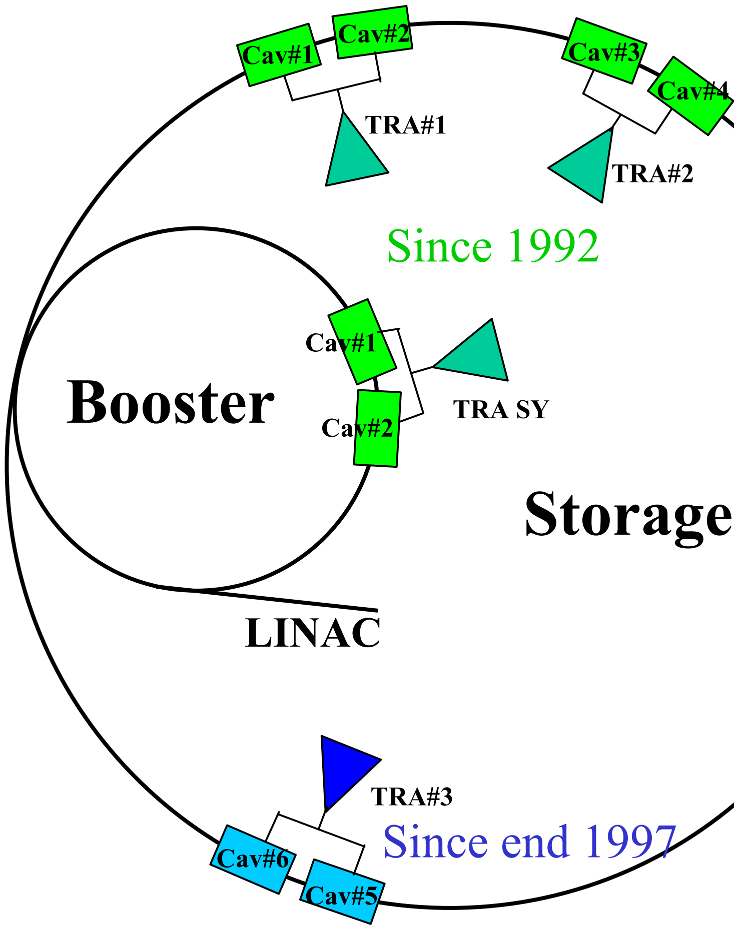
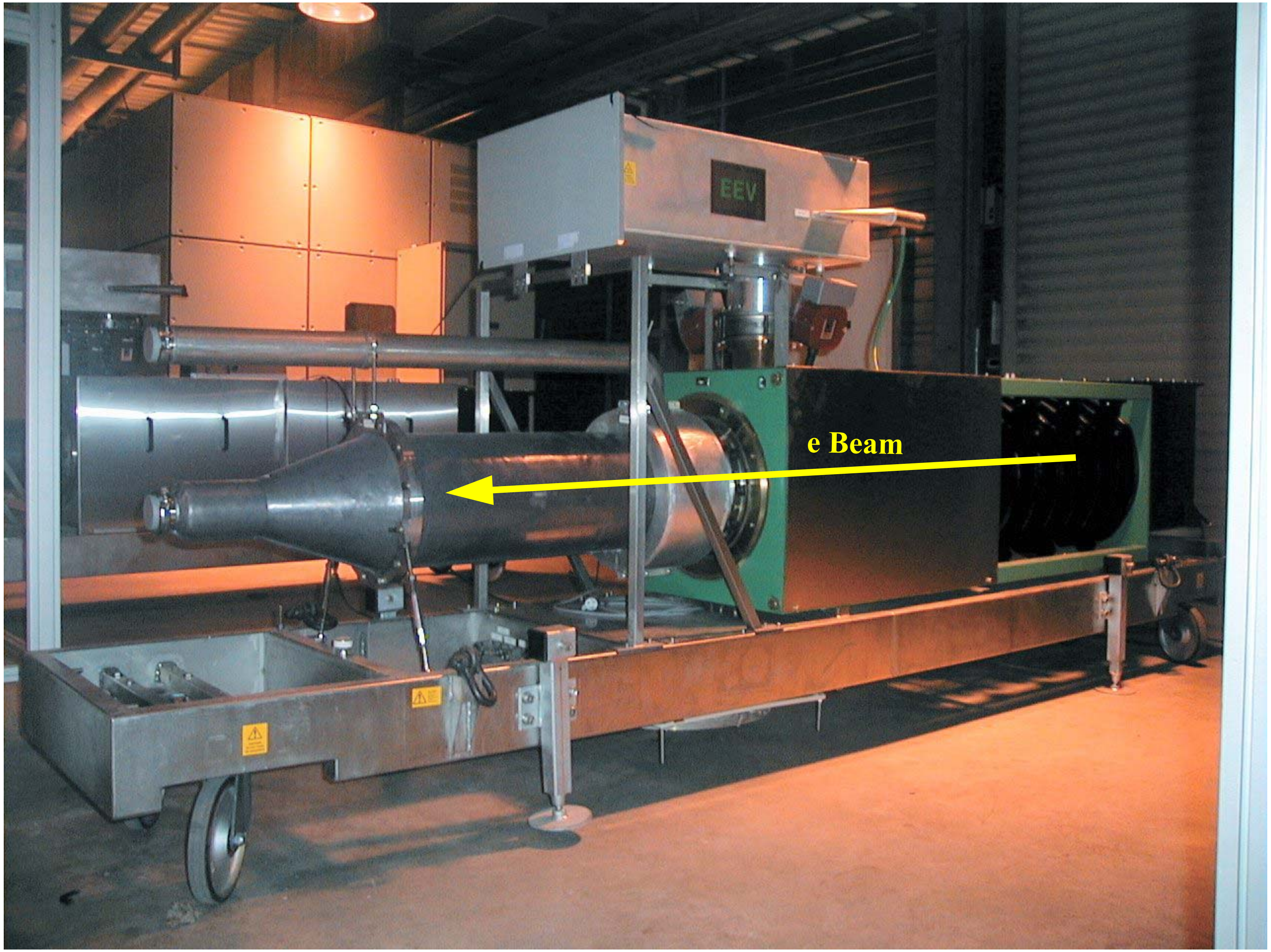
