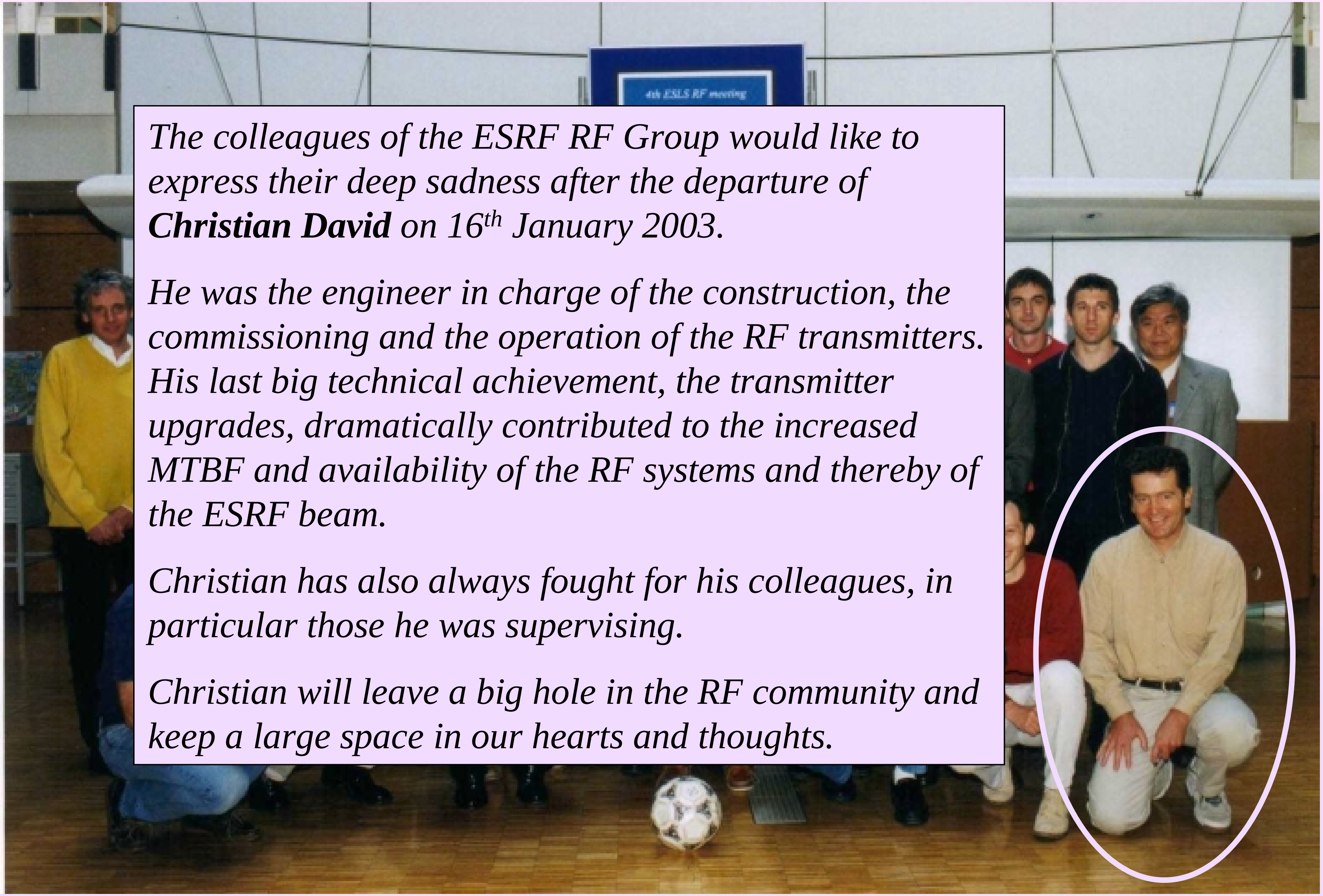
7^{th} ESLS RF meeting

Report from the ESRF RF Group

Jörn Jacob

ANKA / Karlsruhe, 16^{th} – 17^{th} October 2003


4th ESLS RF meeting
ESRF



The colleagues of the ESRF RF Group would like to express their deep sadness after the departure of ***Christian David*** *on 16th January 2003.*

He was the engineer in charge of the construction, the commissioning and the operation of the RF transmitters. His last big technical achievement, the transmitter upgrades, dramatically contributed to the increased MTBF and availability of the RF systems and thereby of the ESRF beam.

