



R2E-related studies on FCC: Scaling of the radiation levels in the arc section and future FLUKA simulations



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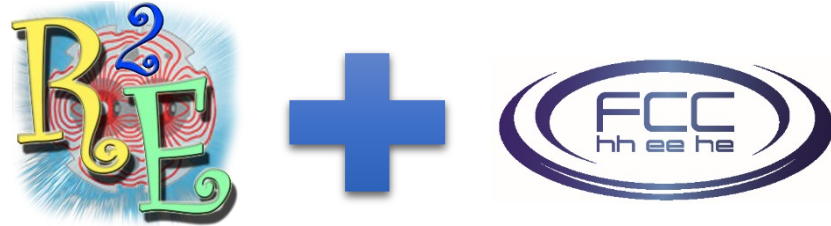
On behalf of R2E & FLUKA team

Outline



- Introduction on R2E-related studies on FCC
- Scaling of the radiation levels in arc section
- FLUKA MC studies (on going and future)
- Requests and Summary

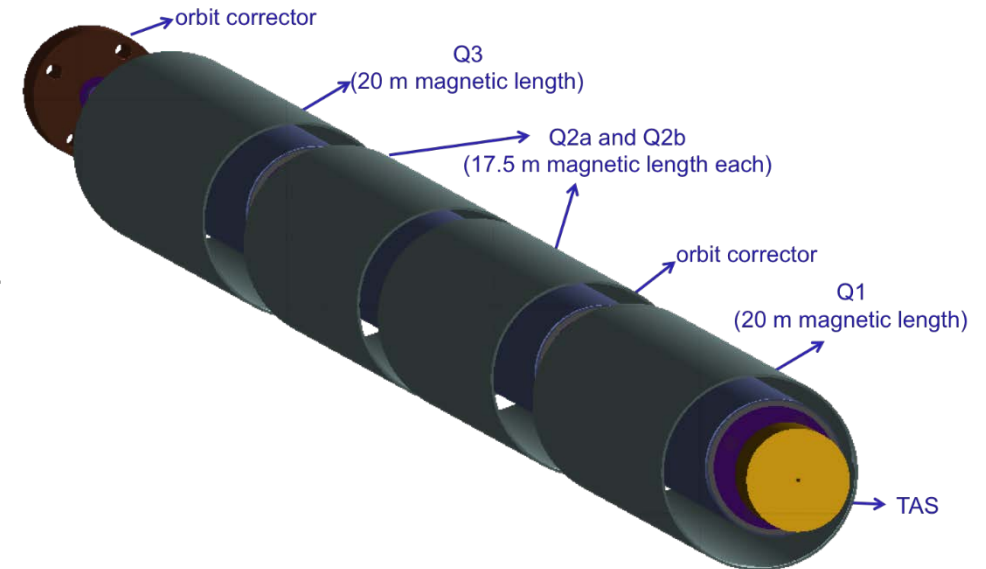
R2E-related studies on FCC



- Integrated in the R2E mission
- Based on the well-consolidated experience for LHC
- Study of the radiation levels in critical areas for electronics
- Extensive use of Monte Carlo FLUKA simulation for an accurate modelling of the radiation environments in a so complex accelerator facility (geometry, source term, interaction with matter, etc)



- Increase FCC reliability by factors to reach performance goals
- Design of “optimized” areas for electronics (alcoves, shielding, etc)
- (First) Evaluation of the requirements for the technology to be used
- Lifetime and choice of critical components (cables, redundancy, etc)



FLUKA model of the FCC triplet
Courtesy of M.I. Besana (EN/STI-FDA)

FCC Scaling in the ARC section

- The scaling has been performed for the generic arc section where **beam-gas interactions** dominate.
- **Energy** and **Intensity** of the beam were taken into account while **residual gas density** was assumed the same in LHC.
- High Energy Hadron (HEH) fluence and doses were calculated from the data available for LHC in 2015.

