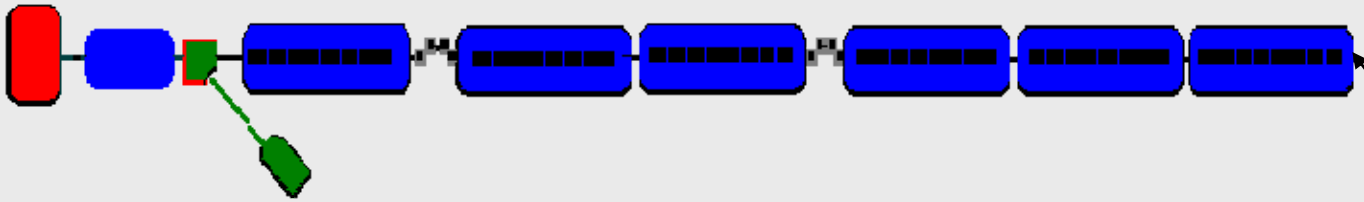
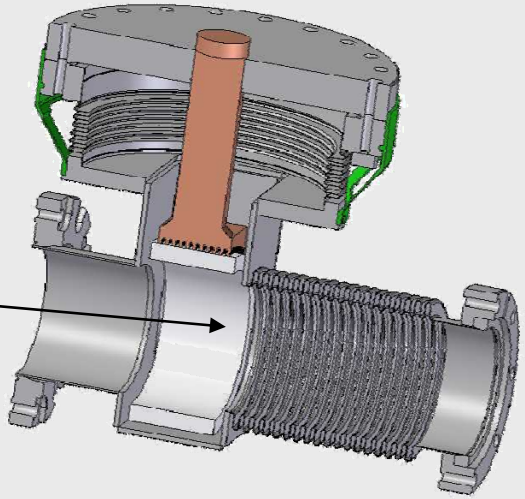
Beam Line Absorber;