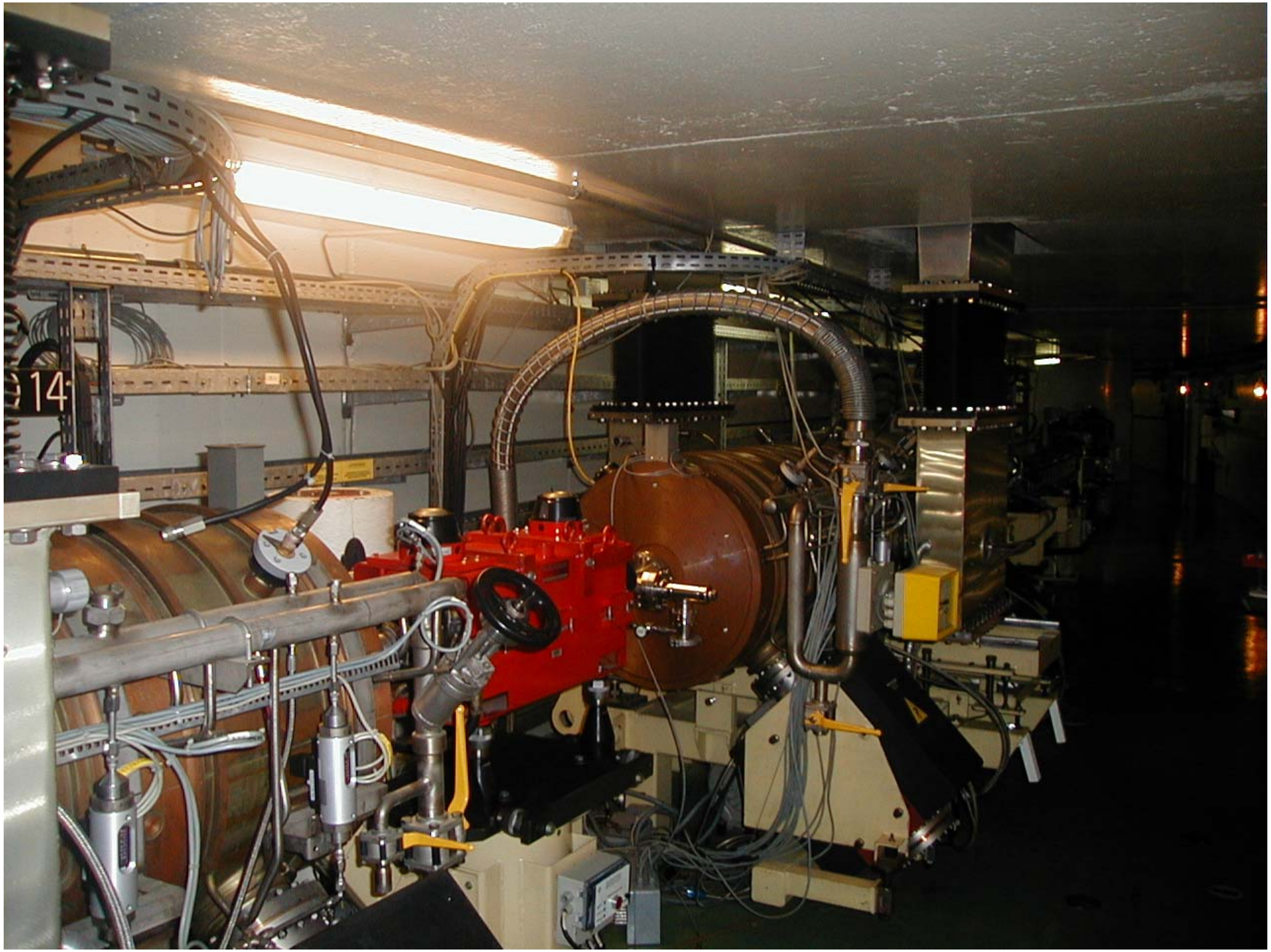


