

Reliability and Availability of SRF-Accelerators

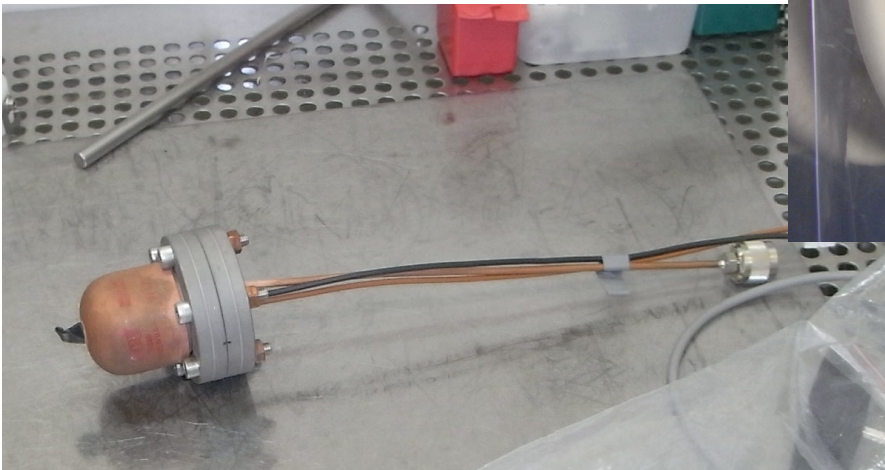
**20 years of
high power CW
machine operation**

Radiation Source ELBE
Ulf Lehnert
10.5.2022



Grid-Pulsed Triode Gun

- Very long lifetime, easy operation
- HV maintenance
- Pulse Electronics on HV platform
(fast diodes die)
- HV spark damage
- Back-bombardment
(ions, field emission) – lead wall



- **SRF Gun** (superior parameters)
- Research Project
(huge effort, expert only op.)
- Temporary routine operation

Klystrons



- Reliable
- Low bandwidth
- Need HV supplies
- Vacuum failures
- Cathode lifetime
- No repairs
- No replacements

2001 - 2011
8kW klystron VKL7811St from CPI



Semiconductor Power-Amplifiers

2012 - today

- 10x 10 kW SSPA (2 per cavity)
- reliable and compact system
- high redundancy

5 LDMOS died

no impact on beam time

2 power supply failures

4 h down time

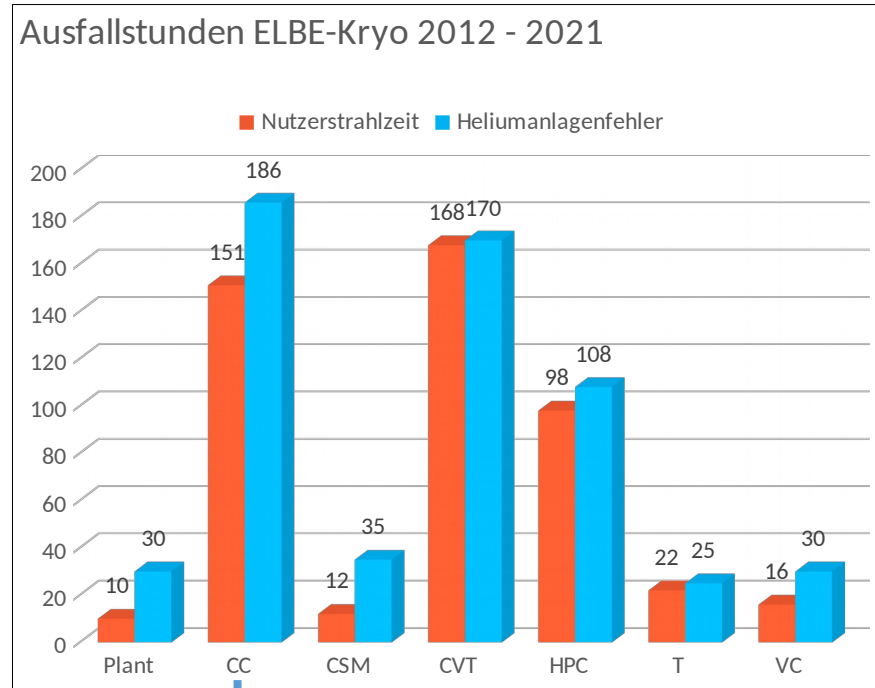
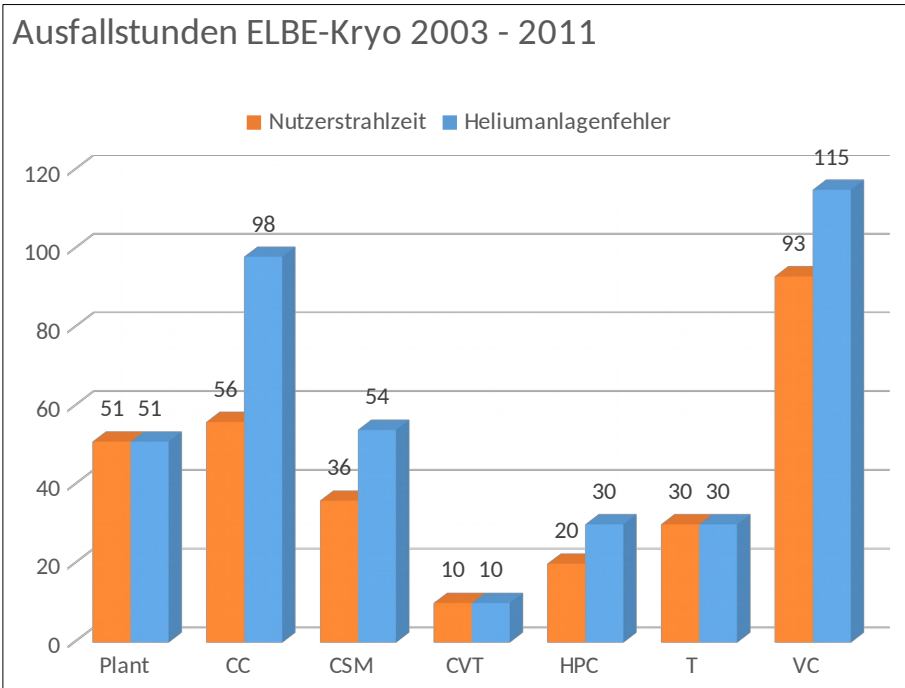
Firmware/Control issues

