

# PETRA veteran cavities.

Unexpected trouble with them

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Unexpected trouble with the PETRA veteran cavities

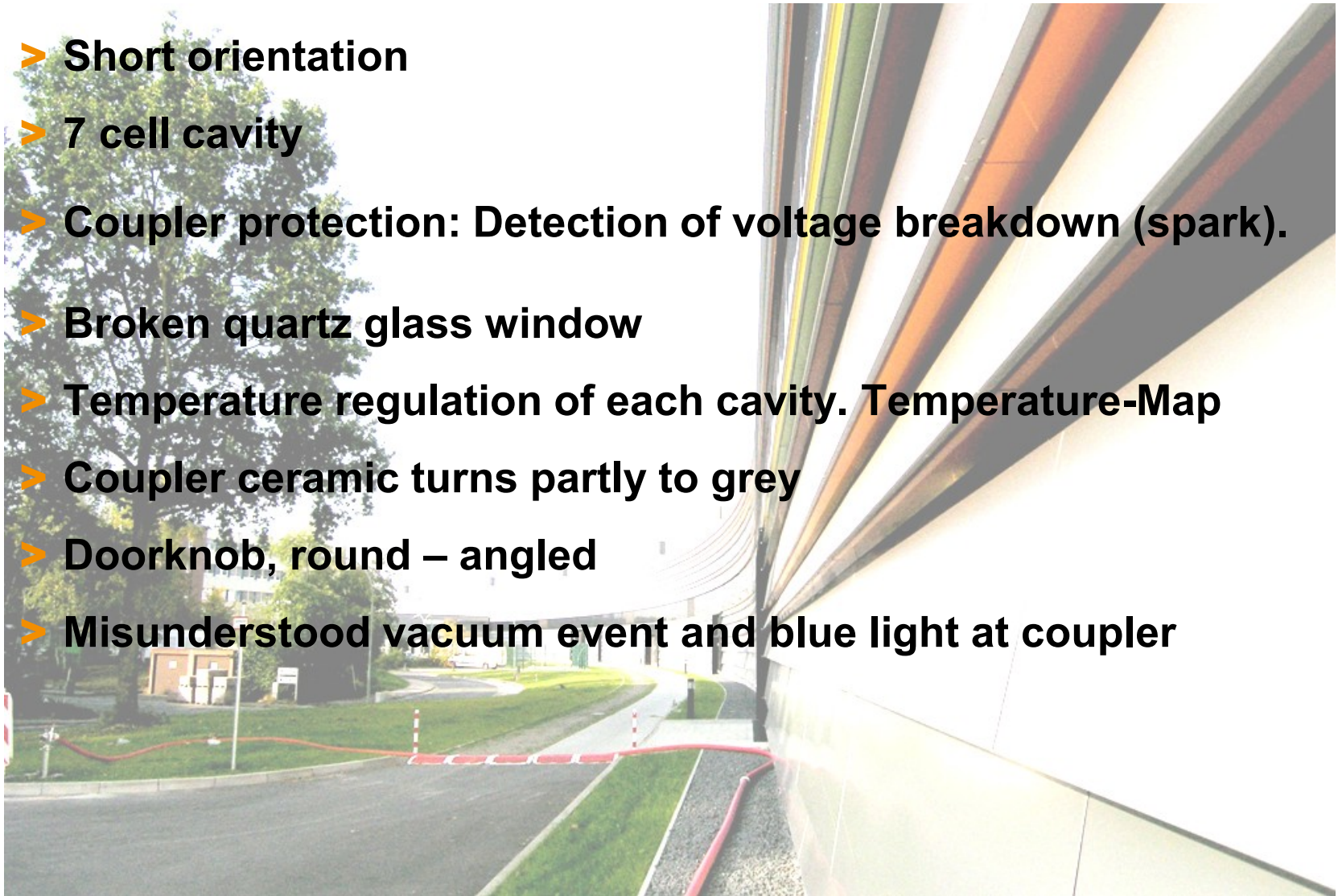
16th ESLS rf meeting

ALBA, Barcelona, 2012-10-09/10

# Topics.

- Short orientation
- 7 cell cavity
- Coupler protection: Detection of voltage breakdown (spark).
- Broken quartz glass window
- Temperature regulation of each cavity. Temperature-Map
- Coupler ceramic turns partly to grey
- Doorknob, round – angled
- Misunderstood vacuum event and blue light at coupler

