UPPSALA
UNIVERSITET

Issues in DB station and TH595A

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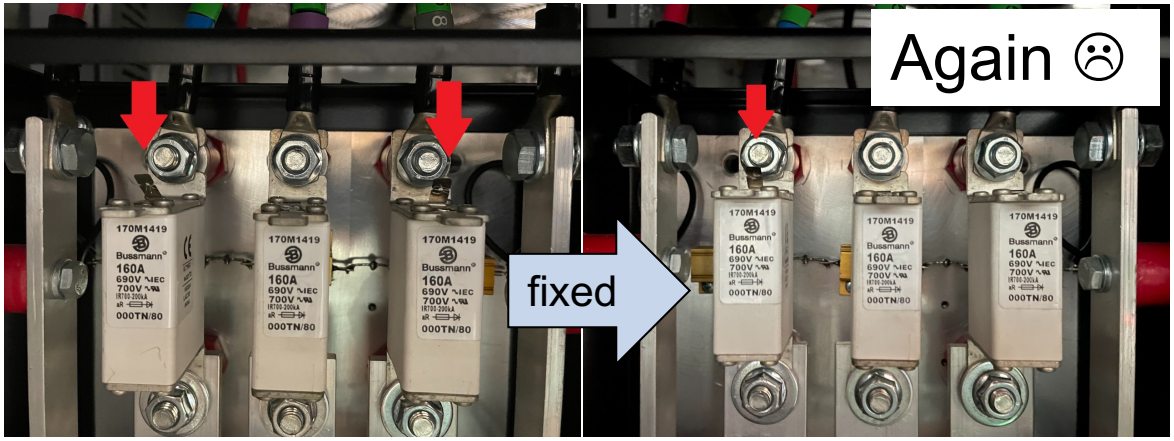
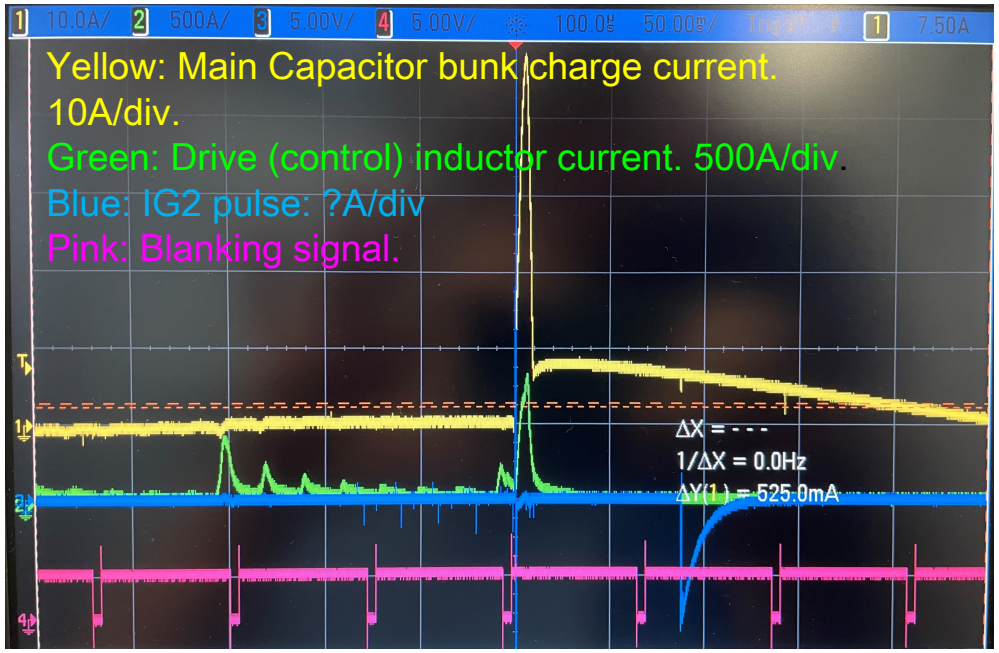
Issues in DB station

Story

- A lot of “Crowbar IN” of DB-B in past months
- This time, fuses were damaged and happen again and again even if it is fixed
- Disconnect the HV line from the tube → no problem

