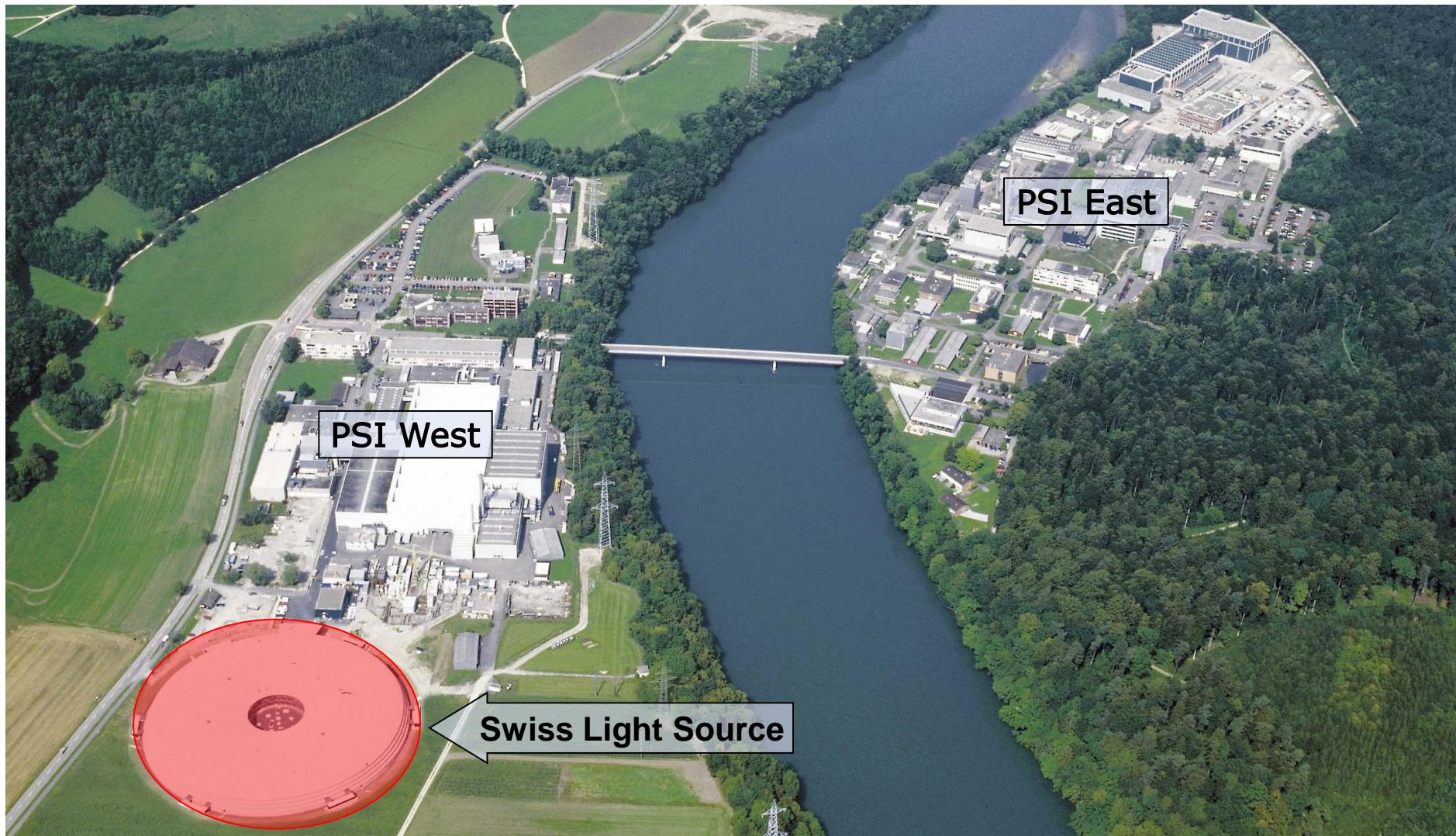


**Wir schaffen Wissen – heute für morgen**

**Paul Scherrer Institut**

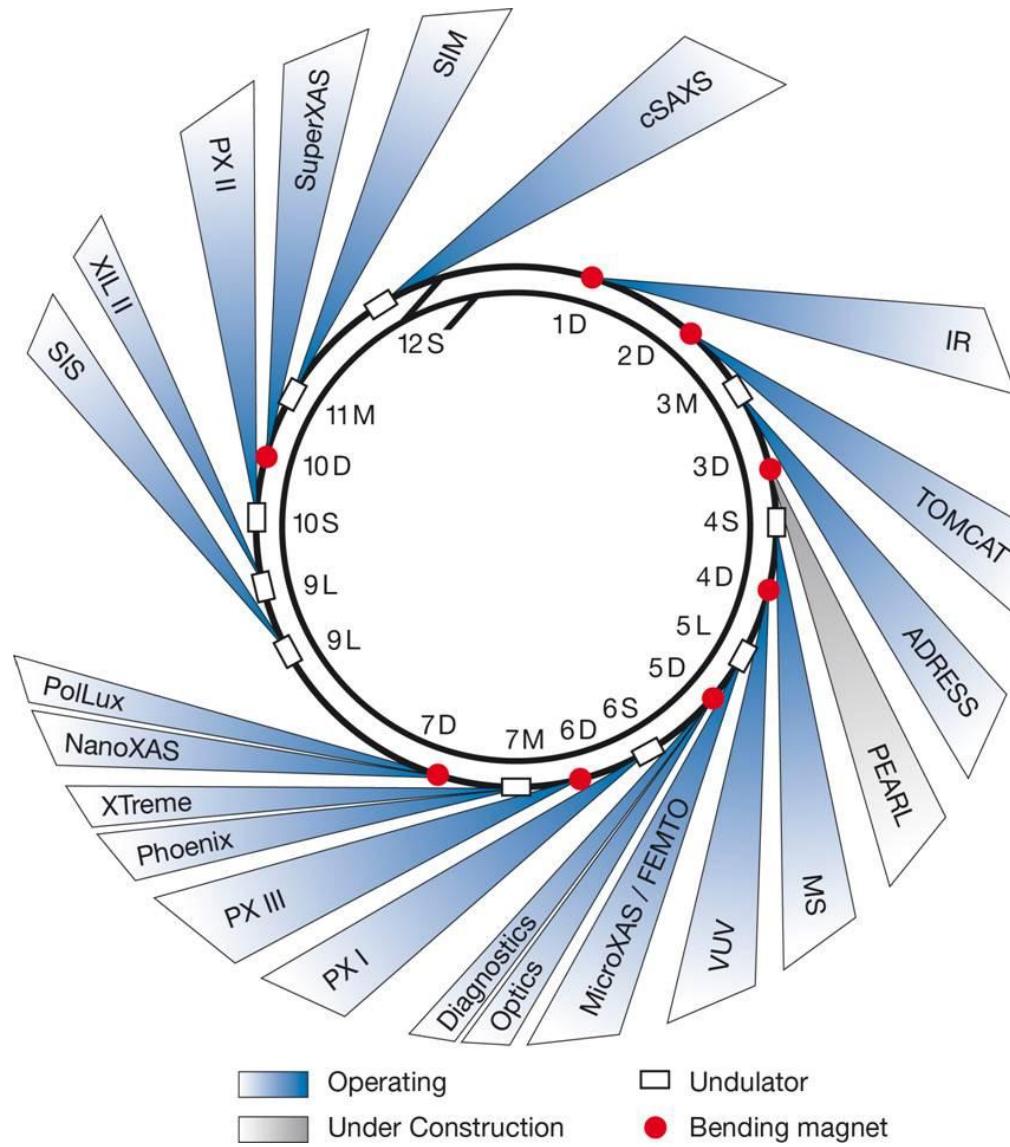
Wolfgang Tron

**10 years of klystron operation and improvement in  
Swiss Light Source**



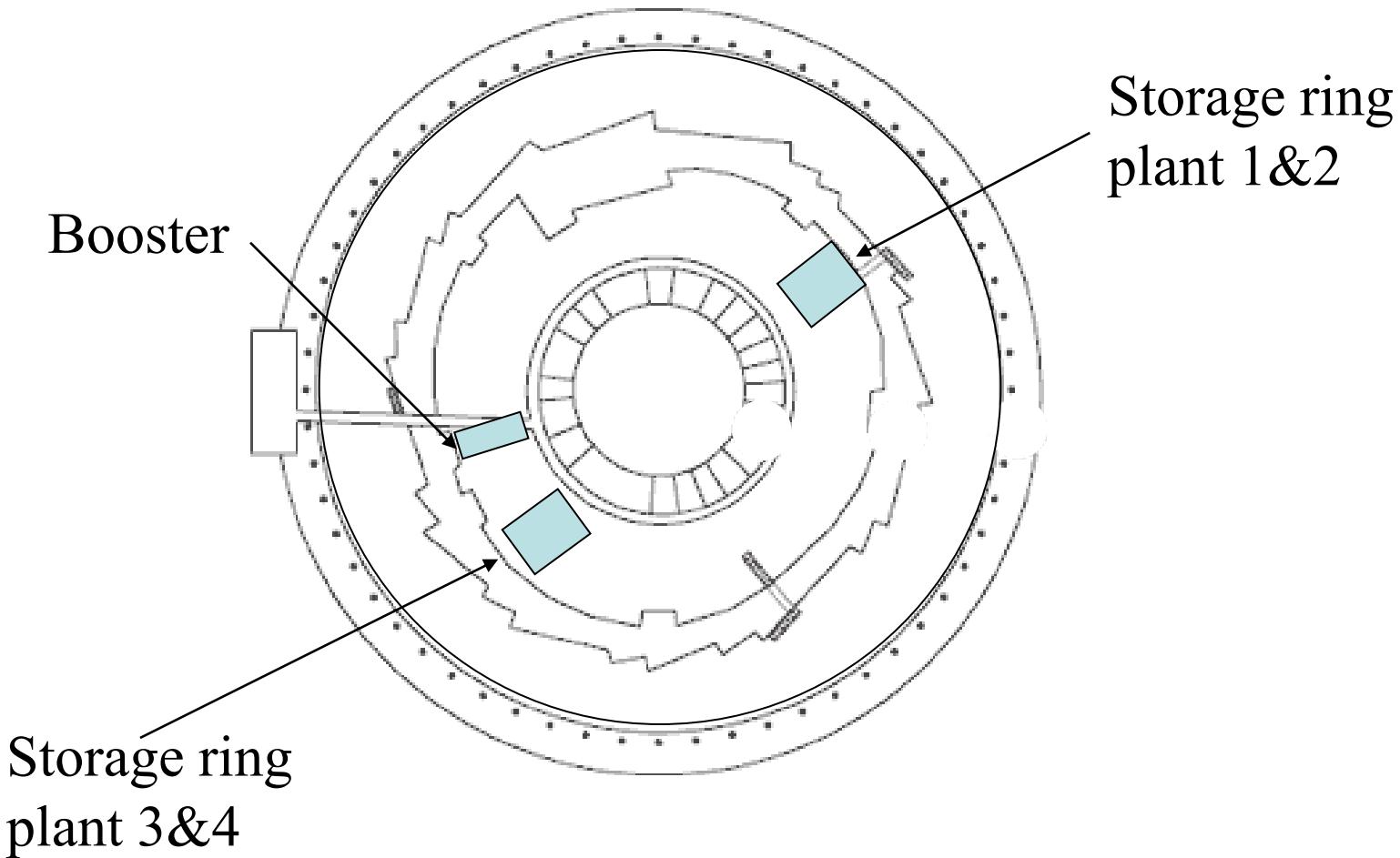
first idea	1991
„Giessbach-Meeting“ (users support SLS)	9.Oct. 1994
ETH-council gives OK	14.Sept. 1995
Parliament gives OK to SLS	18.June 1997
Start building	2.June 1998
Building finished	1.July 1999
Beam in Linac	23.March 2000
Beam in Booster	8.Aug. 2000
Beam in storage ring	13.Dec. 2000
400 mA stored current (=goal)	5.June 2001
Start of experiments with 5 Beamlines	9.Aug. 2001

