Behavior of the TTF2 RF Gun with long pulses and high repetition rates (TESLA note 2003-33)

Jean-Paul Carneiro
DESY Hamburg

TESLA COLLABORATION MEETING

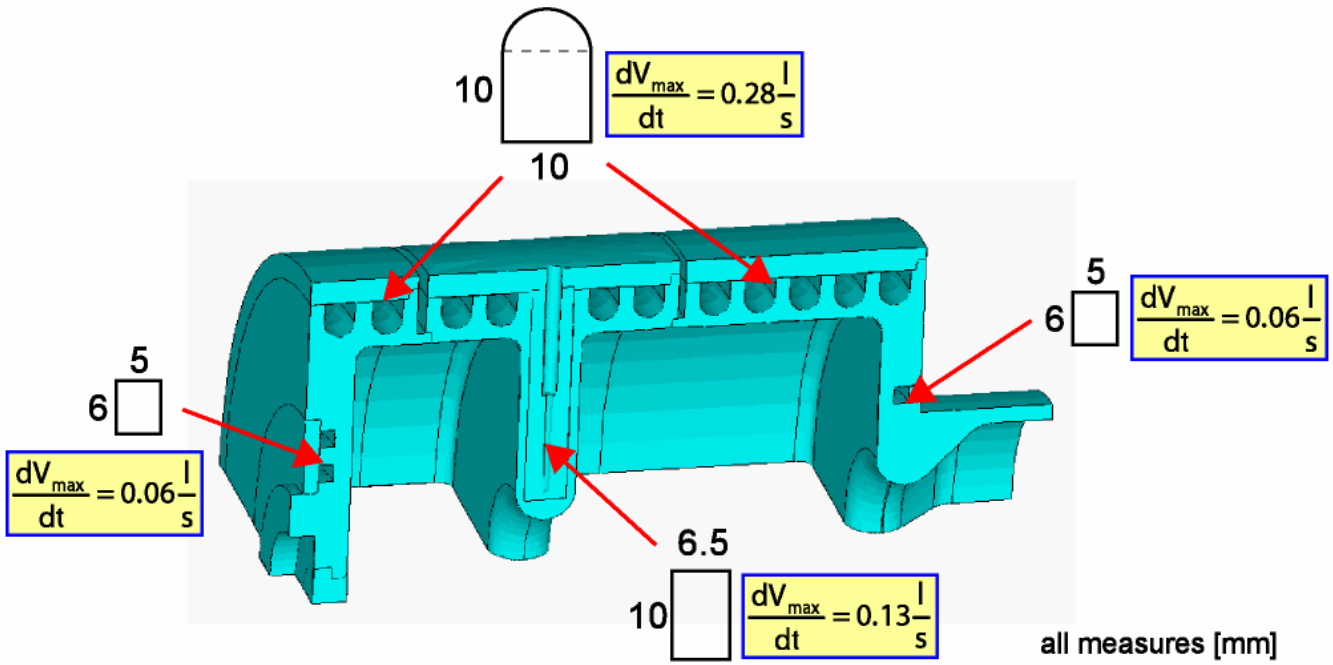
DESY Zeuthen, 22 Jan 2004

TTF2 RF GUN SCHEMATIC (ANSYS, F. Marhauser)