$$\frac{dr}{dt} = \dot{r}$$

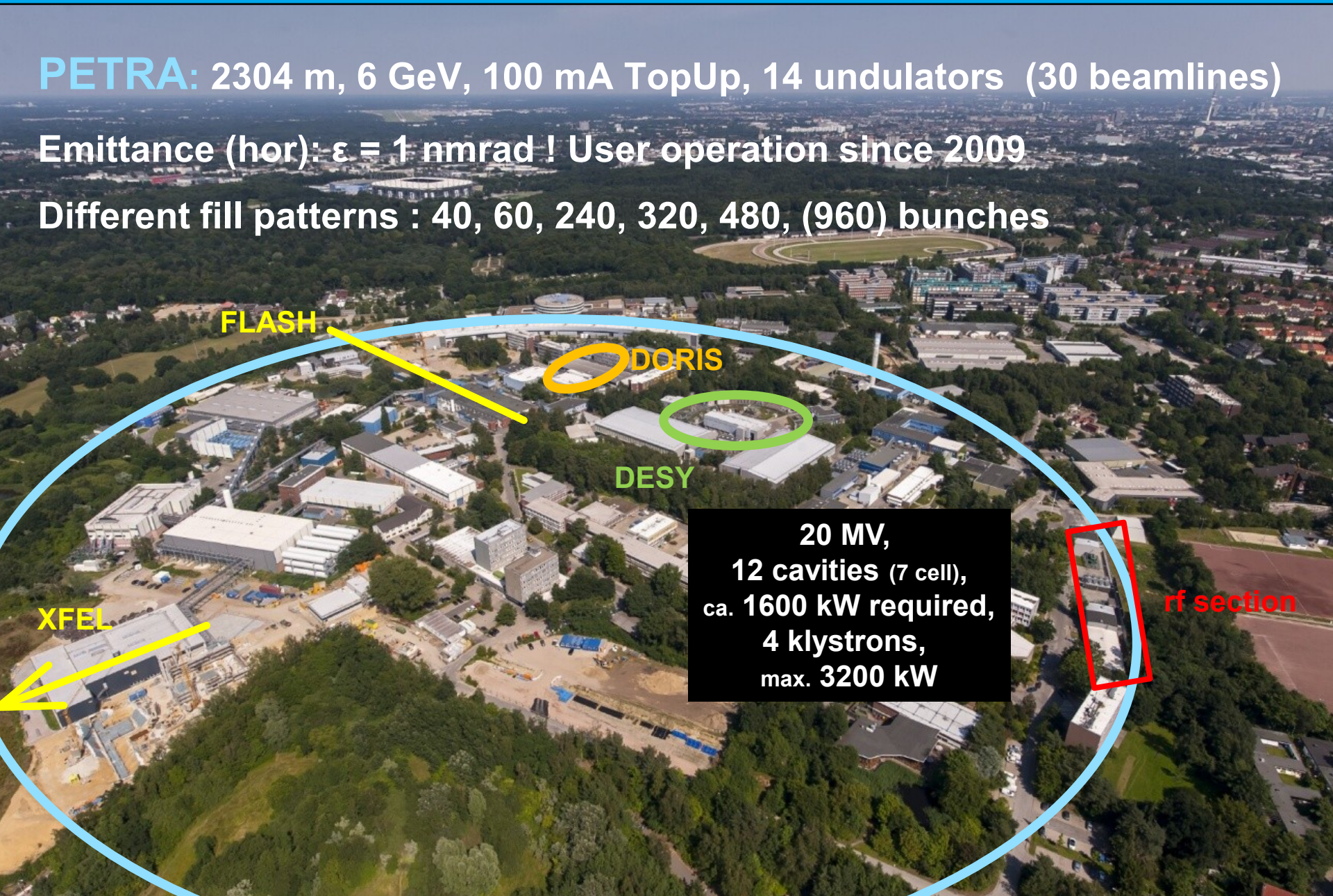


# Short orientation.

**PETRA:** 2304 m, 6 GeV, 100 mA TopUp, 14 undulators (30 beamlines)

Emittance (hor):  $\varepsilon = 1$  nmrاد ! User operation since 2009

Different fill patterns : 40, 60, 240, 320, 480, (960) bunches



FLASH

DORIS

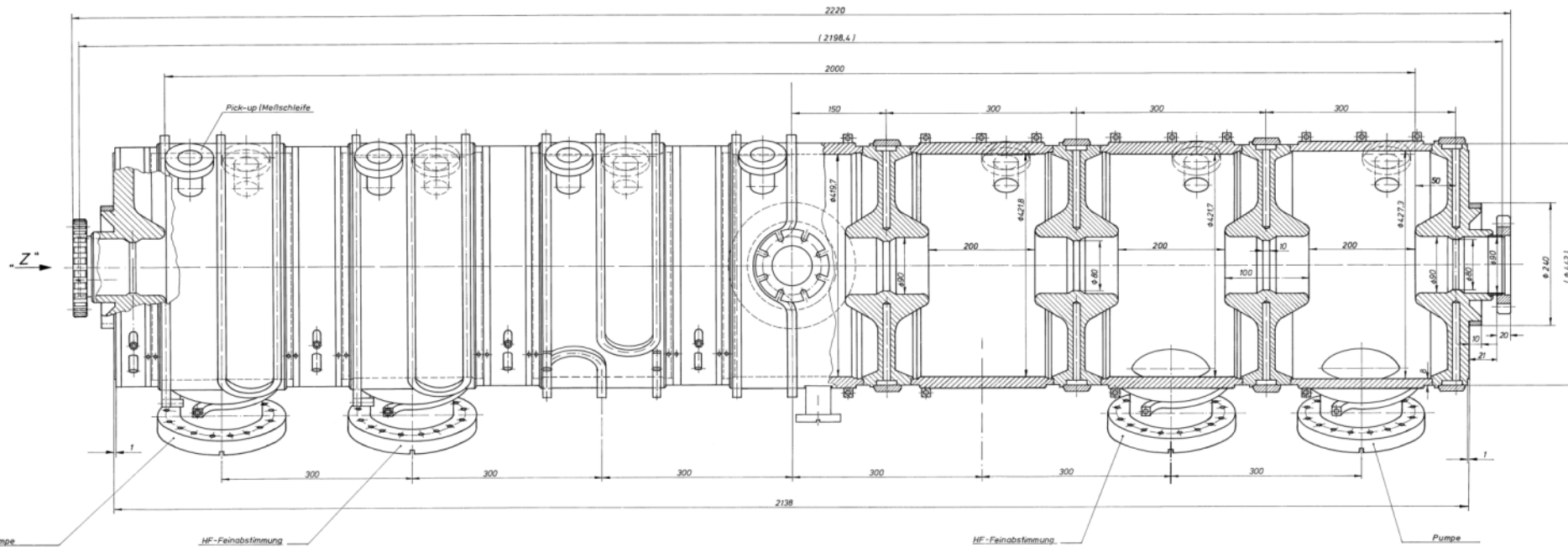
DESY

XFEL

20 MV,  
12 cavities (7 cell),  
ca. 1600 kW required,  
4 klystrons,  
max. 3200 kW

rf section

# 7 cell cavity, 500 MHz.



For PETRA III we re-installed 12 of the old 16 installed 7-cell cavities.

Mainly because of cost reasons.

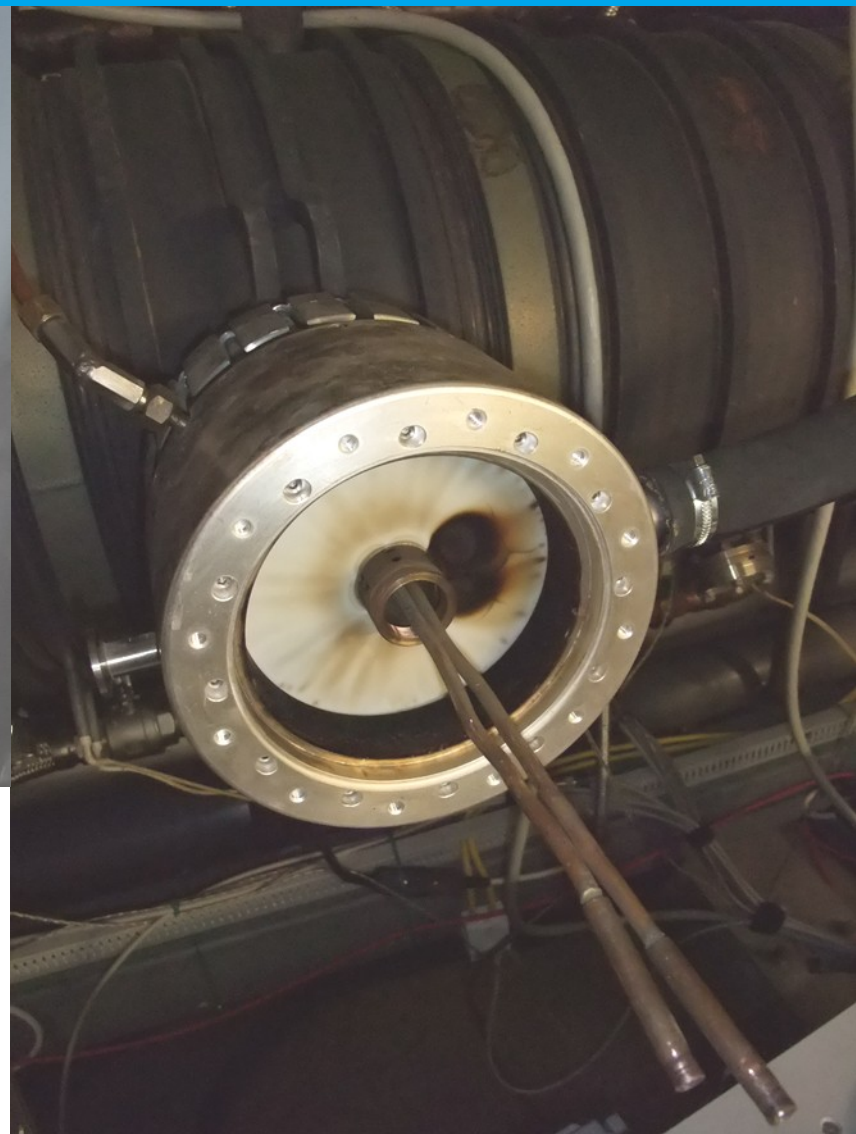
Shunt impedance: ca. 23 MOhm

Band width: ca. 54 kHz

Coupler transmission power: ca. 125 kW

Couplers originally designed for 60 kW,  
but already operated at DORIS 2 up to 120 kW.

