Universität Rostock Traditio et Innovatio

Welcome,
General information,
Information on the status in Rostock

Ursula van Rienen

Kick off Meeting of Task 6.1 in the MuCol EU Design Study

From the application proposal (I)

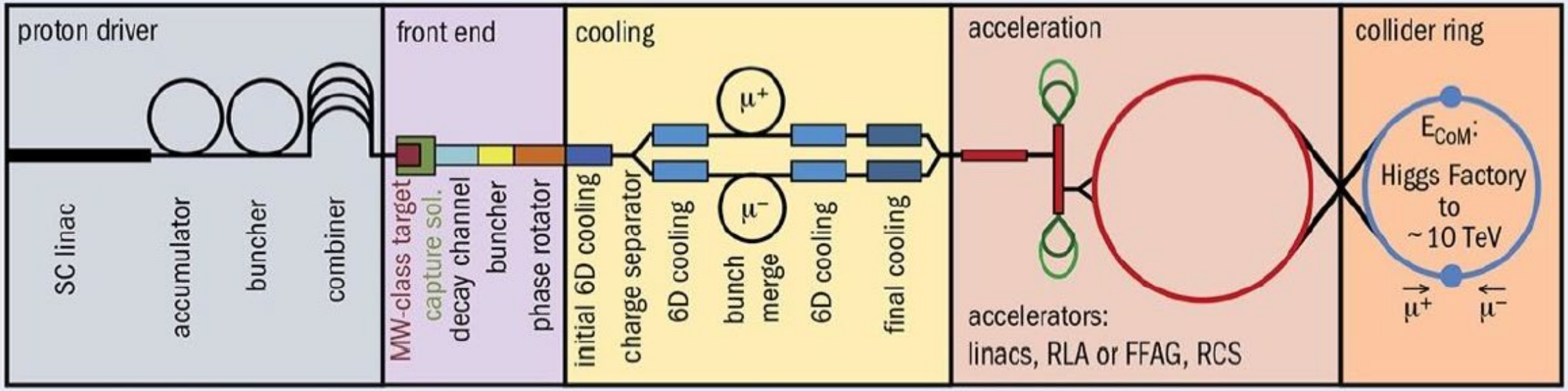


Fig. 2: Layout of the Muon Collider complex as elaborated by the MAP

From the application proposal (II)