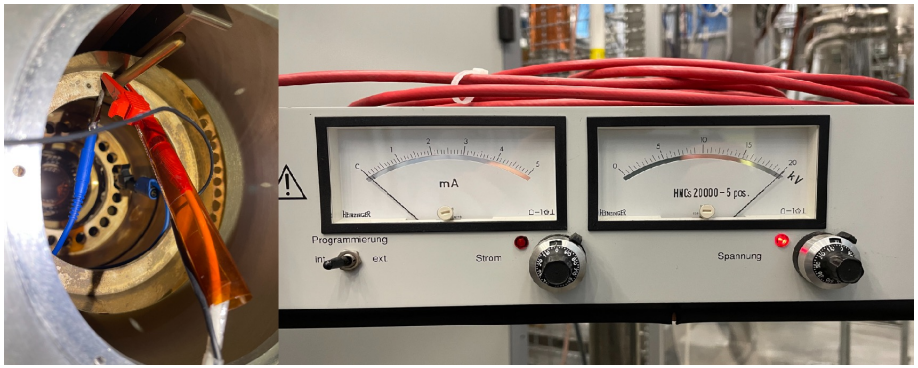




→ tube or cavity of tetrode was doubted

DB-B: either cavity or **tube**

Cavity passed the HV test



Tube did NOT

The tube under debate: 595A 901204

- Start operation on September 2019
- The first 595A type tube
- Total service (filament ON) time: **4800 hours** (0.5 years)
- ESS project requirements :> 20,000 hours (2 years)
- No short-circuit or low capacitance at room temperature between any grids and/or cathode

HV test **at room temperature** without filament ON (*preliminary*)

→ Cathode-G1:2kV OK, Anode-G2:20kV OK,

→ **G1-G2**: 750-1000V discharge << 1500V with 6uA (spec.)

→ It was mitigated after “conditioning” at some voltage for several hours

Cf. TH595 761496 was broken in DB-B in 2019

THALES Customer Technical support RFMS0T 60088363 13 Sep 2019

Tetrode insulation in cold condition is OK.
Short-circuit, K to G1, as soon as filament voltage is exceeding 2 V.

