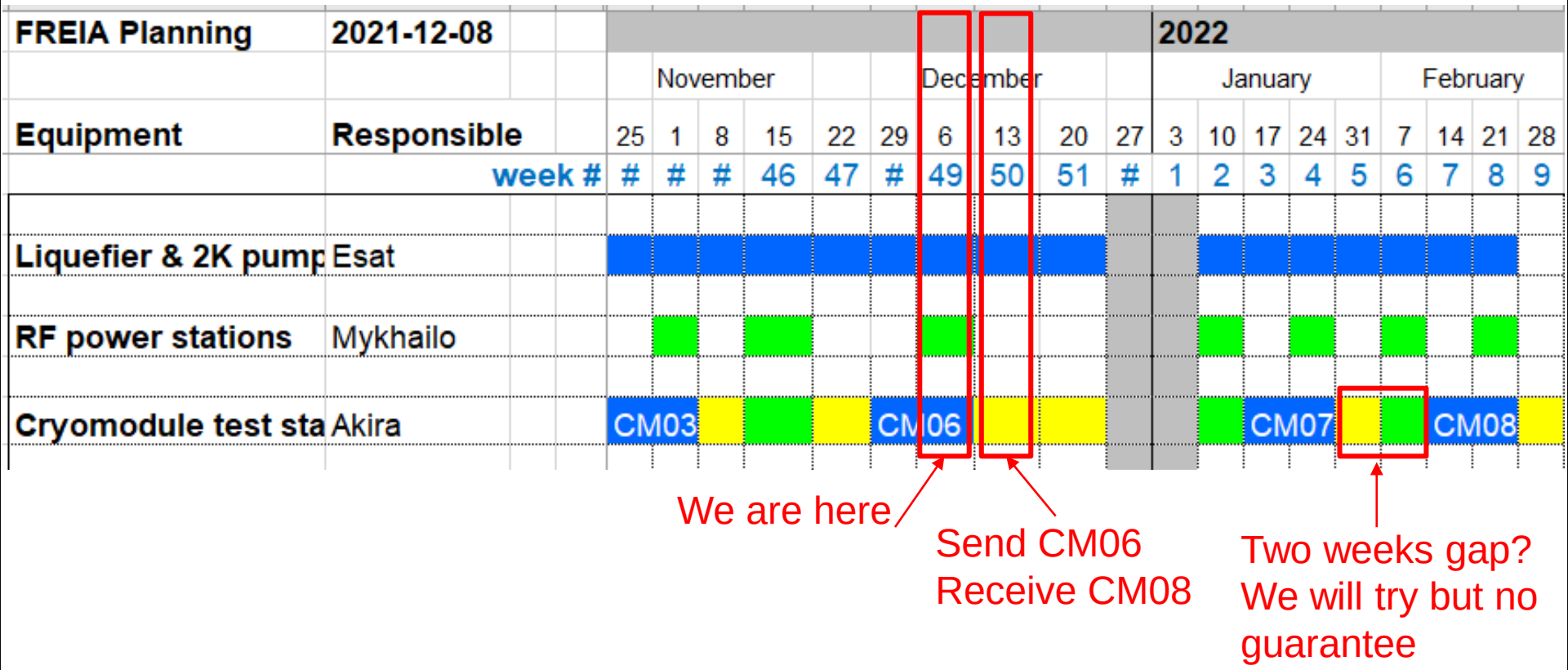
UPPSALA
UNIVERSITET

ESS weekly meeting (2021 W49)

A. Miyazaki et al.

General planning



- CM06 is warming up
- We do not want to leave turbo pumps over the Christmas holidays
  →Coupler conditioning of CM07 after holidays

W48 & W49 progress

week		W48											
date		MON		TUE		WED		THU		FRI		SAT	SUN
		29-nov		30-nov		01-dec		02-dec		03-dec		04-dec	05-dec
		m	a	m	a	m	a	m	a	m	a		
present CM	**CM06**	cooling down	4K filling	2K pumping, coupler cold conditioning, RF calibration		crain training	MP conditioning	CTS test at 2K	heat load measurement	piezo test	kept at 2K		
next CM	**CM07**	waiting in the docking area											
next next CM	**CM08**	preparation at Orsay											

week		W49											
date		MON		TUE		WED		THU		FRI		SAT	SUN
		06-dec		07-dec		08-dec		09-dec		10-dec		11-dec	12-dec
		m	a	m	a	m	a	m	a	m	a		
present CM	**CM06**	RF conditioning of FE		heat load again	start warming up	warming up		break insulation vacuum	warming up completed				
next CM	**CM07**					VNA reception test		doorknob mounting & water leak check					
next next CM	**CM08**	preparation at Orsay											

We are here

- 1 week was enough for the cold test because we started N2 cooling one week before
- 2 additional days for extra work on observed field emission

W50 & W51 & W52 planning

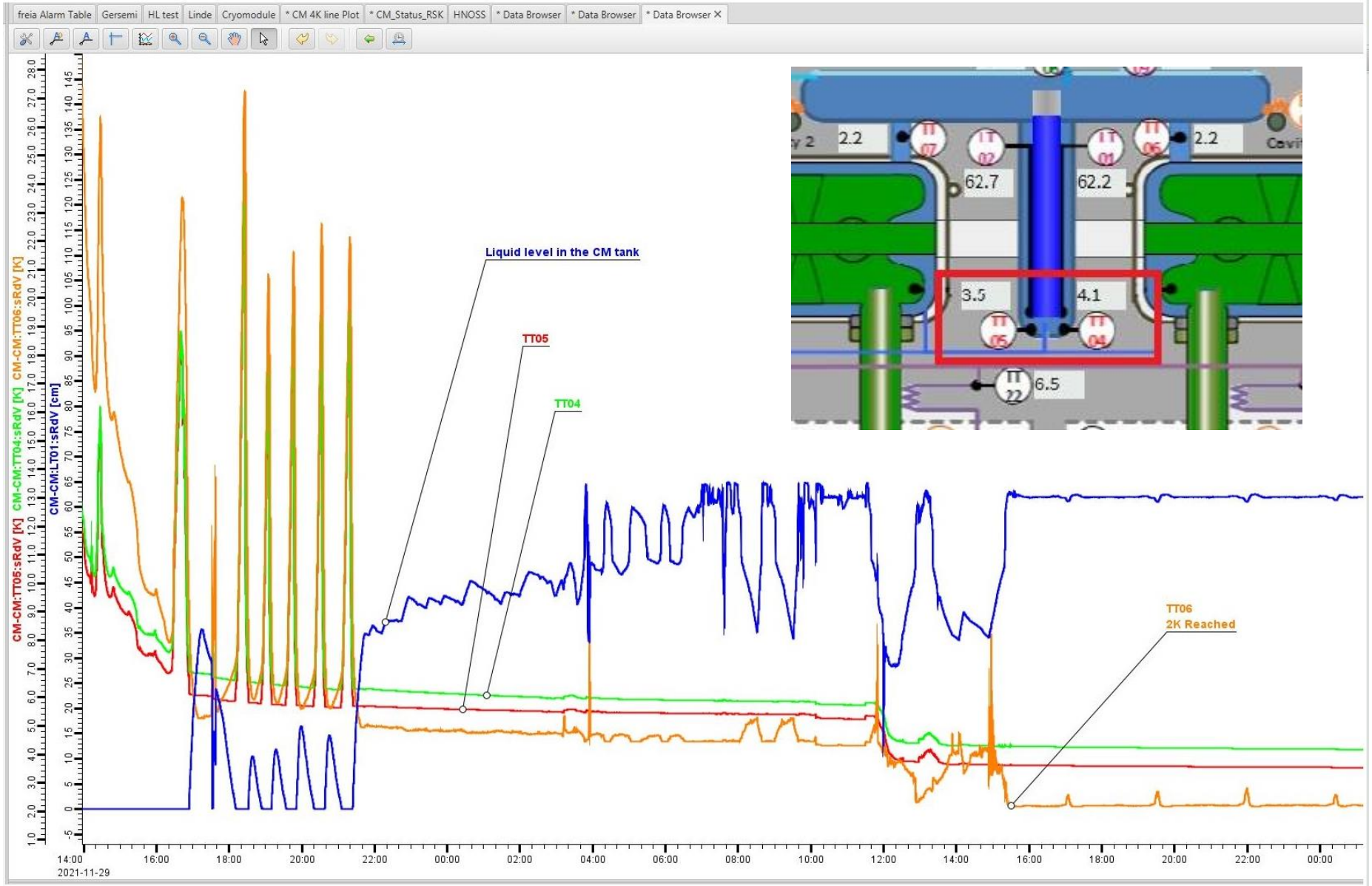
week		W50											
date		MON		TUE		WED		THU		FRI		SAT	SUN
		13-dec		14-dec		15-dec		16-dec		17-dec		18-dec	19-dec
		m	a	m	a	m	a	m	a	m	a		
previous CM	**CM06**	disconnect cryogenic lines	swap modules	filling dry N2		doorknob dismounting	outgoing test (LEMO, VNA) shock sensors	**departure to ESS**		**arrival at ESS / publish reports**			
present CM	**CM07**			connect cryogenic lines		vacuum pump mounting				vacuum pumping			
next CM	**CM08**	departure from Orsay						**reception at UU morning**		reception test LEMO / VNA			

