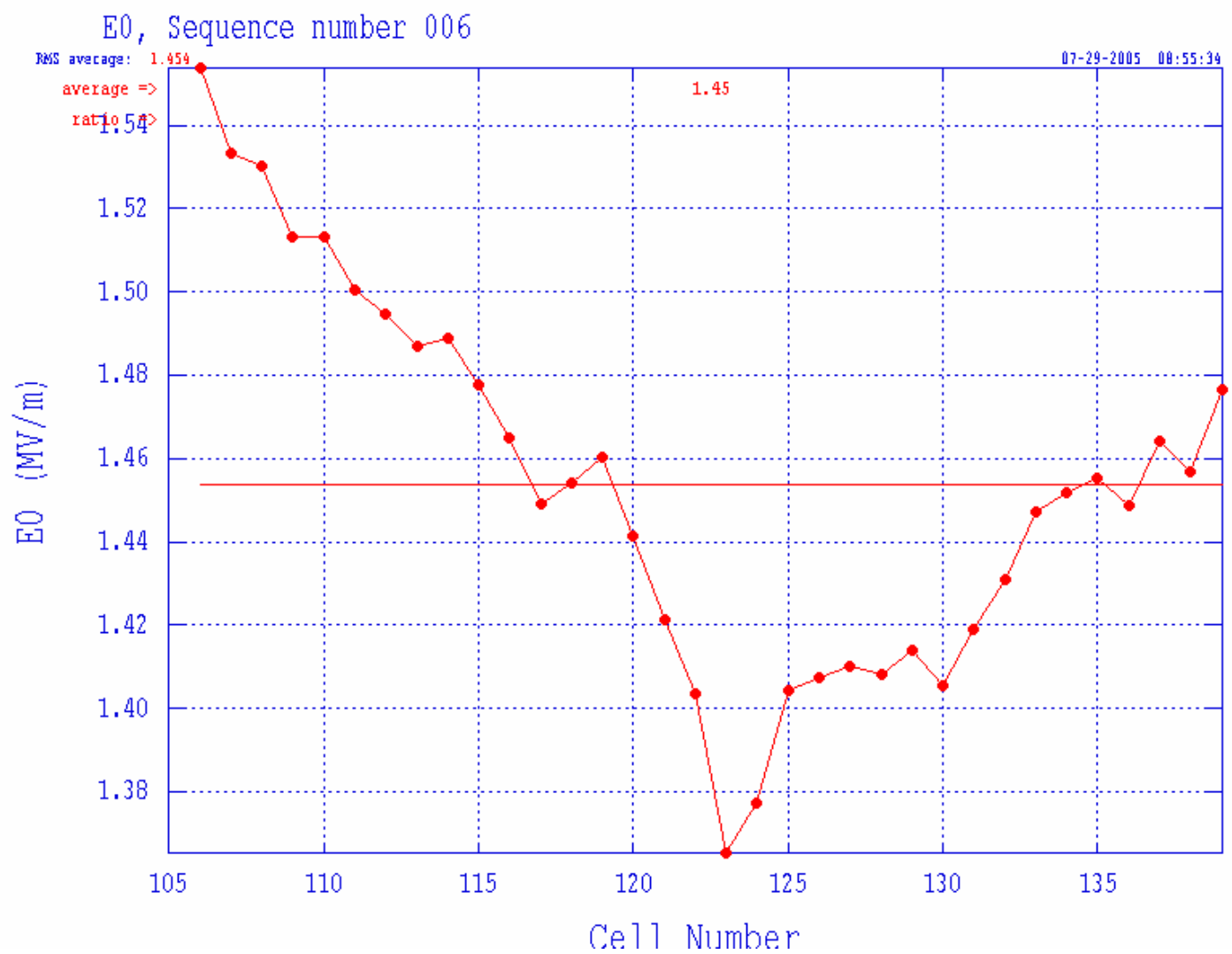


Still, waiting for the bead….

