# Status of the ELETTRA RF Plants

M. Bocciai, C. Pasotti, M. Rinaldi

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elettra

# ELETTRA SYNCHROTRON RADIATION LIGHT SOURCE

Full Energy Injection

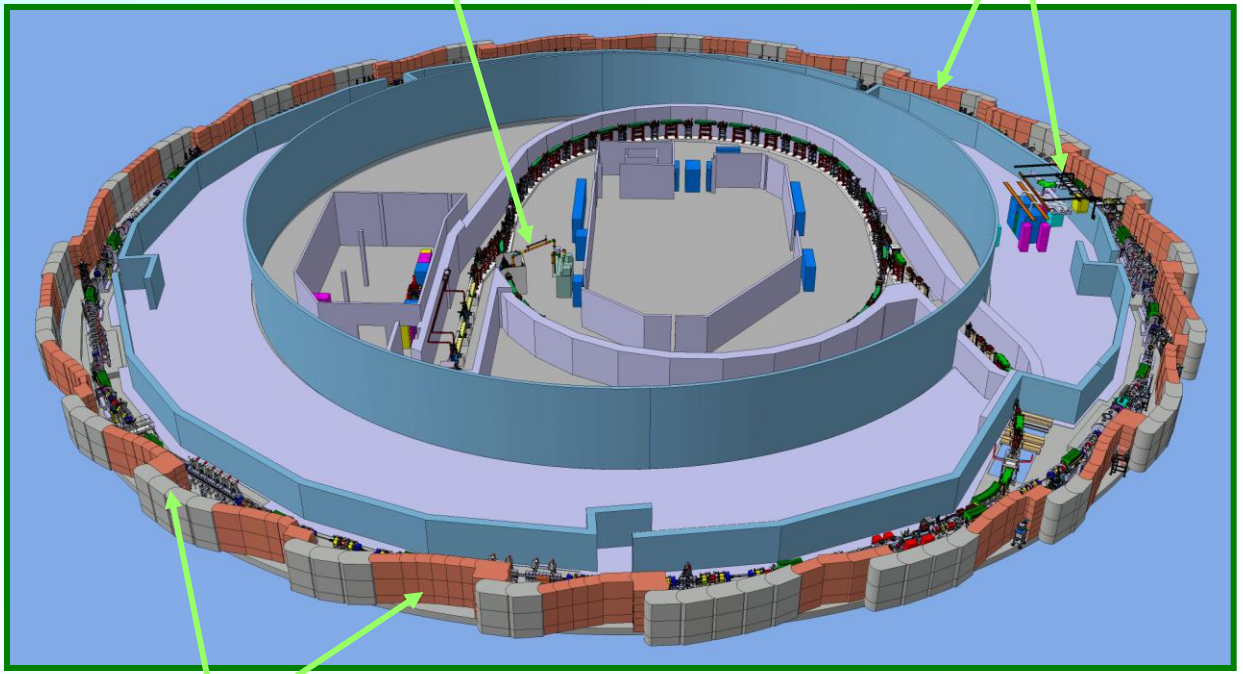
TOP UP Operation

Energy 2.0 ÷ 2.4 GeV

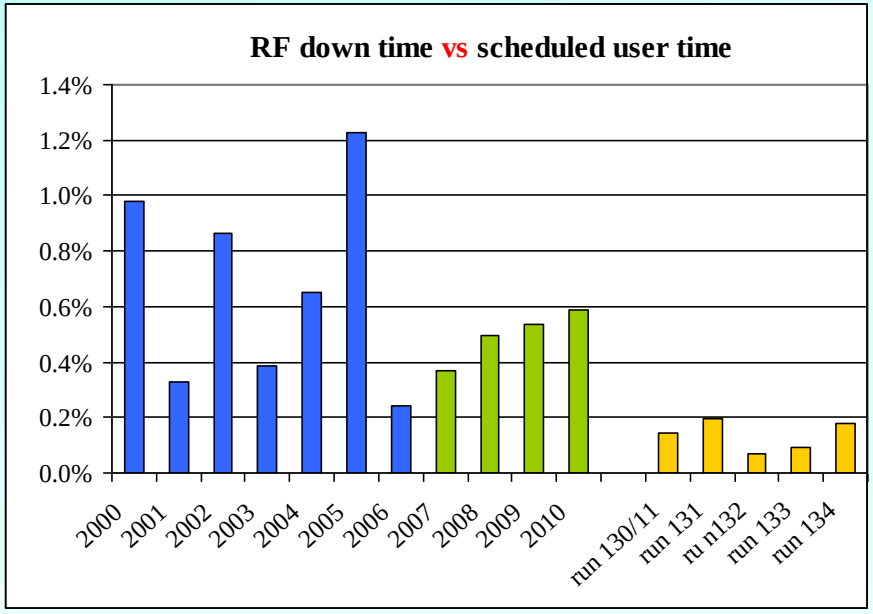