- **ESRF RF is Derived from LEP- CERN**
- **Frequency 352.2 MHz**
- **3 High RF power units of 1MW**

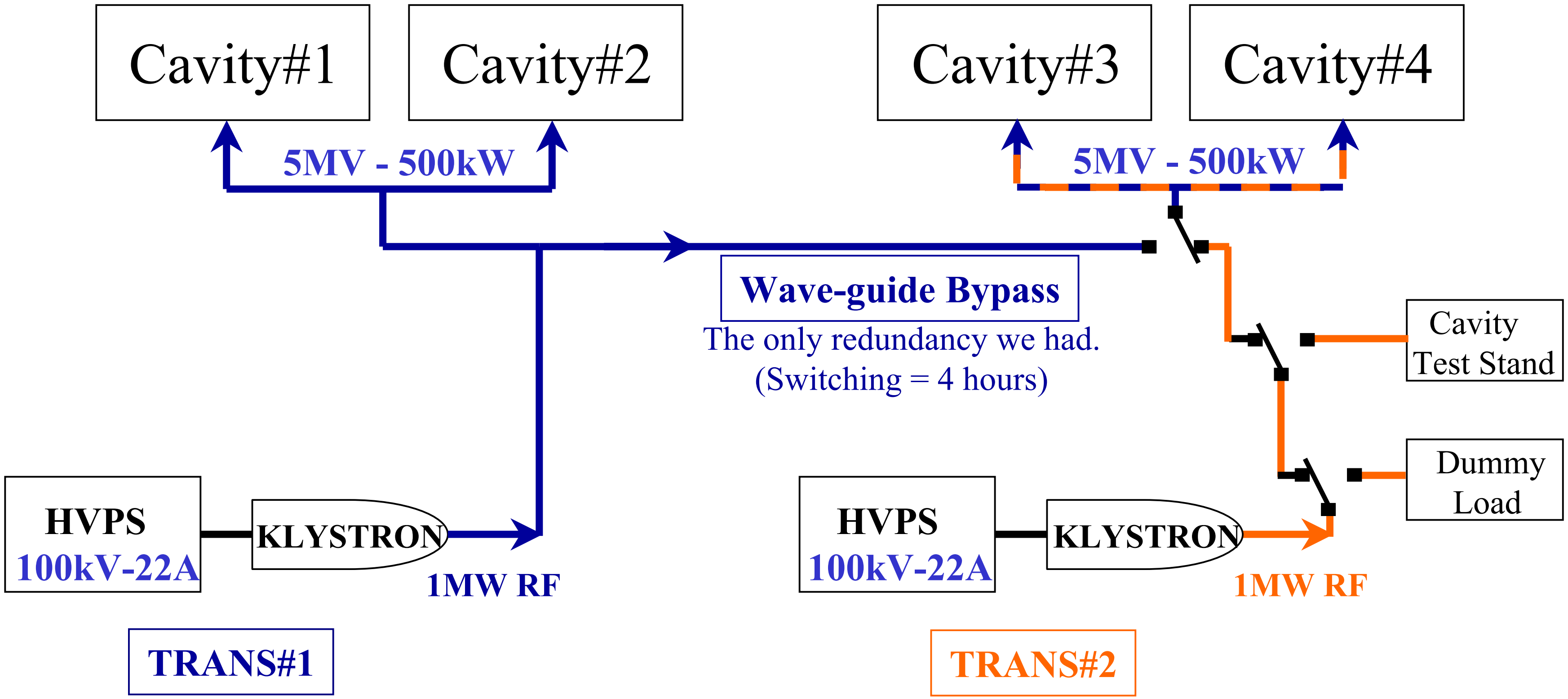
Klystron



Accelerating Cavity



Initial Radio Frequency set-up for the Storage Ring



Limitation of the TURNKEY solution

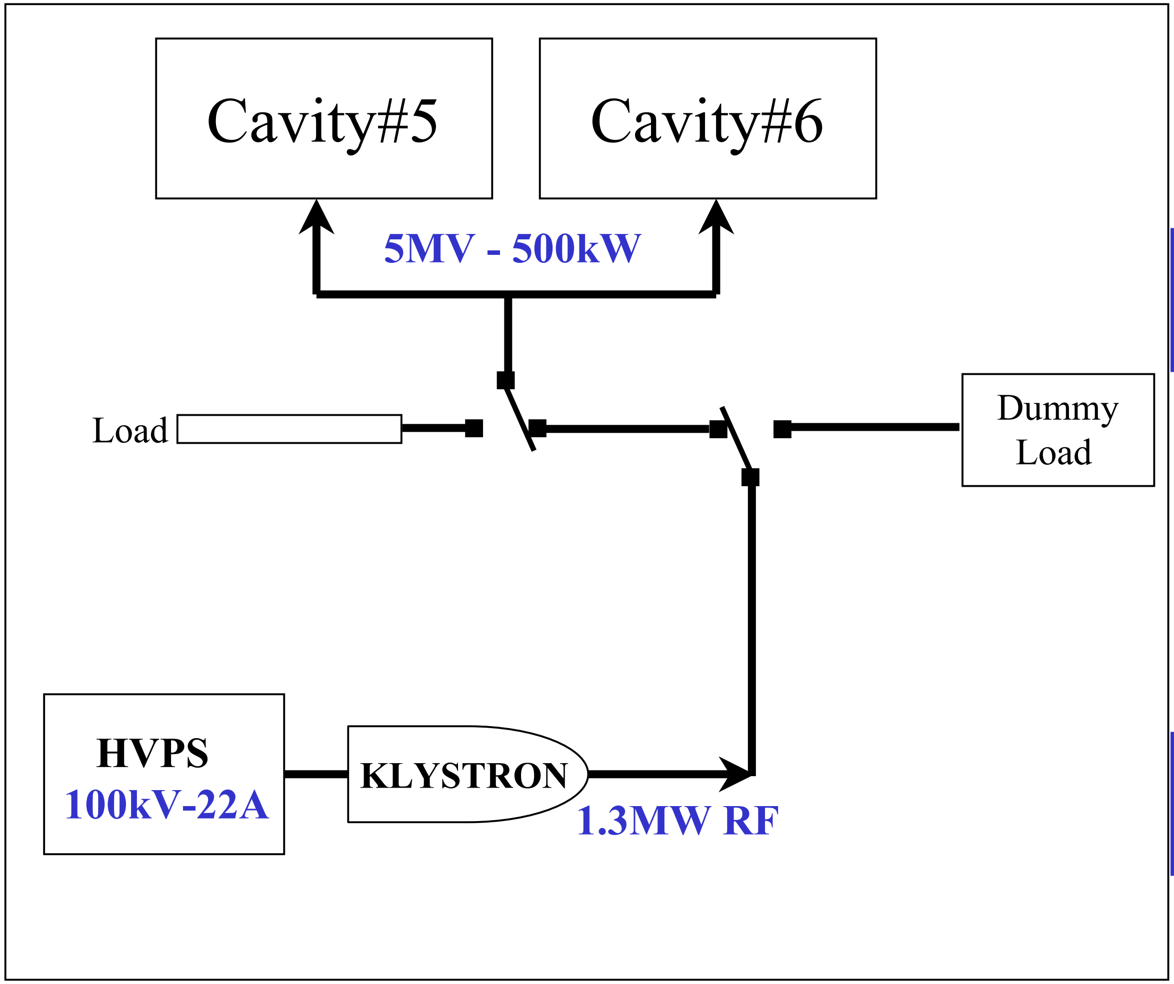
- **The original set-up was based on a turnkey transmitter made by Industry**

- **This solution was chosen because:**
  - **Staff was not yet complete.**
  - **No infrastructure at E.S.R.F.**
  - **Know how available from Industry.**

- **This was a good and reliable choice for a tight construction planning.**

- **This worked fine for 7 years but we had problems of:**
  - **Spare parts (the supplier went to bank route).**
  - **Integration within the E.S.R.F control standards.**
  - **Limitation for testing and in the choice of operation**

