

Issues in DB station and TH595A

A. Miyazaki, M. Zhovner, T. Peterson and R. Wedberg

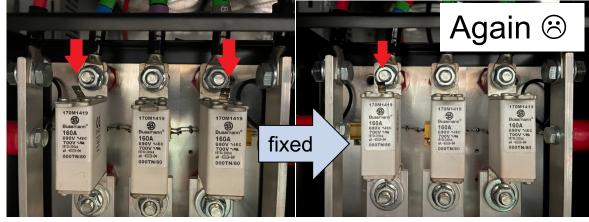


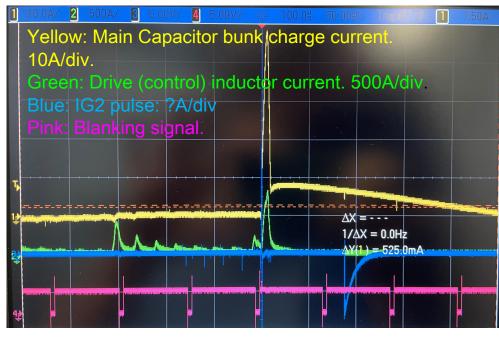
Issues in DB station



<u>Story</u>

- 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



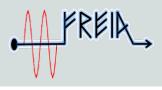


 \rightarrow tube or cavity of tetrode was doubted





DB-B: either cavity or tube

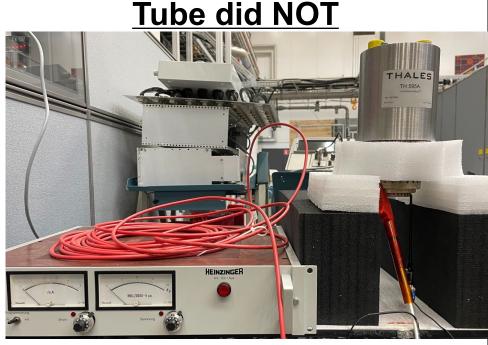


Cavity passed the HV test



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.)
- \rightarrow It was mitigated after "conditioning" at some voltage for several hours 3

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

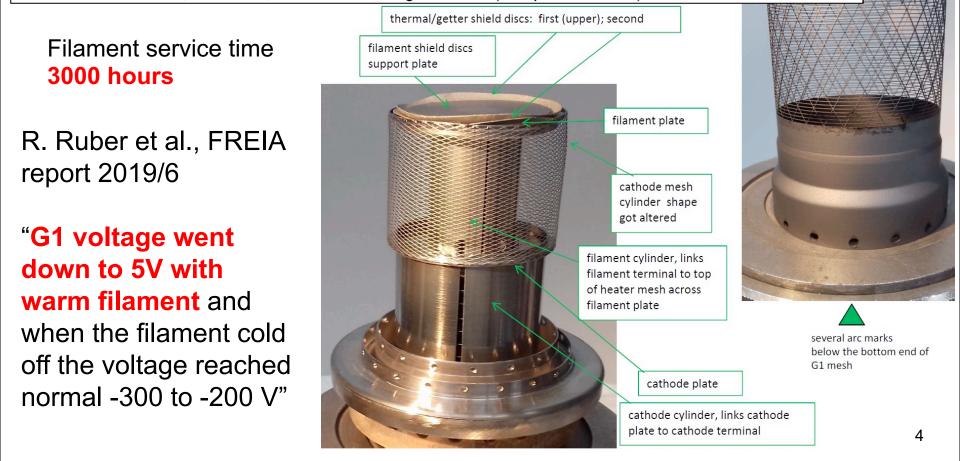
THALES Customer Technical support RFMS0T 60088363 13 Sep 2019

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)



Cf. TH595 755305 was broken in Electrpsys

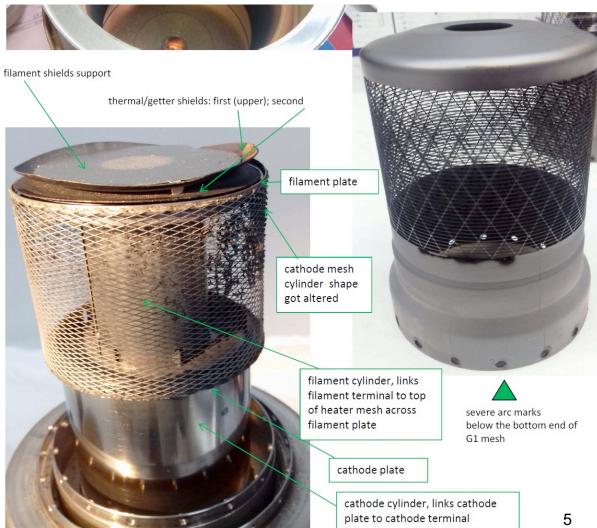
THALES Customer Technical support RFMS0T 60086796 22 Jul 2019 Filament service time 573 hours

-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





- 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 $A \rightarrow$ to be tested more

