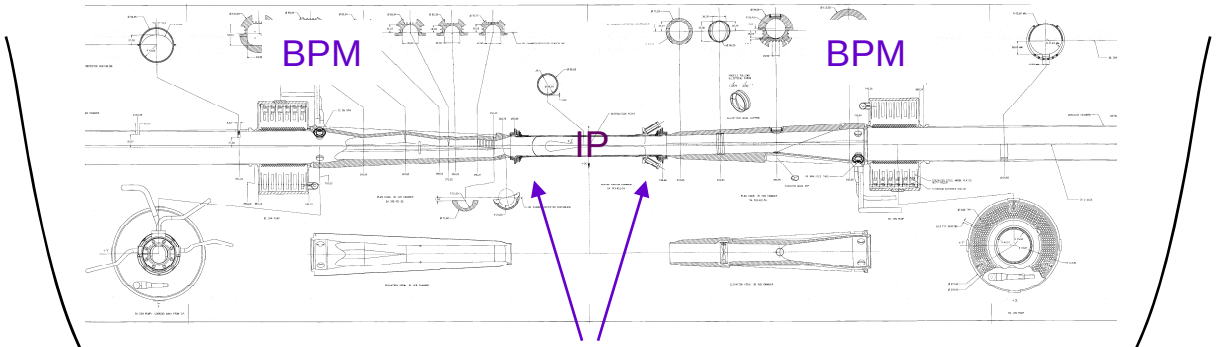
IR Wake fields and HOM Absorbers

Sasha Novokhatski

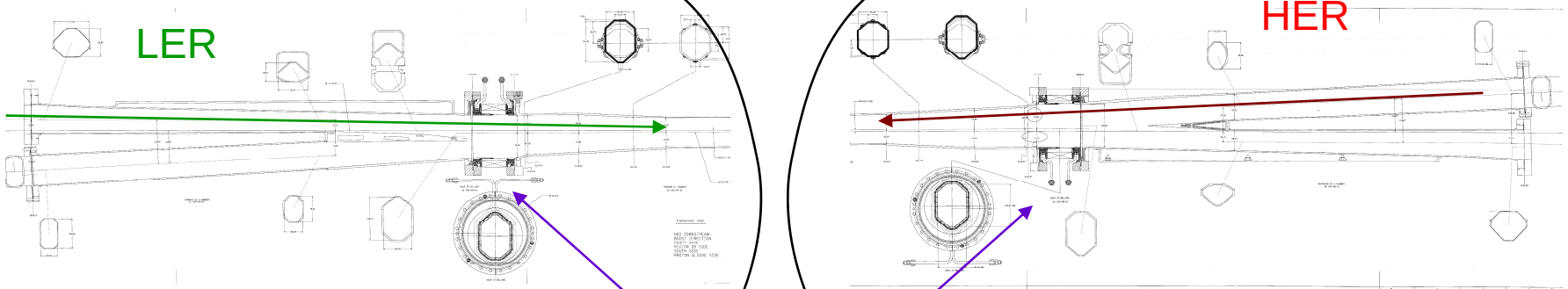
ILC Interaction Region Engineering Design Workshop

September 17-21, 2007
Stanford Linear Accelerator Center

PEP-II IR



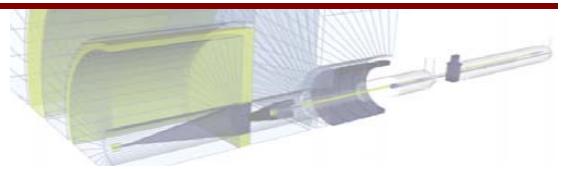
Vertex shielded bellows



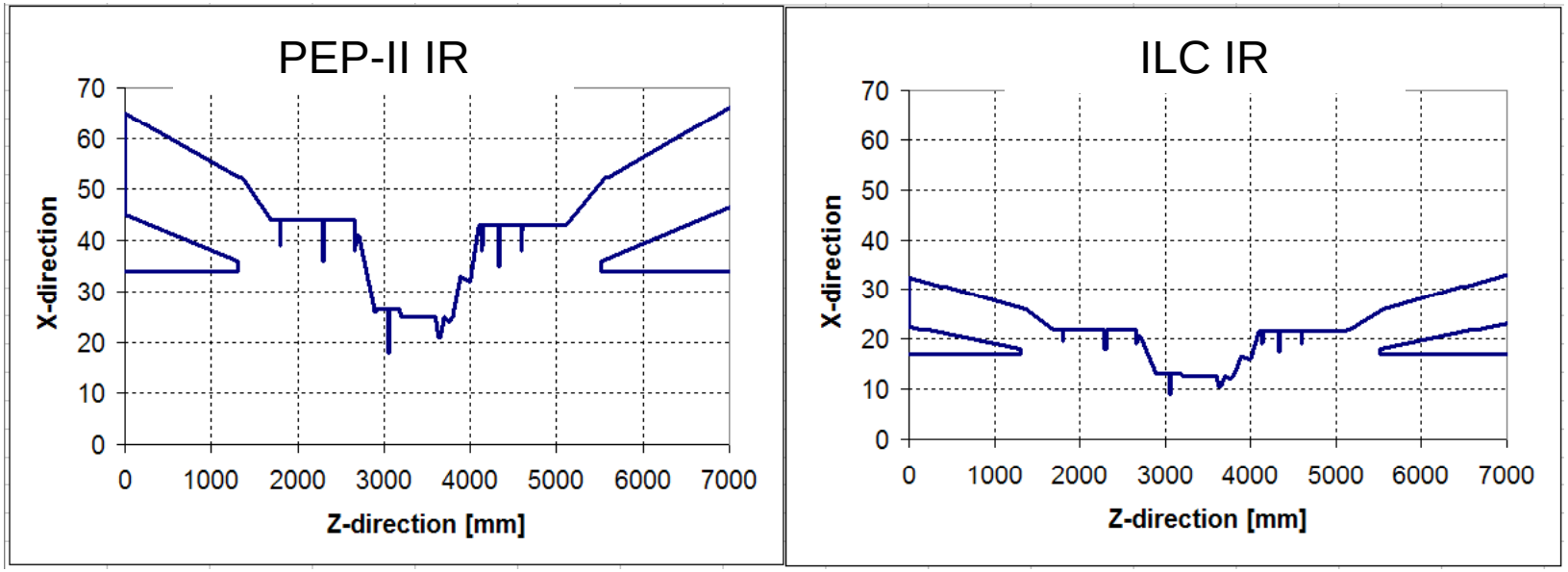
B-side

A-side

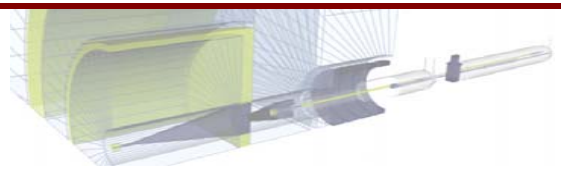
Q2-bellows HOM absorbers



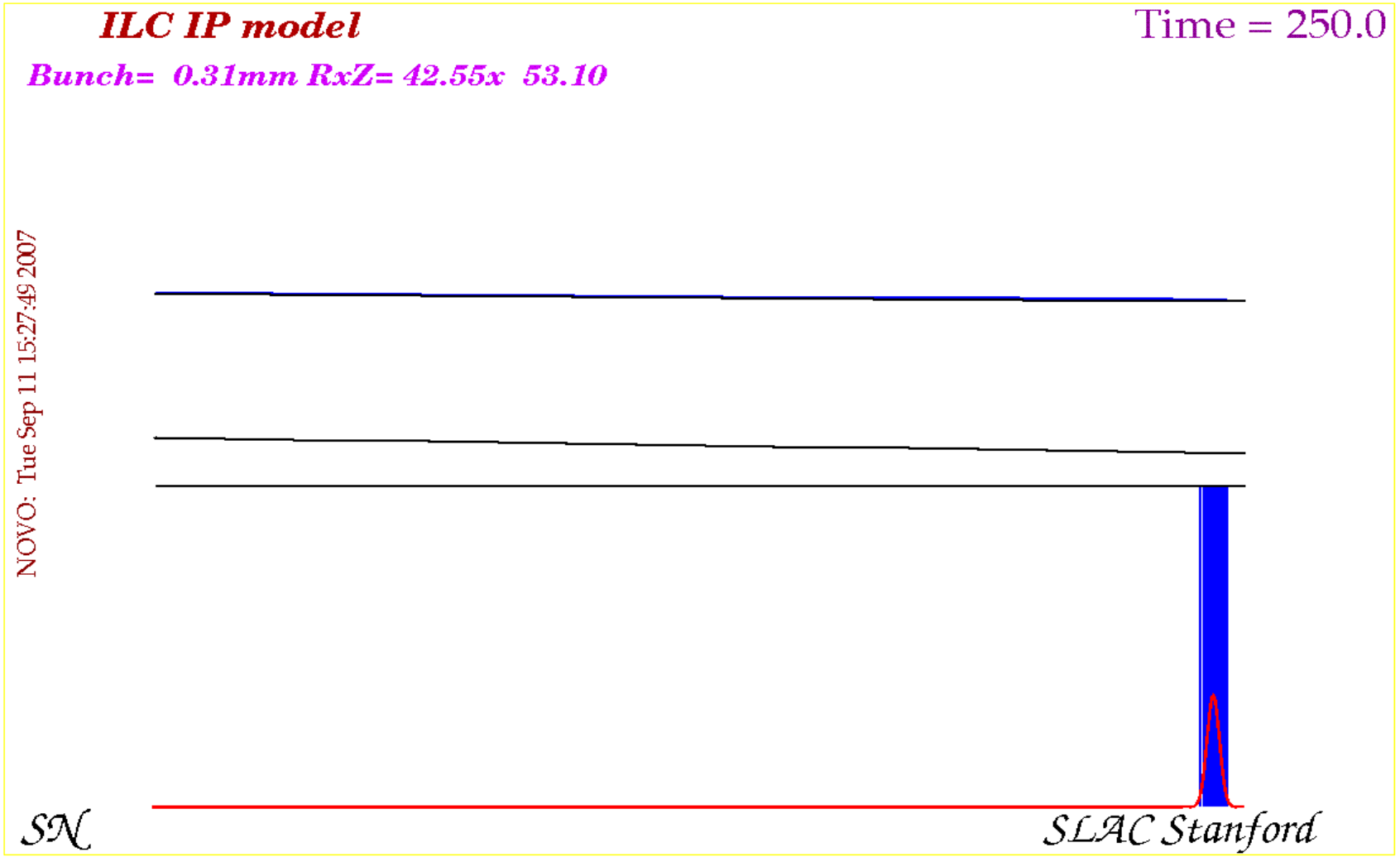
ILC IR model from PEP-II IR



Transverse dimensions are two times smaller



Wake fields at ILC IR (movie)