Current: 310 ÷ 140 mA

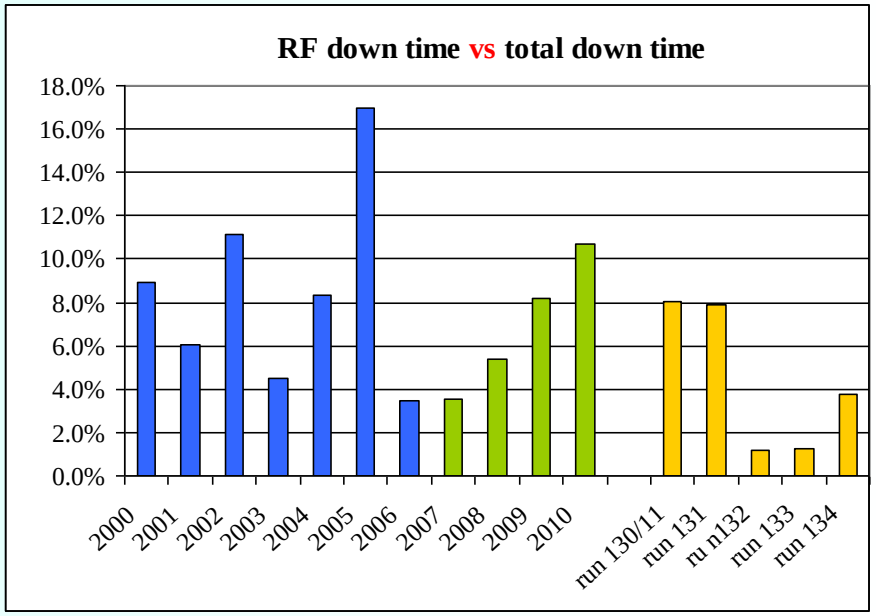
User time > 5000 hrs/year

UpTIME goal > 95%



# RF & Elettra Availabiliy




< 2007: random failures and effective restore strategies

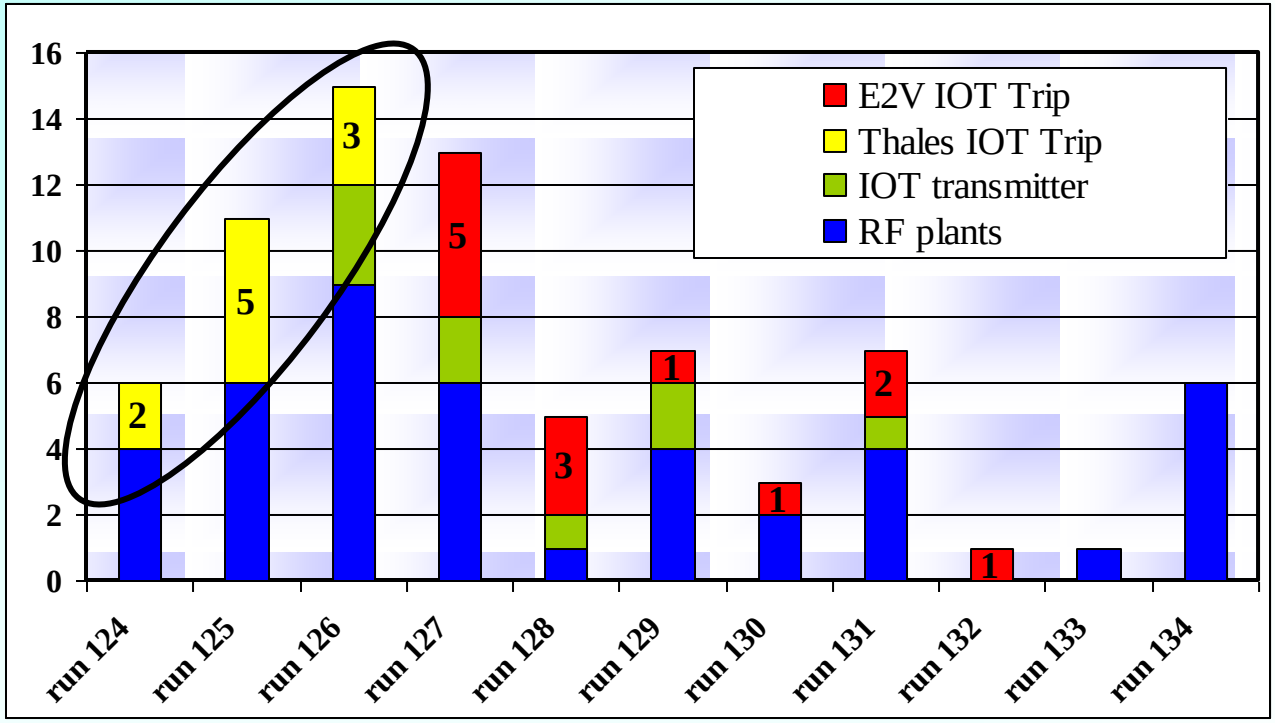
2007-2010: systematic failures, growing - installation & operation IOT transmitter