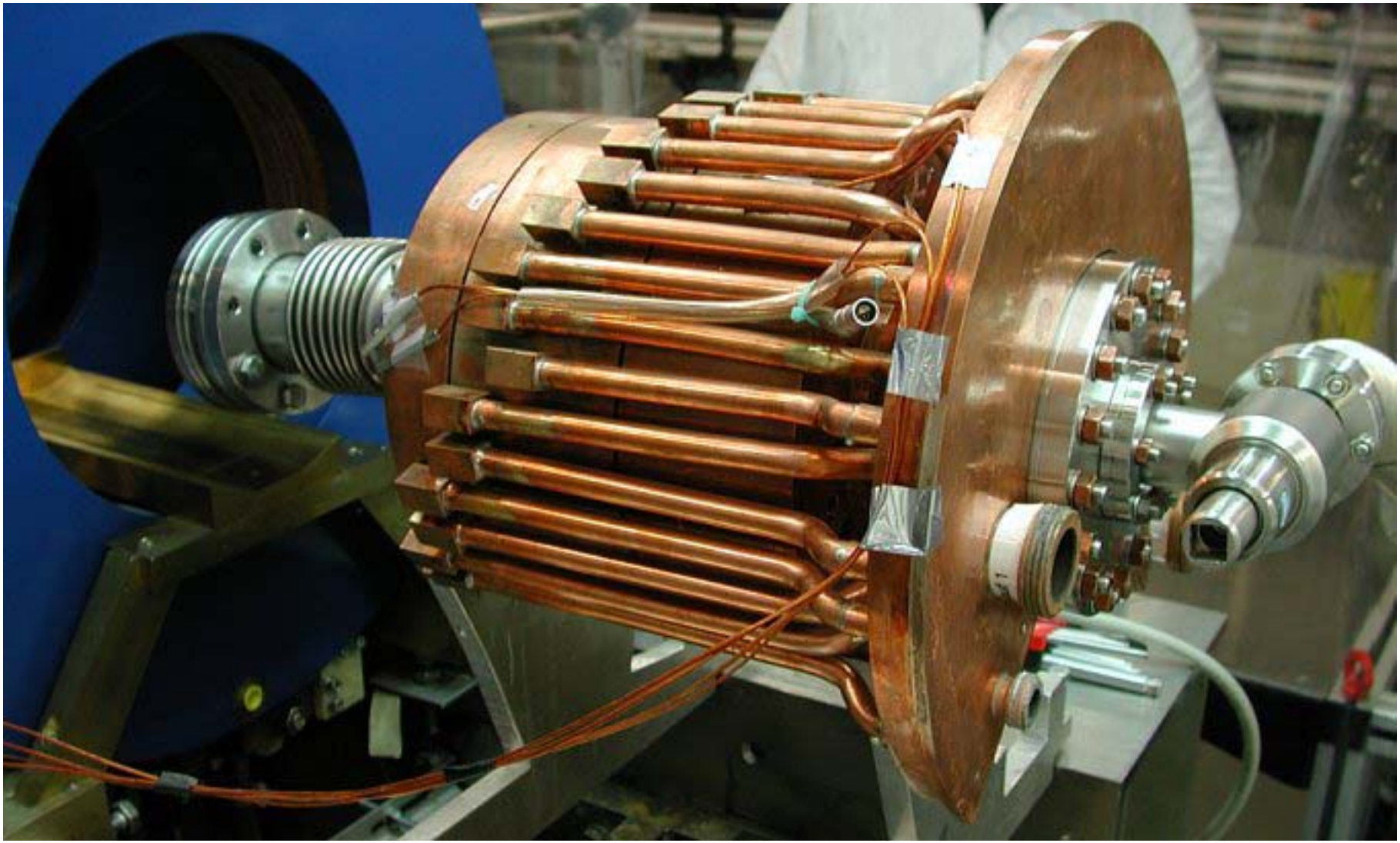
- **14 water channels (1 in the back plane going twice around, 4 around the half cell, 7 around the full cell, 1 in the front plane and 1 in the iris making three loops around it)**

- **Max. water flow rate per channel:** $\frac{dV}{dt} = v_{\max} \cdot A_c$ **with** $v_{\max}$ **max. flow velocity and** A_c **channel cross section**

- **Total Maximum water flow rate :** $\sum_{i=1}^{14} \frac{dVi,\max}{dt} = 3.33\,[l/s] \Leftrightarrow \approx 12\ m^3/h$ **with** $v_{\max} = 2.0\,[m/s]$