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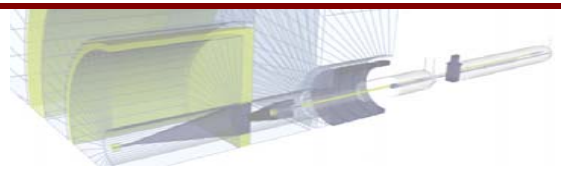
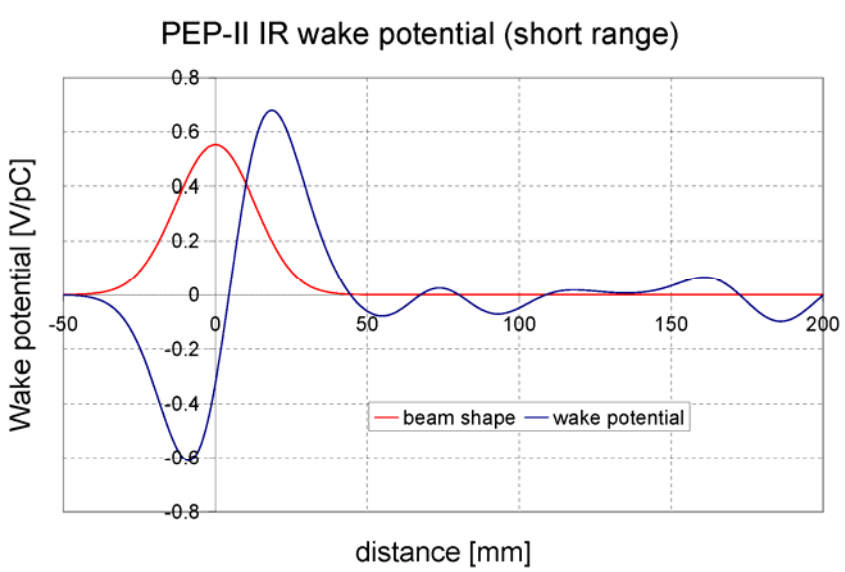
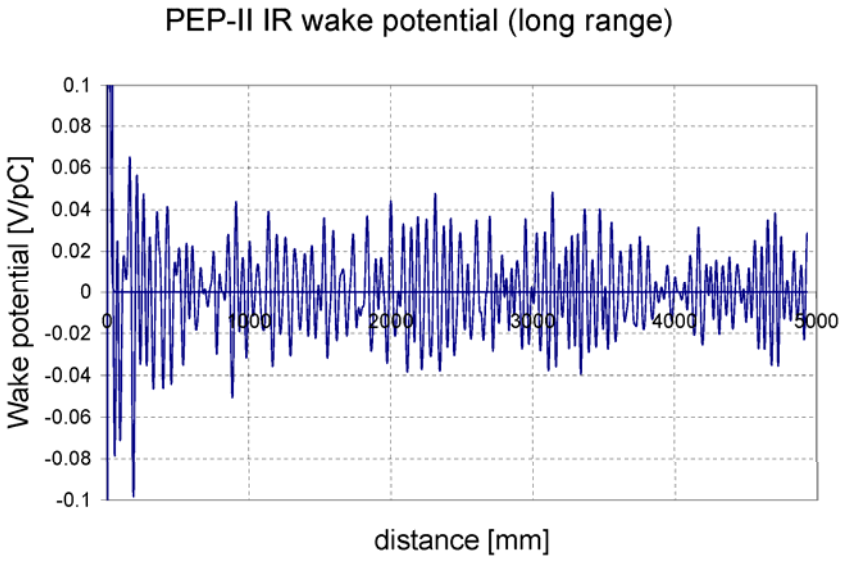
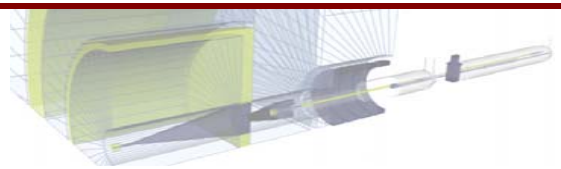


