



Electrodynamics, lecture 5, 2019

Anders Karlsson, anders.karlsson@eit.lth.se

Electrical and information technology

Last lecture

- ▶ Cavities
- ▶ Circular cylindric cavity
- ▶ TM_{010} mode

Resonance cavities

Applications of cavities:

- ▶ High Q band-pass and band-stop filters
- ▶ Cavities in accelerators
- ▶ Klystrons
- ▶ Magnetrons

Shumann resonances

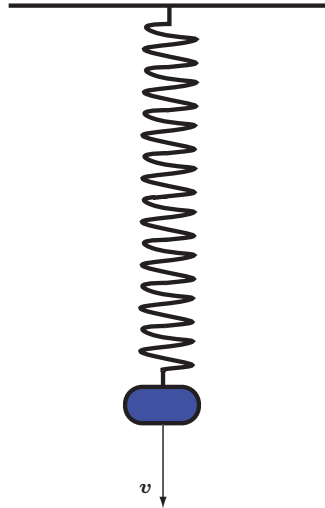
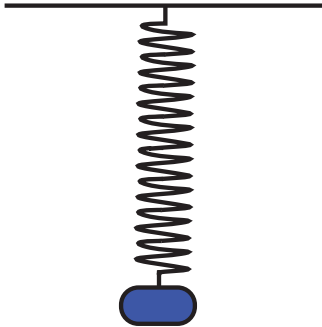
Resonance cavities

To get a resonance you need two energy states!
Potential energy \leftrightarrow kinetic energy



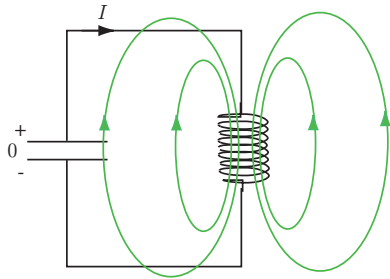
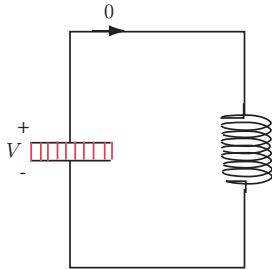
Resonance cavities

Potential energy \leftrightarrow kinetic energy



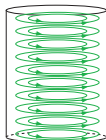
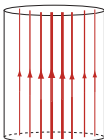
Resonance cavities

Electric energy \leftrightarrow magnetic energy

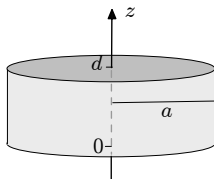


Resonance cavities

Electric energy \leftrightarrow magnetic energy



The pillbox cavity



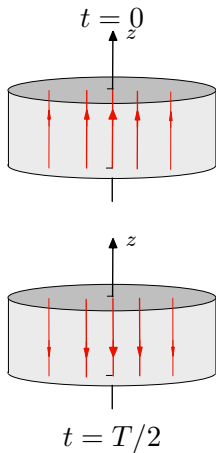
TM₀₁₀

$$\mathbf{E}(\rho, t) = E_0 J_0(k\rho) \cos(\omega t) \hat{z}$$

$$\text{Wavenumber} = k = \frac{2.405}{a}$$

$$\text{Resonance frequency} = f = \frac{kc}{2\pi}$$

The pillbox cavity TM_{010} mode

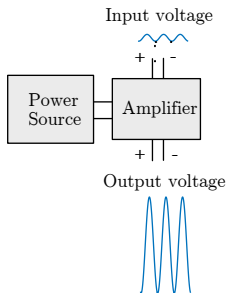


Outline today

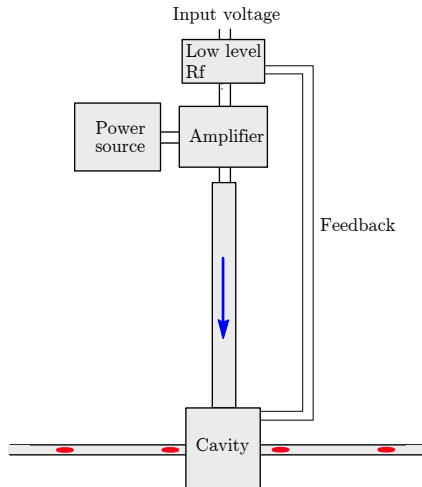
- ▶ RF-systems for particle accelerators
- ▶ Q-factor
- ▶ Evaluating Q-factor with COMSOL