Bead Pull Results – Frequency Shift

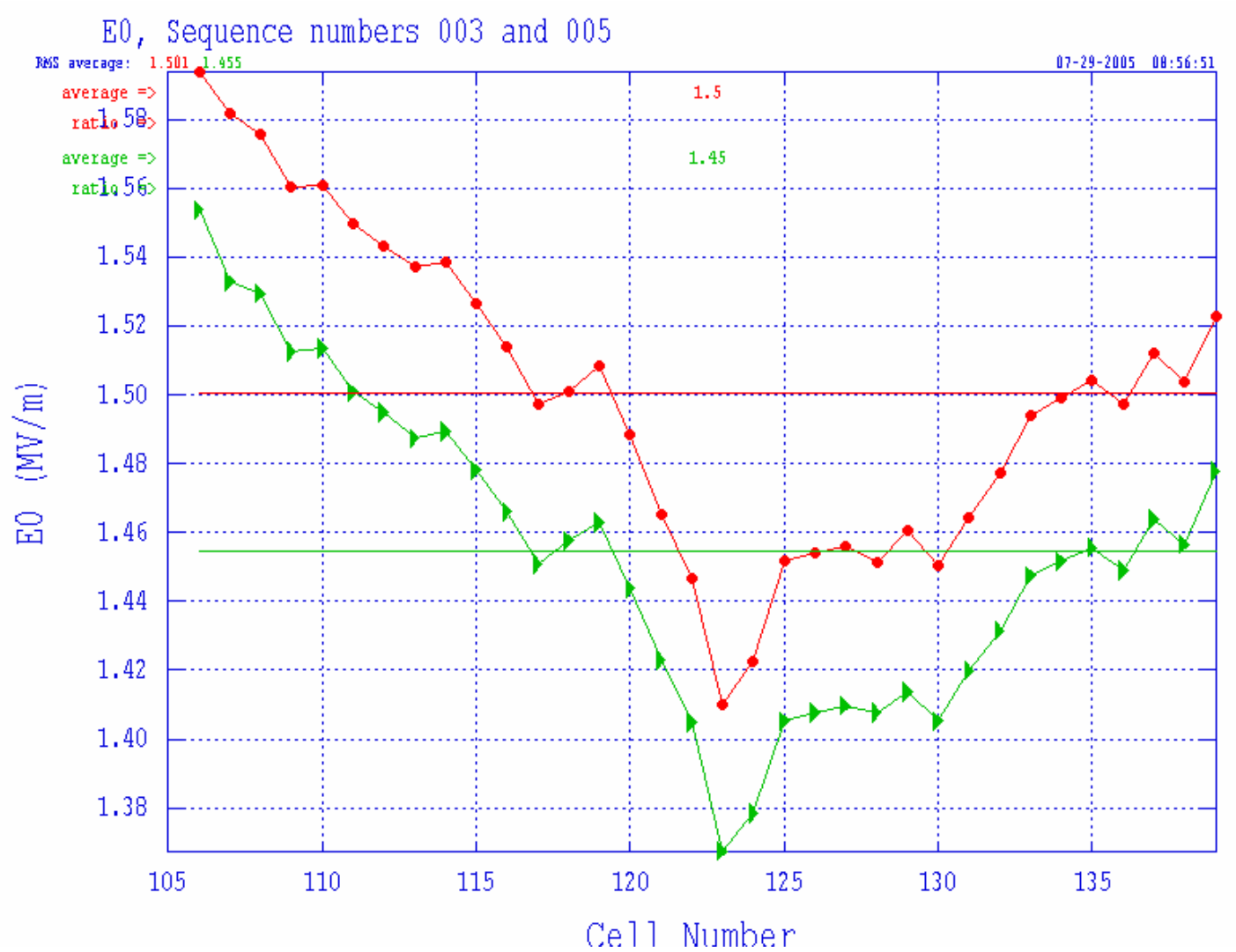


Bead Pull Results –Electric Field



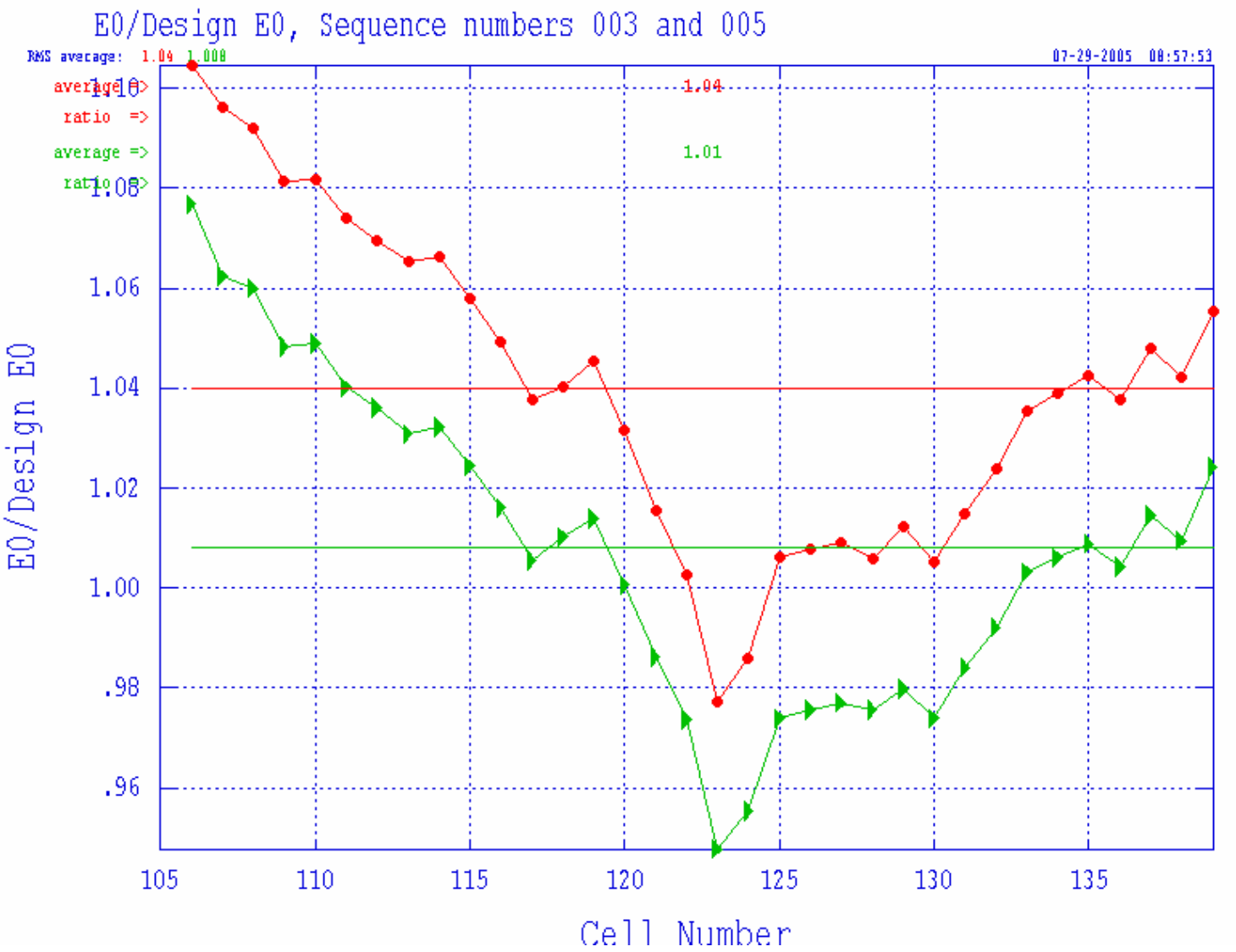
- Saw a 11.6% difference in the field levels across tank 8.
- The CCL tuning specification was less than a 12% variation across each tank.