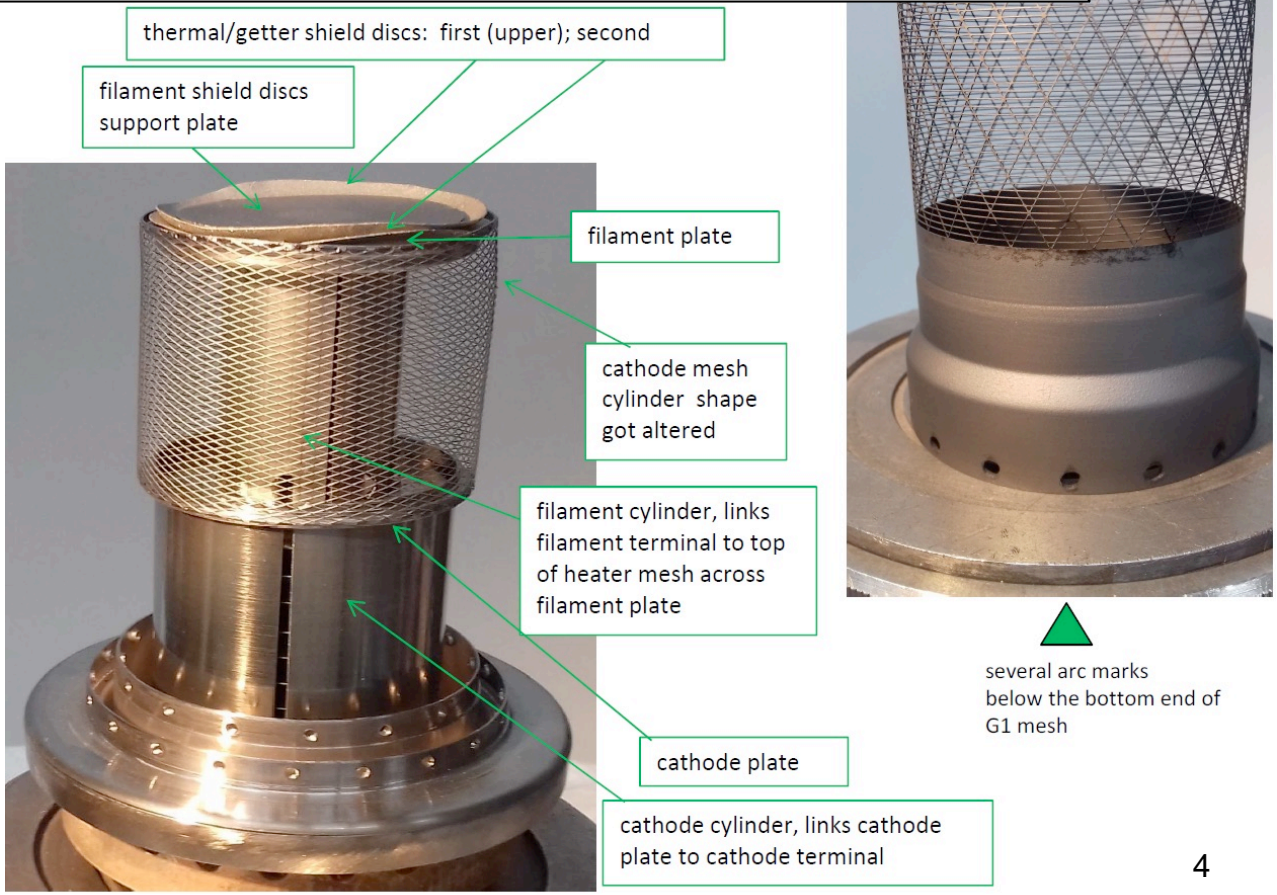
Not repairable / Non réparable

The upper (first) thermal/getter shield got deformed. The second one got partially stuck with filament plate.
Filament plate deformed, resulting in cathode deformed, and cathode eventually in touch to G1 mesh.
Marks of severe arcs, G1 to G2, at the bottom of grid mesh. (see picture of G1)

Filament service time
3000 hours

R. Ruber et al., FREIA report 2019/6

"**G1 voltage went down to 5V with warm filament** and when the filament cold off the voltage reached normal -300 to -200 V"



Cf. TH595 755305 was broken in Electrpsys in 2019

THALES Customer Technical support RFMS0T 60086796 22 Jul 2019

Filament service time 573 hours

-Anode inner surface got blackened. Main insulator got darkened (see picture)

-Marks of severe arcs, G1 to G2, at the bottom of grid mesh. (see picture of G1)

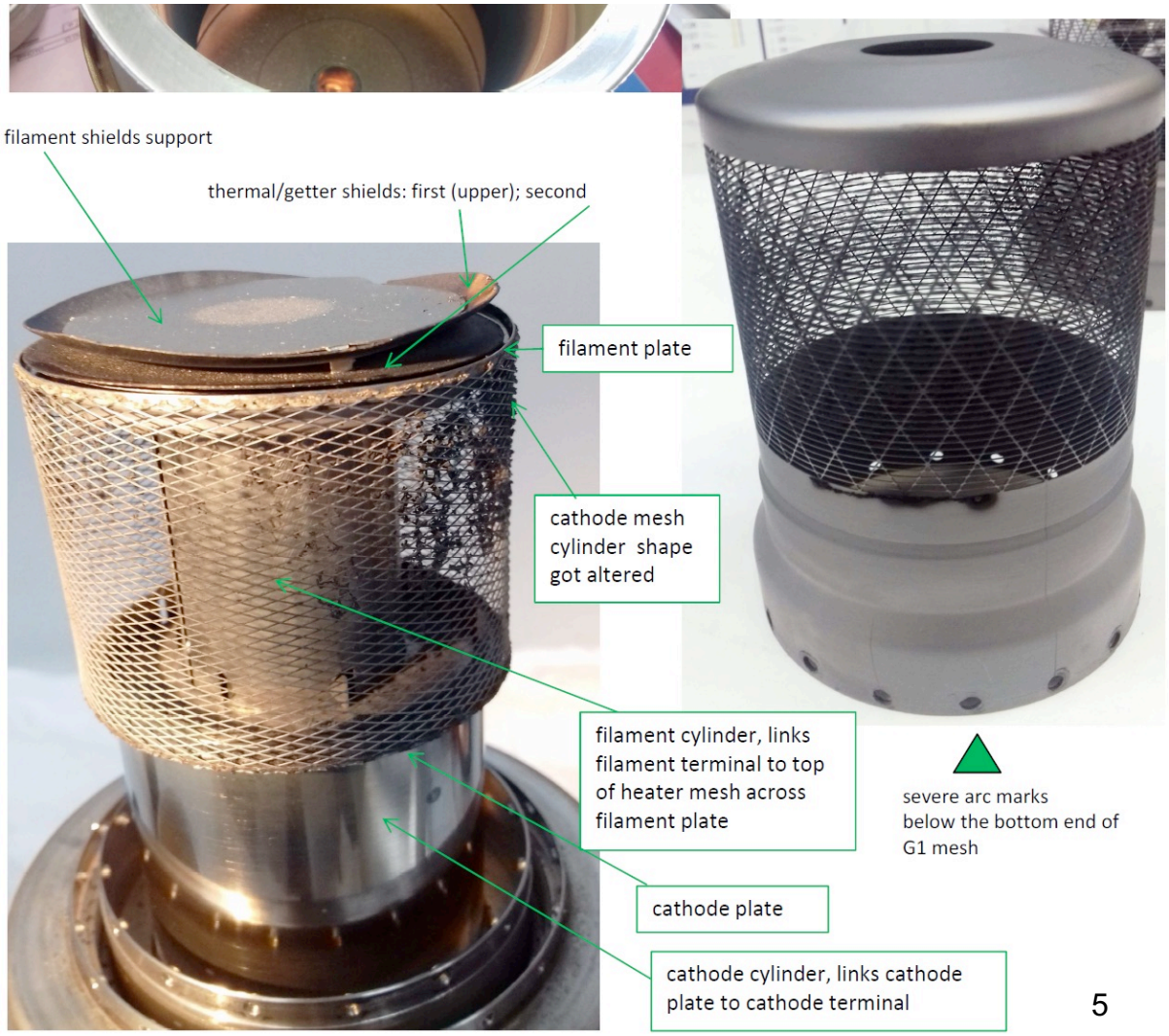
-The upper (first) thermal/getter shield got deformed, which fostered electrical arc with G1 top inner surface

