When we thought summer service was over

Breakdown of the RF feedthrough on the Gustaf Werner cyclotron

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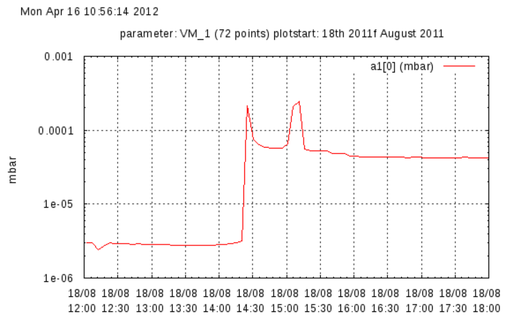
ABSTRACT:
After summer service break 2011 we started the Gustaf Werner cyclotron at TSL, UU, Uppsala, Sweden. We had some weeks booked for heavy ions runs meaning we had reconfigured the machine to run in CW mode and to inject ions from our external ECR ion source. While tuning the RF systems we all of a sudden had a major vacuum leak. This poster describes the work that was done: finding the fault, repairing and start up again. Most of work done by people who had never seen these parts of the machine before.

1. Vacuum leak

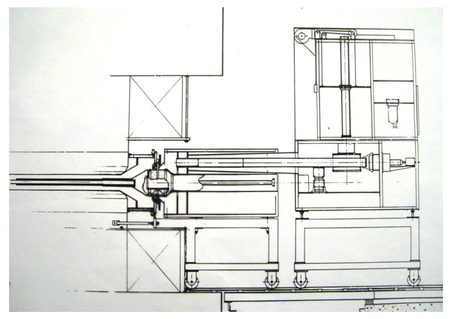
It happened during the last trial to accelerate an Argon 9+ beam from the external ECR and through the cyclotron. We had beam on the inflector but not further. The RF systems were tuned to run 17.467MHz but we still had some mismatch somewhere and retuned once more. Then suddenly we had a big change in vacuum and we started the work to find out why.

2011-08-18 Breakdown moment

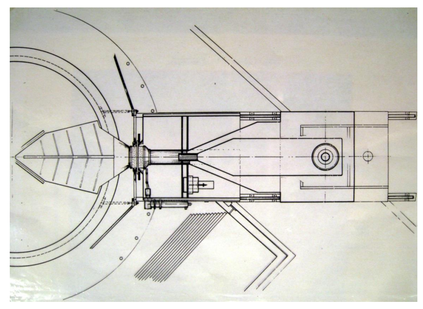


2. Technical details, analysis and planning of what to do

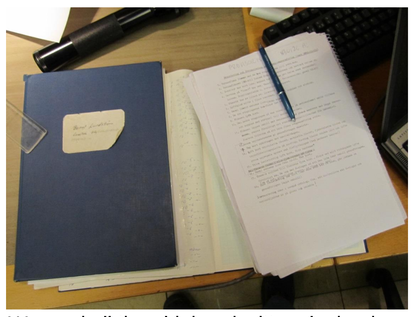
We checked all old drawings to understand



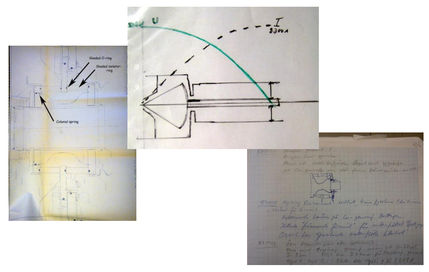
We found pictures that gave us an idea of fault



