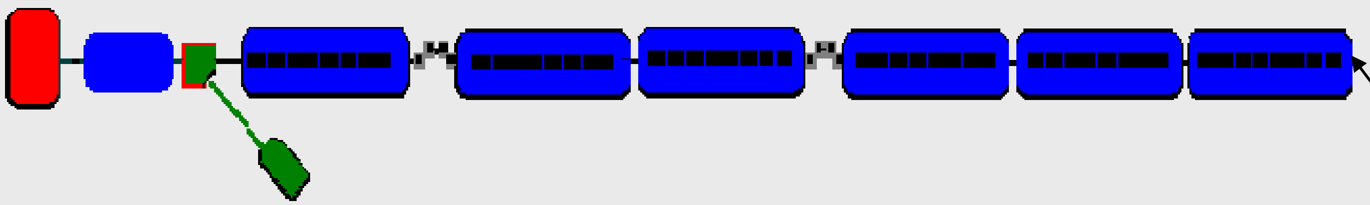
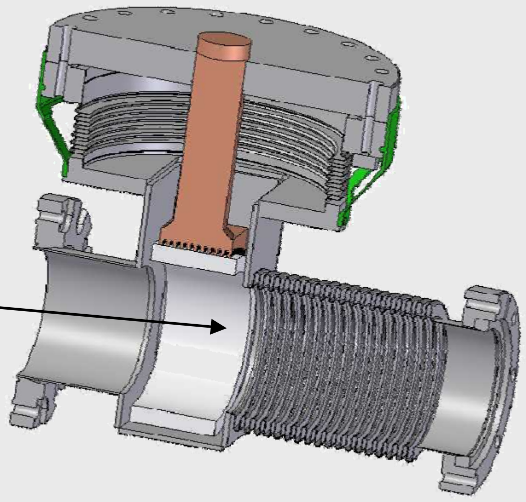
Beam Line Absorber;

First Beam Test at FLASH
September 25th, 2008

J. Sekutowicz

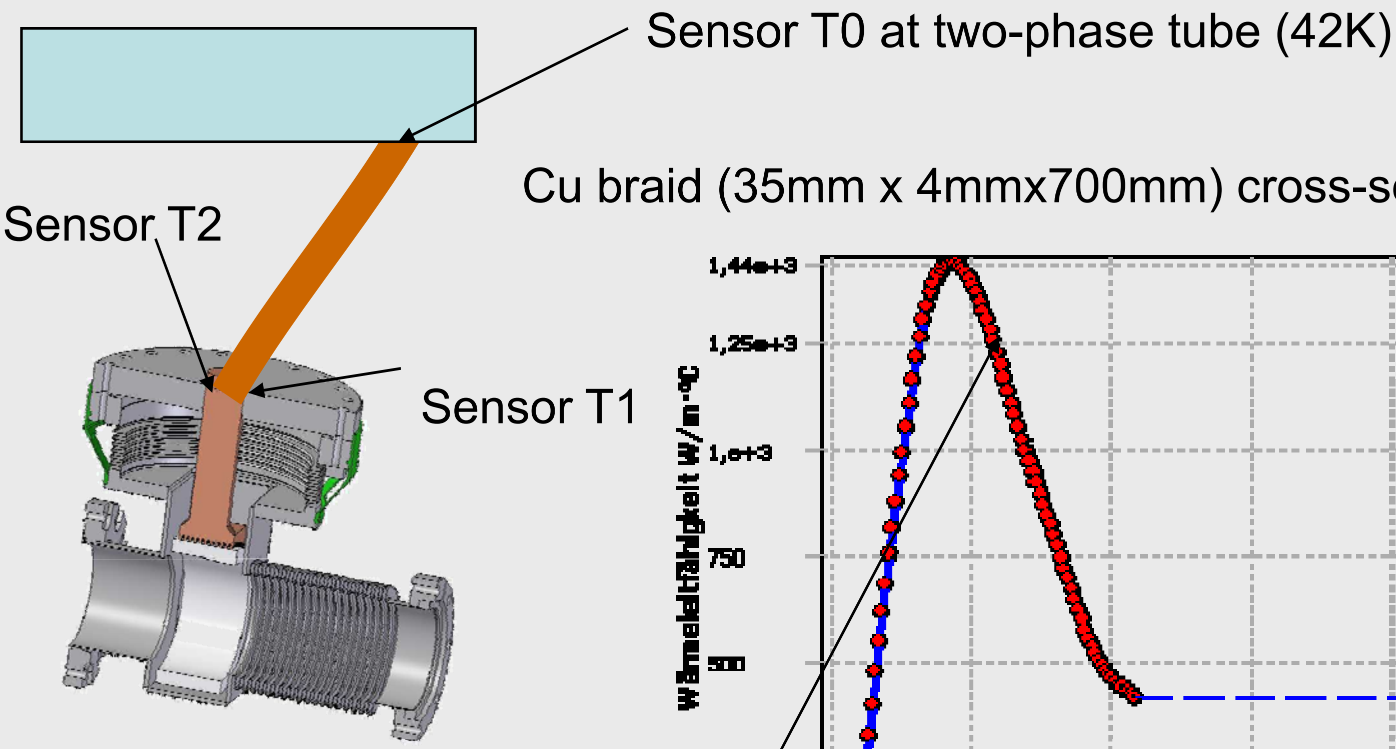
Location of the BLA prototype in the FLASH linac