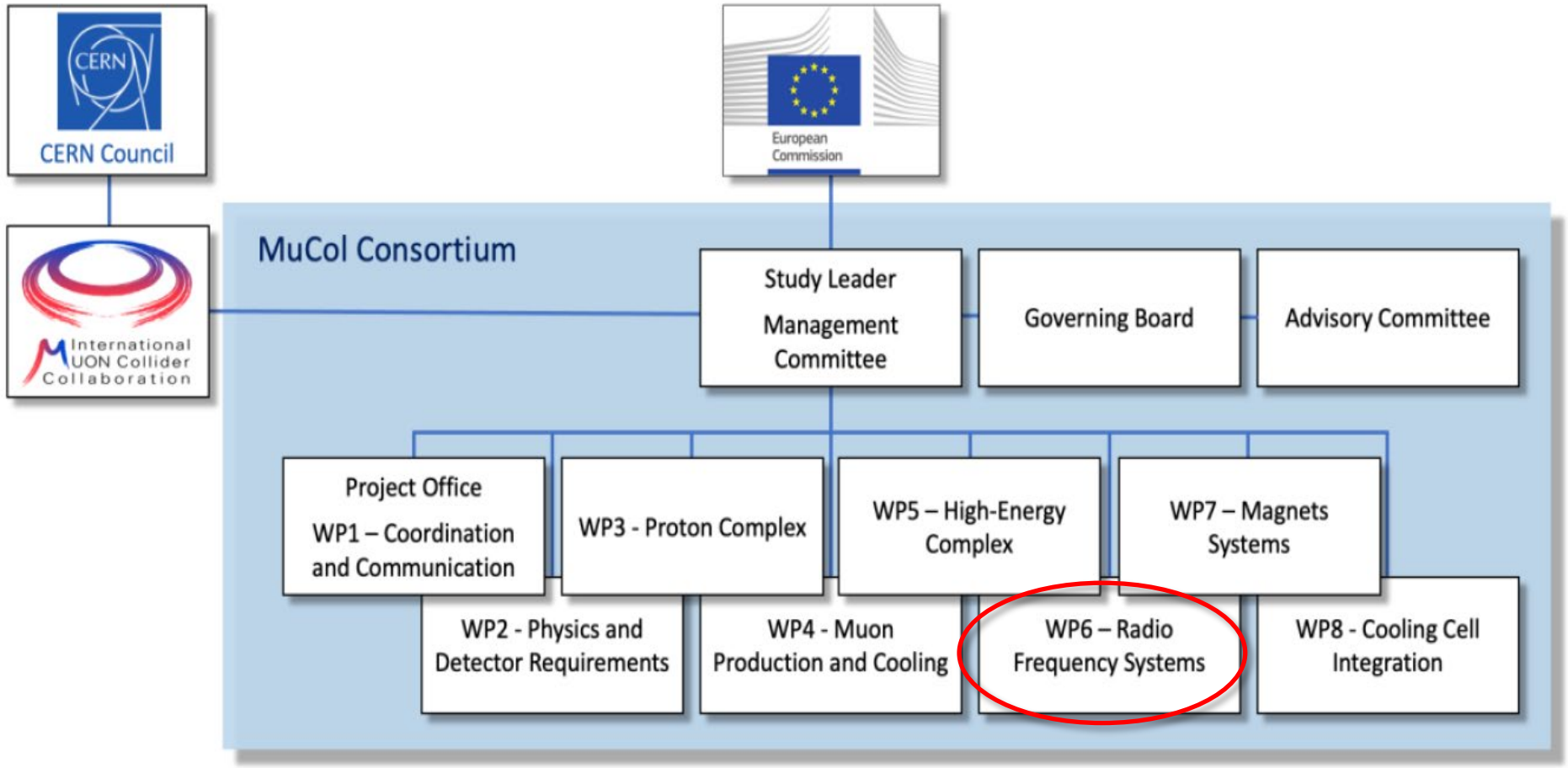


Fig. 5: Proposed organisation of MuCol

From the application proposal (III)