Before Cleaning vs. After Cleaning



Run 003 = Before
Run 005 = After

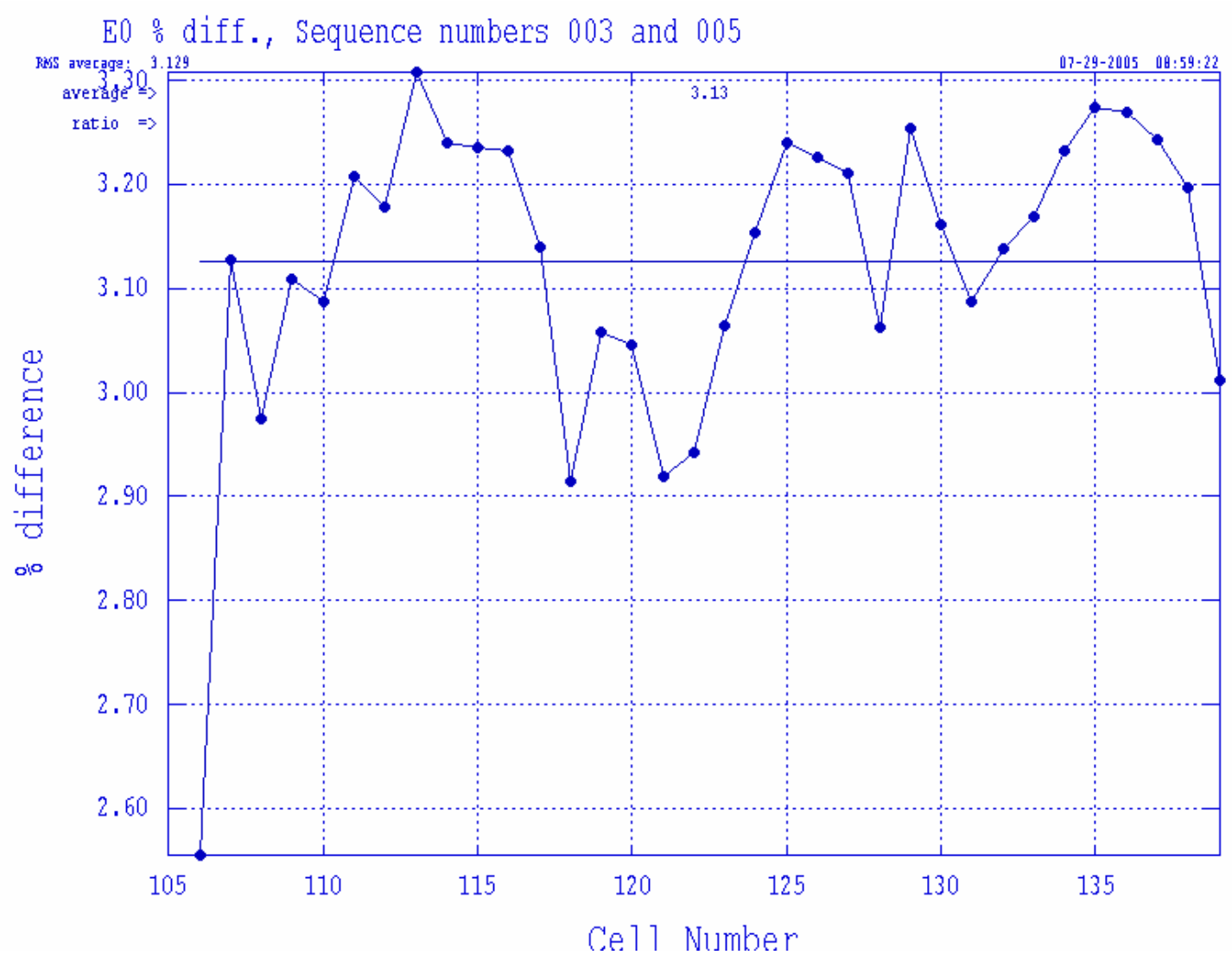
Before Cleaning vs. After Cleaning



Run 003 = Before

Run 005 = After

Before Cleaning vs. After Cleaning



Run 003 = Before
Run 005 = After

Summary of Bead Pull Results

- When two identical runs were compared, there was less than a 0.25% difference.
- When the direction was reversed, there was less than a 0.25% difference.

➔We felt confident about the set up.