The RF-system for accelerators

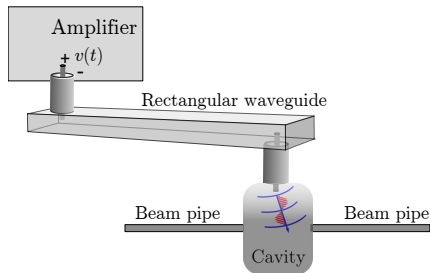
The RF-system uses time-harmonic signals



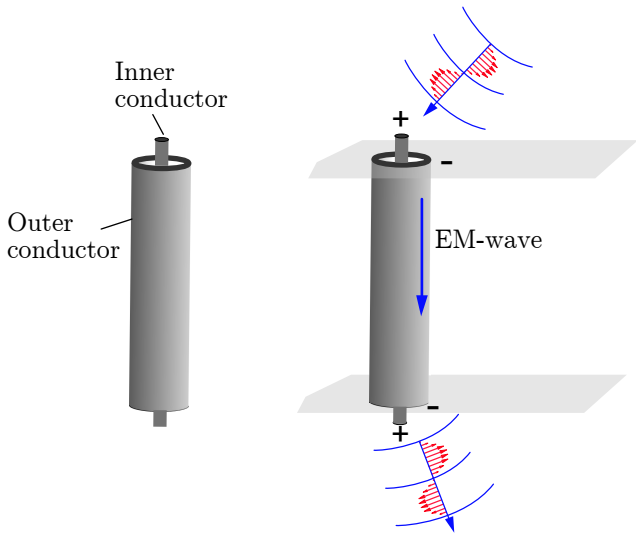
The RF-system



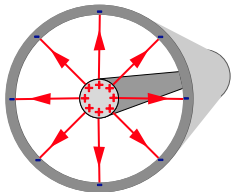
The RF-system



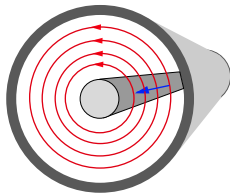
The RF-system: waveguide system



The RF-system: waveguide system

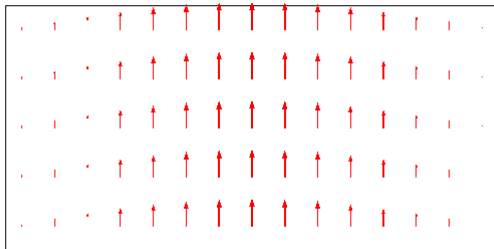


Electric field



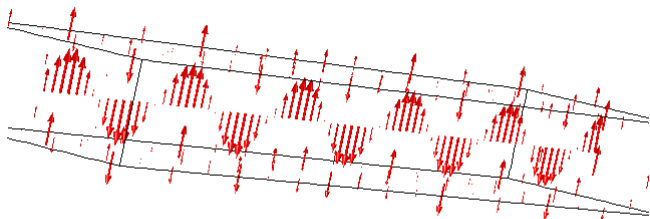
Magnetic field

The RF-system: waveguide system



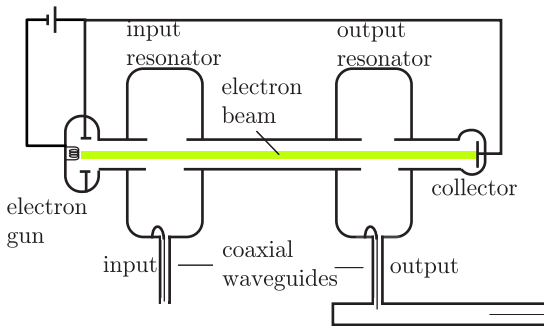
TE₁₀-mode: Cross section.