First Beam Test at FLASH
September 25th, 2008

J. Sekutowicz

Location of the BLA prototype in the FLASH linac



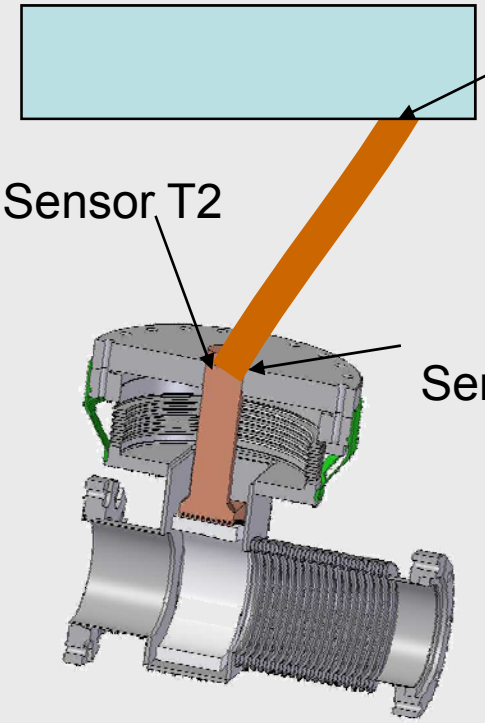


Lossy ceramic Zr10CB5:
ε´ =15 and ε´´ =4

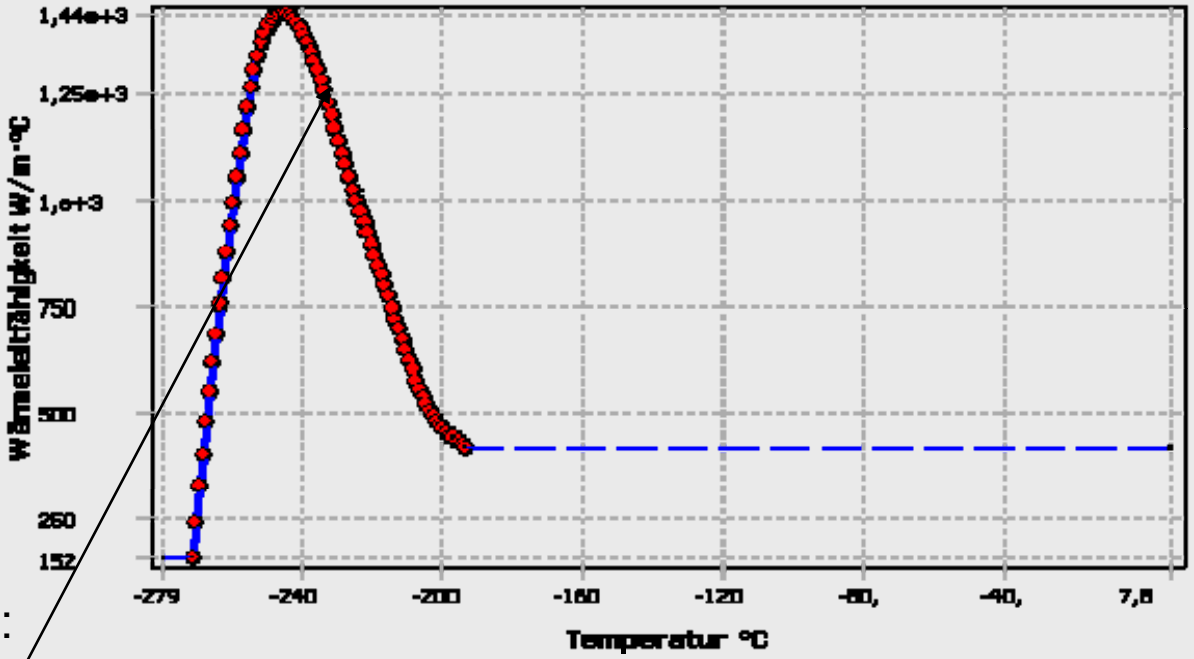
Intended Beam:

3 nC @ 500 bunches/pulse @ 5 Hz rep. rate

σ_z = 2 mm



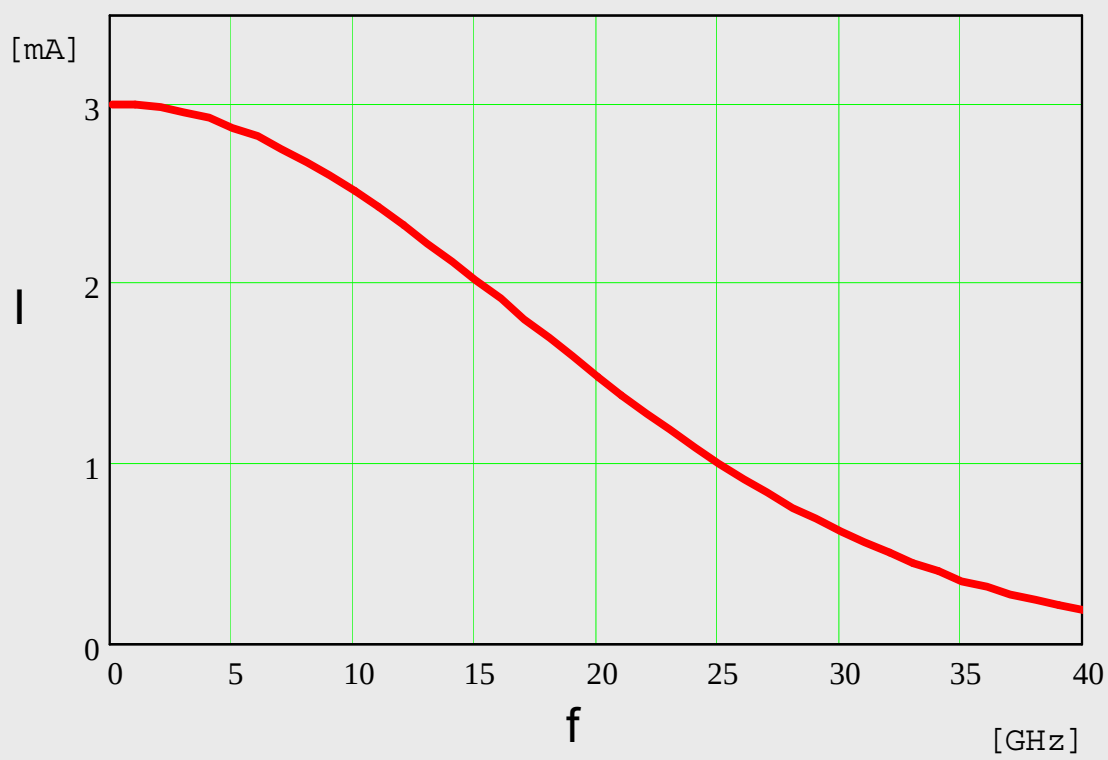
Cu braid (35mm x 4mmx700mm) cross-section 74.4mm^2