-The second thermal/getter shield got stuck with filament plate.

-Inside the heater cylindrical inner structure, the uppest thermal shield got rolled in shape, and brittle.

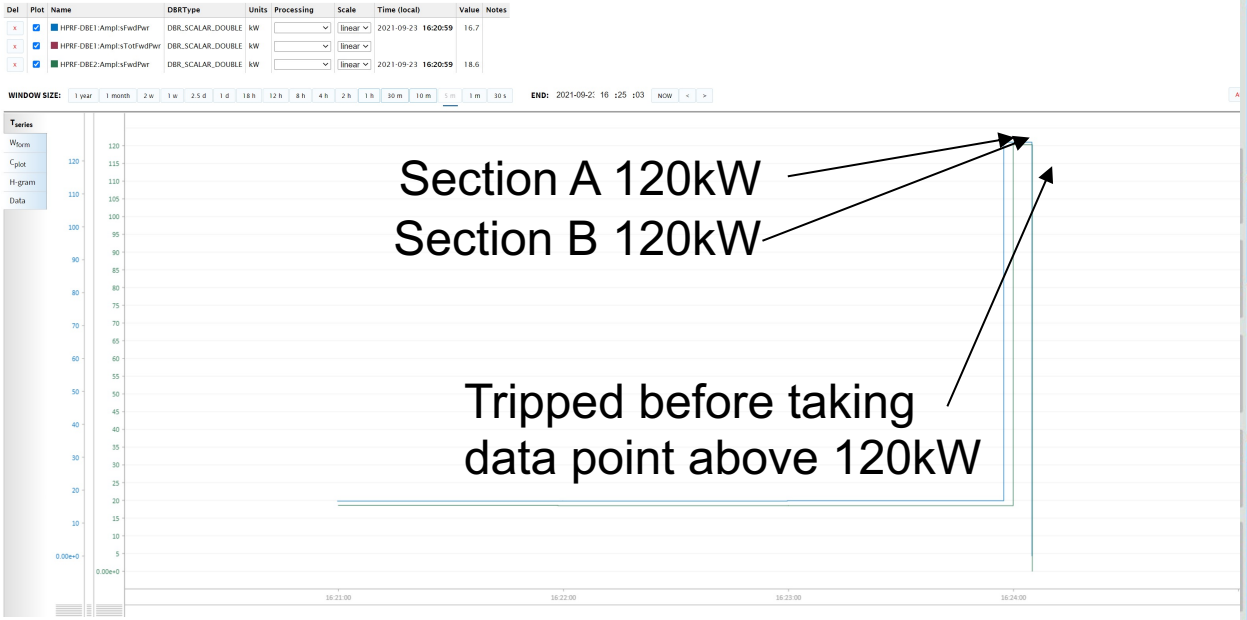
-Cathode got deformed. Also, the tantalum belts, onto which cathode mesh ends are welded, got partly crushed into powder, resulting in **snow crystal-shaped particles** in-between cathode-to-G1 gap.