**Latest version by SigmaPhi Electronics
(former Bruker)**

- 15kW CW 1300MHz based on 6th gen. 50V LDMOS
- Bandwidth: ± 5 MHz
- Small Signal Gain: 73dB typ.
- Operating Dynamic: >30dB



Ausfallzeiten Heliumanlage und ELBE-Nutzerstrahlzeiten



- Plant: Gesamtanlage (Netzausfälle)
- CC: Kaltkompressorsystem
- CSM: Steuerung, Sensoren, Medien
- CVT: Coldbox, Ventile, Transfersystem
- HPC: Hochdruckkreislauf
- T: Turbinen
- VC: Prozessvakuum Pumpstand

Lagerschaden/verschleiß
 Defekt → Verunreinigungsverlagerung

→ Christof Schneider (c.schneider@hzdr.de)

Uninterruptible Power Supplies

Needed for

- Control devices
PLC, CPU,
field bus communication
 - Control system servers
 - Vacuum pumps
 - Helium liquefier (short-time)
-
- Single large central cluster
 - High redundancy
 - Generator backup
 - Operating temperature $\leq 25^{\circ}\text{C}$
 - Bypass switch
 - Signalization



Control system

PLC

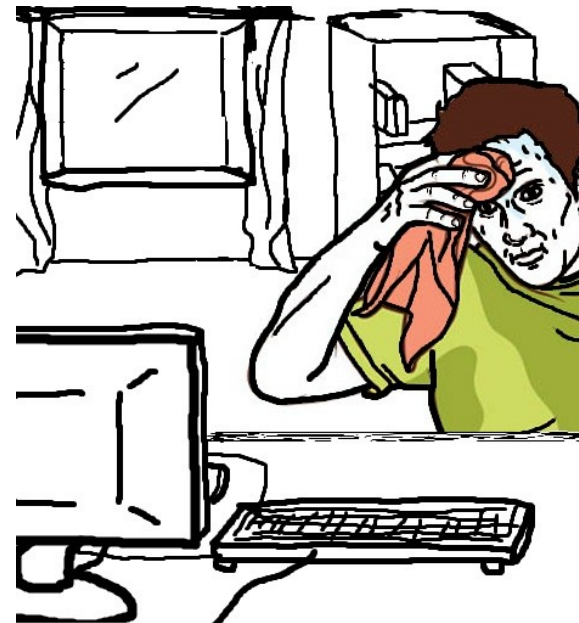
- Device operation
- Interlocks
- **Complex system**

HMI (Siemens WinCC)

- Operator interface
- Settings database
- Tag logging
- **Proprietary software**
- **Limited support**
- **„mandatory“ Version upgrades**
- **Network reliability**

LabView tools

- Special diagnostics



Machine Protection System

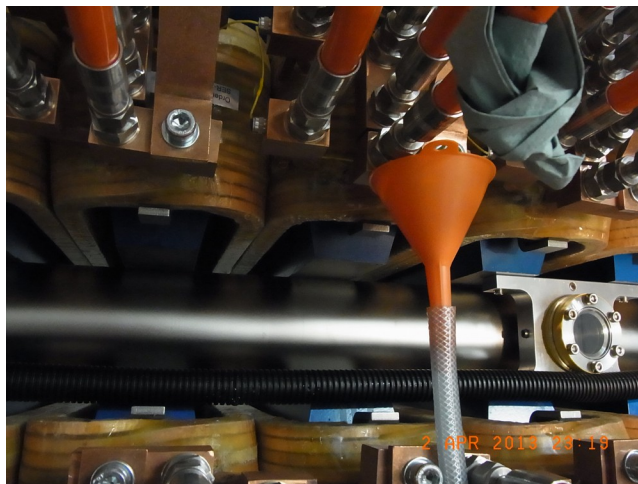
- Beam-loss monitors
- Current-difference monitors
- Current limiting for diagnostics
- RF window protection
- Vacuum valve interlocks
- Dipole current
-
-

**Major source of delays
when setting up the machine**



Auxilliary Systems

- Cooling water
flow sensors
leak sensors
- Pressurized air
central system
LN₂ backup
end position switches



- Local chillers
- Cabinet cooling

Vacuum system

- Fast closing valves
- manual cavity protection valves
- Controllers for getter pumps
- few turbo pumps
- mobile pumping stations for start-up



Beam dumps

- Graphite block suspended in vacuum
- Radiation cooling
- Low activation
- **post-beam cooling necessary**
- **Vacuum windows**



Dipole power supplies

Regular maintenance

Mainboard failures

Water leaks

Camera system

Vidicons → analog CCD → ethernet

Image quality ↑ radiation resistance ↓

Radiation protection

PSS trips

Radiation Damage



Beamline- Troll
gefangen 01.04.2003