# Beamlines at 2012

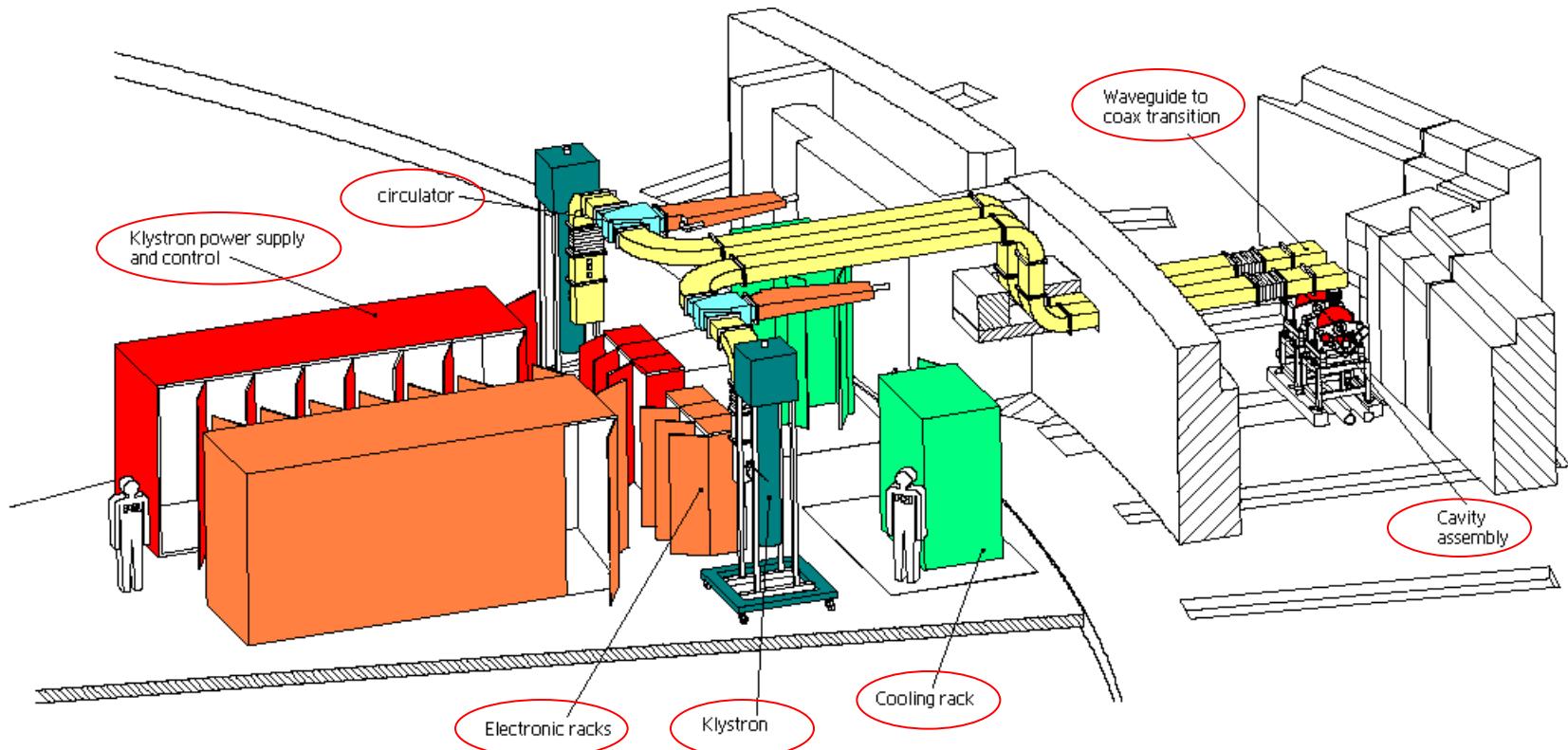


- 20 beam lines in operation
- 1 beam line under construction

# RF plants in SLS with EEV klystrons



# Layout of a storage ring RF plant



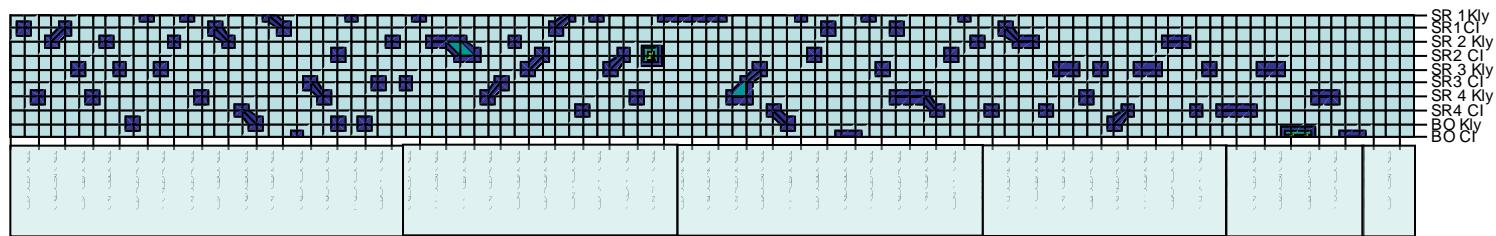
# Picture of the Storage Ring RF plant 3 & 4



# List of improvements

- Coincident arc detection
- Cooling air interlock
- Air tightness of HV cage
- Reinforcement of HV cage
- Refurbishment program
- Retuning of second harmonic cavity
- VSWR improvement
- Water leak on the body after only several weeks of running

# Coincident arc detection chart



Year	2007	2008	2009	2010	2011	2012
Events	30	22	22	19	12	1

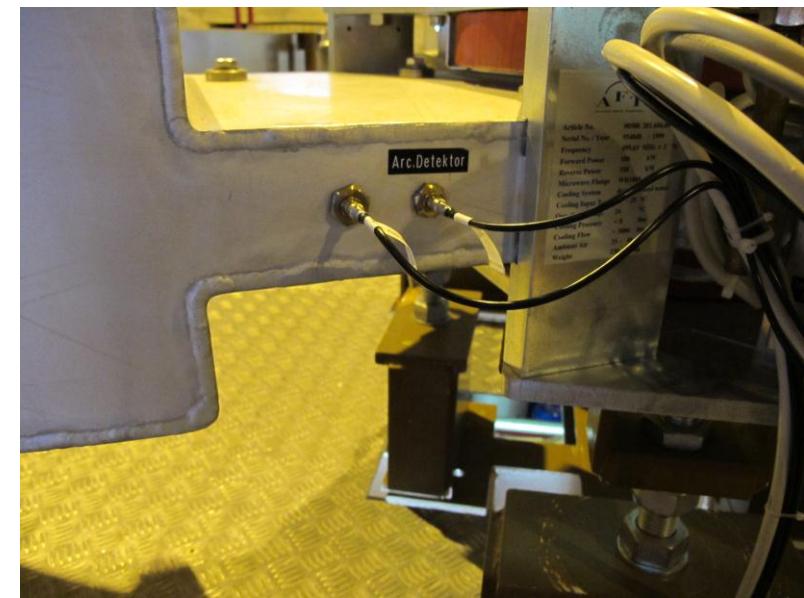
# Coincident arc detection on the klystron