Christian has also always fought for his colleagues, in particular those he was supervising.

Christian will leave a big hole in the RF community and keep a large space in our hearts and thoughts.

1. Towards 250 mA @ ESRF

- HOM detuning:
  - Operational since several years for nominal 200 mA operation
  - Becomes tedious between 200 … 250 mA:
    - → Superposition of HOM with lower (R/Q) x Q from several cavities
    - → Already much time invested to find minimum in a 6-dimensional space (6 cavity temperatures) ⇒ trapped in local minima
    - → Nevertheless: good hope to find working point very soon
    - → However not much hope to get beyond 250 mA !
- Power:
  - With 6 cavities: still far from upper limit for windows
  - Klystrons: 550 kW / pair of cavities
    - → Single transmitter with 1100 kW on Cavitites 1,2,3,4 : still possible
    - → Above 250 mA ⇒ 3 transmitters in operation, i.e. no more spare transmitter
- Goal:
  - Find reliable working point ⇒ deliver 250 mA to users next year

Cavity temperature regulation system: *T = 25 to 60 º C*, precision better than *± 0.05 ºC*

2. Plans for further cavity R&D → 500 mA

- HOM damped SC Cavities:

  After successful test of SOLEIL cavity at ESRF in 2002:

  - R&D required for input coupler 200 kW → 500 kW
  - Power tests at ESRF in collaboration with CERN, CEA envisaged

- HOM damped NC Cavities:
  - Based on EC-funded HOM damped cavities
  - Stacked independent cells ⇒ less space
  - Each cell fed individually ⇒ minimize Power/coupler

    ⇒ Start R&D of multicell HOM damped cavities

    ⇒ Planned collaboration with BESSY

- Depending on cavity choice, the RF power generation and distribution will also have to be reconsidered