TTF2 RF GUNAT PITZ

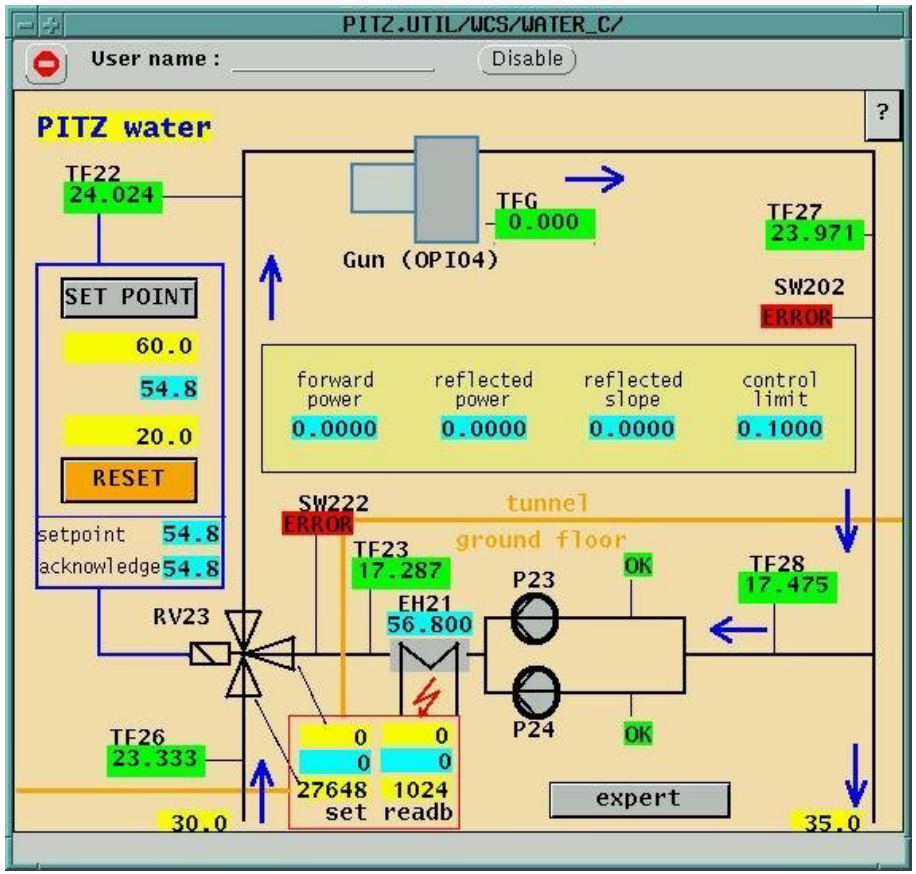


INSTALLATION

• We operated at PITZ the TTF2 RF gun with 27 kW of mean power (10 Hz, 3 MW, 900 µs) which fulfils the TTF2 specifications

	ZEUTHEN	HAMBURG
• We operated without interlock on the reflected power coming from the RF gun		**• OK**
• The waveguides from the circulator to the RF gun window was filled with SF6 in order to avoid sparks		**• In preparation**
• Water temp. :	**Set Point 58 C to 61 C** **Incoming 58 C to 48 C** **Outgoing 58 C to 52 C** **Stability 0.1 C**	**• OK**
• Water flow :	**Estimated : ~1.5 l/s** **(water flow meter being installed at PITZ)**	**• Up to 3.6 l/s**

