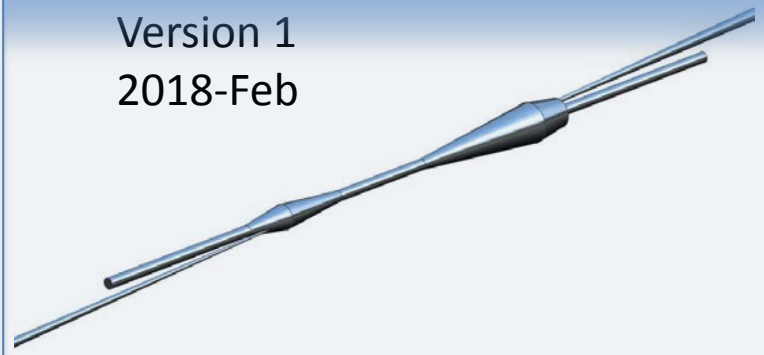
Status of IR Chamber Impedances Analyses (Status May 2019)

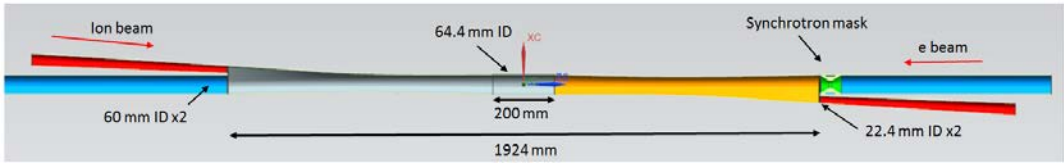
F. Marhauser

JLEIC IR Chamber Version History

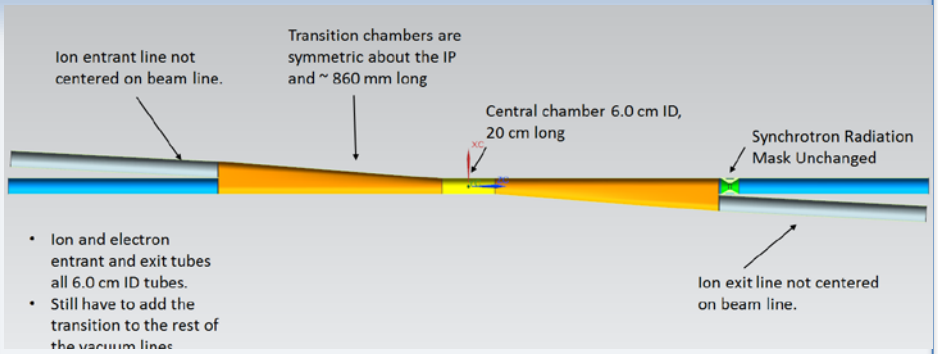
Version 1
2018-Feb



Version 2
2019-Feb

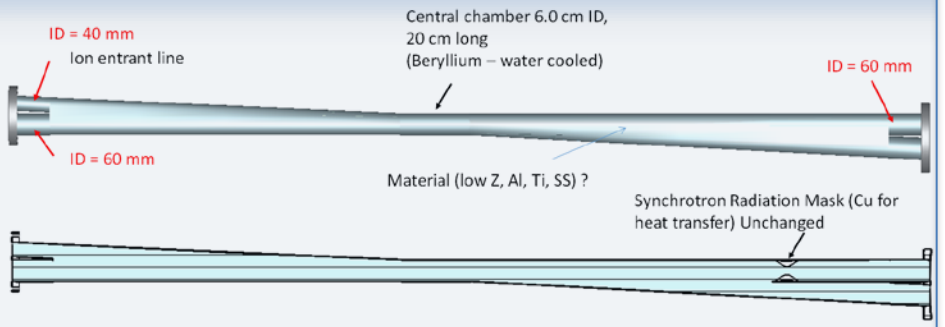


Version 3
2019-Feb

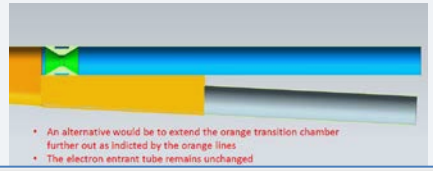


- Ion and electron entrant and exit tubes all 6.0 cm ID tubes.
- Still have to add the transition to the rest of the vacuum lines