Another view of the feedtrough, from top



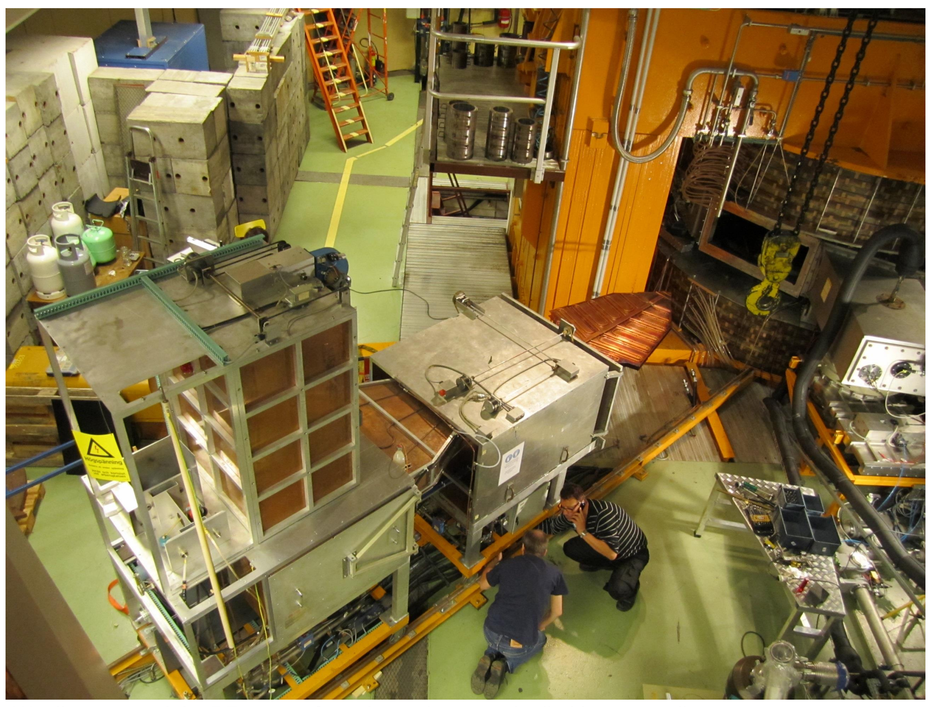
We read all the old, handwritten logbooks



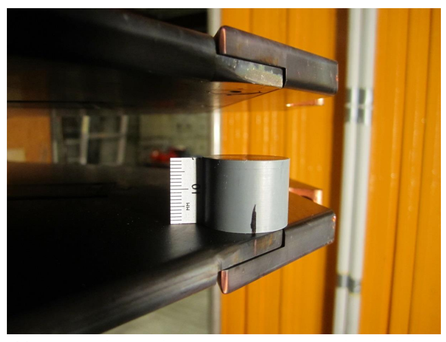
We found several notes of similar cases

We called in former employees to discuss the problem and to make a plan for repairs

3. Measuring in all directions then dismantling



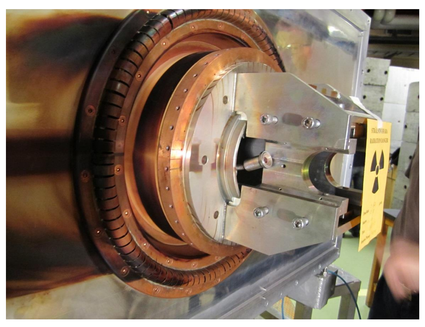
We disconnected the RF system from the cyclotron and rolled it out on rails



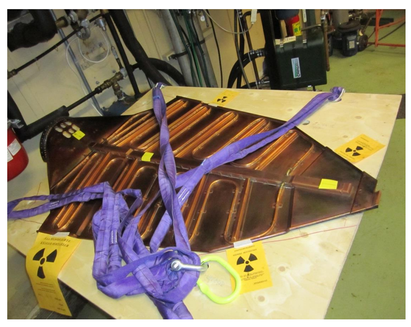
Homemade equipment to measure the height

Measuring the distance between the Dee´s

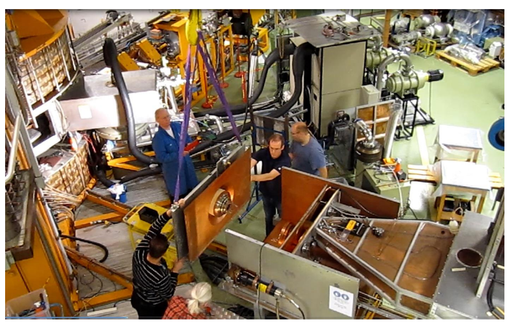
Using a crane to secure heavy parts, here the flange



Details were checked for activation and marked

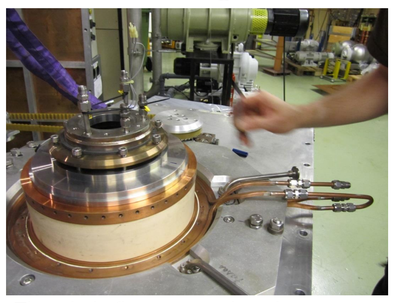


The most active parts were stored shielded



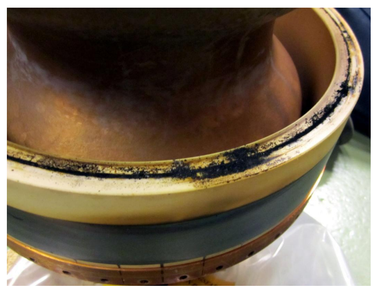
Finally the the flange with the feedthrough was loose