2011 : Troubles sorted out (?!) …

***Run 130/2011***: *Total up-time 99%; user time 840 hours; RF failure of 35'*

***Run 131/2011***: *Total up-time 98.5% ; user time 1143 hours; RF failures total 133*'

# RF Availability / Failures




From 2010: number of RF plants failure and comparison between machine operation with Thales tubes (TH 793 and TH 793-1) and E2V tube D2130.

TH 793-1 and D2130 are new tubes, TH 793 was around 11000 hours in Jan-10.

# IOT twofold transmitter

From 2007, the RF plant # 9 available power *is* 150 kW = max (80 kW + 80 kW)

Combiner: WG switchless

Operational experience: lack of reliability using Thales I.O.T. tubes.

# IOT D2130 parameter

| IOD D2130 | |
|---|---|
| serial | 302-1017 |
| frequency | 499.654 MHz |
| set up date | 14-Jun-10 |
| heater hours | 7700 |
| output power range | 55 ÷ 60 kW |
| gain | 22.9 dB |

Only one tube, any statistic is not possible


**MAIN QUESTION: what is the Time To Failure of such IOT with this working conditions ?**

# IOT TH 793 parameter

| IOT TH 793 | |
|---|---|
| serial | 557132 |
| frequency | 499.654 MHz |
| set up date | 30-Jun-06 |
| heater hours | 16250 |
| output power range | 50 ÷ 55 kW |
| gain | 23.3 dB |

TH 793 is kept as a backup RF power source.

1500 hours of operation during last 12 months.

**Upgrade to E2V foreseen**

# RF Power Budget

In 2012 the superconducting wiggler (SCW) will be re-established and set into operation. New lines are then foreseen for X-Ray diffraction applications. Further STORAGE RING RF power demand **+ 20 kW**.

Actually:

- SR RF power to the beam 70 kW
- SR RF cavity copper losses 120 kW
- SR RF available power (Sep - 2011) 240 kW
- SR RF power (both IOTs -Feb. 2012) 315 kW

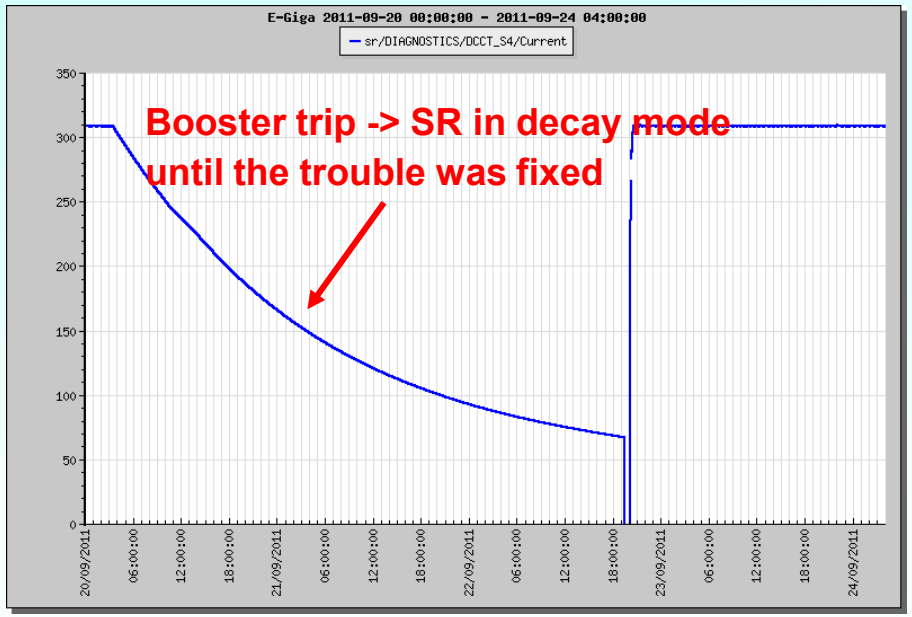
RF power demand does not matter, the question is:

- klystron-transmitter aging > 100000 hours (set up 1992); replacement parts not any longer available
- IOT transmitters: 24000 hours (set up 2006).