Version 4
2019-April



ion beam entrant tube is smaller than others

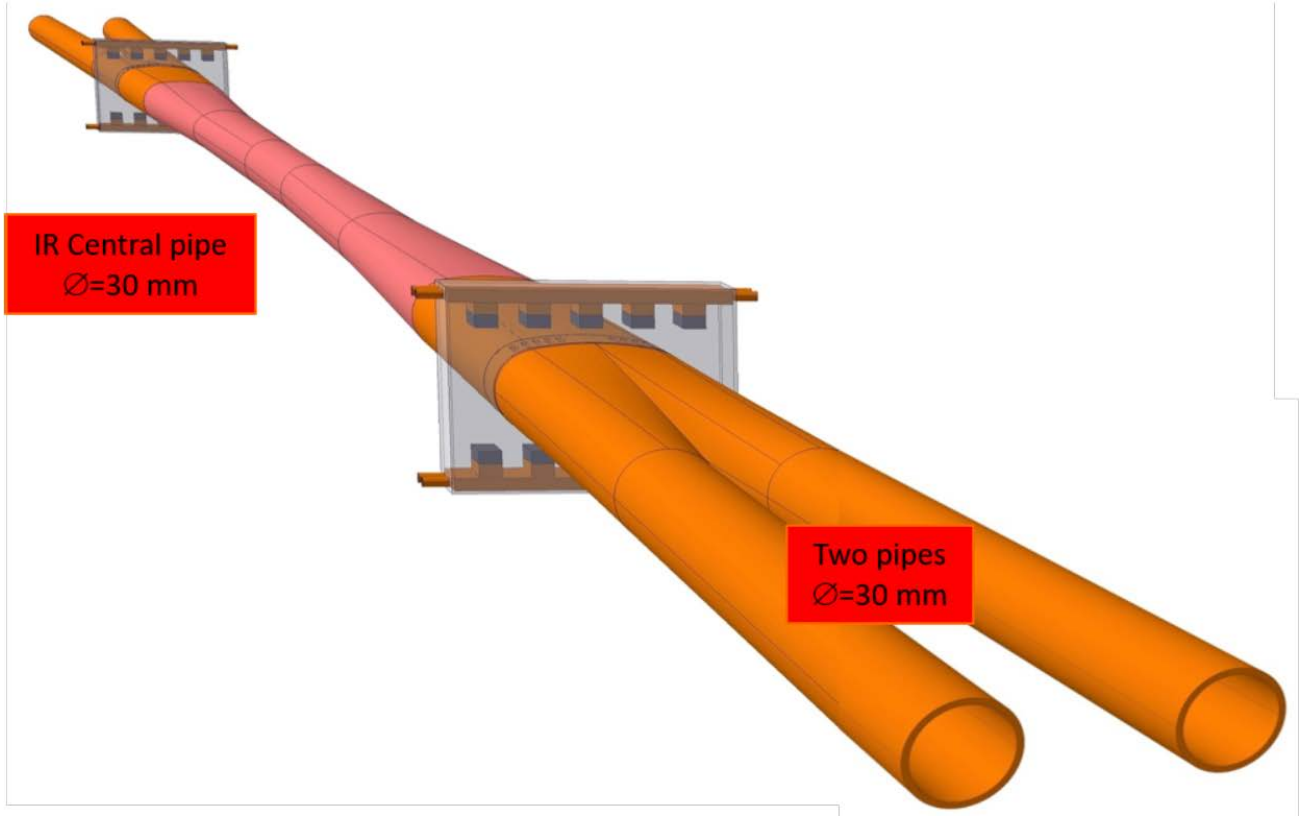


FCC IR Beam Pipe Geometry

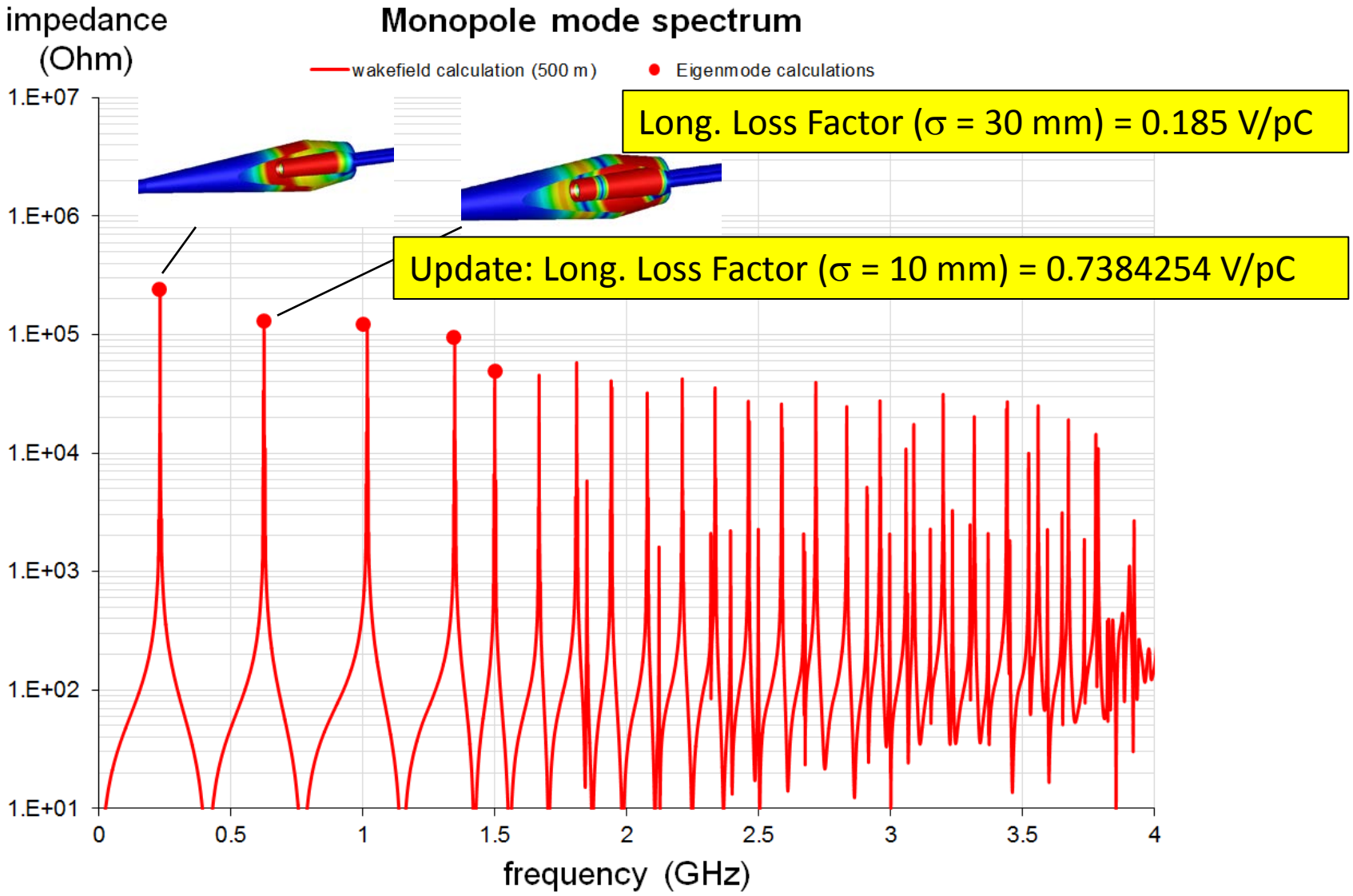
Alexander Novokhatski

SLAC National Accelerator Laboratory

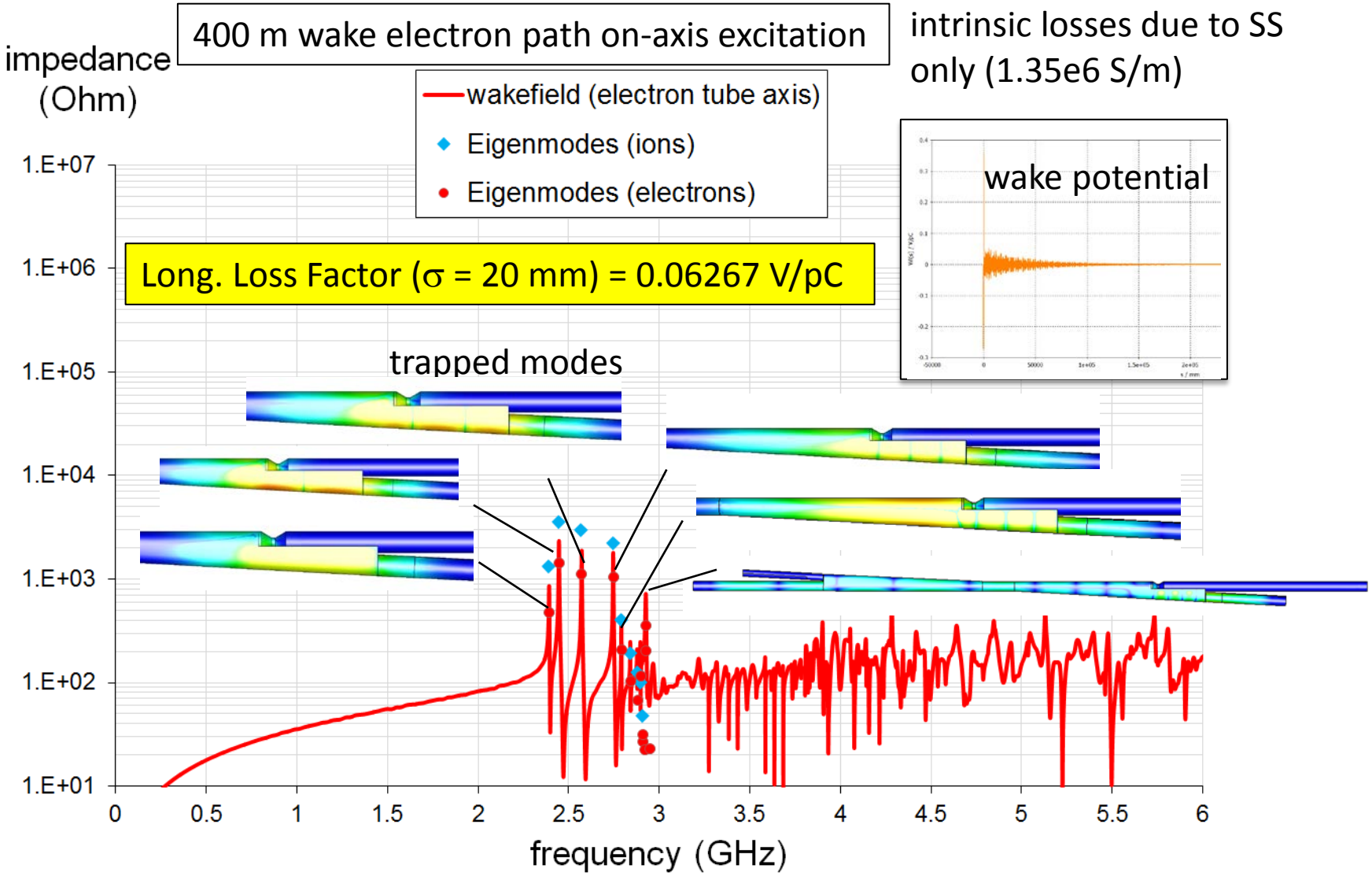
JLEIC Spring Collaboration Meeting
April 1, 2019



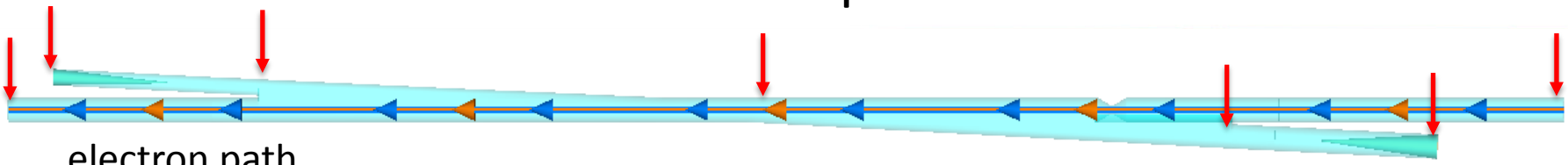
Version 1


impedance (Ohm)
Monopole mode spectrum
wakefield calculation (500 m)
Eigenmode calculations
Long. Loss Factor (σ = 30 mm) = 0.185 V/pC
Update: Long. Loss Factor (σ = 10 mm) = 0.7384254 V/pC
1.E+07
1.E+06
1.E+05
1.E+04
1.E+03
1.E+02
1.E+01
0
0.5
1
1.5
2
2.5
3
3.5
4
frequency (GHz)