The RF-system: waveguide system



TE₁₀-mode: Along waveguide

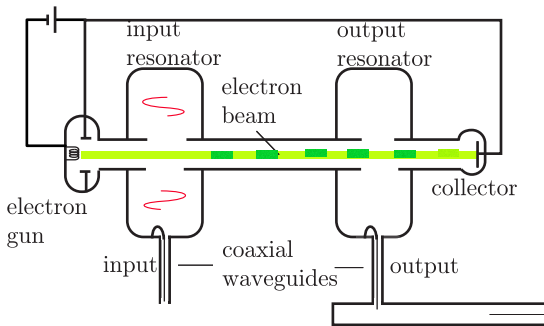
The RF-system: klystron



input resonator= buncher,

output resonator=catcher

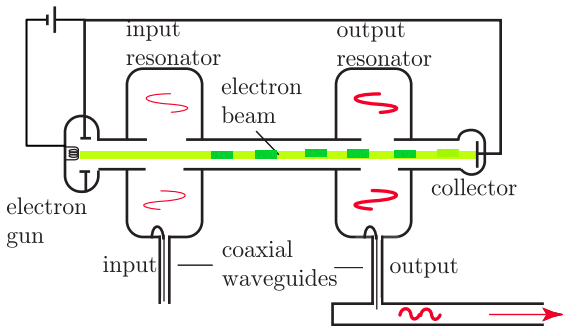
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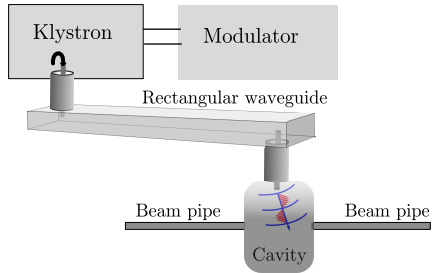
The RF-system: klystron



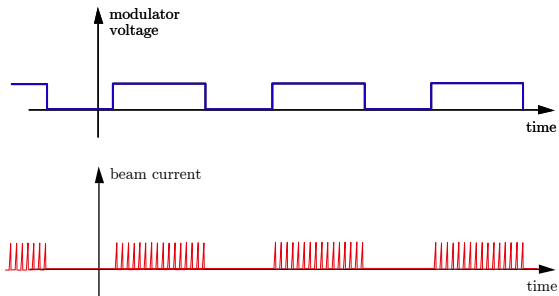
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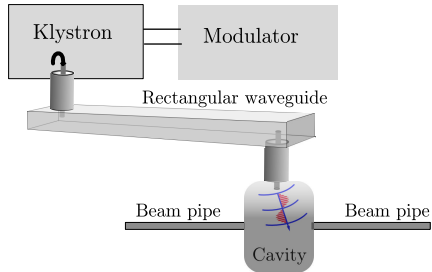
The RF-system