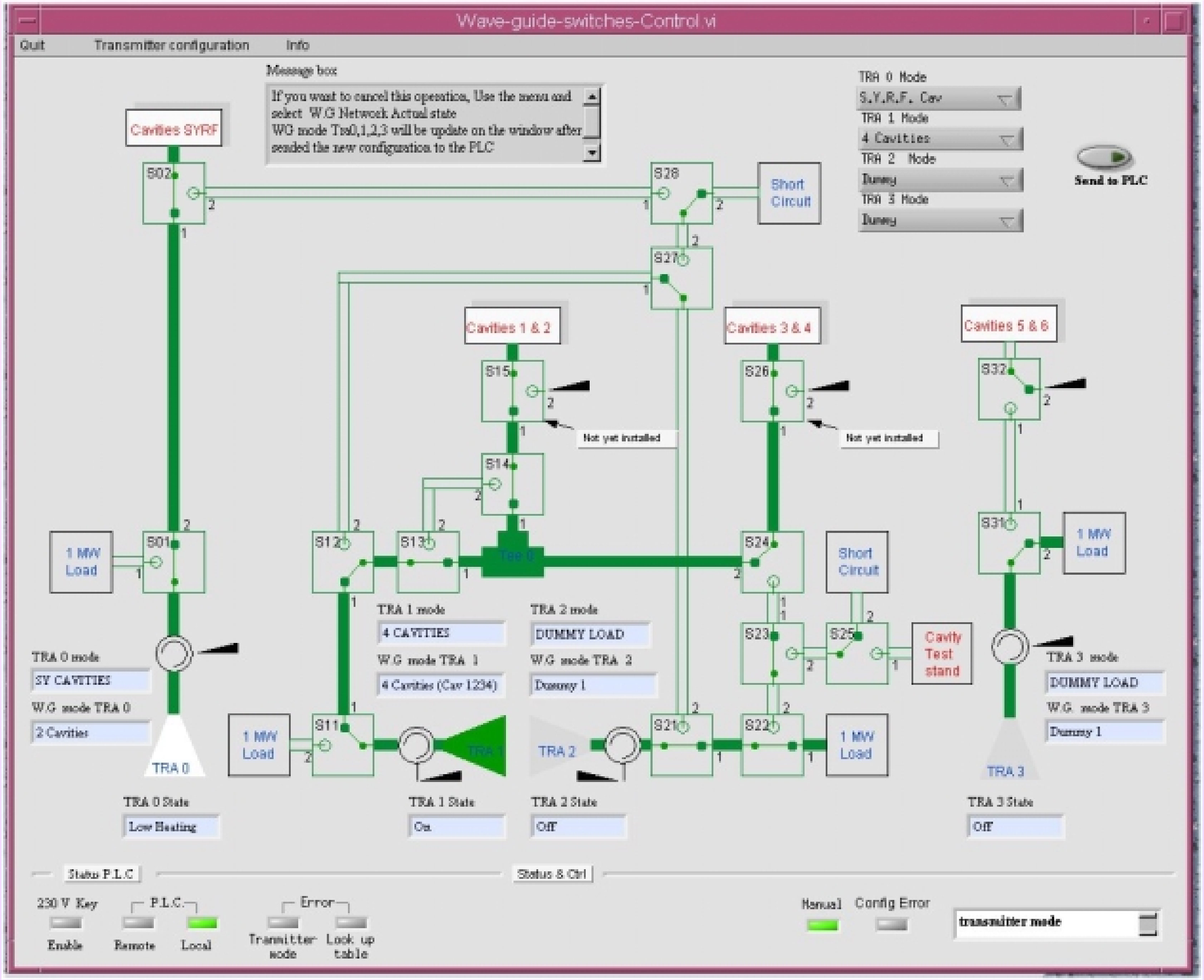
3. Old LEP cavities for ESRF booster

- Same 5-cell cavities, but:
  - ESRF: 2 couplers / cavity
  - LEP: 1 coupler / cavity
- Project
  - Teststand: check 1 coupler with 300 kW pulsed RF
  - Install 2 old LEP cavities in the booster

  ⇒ Use ESRF booster cavities as spares for storage ring
- Status
  - 1 LEP cavity in house
  - Low power tests OK (done in collaboration with SOLEIL team)
  - All hardware in house or ordered for power tests with first cavity

4. RF operation mode and waveguide switch control

- Dedicated PLC with I/O satellites in each transmitter room
- Manual and automatic control of existing motorized waveguide switches
- Consistency check of waveguide positions with transmitter & cavity operation modes
- Higher level LABVIEW application for RF operation mode selection
- Status:
  - Last summer:
    - → waveguide switches connected to new PLC
    - → local manual control via centralized patch panel
  - October 2003 shut down: implementation of manual remote control
  - Then, gradual transition to fully automatic control



[Georges Gautier, ESRF RF Group]