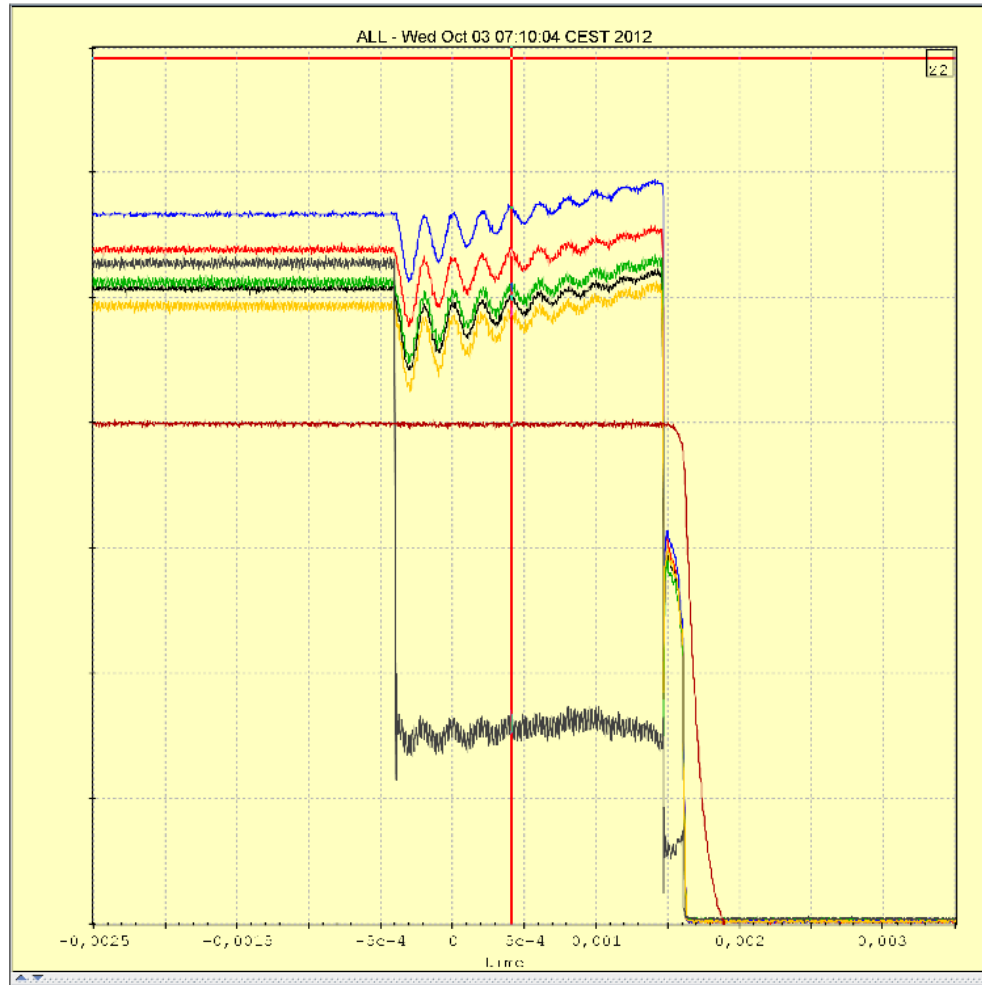
# Strong need to protect the couplers.



This happens on 2010-11-10 at SL\_Cy4:  
An almost broken ceramic.  
Only noticed by a very high difference  
temperature of the cooling air of the  
coupler.

# Sudden voltage breakdown in one cavity.

Watched at different cavities. Here SL\_Cy6



Configurations Browse

Local Configurations

Open Add Save... Load...

Central Configurations

ALL L Cavities

Trigger: mh\_f\_sl1cav\_trc Open Add

Events

882. Wed Oct 03 07:10:04 CEST 2012

RR1 Wed Oct 03 07:10:04 CEST 2012

Number of Events: 883 Refresh

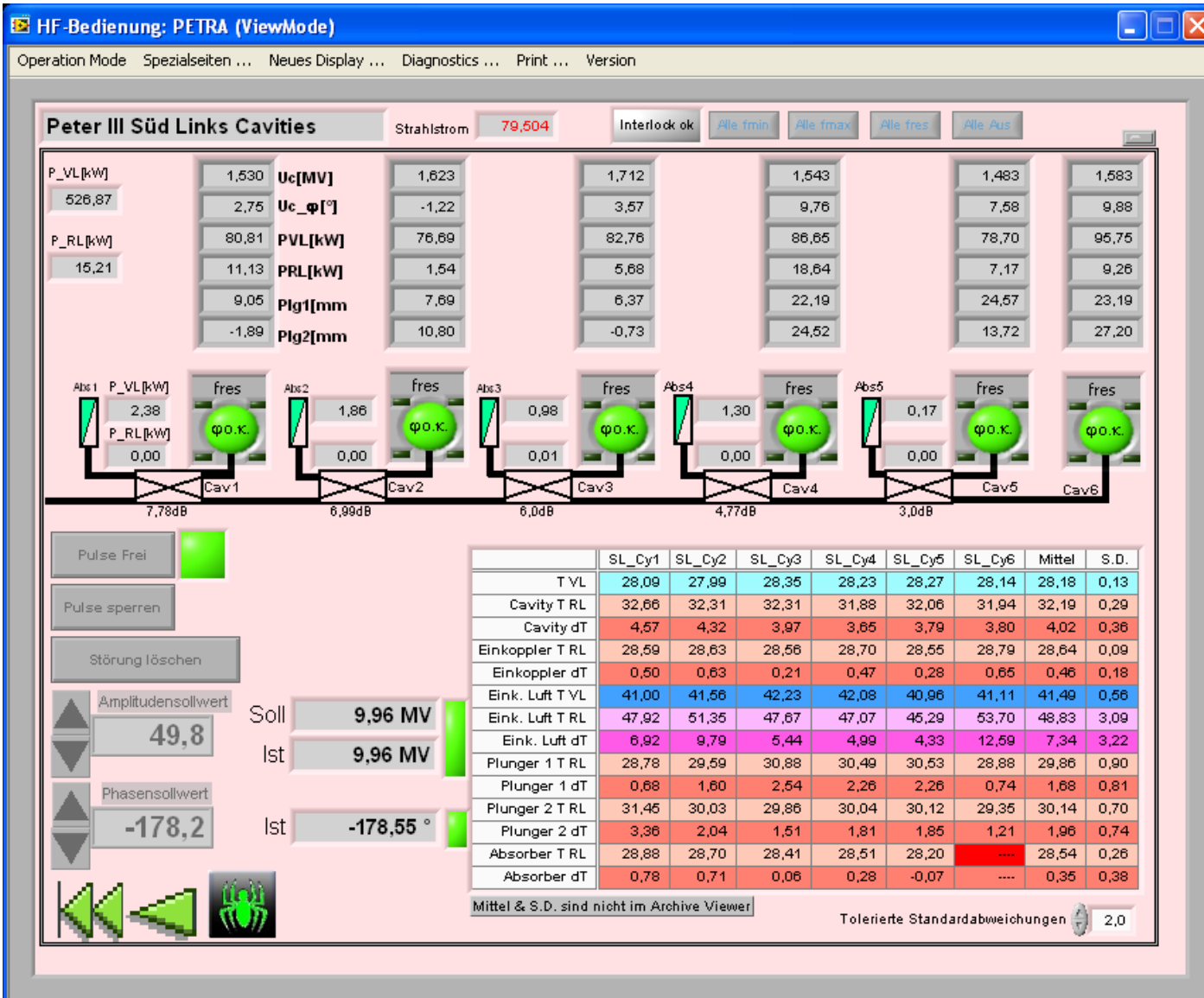
No comment

Keep Update Comment

	St	Device	Evt.	Value	Units
<input checked="" type="checkbox"/>	OK	PE_SL_Cy1/Cavity/U ...	882	1.50E06	V
<input checked="" type="checkbox"/>	OK	PE_SL_Cy2/Cavity/U ...	882	1.61E06	V
<input checked="" type="checkbox"/>	OK	PE_SL_Cy3/Cavity/U ...	882	1.72E06	V
<input checked="" type="checkbox"/>	OK	PE_SL_Cy4/Cavity/U ...	882	1.53E06	V
<input checked="" type="checkbox"/>	OK	PE_SL_Cy5/Cavity/U ...	882	1.48E06	V
<input checked="" type="checkbox"/>	OK	PE_SL_Cy6/Cavity/U ...	882	456.00E3	V
<input checked="" type="checkbox"/>	OK	PE_SL_Control/PETR...	882	0.08	A