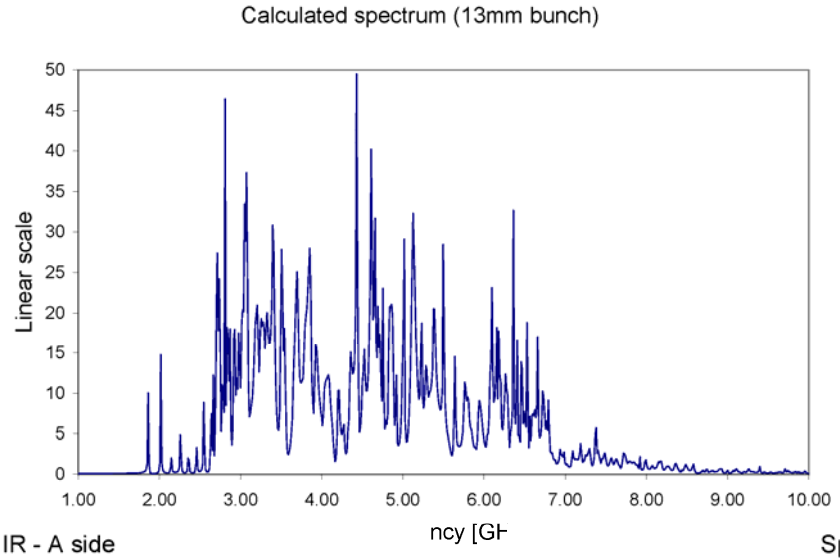
PEP-II IR wake potential
13mm bunch







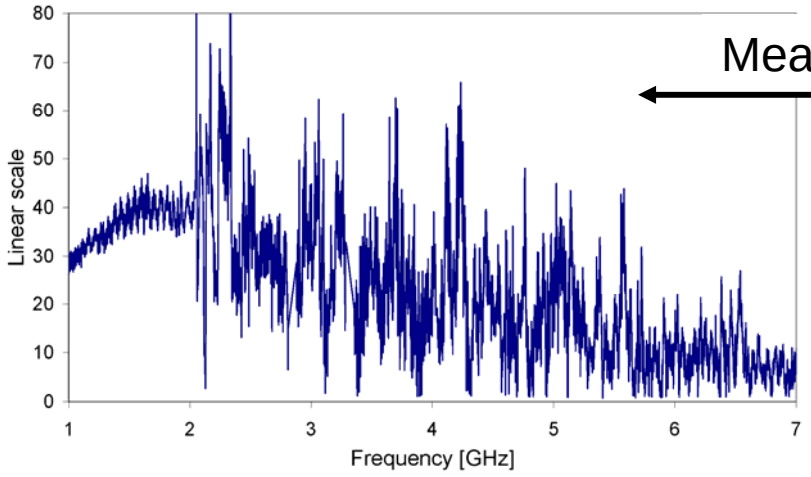
PEP-II IR Spectrum

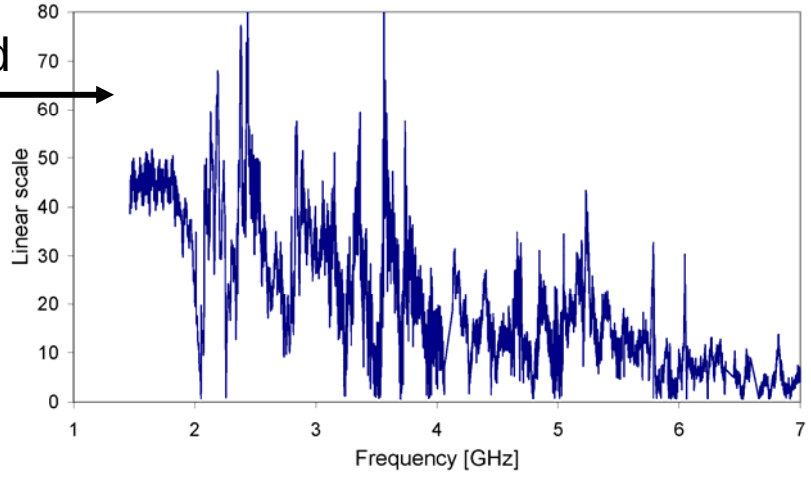


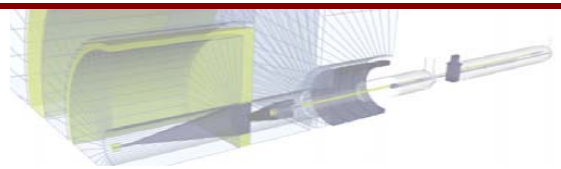
Spectrum IR - A side

Spectrum IR - B side

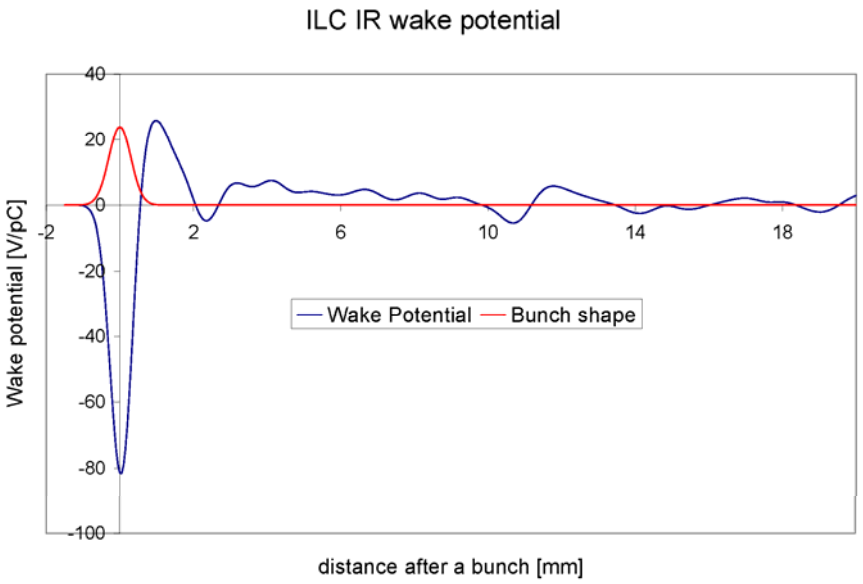
Measured

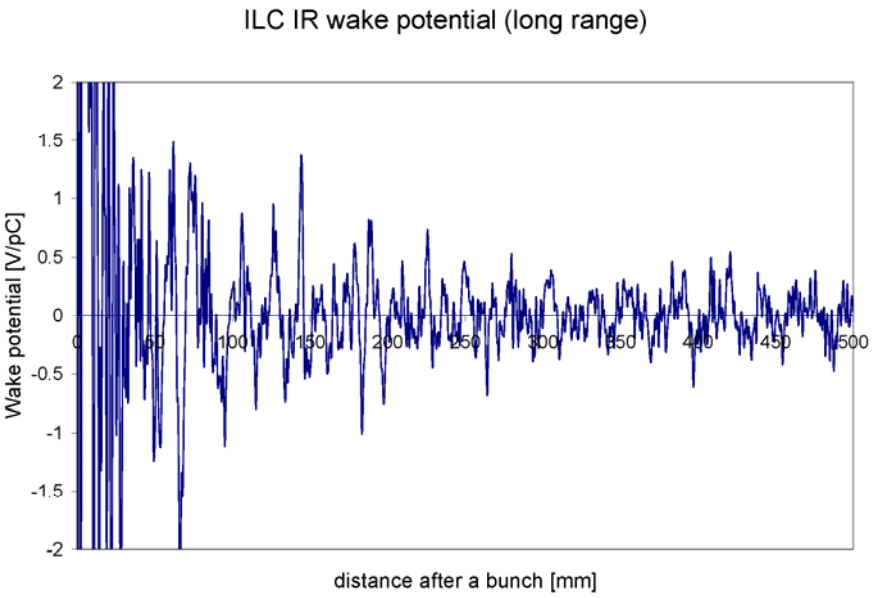