Same track

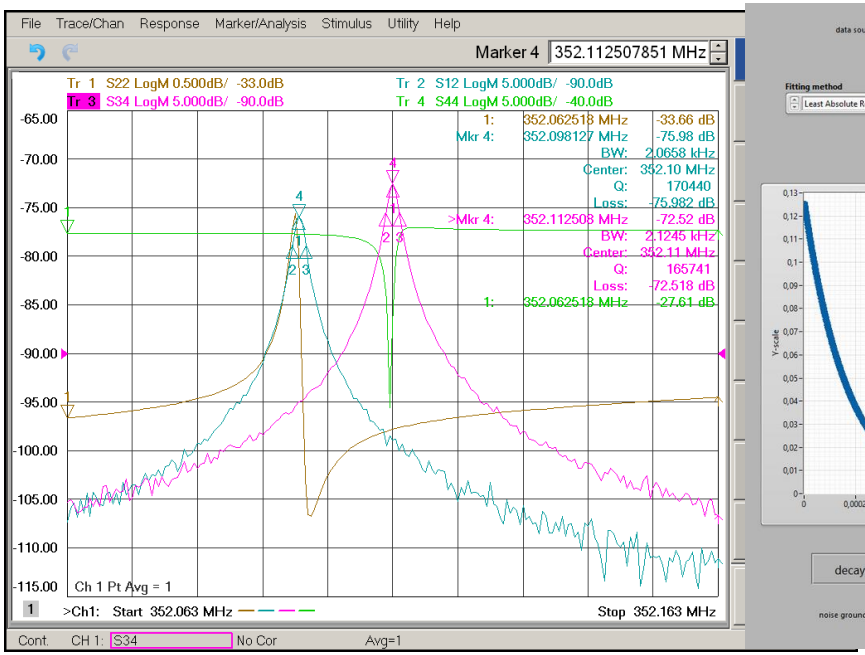
week		W51											
date		MON		TUE		WED		THU		FRI		SAT	SUN
		20-dec		21-dec		22-dec		23-dec		24-dec		25-dec	26-dec
		m	a	m	a	m	a	m	a	m	a		
present CM	**CM07**	vacuum pumping						closed valves					
next CM	**CM08**	doorknob mounting											

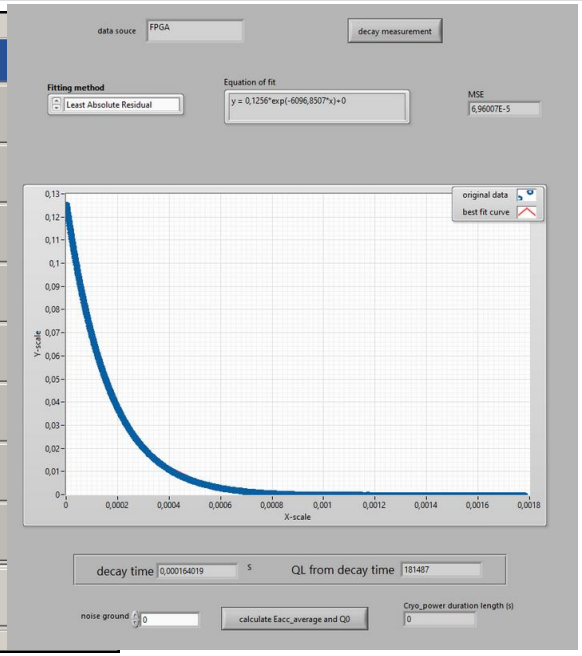
week		W52											
date		MON		TUE		WED		THU		FRI		SAT	SUN
		27-dec		28-dec		29-dec		30-dec		31-dec		01-jan	02-jan
		m	a	m	a	m	a	m	a	m	a		
present CM	**CM07**												
next CM	**CM08**												

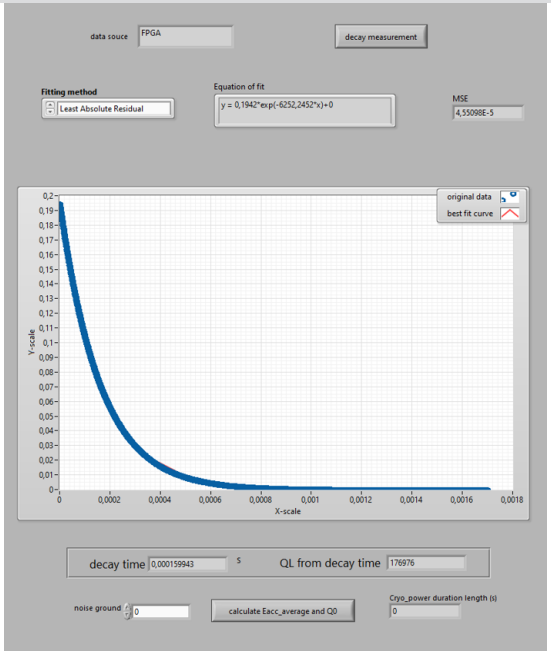
CM06: doubt in TT04 and TT05 → Any answers?