Remove Remove All  Autoscale



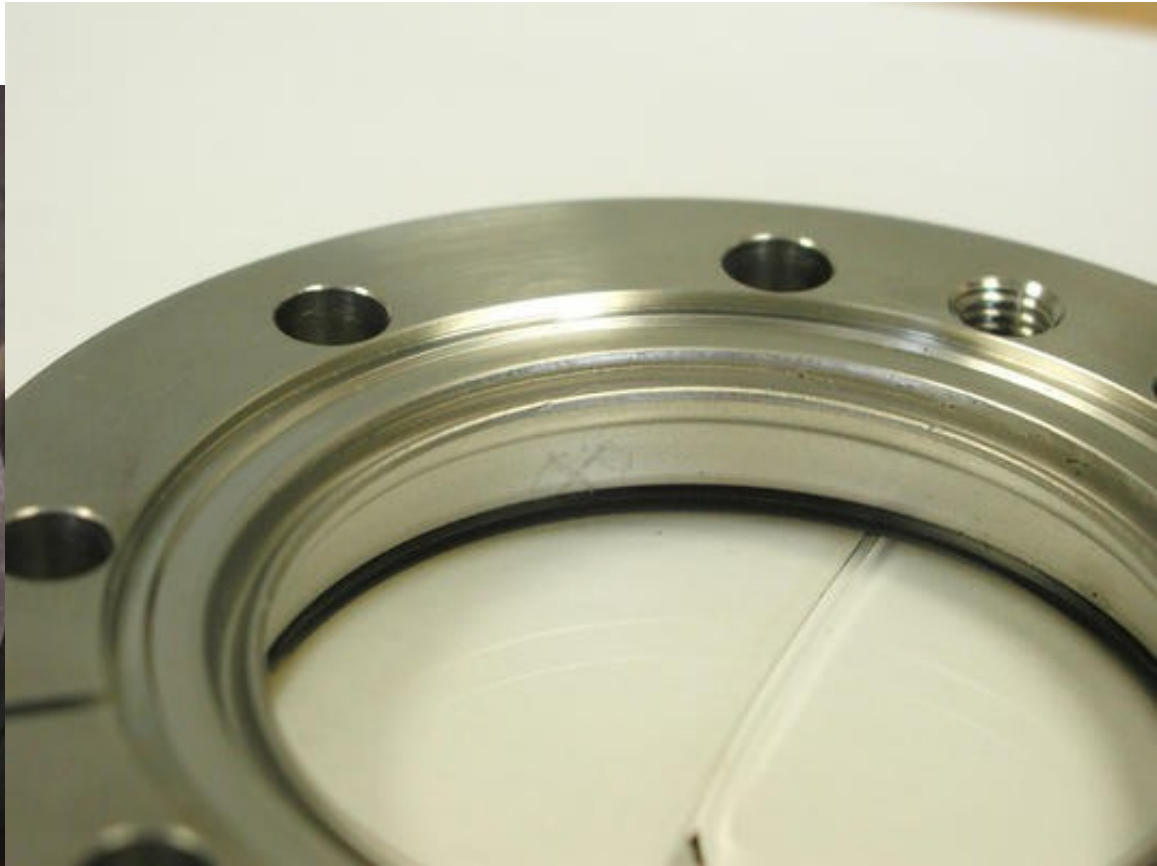


Detection of sparks by looking on fast change of power in absorbers. This fast interlock is done by hardware. Additionally there are light sensors.



# Broken quartz glass window.

> 2011-05-11 at PE\_SR\_Cy3



This was never seen before.  
Reason unknown.



# Individually regulation of cavity temperature.

variation: only max. ca. 3 degree

Cav.Body RL

RL Bypass

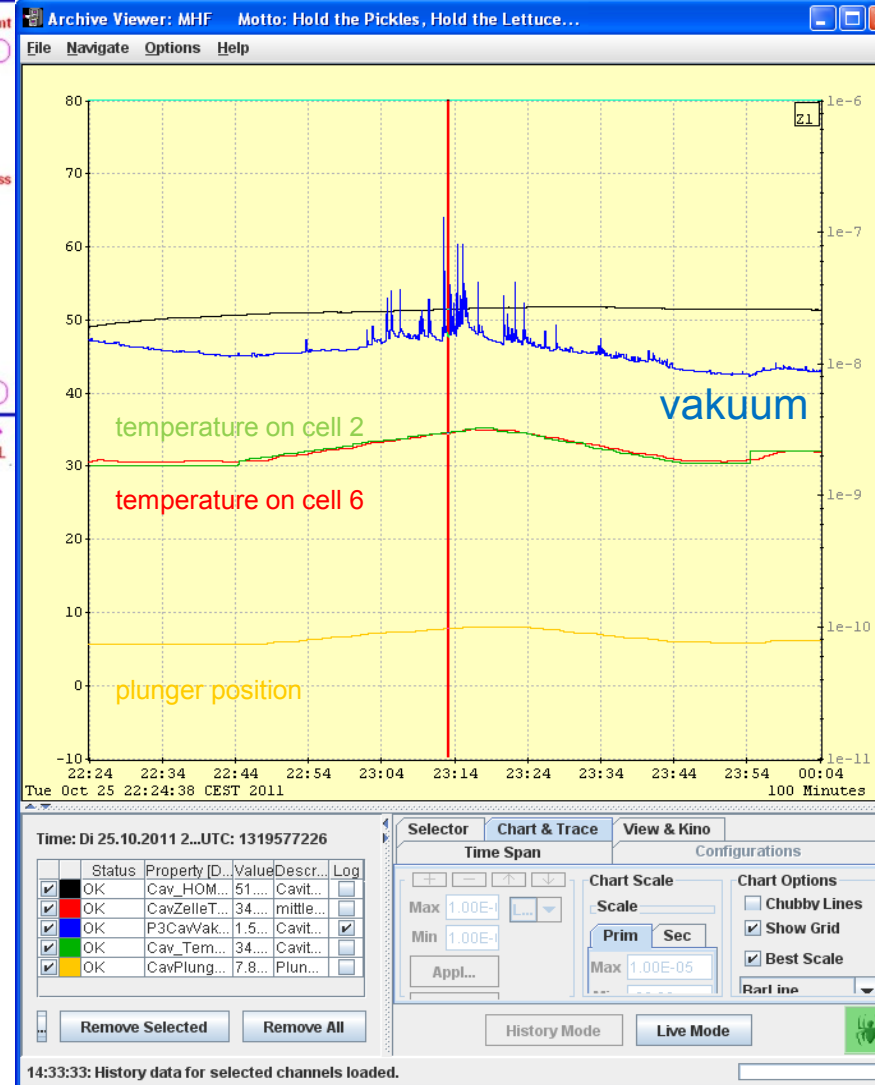
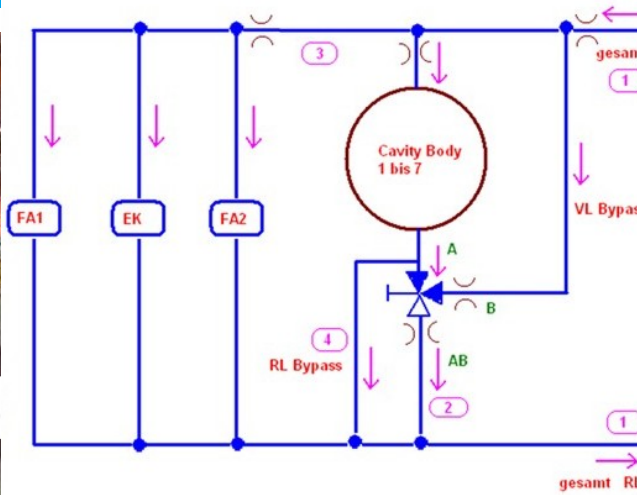
VL Bypass

B

A

AB

RL



At some cavities very strong relation: temp. - vac.



