A TRAPPED MODE OF THE PEP-II EMITTANCE SPOILER

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ICFA mini-Workshop on “Electromagnetic
wake fields and impedances in particle accelerators"
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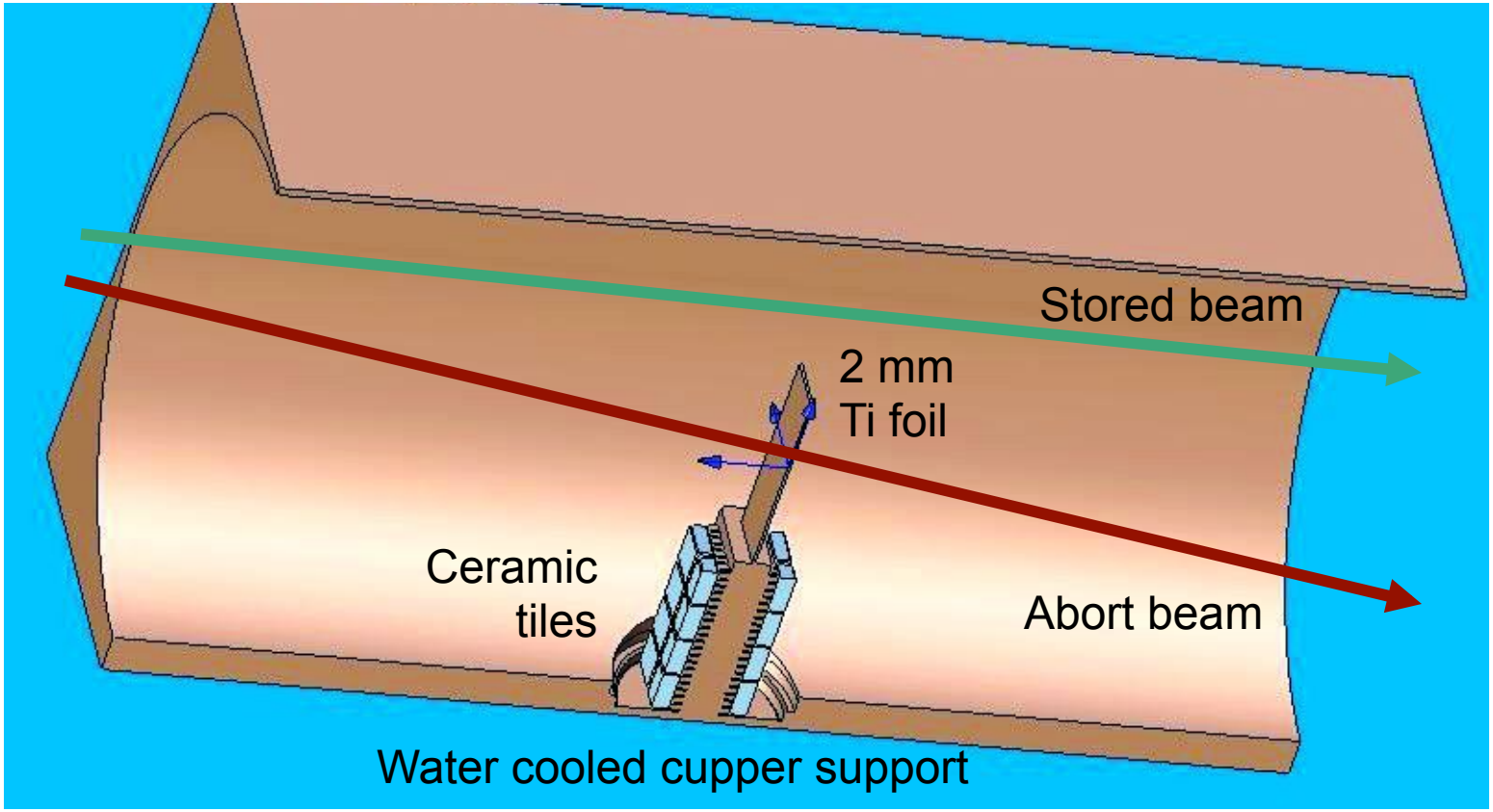
An emittance spoiler for the abort beam



Thermocouples at the input and output water tubes together with a water flow meter allowed to measure the absorbed power