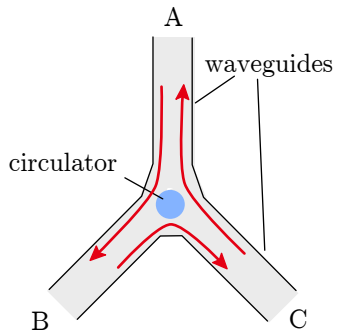
The RF-system



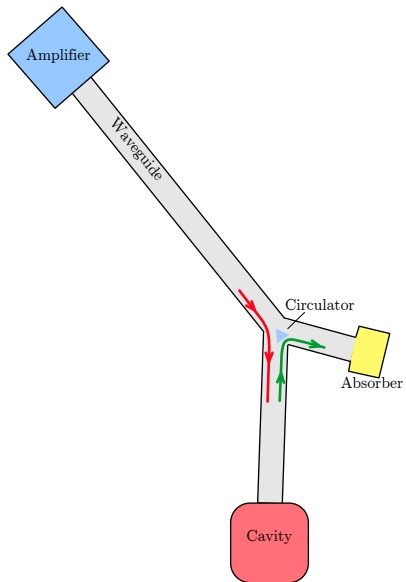
The RF-system: waveguide system



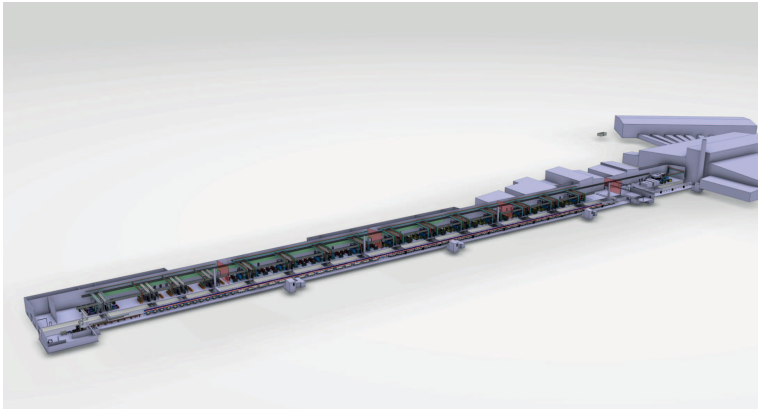
The RF-system: Circulator



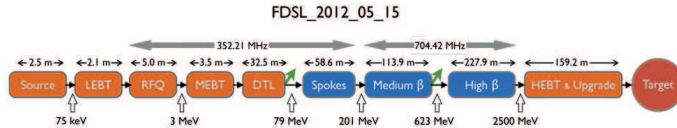
The RF-system: Circulator



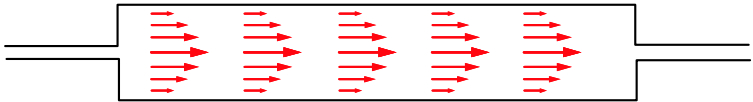
ESS



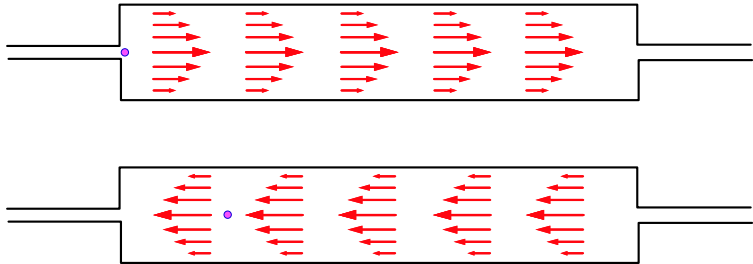
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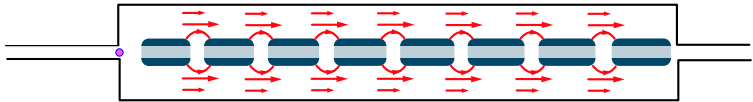
ESS: DTL