# Temperature maps.

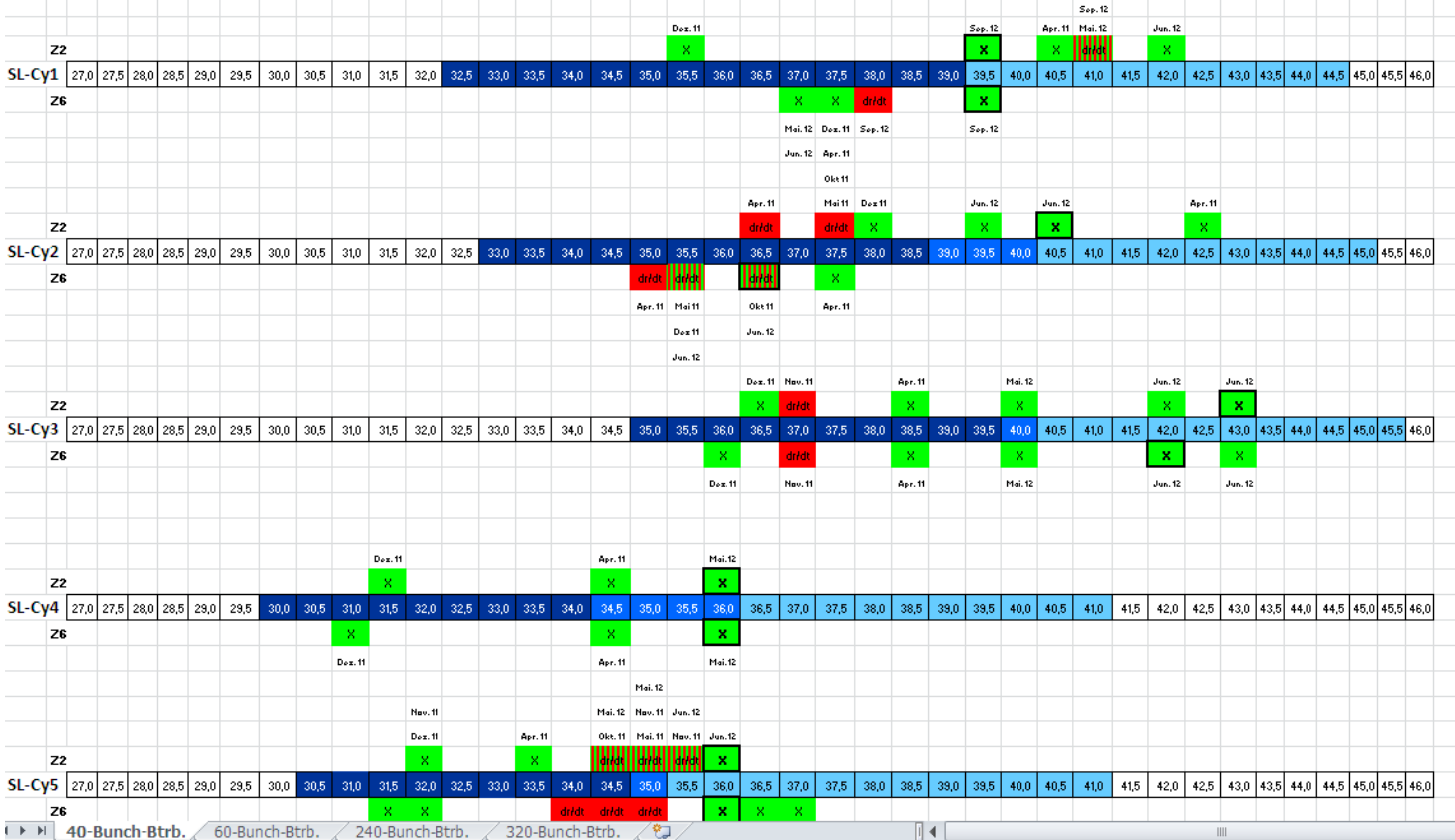
Stand: 03.10.2012

## PETRA-III, 40-Bunch-Betrieb

Geeignete und zu vermeidende Cavity-Temperaturbereiche

- aktuelle Soll-Zellentemperatur
- geeignete Zellentemperatur
- zu vermeidende Zellentemperatur
- ohne klaren Befund abgetaster Temperaturbereich
- bei 22°C KT-Temperatur möglicher Zellentemperaturbereich
- bei 27°C KT-Temperatur möglicher Zellentemperaturbereich

- 507** festgelegter Wert nach Minimierung pi6-Mode
- 720** festgelegter Wert nach Minimierung 720-MHz-Band
- Arc** Ausfall über Lichtdetektor Interlock
- drdt** Ausfall über r-Punkt Interlock
- Rgl** kein Effekt, deshalb T für optimale T-Fglg bei hohem KT-VL festgesetzt
- ToB** festgelegter Wert nach Temp.Tuning o.B.
- Vak** Ausfall über Vakuum-Interlock, bzw. Optimierungskriterium
- vE** Aufweitung der vertikalen Emittanz
- X** ohne Ereignis gewonnener Erfahrungswert (lief bisher gut bei dieser Temp.)
- Ist** derzeit gemessene Zellentemperatur, ob geeignet oder nicht muss sich zeigen



The "best" temperature for each cavities is found empirically. It depends on the number of bunches.