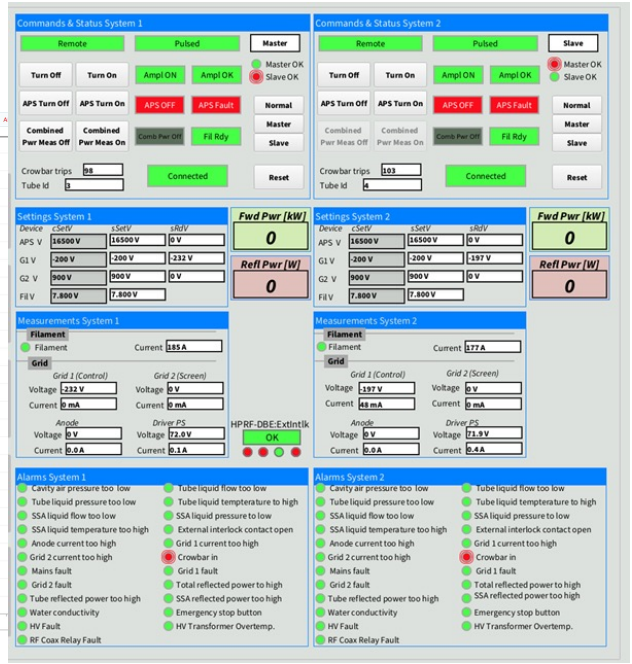
Not repairable / Non réparable



Actions for the ESS project

- The tube 595A 901204 was replaced to a **virgin new spare 912223**
- The new filament was flushed over one night
- OK with HV test **without RF**
- RF test with a dummy load was performed
  - Up to 120kW in section A & 120kW in section B (total 240kW)
- CROWBAR IN above 240kW
  - Not clear yet if it is from section A (with TH595A S/N907196; filament 4800 hours since 2020 March 6th) or B
  - **The issue could be from section A** → to be tested more

