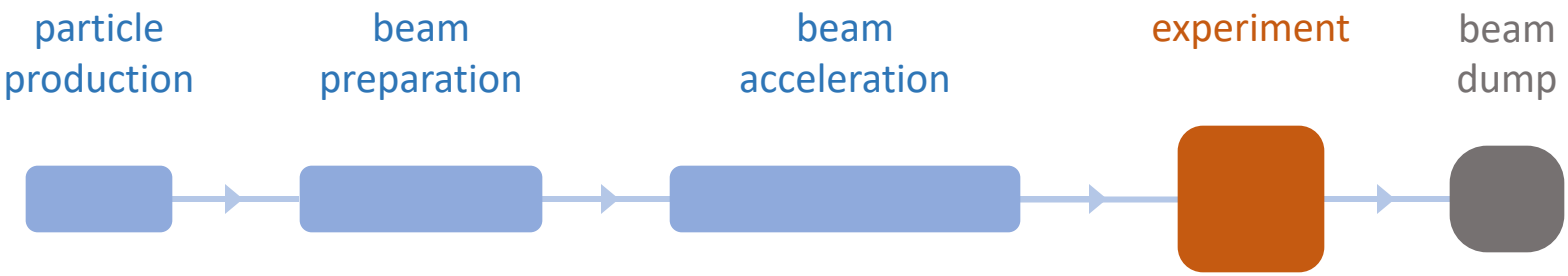
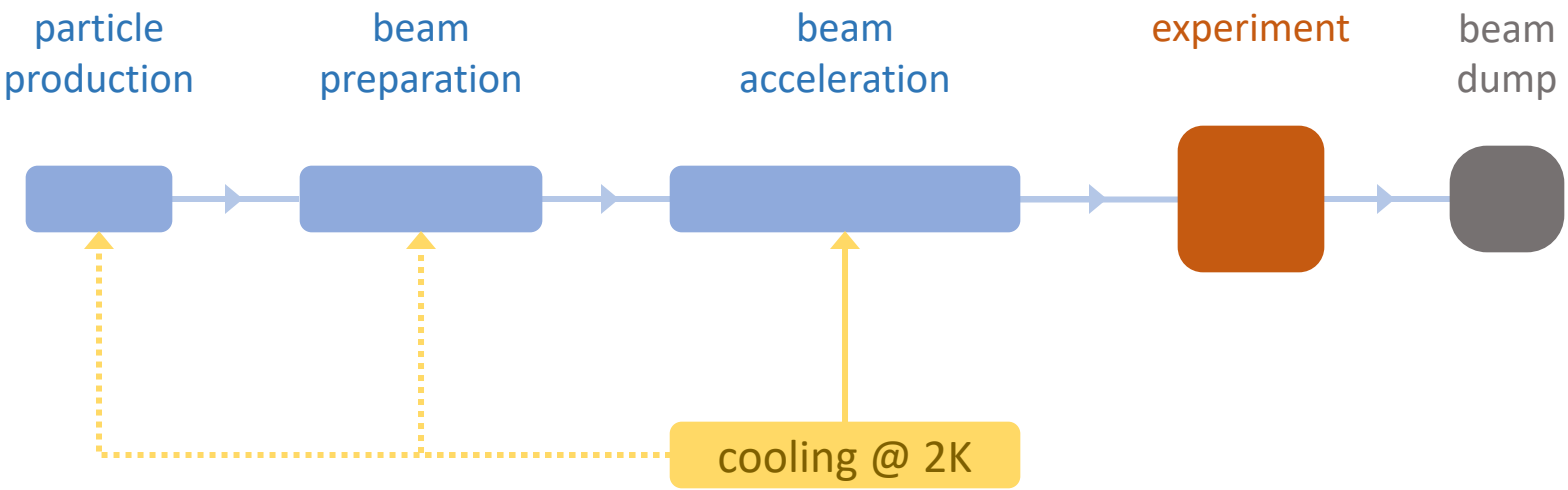
Where do accelerators use power ?

