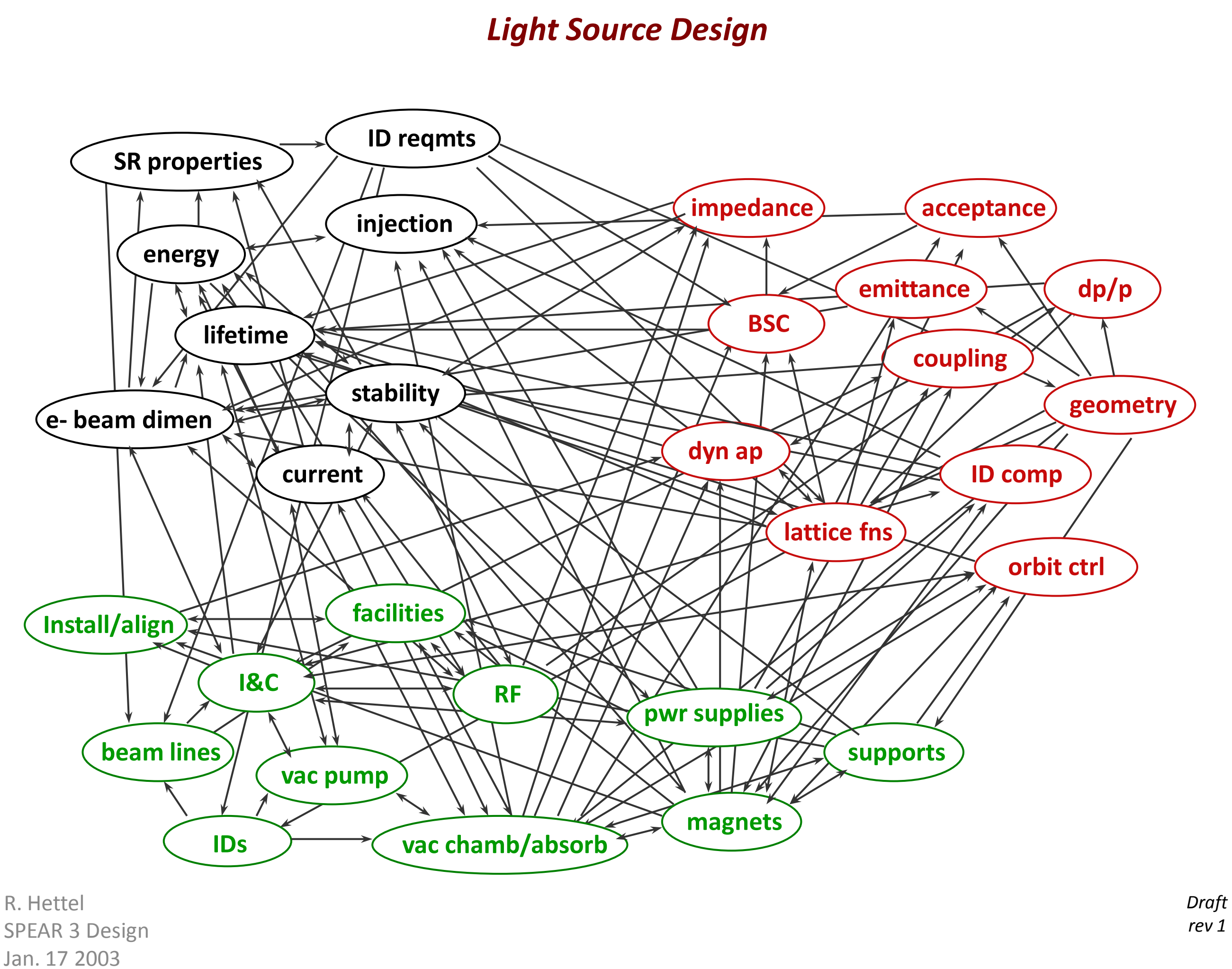
Optimal RF frequency

The

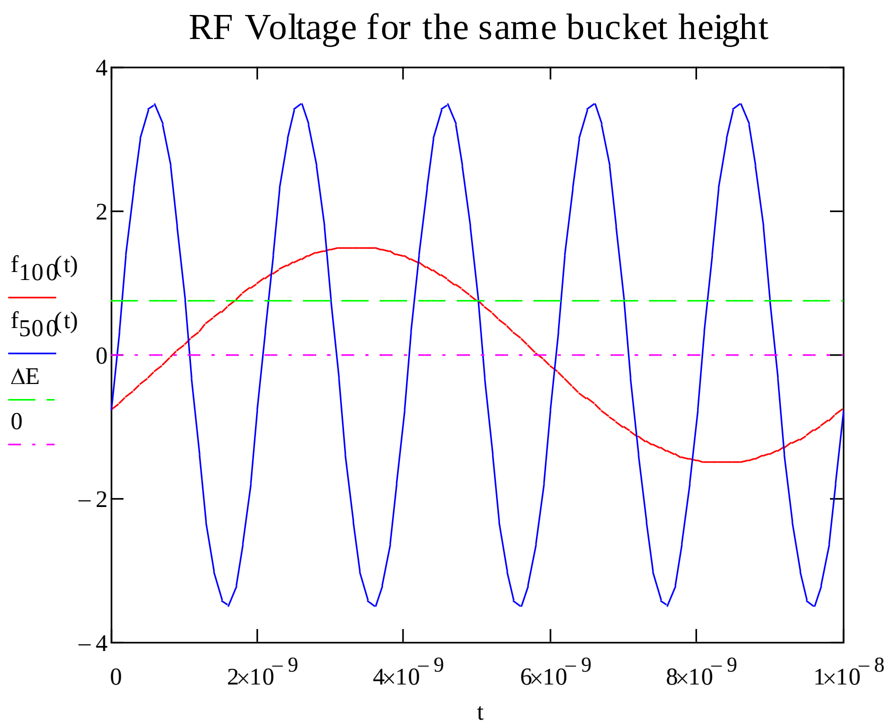
Optimal RF frequency

For USRs depends on applications