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:

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

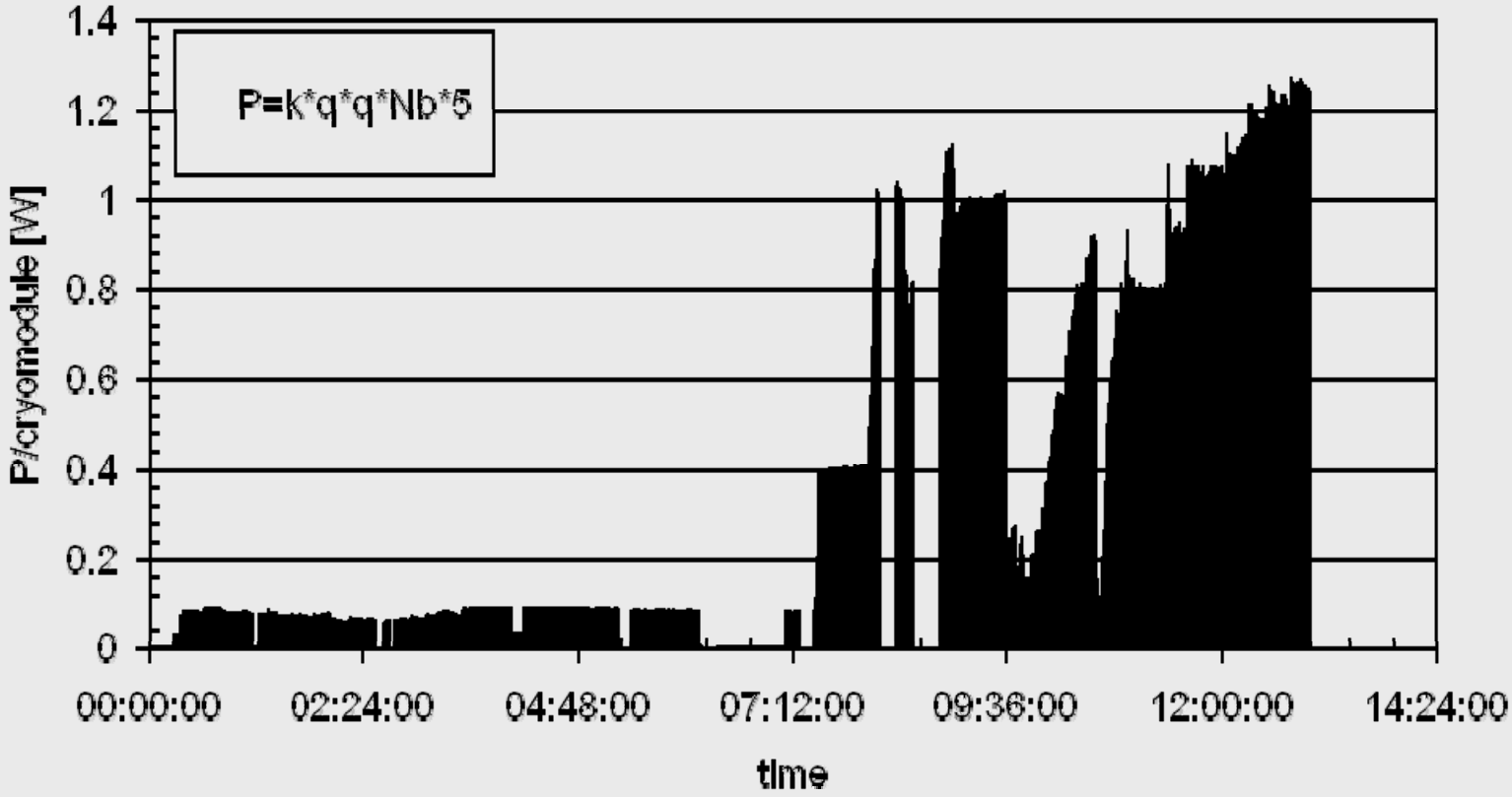
Loss factor for the propagating modes is (k– 2xTM011):

