Wake field potentials of the ILC Interaction Region Upgrade of Part 2

Sasha Novokhatski

ARD MDI Meeting, SLAC
October 7, 2010

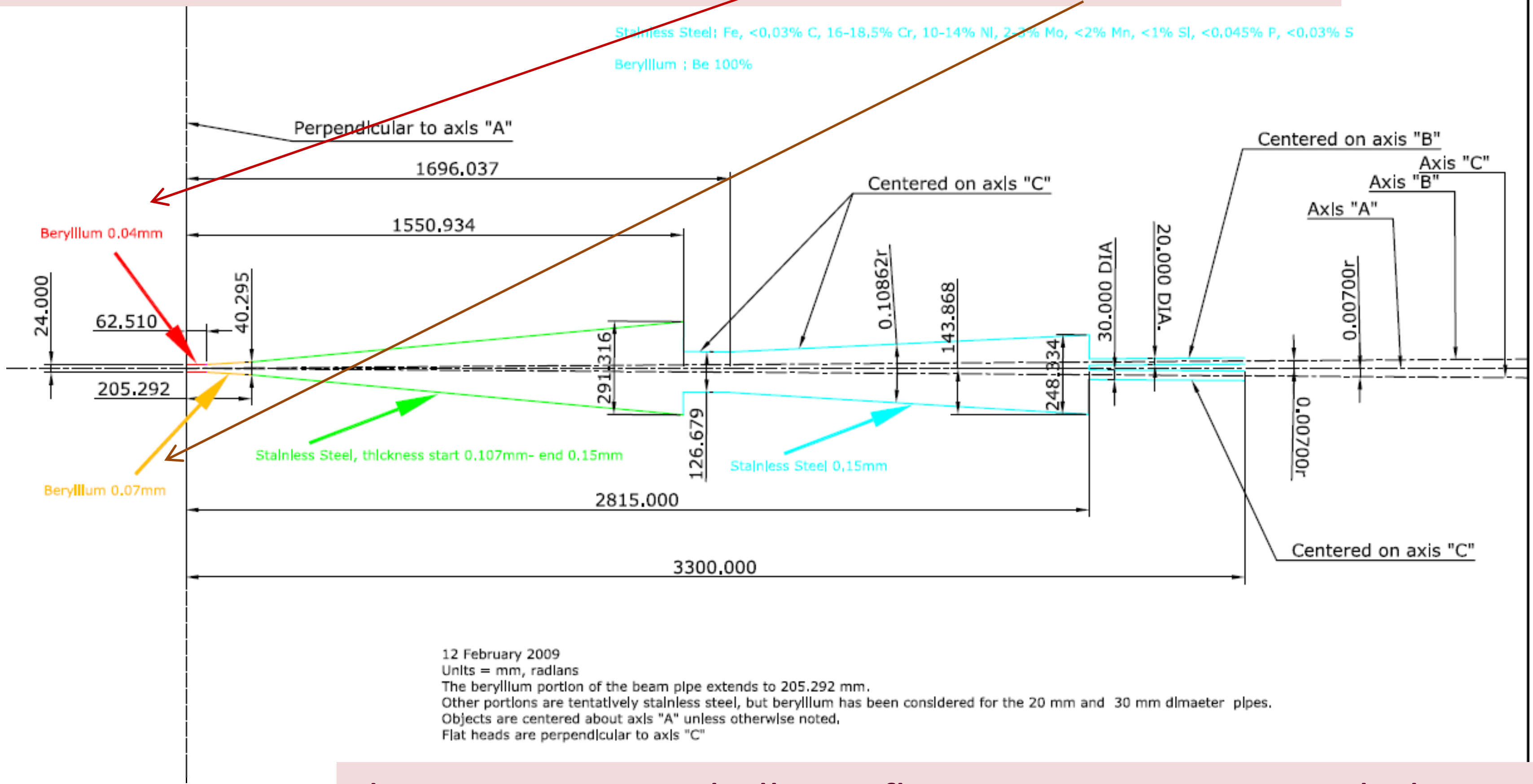
NATIONAL ACCELERATOR LABORATORY

Outline

- *Reference geometry*
- *More detailed study of the power of trapped modes.*
- *Min-Max estimations*