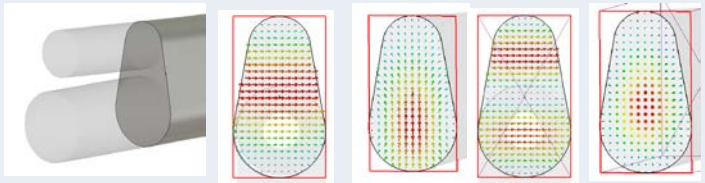
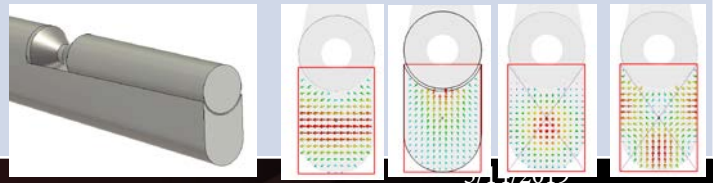
Version 4


400 m wake electron path on-axis excitation
intrinsic losses due to SS only (1.35e6 S/m)
impedance (Ohm)
wakefield (electron tube axis)
Eigenmodes (ions)
Eigenmodes (electrons)
wake potential
Long. Loss Factor (σ = 20 mm) = 0.06267 V/pC
trapped modes
1.E+07
1.E+06
1.E+05
1.E+04
1.E+03
1.E+02
1.E+01
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6
frequency (GHz)

Cutoff Frequencies



electron path

Item	ID mm	f_c TE_{11}(-like)	f_c TM_{01}(-like)
unit	mm	GHz	GHz
- e- entrant and exit tube - ion exit tube - central IR chamber	60	2.93	3.83
ions inlet	40	4.39	5.74
transition chamber (ion entrant tube) 	n/a	1.60 pol. I 2.90 pol. II 3.08 (TE20-like) 3.24	3.22
transition chamber (e- entrant tube) 	n/a	2.327 pol. I & II	3.50 (TE_{21}) 3.54