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

Power deposited by the beam in the propagating modes is:

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

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

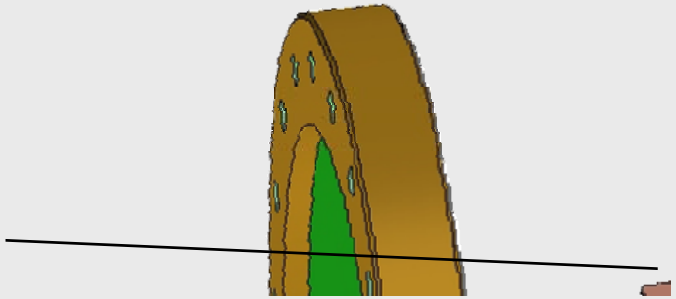


A fraction of this power is absorbed by the BLA and leads to the temperature rise.

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:

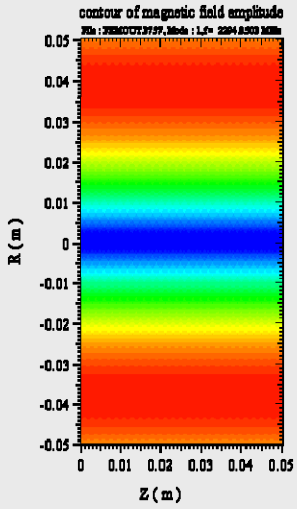
$$P_{dir} = R_{s,cer} \cdot H^2 \cdot (2\pi \cdot 0.04m \cdot 2 \cdot 0.002m) \cdot \frac{0.05m}{3 \cdot 10^8 \frac{m}{s}} \cdot N_b \cdot 5Hz$$