PITZ WATER SYSTEM

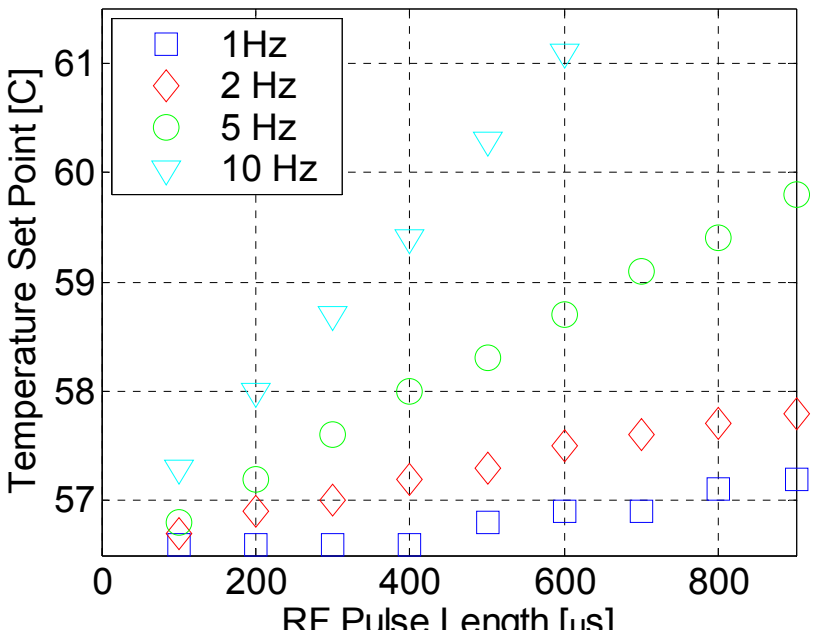


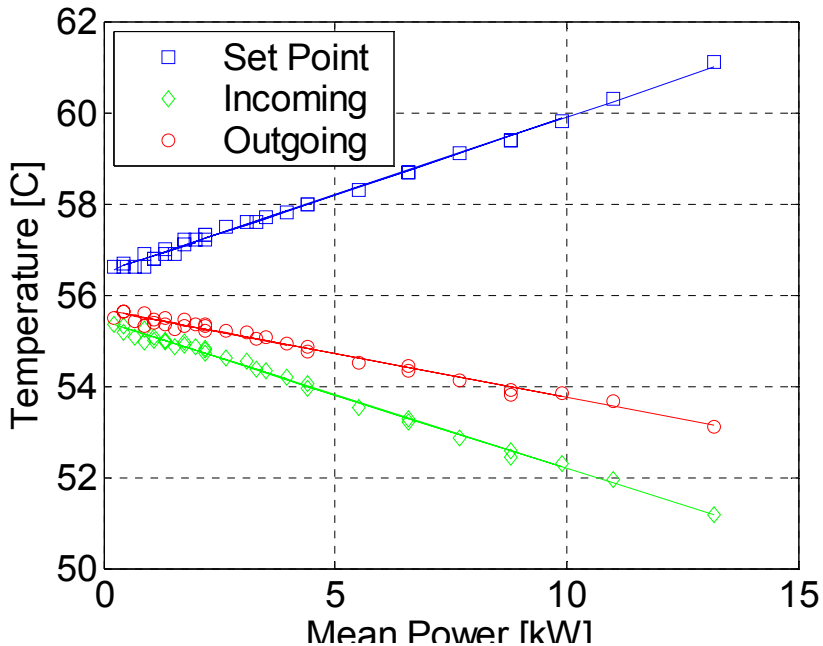
Up to 13.2 kW (10 Hz, 600 µs, 2.2 MW)

- **At 10 Hz, 500 µs, 2.2 MW ΔT=(53.7 C-51.9 C)=1.8 C**

$$\Rightarrow \dot{V} = \frac{P}{\rho_{H_2O} \cdot C_p \cdot \Delta T} \cong 1.46\, l/s \quad (\rho_{H2O} = 1000\, Kg \cdot m^{-3},\ C_p = 4186.8\, J \cdot Kg^{-1} \cdot K^{-1})$$

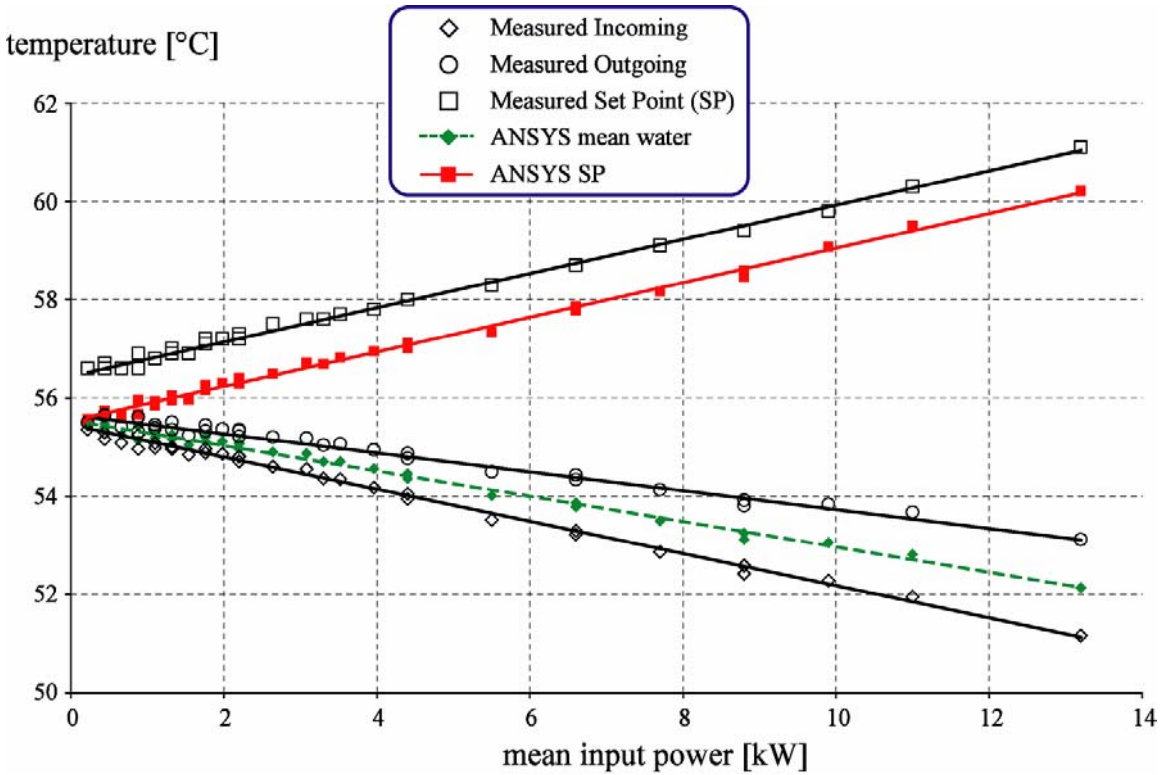
$$\Rightarrow v = 0.8\, m \cdot s^{-1}$$