Above cut-off HOM Power and Absorption

	Today	Future
bunchlength [mm]	13	8
current [A]	2.4	4.5
HOM power [W]	**494.28**	**2823.7**

MAFIA calculations
S. Weathersby

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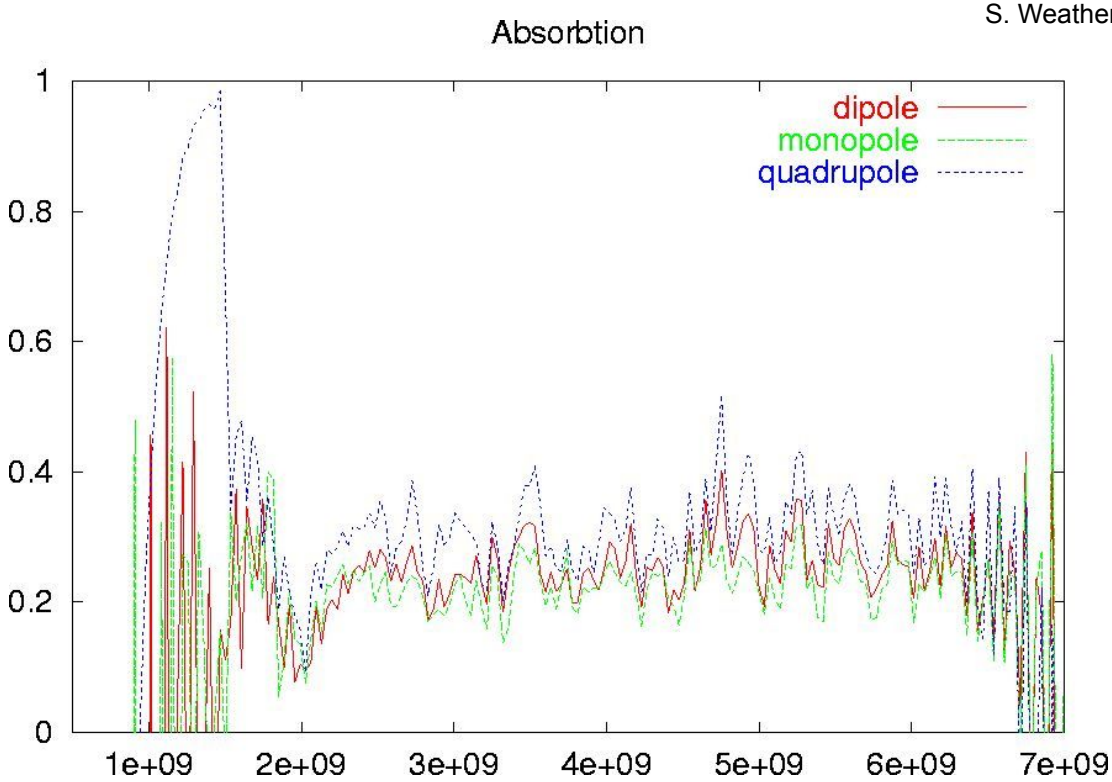


Ceramic tiles
ε_r=30, μ_r=1
loss tangent 0.11

absorb approximately 30 % of the radiated power in the frequency range of 2-7 GHz