ILC IR geometry from Marco Oriunno

Comments from Takhashi Maruyama:
The thickness of the cylindrical beam pipe is 400 microns,
and of the conical section is 700 microns.



does not contains bellows, flanges, BPMs, pumping holes, …

Interaction with one mode

Mode voltage decay $V(t) = V(o)\, e^{-\frac{t}{\tau_{l,n}}}$

Loaded time decay
or filling time $\tau_{l,n} = \frac{2Q_l}{\omega_n} = \frac{2Q_l}{2\pi f_n} = \frac{Q_l}{\pi f_n}$

Loaded Q-value
which includes coupling Q_l

Bunch spacing τ_b

Mode **survives** to
the next bunch if $\frac{\tau_b}{\tau_{l,n}} << 1$

And loaded Q $Q_l >> \frac{\omega_n \tau_b}{2} = \pi f_n \tau_b$

Coherent and incoherent excitation

	Incoherent	Coherent at resonance
condition	$Q_l << \pi f_n \tau_b$	$Q_l >> \pi f_n \tau_b$
Loss power	$P_n = I^2 \frac{\omega_n}{2} \frac{R}{Q} \tau_b$	$P_n = I^2 \frac{R}{Q} Q_l$
Loss factor $k_n = \frac{\omega_n}{2} \frac{R}{Q}$	$P_n = I^2 k_n \tau_b$	$P_n = 2I^2 k_n \tau_{l,n}$

If the bunch spacing is equal to mode decay time the coherent power is only two times larger than incoherent power

Total loss power (all trapped modes)

Total power $P_{incoh.} = I^2 \tau_b \sum_n k_n$ $P_{coh.} = 2I^2 \sum_n k_n \tau_{l,n}$

Trapped mode frequency range 0.85 – 11.5 GHz

Bunch spacing 369.2 ns

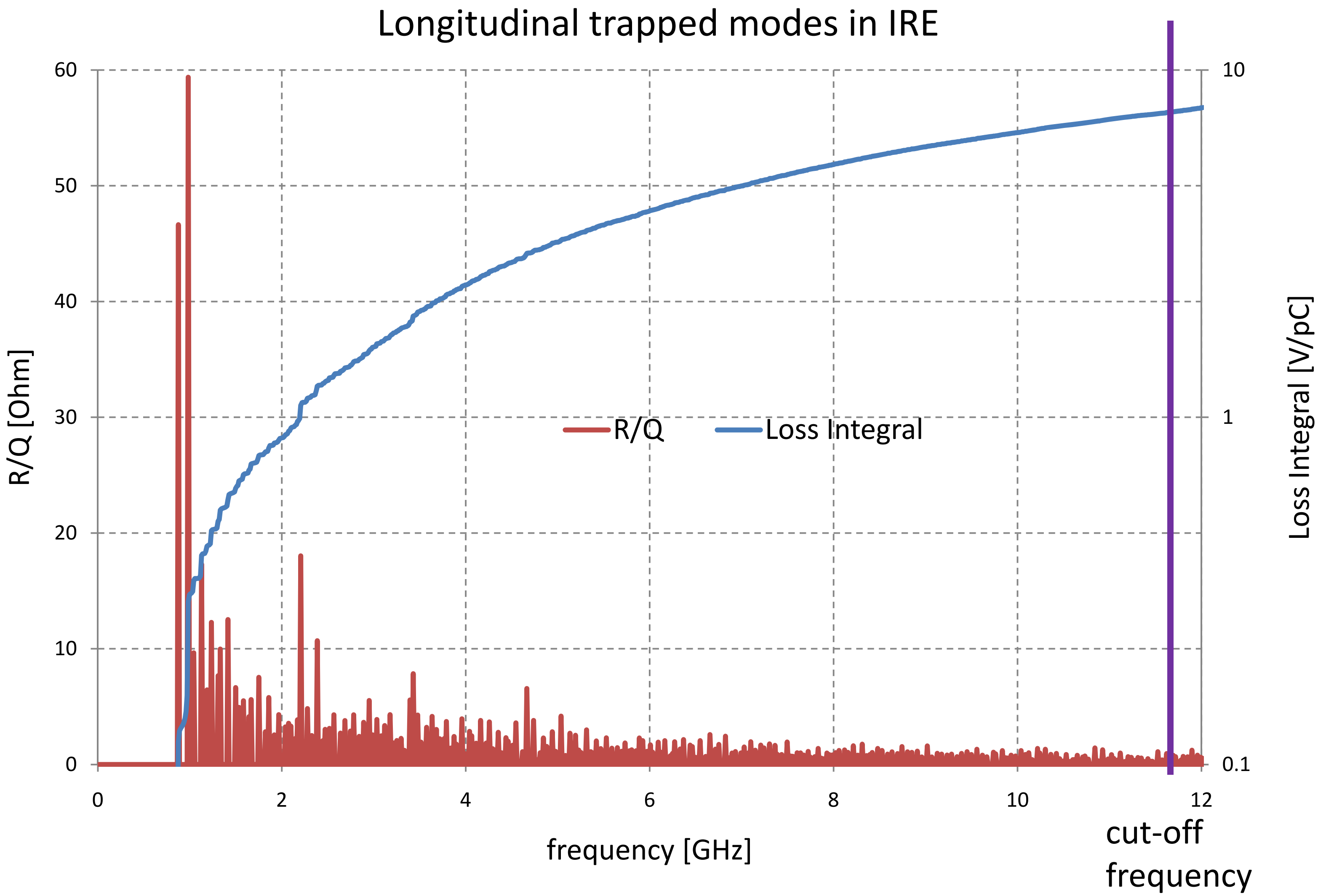
Loaded Q $Q_l = \pi f_n \tau_b$ 990 - 13300