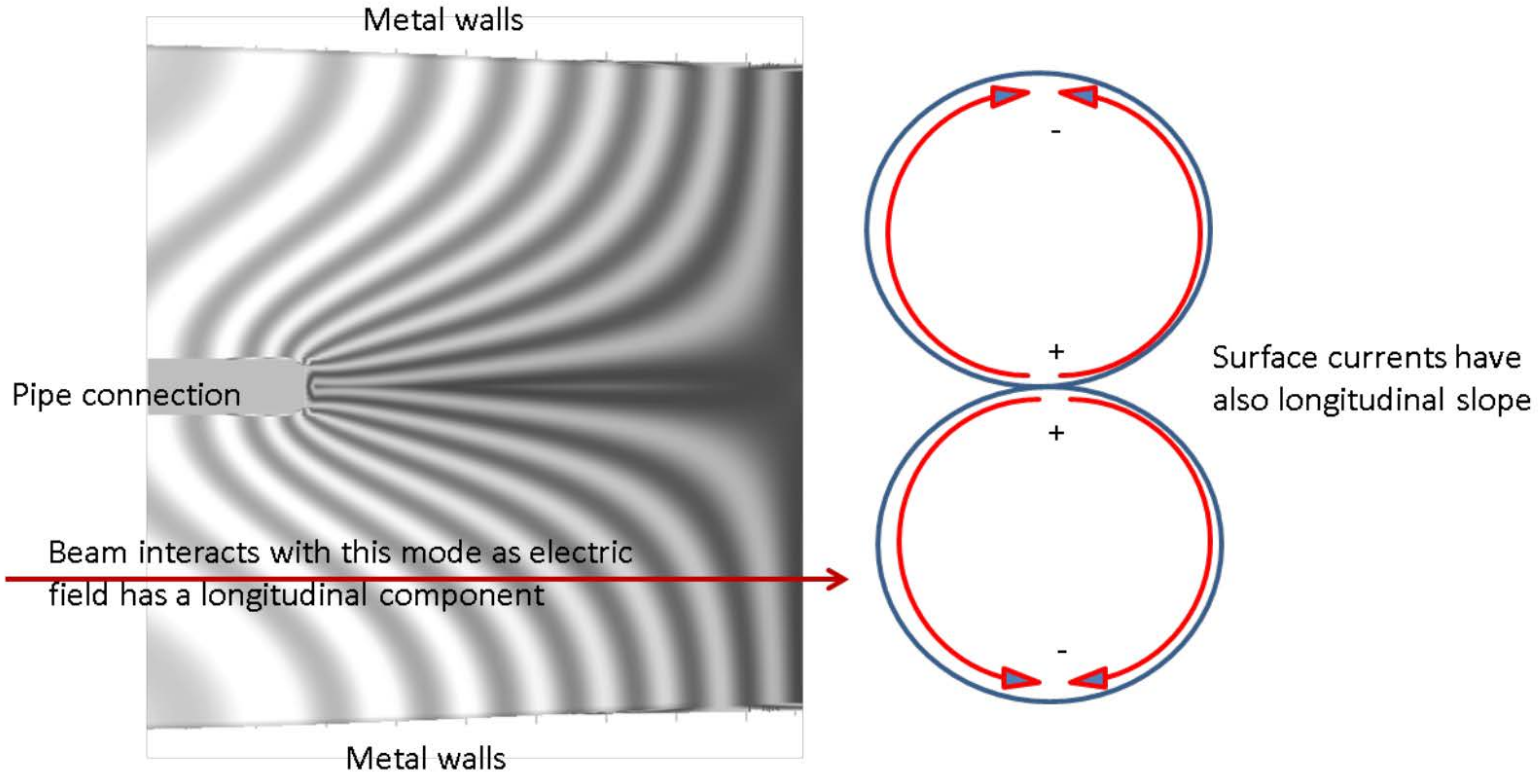
Trapped Modes

Alexander Novokhatski

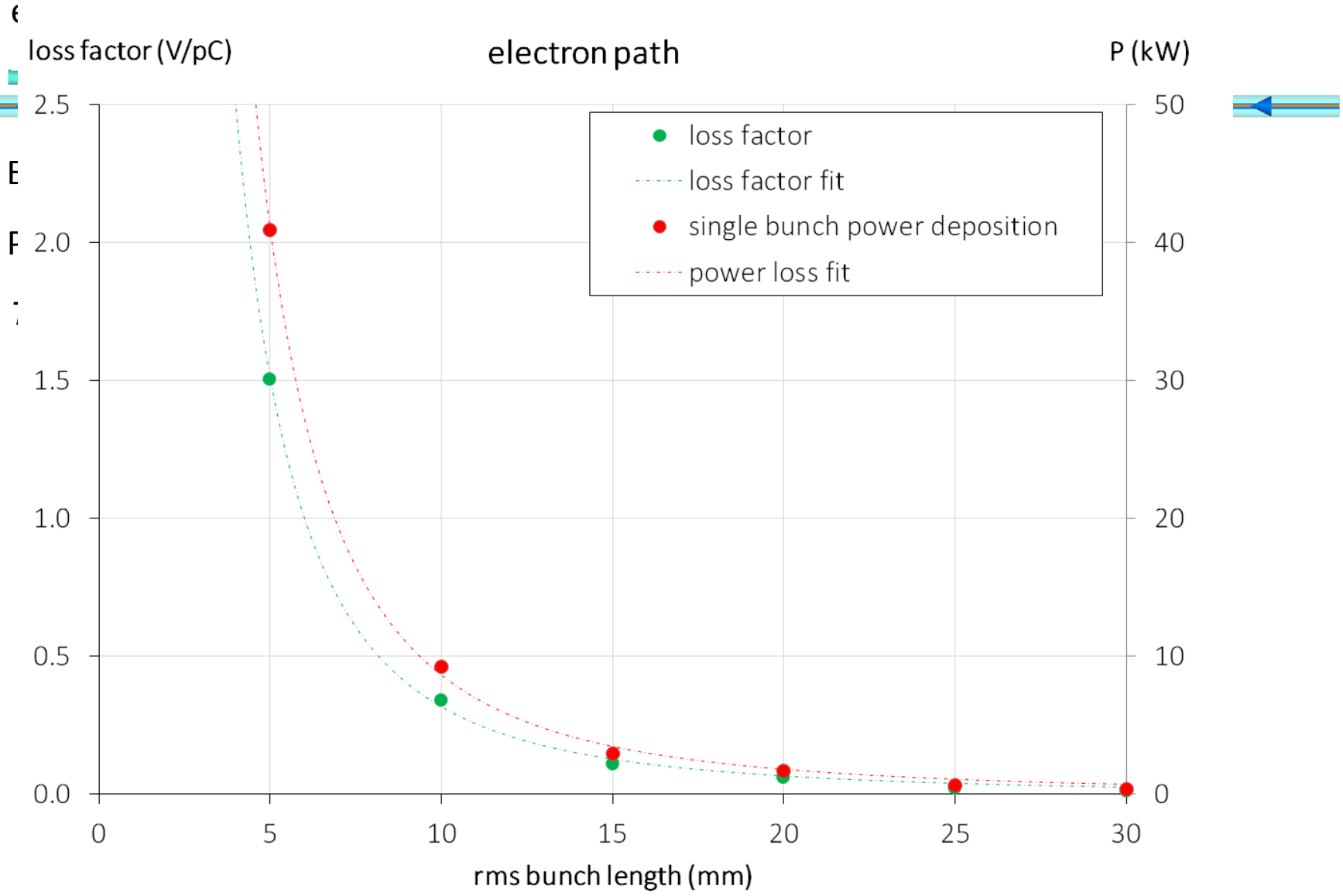
SLAC National Accelerator Laboratory

JLEIC Spring Collaboration Meeting
April 1, 2019

An unavoidable trapped mode

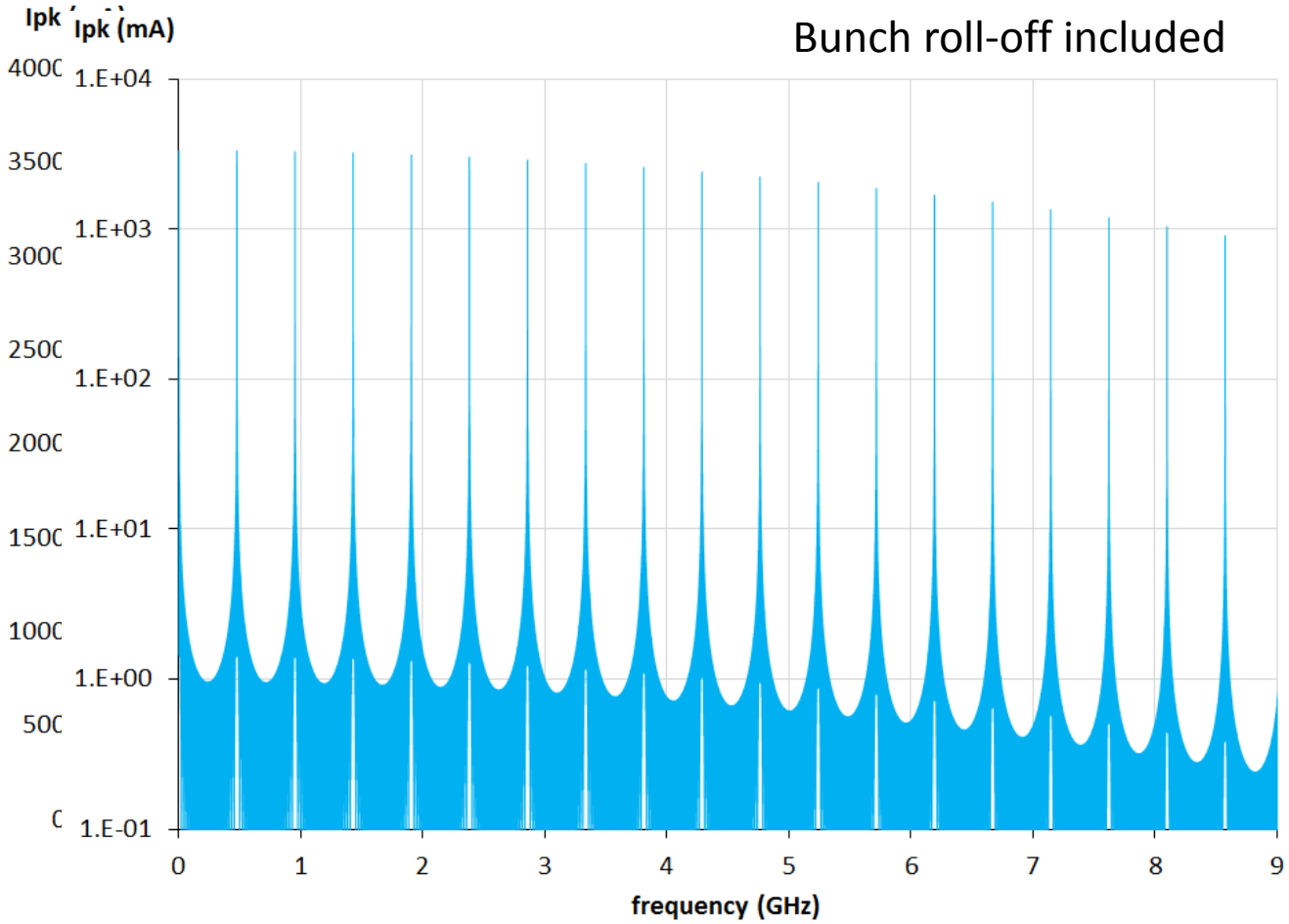