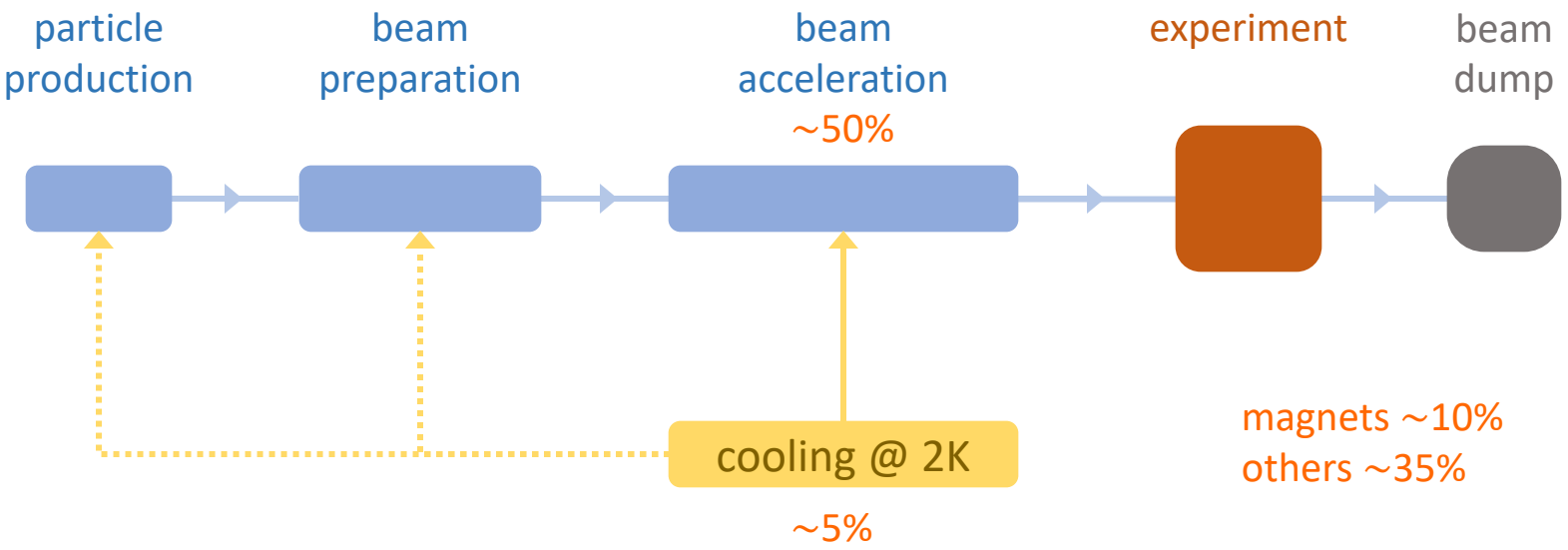
Basic structures of a particle accelerator