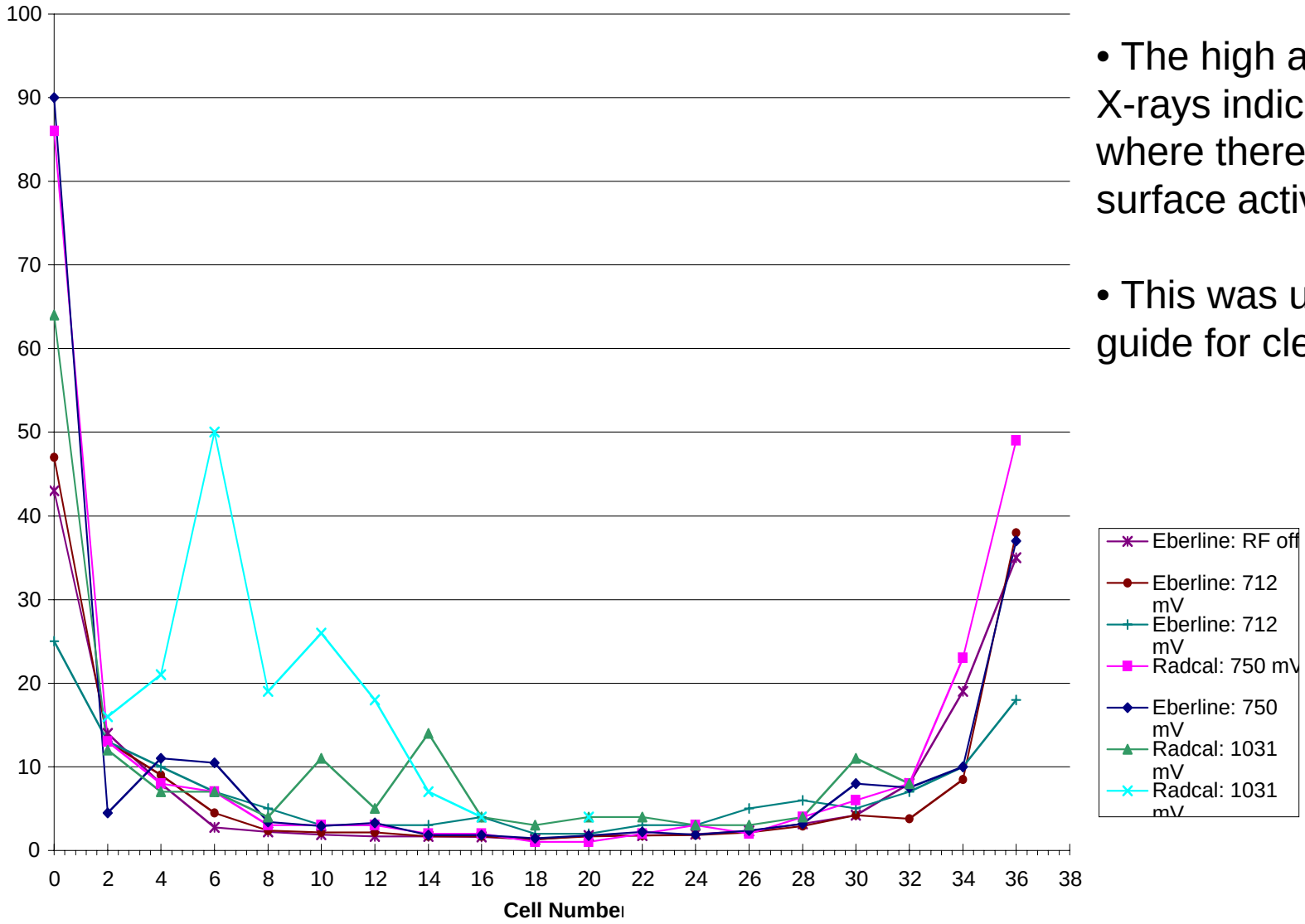
- There was a 11.6% variation in the fields on tank 8.
- The fields before the cleaning averaged 3% higher than the fields after the cleaning.
- The fields before the cleaning were 4% higher than the design value.
- The fields after the cleaning were 1% higher than the design value.