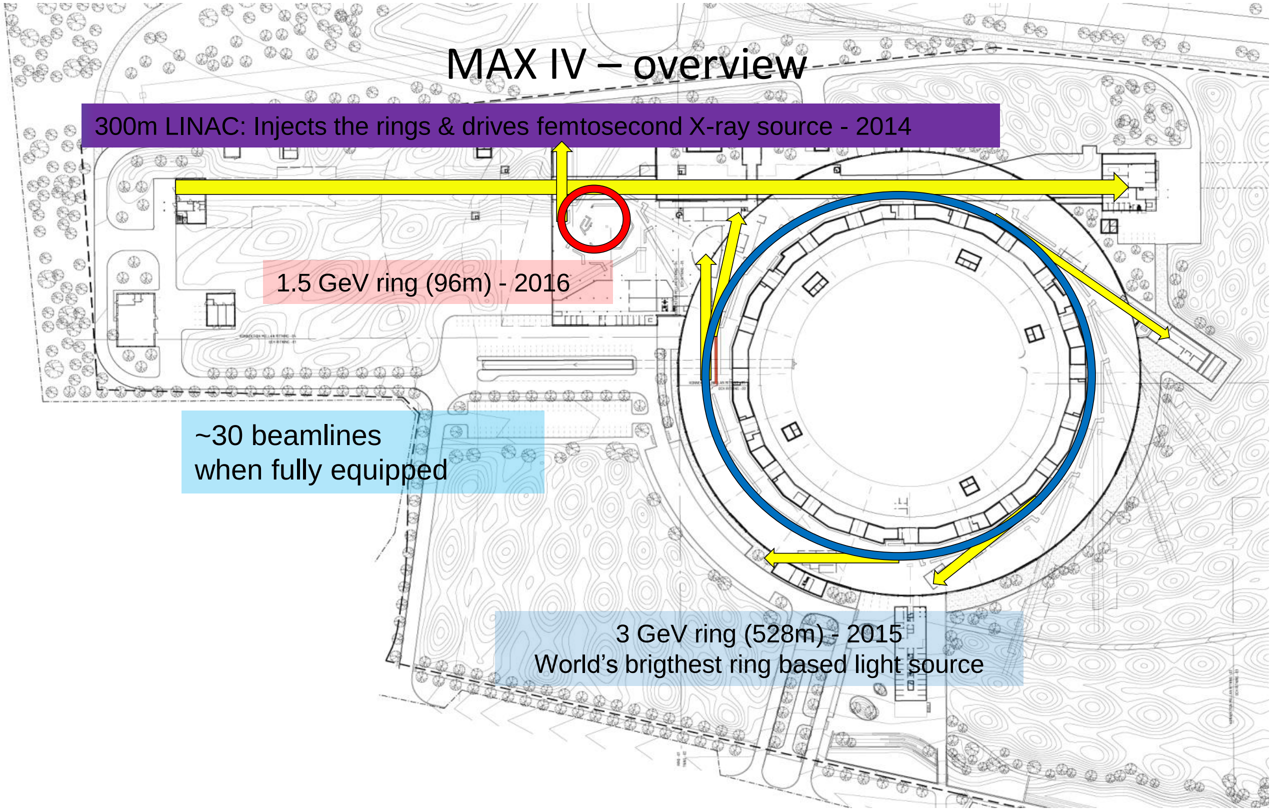
Optimal RF=f(economy, E, ΔE/turn, I_{bunch}, τ_{bunch}, bucket-height, $\tau_{Touschek}$…)