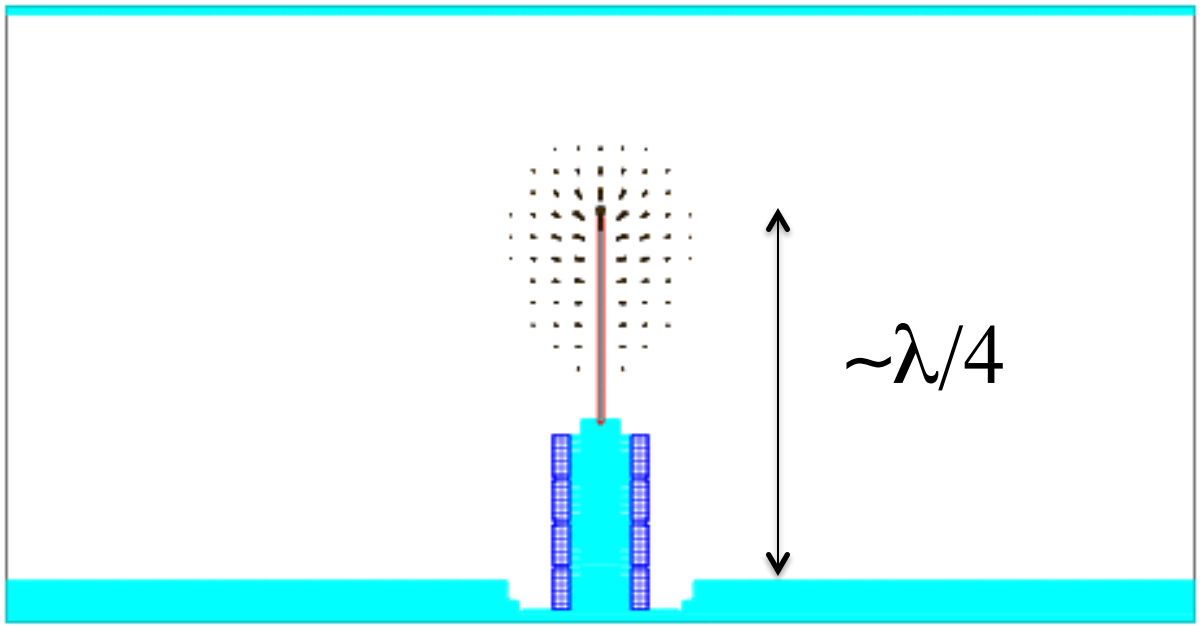
SN 04/28/2014

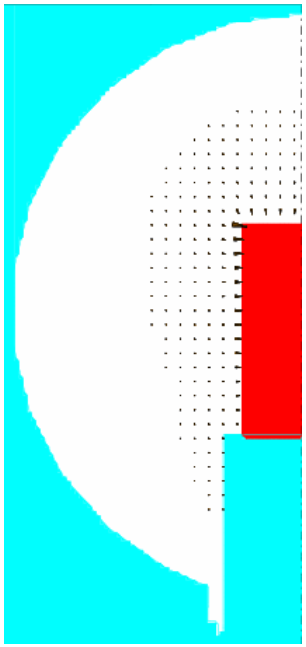
Spoiler has only one trapped mode

a quarter-wave resonance

f=0.539 GHz , Q = 1097

MAFIA calculations
S. Weathersby

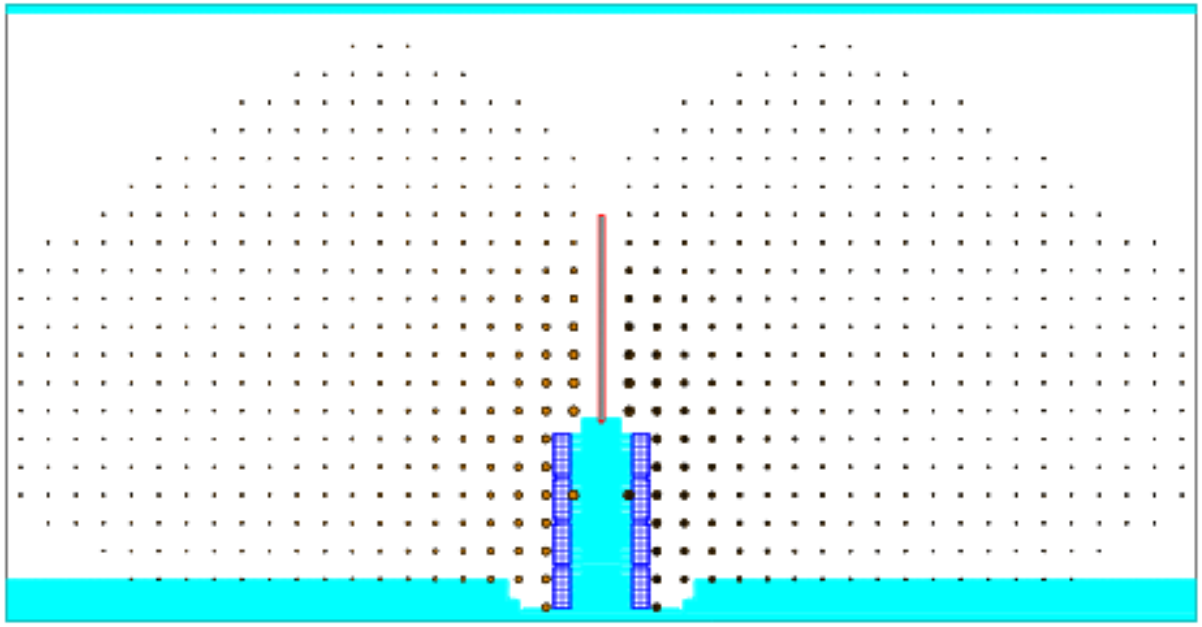


