Test and Operation of the New 150 kW Plant

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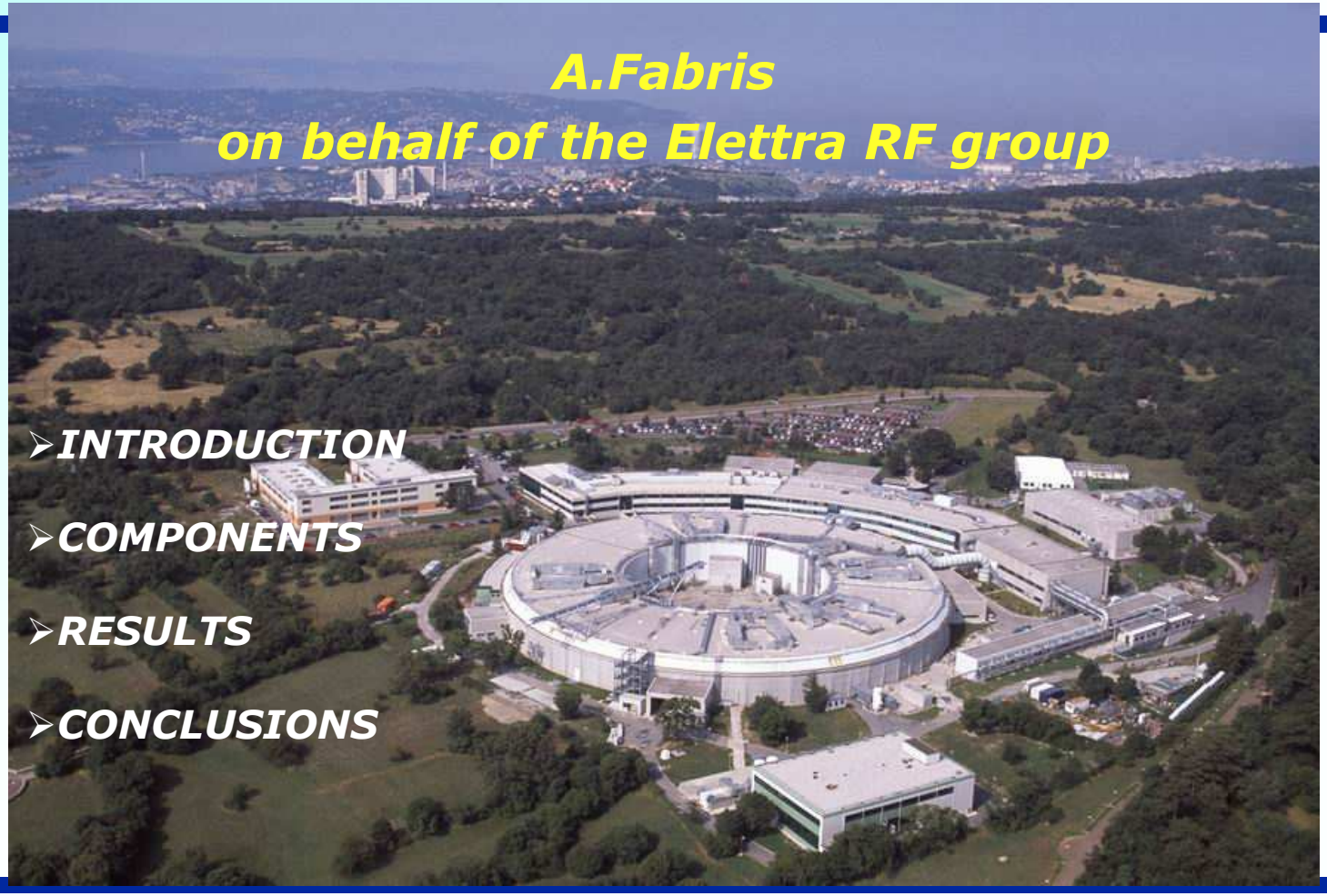
on behalf of the Elettra RF group