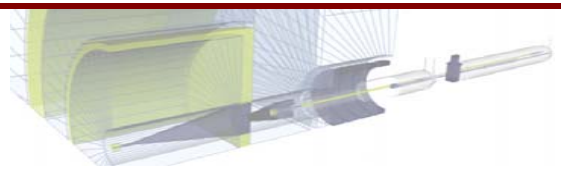




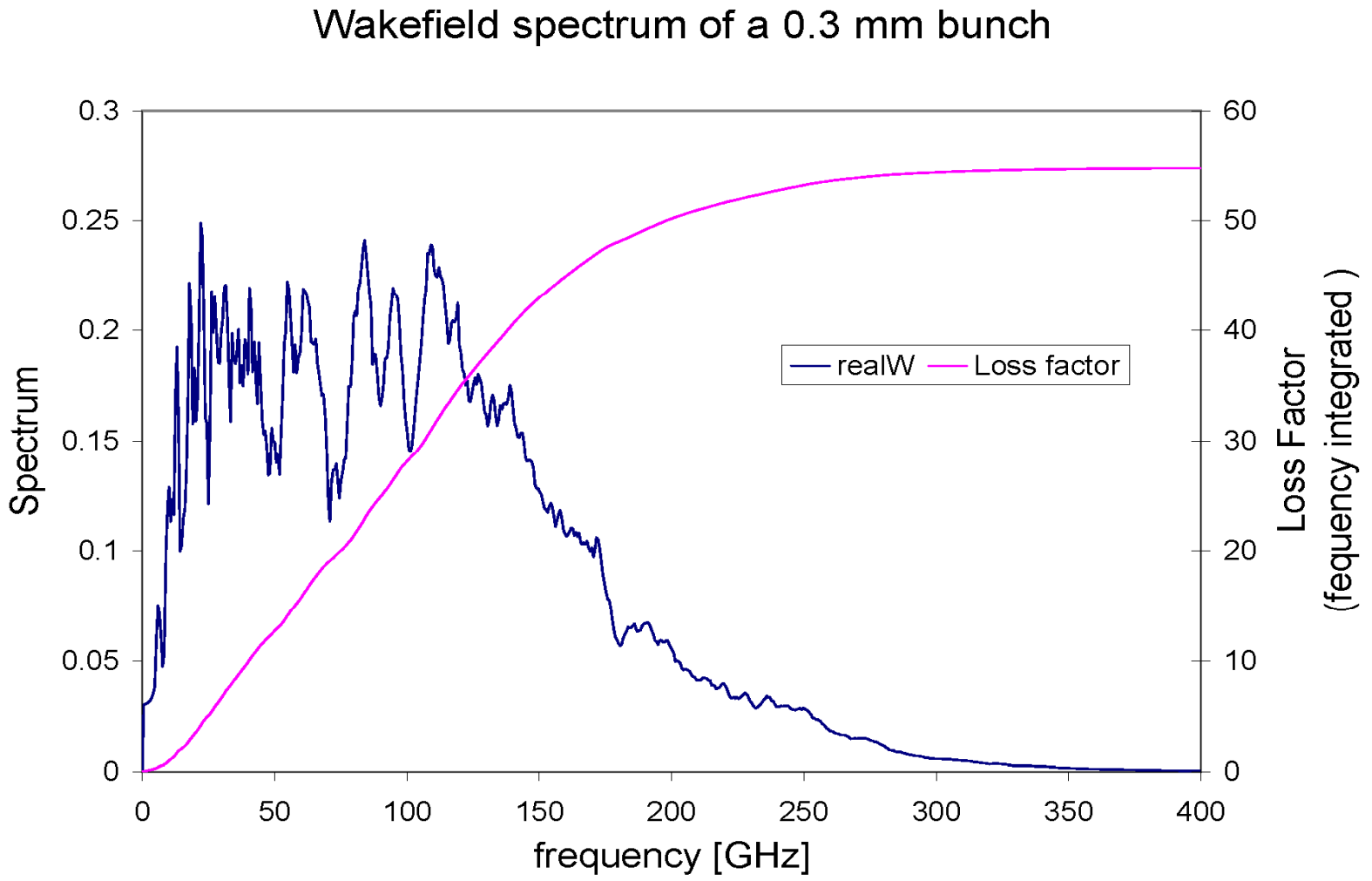
ILC IR Wake potential

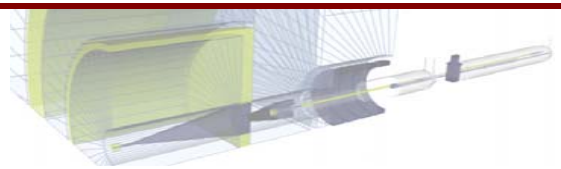




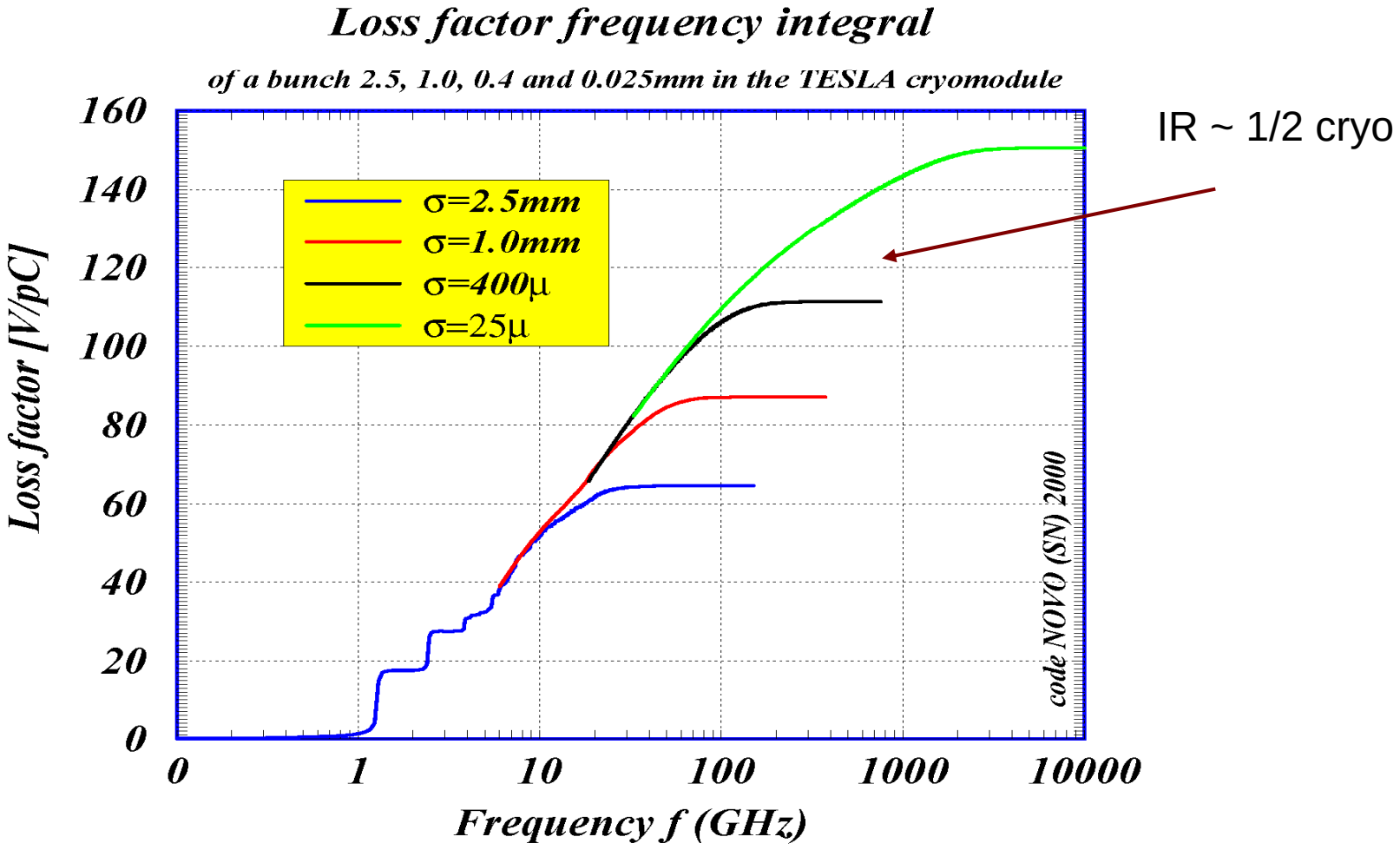


ILC IR Spectrum





Loss factor in TESLA crymodule



IR ~ 1/2 cryo

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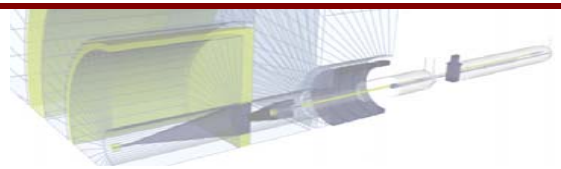
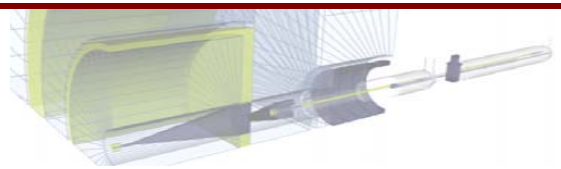