# Decay MODE versus TOP UP

Elettra was operating in DECAY mode (1 injection/day from 310 to 150 mA @ 2.0 GeV) till May 2010.

Since that time, Elettra is operating in TOP UP mode (+ 1 mA each 12 minutes at 2.0 GeV to restore 310 mA.




DECAY MODE: the RF cavity working point shifts according to the stored current. RF POWER $\Delta$~1db, tuning $\Delta$~10%.

↓

Longitudinal stability (no excitation of H.O.M.s and CBMs free beam) was required in a cavity temperature range of 2.4 °C (at least!)

TOP UP: constant cavity working point.

↓

No need to find the proper cavity temperature range for each cavity to ensure the longitudinal beam stability!

# Input Power Coupler

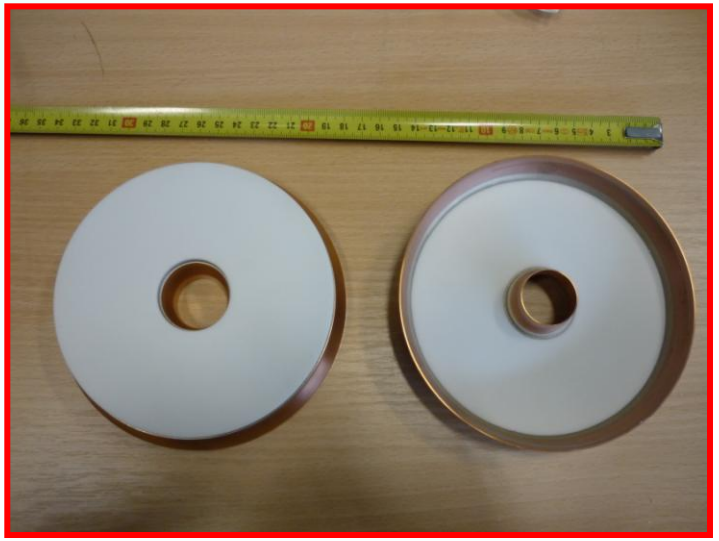
The power coupler of cavity#8 has been replaced after 18 months of operations.
The RF conditioning of this coupler at full reflection power was not successfully.

**Even though the cavity's vacuum level was good (~$10^{-9}$ mbar at 55 kW CW, storage ring current 310 mA), the pressure vacuum level got worse ( >5 $10^{-8}$ mbar) in case of fast beam losses, that means full reflection at the input power coupler.**

Reasons still unknown.

Replacement was good: no more troubles since there.