CM06: QL may be OK from time domain







		CAV IN	CAV OUT
VNA	Γ [kHz]	2.07	2.13
	Q_L	**1.70e5**	**1.66e5**
decay	τ_L [us]	164	160
	Q_L	**1.82e5**	**1.77e5**

- Specification is **>1.74e5**

$$\tilde{P}(f) \propto \frac{1}{(f-f_0)^2 + (\Gamma/2)^2}$$

$$V(t) \propto e^{-t/\tau_L}$$

$$\tau_L = \frac{1}{\pi\Gamma}$$ Fourier transform

$$Q_L = \frac{f_0}{\Gamma}$$

CM06: heat loads through GHe flow

First try on Dec the 2nd

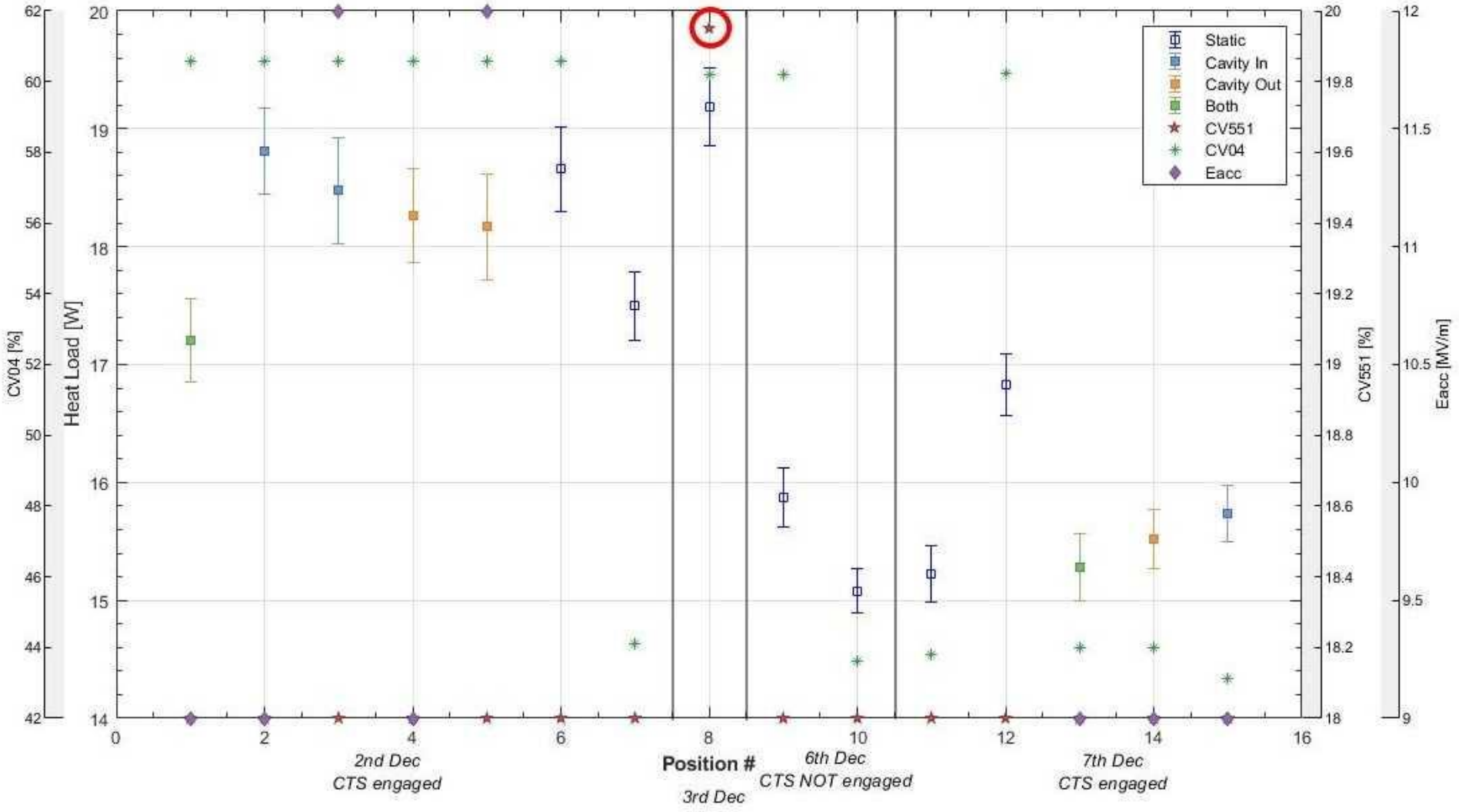
Value name	Dynamic	Dynamic	Dynamic	Dynamic	Dynamic	Static
Cav 1	9 MV/m	9 MV/m	12 MV/m	0 MV/m	0 MV/m	0 MV/m
Cav 2	9 MV/m	0 MV/m	0 MV/m	9 MV/m	12 MV/m	0 MV/m
FT551 [m3/h]	16.09	17.47	17.29	16.93	16.87	17.39
Heat Load [W]	17.22	18.69	18.39	18.12	18.05	18.61

Second try on Dec the 6th

Value name	Dynamic	Dynamic	Dynamic	Dynamic	Dynamic	Static
Cav 1	9 MV/m	9 MV/m	12 MV/m	0 MV/m	0 MV/m	0 MV/m
Cav 2	9 MV/m	0 MV/m	0 MV/m	9 MV/m	12 MV/m	0 MV/m
FT551 [m3/h]	14.25	14.7		14.49		14.26
Heat Load [W]	15.25	15.73		15.5		15.26
sigma [W]	0.31	0.29		0.3		0.28

- We do not have a resolution to see RF power dissipation of the order of 1 W
- The baseline flow became smaller in the 2nd try
  - This correspond to 3W, in this method is reliable
  - The 2nd try showed more typical values from other modules
- The 1st heat load measurement was performed a few days earlier than usual after LHe filling

CM06 heat load measurement summary by Rocio



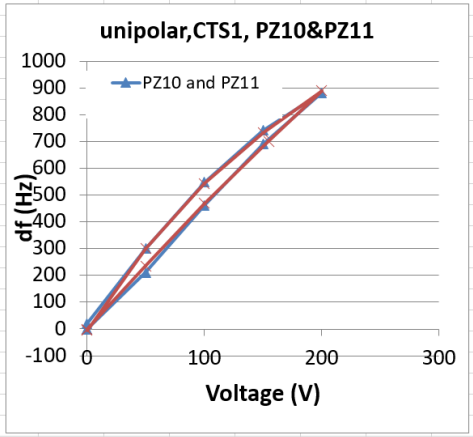
CM06: CAVIN piezo

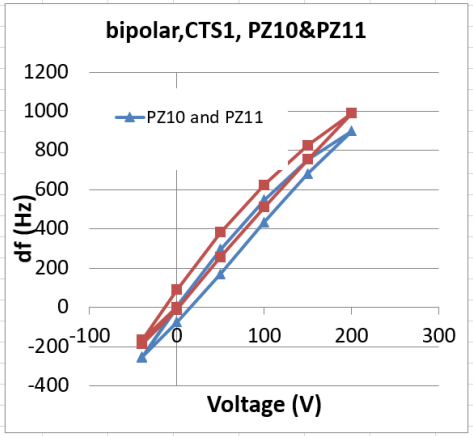
CAV IN BW (Hz)	2043

20211203 TT11=113,6K

both piezos simulaneously

Voltage (V)	Phase (°)	df(Hz)
0	100,65	0
50	109,93	210,656
100	120,99	461,718
150	131,02	689,399
200	139,52	882,349
150	133,28	740,701
100	124,76	547,297
50	113,88	300,321
0	101,53	19,976
0	101,31	0
50	111,69	235,626
100	121,99	469,436
155	132,17	700,522
200	140,53	890,294
150	133,59	732,756
100	125,27	543,892
50	114,51	299,64
0	101,09	-4,994
0	100,75	0
-40	89,51	-255,15
0	97,44	-75,137
50	108,23	169,796
100	119,95	435,84
150	130,8	682,135
200	140,34	898,693
150	134,05	755,91
100	124,88	547,751
50	113,82	296,689
0	101,05	6,81
-40	89,63	-252,42
0	96,95	0
-40	88,73	-186,59
0	96,49	-10,442
50	108,34	258,553
100	119,45	510,75
150	130,18	754,321
200	140,62	991,309
150	133,4	827,415
100	124,51	625,612
50	113,81	382,722
0	100,93	90,346
-40	89,62	-166,39
0	97,03	1,816





