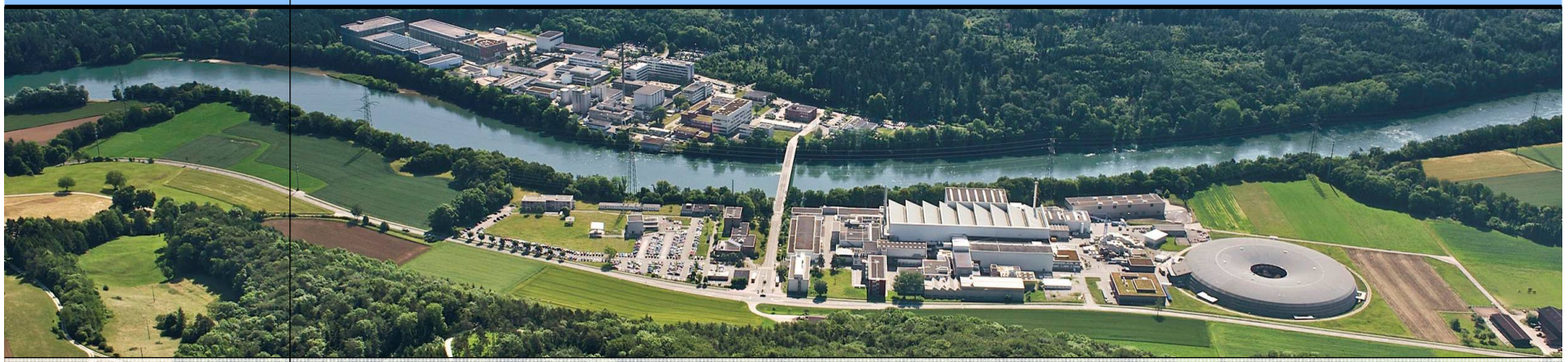
PAUL SCHERRER INSTITUT

PSI



Wir schaffen Wissen – heute für morgen

Paul Scherrer Institut

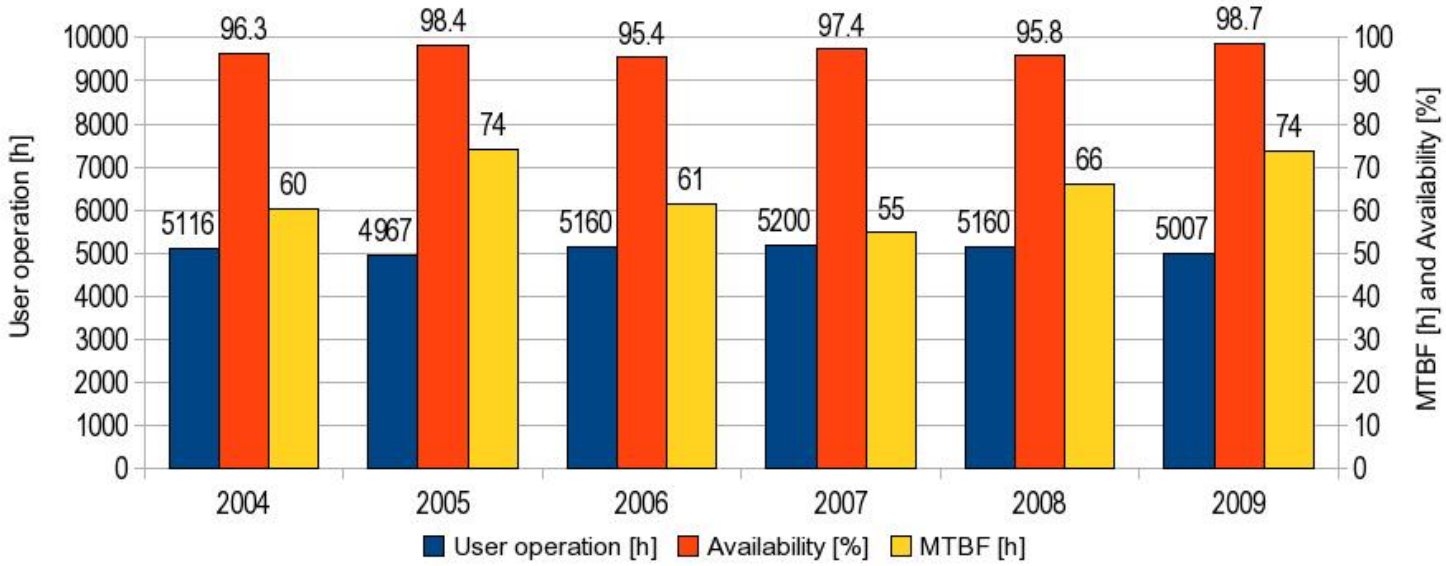
Lukas Stingelin for the PSI rf-group

RF developments at PSI

Overview

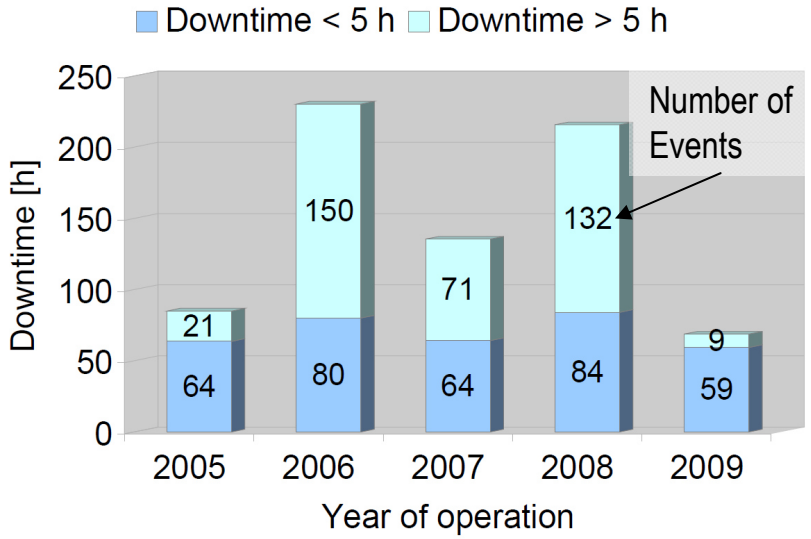
- Operation Statistics