Basic structures of a particle accelerator



Basic structures of a particle accelerator

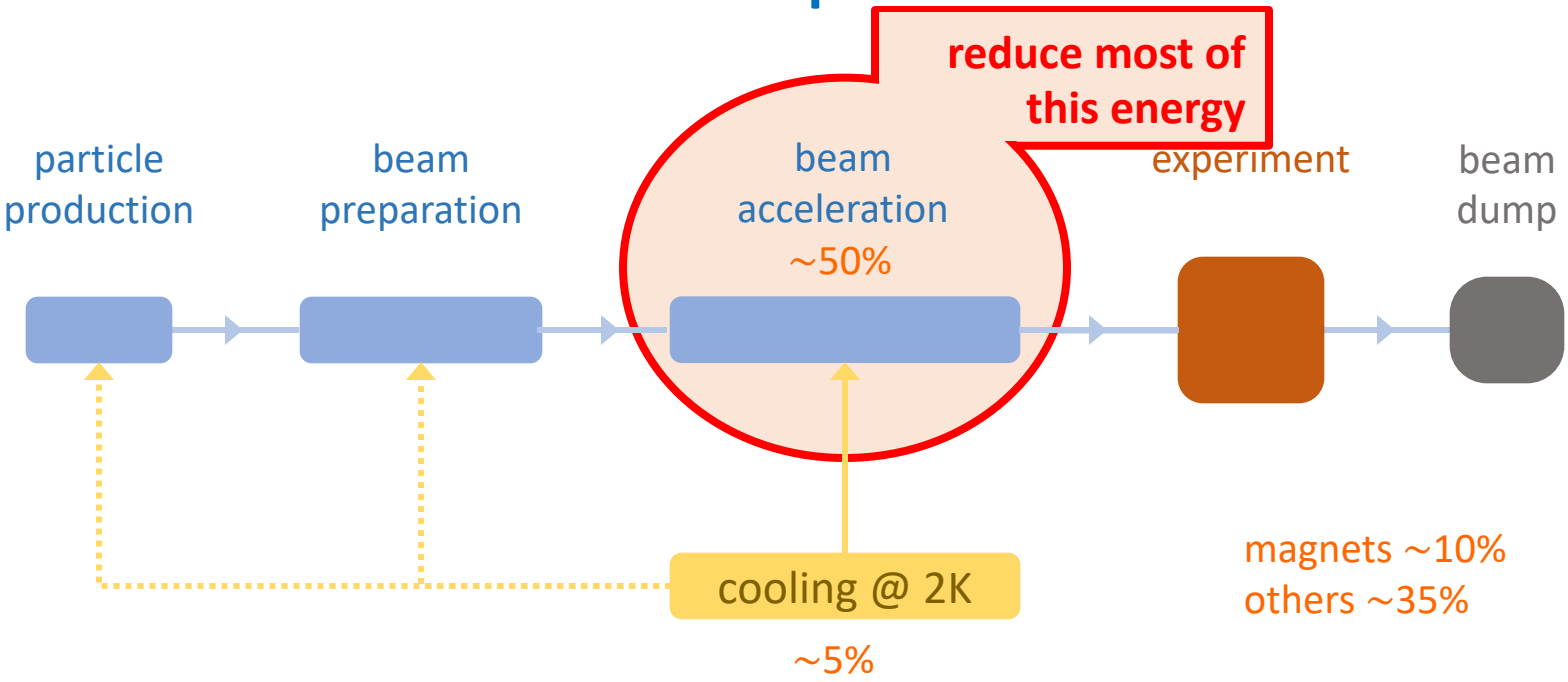


Example: typical power consumption for an electron-positron Higgs Factory

the highest priority next collider for particle physics

example FCC@250GeV

Basic structures of a particle accelerator



Example: typical power consumption for an electron-positron Higgs Factory

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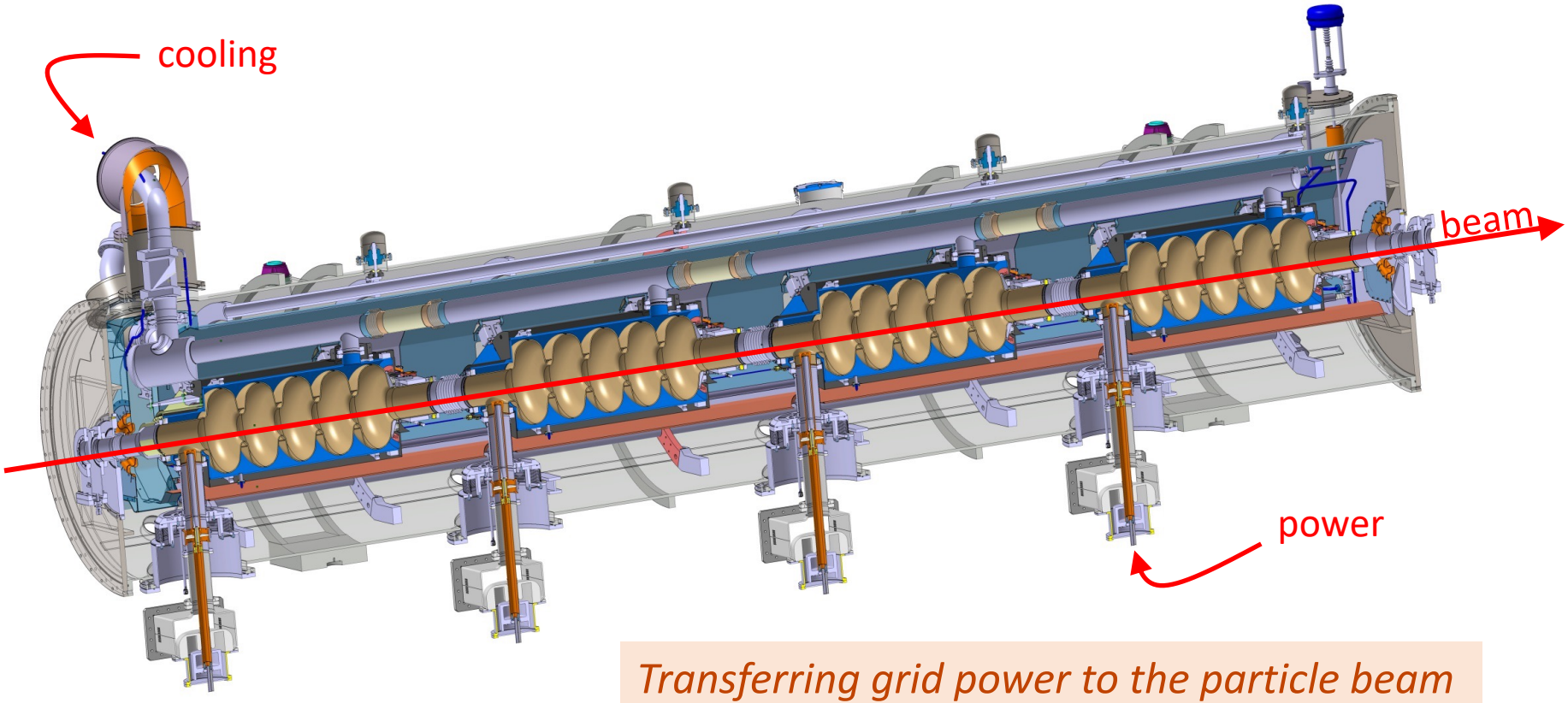
Key building block for beam acceleration: the SRF cryomodule