tuning range bp	1177,9
tuning range up	895,288

PZ10 only

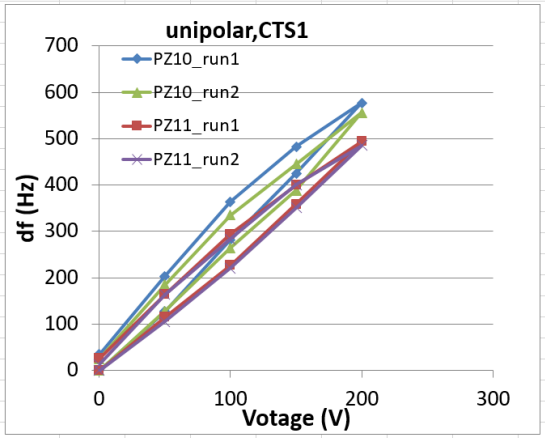
Voltage (V	Phase (°	df(Hz)
0	100,48	0
50	106,11	127,801
100	112,89	281,707
150	119,19	424,717
200	125,91	577,261
150	121,75	482,829
100	116,5	363,654
50	109,45	203,619
0	102,02	34,958
0	101,87	0
50	107,51	128,028
100	113,52	264,455
150	118,98	388,397
200	126,36	555,923
150	121,48	445,147
100	116,64	335,279
50	110,03	185,232
0	102,99	25,424
0	102,91	0
-40	96,6	-143,24
0	101,18	-39,271
50	106,88	90,119
100	113,26	234,945
150	120,03	388,624
200	126,92	545,027
150	122,26	439,245
100	116,43	306,904
50	110,32	168,207
0	103,03	2,724
-40	96,67	-141,65
0	100,83	0
-40	96,65	-94,886
0	101	3,859
50	106,52	129,163
100	112,75	270,584
150	119,95	434,024
200	126,6	584,979
150	122,33	488,05
100	117,19	371,372
50	111,23	236,08
0	104,11	74,456
-40	97,49	-75,818
0	101,4	12,939

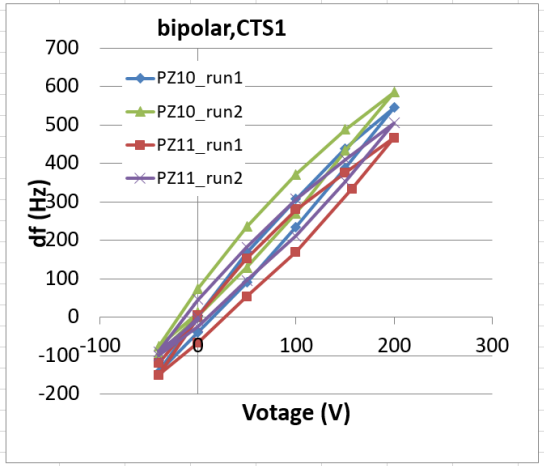
tuning range bp	679,865
tuning range up	555,923

PZ11 only

Voltage (V	Phase (°	df(Hz)
0	99,45	0
50	104,52	115,089
100	109,44	226,773
150	115,24	358,433
200	121,22	494,179
150	117,05	399,52
100	112,42	294,419
50	106,67	163,894
0	100,62	26,559
0	100,42	0
50	105,08	105,782
100	110,16	221,098
150	115,89	351,169
200	121,79	485,099
150	118,06	400,428
100	112,93	283,977
50	107,65	164,121
0	100,98	12,712
0	100,73	0
-40	94,12	-150,05
0	97,81	-66,284
50	103,08	53,345
100	108,2	169,569
157	115,41	333,236
200	121,27	466,258
150	117,29	375,912
100	113,05	279,664
50	107,46	152,771
0	100,93	4,54
-40	95,46	-119,63
0	99,11	0
-40	94,72	-99,653
0	98,05	-24,062
50	103,34	96,021
100	108,42	211,337
150	114,71	354,12
200	121,36	505,075
150	117,18	410,189
100	112,64	307,131
50	107,12	181,827
0	101,15	46,308
-40	95,18	-89,211
0	98,78	-7,491

tuning range bp	604,728
tuning range up	485,099



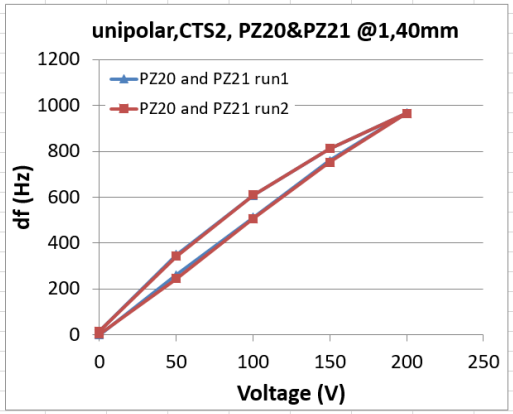


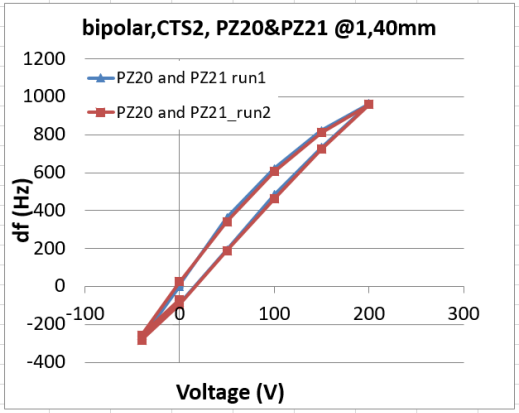
CM06: CAVOUT piezo

CAV OUT BW (Hz)	2070

20211203 TT21=116,5K
both piezos simulaneously

Voltage (V)	Phase (°)	df(Hz)
0	51,48	0
50	62,83	261,05
100	73,74	511,98
150	84,52	759,92
200	93,57	968,07
150	86,77	811,67
100	77,94	608,58
50	66,67	349,37
0	52,15	15,41
0	51,62	3,22
50	62,14	245,18
100	73,5	506,46
150	84,23	753,25
200	93,44	965,08
150	86,78	811,9
100	77,99	609,73
50	66,4	343,16
0	52,21	16,79
0	51,82	0
-40	39,8	-276,46
0	47,85	-91,31
50	60,22	193,2
100	72,88	484,38
150	83,64	731,86
200	93,73	963,93
150	87,56	822,02
100	78,84	621,46
50	67,65	364,09
0	52,37	12,65
-40	40,26	-265,88
0	48,13	-84,87
-40	39,55	-282,21
0	47,69	-94,99
50	60,01	188,37
100	71,86	460,92
150	83,26	723,12
200	93,51	958,87
150	87,06	810,52
100	78,15	605,59
50	66,72	342,7
0	52,92	25,3
-40	40,66	-256,68
0	48,85	-68,31