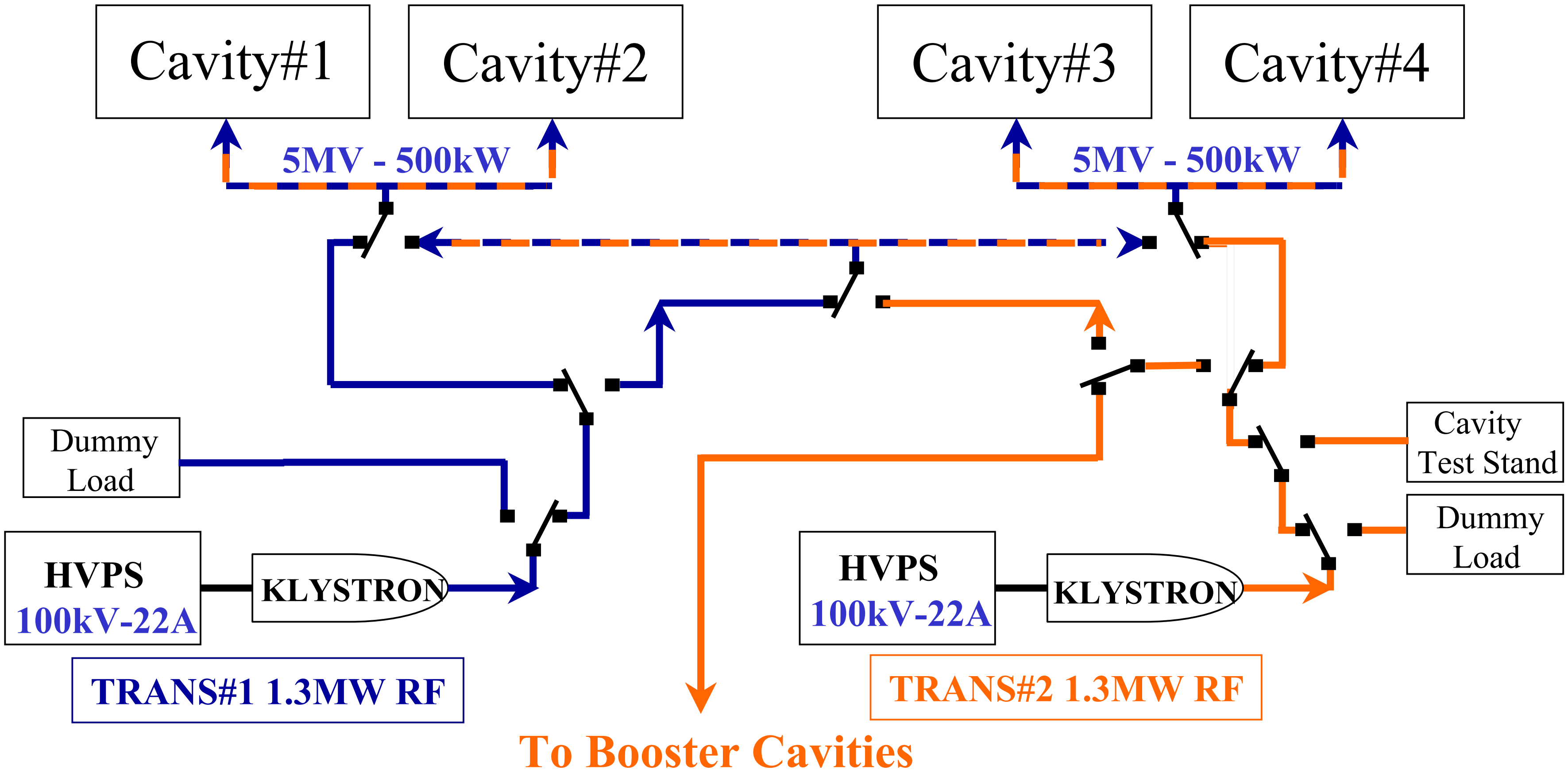
3rd Radio Frequency Transmitter and RF general upgrade



- **Increase power margin @ 200mA** (Decrease the RF power per cavity window)**.**
- **Increase accelerating voltage over 10MVolt.**
- **Object oriented design to get a high modularity.**
- **Control software and VME support from ESRF computing service.**
- **Cavity 5 and 6 can be run in passive mode when less power is needed or for testing on Dummy load**
- **Fast switching in testing mode. (a couple of minutes).**

This new RF module has been operational end of 1997.