## Motive for improvement:

- Several arcs per month and RF plant
- RF plant stop
- Beam loss



# Coincident arc detection on the circulator

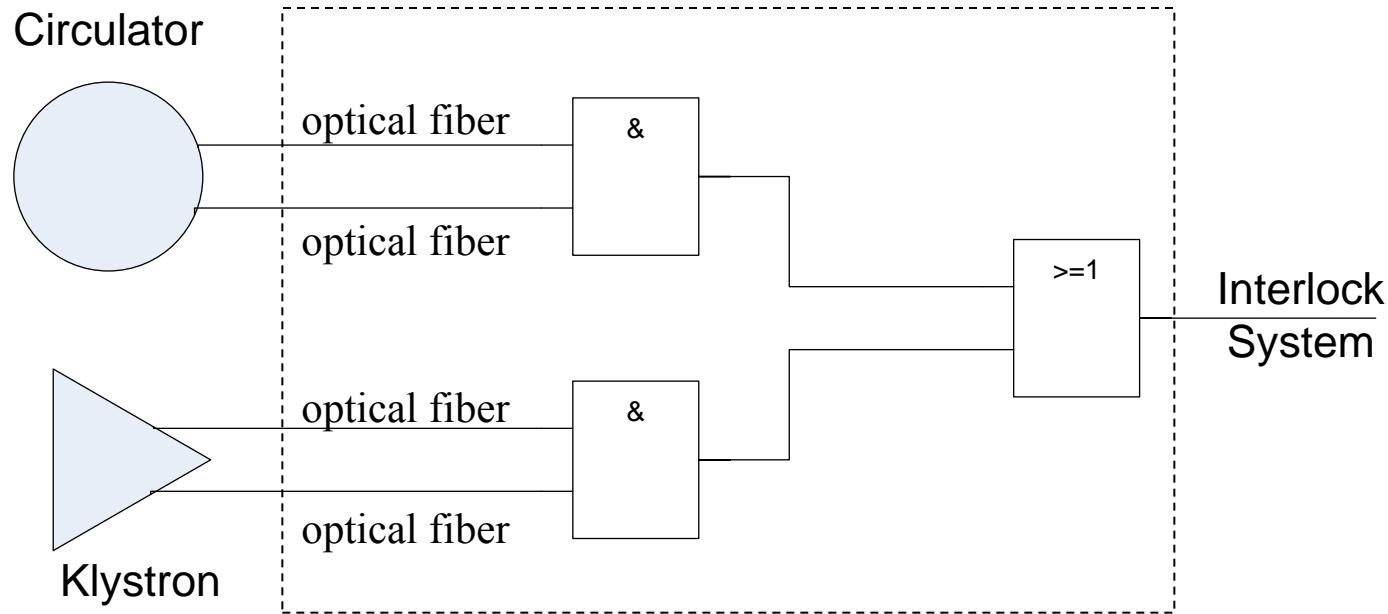


# Coincident arc detection system

## Arc detector system from AFT



# Logic of the coincident arc detection



# Cooling air interlock

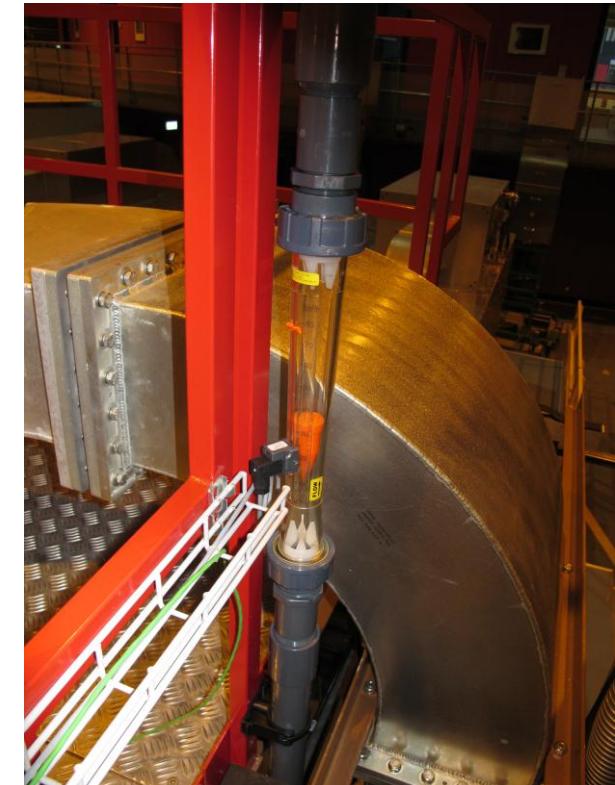
## Motive for improvement:

- Important interlock
- Sometimes no air flow control; pedal stuck
- Several tests of new flow control fails