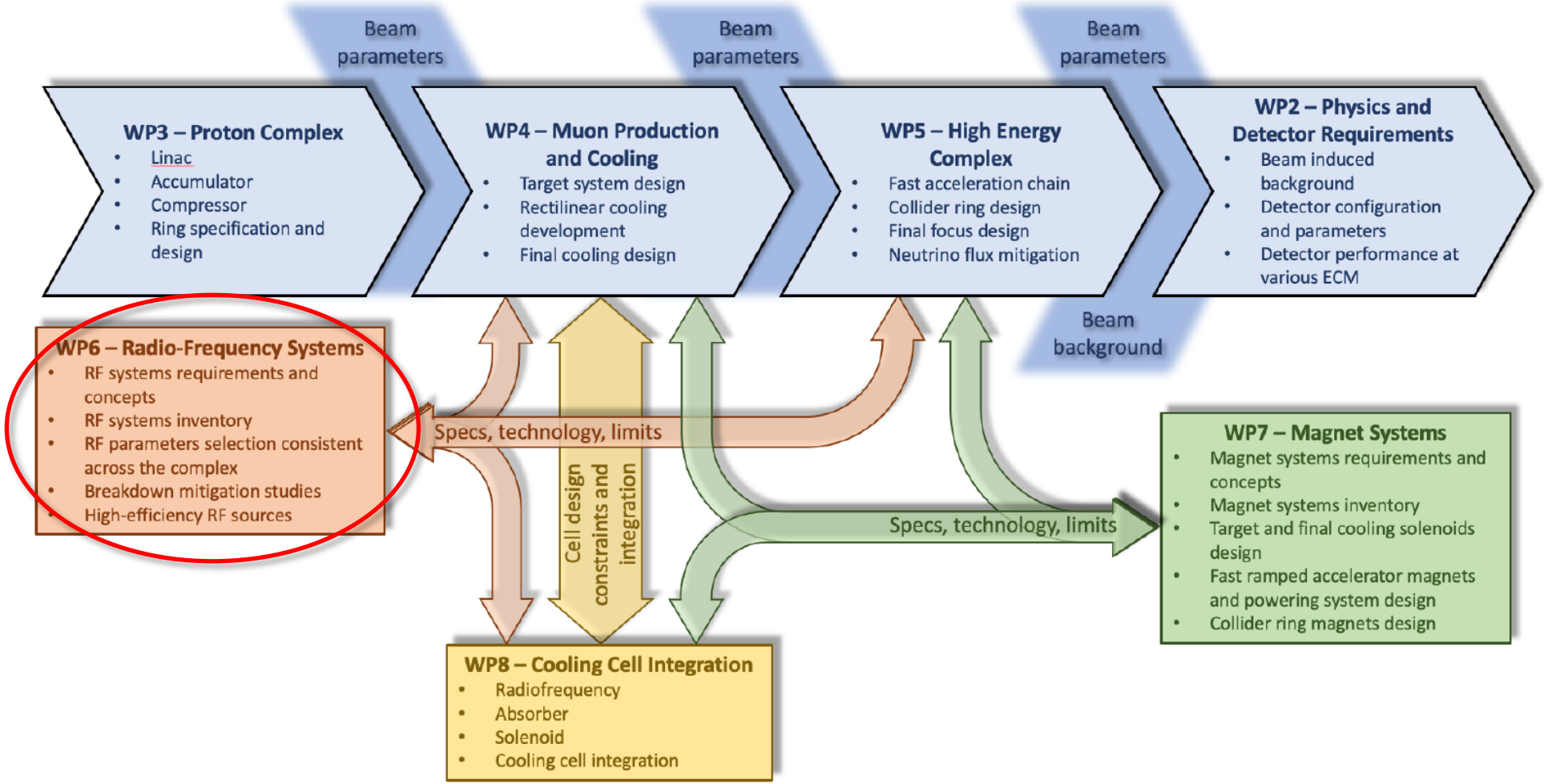


Fig. 6: Schematic diagram of interactions among workpackages

From the application proposal (IV)