- LINAC Problems and Upgrades
- Efficiency of Klystrons
- New Input Power Coupler
- Coincidence Arc Detectors
- Noise Analysis with IR Beamline
- Status of 60kW 500MHz Solid State Amplifier
- Commissioning of RF-Systems for SwissFEL Injector

Operation Statistics



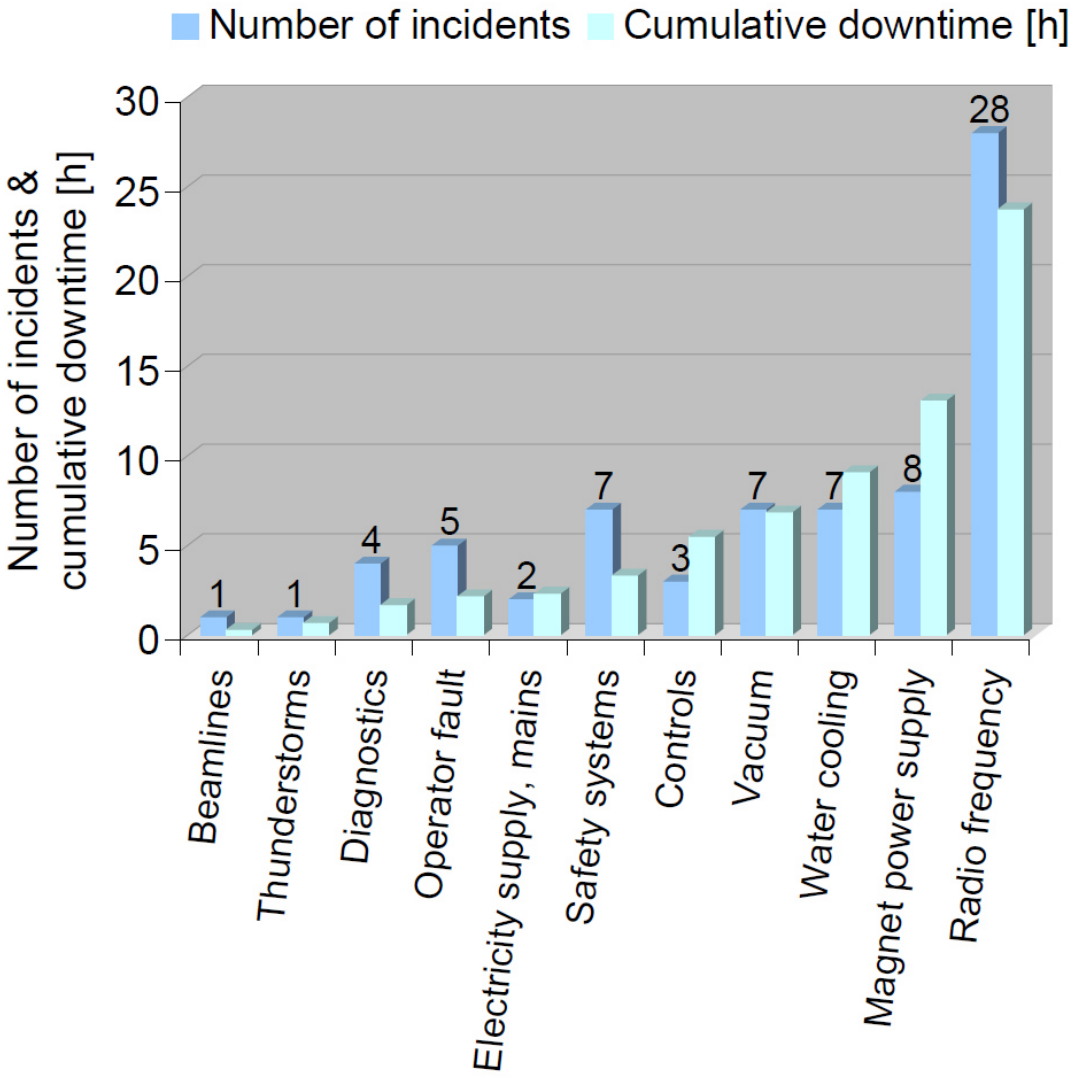
Availability:

- Average 2004-2009: 97%



A.Lüdeke et al., PSI annual report 2009

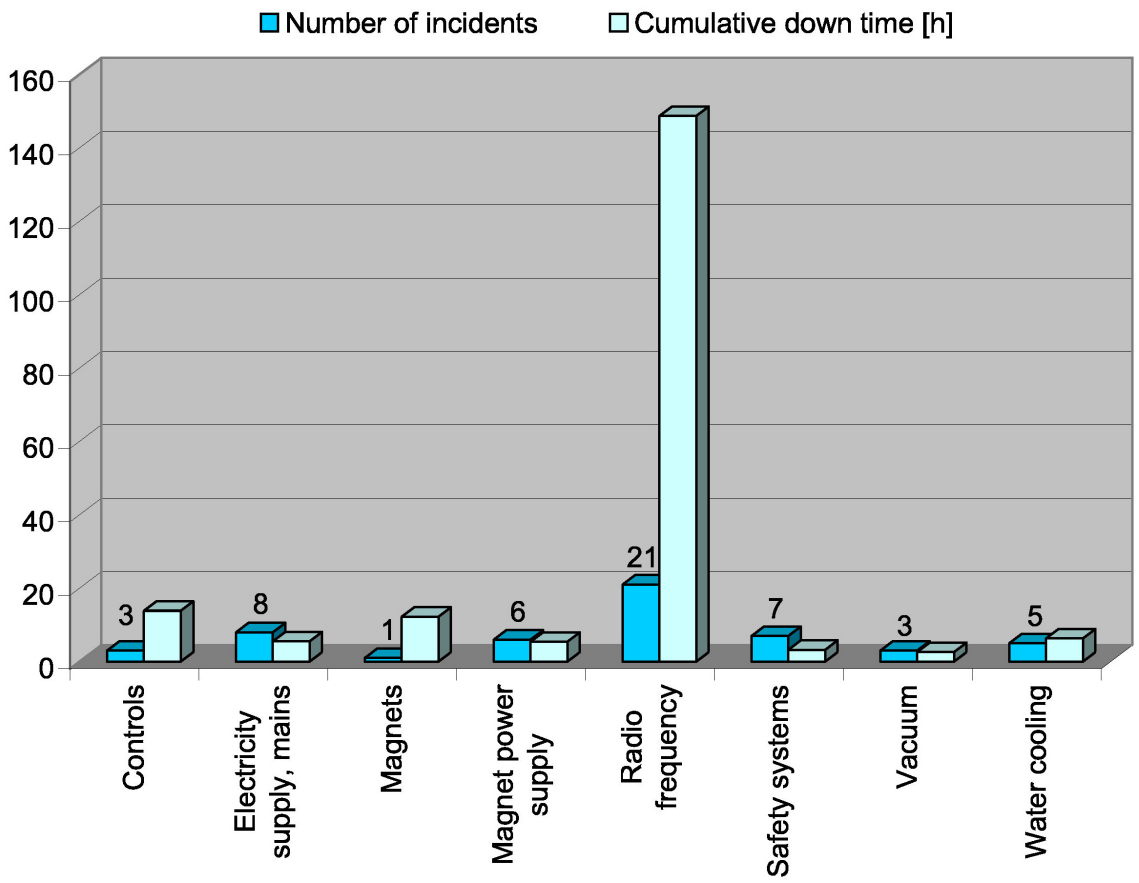
Faillures per System in 2009



Major events:

- Water leak at cavity HOMFS flange
- 20% of beam dumps due to arc detector interlocks

RF faillures in 2010



Major events:

Cryogenic plant of S3HC

- 100h down time due to contamination of heat exchanger
- 35h down time due to trip of helium compressor
- +6h down time due to trip of helium compressor

LINAC:

- 4.5h down time due to defective HV-cable from Charging-Unit to PFN.
- 12h down time due to water leak at Solenoid magnet.

SLS RF Upgrade Programs

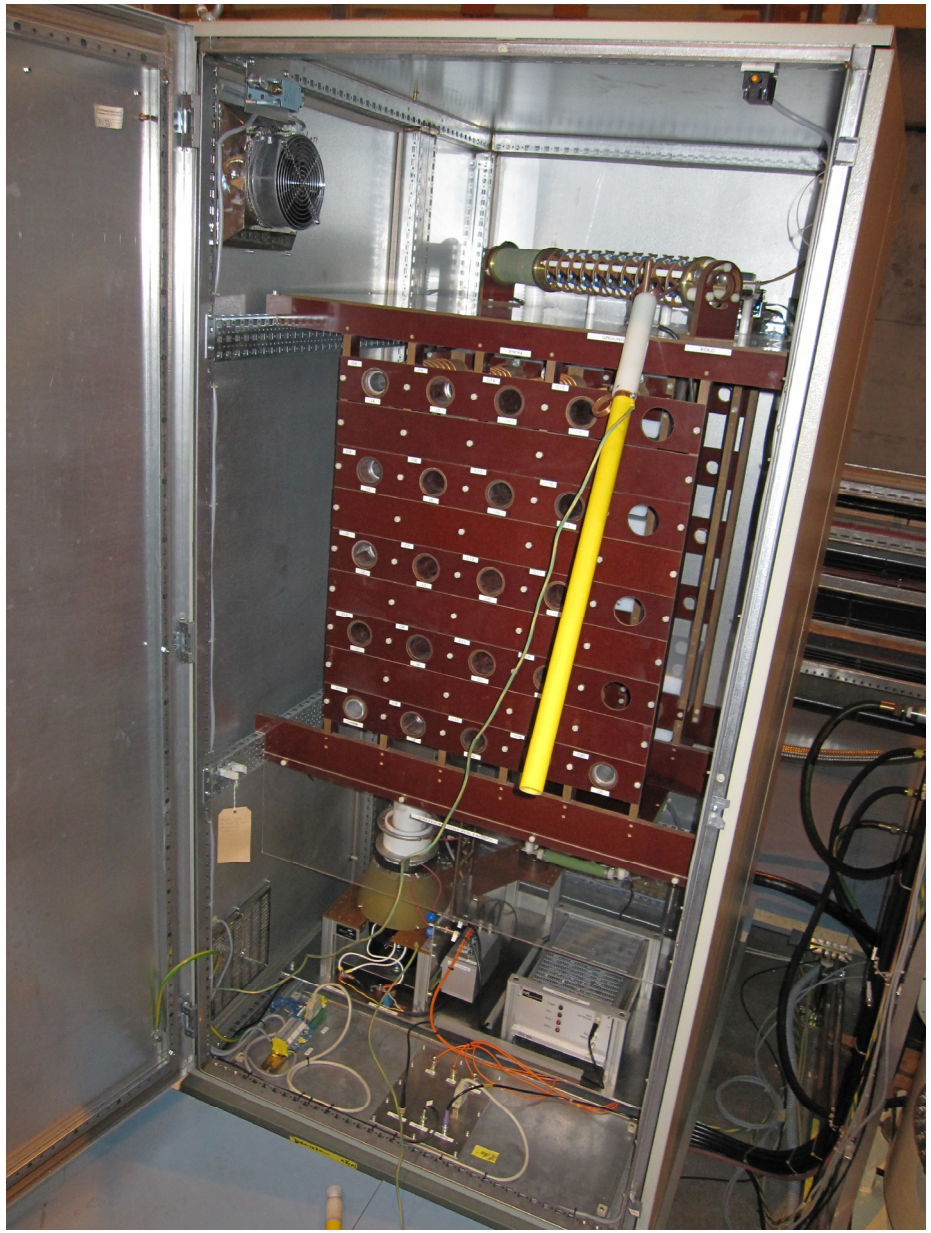
Accomplished:

- ✓ Mini S-band teststand in the LINAC
- ✓ Emergency water-valves at cavities installed (close in case of vacuum interlock)
- ✓ New input power couplers of ELETTRA type built at PSI workshop
- ✓ Coincidence arc detectors prototype installed
- ✓ Spare 500MHz RF cavities ordered at ELETTRA
- ✓ S3HC protection of feedthroughs installed, spare gear-box ordered

Work in progress:

- ❑ New e-gun trigger system (reduce jitter)
- ❑ 500MHz teststand at the booster rf plant (solidstate amplifier for booster cavity)
- ❑ HOM detector boards from ELETTRA?
- ❑ S3HC valve-box in construction at PSI workshop
- ❑ New air flow-switch for Klystron
- ❑ Refurbish Klystrons and optimize efficiency

SLS-LINAC Problems and Upgrades



- Thyratrons heating filament broken.
- Spare Thyratron had „self triggering“ problem.

❑ CX1836A Adapted to CX1836AP-Type (long hold time), but did not really improve.

✓ PFN Capacitors were leaking oil. Had been replaced.

✓ PFN retuned at low voltage.

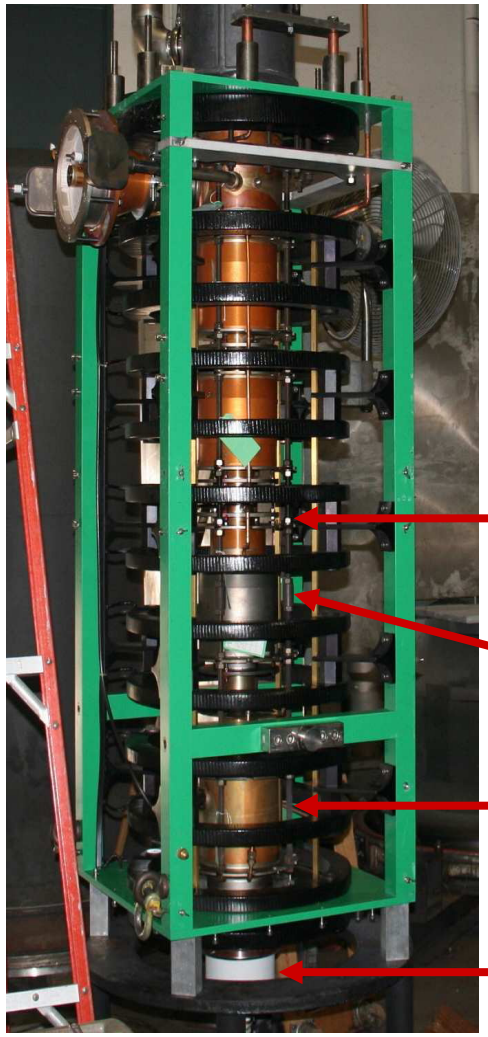
✓ High-voltage cable had short circuit and was replaced.

❑ Fire detection and protection of PFN is under investigation.

- Water leaks at LINAC: Solenoid coils had to be glued.