Loss factor – Electron Path



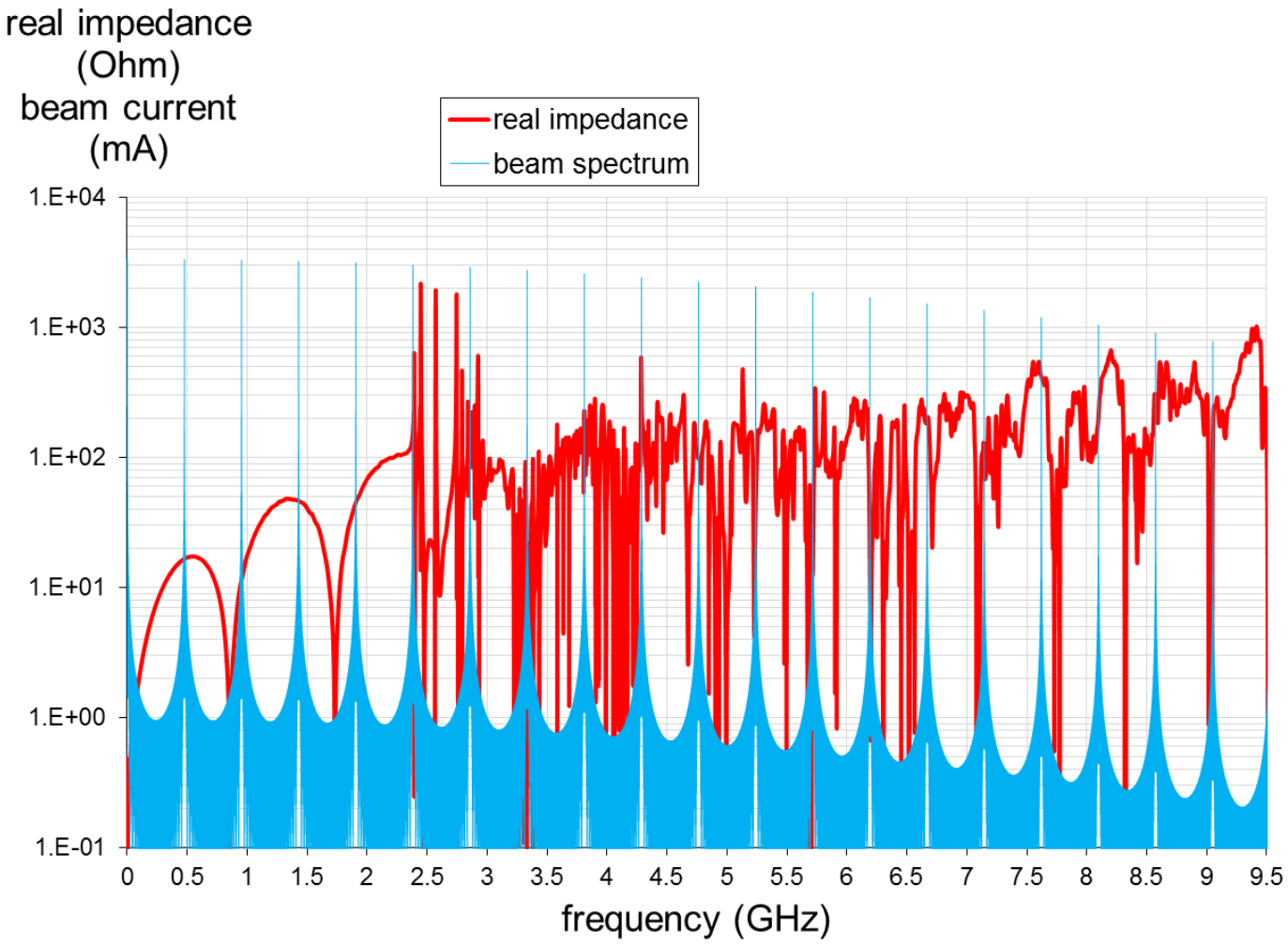
Electron Ring Beam Spectrum

Electron ring: 2366 m, 476.3 MHz, 3.6 A, 267 bucket gap



Electron Ring Real Impedance

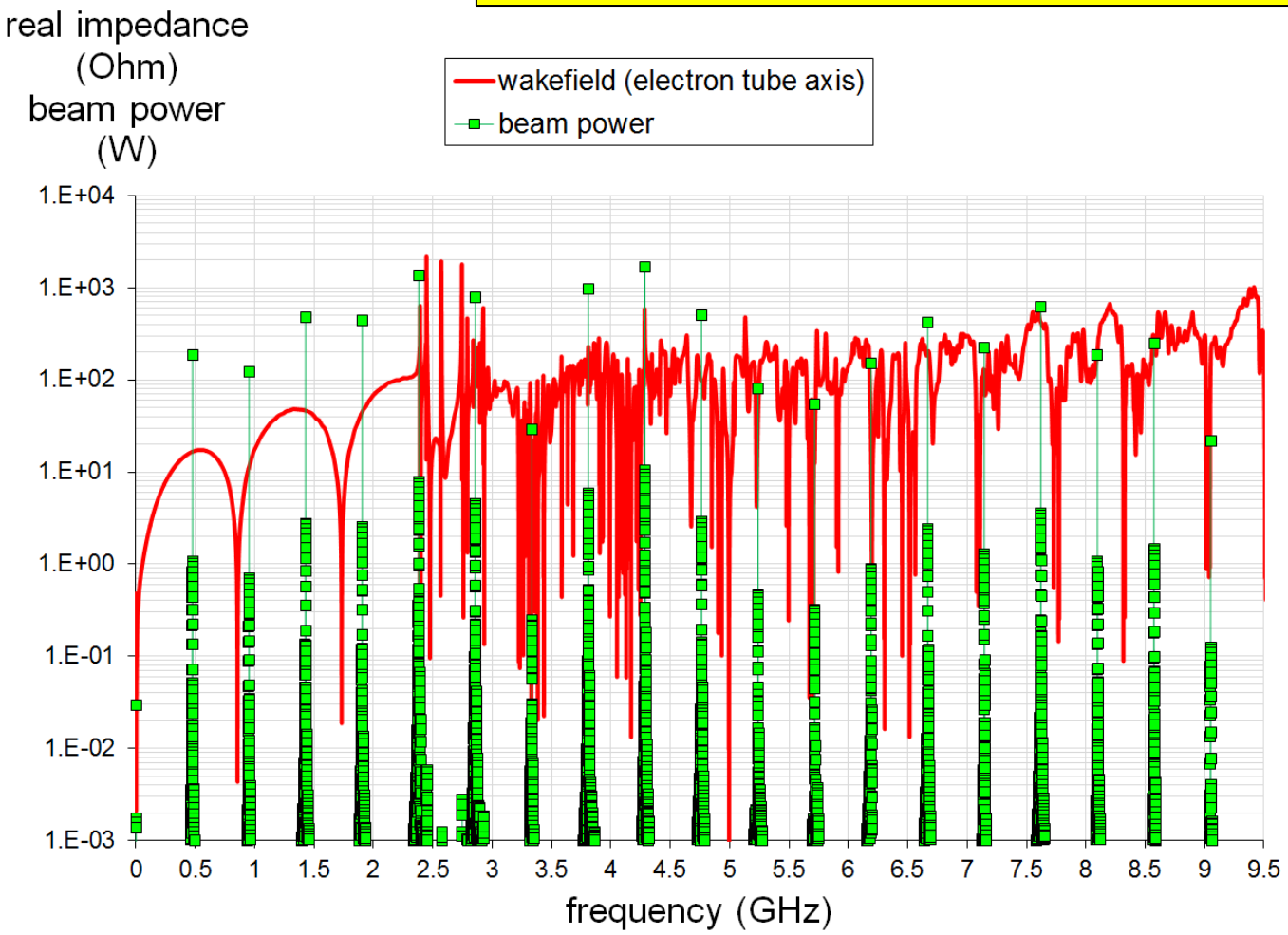
Electron ring: 2366 m, 476.3 MHz, 3.6 A, 267 bucket gap