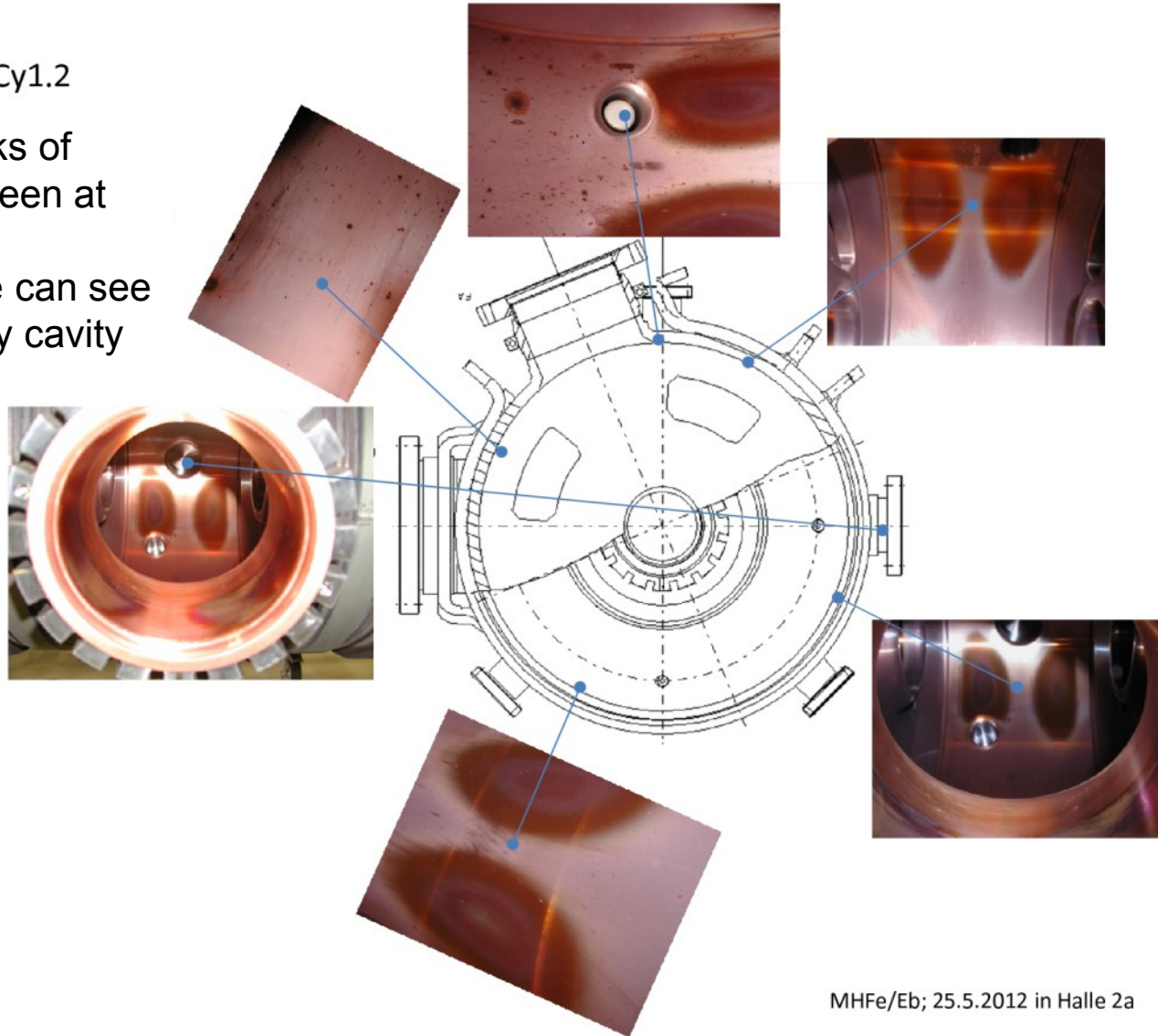
# Pictures from inside a cavity taken by an endoscope.

## Cav #43

ex PETRA-2 Cy1.2

similar marks of  
HOMs (?) seen at  
SR\_Cy3.

Perhaps we can see  
that at every cavity

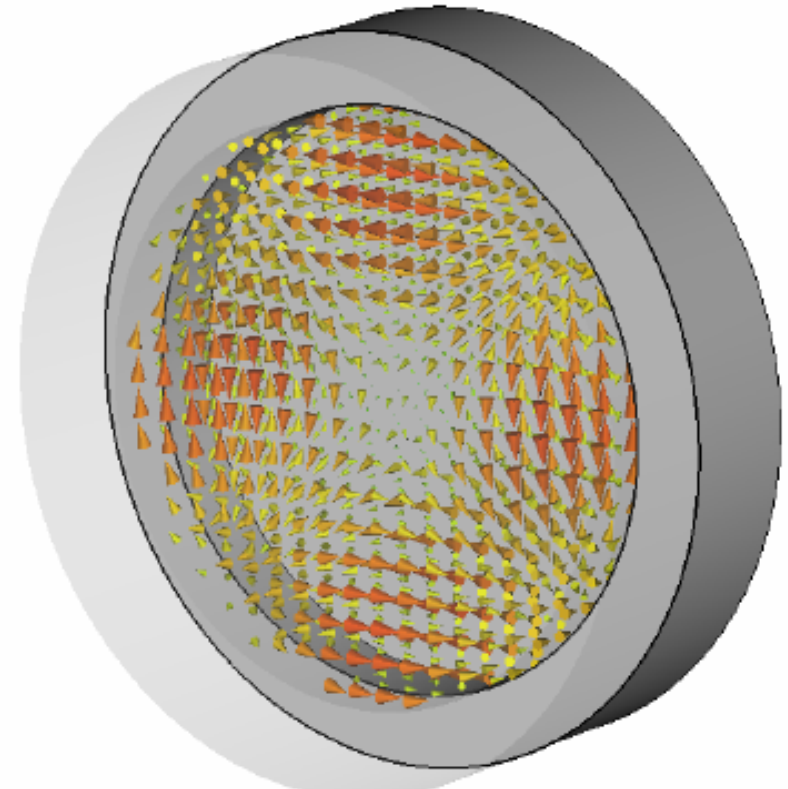
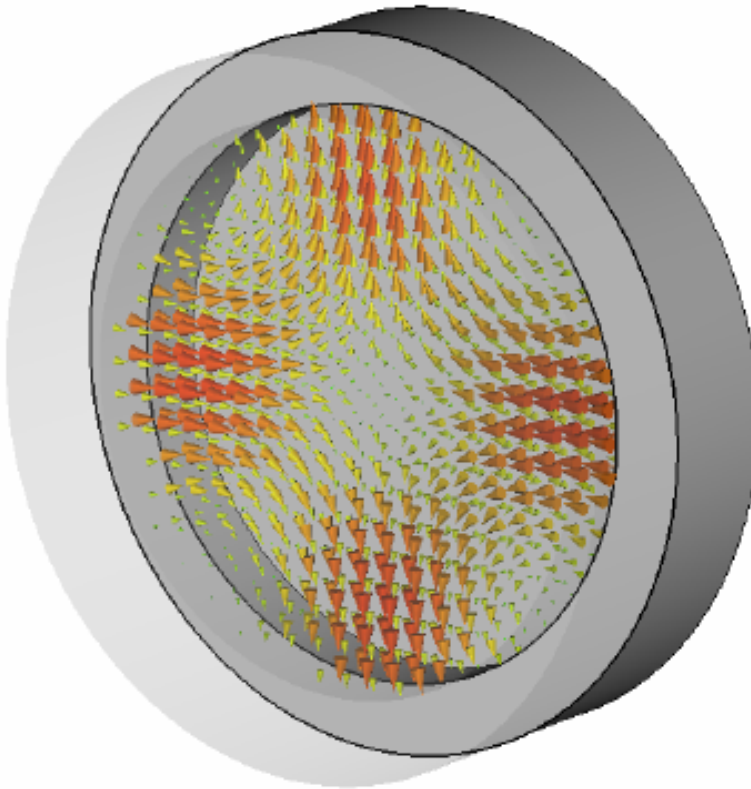


# HOMs? painting mystery.

Electric

magnetic

$TE_{211}$



Is this the responsible mode?  
We need it two times longitudinally!  
 $f = 1,42$  GHz?

pictures from  
W. Hillert, Bonn

# Grey parts on coupler ceramic.

We see this and similar pattern on some other cavities. Also observed at DORIS.

The cavities with that grey ceramics did NOT trip more often!