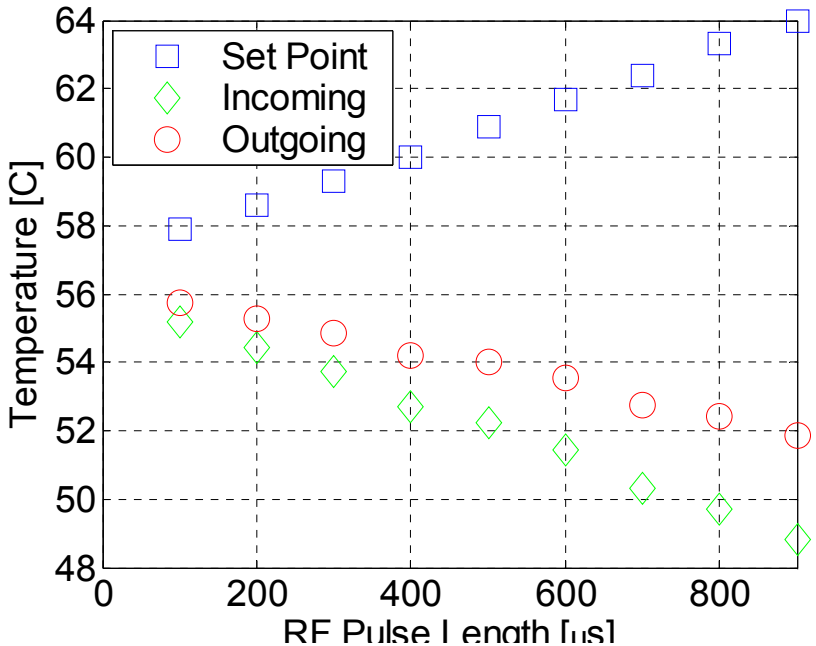
Up to 13.2 kW / Comparison with ANSYS simulations

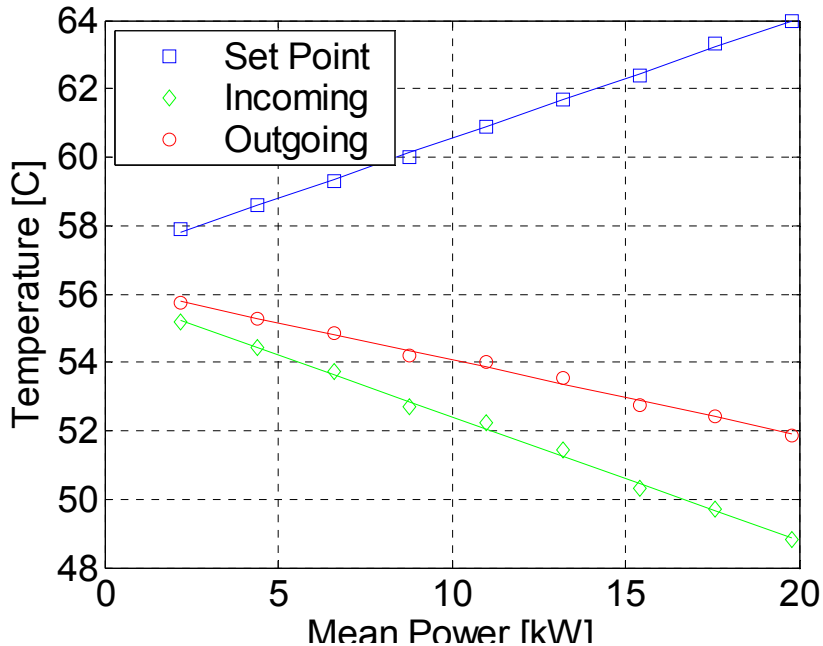
Water velocity (from ANSYS) : $v = 0.86\ m \cdot s^{-1}$



Up to 20 kW (10 Hz, 900 µs, 2.2 MW)