X Ray Measurements

• X-ray measurements were taken at every other accelerating cell

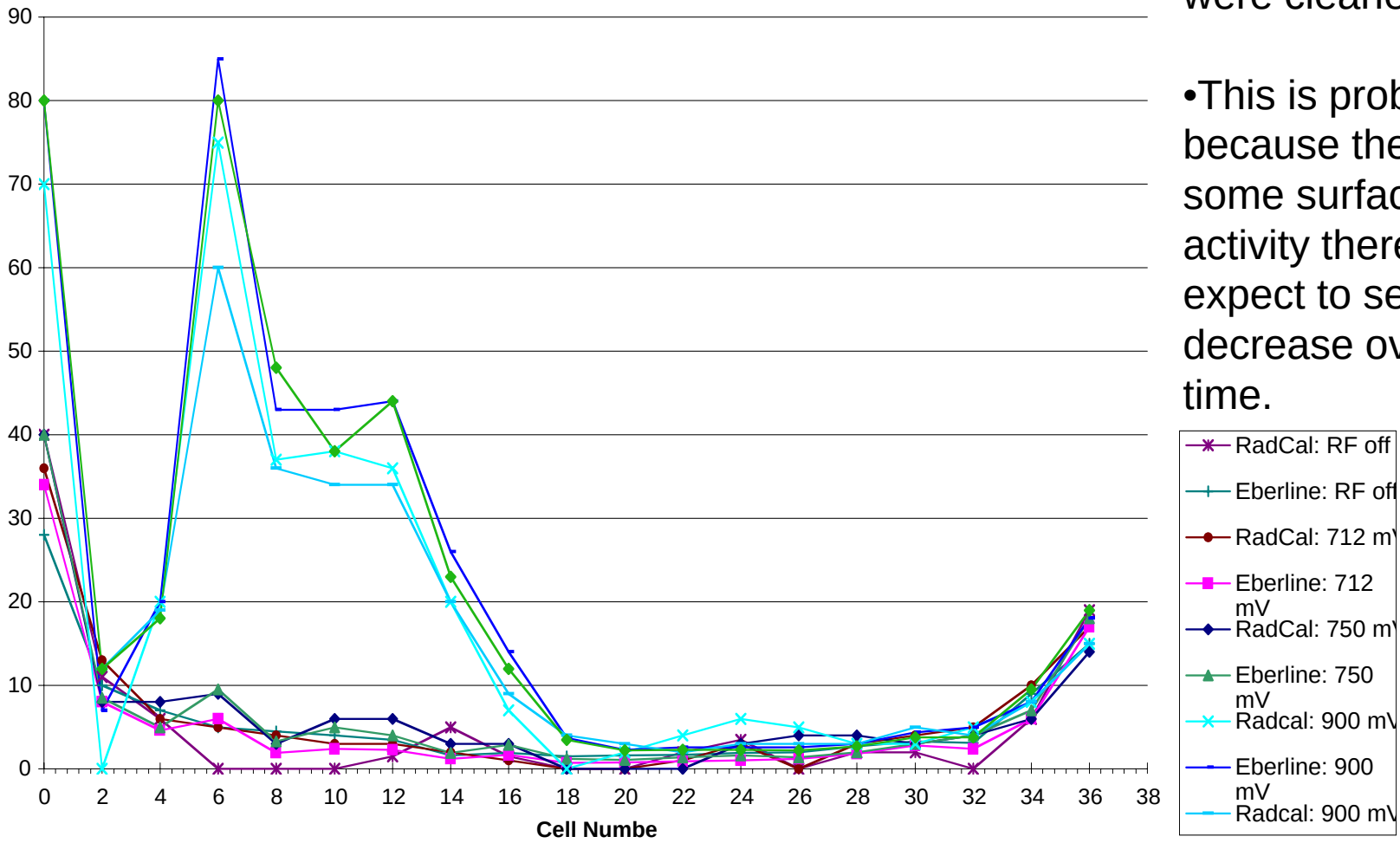
• Two meters were used:
1) RadCal Model 9015
2) Eberline RO^{20}

X Ray Measurements: Before cleaning



- The high areas of X-rays indicated where there was surface activity.
- This was used as a guide for cleaning.