Some fundamentals



To a good approximation, the bunch electron density is independent on RF

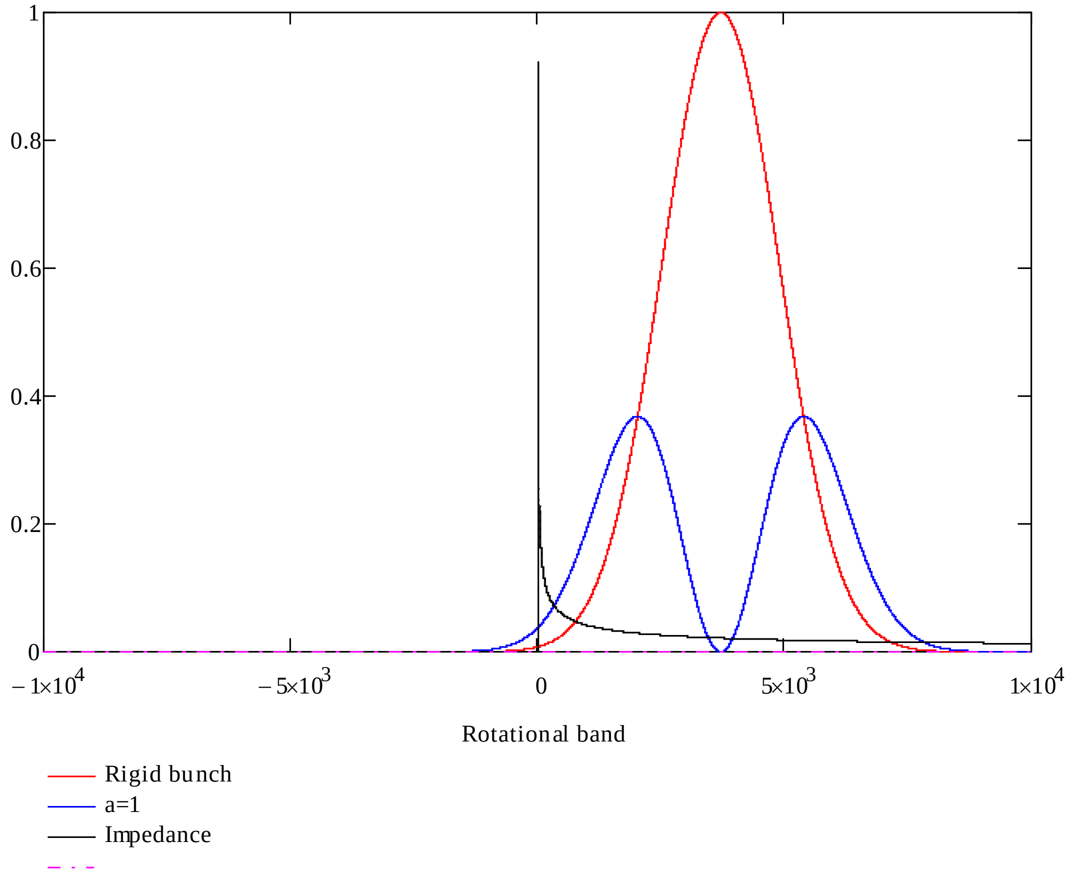
Low RF example: MAX IV DDR, small emittance ring (not USR), 3 GeV
RF priority on cost, small staff, stability and simplicity, not on short bunches