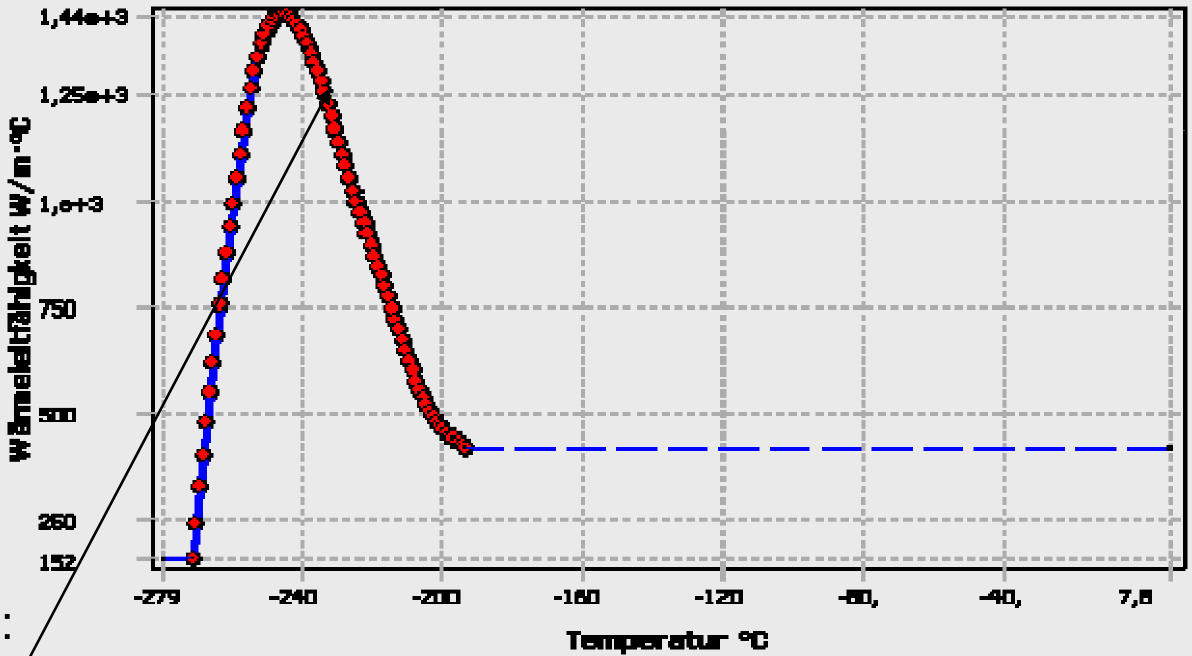


Lossy ceramic Zr10CB5:
ε´ =15 and ε´´ =4

Intended Beam:
3 nC @ 500 bunches/pulse @ 5 Hz rep. rate
σ_z = 2 mm



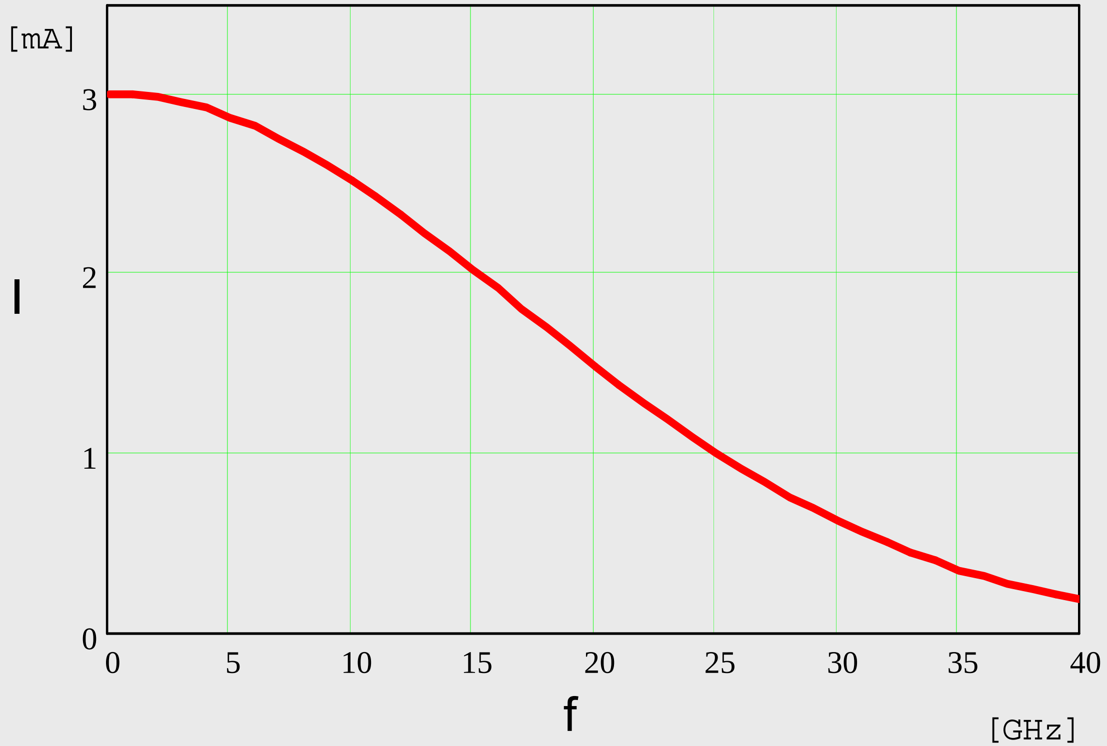
Cu braid (35mm x 4mmx700mm) cross-section 74.4mm^2



Heat conductance of the braid :

$$\kappa = 1250 \frac{W}{m \cdot K} \cdot \frac{74.4 \cdot 10^{-6} m^2}{0.7 m} = 0.13 \frac{W}{K}$$

Beam Spectrum for σz= 2 mm and 3 nC



For σ = 2 mm, the total longitudinal loss factor for the TTF cryomodule is:

$$k = 61\ \text{V/pC}$$

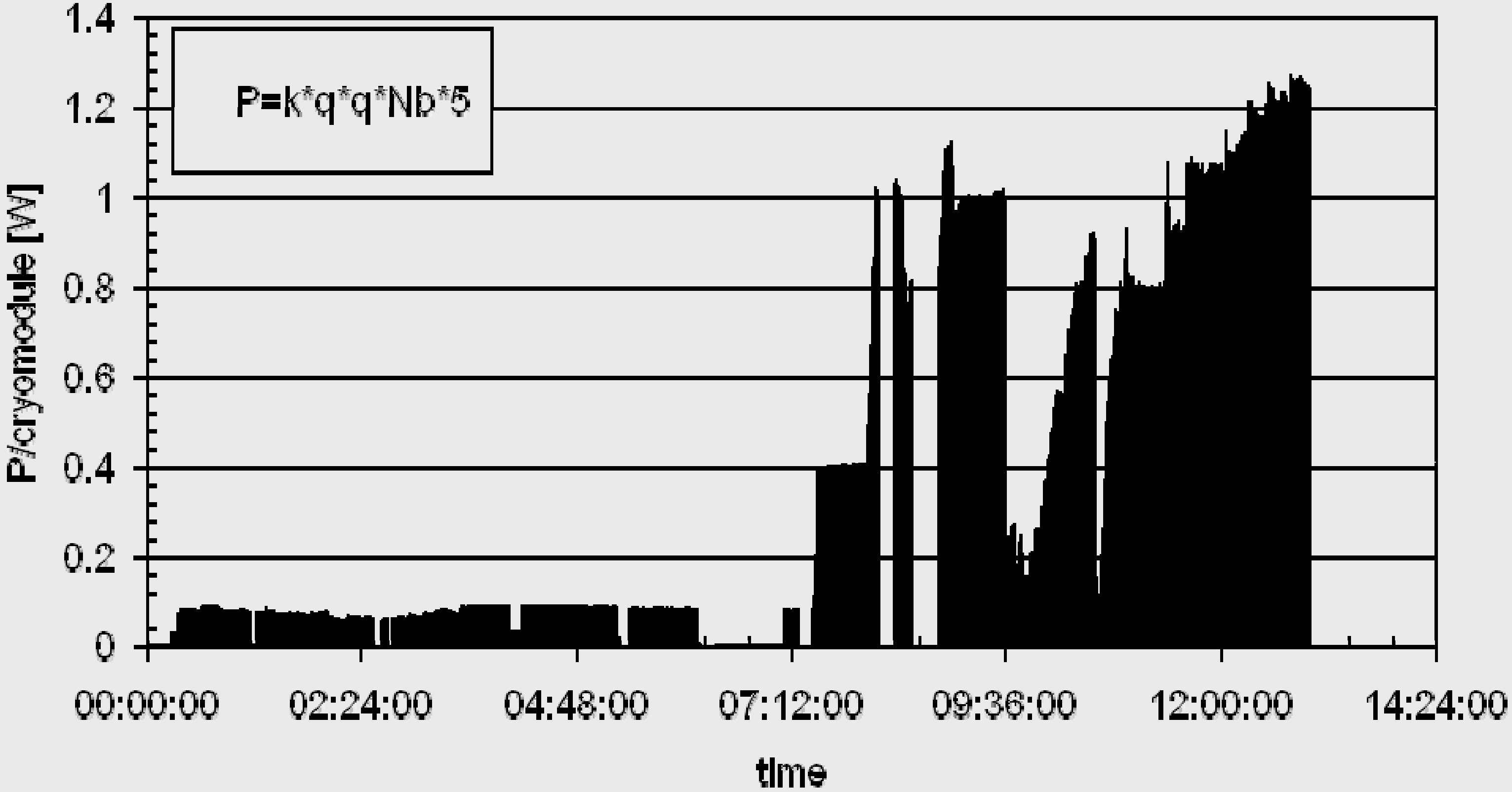
Loss factor for the propagating modes is (k– 2xTM011):

$$k = 54\ \text{V/pC}$$

Power deposited by the beam in the propagating modes is:

$$P/\text{cryomodule} = 54\text{V/pC}*(q\ \text{nC})^2*\text{Nb}*5$$

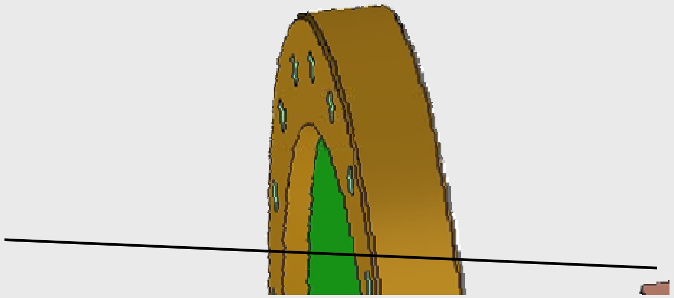
Estimated power induced by the beam in the high current experiment on September 25th



A fraction of this power is absorbed by the BLA and leads to the temperature rise.

M. Dohlus theoretical estimation for the present linac configuration is 15% (180mW)

There is a second source of the heating: the direct interaction of the beam with the lossy ceramic.