IP HOM Power

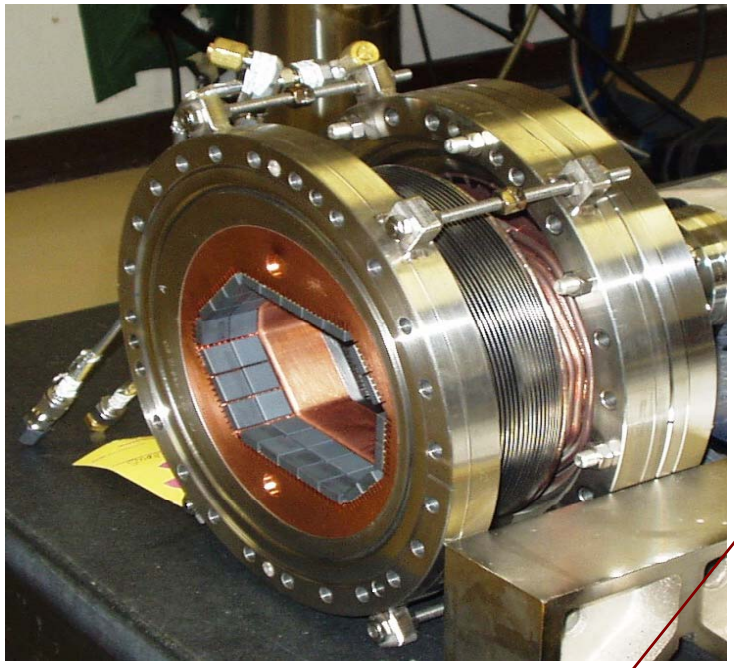
Incoherent Power

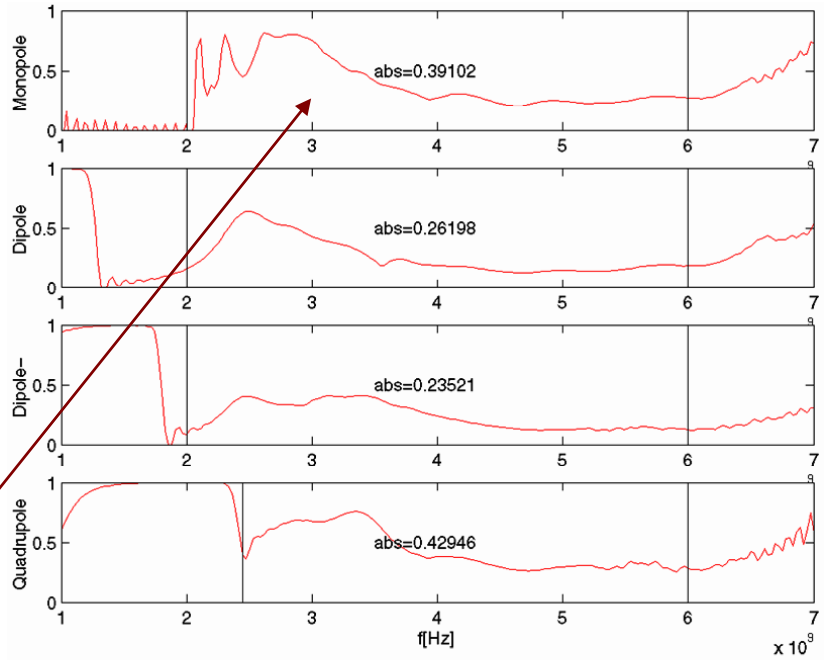
$$P = k\tau_b \left\{ (I_{e^+})^2 + (I_{e^-})^2 \right\}$$

Parameters	PEP-II	ILC
Bunch length [mm]	13	0.3
Loss factor [V/pC]	0.2484159	55.1
LER current [A]	2.4	0.025
HER current [A]	1.5	0.025
Bunch spacing [nsec]	4.2	337
Power loss (pulse) [kW]	8.3572072	23.210875
Average [W] (1 msec, 5 Hz)		116.05438



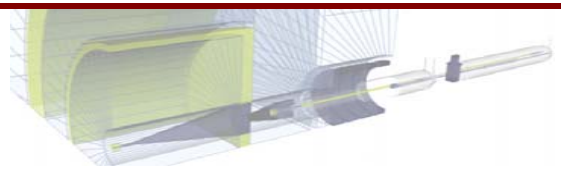
PEP-II IR Q2-bellows HOM absorbers



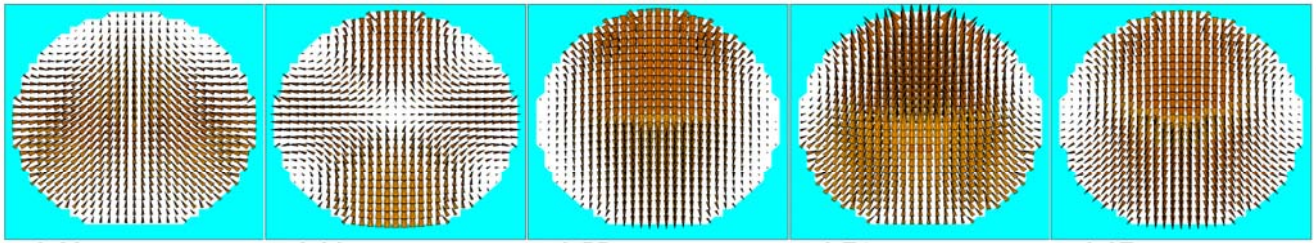


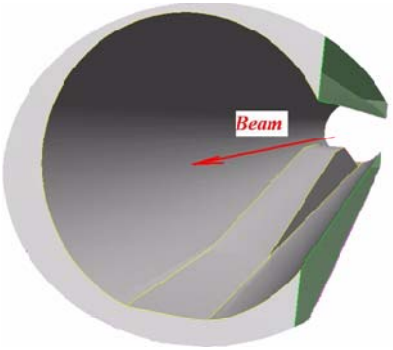
Cherenkov radiation

$$\kappa \approx \frac{cZ_0}{4\pi^{3/2}a} \cdot \frac{L}{\sigma\sqrt{\varepsilon}}$$



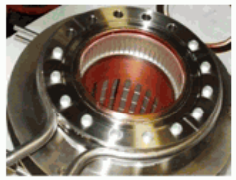
Straight bellows-absorber against collimator wake fields

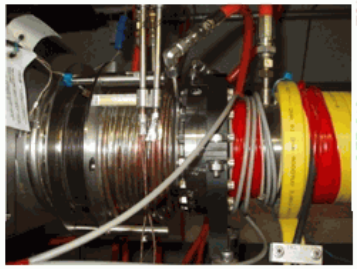




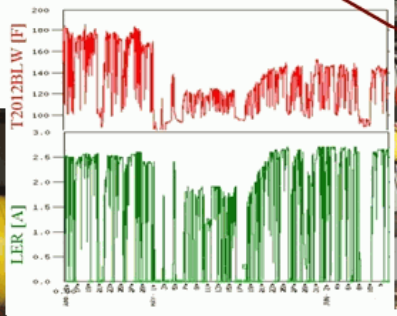
Operational Results

Build and install device between collimator and sensitive beam-line components

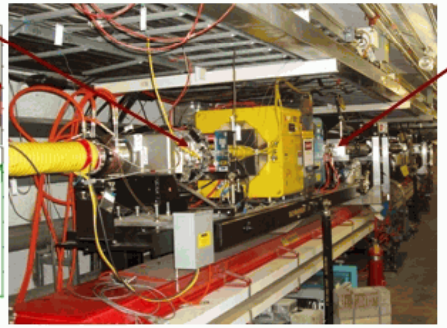




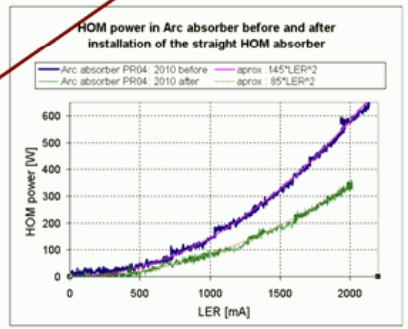
50% reduction in temperature rise in "Super-fan" bellows

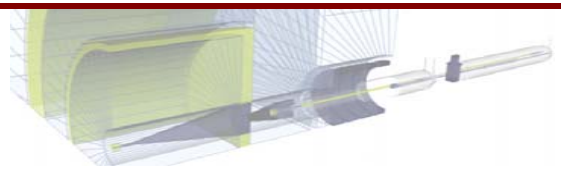


Temperature and power levels lower at nearby bellows, pump ports and anti-chambers