Equivalent surface resistance measured

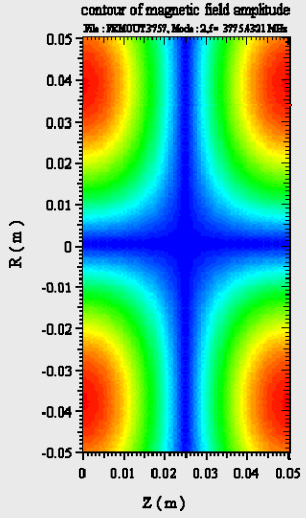
Estimation of the Rs,cer

Pillbox cavity for the ceramic test at 300K

TM010: 2.4GHz

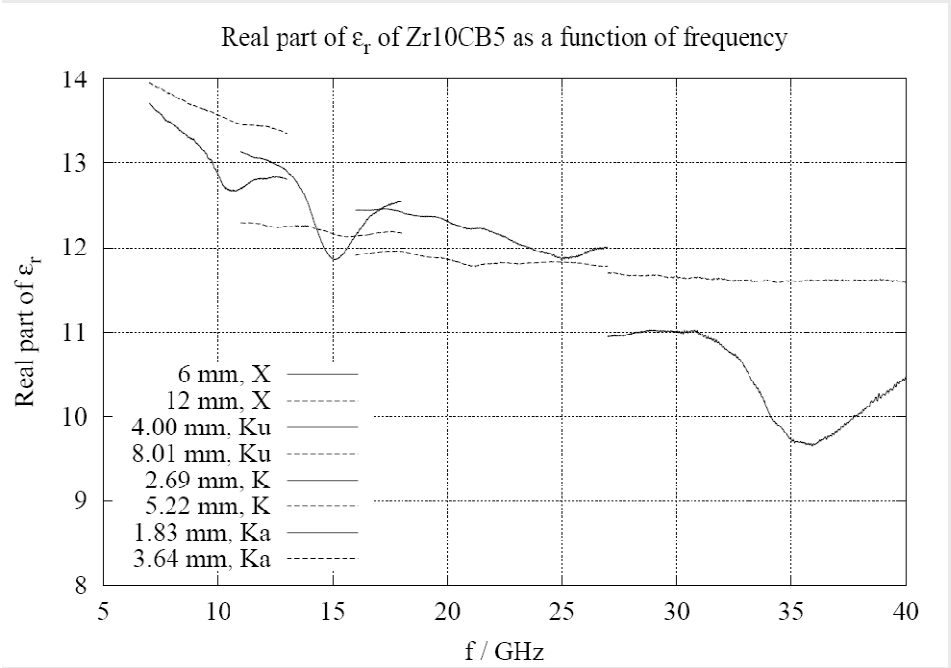


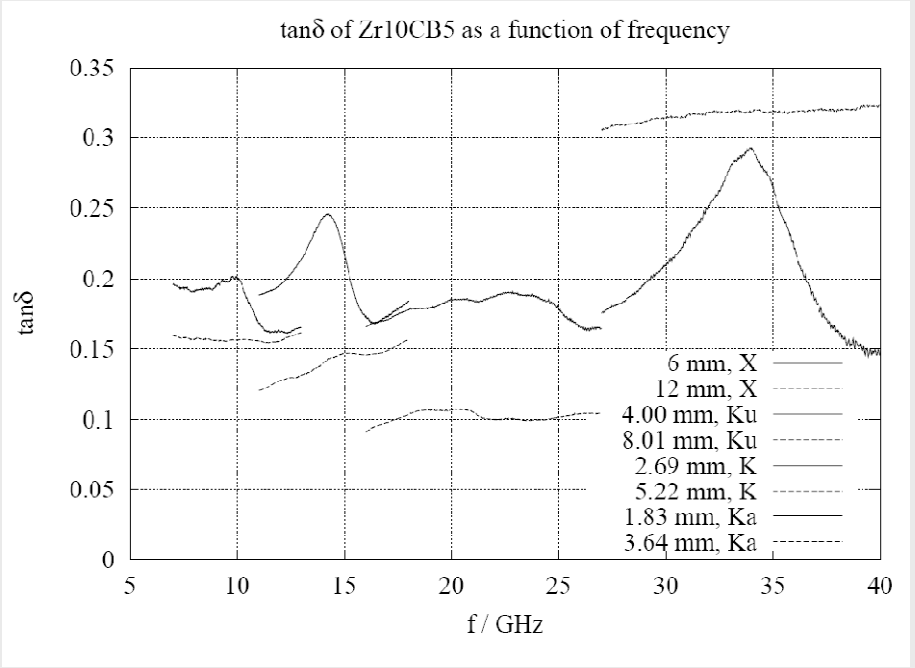
TM011: 3.6GHz



Scaling of Rs,cer vs. frequency

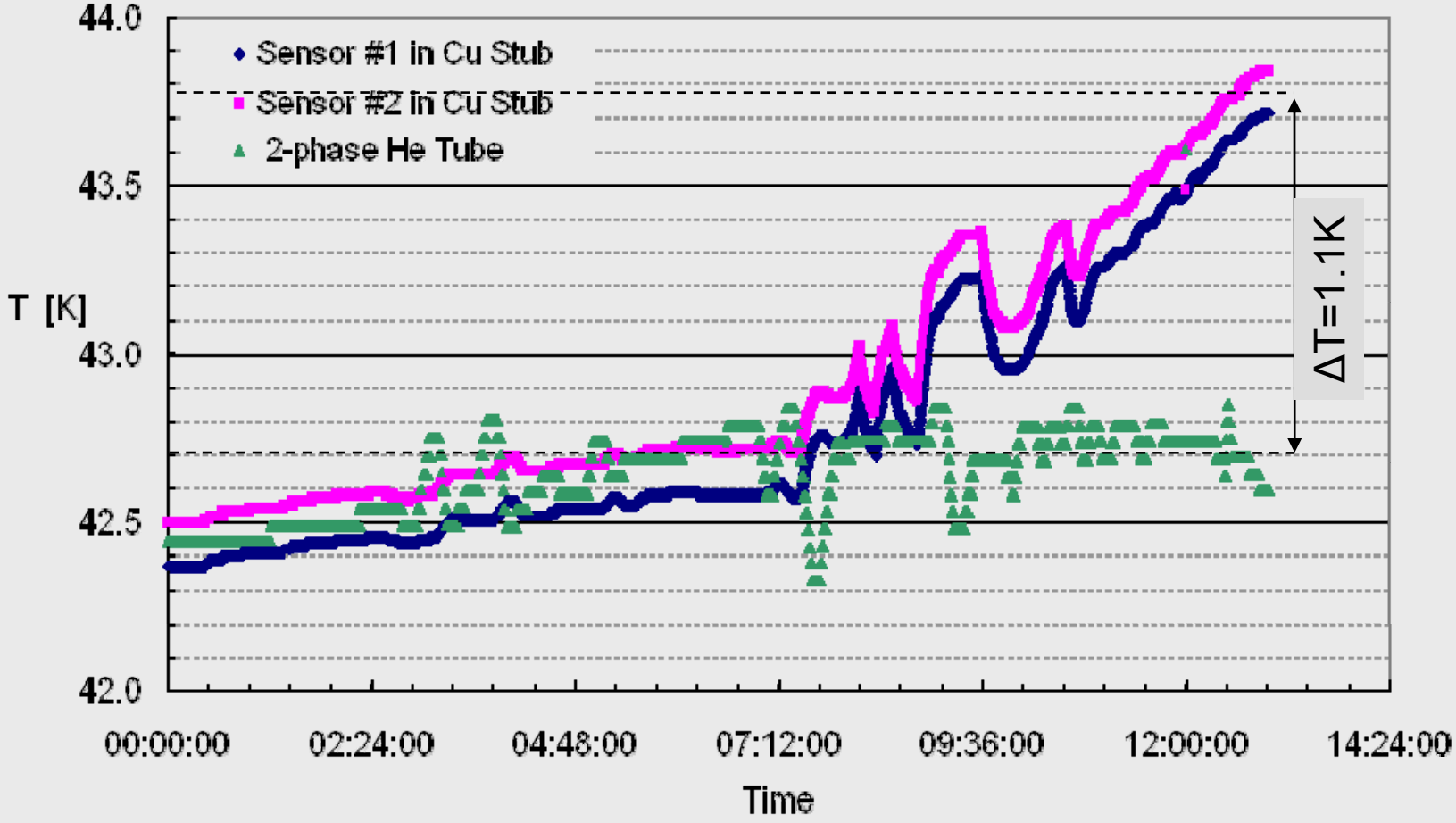