old flow control



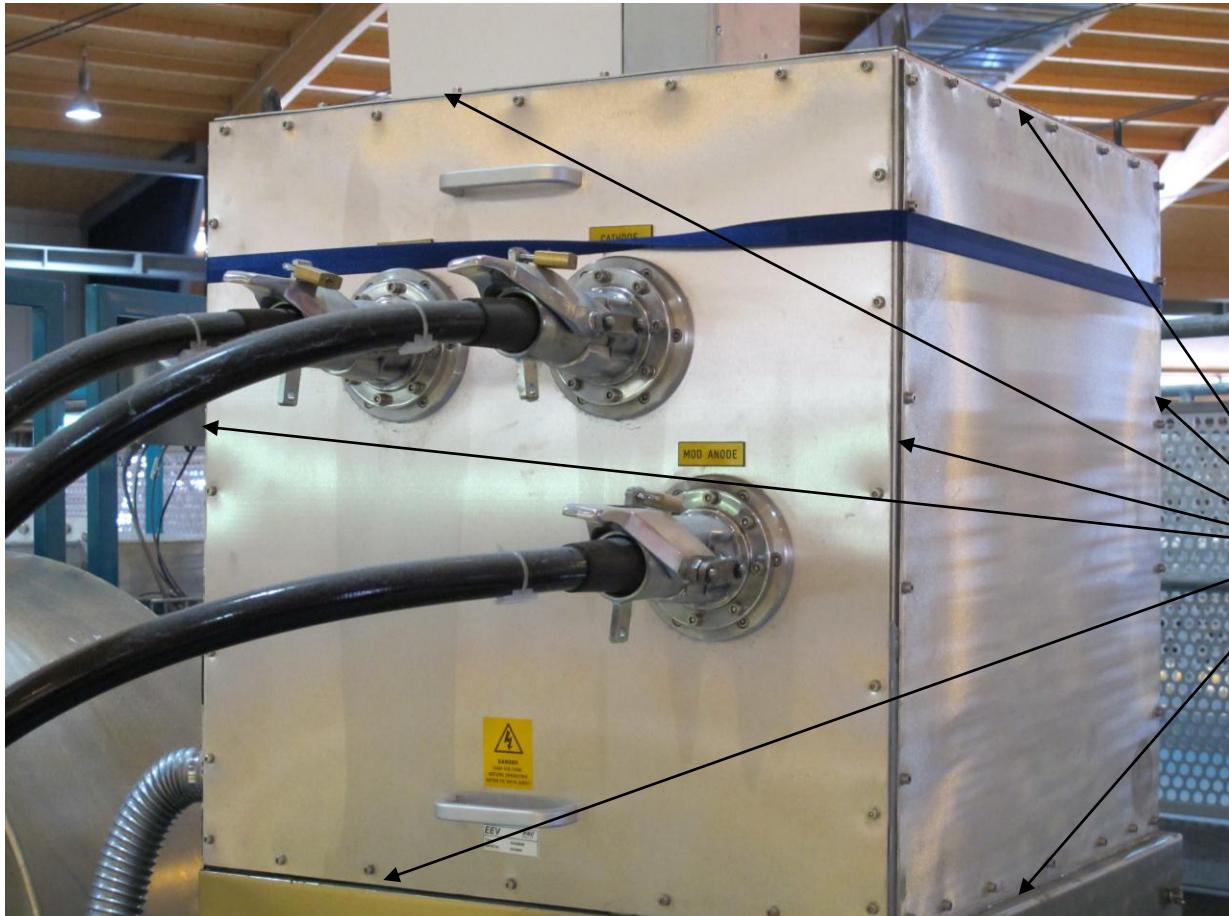
new flow control



# Air tightness of HV cage

## Motive for improvement:

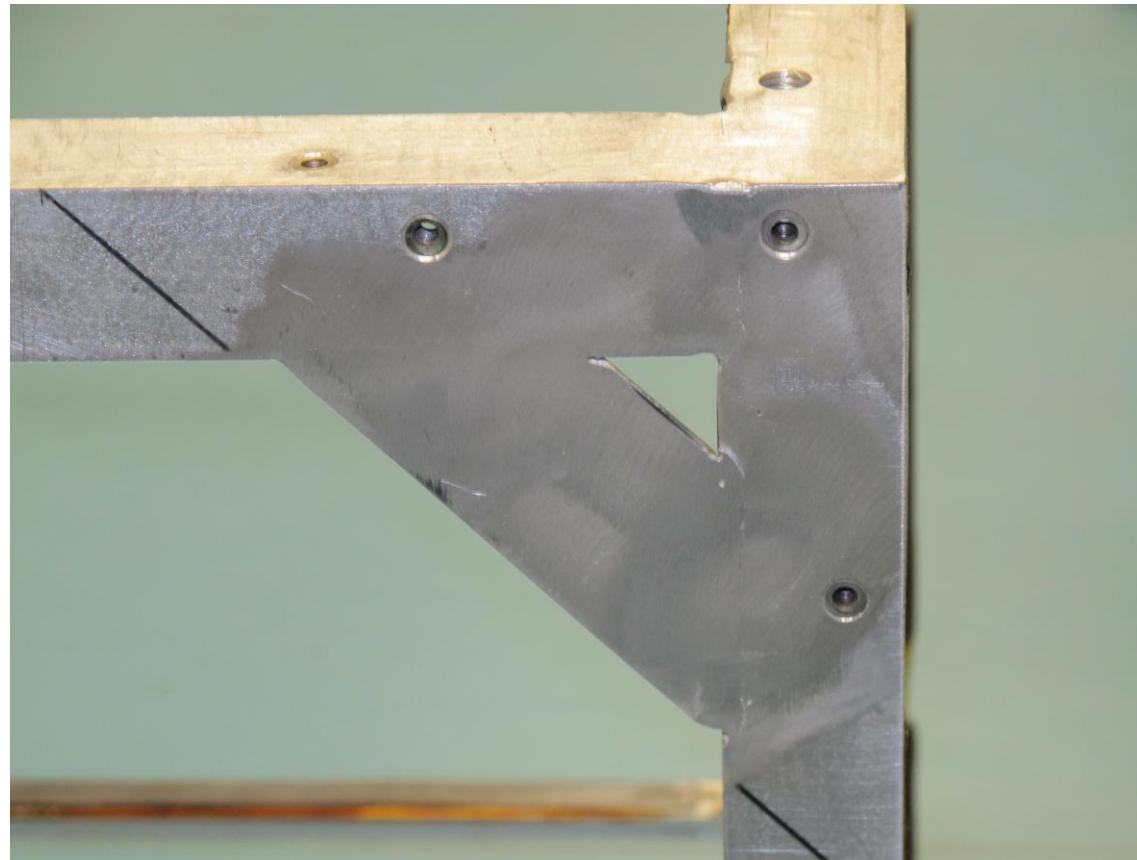
- Air leaks too big
- Cooling air interlock doesn't work
- Used a sealing tape



# Reinforcement of HV cage

## Motive for improvement:

- we stumble upon the cracks by removing the shielding panels
- Cause: Connecting and disconnecting the HV Pantak connectors



# Refurbishment program

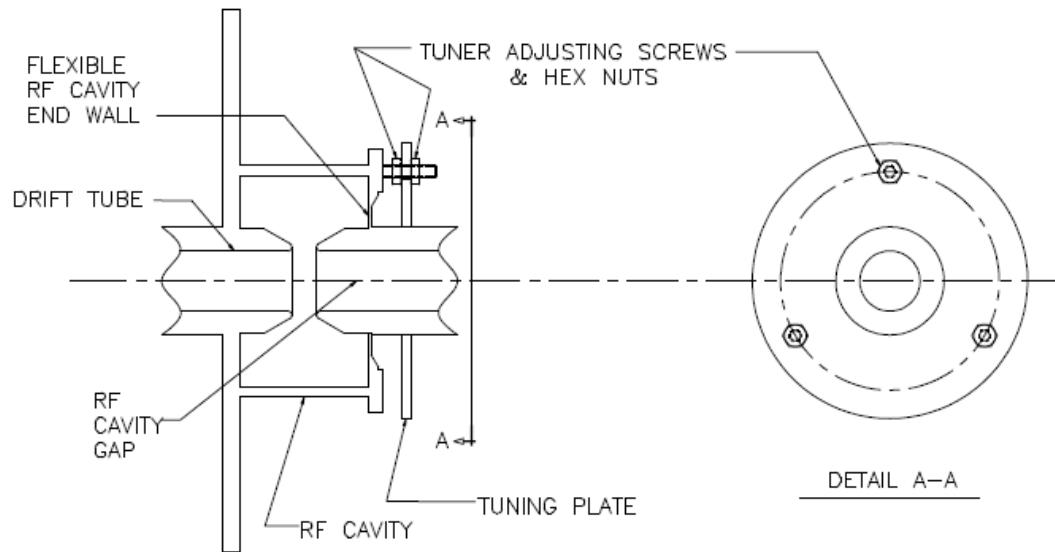
## Motive for refurbishment:

- In the year 1999 we ordered six Klystrons