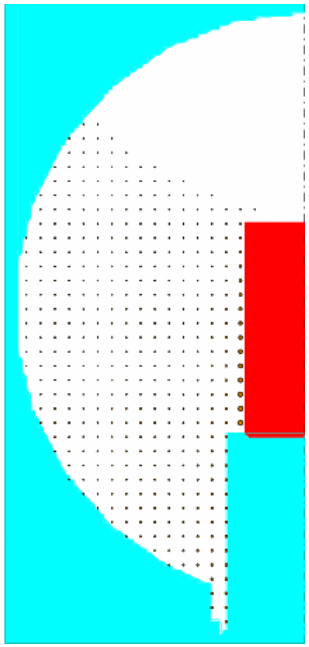


Electric field

Magnetic field of a trapped mode

MAFIA calculations
S. Weathersby





Magnetic field

PEP-II beam spectrum

Bunch spacing

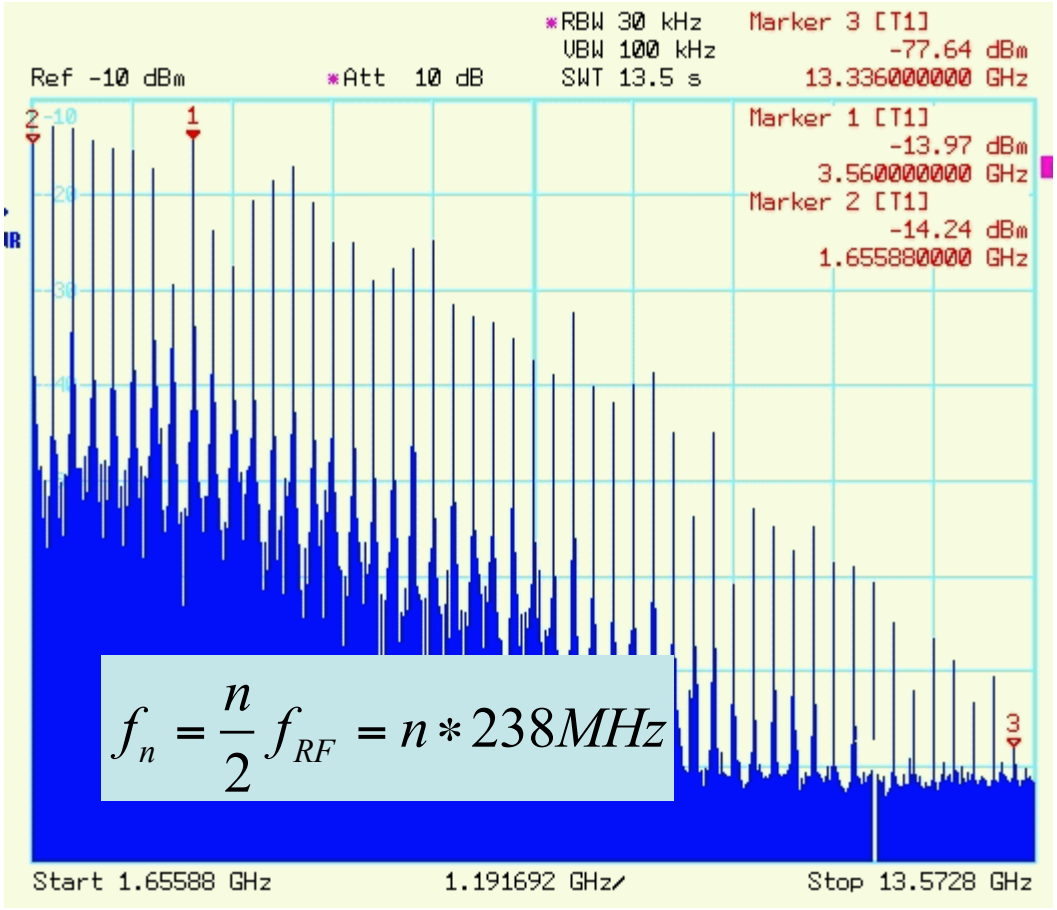
$$\tau_b = \frac{m}{f_{RF}} \qquad m = 1, 2, 3, \ldots$$