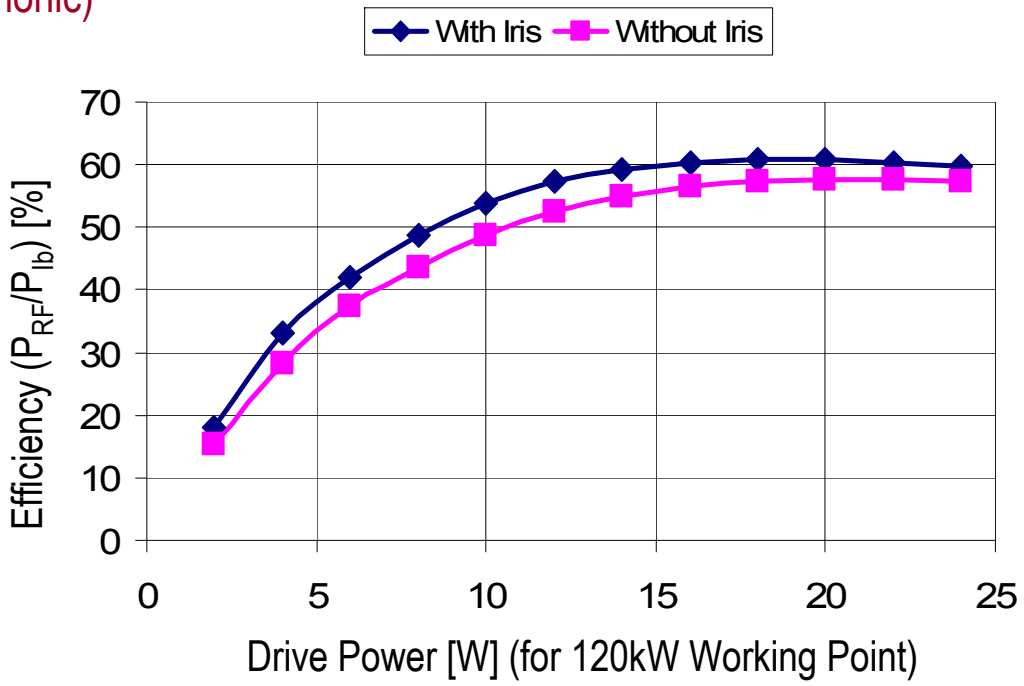
❑ Maybe, solenoids will be replaced in future.

Refurbishing and Efficiency of EEV 500MHz Klystron.

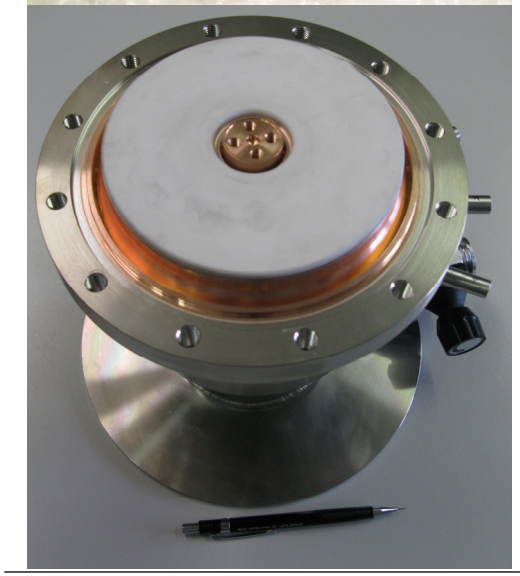


EEV Type K3418P Klystron

- ✓ First EEV Klystron sent to CPI for Refurbishing in 2009
- ✓ FAT in Palo Alto CA successful
- ☒ However, problems at PSI to reach maximum output power
- → 2nd harmonic cavity had to be retuned
- ☒ Efficiency not optimal
- → Attempt to adjust matching with Iris



“New“ Input Power Coupler (IPC) for BO+SR Cavities



- After Problems with water leaks, an attempt was made to build spare IPC at the PSI workshop

✓ Slightly modified design for cooling and ceramic (metallized ceramic from KYOCERA)

✓ Vacuum-tight storage container designed and built

✓ First IPC has been tested in the Booster cavity up to 60kW CW

✓ Runs without any problems at the booster rf-plant since January 2010

❑ Installation of first IPC in Storage-Ring cavity during January Shutdown 2011

New Coincidence Arc Detectors

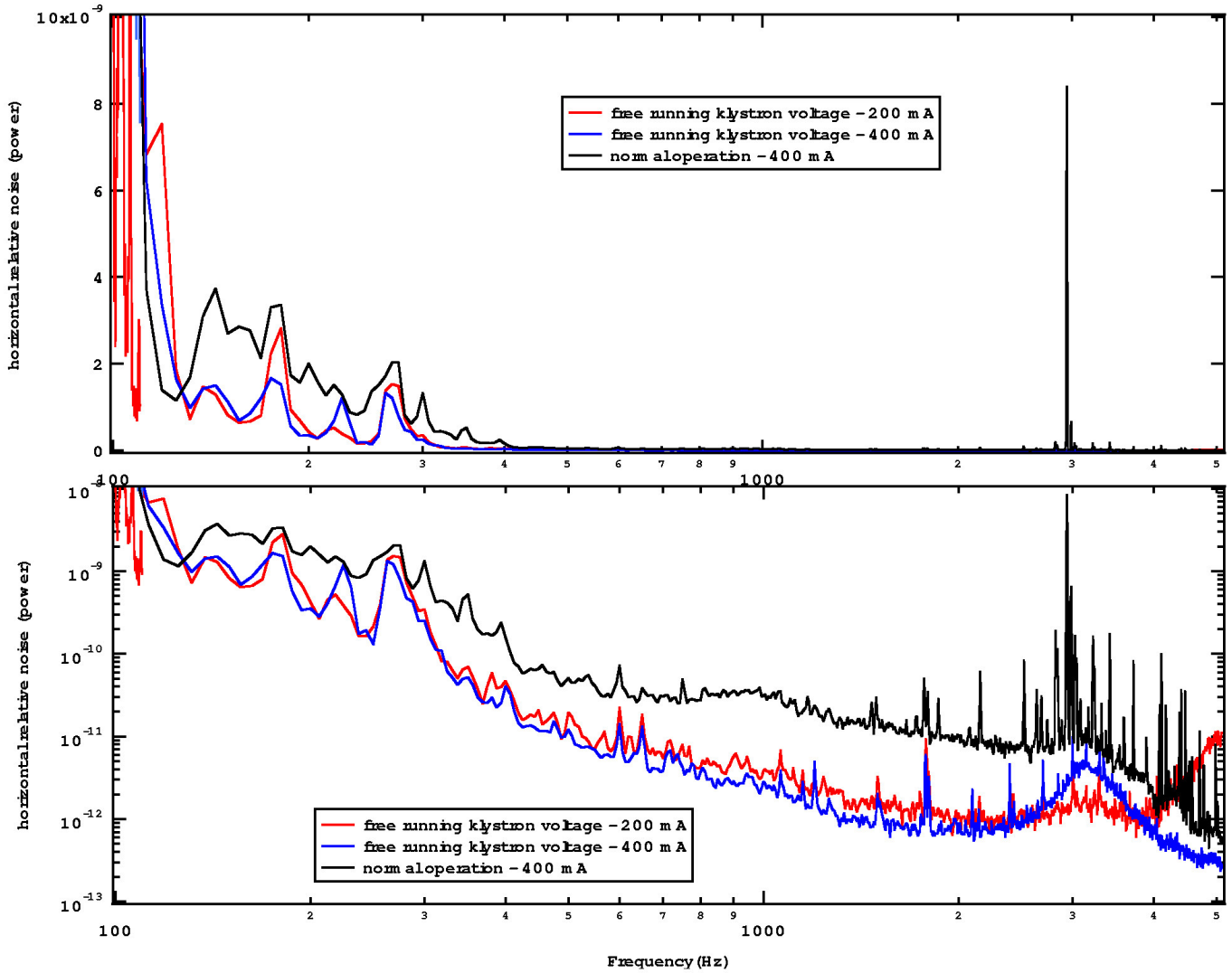
✓ Installed during April 2010 shutdown for circulator (Additional arc view-port installed)