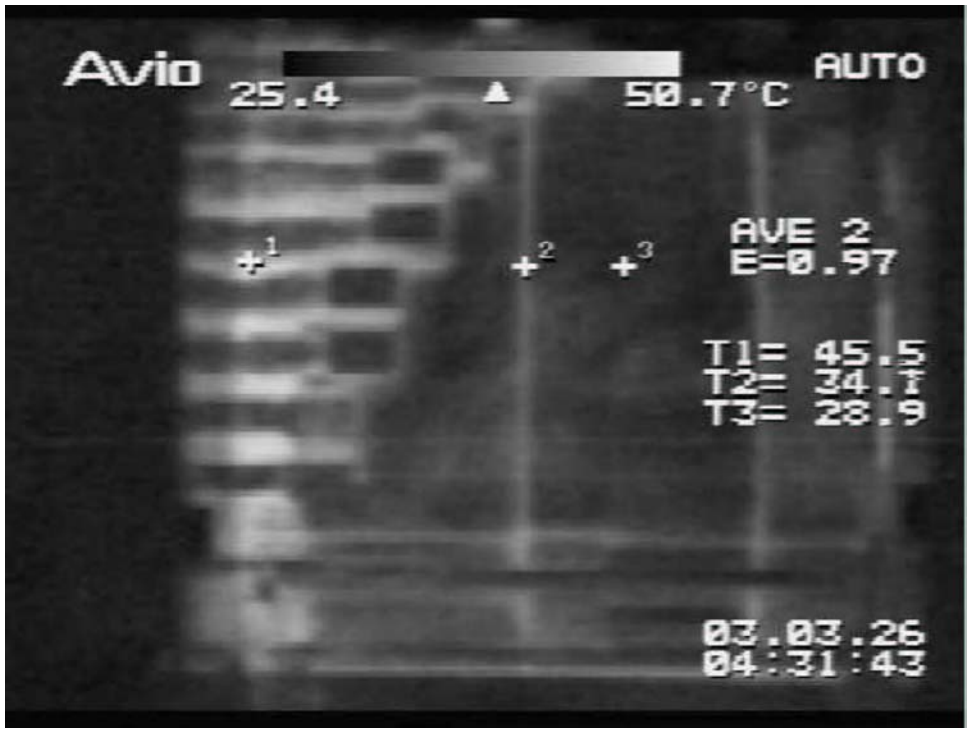
• **Max Set Point Temp. of 64 C reached at ~ 20 kW. To go at higher mean power we decided to slightly remove the temp. probe in the iris.**





Infrared camera observation of the RF Gun (10 Hz, 800 µs, 2.2 MW)

- **Channels temp. stable at ~ 45.5 C, iris at ~35 C, body and waveguide at ~30 C while going from P=2.2 kW to P=17.6 kW.**



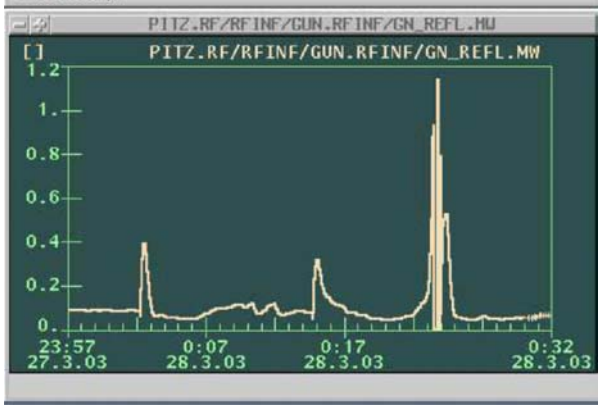
STABILIZATION OF THE TEMPERATURE

- **Stable operation going from 200 µs to 500 µs at 2.2 MW, 10 Hz reached in less than 5 mn.**
- **Should avoid getting more than 500 kW of reflected power.**
- **Easier to warm up the cavity rather than to cool it down.**

From 200 µs to 500 µs to 800 µs
(2.2 MW, 10 Hz)