Main spectrum lines

$$f_n = \frac{n}{\tau_b} = \frac{n}{m} f_{RF} \qquad n = 1, 2, 3, \ldots$$

- Field spectrum goes to higher frequency with shorter bunches exponentially

$$A(\omega) \sim e^{-\left(\frac{\omega}{c}\sigma\right)^2}$$



Spectrum from a BPM signal of a train of 12 mm bunches

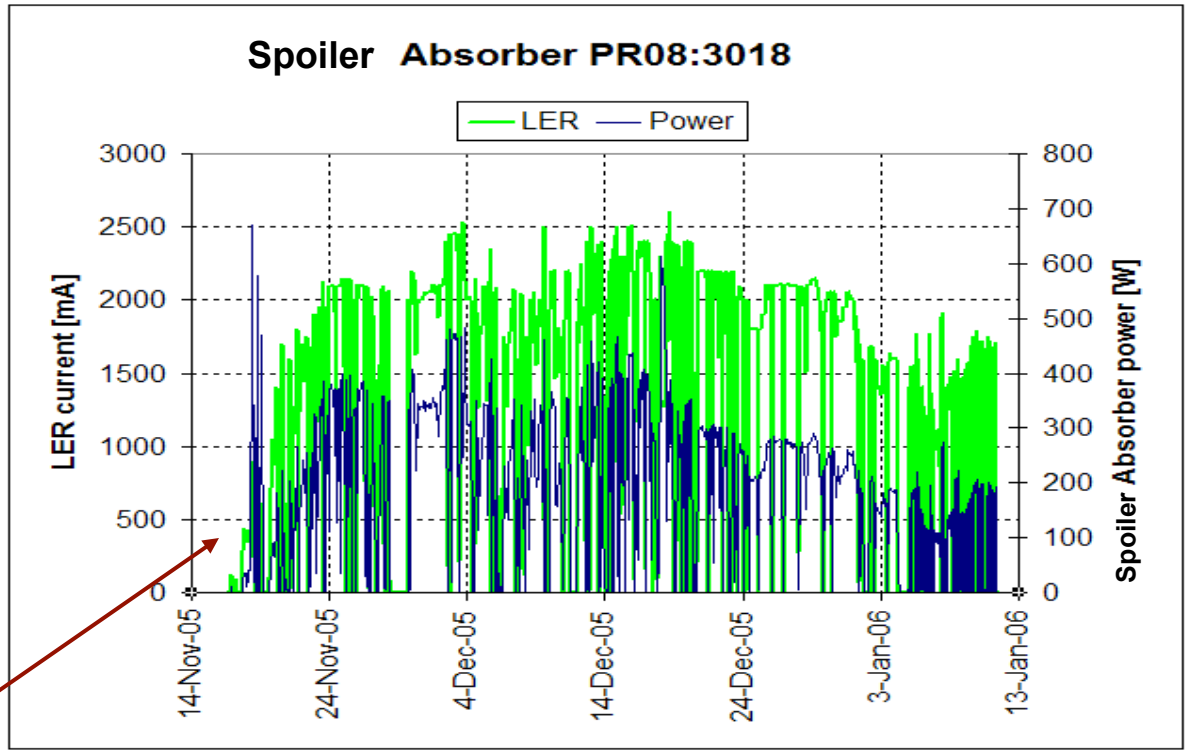
Beam spectrum for bunch patter by 2

Bunch pattern by 2 (m=2)	
n=2	f=476 MHz
Resonance	f=539 MHz
n=3	f=714 MHz

$$f_n = \frac{n}{2} f_{RF} = n * 238MHz$$

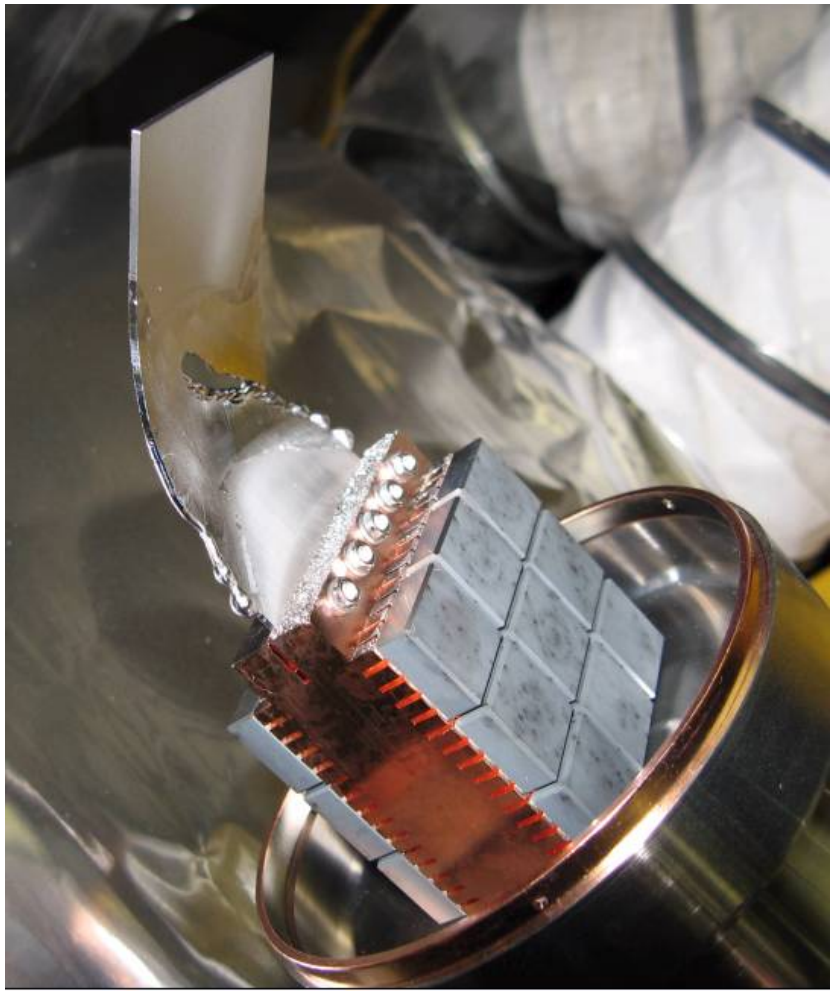
Spoiler resonance was between two beam resonances