4. Finding the faults



The whole flange was placed on supports

We found the main cause of the leak, a broken O-ring



Remains of the O-ring on the cracked ceramics

The colonial spring made of CuBe was damaged

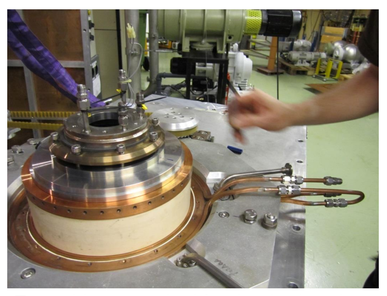
All details were checked and cleaned

5. Repairs and reassembly

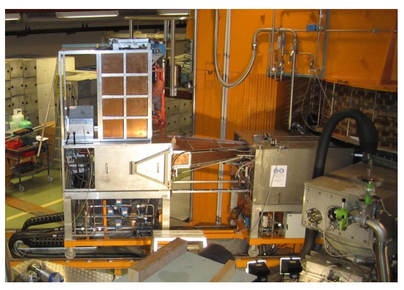
The flange was thoroughly cleaned and polished

The feedtrough assembled with new parts

The feedtrough docked with the flange



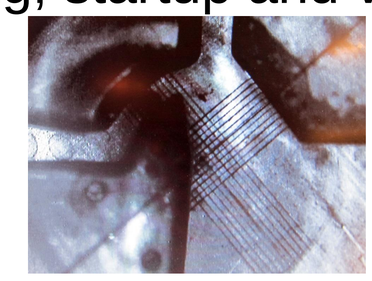
Everything was double checked and measured



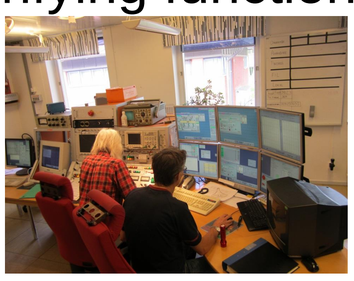
Finally the RF system could be rolled in again

6. Aligning, startup and verifying functionality

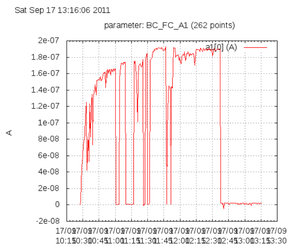
Measuring everything



The central region was aligned



We started up again with standard run case

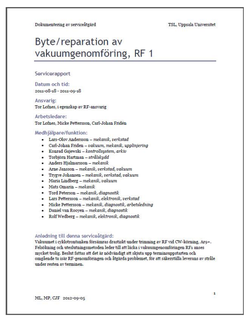


2011-09-05: Back up running

7. Conclusions and paperwork

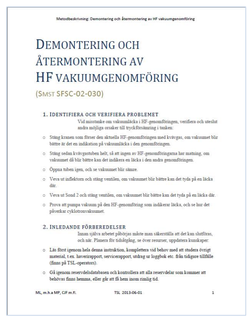
Failure investigation

Most probable cause of failure: The O-ring had aged due to radiation, mechanical stress, heat changes, arcing and ozone. The Nitrogen in the feedtrough leaked through the damaged O-ring into the tank. The nitrogen was shut off as in standard run cases low effect. During this odd run case we had high power in the feed-through and arcing caused the O-ring to disintegrate and the ceramics to crack.



Report of work done

It took about 23 work days to repair and get back in running conditions. About 14 of these days were spent on localize the fault, decide what to to and corrective adjustements afterwards.
15 persons were directly involved in the repairs and we also contacted former employees to assist us, either by coming in or via phone.



Procedure how to do next time

If it would happen again, we have compiled a procedure how to do it.
It includes how to identify the problem, preparations, dismantling, repair and clean up, asssemling, aligning, checking and verifying function.

The Svedberg Laboratory
Uppsala University

Proton Therapy and Irradiation facilities
Protons, neutrons and Heavy Ions
Some years in history:
1949: Commissioning
1951: First beam
1957: First proton patient
1977-1986: Rebuild
2005: Reorientation from physis