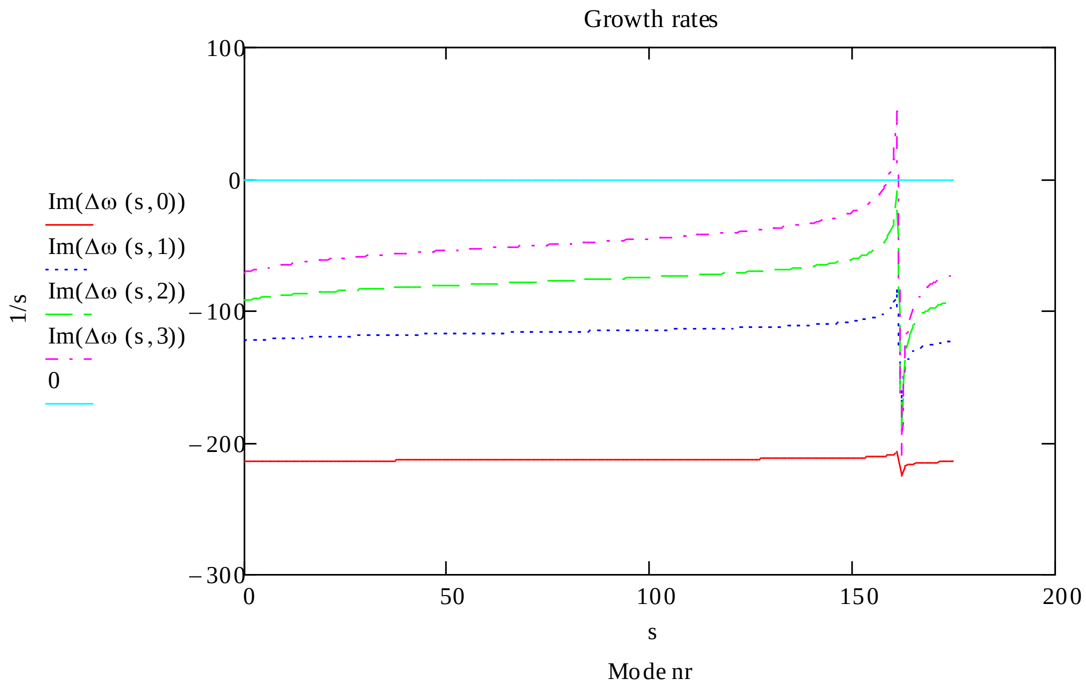
MAX IV DDR:

	SC	EURO	CAP LOADED
Operating frequency [MHz]	500	500	100
Energy loss/turn (keV)	756	756	756
Rms bunch length [mm] (incl HC)	15	15	70
Nr of cavities	2	6	6
Shunt impedance [MΩ]	1)	6.2	3.2
Refrigerator power [kW]	200	-	-
Amplifier type	IOT	IOT	Tetrode
Voltage [MV] for 4.5% bucket height	3.5	3.5	1.5
Total RF power [kW]	378	710	500
Electric power [kW]	840	1180	670
Nr of RF amplifiers	2	6	6
Cost	High	Medium	Low
Ease of operation	-	++	++
Resistive wall effect	-	-	+
Higher order mode spectrum	Good	Medium	Good