Upgraded Radio Frequency set-up



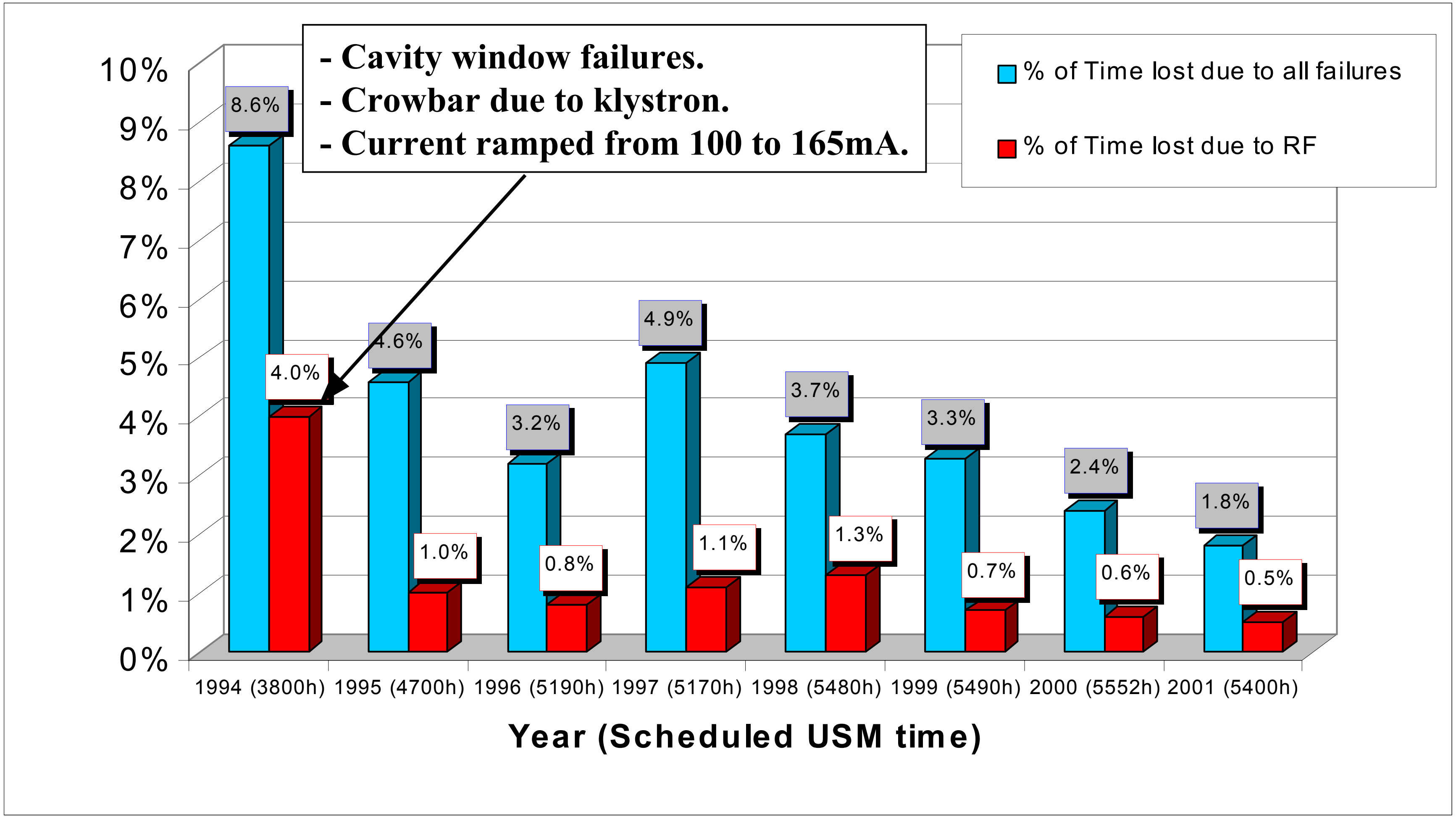
Where do we stand ?