Device	Waveguide mode description	WG-mode	Interl-mode	S01	S02	S11	S12	S13	S14	S15	S21	S22	S23	S24	S25	S26	S27	S28	S31	S32	S33	S34
SYRF	Dummy 1	101	03, 04, 05, 06	1	2																	
	Dismount 1	103		1	2																	
	2 Cavities (SY Cav)	107	01, 07	2	1													2				
SRRF3	Dummy 1	131	03, 04, 05, 06												2				2	2		2
	Dismount 1	133													2				2	2		2
	2 Cavities (Cav 56)	137	01, 07												2				1	1	1	
	SOLEIL cavities	136													2				1		2	1
SRRF1	Dummy 1	111	03, 04, 05, 06			2	2								2							
	Dummy 2	112	03, 04, 05, 06			2		2	1						2							
	Dismount 1	113				2	2								2							
	Dismount 2	114				2		2	1						2							
	2 Cavities (Cav 12)	117	01, 07			1	1	2	2	1					2							
	4 Cavities (Cav 1234)	118	02, 08			1	1	1	1	1				2	2	1						
SRRF2	Dummy 1	121	03, 04, 05, 06				1				1	1	1	2	2		1	2				
	Dismount 1	123					1				1	1		2			1					
	Teststand in access	125	0A				1				1	2	2	2	2		1	2				
	Teststand OK for RF	126	0A				1				1	2	2	2	1		1	2				
	2 Cavities (Cav 34)	127	01, 07								1	2	1	1	2	1	1	2				
	4 Cavities (Cav 1234)	128	02, 08				2	1	1	1	2		1	2	2	1	1	2				
	SY-Cav / SRRF2	129	09 /		2		1				2	1					2	1				
Cav12	Cavity not powered (Cav 12)	212								2												
Cav34	Cavity not powered (Cav 34)	234														2						
Cav56	Cavity not powered (Cav 56)	256																		2		
Cav78	Cavity not powered (Cav78)	278																				2

Legend:

- x **PSS condition**
- *x Electrical safety condition*
- x Defined for correct power transmission
- x Defined for consistency
- 2 **PSS:** (S25/2) OR (Teststand permit)