Both tanδ and ε change rather slowly vs. f





$$P_{dir} = 0.7\ mW$$

Measured temperature rise at the braid

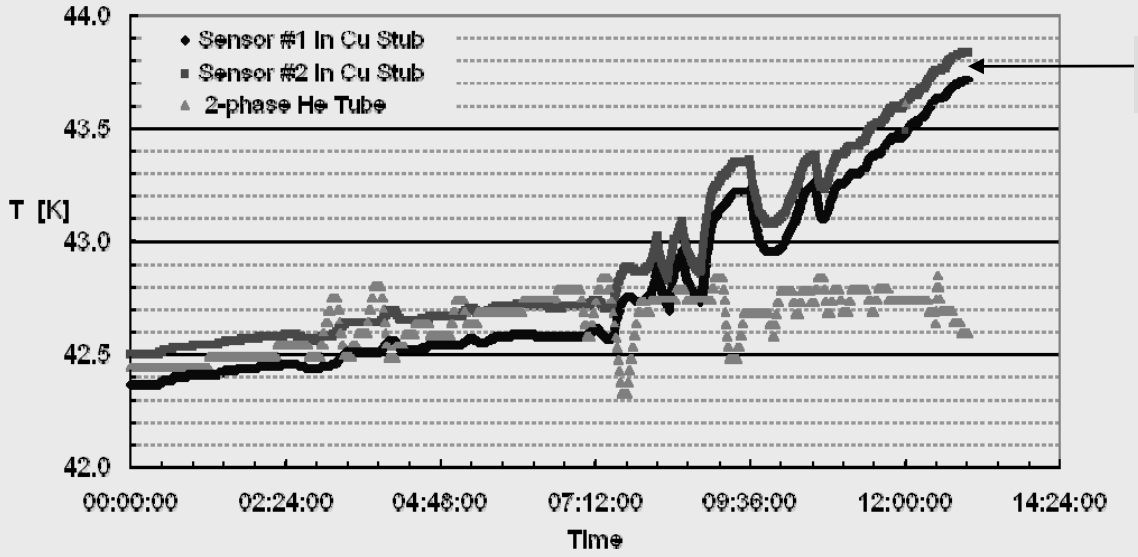


$$P_{1250} = 0.13\frac{W}{K}\cdot 1.1K = 143mW$$

(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 25th.



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