- All klystrons have the similar number of heating hours
- Klystrons are not any longer produced by EEV or E2V
- We bought two klystrons from Thales to have spare EEV Klystrons
- CPI offer an refurbishment of EEV klystrons of about 60% of the price from a new Thales Klystron
- September 2008 we sent the first klystron to CPI
- Uncertainties in technical questions by CPI (minor or major repair)

# Retuning of second harmonic cavity

## Motive for improvement:

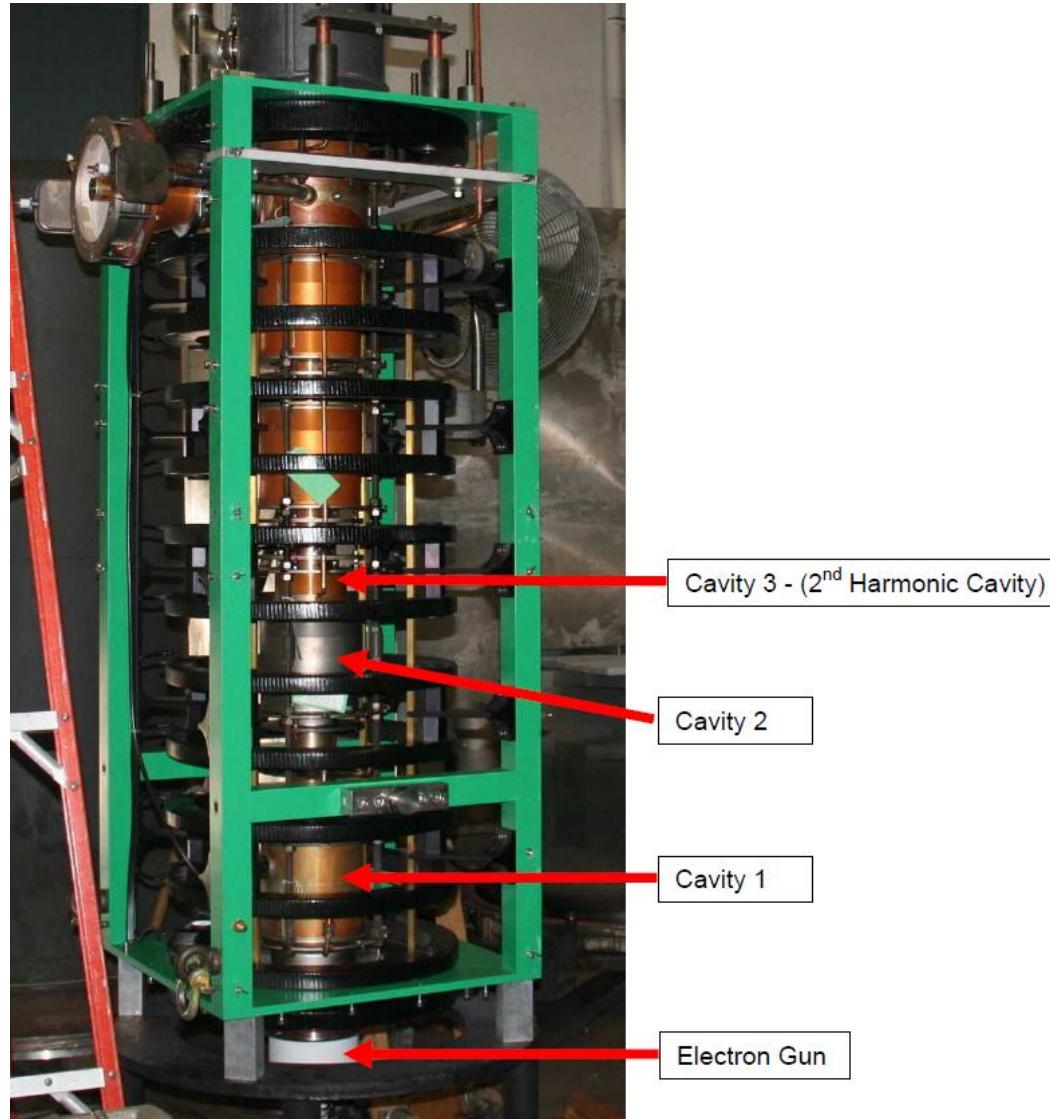
- maximum output power level was not reached in FAT