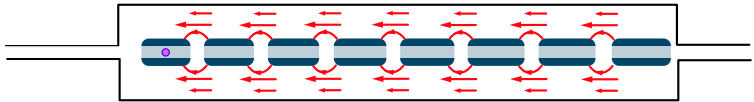
ESS: DTL



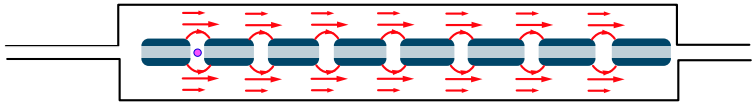
ESS: DTL



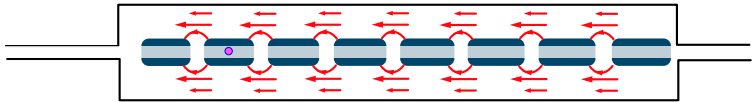
ESS: DTL



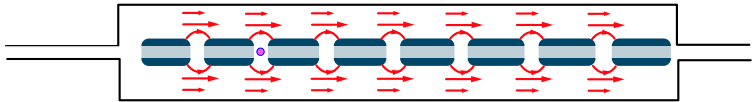
ESS: DTL



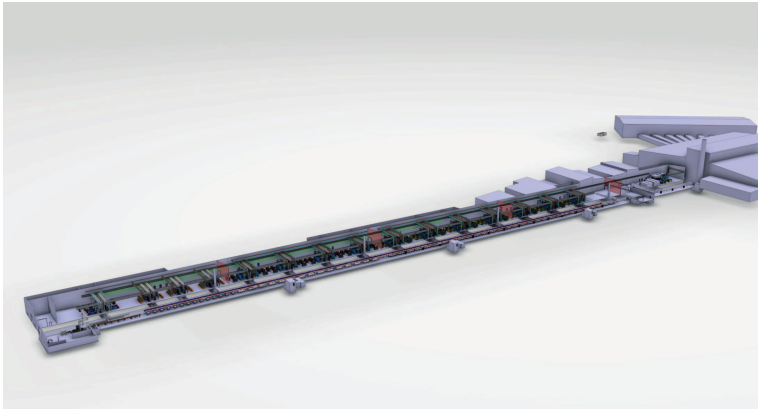
ESS: DTL



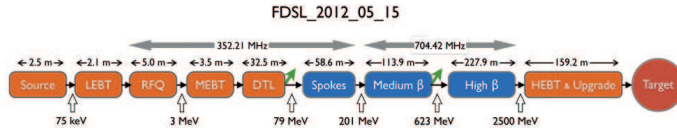
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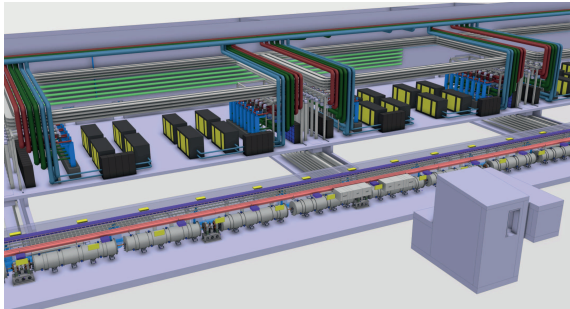
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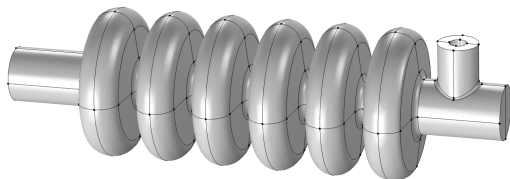
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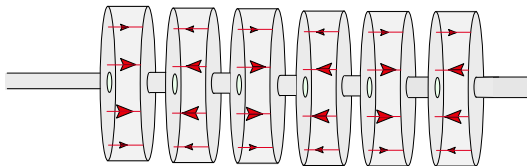
ESS



ESS: Elliptic cavity



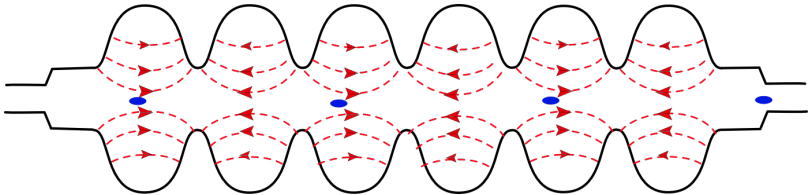
ESS: Elliptic cavity



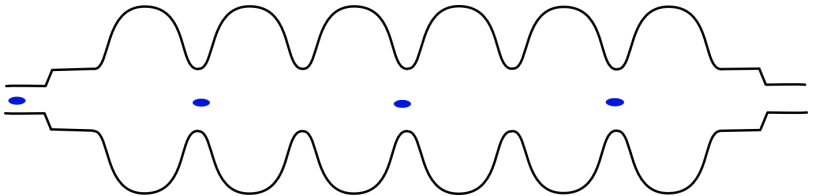
TM₀₁₀-mode in every cell.