tuning range bp	1241,08
tuning range up	961,86

PZ20 only

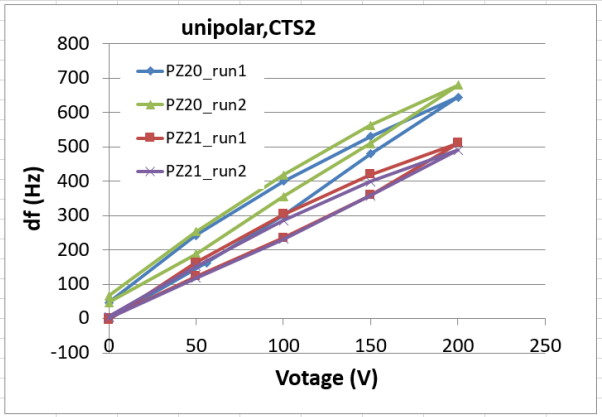
Voltage (\	Phase (°)	df(Hz)
0	50,1	0
56	57,16	162,38
100	63,18	300,84
150	70,93	479,09
200	78,11	644,23
150	73,14	529,92
100	67,46	399,28
50	60,59	241,27
0	52,12	46,46
0	52,11	46,23
50	58,24	187,22
100	65,56	355,58
150	72,23	508,99
200	79,61	678,73
150	74,55	562,35
100	68,28	418,14
50	61,06	252,08
0	52,97	66,01
0	52,95	0
-40	45,79	-164,68
0	50,44	-57,73
50	57,52	105,11
100	64,66	269,33
150	72,11	440,68
200	79,85	618,7
150	74,76	501,63
100	68,98	368,69
50	61,35	193,2
0	53,54	13,57
-40	45,36	-174,57
0	49,81	-72,22
-40	45,13	-179,86
0	49,47	-80,04
50	56,37	78,66
100	63,58	244,49
150	71,28	421,59
200	78,86	595,93
146	73,38	469,89
100	67,66	338,33
50	60,87	182,16
0	52,37	-13,34
-40	45,48	-171,81
0	50,15	-64,4

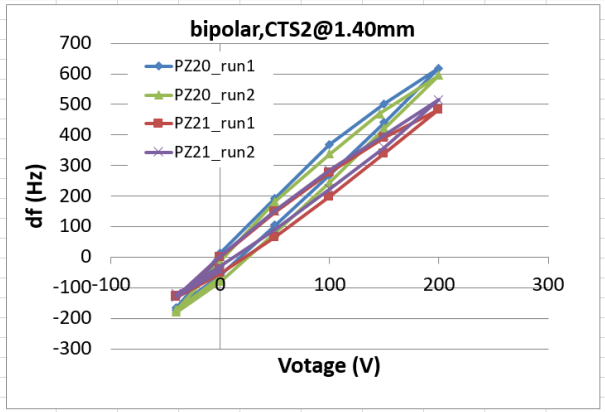
tuning range bp	798,56
tuning range up	612,72

PZ21 only

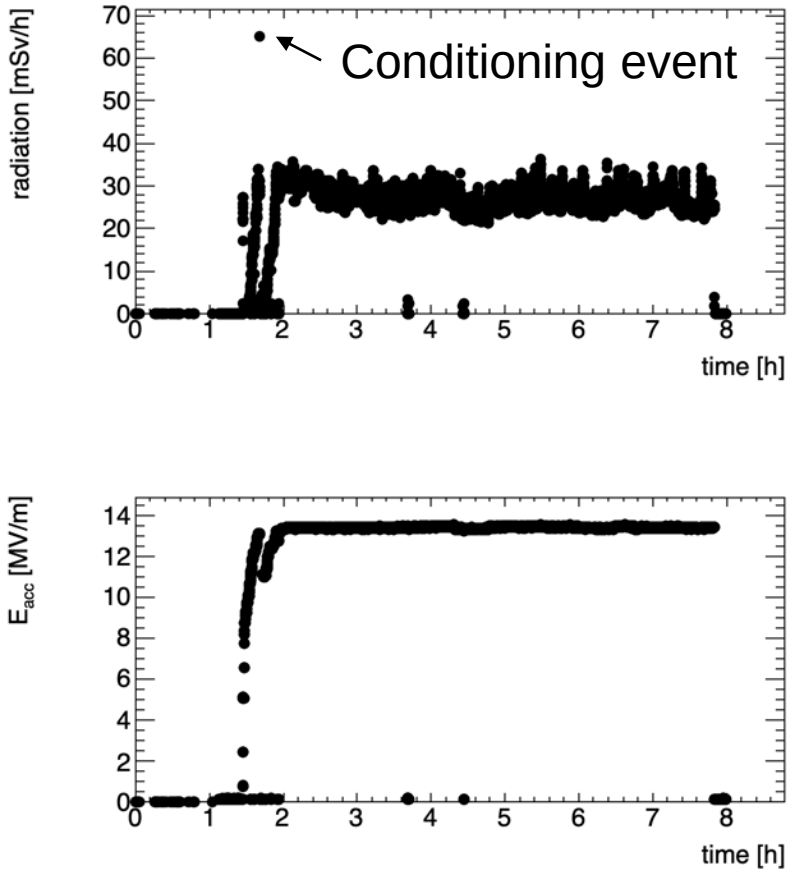
Voltage (\	Phase (°)	df(Hz)
0	52,21	0
50	57,52	122,13
100	62,38	233,91
150	67,81	358,8
200	74,42	510,83
150	70,4	418,37
100	65,37	302,68
50	59,26	162,15
0	52,05	-3,68
0	52,27	1,38
50	57,32	117,53
100	62,27	231,38
150	67,75	357,42
200	73,54	490,59
150	69,54	398,59
100	64,59	284,74
50	58,79	151,34
0	52,47	5,98
0	52,64	0
-40	46,95	-130,87
0	50,38	-51,98
50	55,46	64,86
100	61,28	198,72
150	67,37	338,79
200	73,65	483,23
150	69,65	391,23
100	64,67	276,69
50	59,08	148,12
0	52,63	-0,23
-40	47,06	-128,34
0	50,81	-42,09
-40	47,41	-120,29
0	51,37	-29,21
50	56,63	91,77
100	62,36	223,56
150	68,3	360,18
200	75,03	514,97
150	70	399,28
100	65,06	285,66
50	59,24	151,8
0	52,78	3,22
-40	47,02	-129,26
0	50,68	-45,08

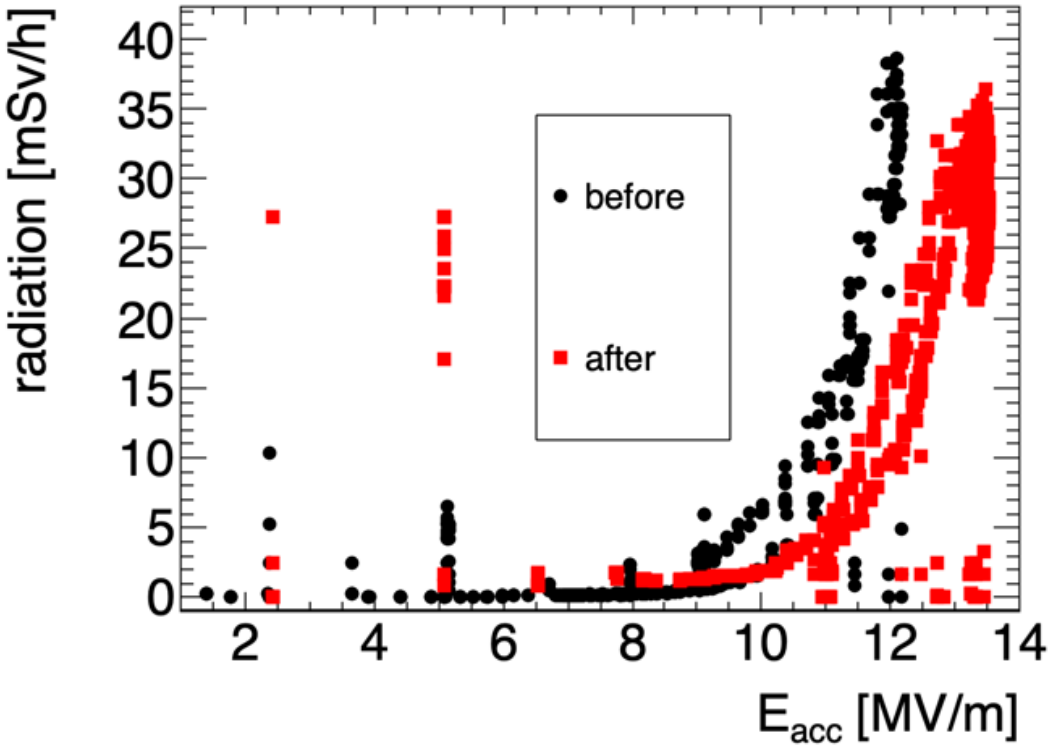
tuning range bp	603,52
tuning range up	484,61