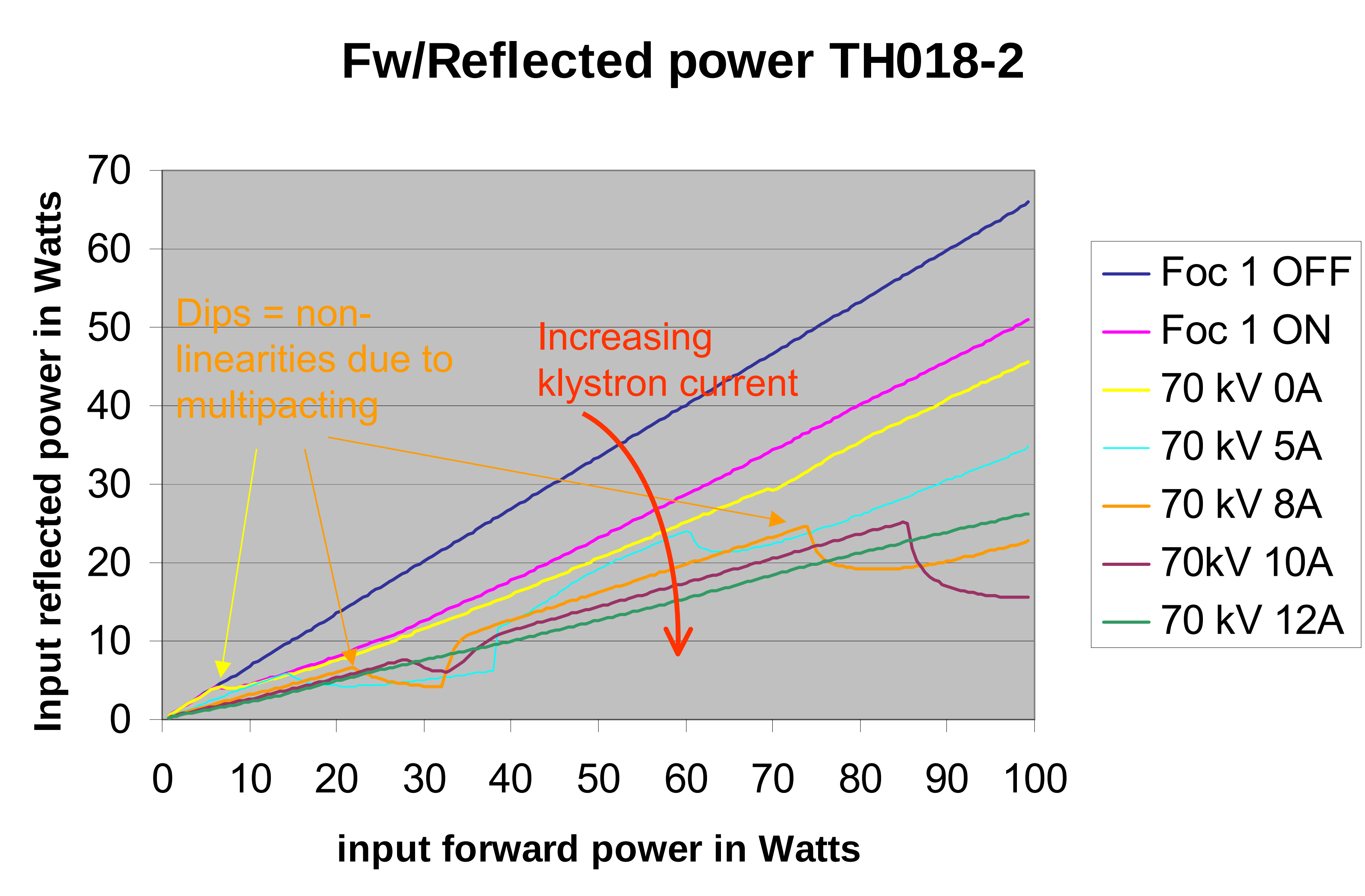
5. Klystrons

- 11 operational klystrons in house for 4 transmitters
  - → Including 3 LEP klystrons on loan from CERN (loan contract)
  - → Presently: CERN klystrons are being taken into operation 1 by 1

    ⇒ Big work load
- Some problems with klystron instabilities
  - Multipacting in the input cavity:
    - → Phase noise
    - → Spurious power steps
    - → RF loop saturation
      - Booster: over-drive trips, peak power interlock on cavities
      - Storage ring: phase noise, sometimes transient synchrotron motion
    - → Effect difficult to master, all measures only shift the problem:
      - Adjusting drive / current working point, at expense of efficiency
      - Varying the focus in the input cavity (small margin)
      - Tuning cavity resonances