Before tuning the klystron cavity be sure to take a good set of baseline power output data (E.L. Eisen, CPI)

10/22/2009 – E. L. Eisen

# Retuning of second harmonic cavity



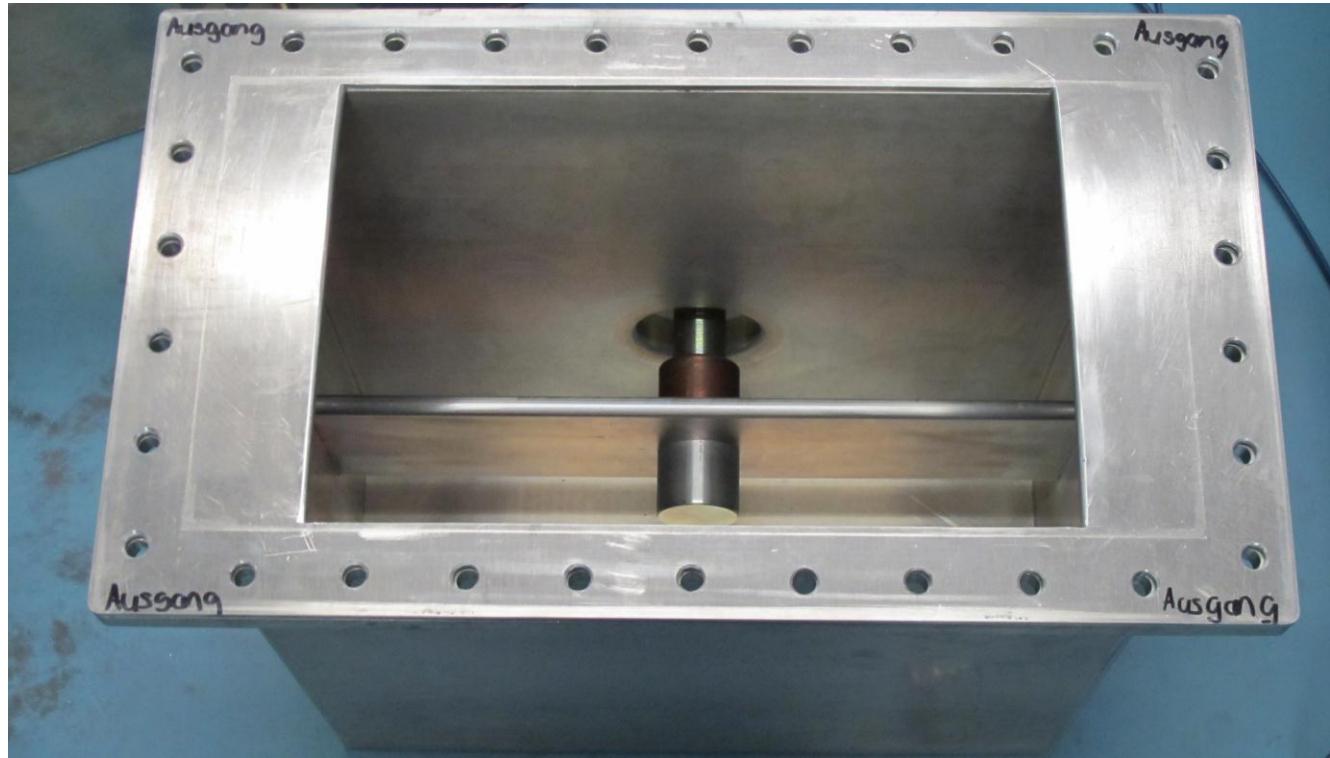
Picture 1 – K3418P Klystron S/N 006

## Motive for refurbishment:

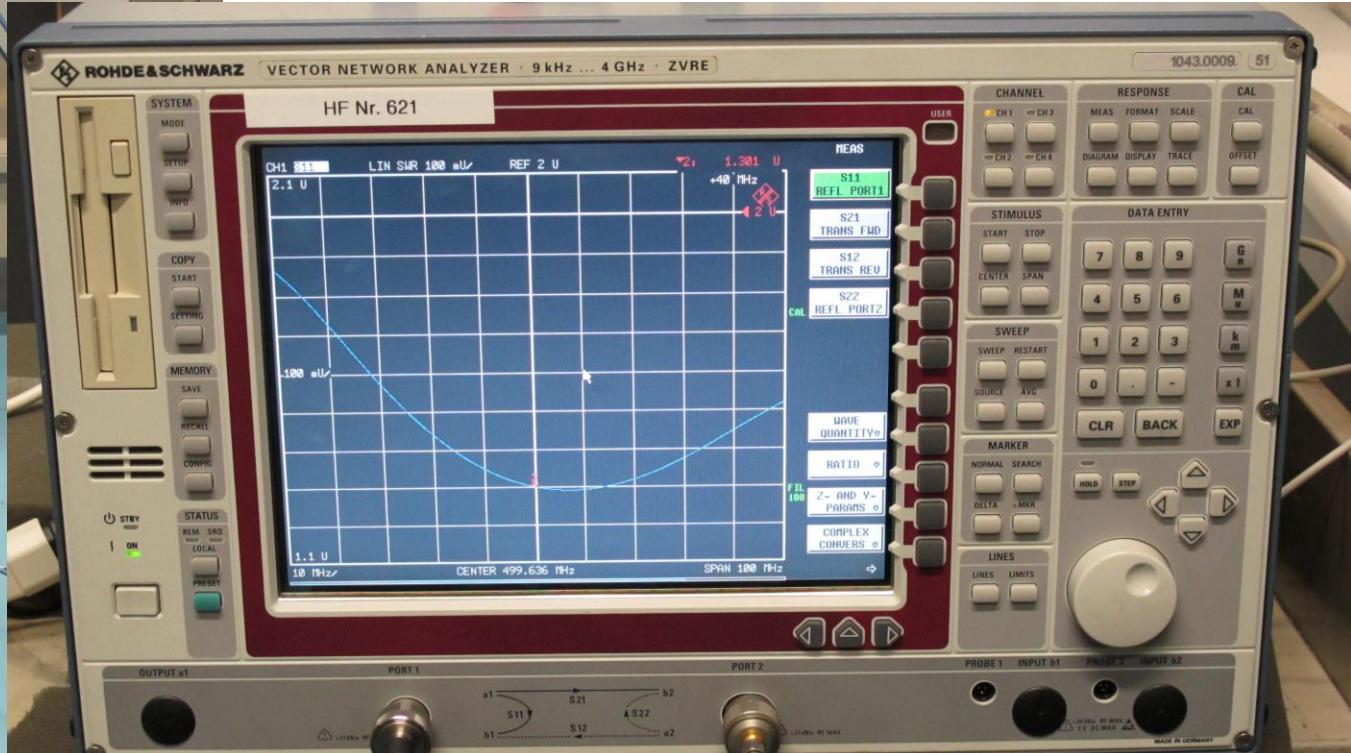
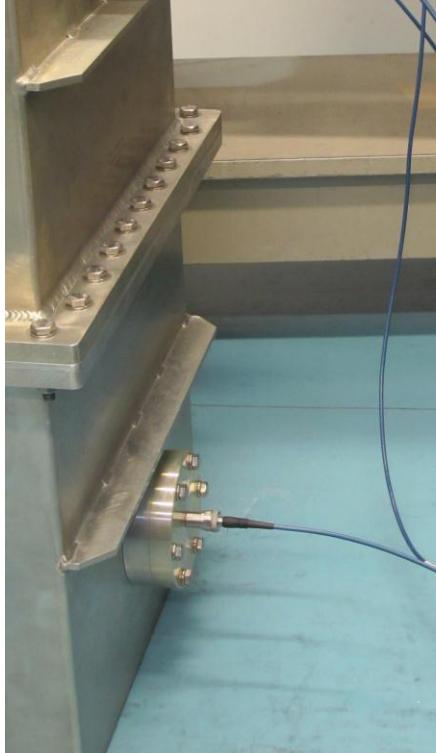
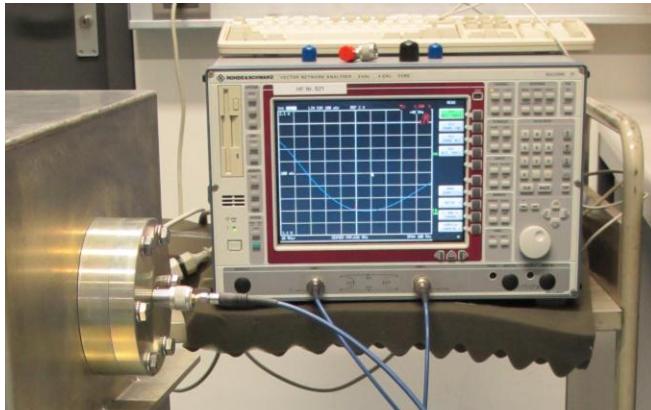
Misunderstandings in matching the Klystron:

PSI: operation possible until VSWR  $\leq 1.3:1$

CPI: operating point VSWR 1.3:1



# VSWR improvement test assembly



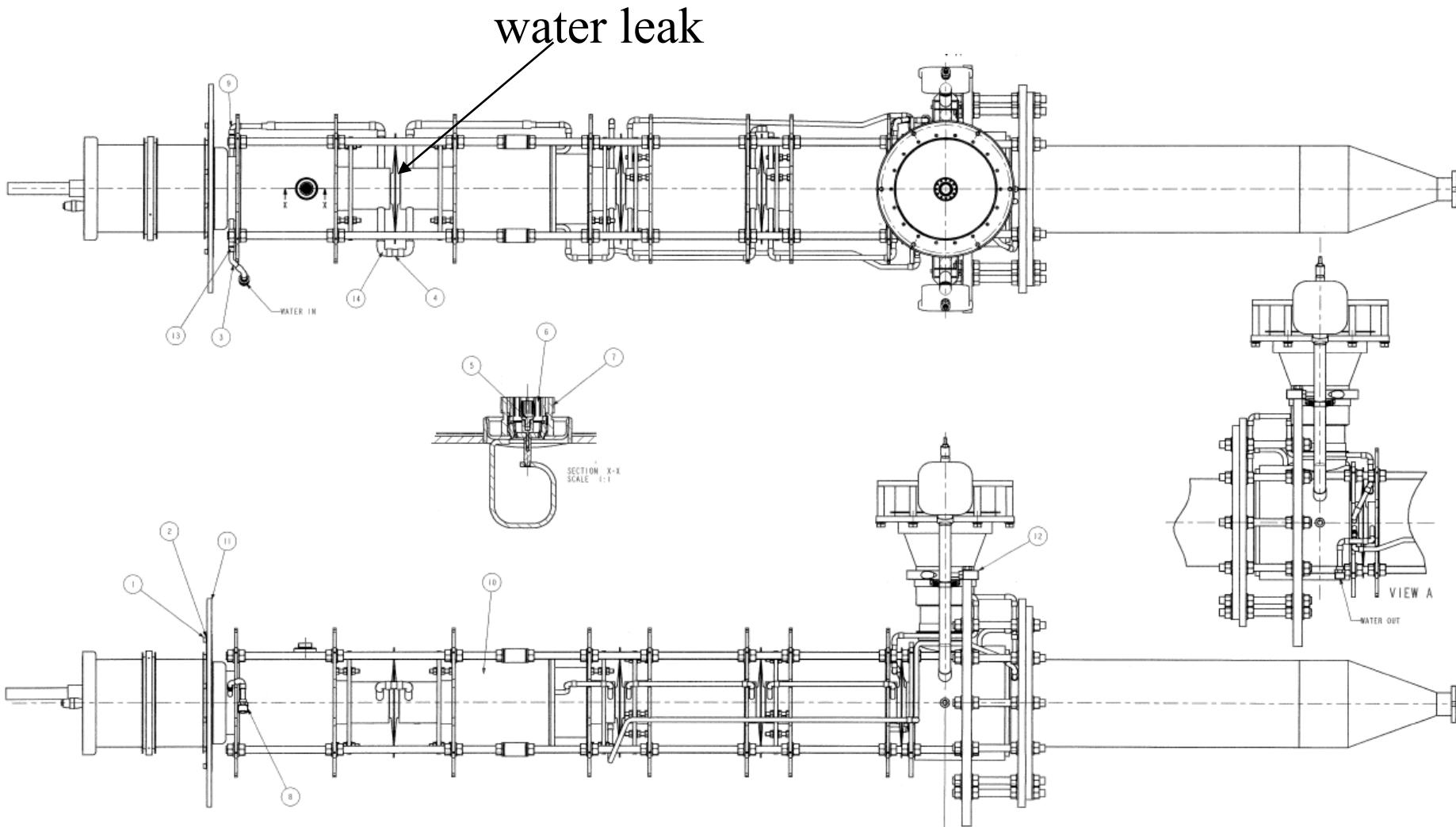
# Water leak on body cooling channel

## Motive for repair of the body cooling channel:

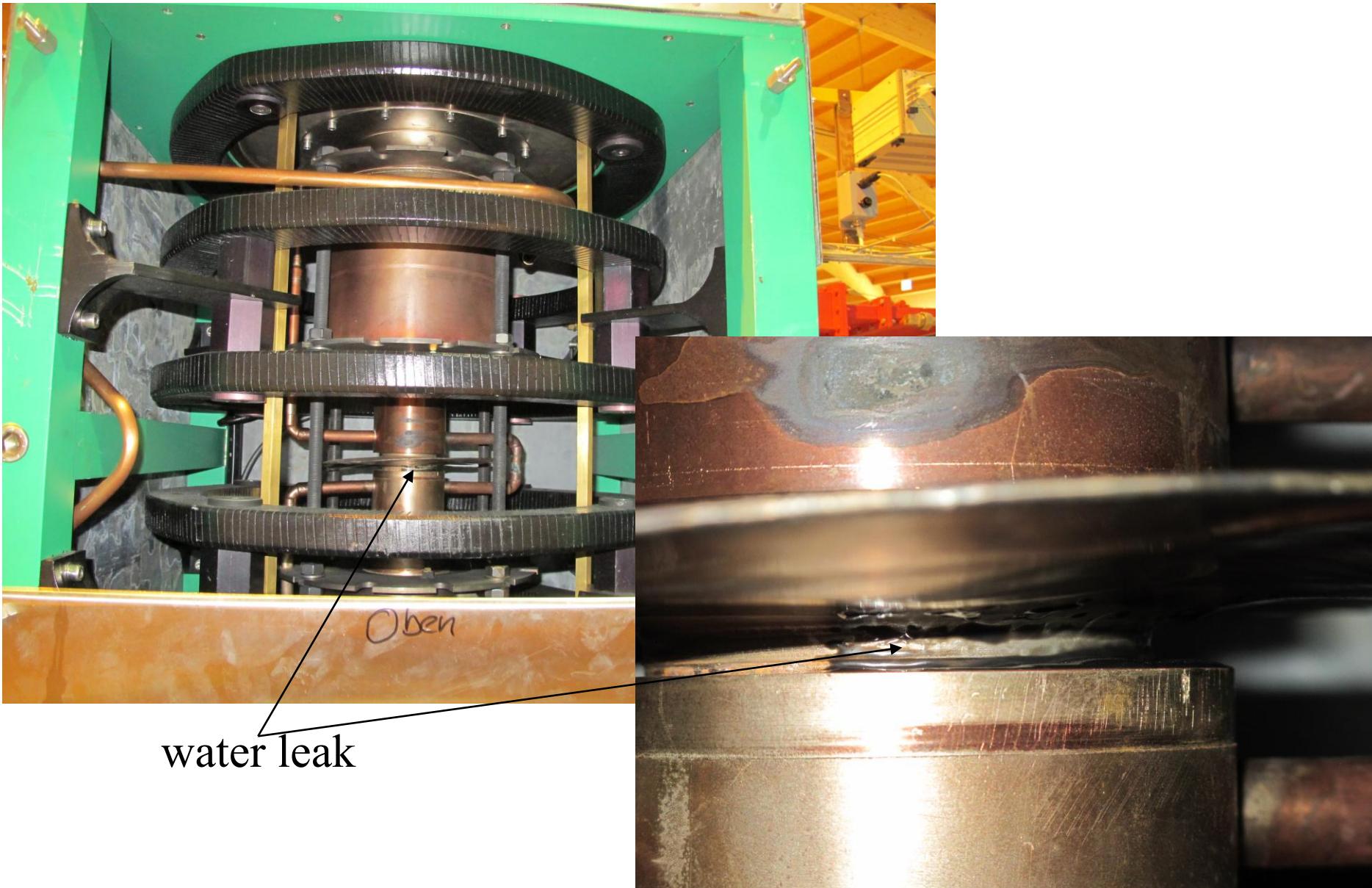
- After only several weeks of operation the klystron were droping
- No interlock stops the klystron operation
- hair crack in cooling channel of drift tube



# Water leak on body cooling channel



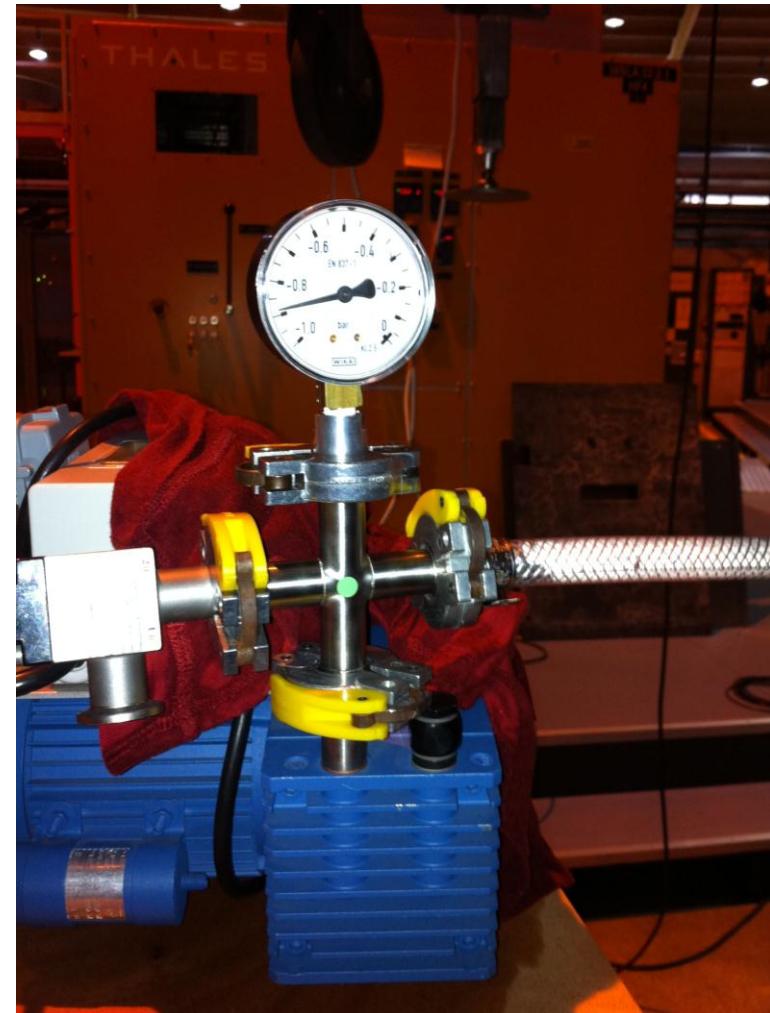
# Water leak on body cooling channel



# Water leak on body cooling channel (Consultants)



# Water leak on body cooling channel



# Conclusion

- The availability of beam time increase dramatically after implementation of the coincident arc detection
- During the past 10 years the EEV Klystrons worked without nameable Klystron problems
- We continue the refurbishment program with CPI
- After the FAT of the forth klystron, we should reconsider either to a new refurbishment program or buying new klystrons

**Acknowledgments:**  
**Lukas Stingelin (PSI), Daniel Kunz (PSI), E. L. Eisen (CPI)**