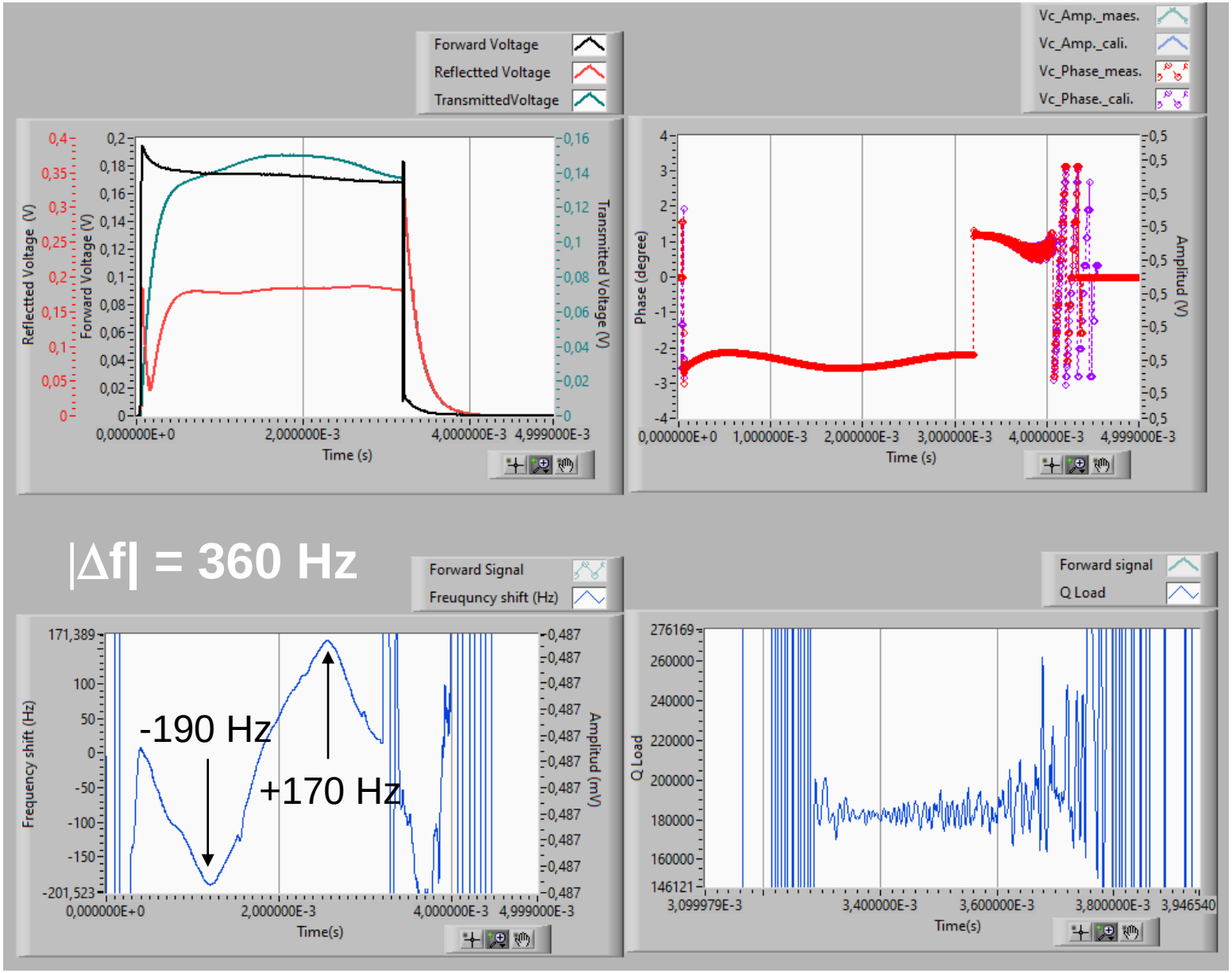
CM06 CAVOUT: FE conditioning



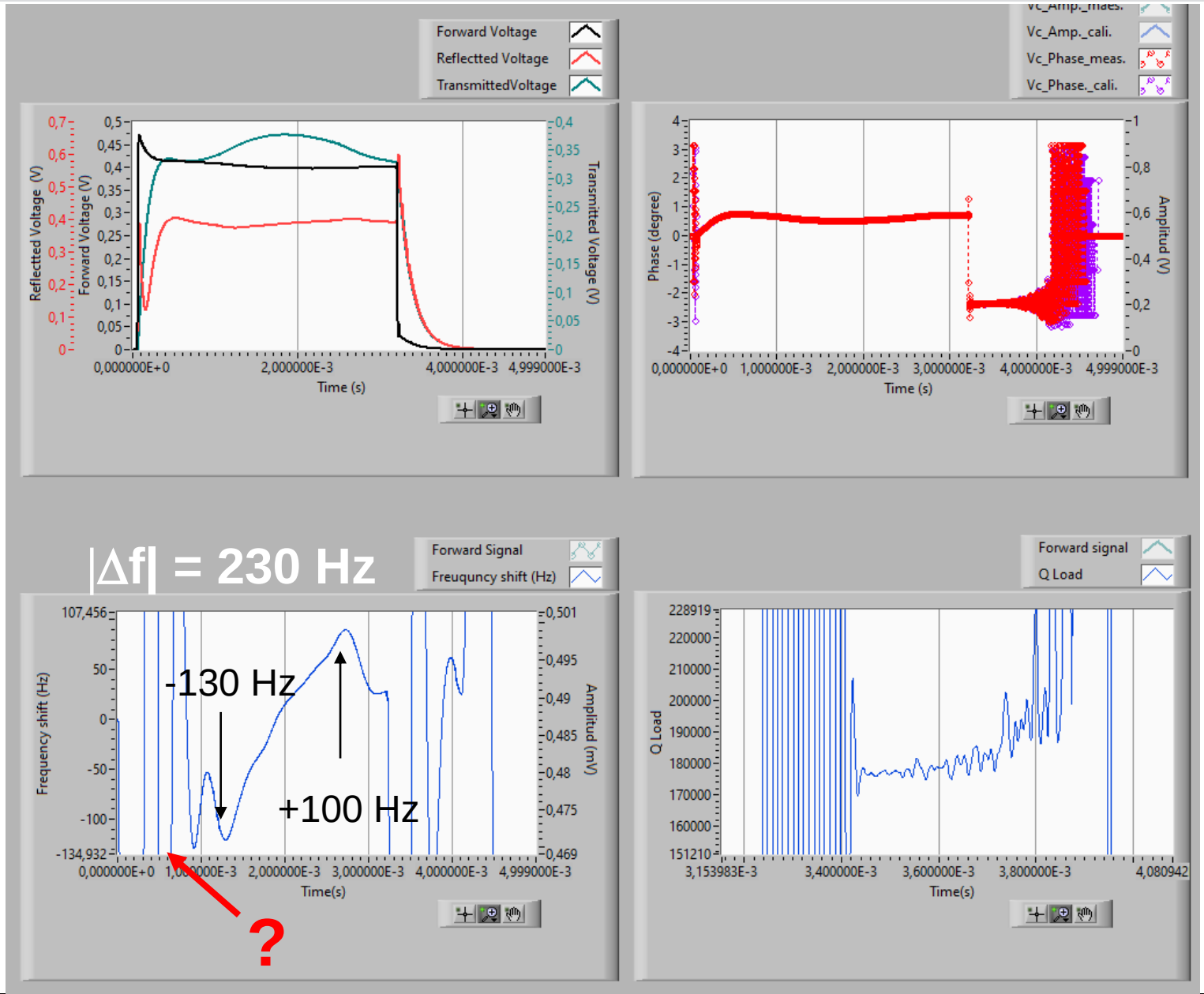


- Slightly improved just within 30 minutes
- After that, no improvement for 6 hours
- ESS may try to condition this during RF commissioning

CM06: CAVIN Lorentz force detuning@9MV/m

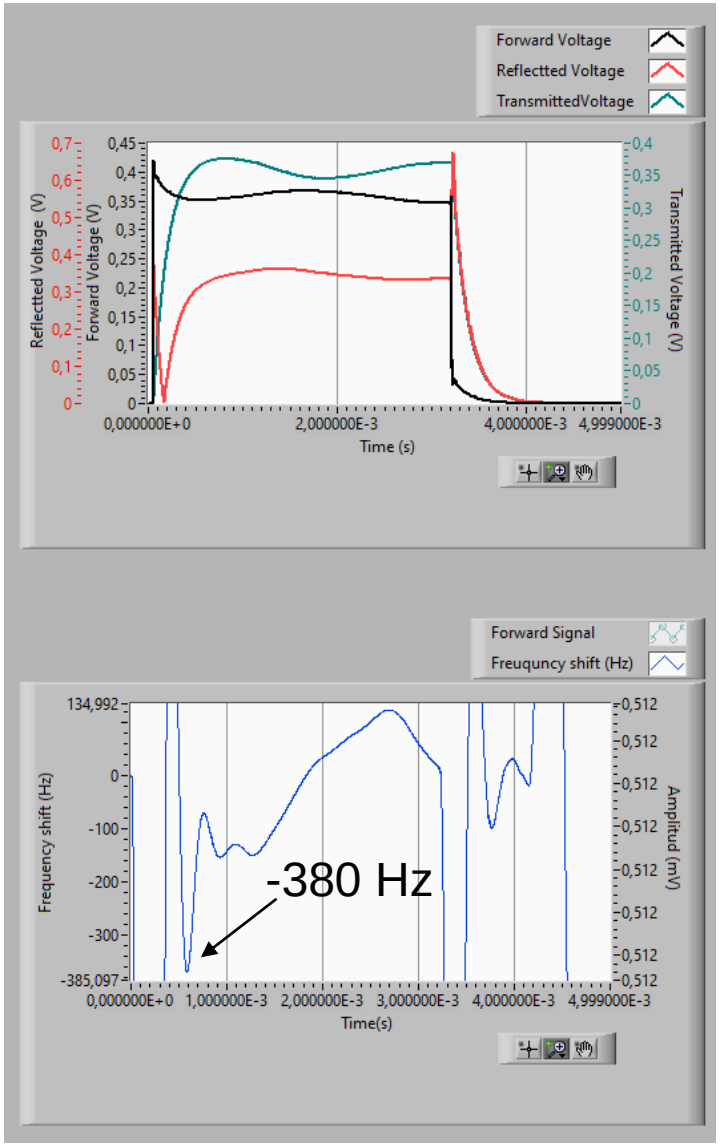


CM06: CAVOUT Lorentz force detuning@9MV/m



CM06: CAVOUT doubt in LFD

Tune CTS after FE conditioning



- A huge drop in reconstructed resonant frequency was observed during RF filling
- This exists at 600 us from the beginning of the pulse
- The reconstruction of Δf is from