π -mode

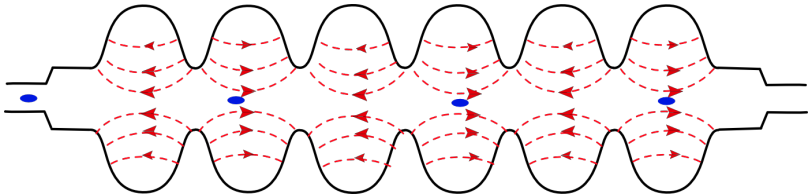
ESS: Elliptic cavity



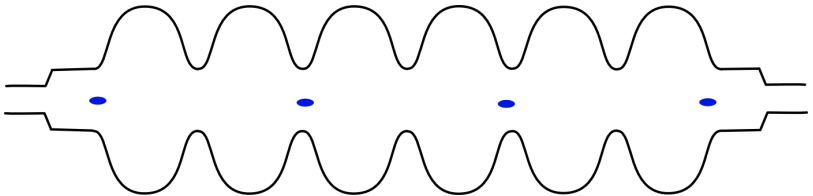
ESS: Elliptic cavity



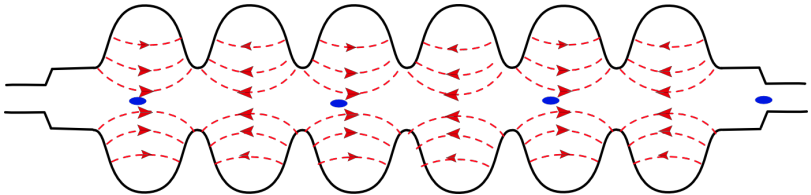
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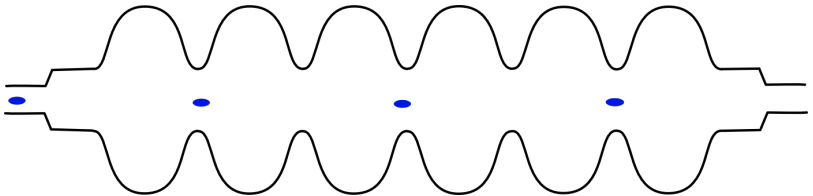
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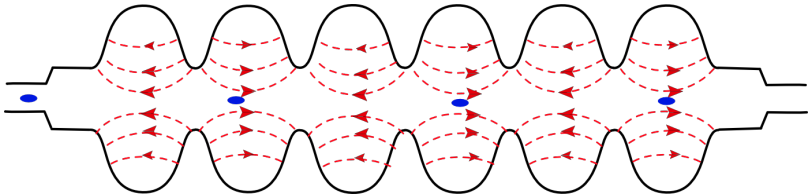
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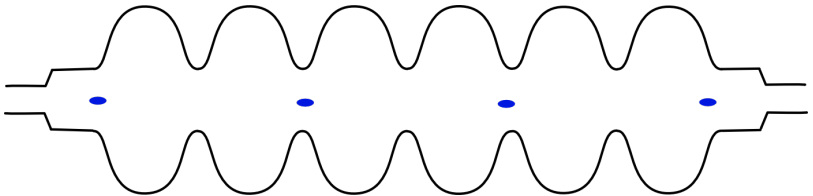
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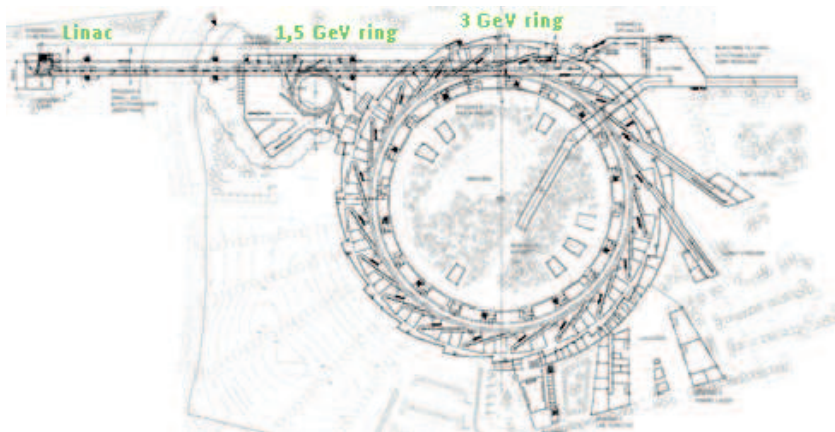
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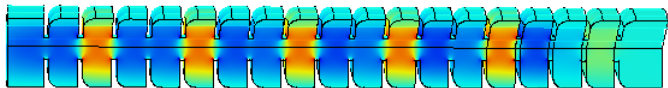
MAX IV



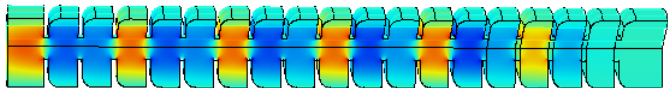
MAX IV: Linac



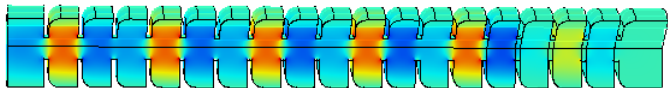
MAX IV: Linac



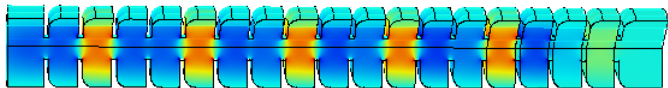
MAX IV: Linac



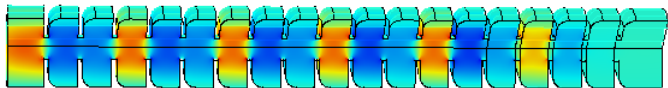
MAX IV: Linac



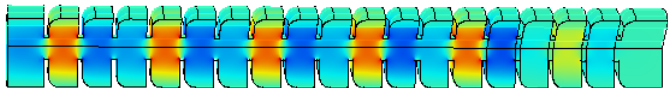
MAX IV: Linac



MAX IV: Linac



MAX IV: Linac



MAX IV: Undulator