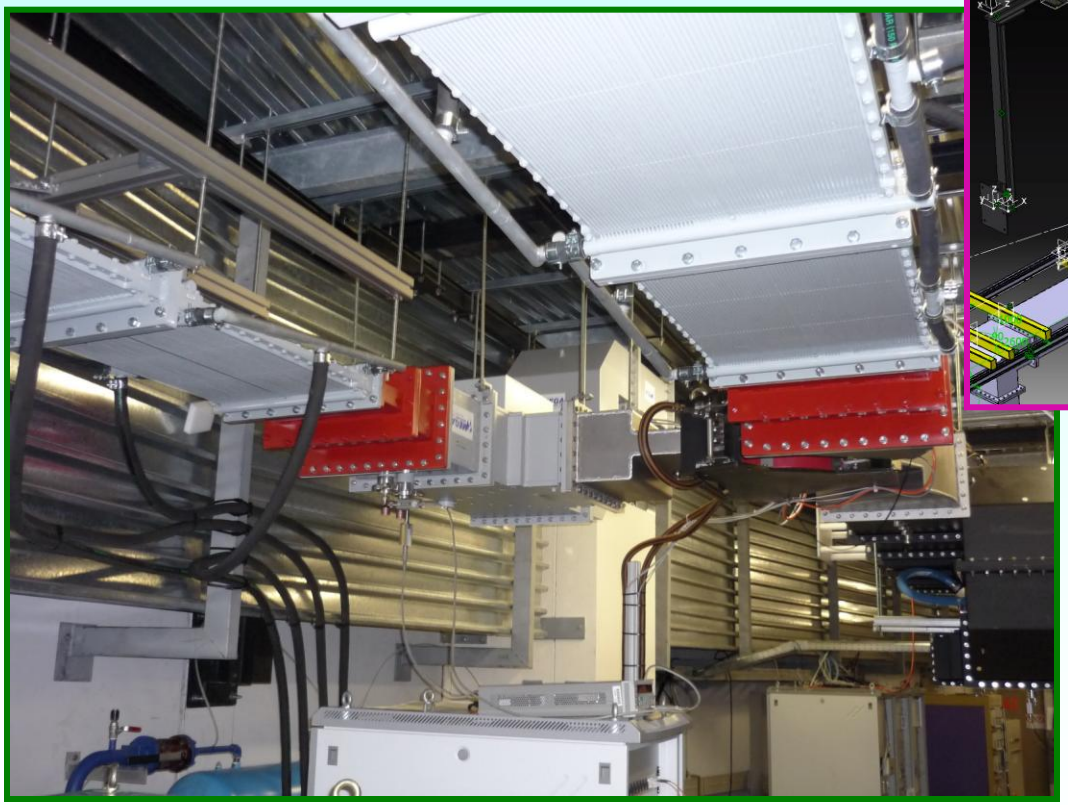
Looking to qualify more factories to build spare IPC. Each fabrication step shall be followed closer.

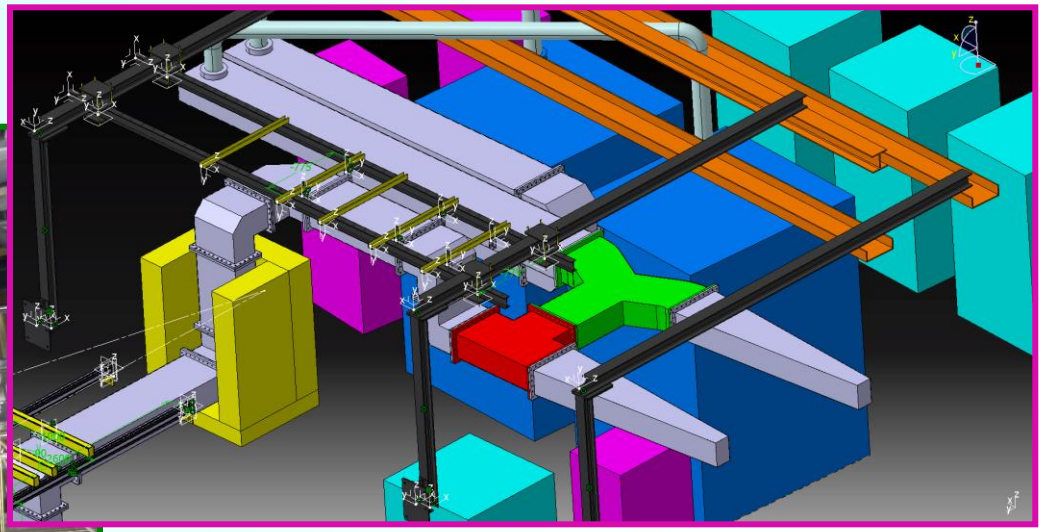


# WR1800 H-Plane Tee Switch

I.O.T. transmitter's switch on during shut down time quite difficult.