- *INTRODUCTION*
- *COMPONENTS*
- *RESULTS*
- *CONCLUSIONS*

Introduction /Components/ Results / Conclusions

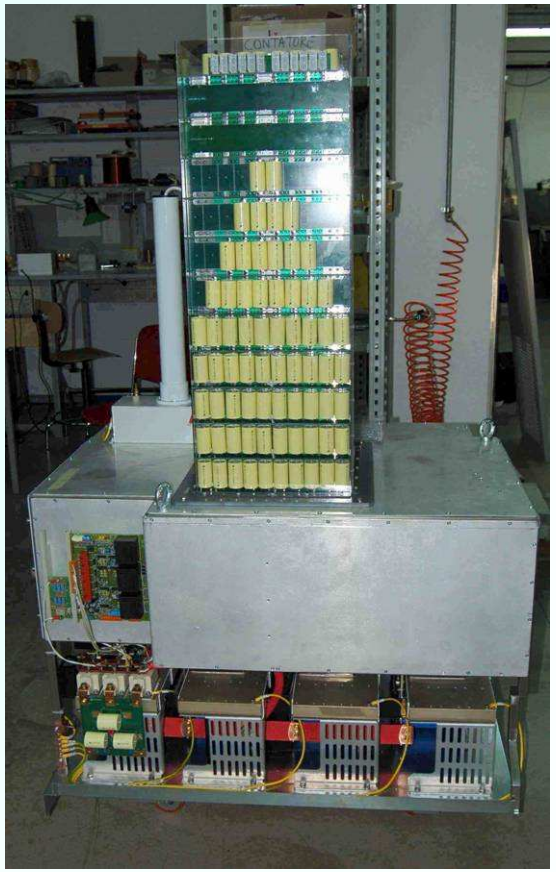
- **TARGET OF THE RF UPGRADE PROJECT:**
  - Provide the RF system with the necessary **operating margins**, when all IDs are operational.
  - Increase available RF power in view of possible increase of beam current and energy.
- **DESIGN STRATEGY:**
  - Increase in steps available RF power from **240 to 600 kW**.
  - **Minimum interference** with machine operation.
    - Gradual approach.
    - No increase of the space for RF components in the machine.
    - **Consistency** with other upgrades of the facility.
  - **Take benefit of working in the UHF band.**
    - Use as much as possible solutions adopted in broadcast applications.

PHASE A (UPGRADE OF ONE PLANT TO 150 KW) IS BEING COMPLETED

	2005								2006												2007		
	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M
Launch of amplifier tender																							
Amplifier order																							
Plant components order																							
Preparatory activities																							
Installation																							
FAT																							
Test on dummy loads																							
Connection to the cavity																							

- The 150 kW amplifier is made **combining two 80 kW IOT transmitters**.
- It has been provided **turn-key system by industry (ELECTROSYS, Italy).**
- **Each transmitter can work standalone, thus increasing operational flexibility**.

- The tube is IOT TH 793 from Thales.



- **The HV power supply of each IOT is a switched mode power supply.**
  - The structure is **more compact**.
  - Beam voltage is stabilised versus output power and mains input variations.

- The two transmitters are combined by means of a **switchless combiner.**
- **Combiner, circulator and waveguide run are suspended**

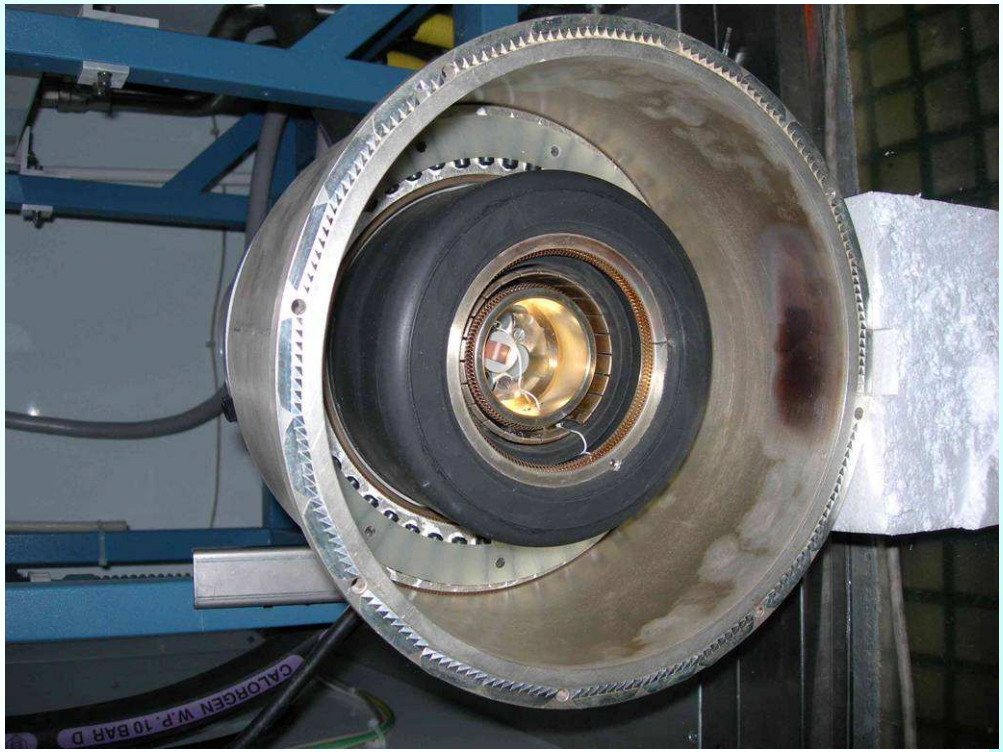
- **All installations and FATs of amplifier, circulator and power plant components were completed by end of August 2006.**
- **From beginning of September to end of the year a long term test was performed.**
- **The amplifier was let in operation** connected to the circulator and two dummy loads **24 hours/day** at different power levels from 100 to 150 kW.
- The purpose of this text was to debug the new plant before starting operation on the storage ring.

