Some power considerations

F. Batsch, I. Karpov, H. Damerau

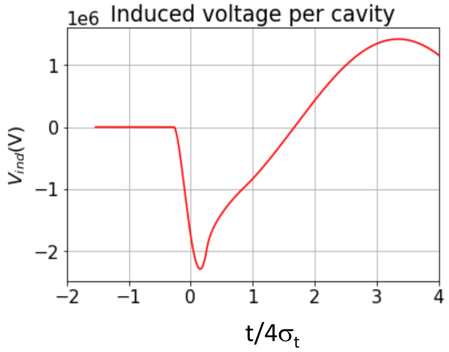
HEMAC meeting #9
01/11/2022

What will be the HOM power for the TESLA cavity?

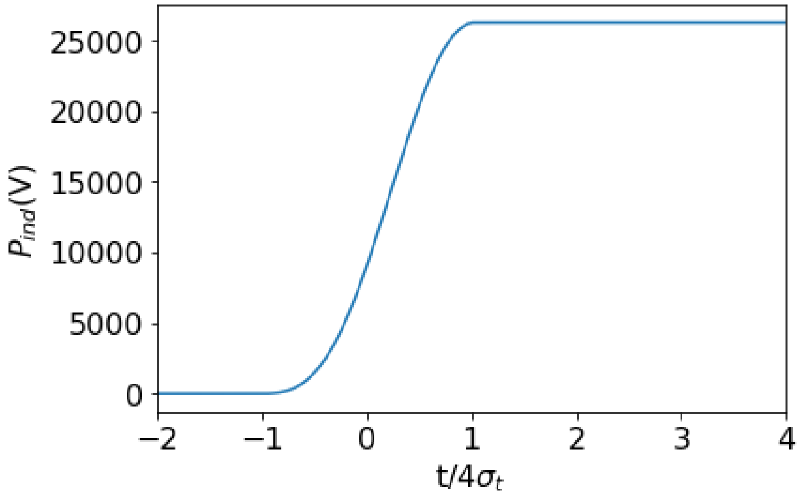
- **Looking at beam loading power**
- **Bunch population 2.54×10^{12}, T_{rev} = 20 μs → I = 20.4 mA**
- **Induced voltage V_{ind} = 2.2 MV**

→ Rough estimate 20.4 mA x 2.2 MV = 45 kW

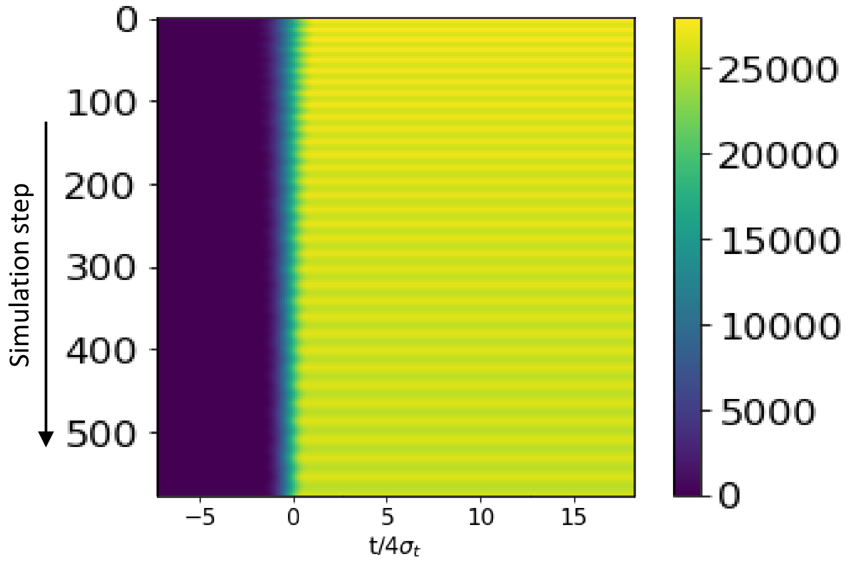
→ Calculate $\mathrm{I} \cdot \int \lambda(t) V_{ind}(t)$ for each simulation step / RF station



For 1 station:



For cycle:



- Can this be a show-stopper?
- J-PARC had similar considerations for their kicker magnets → **next slide**

International MUON Collider Collaboration

CERN

What will be the HOM power for the TESLA cavity?

- J-PARC had similar considerations for their kicker magnets:
- *“Design and actual performance of J-PARC 3 GeV rapid cycling synchrotron for high-intensity operation”*
- **In chapter 3.5:**

3.5. Suppression of instability

Resolving beam instabilities is important for accelerating a high-intensity beam. While the RCS accelerates an extremely large beam current, the kicker has a large impedance for the beam. Thus, we first considered that the transverse coupled bunch instability would arise at a beam power of several hundred kW if no measures were taken [54,88]. However, actually the instability was not observed even accelerating a beam current of 1 MW when we choose some specific parameters. We succeeded in understanding this phenomenon by a theoretical evaluation including the space charge effect [54]. Based on this evaluation, we can suppress the instability by selecting an appropriate tune. Besides, theoretical and numerical simulations confirmed that the instability can also be suppressed by optimizing the correction pattern of chromaticity [89,90].

- **Conclusions?**

CERN

Muon RCS in LHC tunnel?

- An RCS with 10 T / ±1.8 T SC/NC magnets, 1.5 → 5 TeV RCS does not fit into the LHC tunnel

- The av. magnetic field strength must be high enough to allow for 2300 cavities (90% survival rate)
- → Stronger magnets, e.g. 16 T / ± 2.0 T required if energy gain / survival kept constant

Survival rate	90%
Turns	72
Circumference [m]	26659
SC / NC magnetic strength [T]	16 / ±2
Length NC section [m]	18339
Length SC section [m]	4257
Length straight section [m]	4063
Number of cavities	2292

Next: study which final energy can be achieved using the LHC