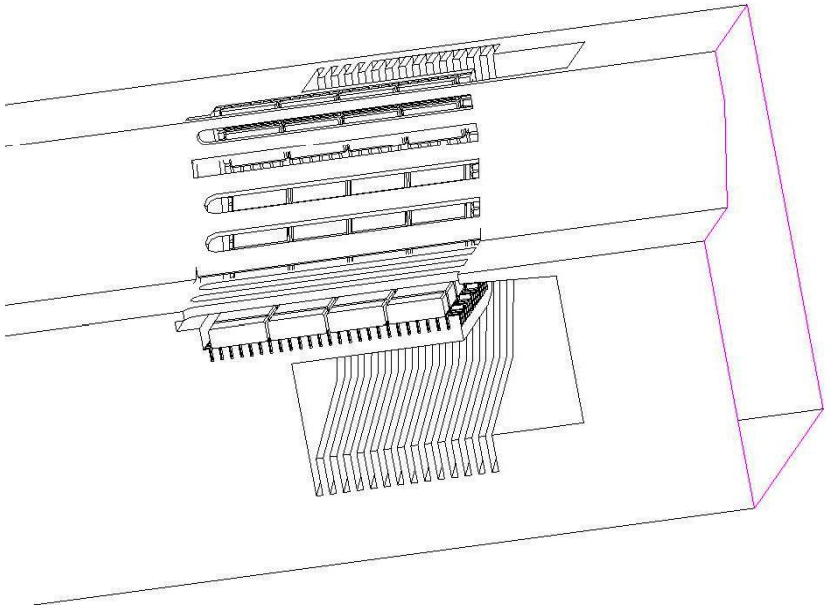


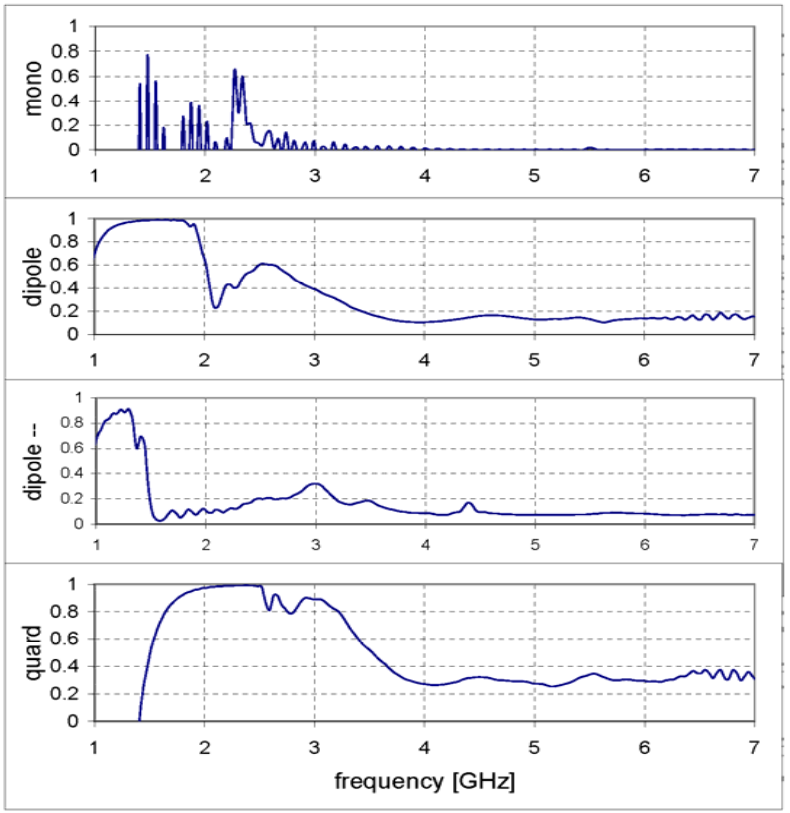
41% efficiency measured from the power change in the Arc absorber



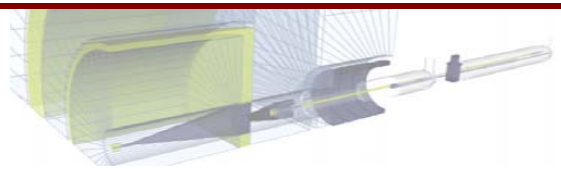


A computer model for a new Q2-bellows

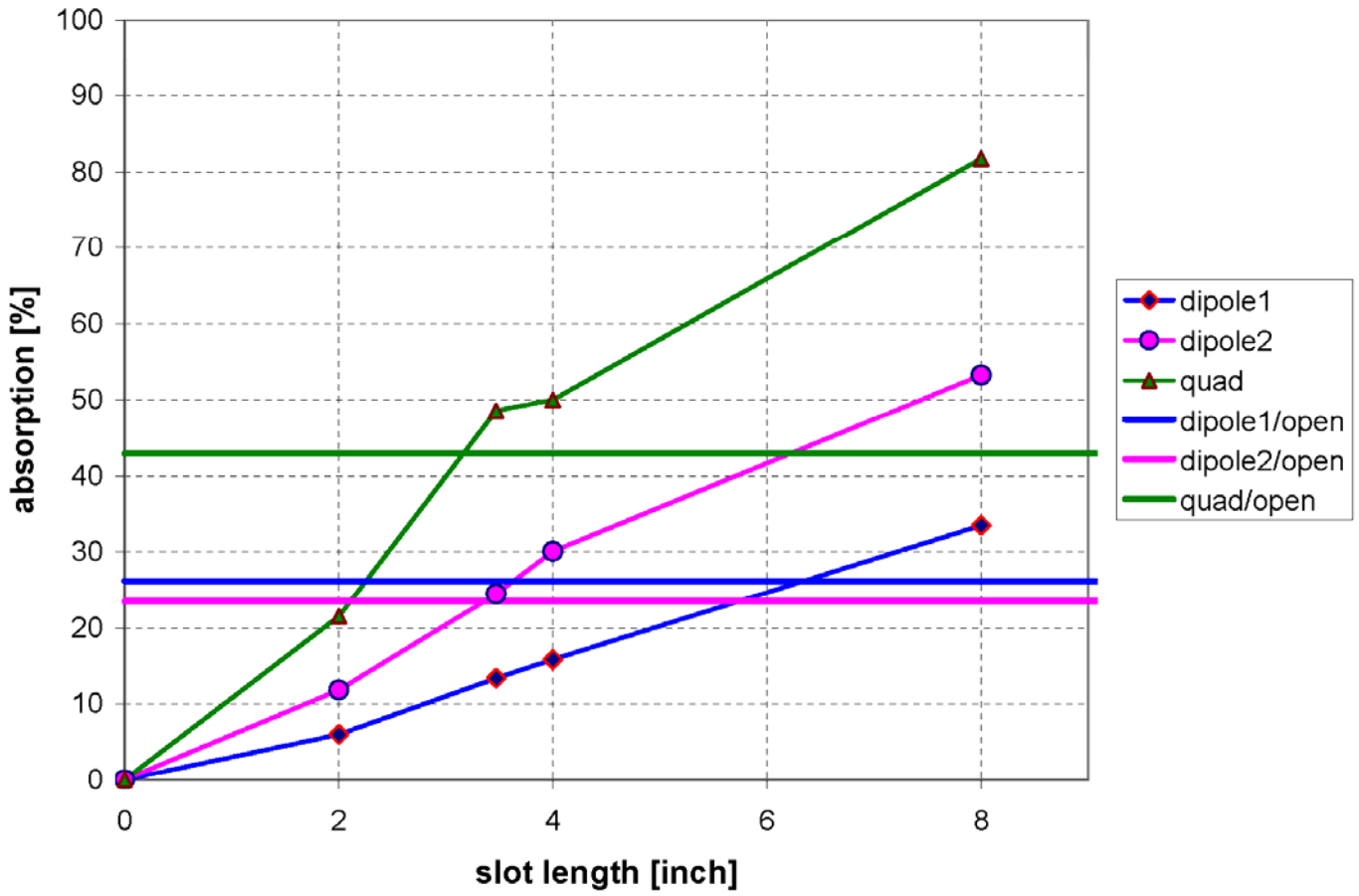


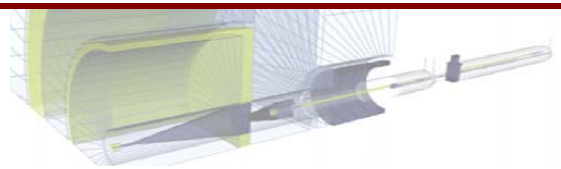


Absorbing parameters of a new Q2 absorber

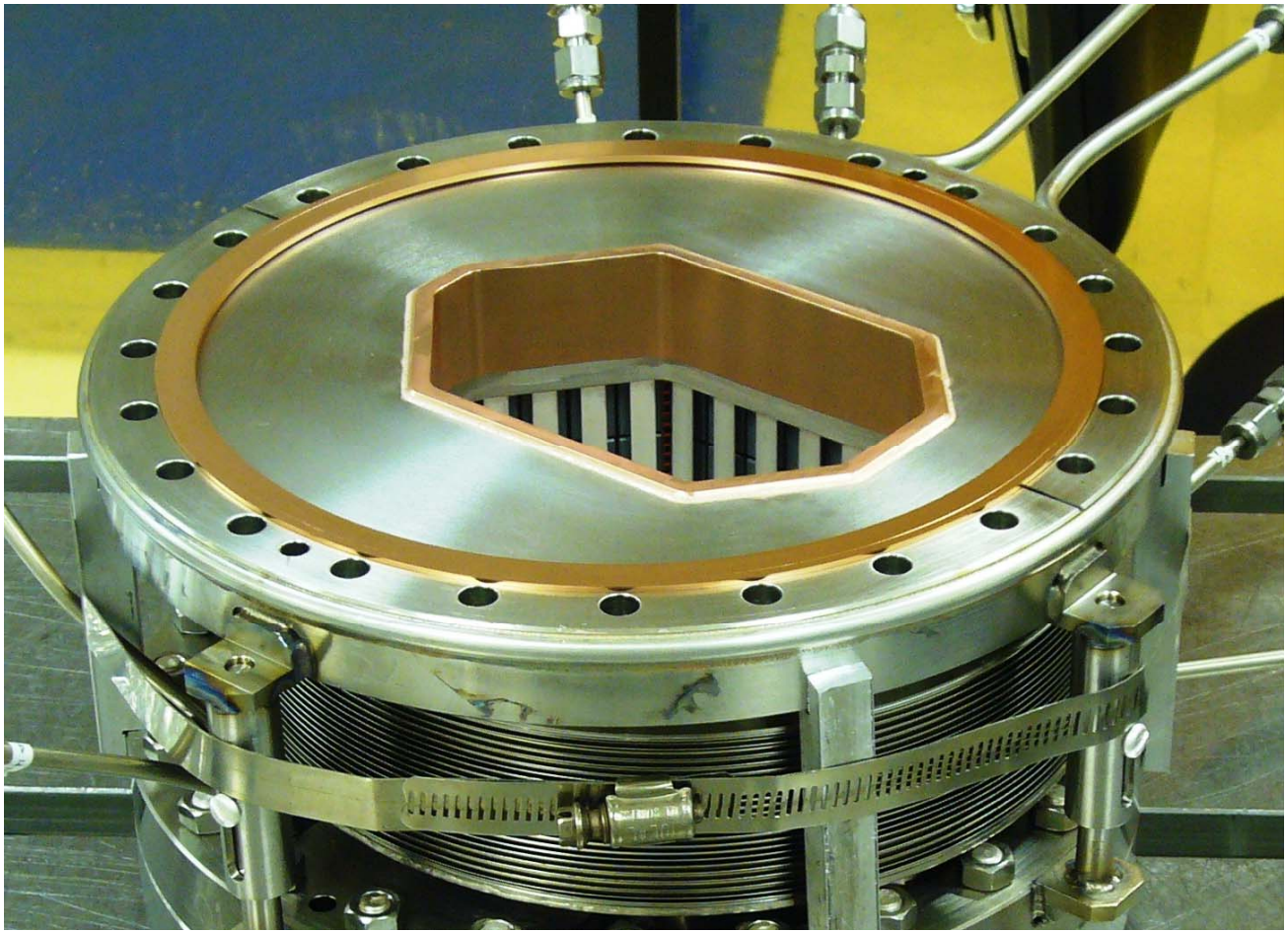


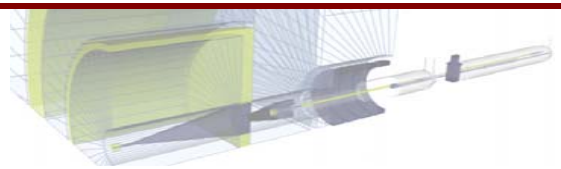
Absorber efficiency as a function of a slot length