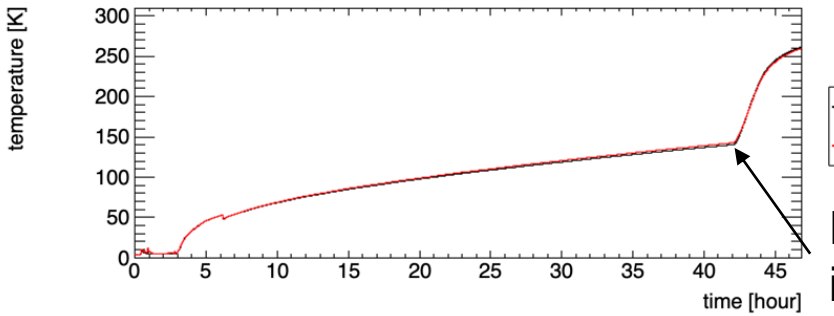
$$\frac{d}{dt}\Delta f(t) = -\frac{1}{\tau_m}\Delta f(t) - \frac{K_L}{\tau_m}E_{acc}^2(t)$$

$$\frac{d}{dt}E_{acc}(t) = -\left[\omega_{1/2} - i2\pi\Delta f(t)\right]E_{acc}(t) + 2\omega_{1/2}V_f(t)/L_{acc}$$

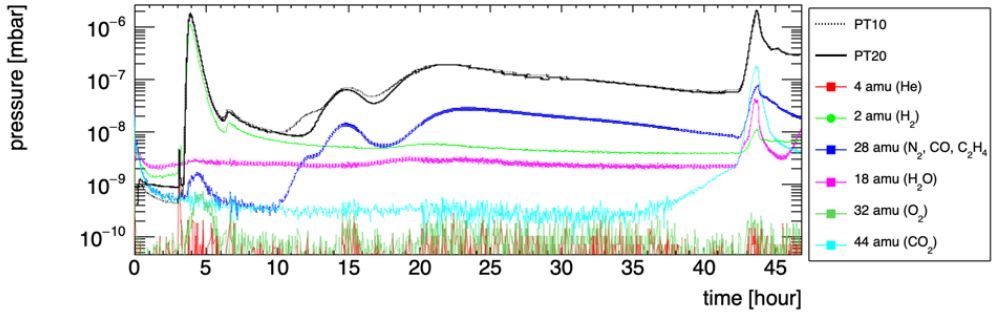
- After normalizing $E_{acc}(t)$ and $V_f(t)$, numerical derivative of the complex pulse shape gives Δf(t)
- Nonlinear response from field emission is not included in the model
- Higher power in “prepulse” would accelerate the filling and this “-380 Hz” would be anyway earlier than 600 us in real operation