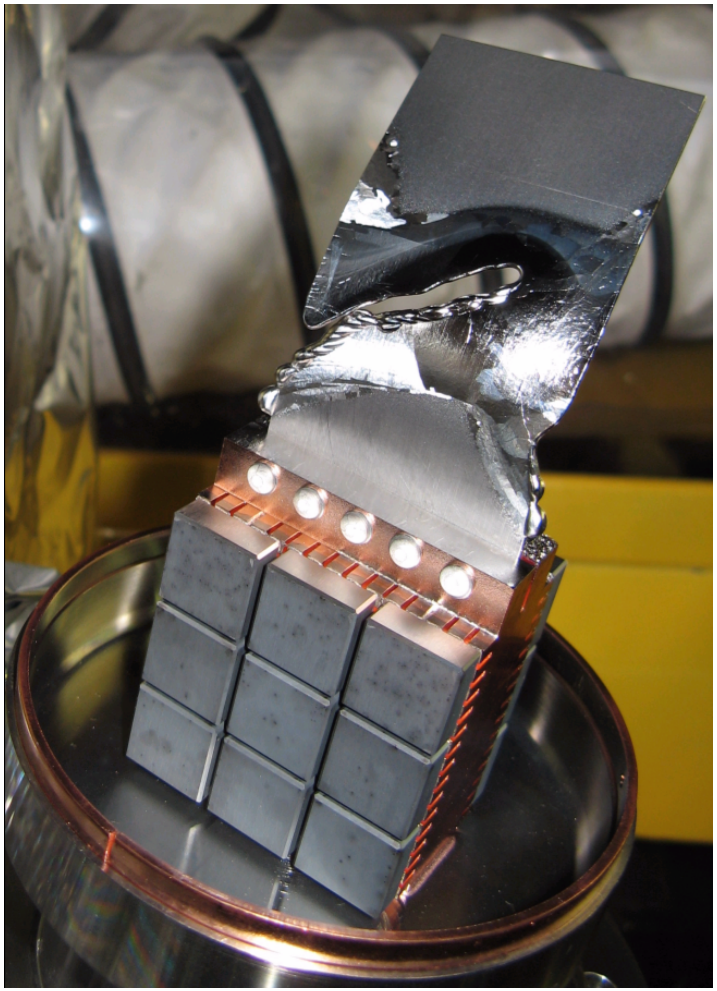
Spoiler in operation



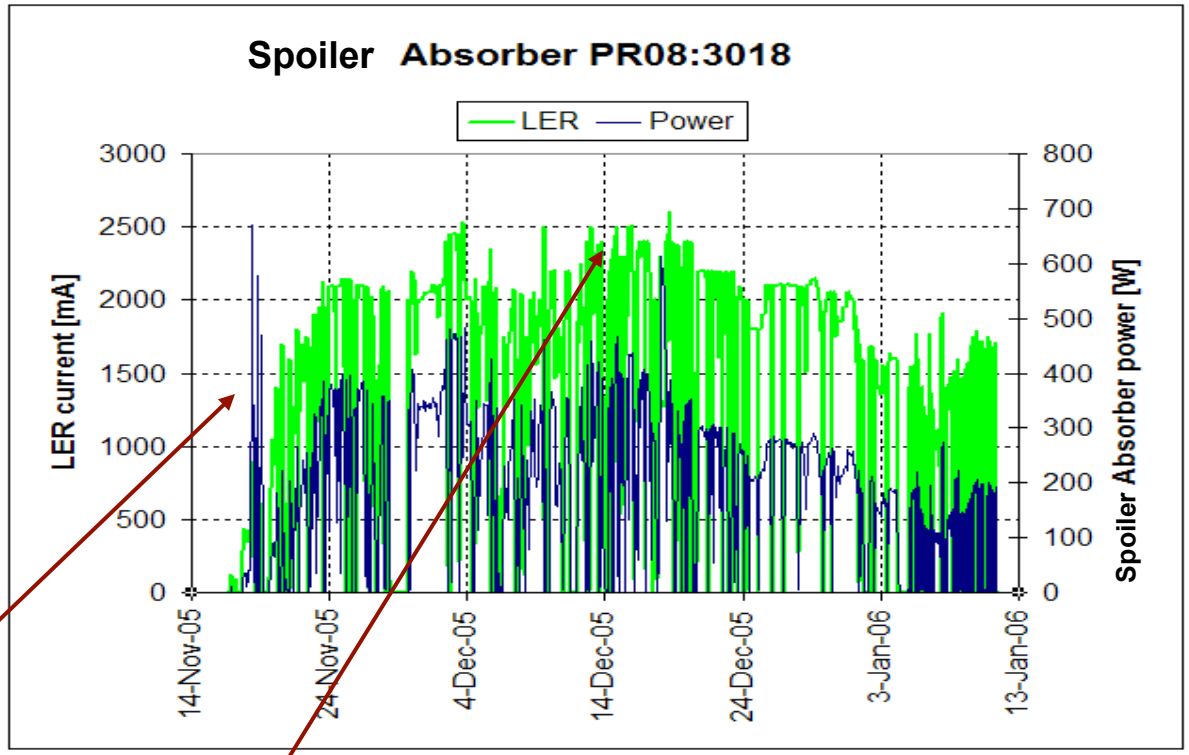
Unfortunately somebody decided to start with a bunch pattern by 4. This pattern contains a bunch spacing resonance, which has a frequency very close to a frequency of a trapped mode: 476/4*5=595 MHz. The LER current was relatively small. What happened? Next page.

How strong wake field effect in resonance could be: melting the Ti foil at the current of only 500 mA.