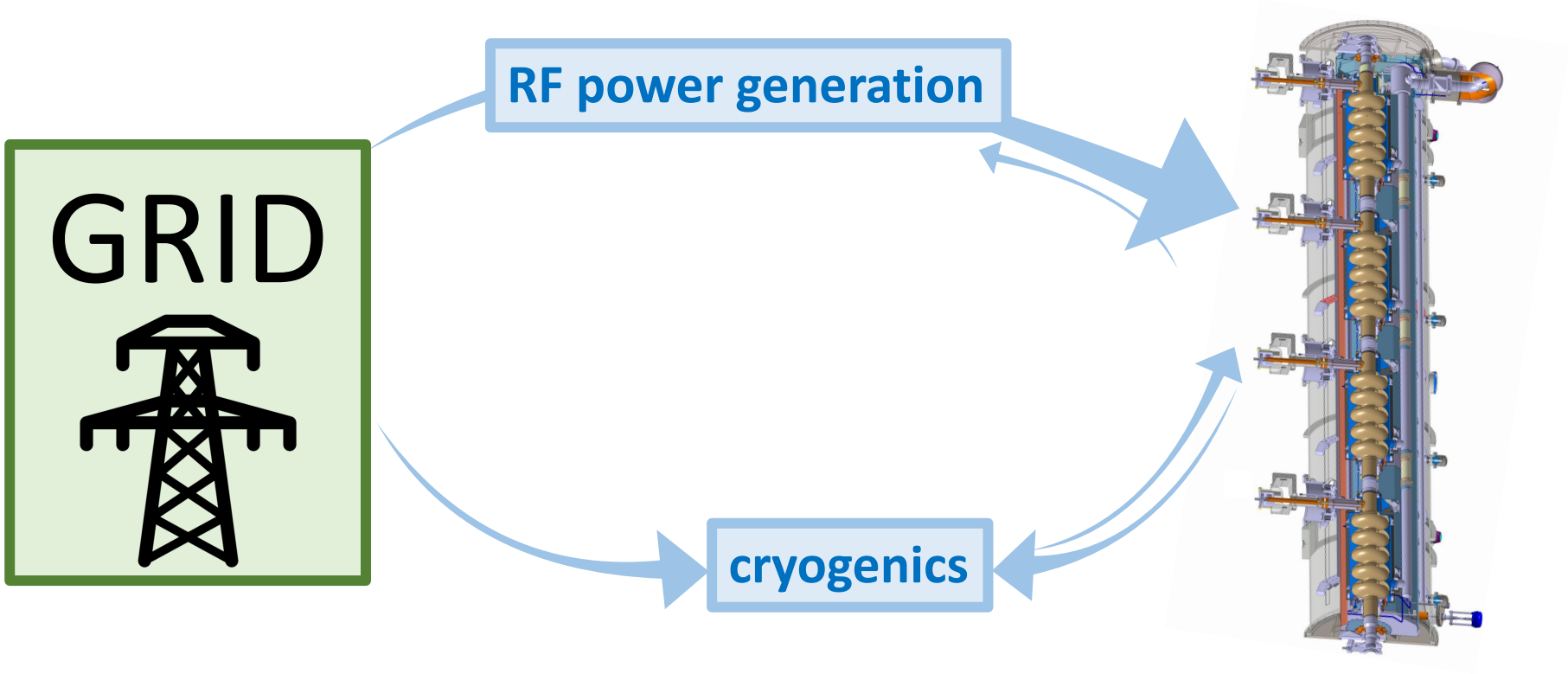


Transferring grid power to the particle beam

Superconducting Radio Frequency (SRF) is the enabling technology for modern accelerators