⇒ **10 years operation.**

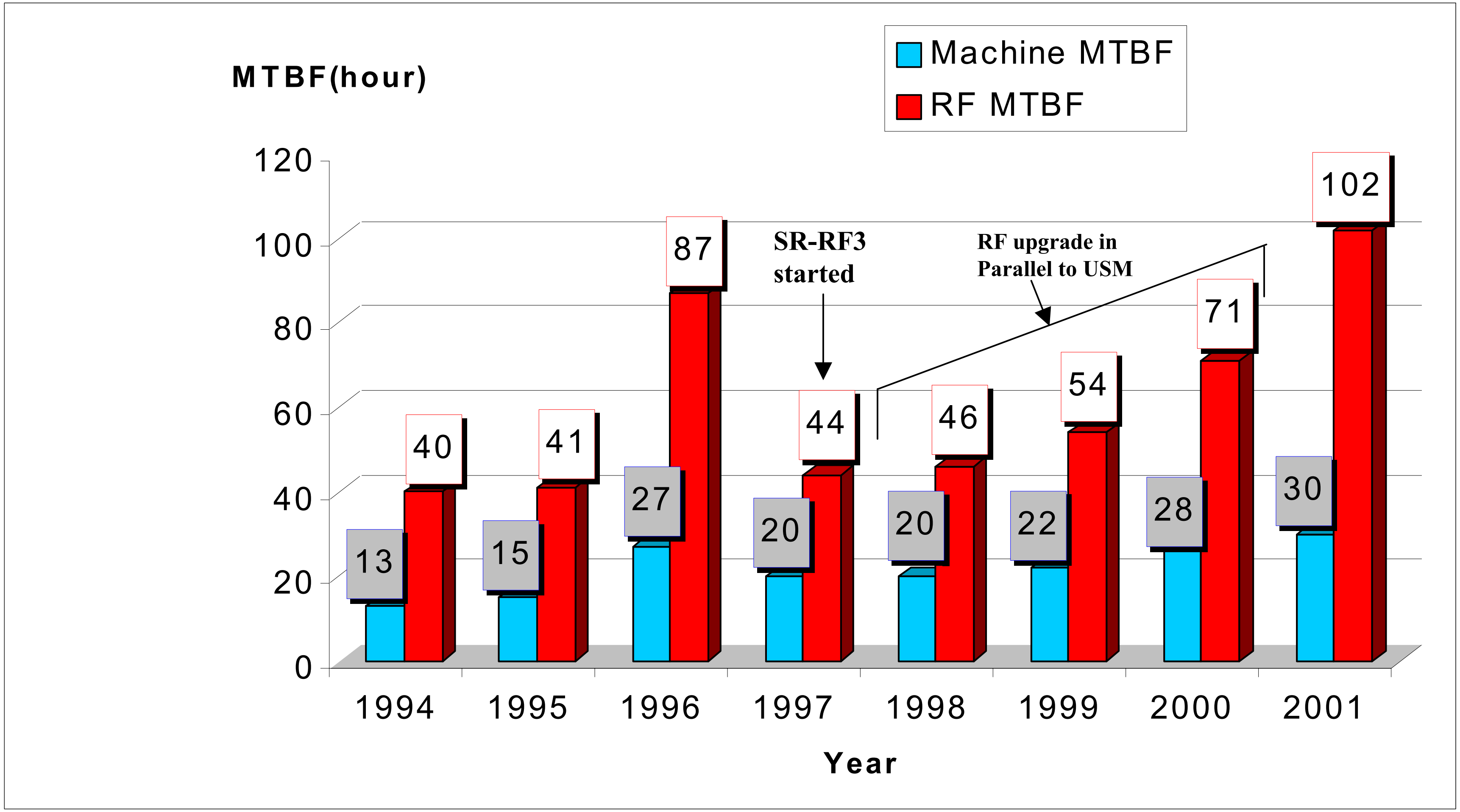
⇒ **> 7 years of User service (5500h/year).**

⇒ **The RF represents about 25% of the machine downtime.**

RF contribution to the USM time loss



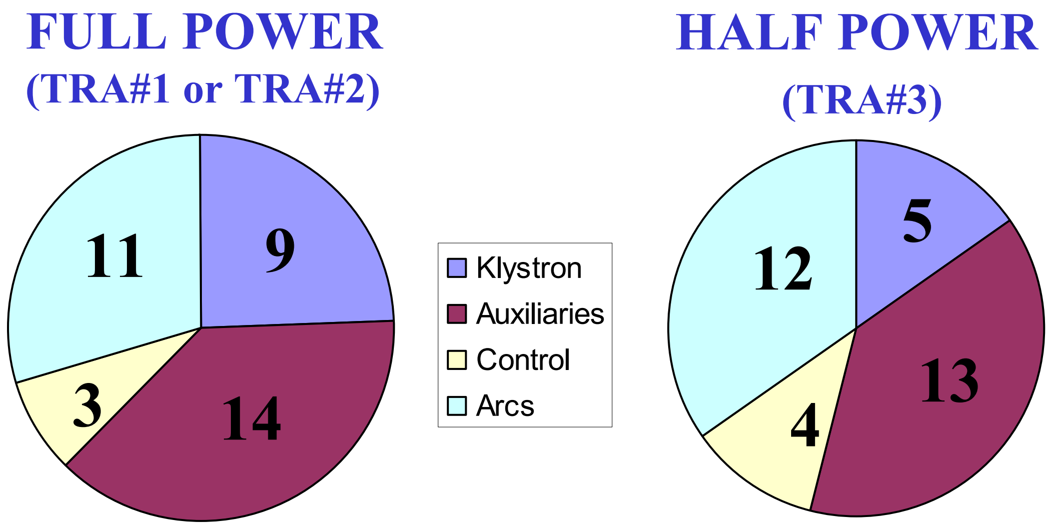
RF and Machine "engineer" MTBF



	2000	2001	
Machine trips	**199**	**176**	**-23**
RF trips	**76**	**52**	**-24**

FULL POWER / HALF POWER - AUXILIARIES IMPACT

RF trips over the 2 last years.
(normalized with running hours)