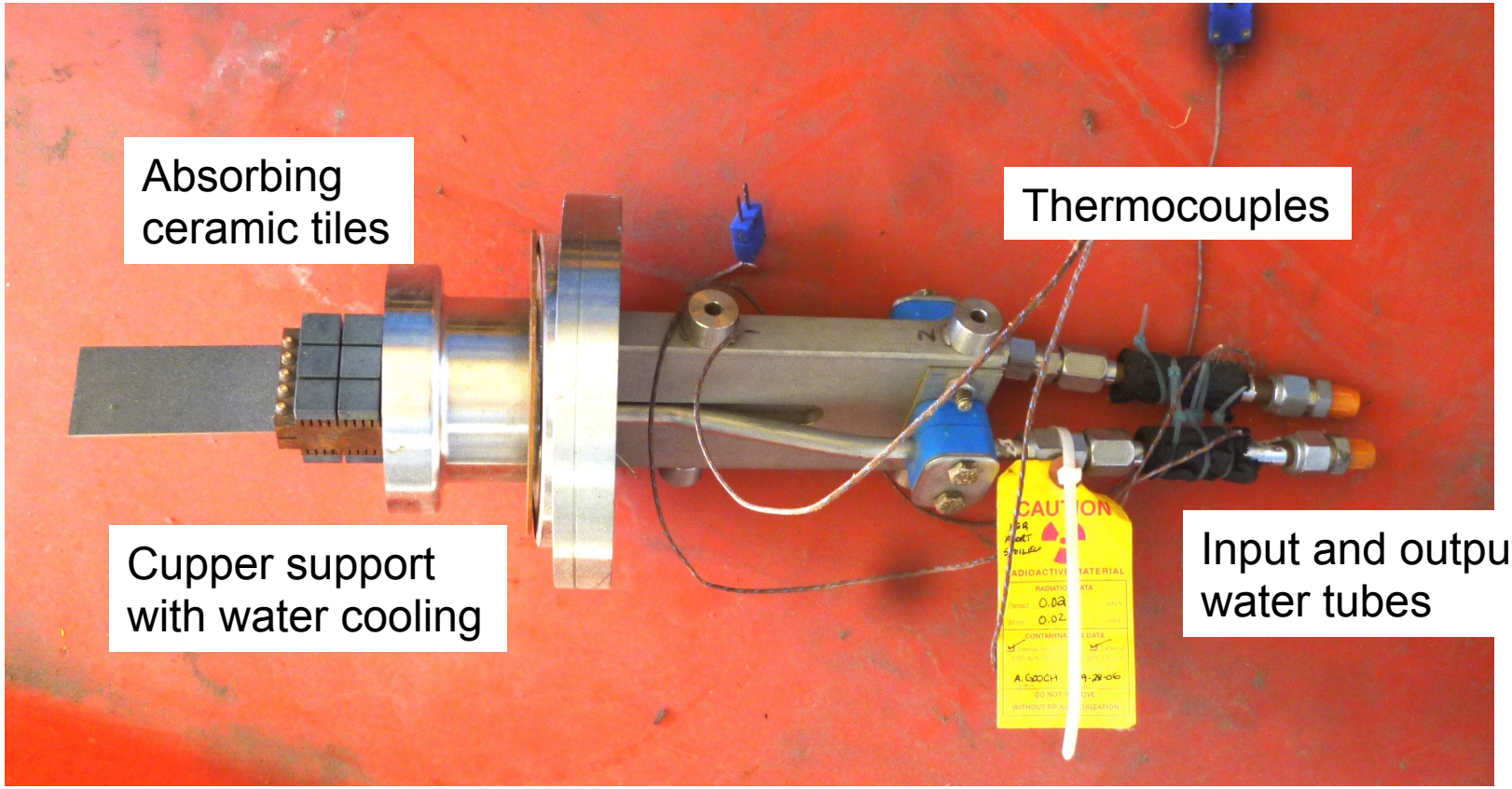


Even the foil was melted the ceramic tiles continue to absorb the power



The foil changed the shape almost immediately and the wake field excitation power also changed, but ceramic tiles continue to absorb the power. At the positron current of 2.5 A, they absorb power of approximately of 400 W. This number correlates very well with the calculation numbers.

Then we installed a new spoiler and never used bunch pattern by 4



The spoiler survived 3.2 A of a positron current.
Now it is taken out of the PEP-II beam pipe.