Transverse resistive wall

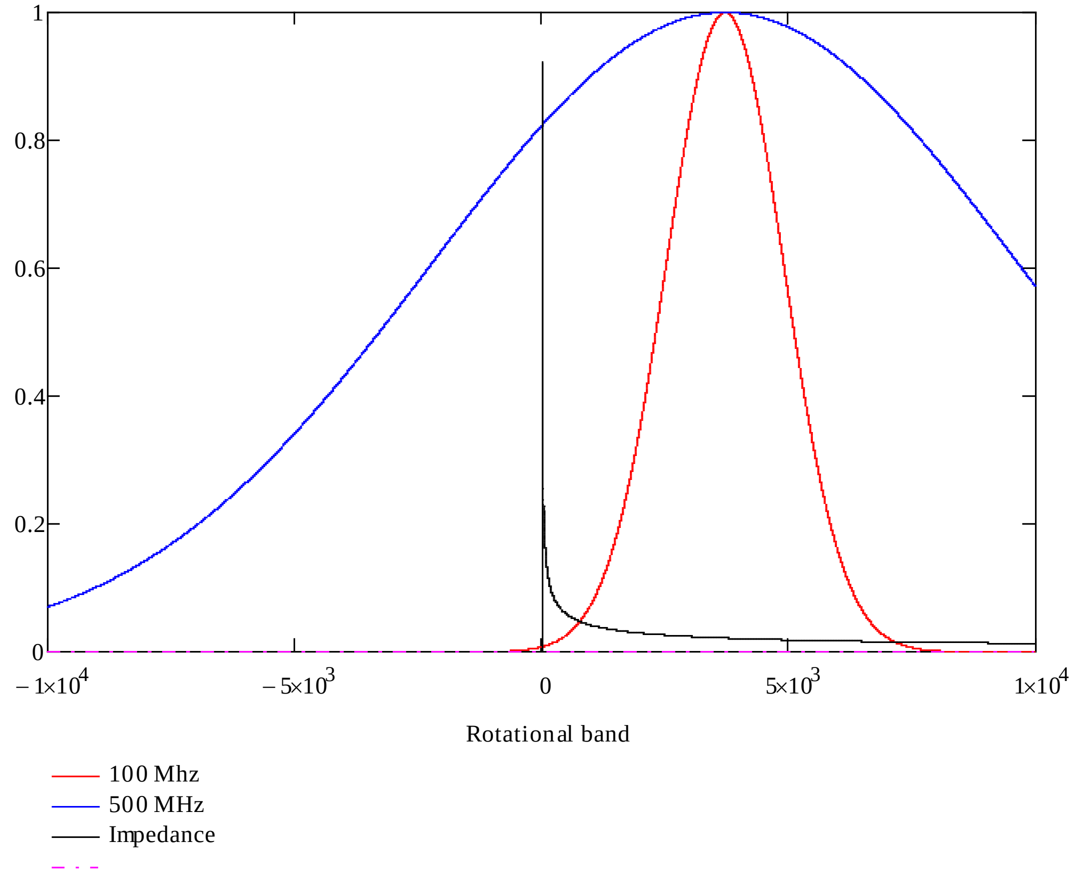


Power spectra and impedances, Chromaticity=1



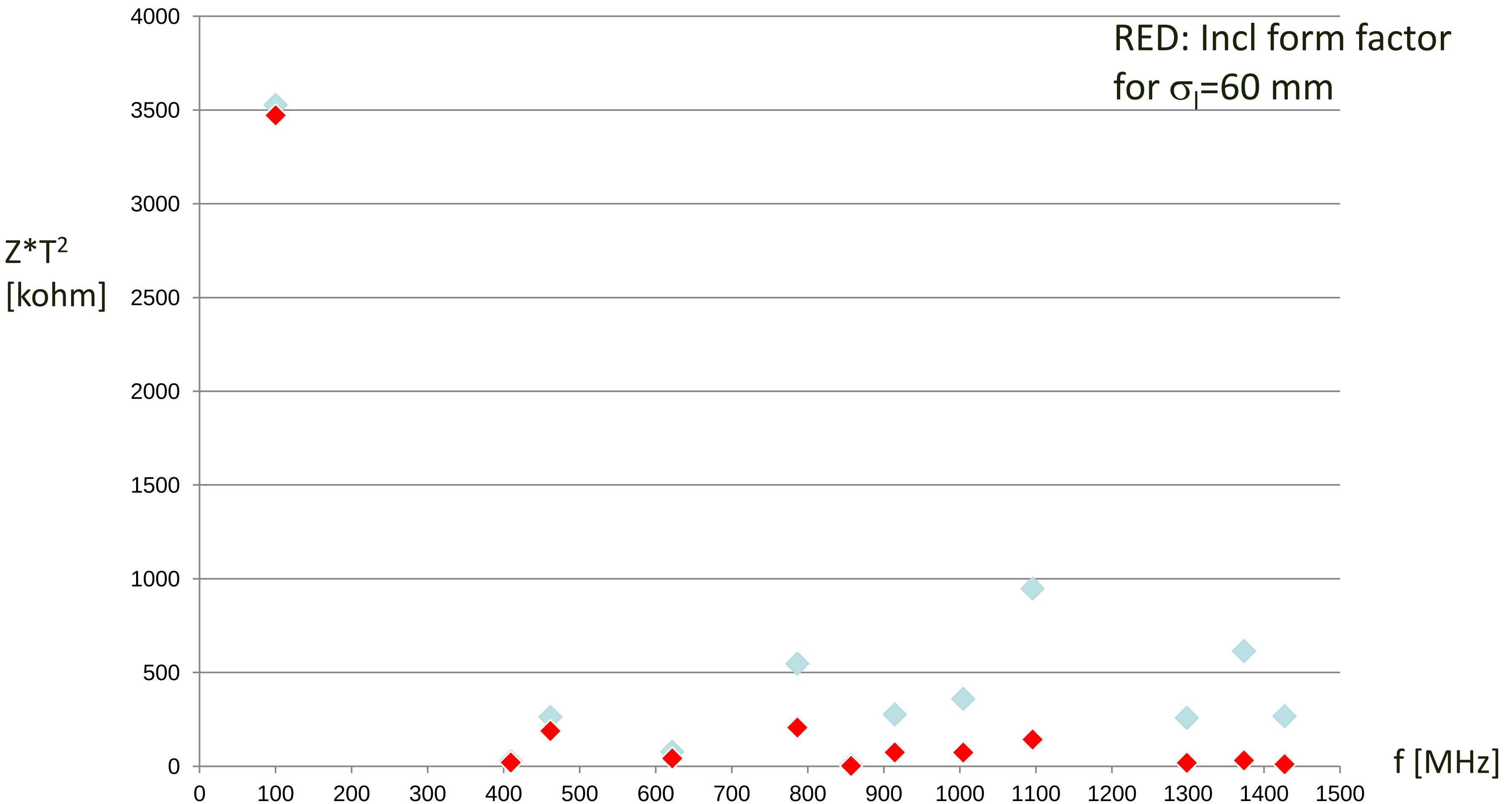
All modes are damped (negative Im(omega))

Transverse resistive wall



Power spectra 100 and 500 MHz, Chromaticity=1

Longitudinal HOM spectrum for MAX 100 MHz cavities



MAX IV LABORATORY

Level of ambition for an USR

1. Diffraction limited @ 1 Å. => E > 3 GeV with present undulator technology. 100 MHz offers passive stability.

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3. Short bunches. How short? IBS pushes up E. RF goes up. 3 GHz?

Conclusions (to be discussed):

•RF optimization is a strong function of ring performance priorities

•If ΔE/turn < 2 MeV and economy + passive stability important, 100 MHz could be contemplated

•An USR (emittance <10 pm) is probably favored by E>3 GeV (IBS)