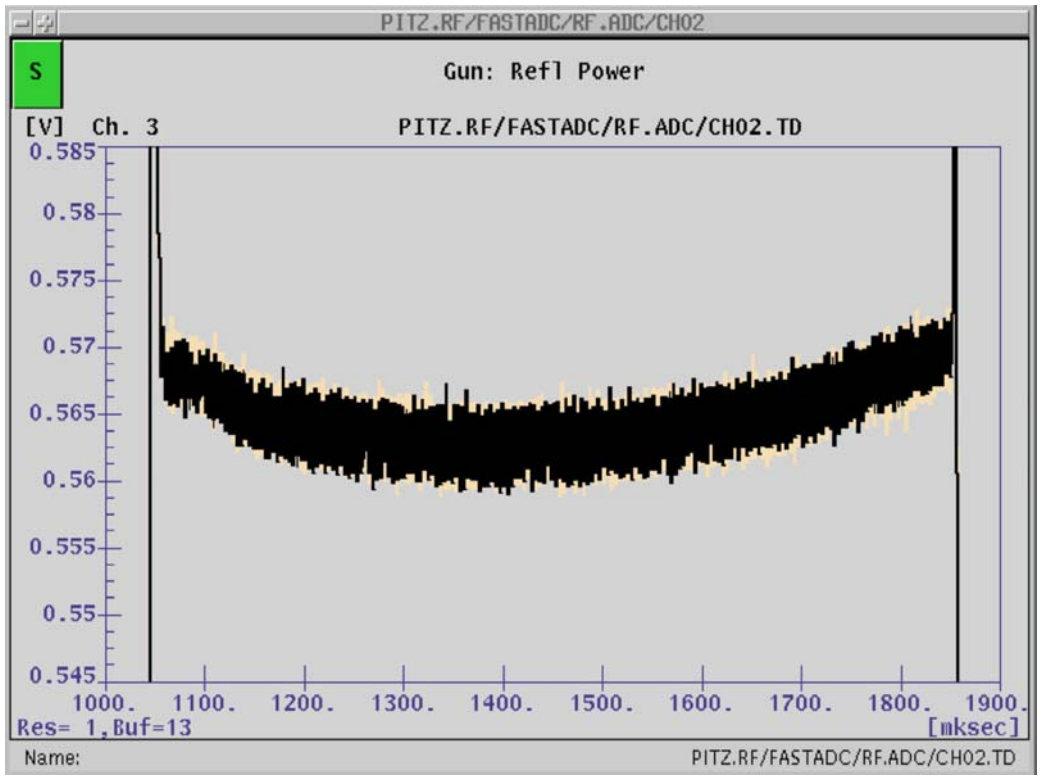
Temperature (SP) →

Reflected Power →



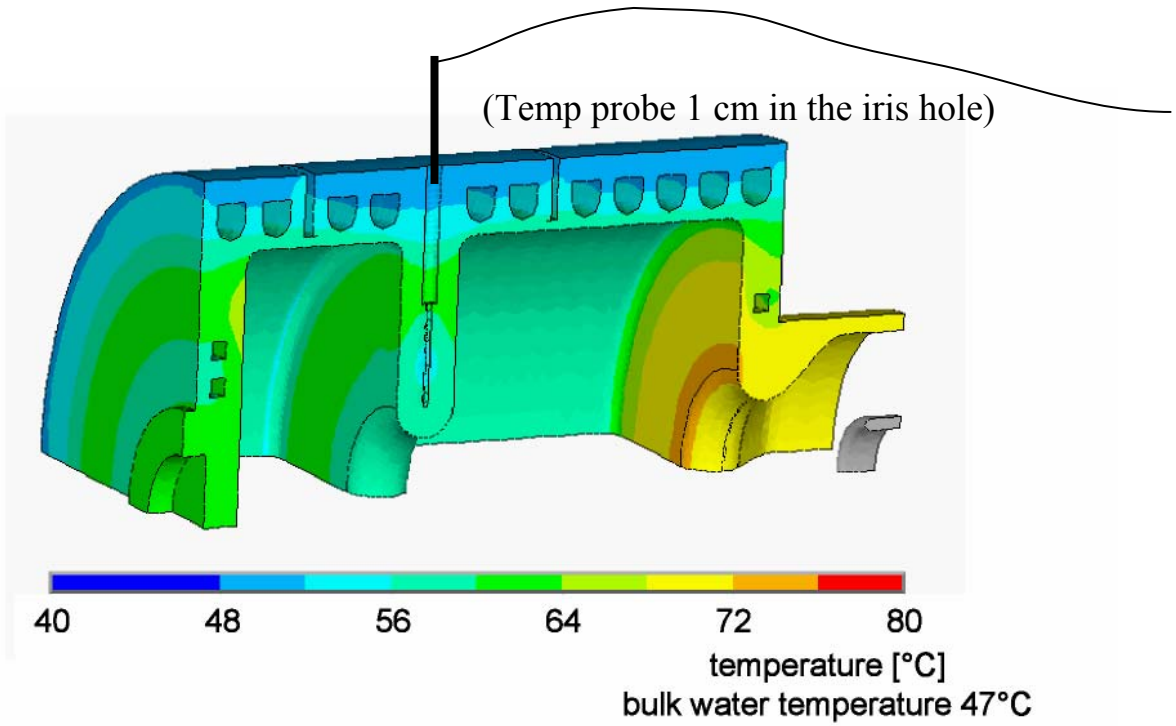
DETUNING OF THE RF GUN WITH LONG RF PULSES