CM06: warming up in progress

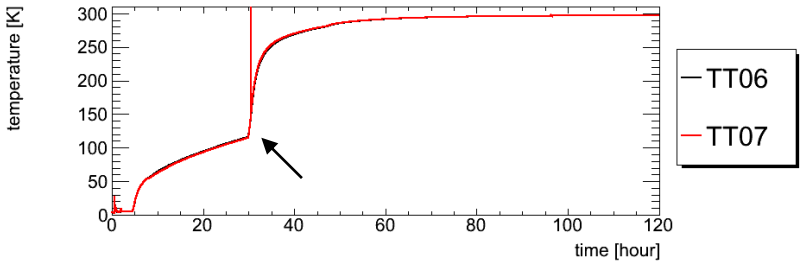
CM06

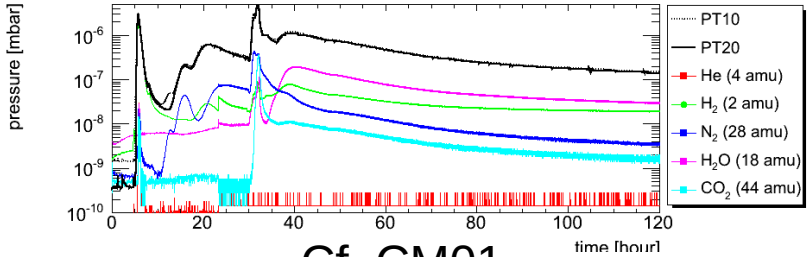


N2 vent
insulation
vacuum

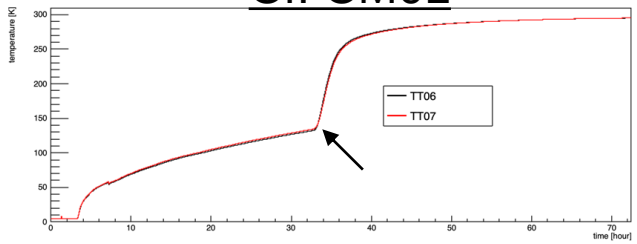


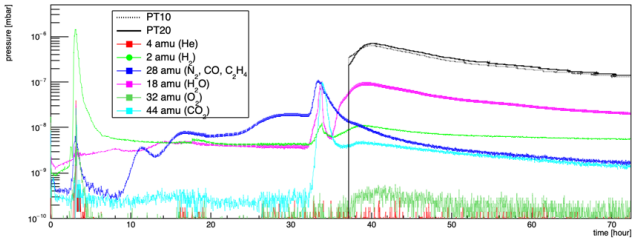
Cf. CM05





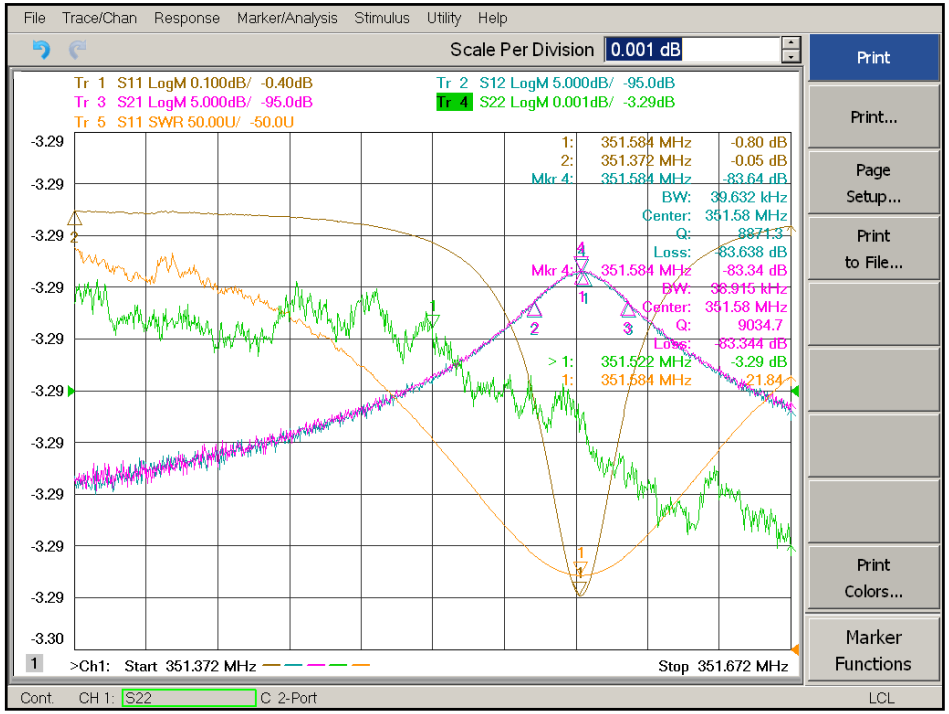
Cf. CM01



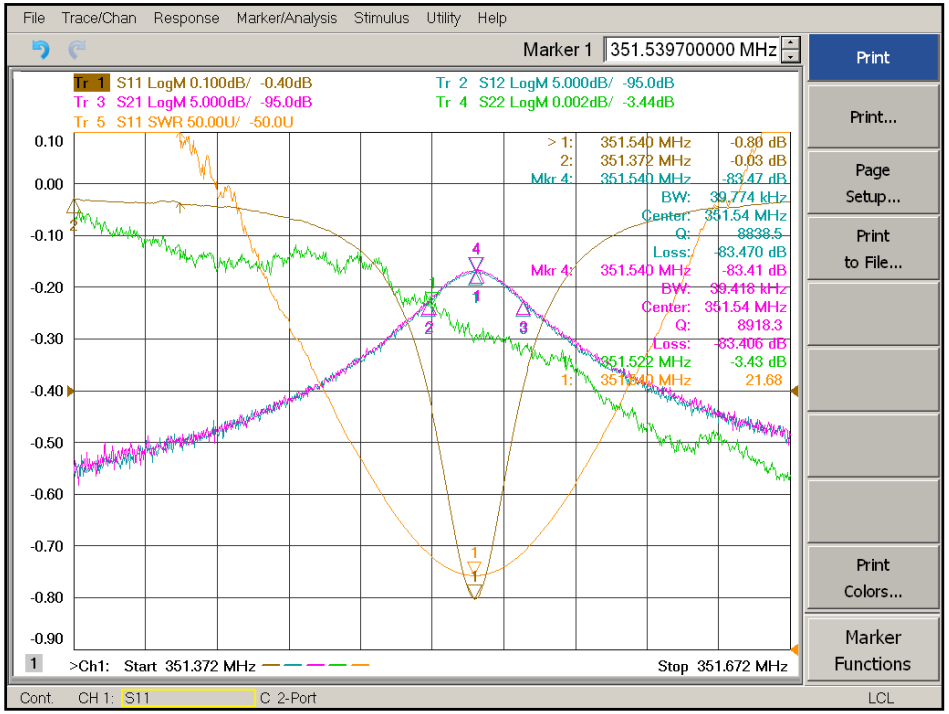


- 24 hours after venting is a time to start disconnecting cryogenic lines (Friday morning)
- 28 amu line is interesting because it may contain C_2H_4 signal which decreases work function of Nb and trigger field emission
- 28 amu line always shows more than three peaks

CM07: cavity reception test



CavIN



CavOUT

The insulation vacuum seemed slightly pressurized than atmospheric pressure in Sweden

Grease ?

- The grease on the module is as received
- We do not add grease there because it is too much from the beginning
- We added grease on safety valve section when we investigated leak there
- Small amount of grease too keep O-rings fresh unavoidably exist in our 2K infrastructure