σ_z= 2 mm, q_{max}=3.1 nC

Peak magnetic field at the ceramic:

$$H = \frac{3.1nC \cdot 3 \cdot 10^8 \frac{m}{s}}{2 \cdot 0.002m} \cdot \frac{1}{2\pi \cdot 0.04m} = 925 \frac{A}{m}$$

Power deposited direct is:

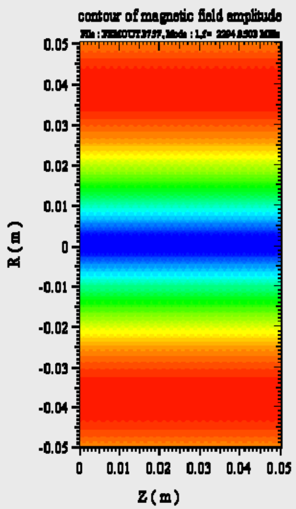
$$P_{dir} = R_{s,cer} \cdot H^2 \cdot (2\pi \cdot 0.04m \cdot 2 \cdot 0.002m) \cdot \frac{0.05m}{3 \cdot 10^8 \frac{m}{s}} \cdot N_b \cdot 5Hz$$

Equivalent surface resistance measured

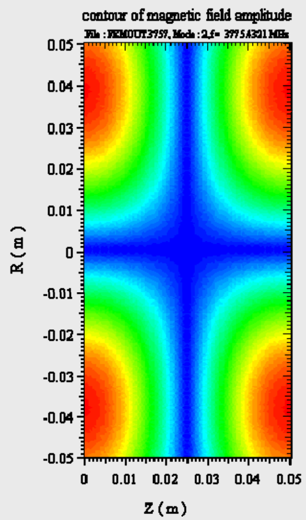
Estimation of the Rs,cer

Pillbox cavity for the ceramic test at 300K

TM010: 2.4GHz

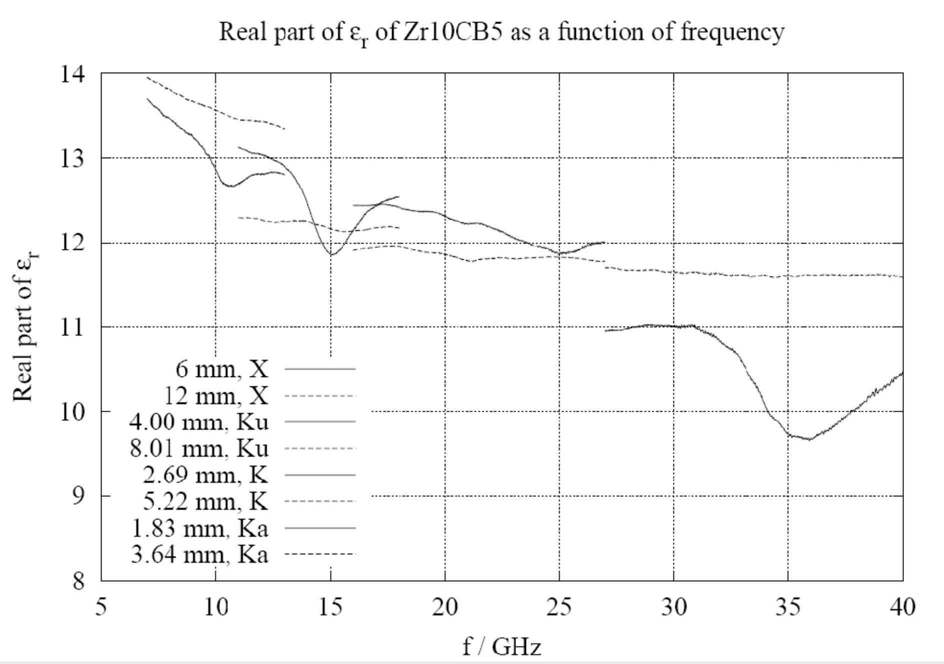


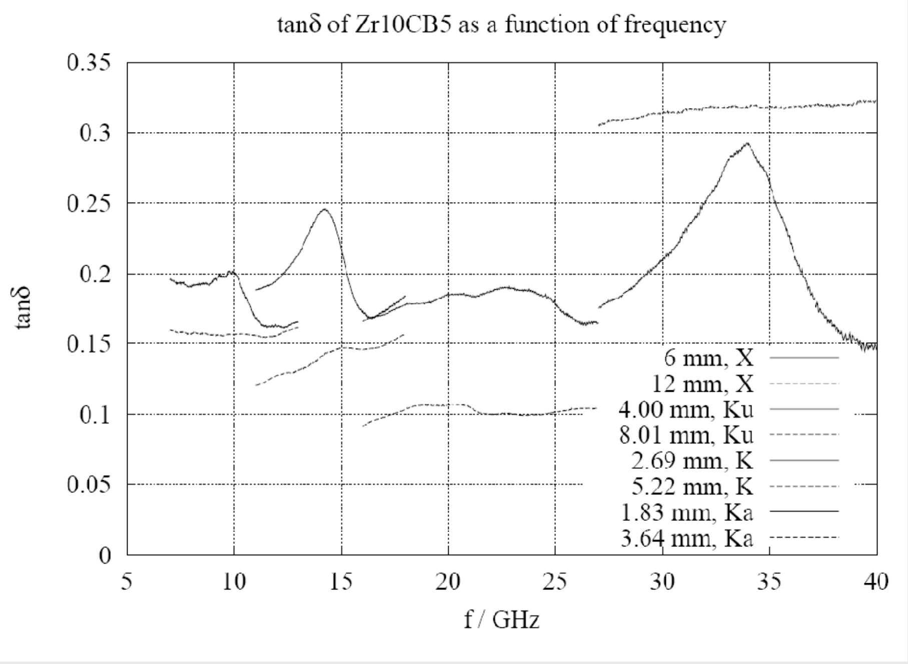
TM011: 3.6GHz



Scaling of Rs,cer vs. frequency

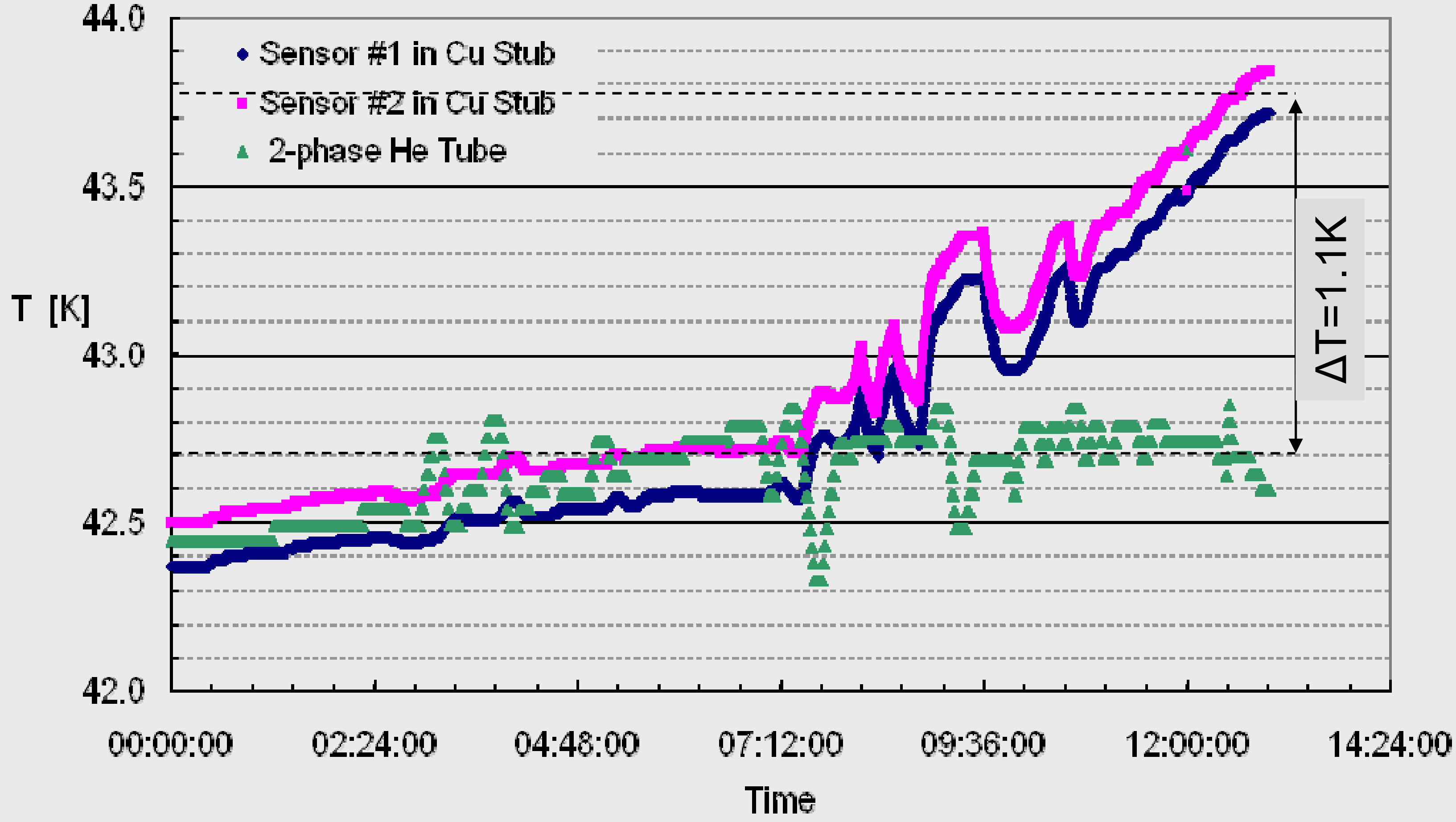
Both tanδ and ε change rather slowly vs. f