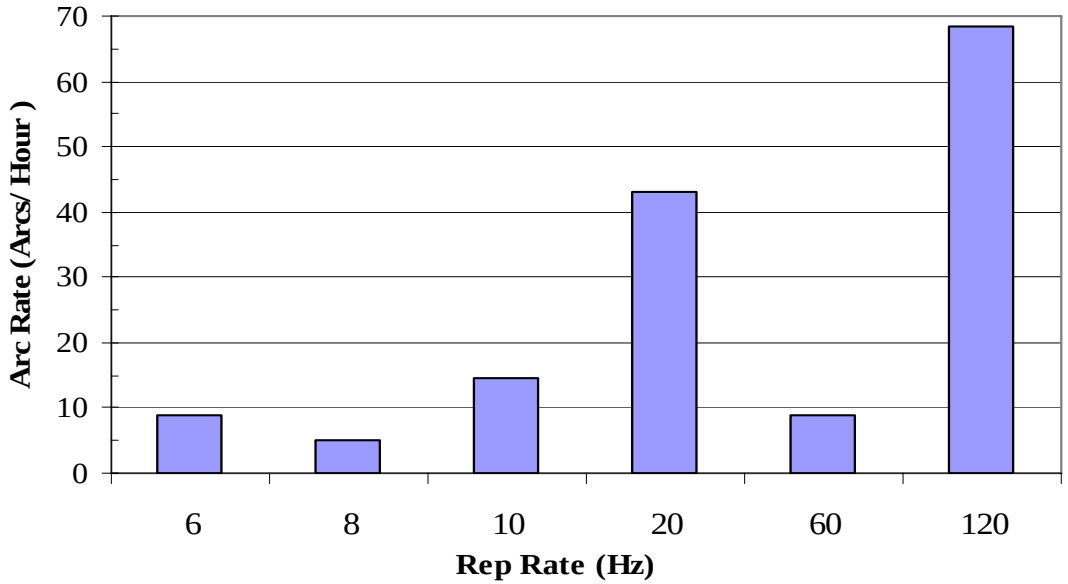
X Ray Measurements: After cleaning



- High X-rays were measured in the areas that were cleaned.

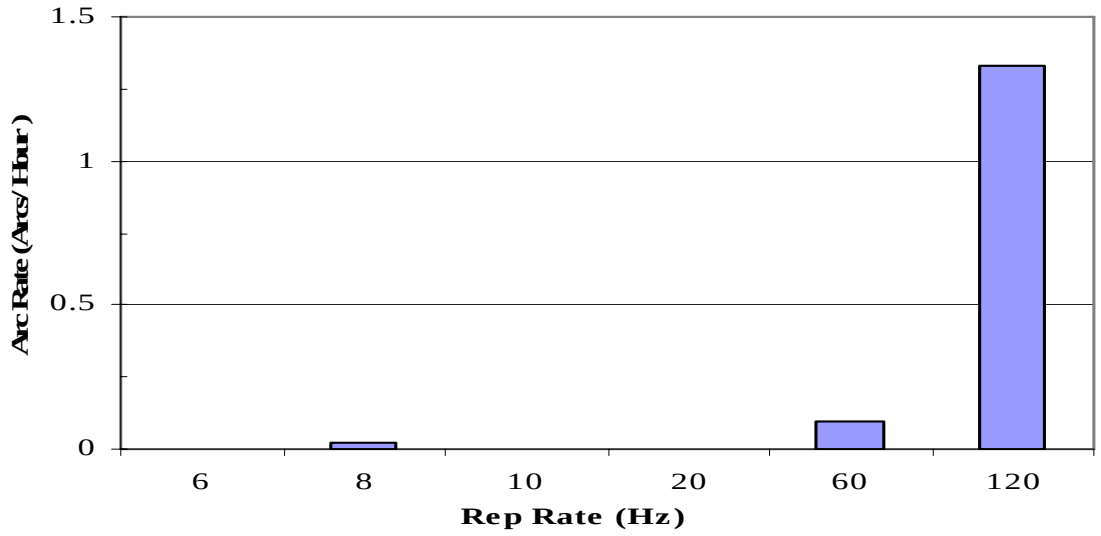
- This is probably because there is some surface activity there. We expect to see this decrease over time.

Arc Rates:
Pre Cleaning vs. Post Cleaning



Pre Cleaning Arc Rate

•The arc rate per hour listed is the maximum arc rate recorded.



Post Cleaning Arc Rate

• Limited data has been taken since the cleaning.

Conclusions

• The O-ring had been burnt into the surface which led to debris in the vacuum. The high VSWR before the cleaning was probably caused from the O-ring debris in vacuum system, especially in the high field region.

• The cleaning reduced the number of VSWRs significantly. Hopefully as the module is conditioned this number will still decrease. Even after the cleaning Module 6 VSWRs way more than a healthy module.

•The X ray measurements before cleaning were a great tool to isolate where the cleaning was needed.

•After cleaning, the X ray measurements were high in the regions that were cleaned. We are expecting the X-rays to decrease over time as the module is conditioned.

• The electric fields in tank 8 had a 12% variation.

• The electric fields decreased by 3% after the cleaning. Without measuring the fields in tank 7, we can not say why. We are speculating this may be because the tuning in the bridge coupler between tank 7 and tank 8 changed slightly or because the tuning.