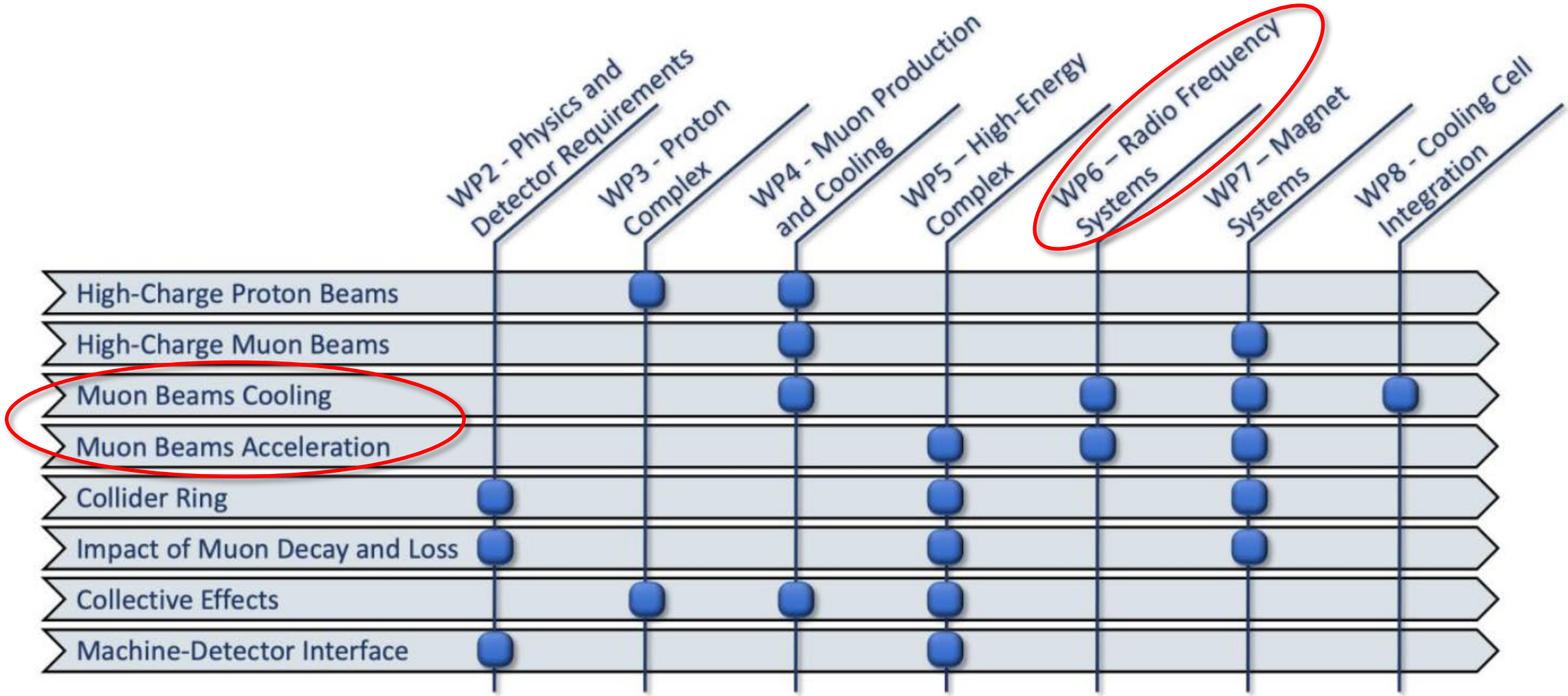


Fig. 7: Responsibility Assignment Matrix

From the application proposal (VII)

Table 3.1b.6: WP6 - Work package description

Work package number	**6**	**Lead beneficiary**			**CEA**		
Work package title	**RadioFrequency Systems**						
Participant number	**5**	**16**	**4**	**6**	**1**		
Short name of participant	**CEA**	**ULA**	**UROS**	**INFN**	**CERN**		
Person months per participant:	**22**	**36**	**12**	**36**	**0**		
Start month	**1**			**End month**	**48**		

Objectives

The objective of this work package is to assess crucial feasibility issues and technological challenges of the RF systems. The study will concentrate on the two most challenging sections, the Muon Cooling Complex (MCC), and the muon acceleration stage of the High Energy Complex (HEC), for which a baseline concept of most critical RF components will be outlined.

Description of work

This workpackage will be led by **CEA**, supported in some tasks by **INFN** that will provide the deputy WP leader. Apart from the coordination of the work inside the WP, CEA and INFN will ensure proper integration of the work of this work package with the studies done in WP4, WP5 and WP8. Other Participants to this WP are **UROS, CERN, ULA, Strathclyde.**

From the application proposal (VIII)
Task 6.1 Baseline concept of the RF system for acceleration to the High Energy Complex (HEC)

- This task, led by the University of Rostock, aims to provide a **preliminary design concept for the SRF cavities** for acceleration **in the Rapid Cycling Synchrotrons (RCS) of the HEC** of the muon collider.
- For the acceleration stage of the HEC, the short muon lifetime **requires the highest possible acceleration rate** to **reach energy gains on the order of 10 GeV per turn**.
- This is foreseen to be provided with **very high-voltage SRF cavities**.
- A suitable **cavity technology**, including the accelerating **cavity type and shape**, the **cavity material**, and the **main RF frequency**, will be determined for this system.
- **Strong transient beam loading** effects **and strong wakefield effects** due to the very high intensity of the muon bunches will also have to be addressed in the cavity optimisation.

From the application proposal (IX)
Task 6.1 Baseline concept of the RF system for acceleration to the High Energy Complex (HEC)

- **In cooperation with WP5**, a **full set of parameters for the RF cavities** that address longitudinal beam dynamics and stability will be established (R/Q, Vmax, …) for the fundamental mode and HOMs' suppression.
- This will provide input specifications for the design concept of the RCSs cavities.