$P_{dir} = 0.7\ mW$

Measured temperature rise at the braid

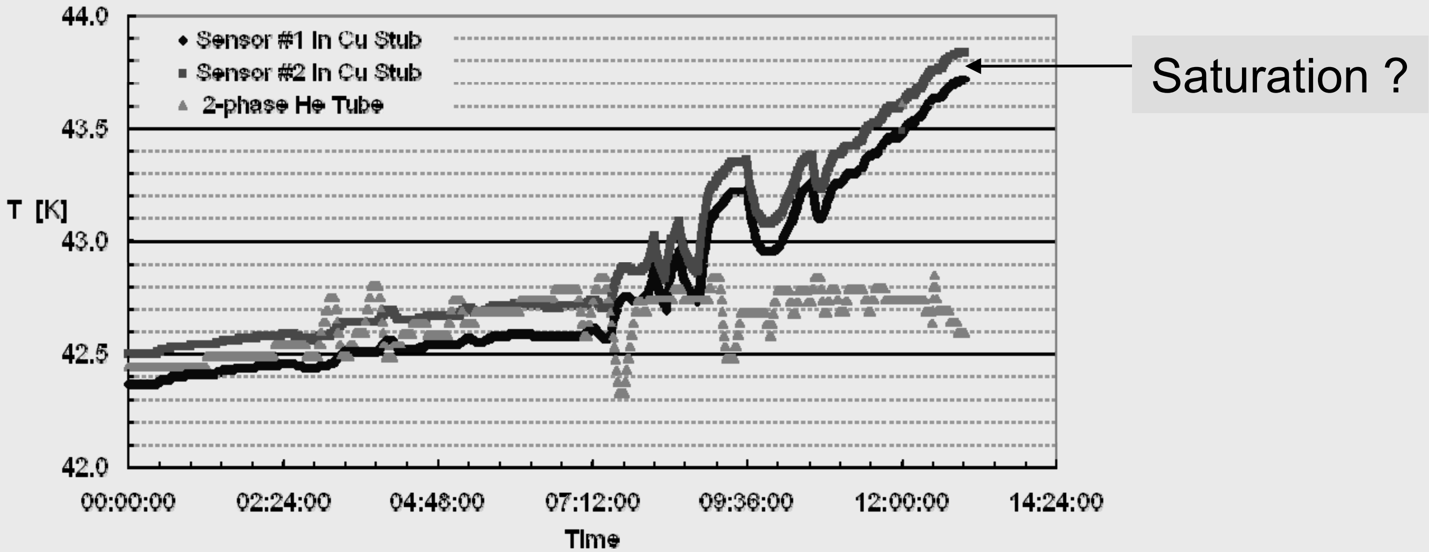


$$P_{1250} = 0.13 \frac{W}{K} \cdot 1.1K = 143mW$$

(reasonable close to the theoretical value of 180 mW)

The result looks very promising, but there are some open questions:

1. 1. How long does it take to stabilize the temperature of the BLA?
   To answer this question we need the stable operation for time longer than it was on September 25^{th}.



1. 2. What happens to the power deposited in two other cryomodules.
   To answer this question we need operation with various bunch length.