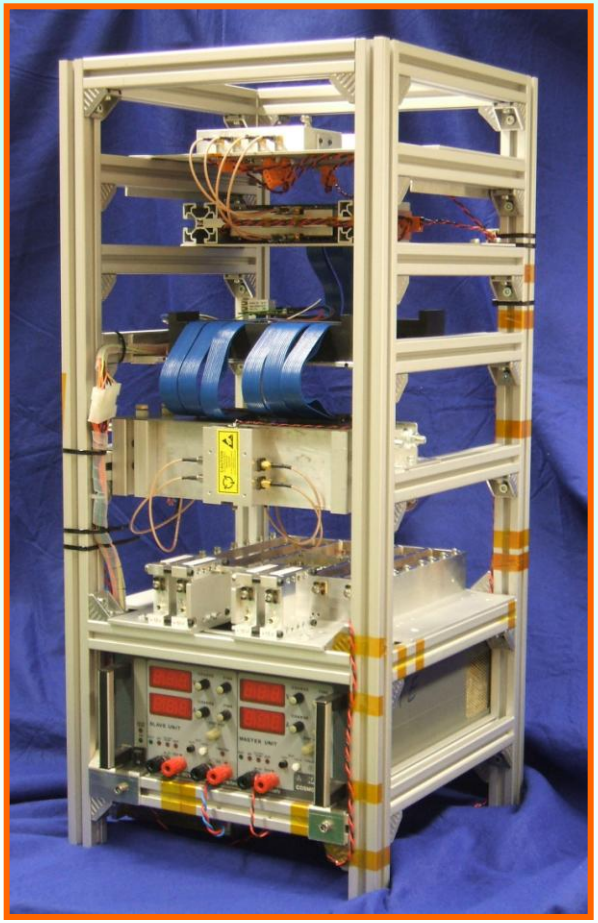
Installed a motorized WG Y switch





**Freq. 500 MHz**
**SWR 1.03 max**
**Isolation >-90 dB**

# Digital Low Level RF



**In stand by !**

- Down-Conversion, (RF=500MHz IF=20MHz).
- ADC (16 bit, 160MS/s)
- FPGA digital board
- DAC (16 bit, 160MS/s).
- Low Noise filters.
- 500 Mhz Modulator.

ADC RF sampling resolution , IF (20 MHz)

$\varphi$ < 0.04° nominal < 0.1°

$|\rho|$ < 0.024% nominal < 0.1%

DAC + modulator resolution

$\varphi$ < 0.04° nominal < 0.1°

$|\rho|$ < 0.05% nominal < 0.1%

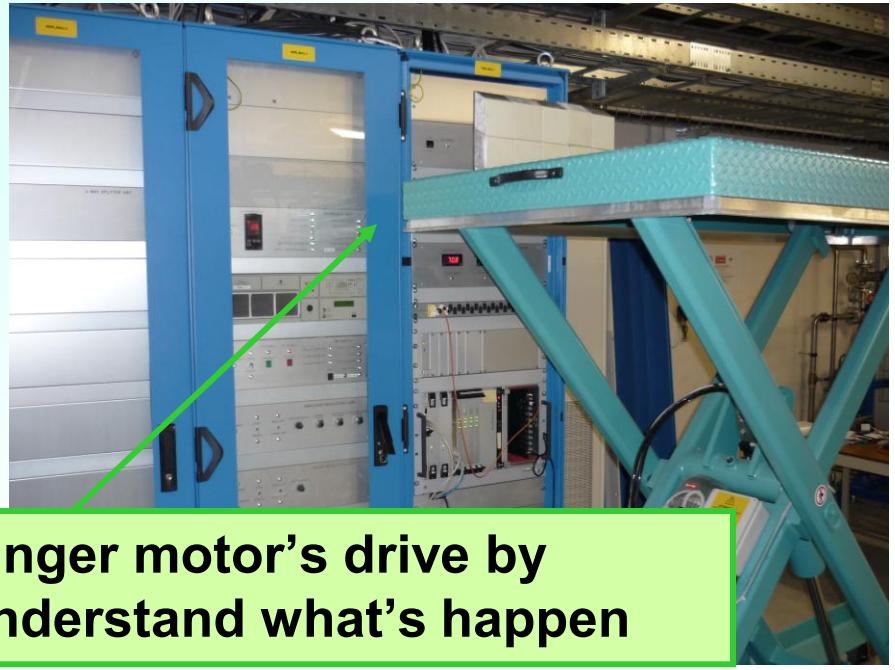
Mod. BW > 40 kHz nominal 17 kHz

*Courtesy of P. Pittana*

# Booster RF Plant

There is not a radiation shielding wall between the booster machine and its equipment.

The frequency tuning system of the RF cavity (the two plungers) shows some malfunctioning mainly in conjunction with higher gun grid voltage (i.e. more electrons from the 100 MeV Linac).



**Temporary shield of the plunger motor's drive by means of lead's bricks to understand what's happen**

# Conclusion

✓ reliability of the RF plants is good. The E2V I.O.T. tube finally works properly

✓maintenance : planned on "strategic" pieces of booster and RF distribution, "on-failure" in case of klystrons and storage ring plants. Storage of spare parts is required

✓digital LL RF project is in stand-by. Highly required because of the new beam line experiment's accuracy and resolution, but the installed analogic loops still works perfectly

✓aging of the klystron transmitter and choice of the future RF power source. Get in contact with SLS and Soleil to investigate the feature of the solid state amplifier.