›MAIN IMPROVEMENTS FOLLOWING THE NEARLY 2000 HOURS TEST (performed by the tube and/or the amplifier manufacturers):

›**Installation of a ring of ECOSORB** in the input cavity, to dump eventual spurious oscillations which might appear at high beam current.

›**Improvement to arc detectors** to have more light intensity on the photo resistor. (in one transmitter traces of ionization were found).

›**Improvement to the coaxial line** just after the tube, to avoid discharges in the line due to mismatch caused by heat load.



➢MAIN IMPROVEMENTS FOLLOWING THE TESTS

➢In addition to the one for maximum power, different operating points were defined for the different operating configuration in the ring:

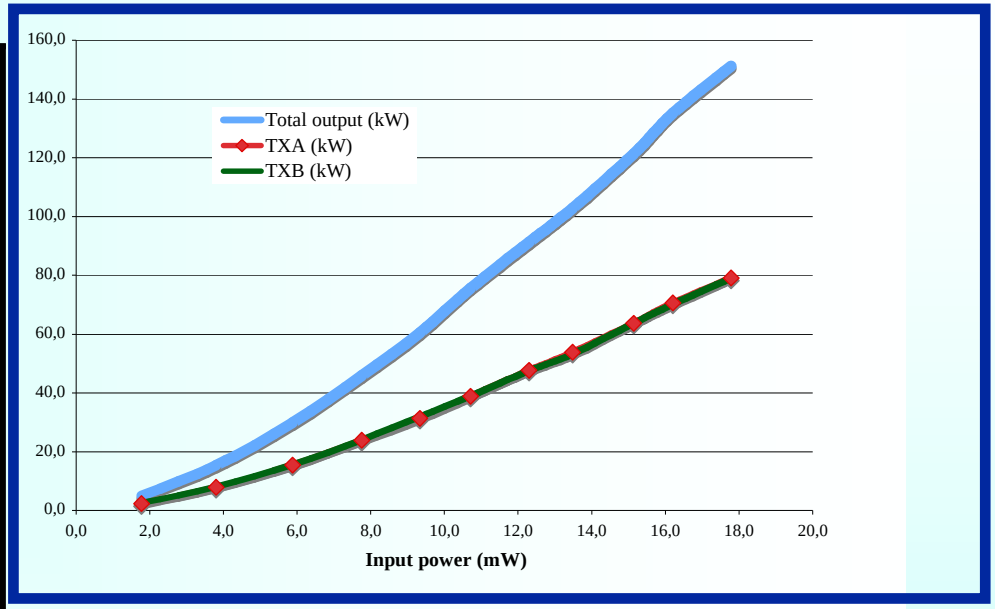
➢**Two times 60 kW ➔ 120 kW** combined to the cavity

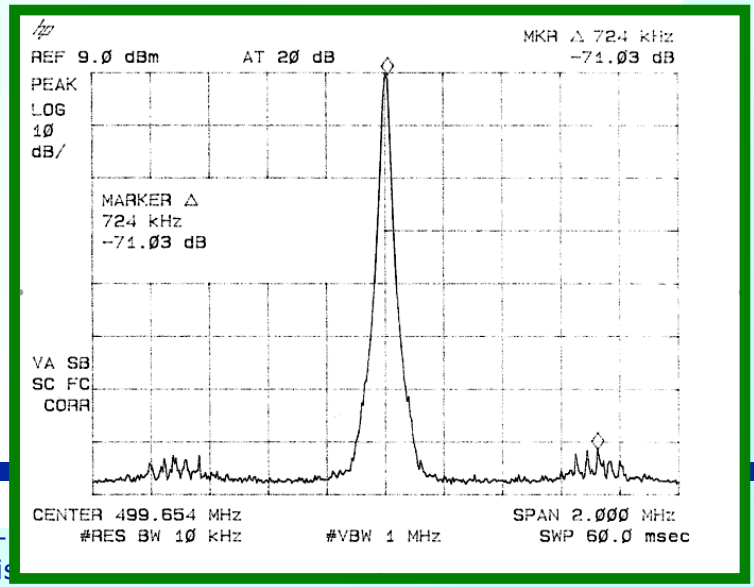
➢**One time 60 kW** to the cavity with either TXA or TXB on