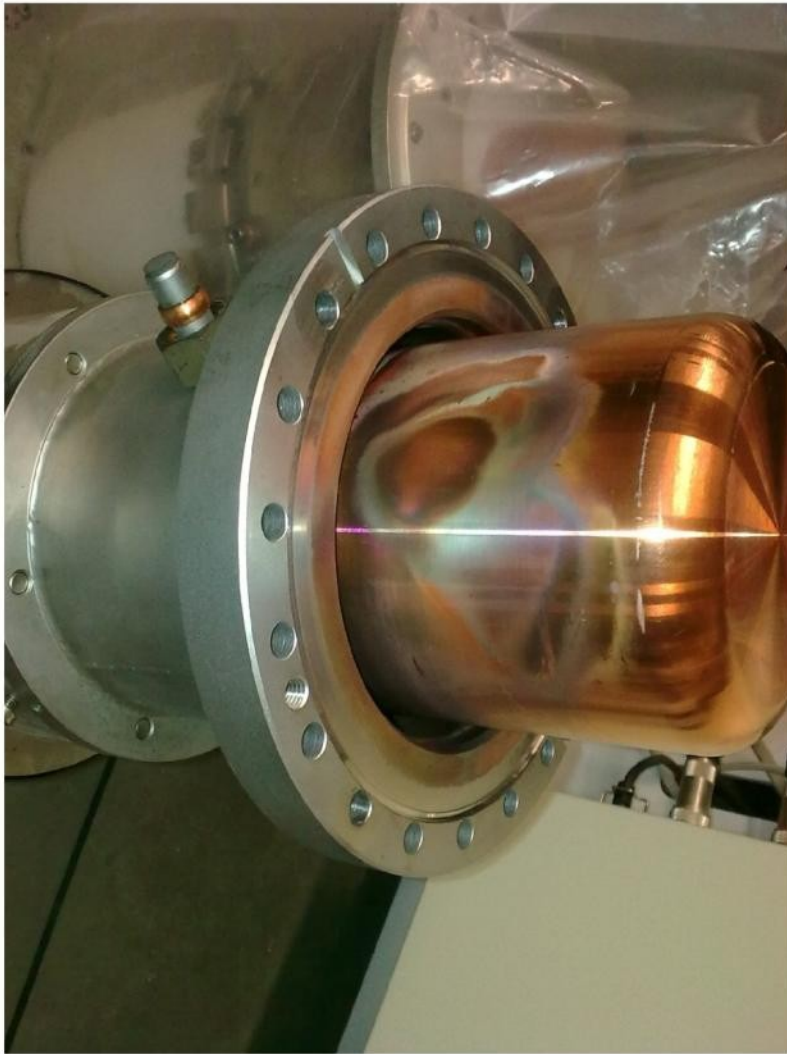
SL\_Cy4



SR\_Cy2

2010-07-07, SL\_Cy2

# Change of coupler and plungers at SR\_Cy3. 2012-04-16.

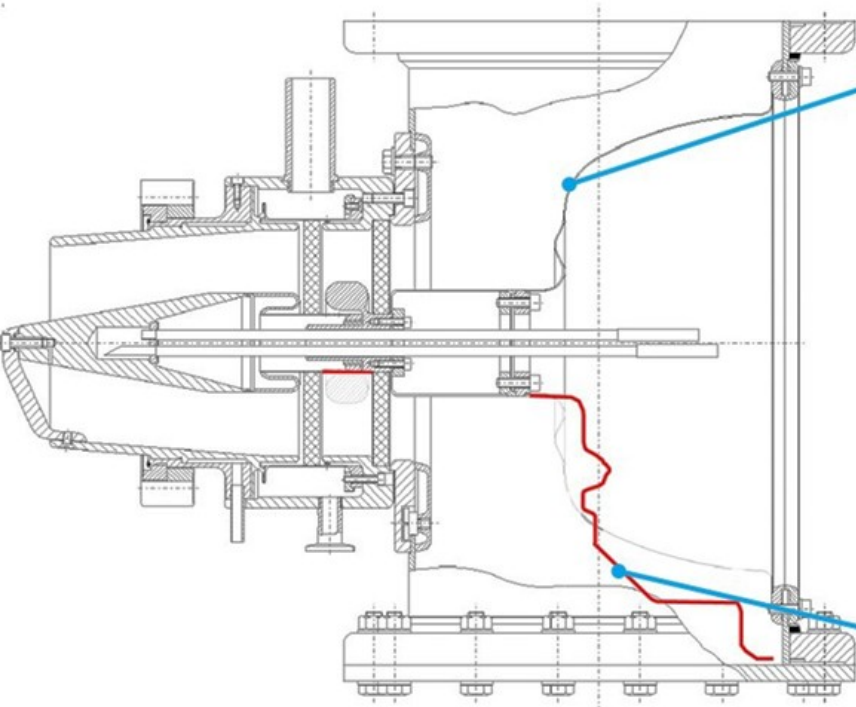


After many trips we changed the coupler and the plungers. One of them looks strange.

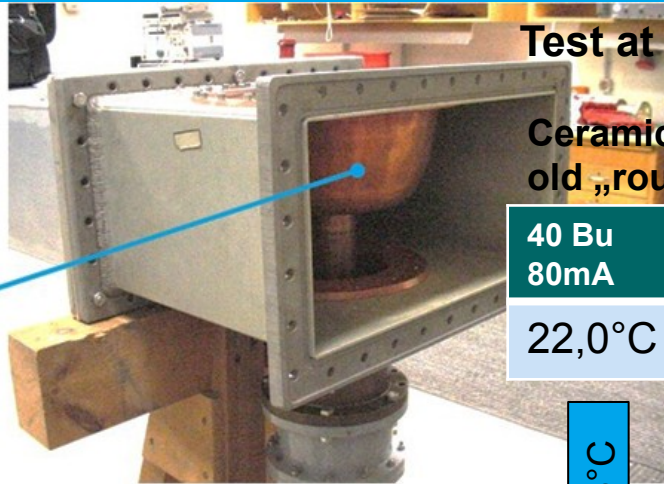


# Better matching with different doorknob.

original: round  
return loss: -7 dB



recovered: angled, multi steps:  
return loss: -33 dB



Test at SR\_Cy6:

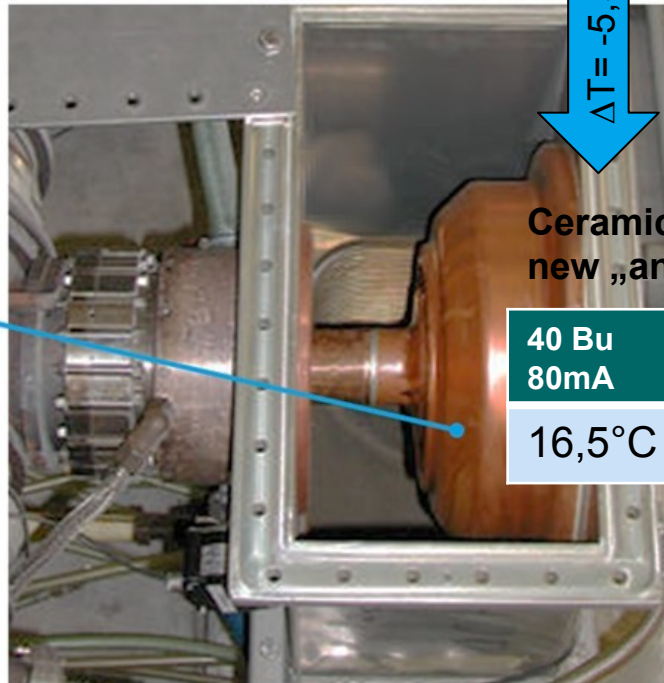
Ceramic window- $\Delta T$  with old „round“ doorknob

40 Bu 80mA	60Bu 100mA	240Bu 100mA
22,0°C	21,8°C	17,4°C

$\Delta T = -5,5^\circ\text{C}$

$\Delta T = -3,1^\circ\text{C}$

$\Delta T = -5,1^\circ\text{C}$



Ceramic window- $\Delta T$  with new „angled“ doorknob)