Reflected power



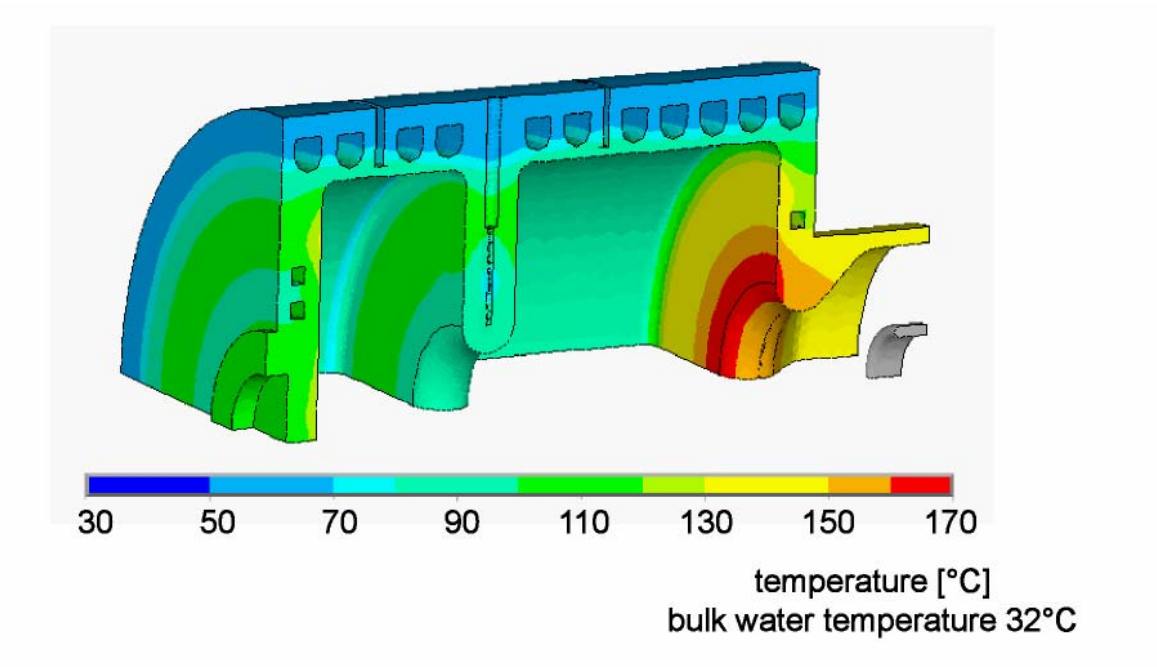
ANSYS SIMULATION AT 27 kW OF MEAN POWER

- We operated at PITZ the TTF2 RF gun at 10 Hz, 900 μs, 3.0 MW. Stable operation could be reached for ~ 2/3 minutes then vacuum interlocks. More conditioning is still needed at this mean power.



TOWARDS 50 HZ OPERATION (~130 kW MEAN POWER)

- At 50 Hz operation, ANSYS predicts temperatures in the waveguide iris of ~170 C and stresses of ~130 MPa which are not tolerable.
- The operation of the RF Gun at 50 Hz would necessitate adding more cooling channels.
- At 50 Hz, Cs2Te photocathode temp. is expected at 120 C which is OK.



RESUME

- **The TTF2 RF gun has been successfully tested at PITZ for 27 kW of mean power.**
- **More conditioning is needed at 27 kW of mean power to avoid vacuum interlocks.**
- **Compensation of the RF detuning should be tested.**

Aknowledgment

K. Floettman, O. Krebs, S. Schreiber, **DESY Hamburg**

J. Baehr, I. Bohnet, J.H. Han, M. Krasilnikov, D. Lipka, V. Miltchev, A. Oppelt, B. Petrossyan, F. Stephan, **DESY Zeuthen**

M. v. Hartrott, F. Marhauser, **BESSY Berlin**