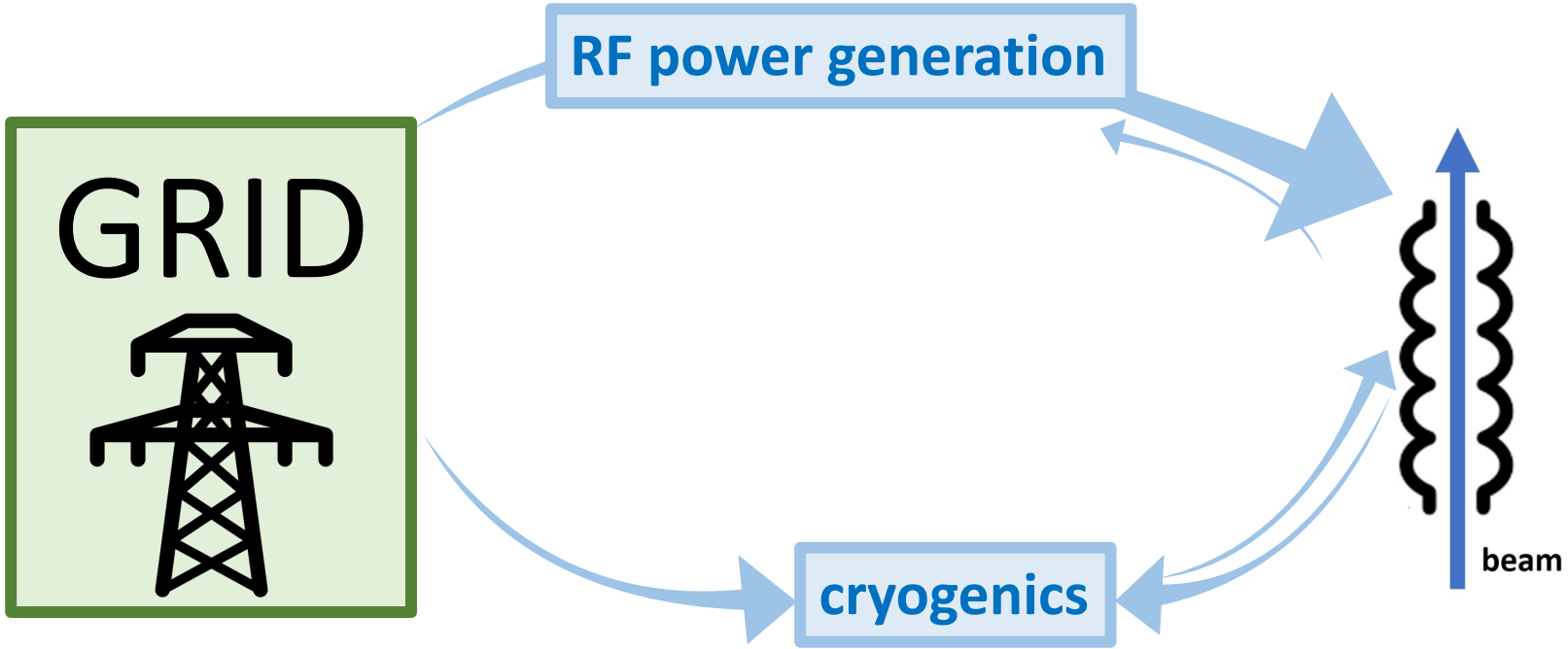
The main energy-saving technologies are universally applicable across SRF cryomodules and accelerators
(e.g., ESS, EuXFEL, HL-LHC, …)