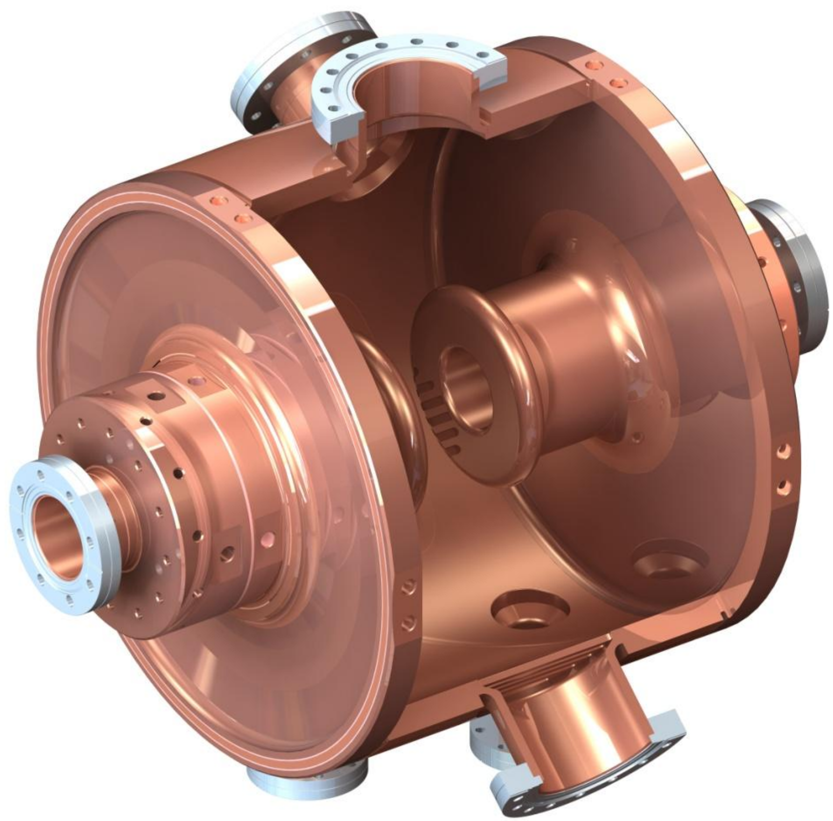
•If ΔE/turn > 2-3 MeV, low RF cavities (100 MHz) will become bulky

•If short bunches requested, 0.35-3 GHz should be considered.

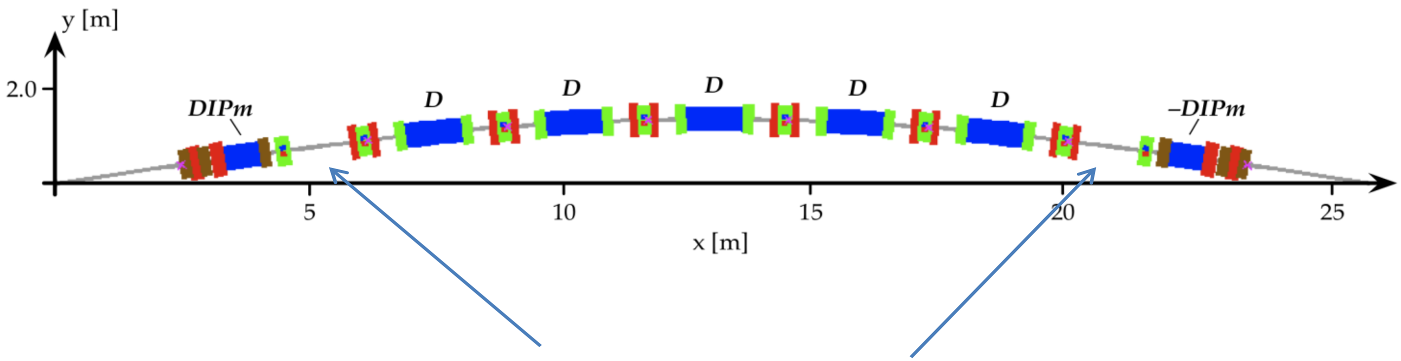
•Very short bunches favored by RF>1 GHz, probably calls for SC since high RF voltage needed. IBS+high charge/bunch => High electron energy

Thanks for your attention!

The MAX-lab Landau cavity prototype



One of the 20 achromats in the 3 GeV ring



- Relatively compact magnet structure, except for two ”matching” short straights.

- MAX II & MAX III main cavity