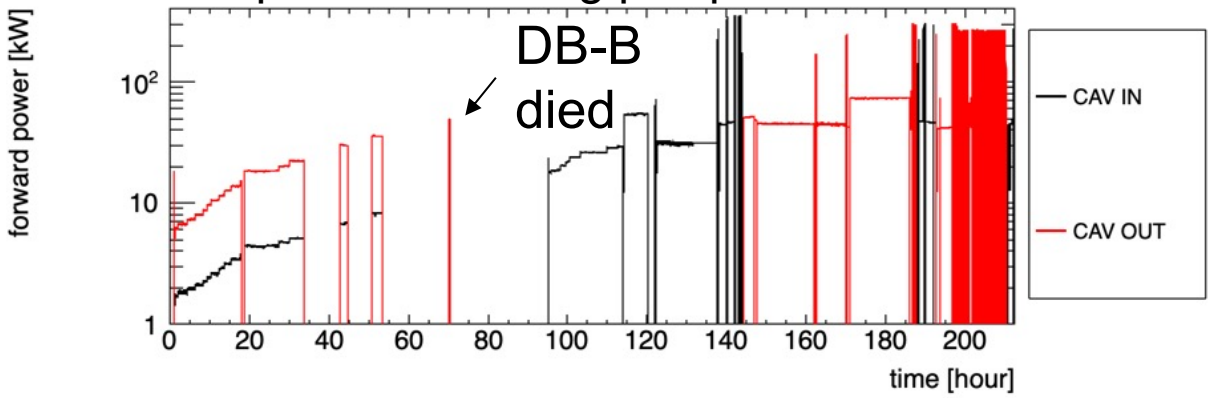




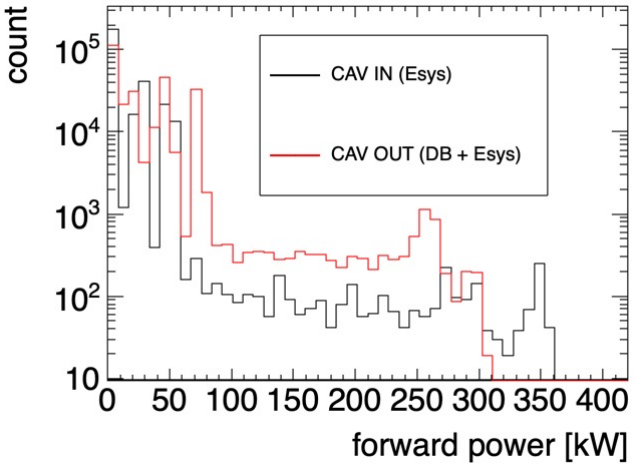
Requirements from the ESS project

1. Machine **operation** at ESS in Lund
   - 20 years stable
   - 350kW-400kW stable
2. Qualification **tests** at Uppsala
   - Condition couplers (**mainly <100kW**; 1 week per one month)
   - Qualify cavities (typically **<200 kW**; 2-3 days per one month)
   - Assess 13 modules in series
   - Until the end of 2021

Coupler conditioning plot power vs time

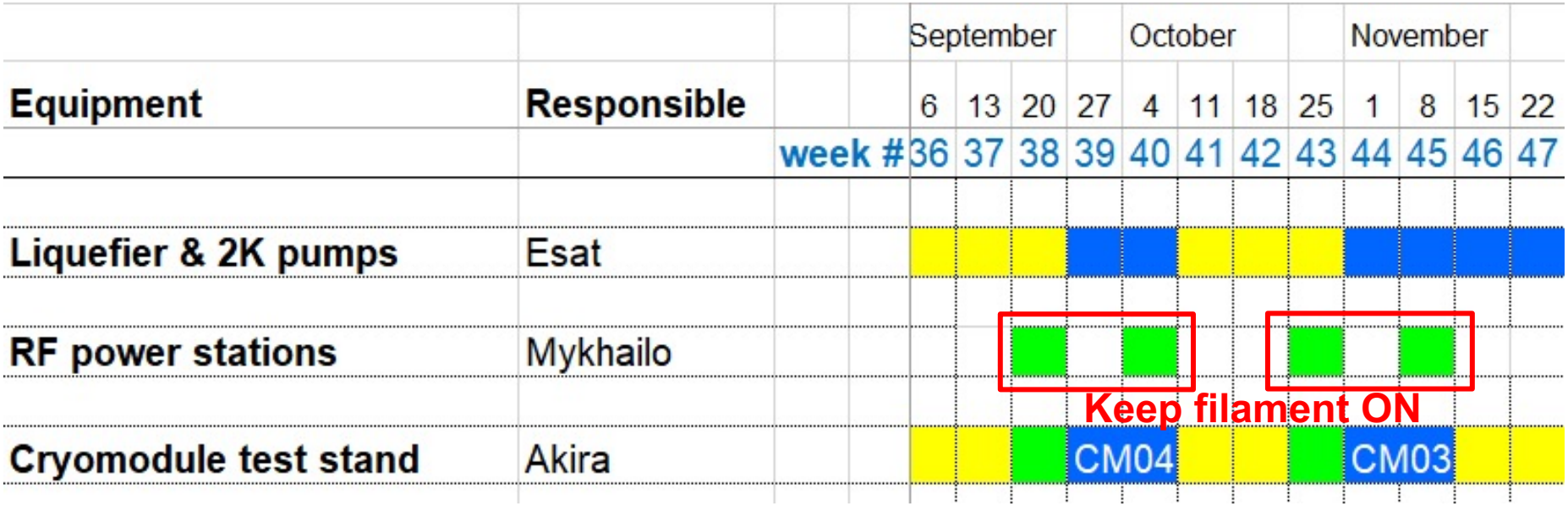


Histogram of required power during coupler conditioning



- ✓ Most demanding test at Uppsala is coupler conditioning
- ✓ Power requirement is low still the stations often trip
- ✓ Uppala needs to continue this test for another year

Typical test schedule at Uppsala



Maintenance
Installation and test
Operation - warm
Operation - cooldown
Operation - cold

- ✓ One module test per five weeks
- ✓ 13 modules continuous without a gap
- ✓ Little chance for dedicated maintenance

- Filament current is kept ON for three weeks during one test
- Filament current is often OFF between two modules (>two weeks)
- To observe the issues, the weeks for coupler conditioning are the best to visit Uppsala
  - W38 or W43 in this example: 24/24 7/7 operation <100kW
  - But we cannot stop the process ← strict demand & deadline from ESS