$$\sum_n k_n = 7.3 \text{ V/pC}$$

$$P_{incoh.} = 440 \text{ W} \qquad P_{coh.} = 880 \text{ W}$$

Average power is 200 times smaller

R/Q of trapped modes



Power loss. Not so much.

Resistive wall wakes		Be 40 mu	a [mm]	L/2 [m]		Total resistive	Power [W]
			12	0.0625			
bunch [mm]	f bunch	1/mm	V/pC/m		Power [W]		
0.2	238.7324146	5	0.7710933		5.764924839		224.4359994
0.3	159.1549431	3.333333333	0.4153219		3.105071121		114.3046605
0.5	95.49296586	2	0.1917086		1.433271006		45.96733098
Resistive wall wakes		Be 70 mu	a [mm]	L/2 [m]			
			16	0.14279			
bunch [mm]	f bunch	1/mm	V/pC/m		Power [W]		
0.2	238.7324146	5	0.5829		9.956313235		
0.3	159.1549431	3.333333333	0.3127758		5.342415229		
0.5	95.49296586	2	0.1440609		2.460654392		
Resistive wall wakes		SS 150 mu	a [mm]	L/2 [m]			
			82.81	1.345644			
bunch [mm]	f bunch	1/mm	V/pC/m		Power [W]		
0.2	238.7324146	5	0.6931		111.5662359		
0.3	159.1549431	3.333333333	0.3488		56.14529371		
0.5	95.49296586	2	0.1386		22.31002783		
Resistive wall wakes		SS 150 mu	a [mm]	L/2 [m]			
			63.3485	0.145			
bunch [mm]	f bunch	1/mm	V/pC/m		Power [W]		
0.2	238.7324146	5	0.8888		15.41625022		
0.3	159.1549431	3.333333333	0.4305		7.467029388		
0.5	95.49296586	2	0.174		3.018032784		
Resistive wall wakes		SS 150 mu	a [mm]	L/2 [m]			
			93.8	1.119			
bunch [mm]	f bunch	1/mm	V/pC/m		Power [W]		
0.2	238.7324146	5	0.6106		81.73227528		
0.3	159.1549431	3.333333333	0.3156		42.24485109		
0.5	95.49296586	2	0.1251		16.74534497		

Next steps

- Continue Eigen mode simulations with MAFIA
  - Check several modes for Q-value
- Study other modes (transverse)
- Discuss new details or other shapes of IR