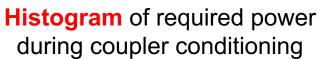
el Plot Name DBRType Units Processing Scale Time (local) Value Notes	Commands & Status System 1 C	Commands & Status System 2
1 700 Ammeric de Style de Statue de Style de Statue de Statu	Remote Pulsed Master	Remote Pulsed Slave
	Master OK	🖲 Master OK
	Turn Off Turn On AmplON AmplOK Slave OK	Turn Off Turn On Ampl ON Ampl OK Slave OK
	APS Turn Off APS Turn On APS OFF APS Fault Normal	APS Turn Off APS Turn On APS OFF APS Fault Normal
NDOWSIZE: 1 year 1 month. 2 w 1 w 2.5 d 1 d 18h 12h 8h 4h 2h 1h 30m 10m 5 m 1 m 305 END: 2021-09-21 16 :25 :03 NOW < >		Master
	Combined Combined Comb Pwr Dff Fil Rdy Slave	Combined Combined Comb Pwr Off Fil Rdy Slave
vrias	Slave	Slave
km 120	Crowbar trips 98 Connected Reset	Crowbar trips 103 Connected Reset
	Tube Id 3	Tube Id 4
Section A 120kW		
	Settings System 1 Fwd Pwr [kW] SetV SetV SetV SetV SetV SetV SetV Set	Settings System 2 Device cSetV sSetV sRdV
		APS V 16500 V 16500 V 0 V
Section B 120kW	G1 V -200 V -200 V -232 V Refi Pwr (W)	G1 V -200 V -200 V -197 V Refl Pwr [W]
	G2 V 900 V 900 V 900 V	G2 V 900 V 900 V
90	FilV 7.800V 7.800V	Fil V 7.800 V 7.800 V
80-	Measurements System 1	Measurements System 2
3	Filament	Filament
70 70	Filament Current 185 A	Filament Current 177 A
	Grid 1 (Control) Grid 2 (Screen)	Grid 1 (Control) Grid 2 (Screen)
60 - 60 -	Voltage -232 V Voltage 0 V	Voltage -197 V Voltage o V
	Current 0 mA Current 0 mA	Current 48 mA Current 0 mA
Tripped before taking /	Anode Driver PS HPRF-DBE:Extintlk	Anode Driver PS
	Voltage 0V Voltage 72.0V OK	Voltage V Voltage 71.9V
	Current 0.0A Current 0.1A	Current 0.0A Current 0.4A
data point above 120kW	Alarms System 1	Alarms System 2
	Cavity air pressure too low Tube liquid flow too low Tube liquid pressure too low Tube liquid pressure too low Tube liquid tempterature to high	Cavity air pressure too low Tube liquid flow too low Tube liquid pressure too low Tube liquid tempterature to high
20-	SSA liquid flow too low SSA liquid pressure to low	SSA liquid flow too low SSA liquid flow too low SSA liquid flow too low
	SSA liquid temperature too high External interlock contact open	SSA liquid temperature too high SSA liquid temperature too high
10- 15	Anode current too high Grid 1 current too high	Anode current too high Grid 1 current too high
10	Grid 2 current too high Grid 1 fault	Grid 2 current too high Grid 1 fault
0.00+0 - 5	Grid 2 fault Total reflected power to high	Grid 2 fault Total reflected power to high
0.00+0	Tube reflected power too high SSA reflected power too high	Tube reflected power too high SSA reflected power too high
142100 142200 142200 142400	Water conductivity Emergency stop button	Water conductivity Emergency stop button HV Fault HV Transformer Overtemp.
		PE Coay Palay Fault

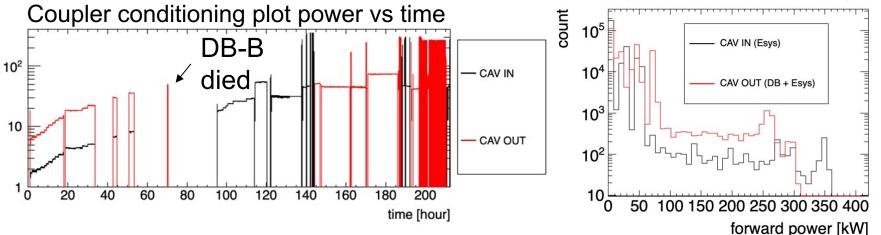






- 1. Machine **operation** at ESS in Lund
 - 20 years stable
 - 350kW-400kW stable
- 2. Qualification tests at Uppsala
 - Condition couplers (mainly <100kW; 1 week per one month)
 - Qualify cavities (typically <200 kW; 2-3 days per one month)
 - Assess 13 modules in series
 - Until the end of 2021

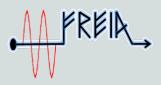




- ✓ Most demanding test at Uppsala is coupler conditioning
- \checkmark Power requirement is low still the stations often trip
- \checkmark Uppala needs to continue this test for another year



Typical test schedule at Uppsala



				Sep	tem	ber		Oct	obe	r		Nov	vemb	ber	
Equipment	Responsible			6	13	20	27	4	11	<mark>1</mark> 8	25	1	8	15	22
		weel	k #	36	37	38	39	40	41	42	43	44	45	46	47
Liquefier & 2K pumps	Esat														
RF power stations	Mykhailo														
							K	eep	fil	am	ent	: O	N		
Cryomodule test stand	Akira						CN	104				CN	103		

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

- \checkmark One module test per five weeks
- \checkmark 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