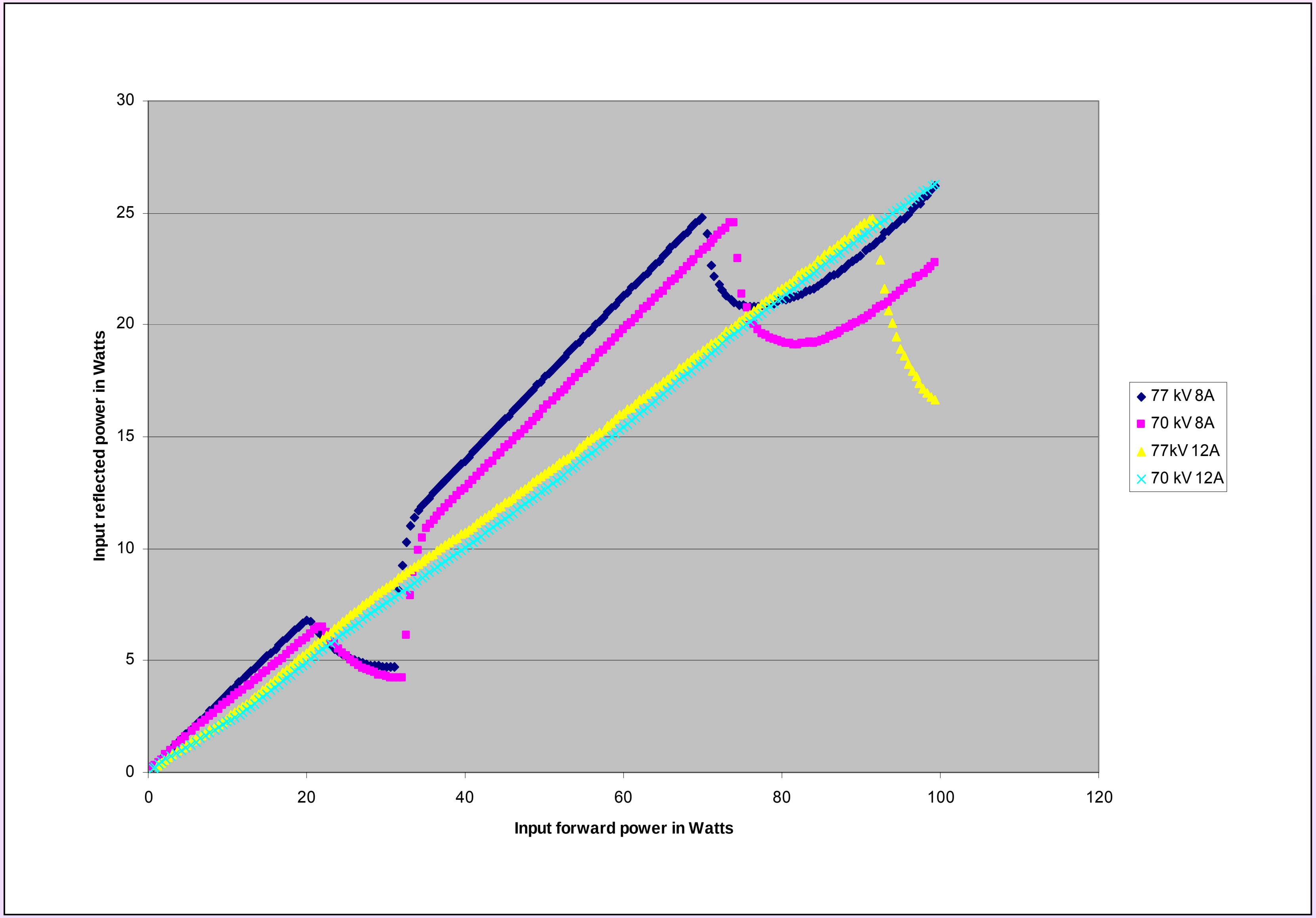
Input cavity multipacting: → detected on Input Reflected Power

→ appears at many working points



[Pierre Barbier, Jean-Maurice Mercier, ESRF RF Group]

Little influence of the High Voltage



[Pierre Barbier, Jean-Maurice Mercier, ESRF RF Group]

5. Klystrons, followed …

- Only one supplier left for 352 MHz 1.3 MHz CW klystrons
- What will be the long term future?
- We expect some inputs from future experience with:
  - IOT's: Diamond, Elettra
  - Solid state amplifiers: SOLEIL
  - Will these techniques be applicable to very high power ?

    (e.g. 500 mA at ESRF ⇒ about 2500 kW of beam power !)
  - Or will klystrons remain the best choice?
- ESRF proposes a workshop in 1.5 years from now: around March 2005
  - See corresponding point on the agenda of this workshop

6. Other hardware developments for increased reliability

- Arc detection system
  - Arcs: significant contribution to RF trips (30 to 50 %)
  - Sometimes true arcs / sometimes wrong ones
  - Test setup: waveguide with movable pointed posts
  - Power tests about to start
  - Goal: optimize detector sensitivity vs response time, so as to surely detect real arcs and not trigger on noise
- Upgrade of VME controllers
  - Existing VME under OS9 = no more supported
  - Frequent VME crashes => normally transparent, sometimes RF trips
  - Under way: implementation of VME CPU with Pentium processor under LINUX *[ESRF Computing Service]*
- Upgrade of aging equipment
  - Anode, focus, filament power supplies, …

CONCLUSION

At ESRF: many ongoing projects to

- Replace obsolete components on the existing RF system
- Maintain and hopefully improve the reliability
- Push the performance (250 mA)
- Prepare the future (Cavity R&D for 500 mA)