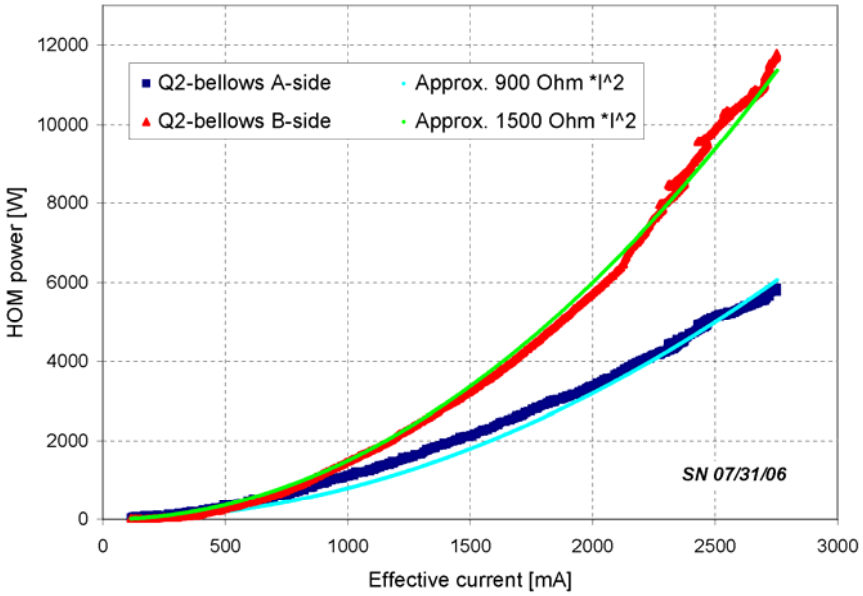
A new Q2-bellows



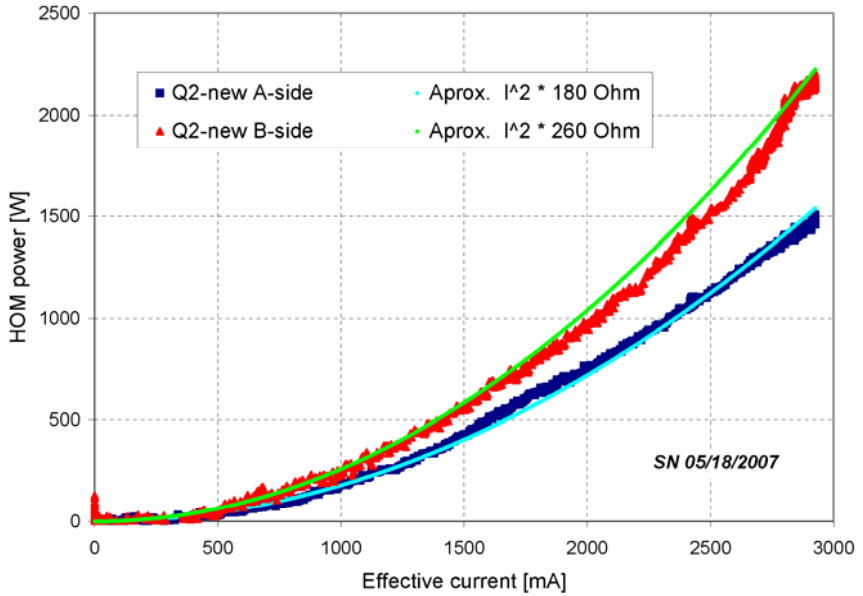


HOM Power in Q-2s

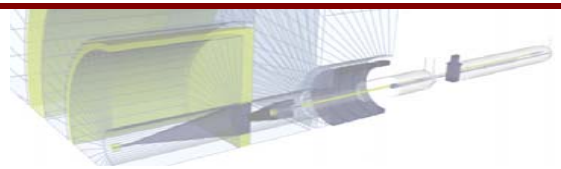
Old



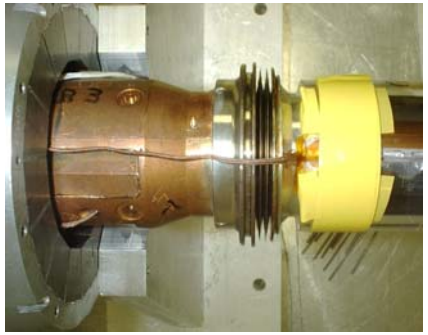
New



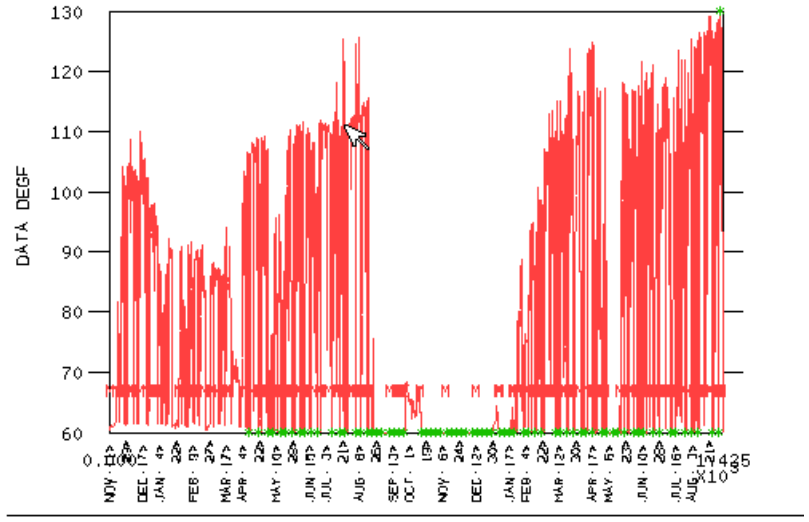
Effect: five times less power

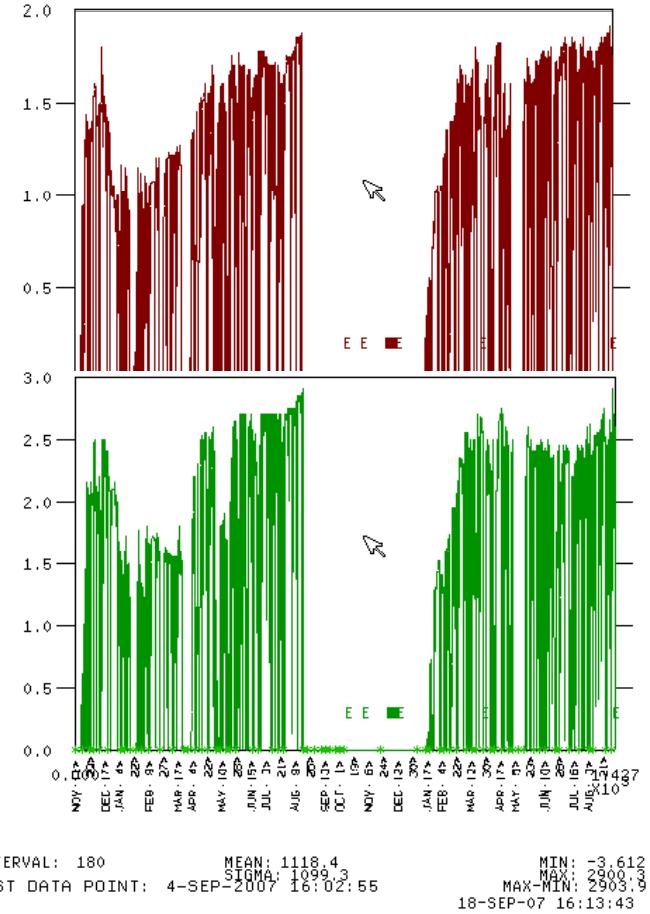


HOM power in a vertex bellows increased only by 20%



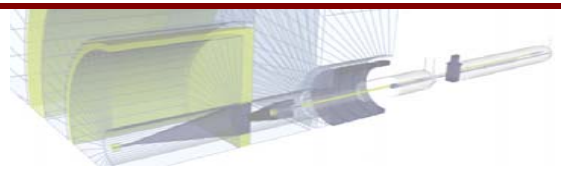
Temperature in VTX bellows



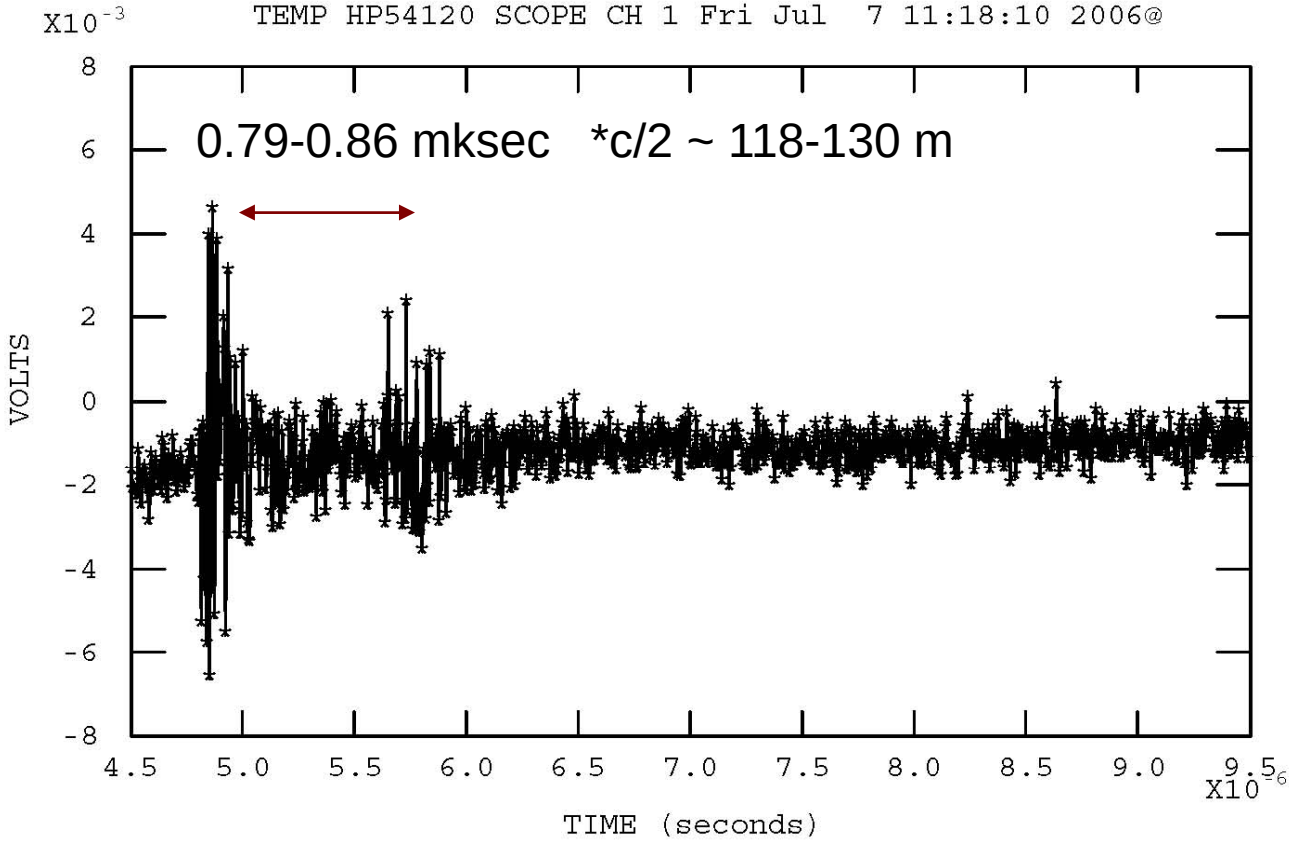


HER

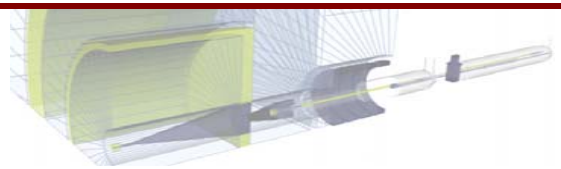
LER

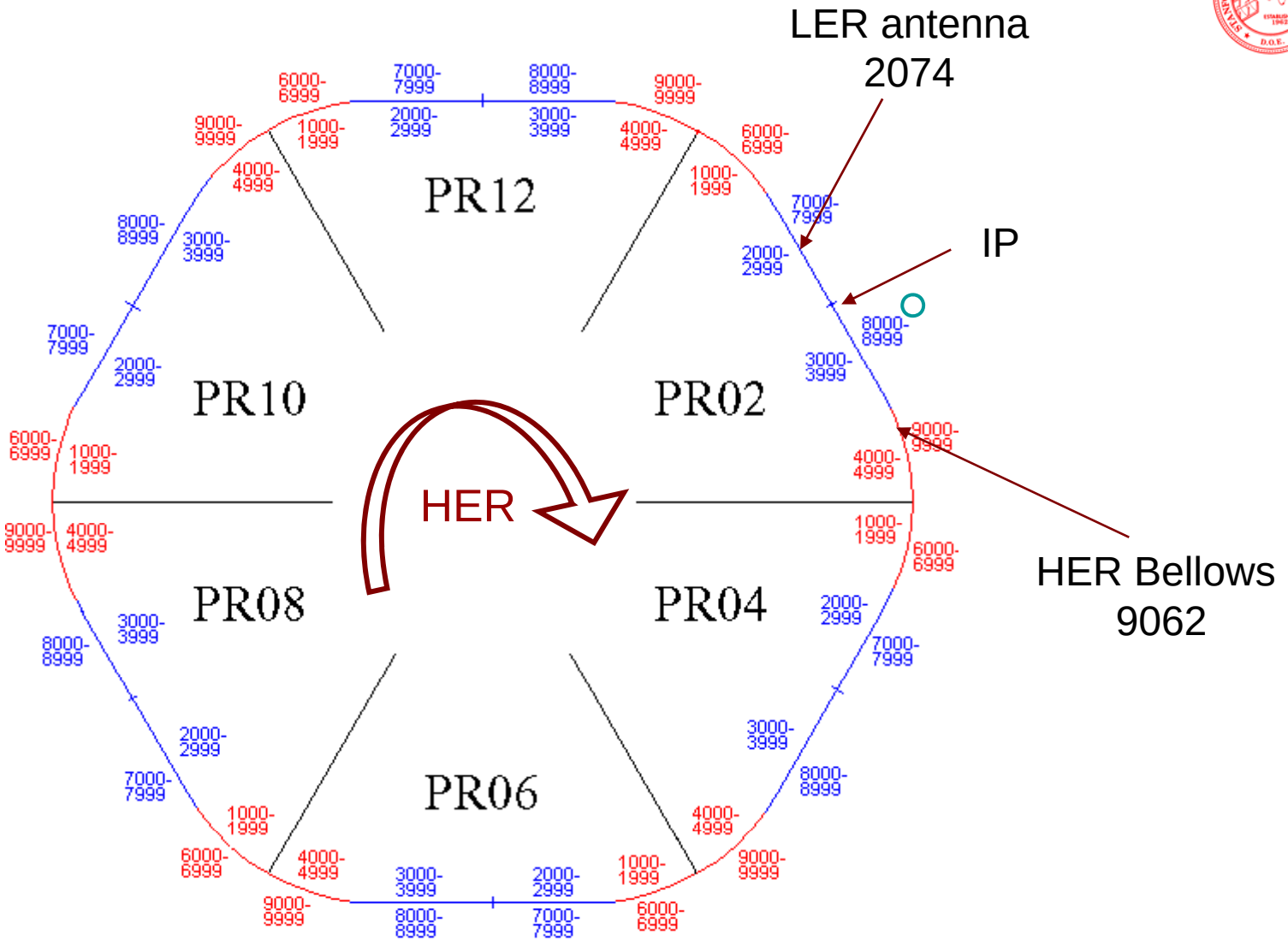


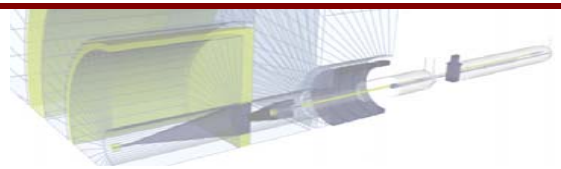
How far wake field can propagate?