Deliverables (brief description and month of delivery)

D6.1: Consolidated report on baseline concept of high efficiency and high-power RF sources - M42

D6.2: Consolidated report on baseline concepts of the RF systems for the MCC and HEC complexes, including breakdown mitigation studies for MCC cavities - M45

Status at Rostock – the team

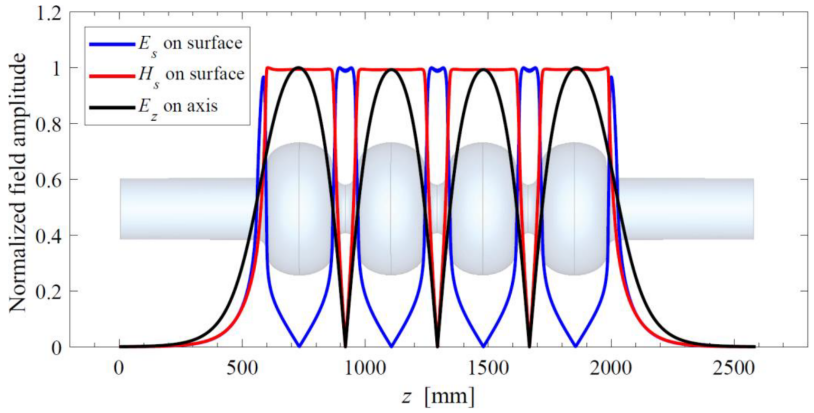
- Ursula van Rienen, Chair of Electromagnetic Field Theory, https://www.iae.uni-rostock.de/en/institut/chairs/vanrienen/
  - Long-lasting experience in code development and numerical simulations for various accelerators
  - Recent contributions covered SRF cavity design and HOM coupler design for the following machines, e.g., FCC-ee, CERN's SPS the European X-FEL, BESSY-VSR and BERLin-Pro
  - Exemplary more basic studies comprise robust shape optimization of SRF cavities, general systematics and the use of perturbation methods in cavity design or those on the manufacturing process, to name only a few
  - Regarding multipacting, her group contributed a design for multipacting suppression for the ELBE SRF gun
  - Another example is the design and prototype of a compact RF deflecting cavity for ELBE
- Simon Adrian, Assist. Professor for Computational Electromagnetics, https://www.iae.uni-rostock.de/en/institut/chairs/simon-adrian/
  - Co-PI
  - expertise in integral equation solvers, particularly fast solvers, among others
  - areas of application include antenna modelling

Status at Rostock – the team

- Sosoho Abasi Udongwo, PhD candidate, https://www.iae.uni-rostock.de/en/team/udongwo-sosoho-abasi/
  - Mainly working on the SRF cavity and HOM coupler design for FCC-ee, but supporting for the time being
  - Will be financed as a Post Doc for 12 months by the MuCol EU Design Study in 2024
- NN, an applicant for a Gentner grant in the CERN doctoral program
  - Studied Electrical Engineering at the University of Rostock, finishing his master's thesis in January 2023
  - Currently, a technical student at CERN
  - Applied for part 2 of the JUAS School
  - He would start his PhD in April 2023 if selected by the grant committee
- NN, research assistant from the university budget
  - The position will be announced soon
  - Backup to possibly support part-time, depending on the applicant's qualifications

Preliminary quick study by Shahnam Gorgi Zadeh, July 2020

Four-cell Nb/CU at 400 MHz



$$\frac{R}{Q} = 411.3\ \Omega \qquad k_{\parallel}(\sigma_z = 2\ \text{mm}) = 2.27\ \text{V/pC}$$

HOM power for single bunch excitation is calculated from:

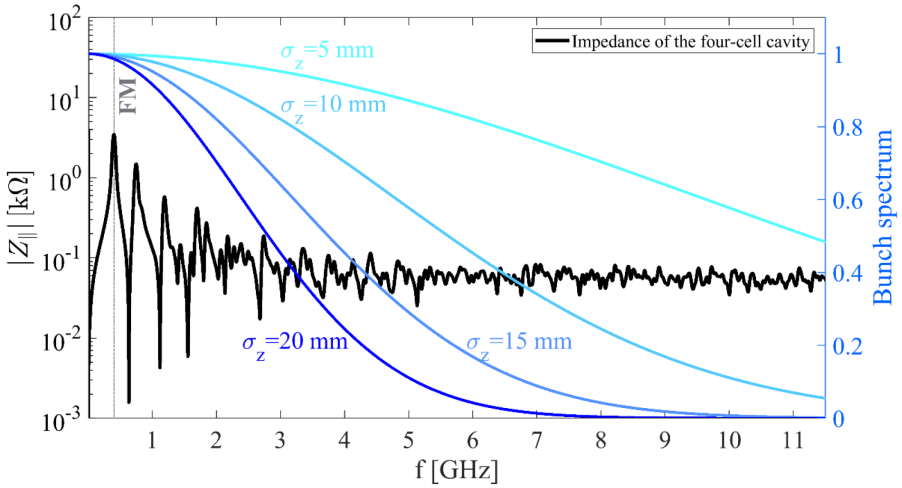
$$P = k_{\parallel} q_b I$$

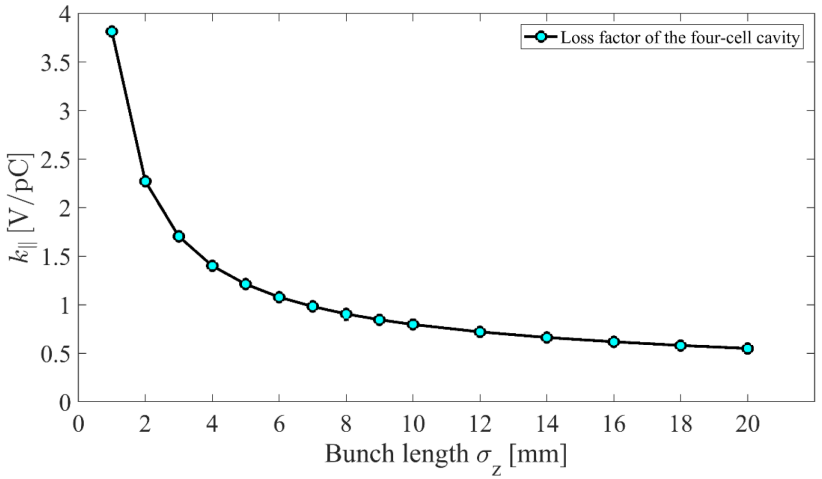
where q_b is the bunch charge and I is the average beam current.

Number of muons per bunch= 2×10^{12} → $q_b = 320435\ \text{p}C$

$I = 16\ \text{m}A$ [p.40, 1] → $\boldsymbol{P = 11.6\ \text{kW}}$

The high HOM power limits using multi-cell cavities.

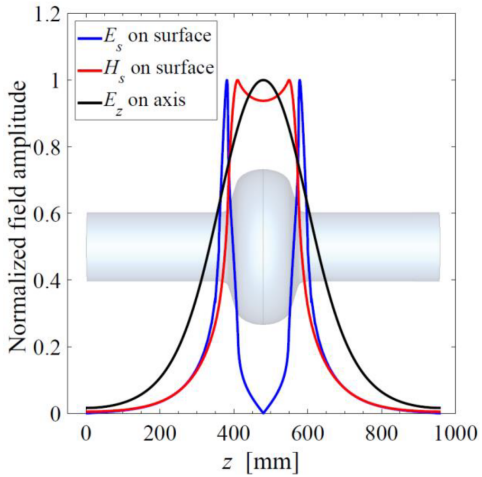




1) V. Shiltsev and F. Zimmermann. Modern and Future Colliders. https://lss.fnal.gov/archive/2019/pub/fermilab-pub-19-481-ad-apc.pdf

Preliminary quick study by Shahnam Gorgi Zadeh, July 2020

Single-cell Nb/CU at 400 MHz



$$\frac{R}{Q} = 79.0\ \Omega$$

$$k_{\parallel}(\sigma_z = 2\ \text{mm}) = 0.314\ \text{V/pC}$$

HOM power $P = k_{\parallel} q_b I$

$q_b = 320435\ \text{pC}, I = 16\ \text{mA}$ → $\boldsymbol{P = 1.61\ \text{kW}}$

The high HOM power favors using single-cell (or two-cell) cavities for this collider.