➢**Two times 32 kW ➔ 60 kW** combined to the cavity

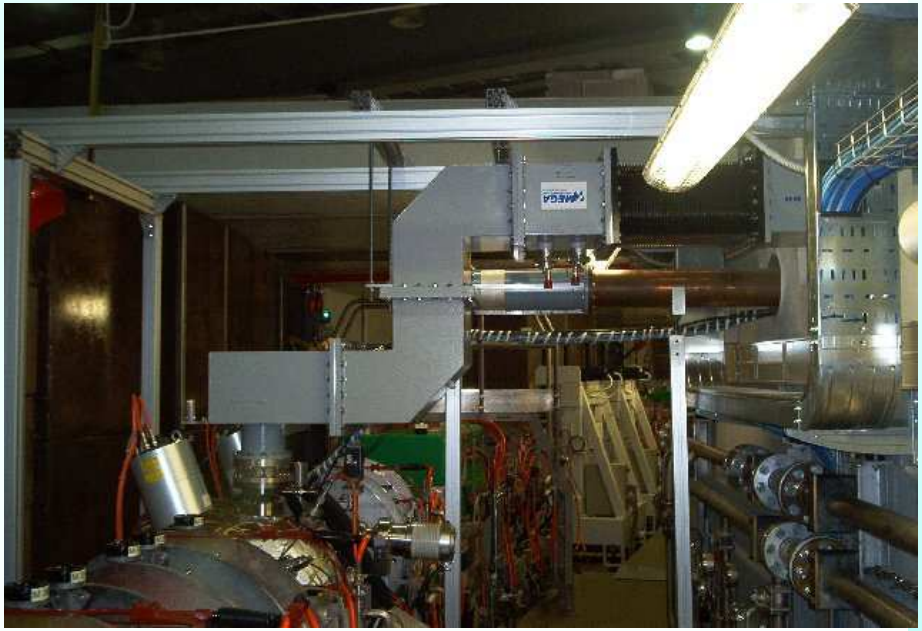
TOTAL POWER	IOT A			IOT B		
	OUT	EFF.	GAIN	OUT	EFF.	GAIN
150 kW	80.0 kW	70.9 %	24.0 dB	80.3 kW	70.0 %	24.1 dB
120 kW	62.9 kW	58.3 %	23.9 dB	60.9 kW	55.7 %	24.2 dB
60 kW	34.4 kW	49.7 %	20.3 dB	28.5 kW	44.5 %	19.7 dB
60 kW	61.6 kW	67.6 %	22.8 dB	OFF	/	/
60 kW	OFF	/	/	61.2 kW	66.5 %	23.0 dB

Output power	150 kW
Frequency	499.654 MHz
Bandwidth (± 0.5 dB)	> ± 2MHz
Total gain	69.3 dB
Gain IOT A	24 dB
Gain IOT B	24.1 dB
I.L. Combining system	<0.1 dB
Total phase variation (0 to 150 kW)	11 degrees
Harmonics	< 41 dB
Signal to noise	<71 dB





- **From January 2007 the new plant is powering the cavity in section 9.**
- A standard WG to coaxial transition has been used.
- Since the cavity has not yet been conditioned at input power levels higher than 60 kW, power has been limited to this level.



- **The change of the power source was very smooth.**
- **Operation of the new system has been very reliable till middle September 2007 (i.e. roughly 5000 hours of machine operation)**
- In September **TXA start to have trips** on HV inhibit (four trips).
- **At the second trip in one day, since it was not possible to investigate the problem with the machine on and the shutdown is near, TXA has been switched to the combiner load and the cavity is powered by TXB only.**
- **The source of the problem could be:**
  - Tube (8000 operating hours) or tube cavities problems
  - Problems of isolation of the ancillary PS (floating at HV)
  - HVPS problems
- **The problem will be fully investigate during the Autumn shutdown.**
- **Flexibility of the layout has greatly helped in minimising downtime.**

- **To fully exploit the possibilities coming from the increased available power, it is necessary:**
  - **A conditioning of the cavity at full power.**
    - For radiation safety reason this can be done only with the machine tunnel closed and searched.
    - We should have the possibility to complete it at least during the long shutdown at the end of this year.
  - The replacement of the waveguide to coaxial transition with the new one which has been constructed and **will be tested at high power at the RF test stand at DESY this Autumn**.
- At this point:
  - ***A 25 % increase of the total available RF power*** for cavity and beam will be available
  - ***The gap voltage in one cavity could be increased by a factor 1.4.***

- **The first phase of the ELETTRA RF Upgrade is almost completed.**
  - Power plant has been installed and set in operation.
  - Cavity conditioning at higher power will be soon performed.
- **As for reliability consideration** (especially in comparison with klystrons) it would be advisable to wait for more operating hours (and the understanding of the recent problems of TXA).
- **This phase has restored the needed safety margin to the Elettra RF system.**
- ***The upgrade of the remaining plants will be evaluated also in relation with the other upgrades of the facility .***