✓ Installed during August 2010 shutdown for klystron (Additional arc view-port installed at coaxial output-line of klystron)

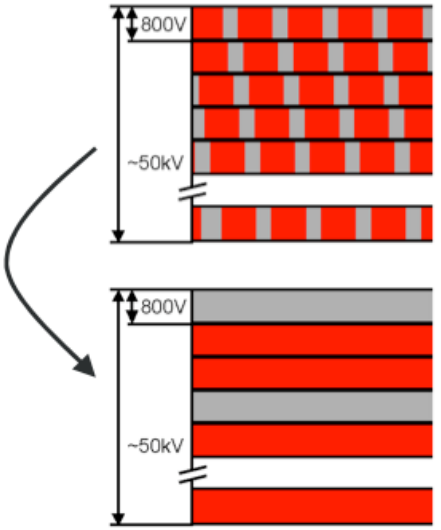
➢ Since April 2010: 1 false arc registered at circulator (no beam-dump)

❑ Planned to upgrade the reminding 3 SR-RF plants

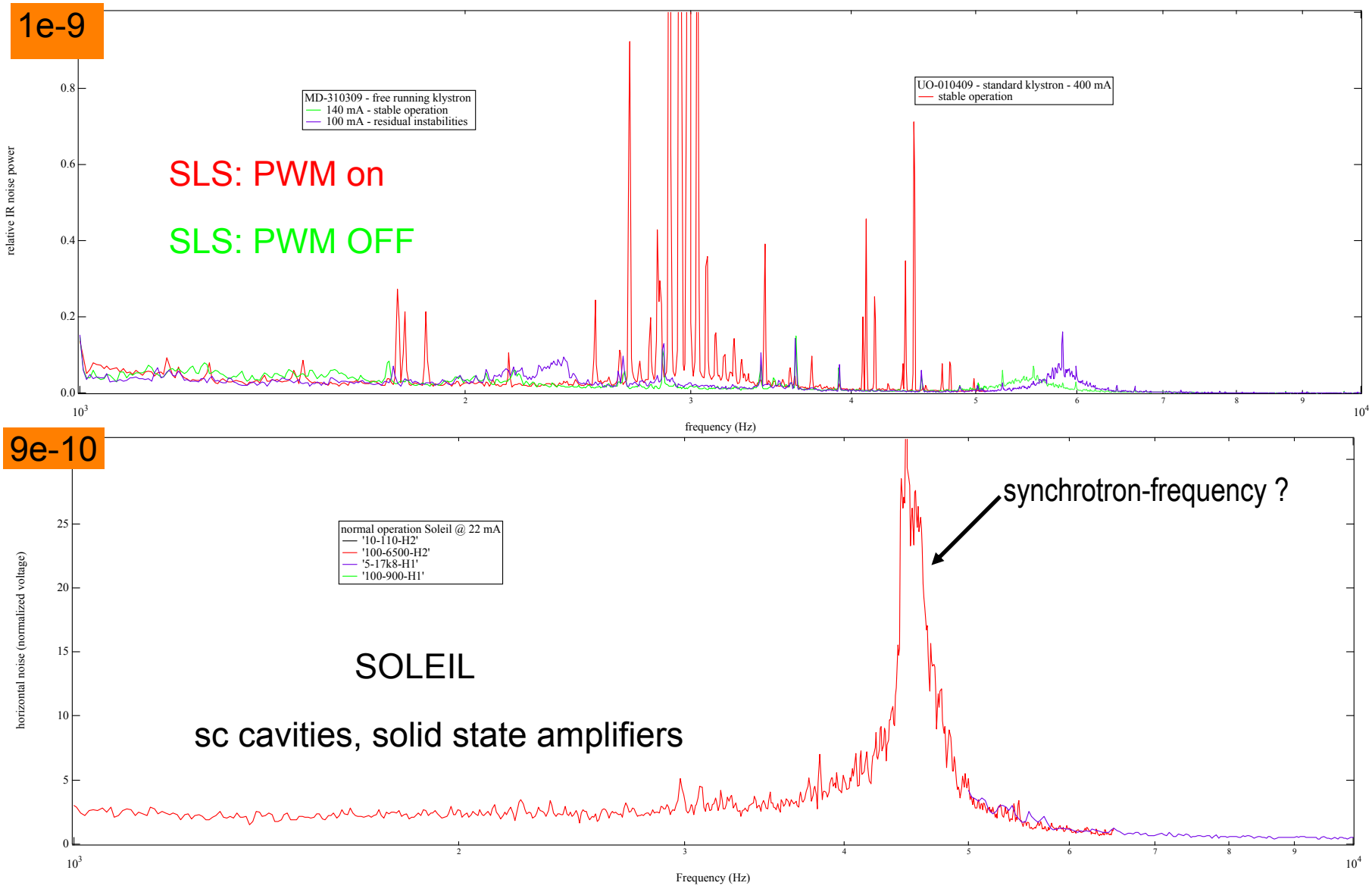
RF-Noise Problem



✓Since January 2010, HVPS for Klystrons run without PWM and rotation.



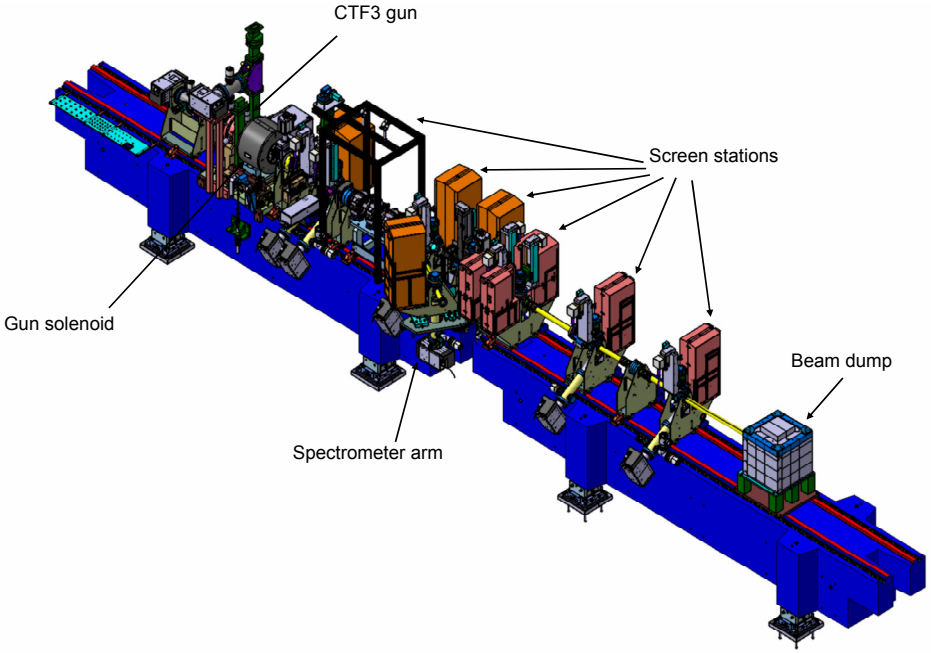
RF-Noise Problem



Status of 60kW 500MHz Solid-State Prototype:

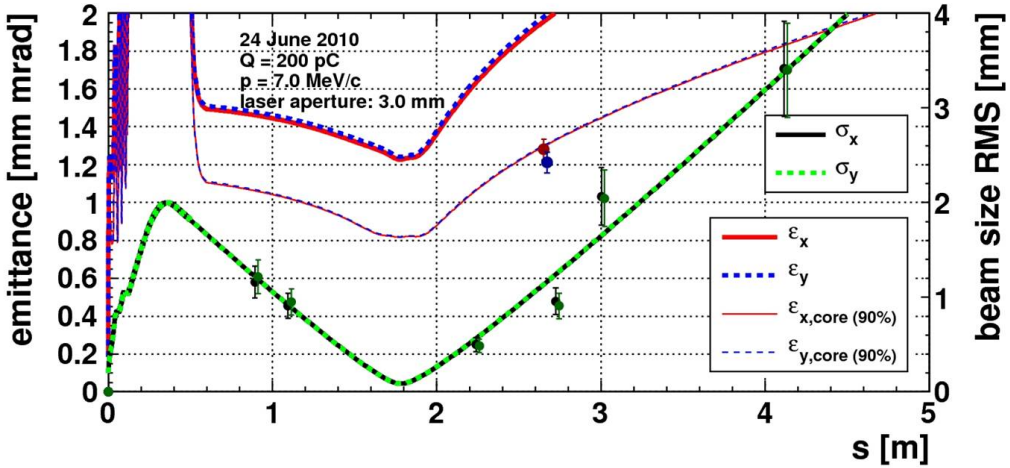
Power supplies	design finished	tests OK	in production
2-way splitters	design finished	tests OK	production finished
6-way splitters	design finished	tests OK	substrates in production
9-way splitters	design finished	tests OK	more substrates in production
Amplifier modules	in design phase	preparation for test of new transistors	
9-way combiners (5kW)	design finished	LLRF-test OK	mass production almost finished
Directional couplers (5kW)	ready	tests OK	all devices produced
6-way combiners (30kW)	design finished	LLRF-test OK	production finished
2-way combiners (60kW)	design almost finished		
Interlock, control and software			ready

SwissFEL 250MeV Injector Commissioning Phase 1



RF Gun:

- CTF3 gun V (CERN)
- 2.6 cell standing wave S-band
- Nominal gradient 100 MV/m
- 21 MW peak power, 2.0 µs pulse length
- 10 Hz repetition rate
- Circulator from AFT, Waveguides from IHEP, Directional Couplers and Window from Spinner
- Measured Pulse-to-pulse jitter: < 0.02º (phase), < 0.019% (amplitude)

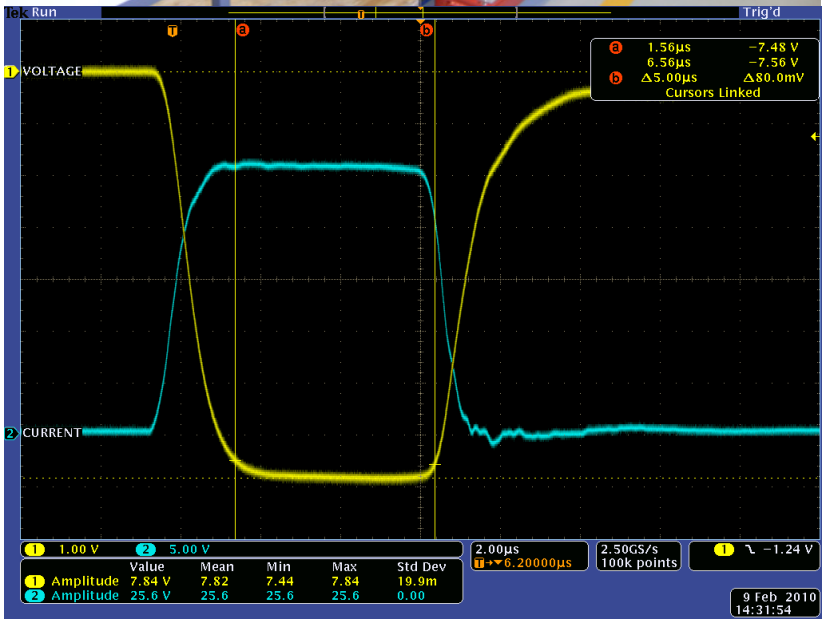


Beam Envelope:

Comparison with 3D particle tracking code (OPAL)

(90% core emittance removes 10% of the bunch charge in head and tail)

Modulator Commissioning for SwissFEL Injector

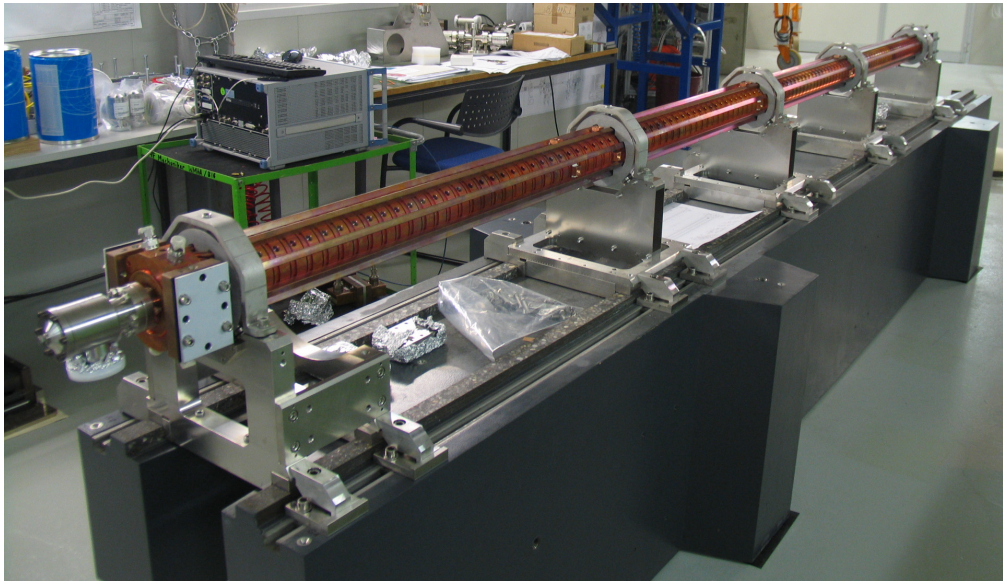


For e-gun rf-plant:

- Solid State Modulators from ScandiNova K2-1L, Model 007174
- 265kV, 262A pulse of 5µs duration 10-100Hz
- Pulse Stability < 0.04%
- Dimensions: 2.8 x 1.7 x 2m

- Mechanical support structure had to be reinforced
- Radiation shielding had to be improved
- Oil tank had leak and had to be glued
- Control system blocks from time to time and requires hard-reset of modulator
- Oil-pump gets hot and has to be replaced
- Harmonic distortion on power line has to be improved

Structure Commissioning for SwissFEL Injector



- Structure from RI (former ACCEL) based on PSI design
- Wave guide splitter and 180°-bend from IHEP
- Waveguide components, directional couplers from MEGA
- Loads and windows from CML

Parameters:

Total length	4150 mm
Iris diameter	9.31-13.243 mm
Number of cells	122
Cell period	33.333 mm
Operating frequency (40°C)	2997.912 MHz
Phase advance	2π/3
Nominal gradient	20 MV/m
Nominal input power	36.5 MW
Fill time	0.955 µs
Operating temperature	38-42°C

- 1 structure broken during tuning.

➢ Has been replaced.

- Input coupler of 3 structures had to be retuned to match input impedance
- 2 structures conditioned up to 35MW, 1.5µs, 10Hz

PAUL SCHERRER INSTITUT

Thank you for your attention!