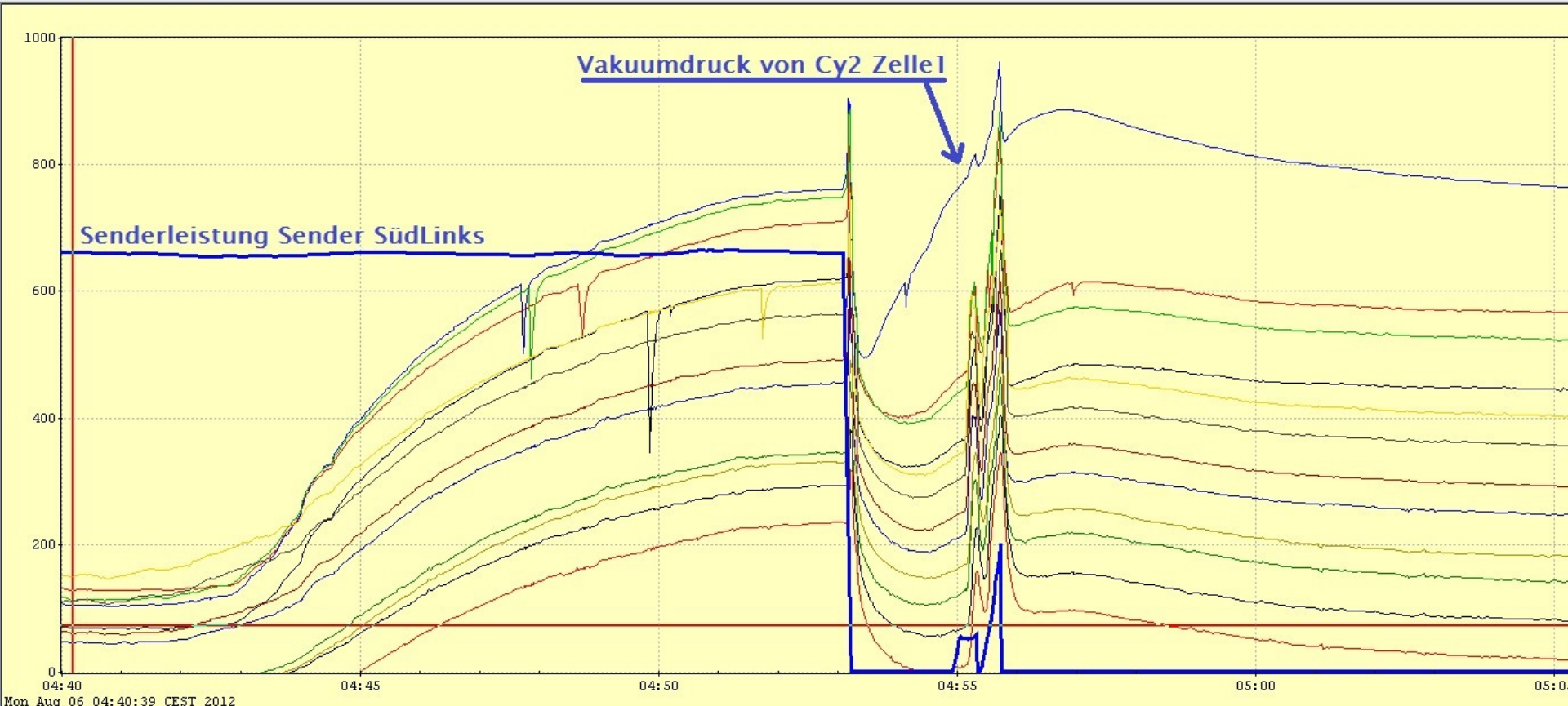
40 Bu 80mA	60Bu 100mA	240Bu 100mA
16,5°C	18,7°C	12,3°C



# vacuum event.

Archive Viewer: PETRA/Diagnostics Motto: Hold the Pickles, Hold the Lettuce...

File Navigate Options Help



Mon Aug 06 04:40:39 CEST 2012

Time: Mo 06.08.2012 04:40:50.681 MESZ

UTC: 1344220850

Status	Property [Device]	Value	Description	Log
OK	CavWakuum [VakSL_Cy1_Z1]	1.61E-09 mbar	Cavity Vakuuum in mbar	<input checked="" type="checkbox"/>
OK	CavWakuum [VakSL_Cy1_Z7]	2.43E-09 mbar	Cavity Vakuuum in mbar	<input checked="" type="checkbox"/>
OK	CavWakuum [VakSL_Cy2_Z1]	2.06E-09 mbar	Cavity Vakuuum in mbar	<input checked="" type="checkbox"/>
OK	CavWakuum [VakSL_Cy2_Z7]	2.17E-09 mbar	Cavity Vakuuum in mbar	<input checked="" type="checkbox"/>
OK	CavWakuum [VakSL_Cy3_Z1]	2.83E-09 mbar	Cavity Vakuuum in mbar	<input checked="" type="checkbox"/>
OK	CavWakuum [VakSL_Cy3_Z7]	2.15E-09 mbar	Cavity Vakuuum in mbar	<input checked="" type="checkbox"/>
OK	CavWakuum [VakSL_Cy4_Z1]	1.52E-09 mbar	Cavity Vakuuum in mbar	<input checked="" type="checkbox"/>
OK	CavWakuum [VakSL_Cy4_Z7]	1.37E-09 mbar	Cavity Vakuuum in mbar	<input checked="" type="checkbox"/>
OK	CavWakuum [VakSL_Cy5_Z1]	8.84E-10 mbar	Cavity Vakuuum in mbar	<input checked="" type="checkbox"/>
OK	CavWakuum [VakSL_Cy5_Z7]	8.75E-10 mbar	Cavity Vakuuum in mbar	<input checked="" type="checkbox"/>
OK	CavWakuum [VakSL_Cy6_Z1]	8.69E-10 mbar	Cavity Vakuuum in mbar	<input checked="" type="checkbox"/>
OK	CavWakuum [VakSL_Cy6_Z7]	5.78E-10 mbar	Cavity Vakuuum in mbar	<input checked="" type="checkbox"/>
OK	TX-VorlaufLeistung [SenderLinks]	661.49 kW	Sender VorlaufLeistung (RK03) in kW	<input type="checkbox"/>

Time Span Configurations Selected Trace: TX-VorlaufLeistung

Max 1600.00 Min 0.00

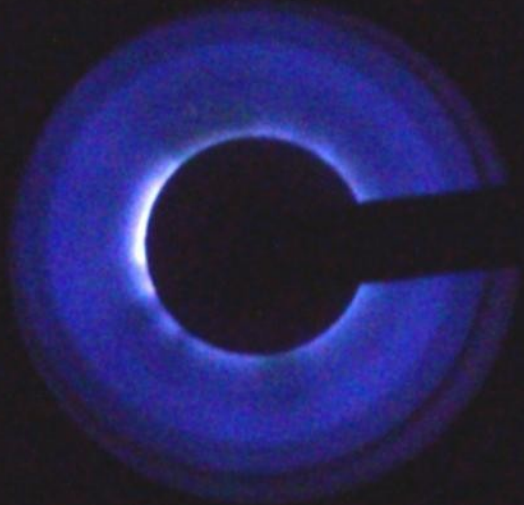
Apply Scale Default Scale

Remove



# Blue light.

2012-08-06:  
at SL\_Cy2  
starts at ca. 8 kW  
but did not expire  
up to ca. 35 kW



2011-05-25:  
only at cavity SL\_Cy4  
ca. 30 kW, tuned  
light expired at ca. 38 kW



# Removed coupler from SL\_Cy2.



2012-08-07

The last one.



Thank you!