From Grid to Beam



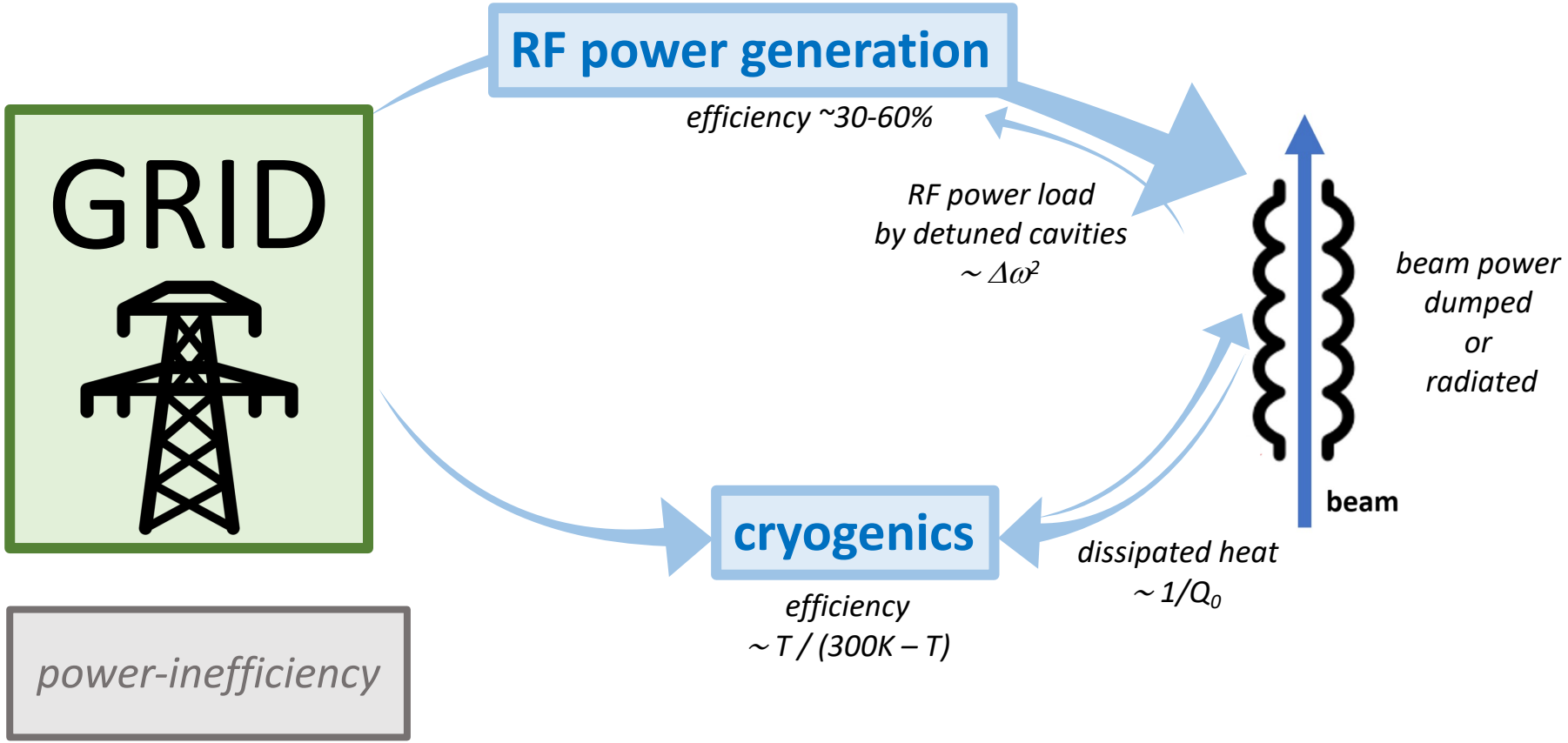
Picture adopted from M. Seidel (IPAC 2022)

From Grid to Beam



Picture adopted from M. Seidel (IPAC 2022)

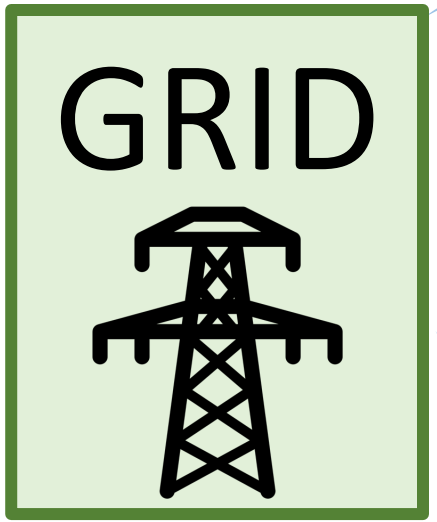
From Grid to Beam



From Grid to Beam

improve amplifier efficiency

e.g. solid state amplifiers for oscillating power demands



RF power generation

efficiency ~30-60%

recover the energy from the beam

e.g. ERL reaching 100% recovery

RF power load by detuned cavities

$\sim \Delta\omega^2$

dealing with microphonics

e.g. Fast Reactive Tuners

beam power dumped or radiated

cryogenics

efficiency

$\sim T / (300K - T)$

dissipated heat

$\sim 1/Q_0$

mitigation with novel technologies

operate cavities at higher T & improve Q_0 of cavities

e.g. Nb_3Sn from 2K to 4.2K ➔ 3x less cooling power needed

Three main iSAS Technology Areas