Power Deposited

Electron ring: 2366 m, 476.3 MHz, 3.6 A, 267 bucket gap

Up to 9.5 GHz sum of 9.2 kW power deposited by electrons

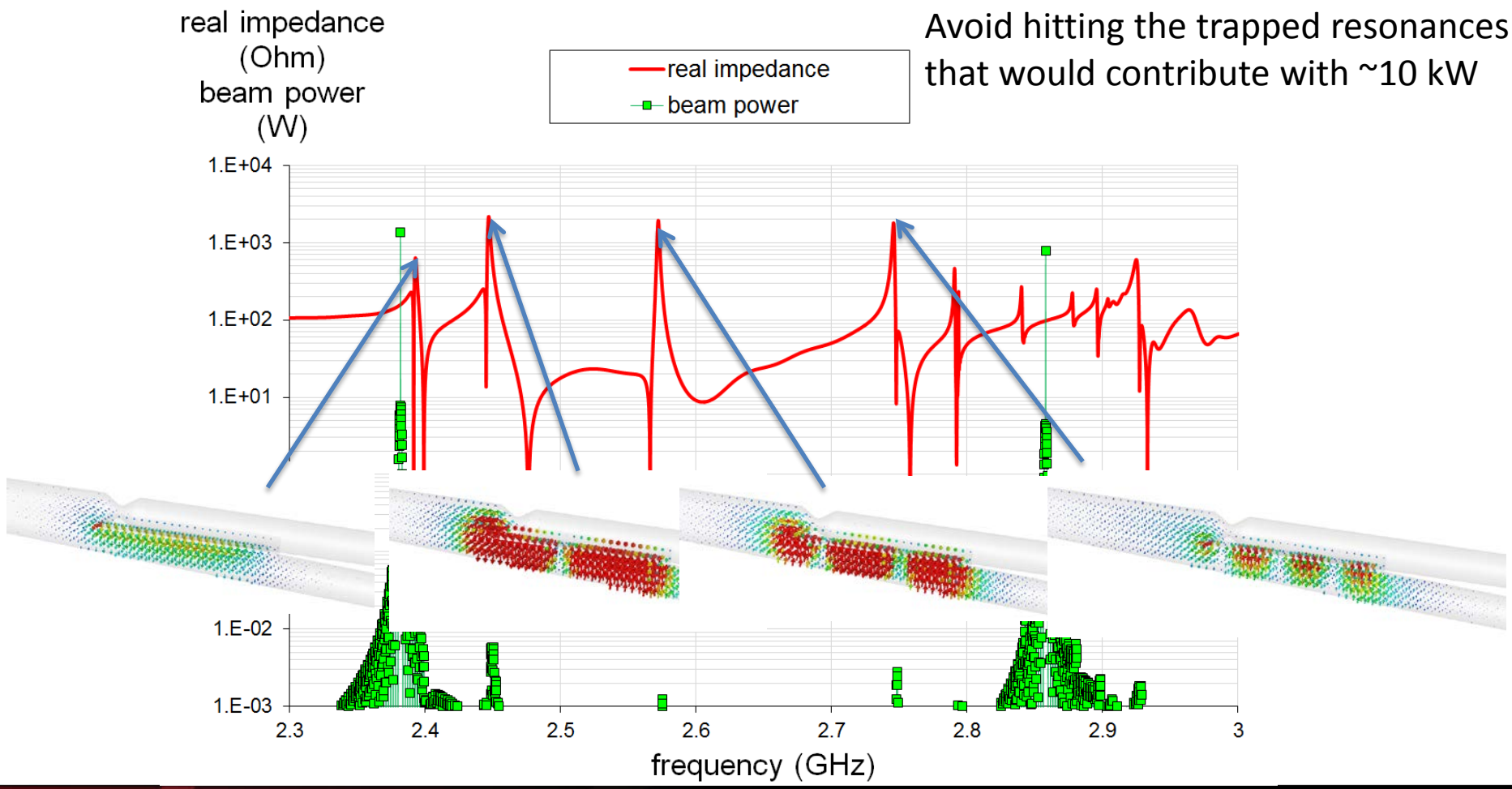


Power Deposited

Electron ring: 2366 m, 476.3 MHz, 3.6 A, 267 bucket gap

Up to 9.5 GHz sum of 9.2 kW power deposited by electrons

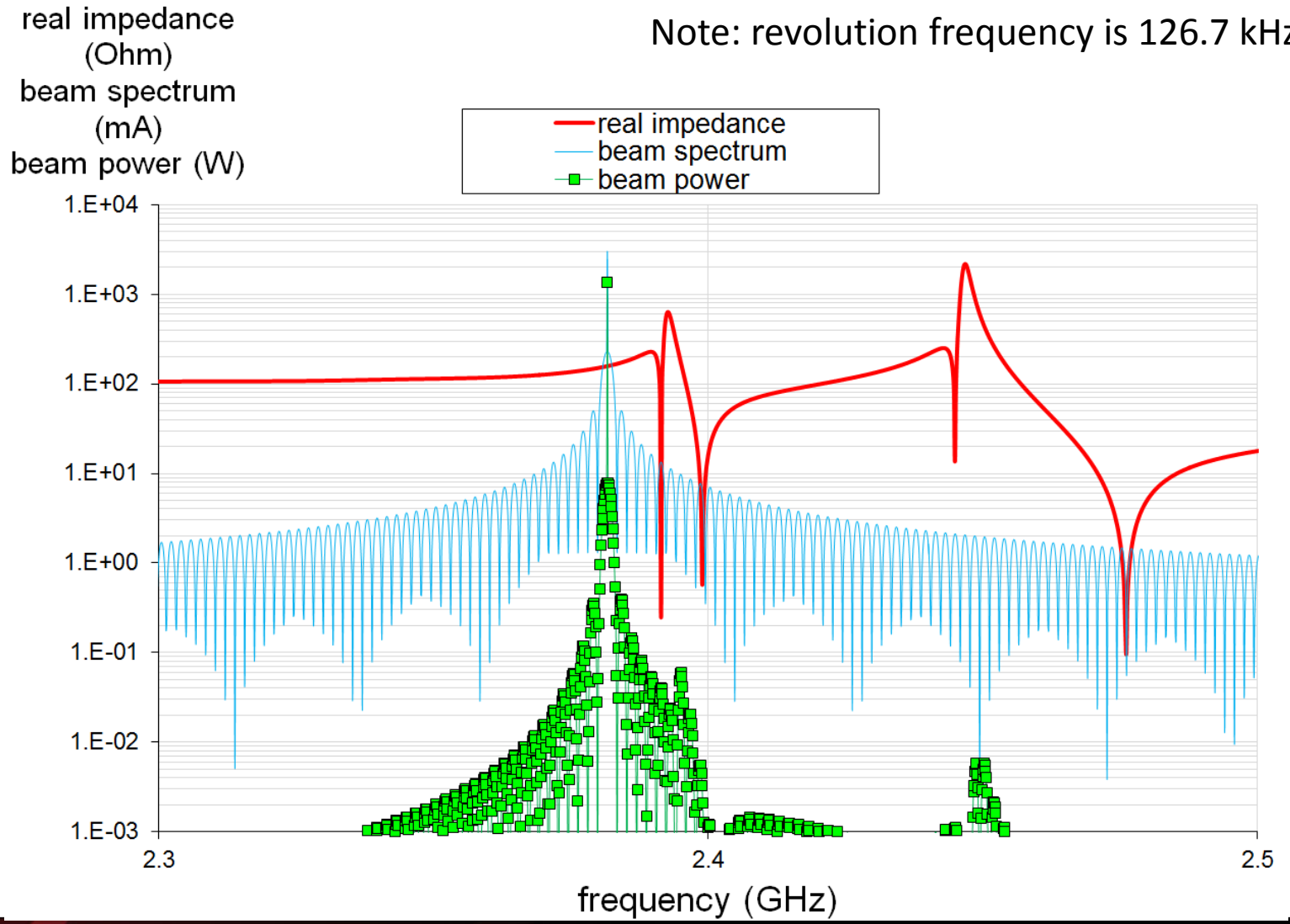
Avoid hitting the trapped resonances that would contribute with ~10 kW