⇒ **Auxiliaries - Many youth troubles such as:**
- **Small DC power supply.**
- **Panel display giving interlock.**
- **Ion pump HV transformer.**
- **Master source.**

⇒ **Klystron - 5 @ 500kW and 9 @ 1MW (Several trips due to a turbulent klystron).**

⇒ **Arcs are a significant part of the RF trips.**

⇒ **Control - Problem of VME.**

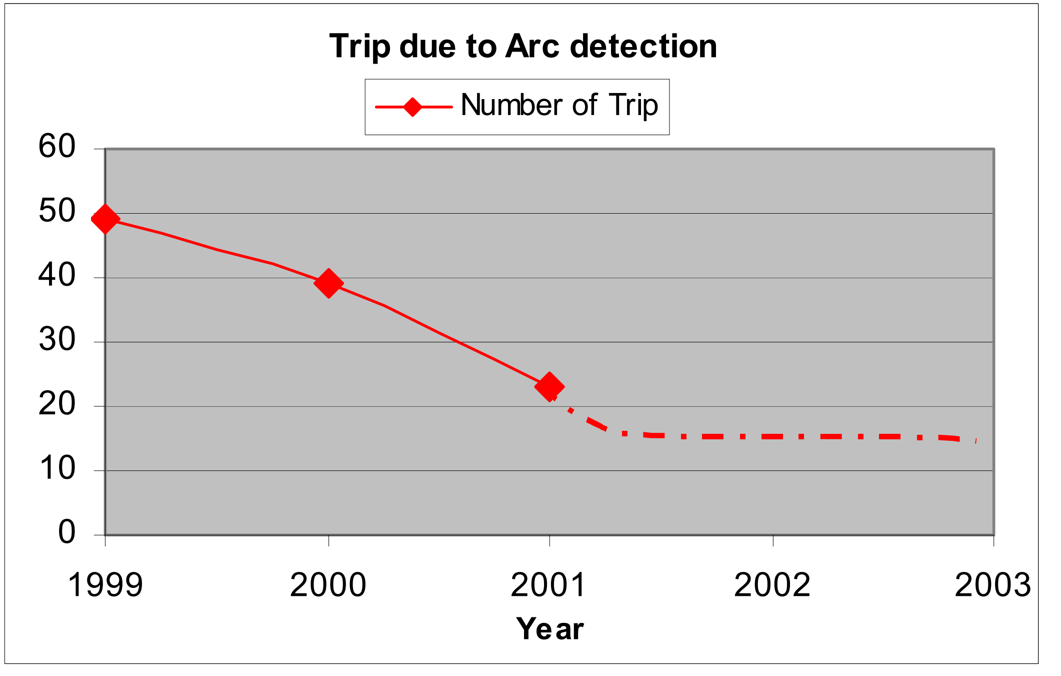
⇒ **Crowbar is very quiet: 0 crowbar over 2 years.**

Arc detection

⇒ **50 arc detectors** are installed on Storage Ring RF transmitters
Total response time (between detection → No RF) is 5µSec.

⇒ Arc detection trip participation

2000: 51% of RF trips, 20% of Machine trips.
2001: 43% 13%



⇒ **June 2000**: Modification of electronic design of cavity window detectors. Removed flip-flop and added noise filtering @ 500nSec.

⇒ **August 2001**: Extension of modification to all detectors with noise filtering @ 100nSec.

KLYSTRONS END OF LIFE

⇒ **Average lifetime = 16000 hours.**

⇒ **6 klystrons failures over 10 years.**

⇒ **No correlation between failures and operation at full power.** **ONLY ONE KLYSTRON DEATH AT FULL POWER.**

⇒ **The klystron H.V Gun is the dominant problem.**

A statistic done at LEP over 44 transmitters showed that 61% of the klystron failures were due to the gun.

KEY ISSUES

⇒ **The hardware implementation is a dominant factor.**

- **Electro Magnetic Immunity** must be seriously considered (Grounding of cubicles and racks, short wire, shielding …).
- Good protections: in case of problem, particularly with high power, it is very important to act very fast on the equipment (crowbar, arc detectors).

⇒ **Protection: A good compromise between a fast interlock protection and a good RF equipment stability is a key issue.**

⇒ **Component over-dimensioning is beneficial to the reliability of the equipment. This was applied with success to the HVPS and the HV interface.**

CONCLUSION

For the next years we hope to double the RF MTBF and reach 200 hours.

Many thanks to C.David for his collaboration in the preparation of this presentation.
Thank also to my colleagues of RF Group an Operation Group.