Signal of a HER bunch captured by antenna in the LER ring

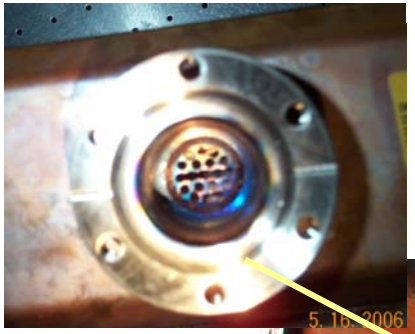



LER antenna
2074
IP
HER Bellows
9062
HER
PR12
PR10
PR02
PR08
PR04
PR06

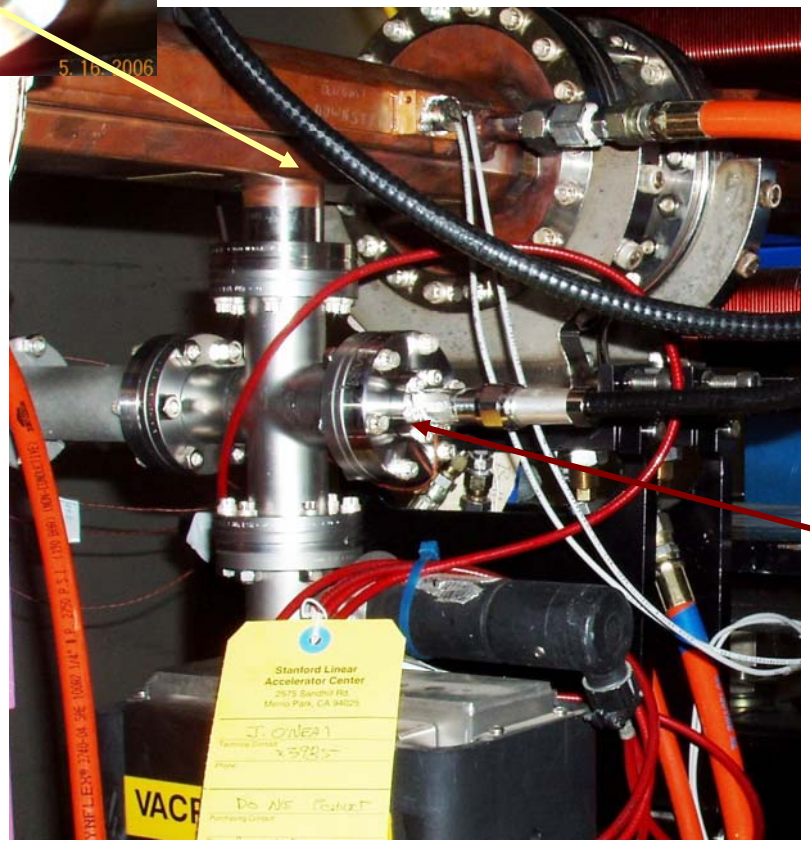


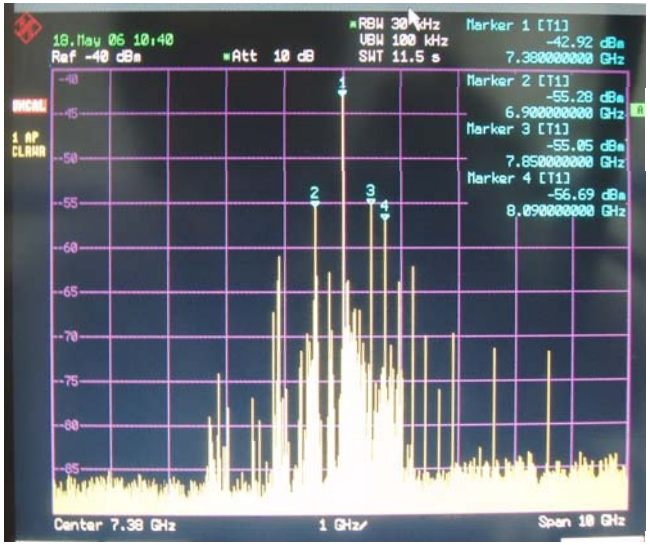
Antenna

7 GHz



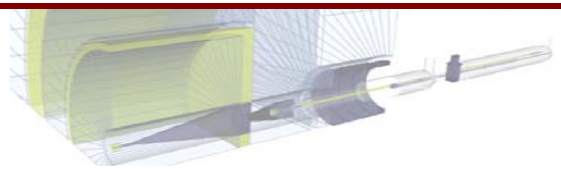
Coupling slots



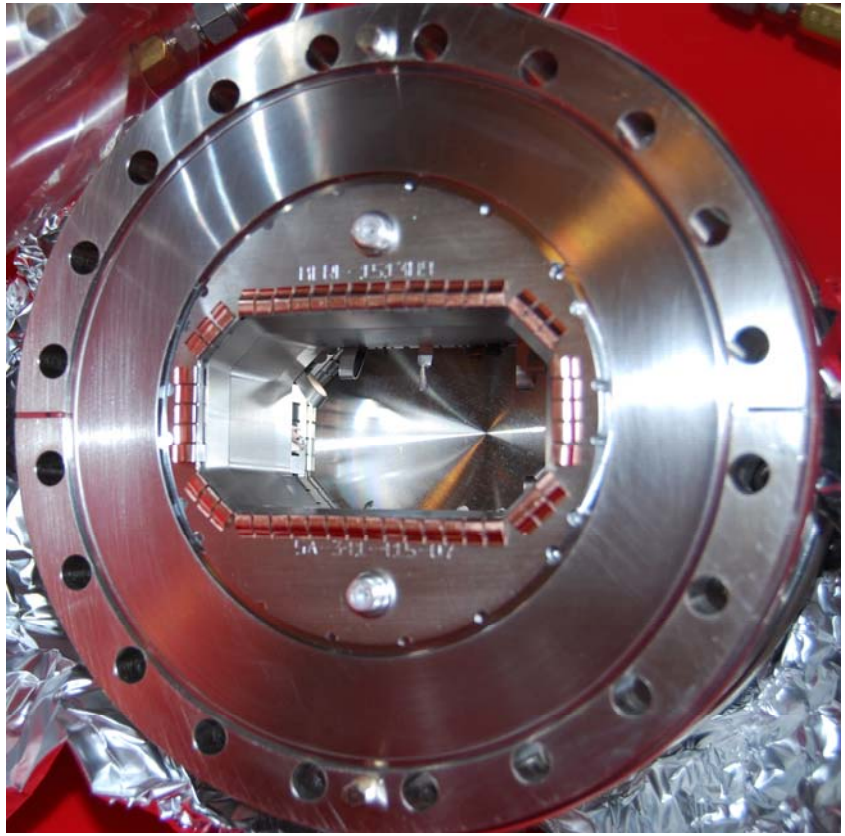


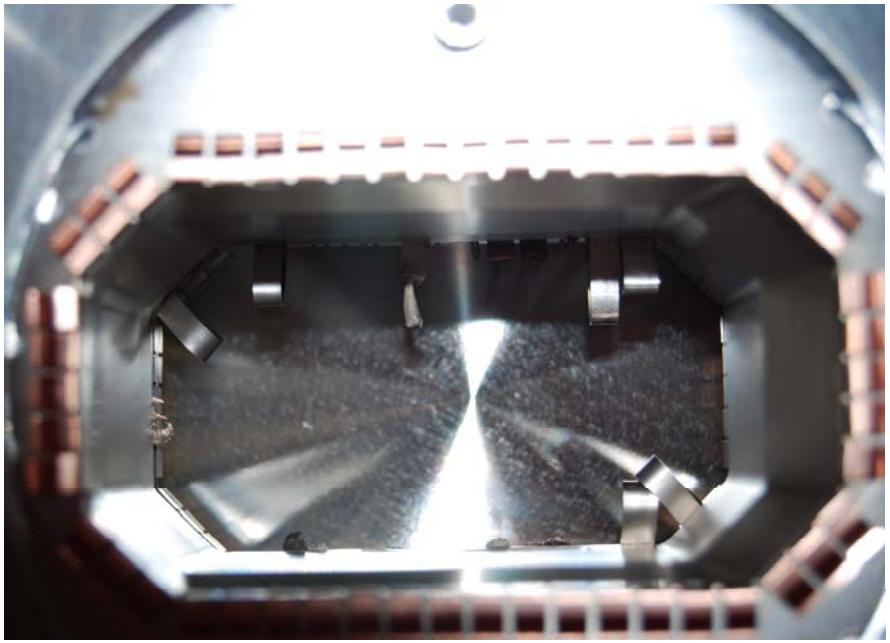
spectrum

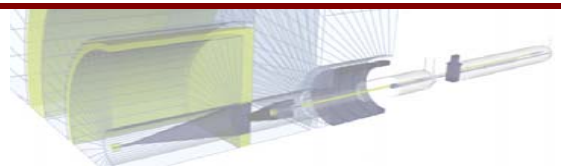
antenna



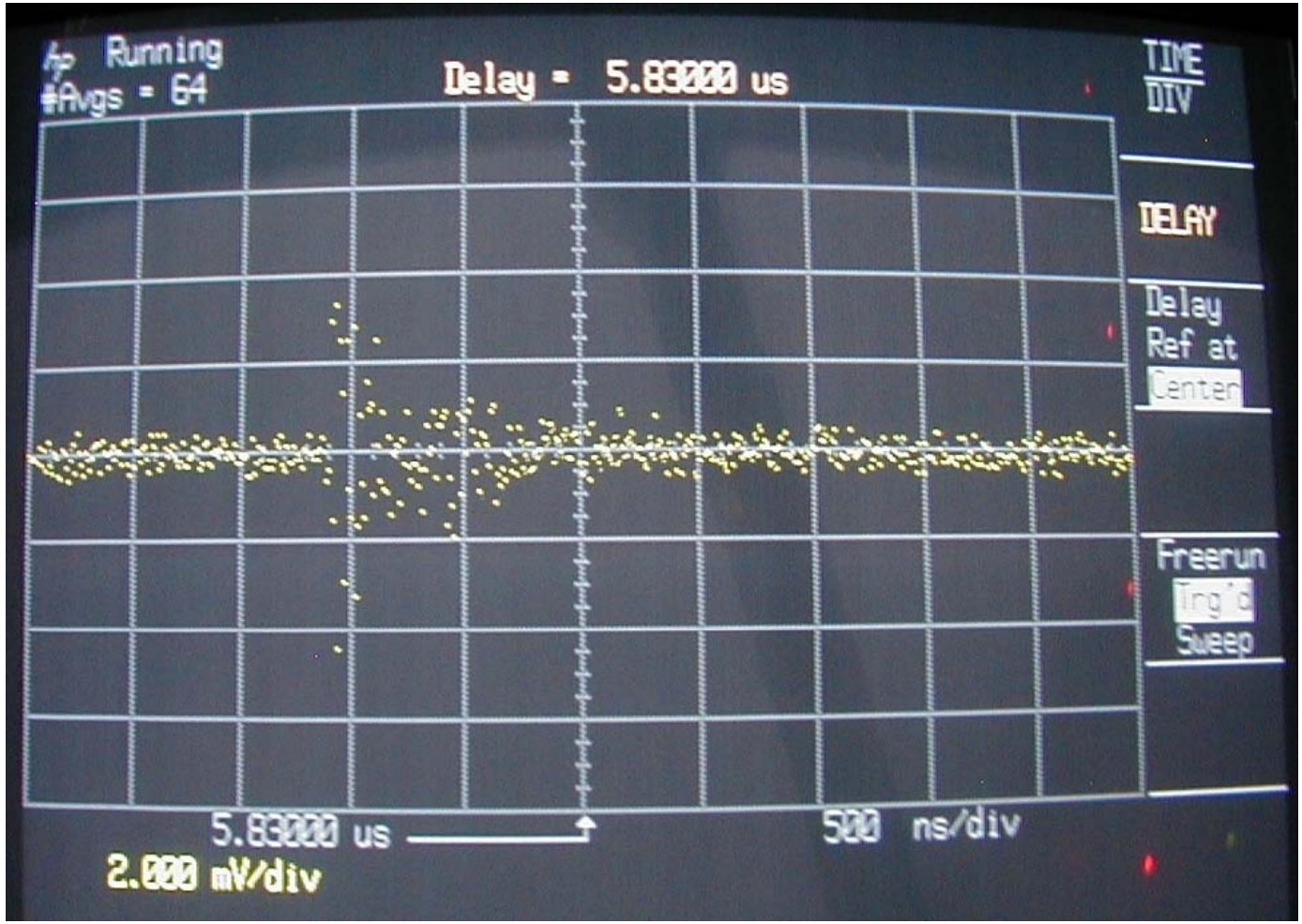
Arc bellows PR02:9092 is a HOM generator

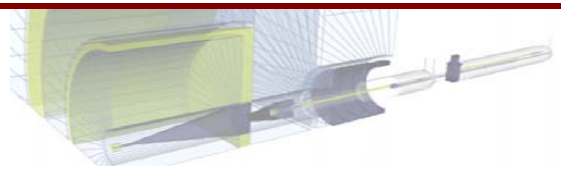


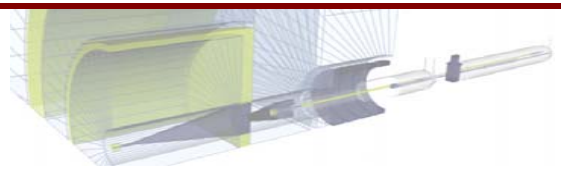




After bellows replacement





Summary

- An IR loss factor is approximately half of the loss factor getting by a bunch in an accelerating cryo-module.
- Addition energy spread at IR is not more than 0.2 MeV
- Average power of IR wake fields is of order of 100 W, when pulse power is of order of tens of kilowatts.
- The spectrum of the wake fields is bounded by 250-300 GHz
- Transverse wake fields may travel long distance and penetrate inside bellows, pumps and vacuum valves and may interfere with sensitive electronics.
- HOM absorbers must be designed in the way not to produce additional beam energy losses, absorbing mainly transverse fields and high frequency part of the longitudinal fields.