Power Deposited

Electron ring: 2366 m, 476.3 MHz, 3.6 A, 267 bucket gap

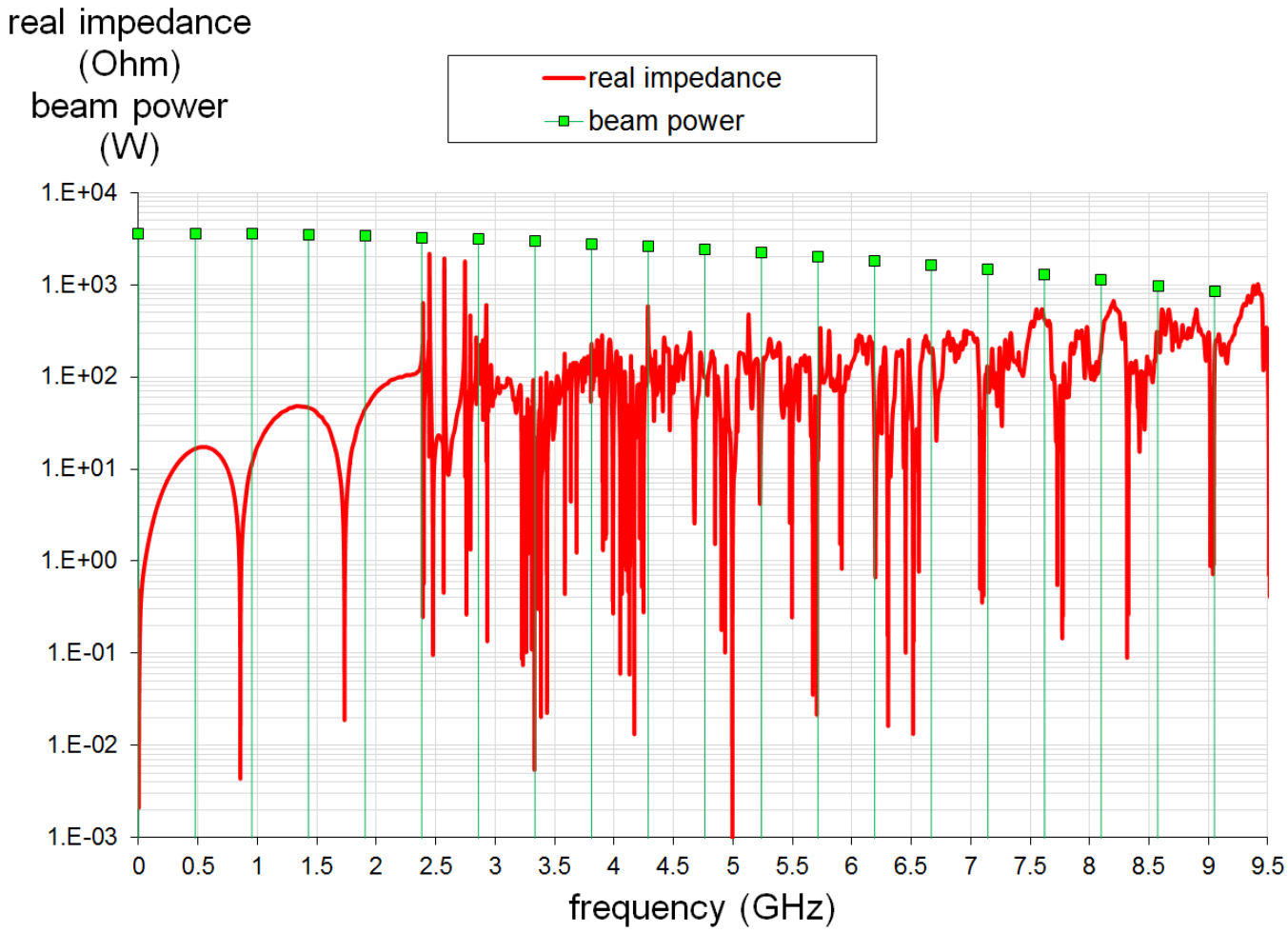
Note: revolution frequency is 126.7 kHz



Power Deposited

Electron ring: 2366 m, 476.3 MHz, 3.6 A, NO GAP

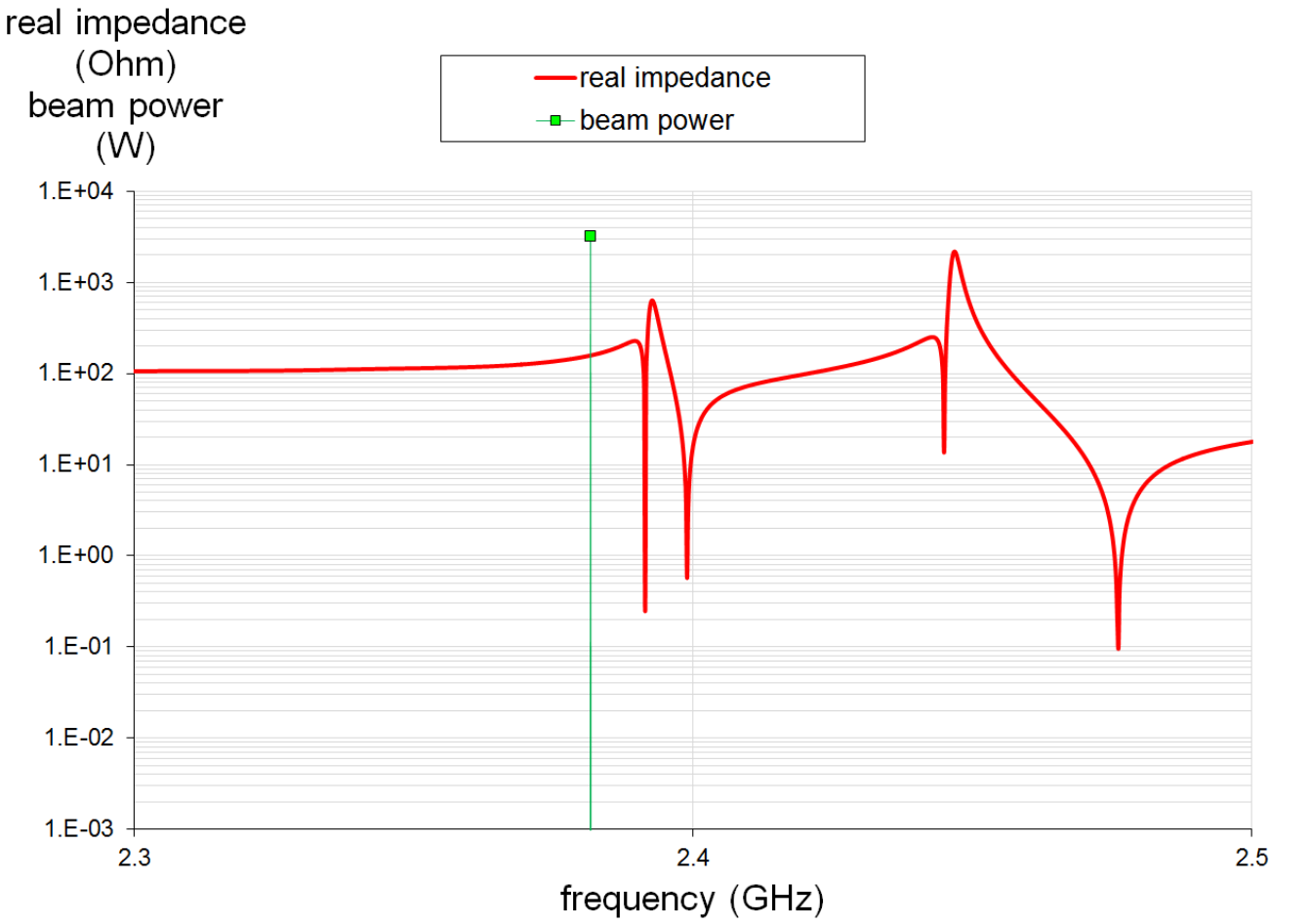
Up to 9.5 GHz sum of 9.9 kW power deposited by electrons



Power Deposited

Electron ring: 2366 m, 476.3 MHz, 3.6 A, NO GAP

Up to 9.5 GHz sum of 9.9 kW power deposited by electrons

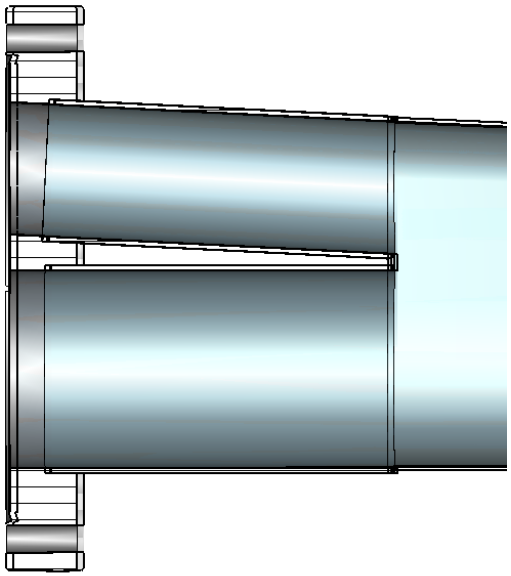


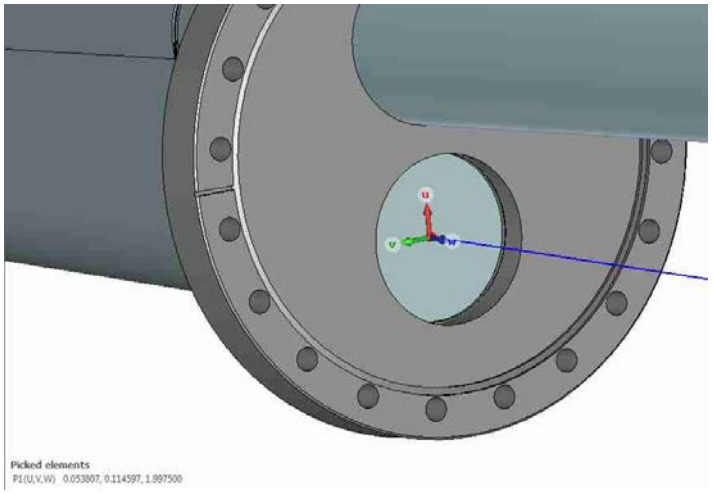
Simulations for Ions to be done with proper model

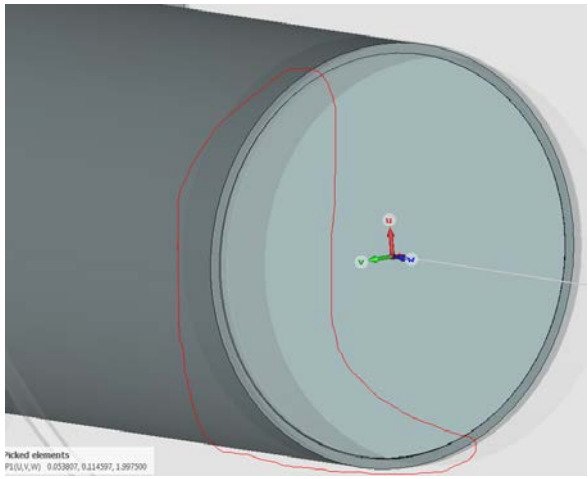
T_b ~ 2.1 ns at 476.3 MHz, I_{avg} = 0.75 A

Tilted model – model failed to simulate wakefield !

⚠ Particle beam "ParticleBeam1" is outside the calculation domain due a symmetry plane. It will be ignored for the simulation.

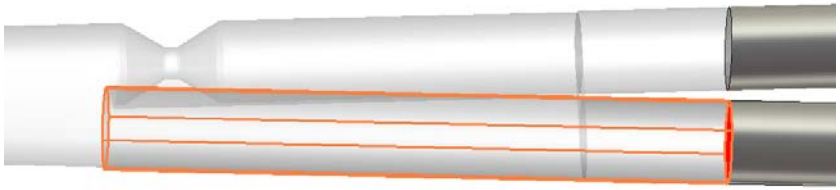




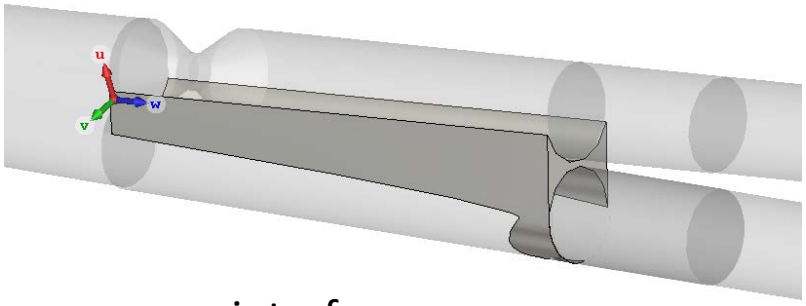


Re-Modelling ?

extrude



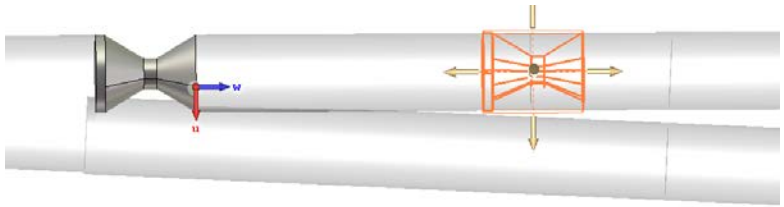
delete



repair

interference

move SR mask?



HOM Absorbers Needed?

Primary concept of the HOM absorber for FCC ee

Alexander Novokhatski

SLAC National Accelerator Laboratory

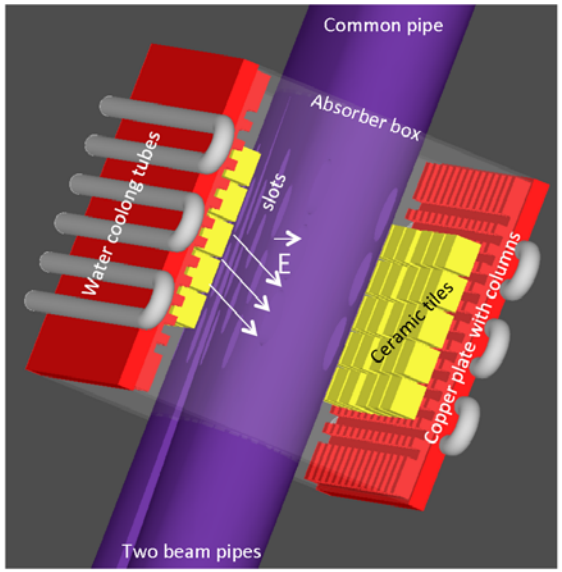
JLEIC Spring Collaboration Meeting
April 1, 2019

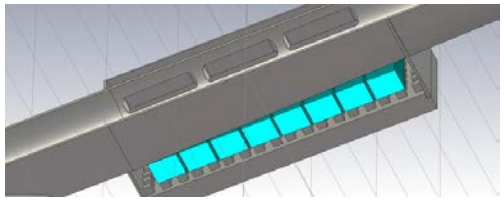
The absorber vacuum box is situated near (around) beam pipe connection. Inside the box we have ceramic absorbing tiles and copper plates (walls). The beam pipe in this place have longitudinal slots, which connect the beam pipe and the absorber box. Outside the box we have stainless steel water-cooling tubes, braised to the copper plates.

HOM fields, which are generating by the beam in the IR have a transverse electrical component and can pass through the longitudinal slots in the beam pipe.

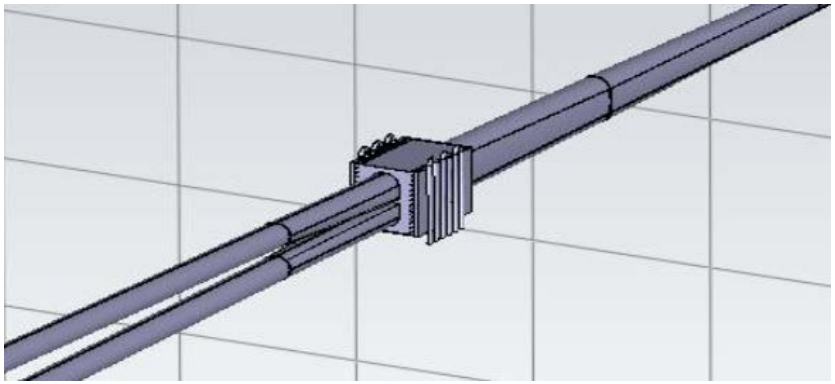
Inside the absorber box these fields are absorbed by ceramic tiles, which have high value of the loss tangent.

Ceramic tiles are braised to copper plates with columns. The heat from ceramic tiles is transported through the copper plates to water cooling tubes.

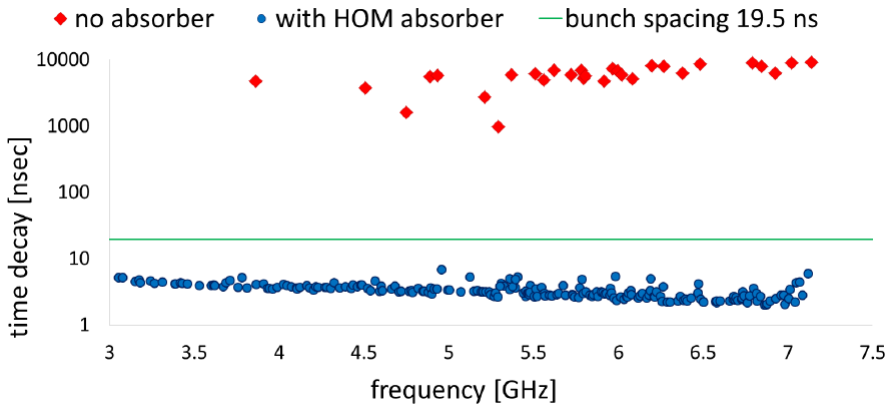




HOM absorber design for 10 kW power



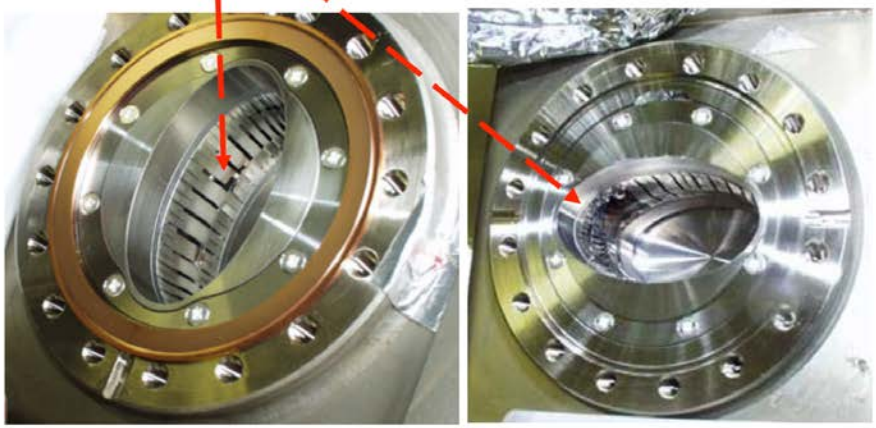
Efficiency of Damping Trapped and Propagating Modes



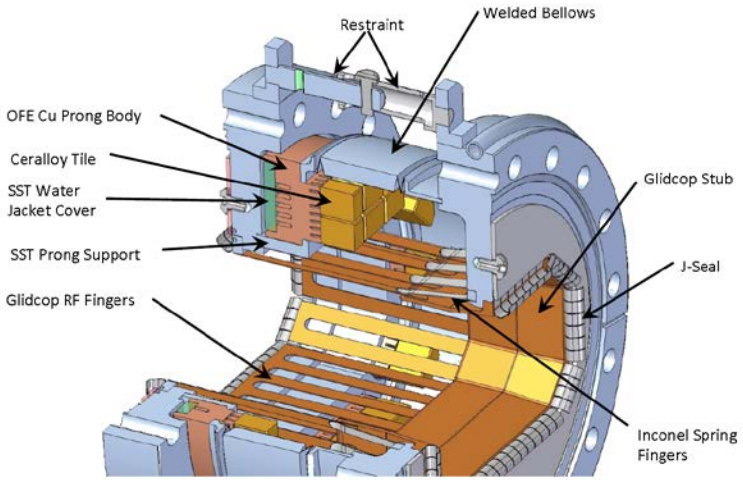
Shielded Bellows

Wake fields discharge in shielded fingers of vacuum valves

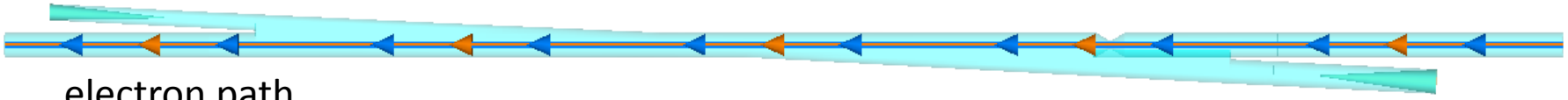
- Shielded fingers of some vacuum valves were destroyed by breakdowns of intensive HOMs excited in the valve cavity.



HOM absorber for IR of PEP-II



Wave Impedance of Different Chamber Cross-Sections



electron path

Item	ID mm	Wave impedance @ 3 GHz TE_{11}(-like)	Wave impedance @ 3 GHz TM_{01}(-like)
unit	mm	Ω	Ω
- e- entrant and exit tube - ion exit tube - central IR chamber	60	1722	299
ions inlet	40	351	617
transition chamber (ion entrant tube)	n/a	446/1522	156
transition chamber (e- entrant tube)	n/a	597 pol. I & II	237