Scaling Factor ~15



FCC Expected

Location	HEH [cm ⁻² y ⁻¹]	Dose [Gy y ⁻¹]
ARC MQ	7.91E+09	15.8
ARC MB	3.16E+09	6.3

Assuming a
"Radiation Safe" and
an "Optimization"
criteria



Expected Shielding

Radiation Safe [HEH/cm²/y]

1.00E+05

Location	R.F.	Iron [cm]	Concr [cm]
ARC MQ	1.26E-05	>>200	>>200
ARC MB	3.16E-05	>>200	>>200

Optimization [HEH/cm²/y]

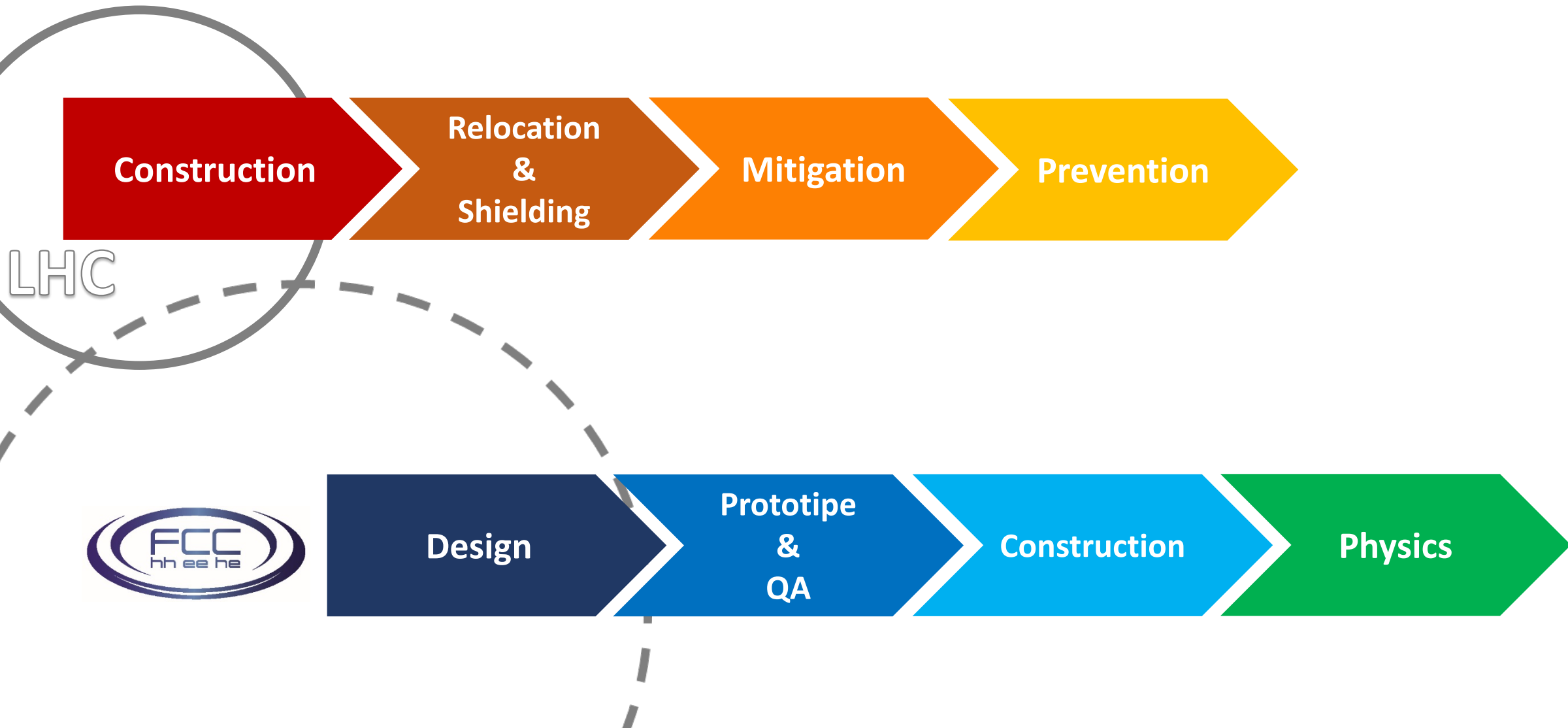
1.00E+06

Location	R.F.	Iron [cm]	Concr [cm]
ARC MQ	1.26E-04	>200	>>200
ARC MB	3.16E-04	190	>>200

Note:

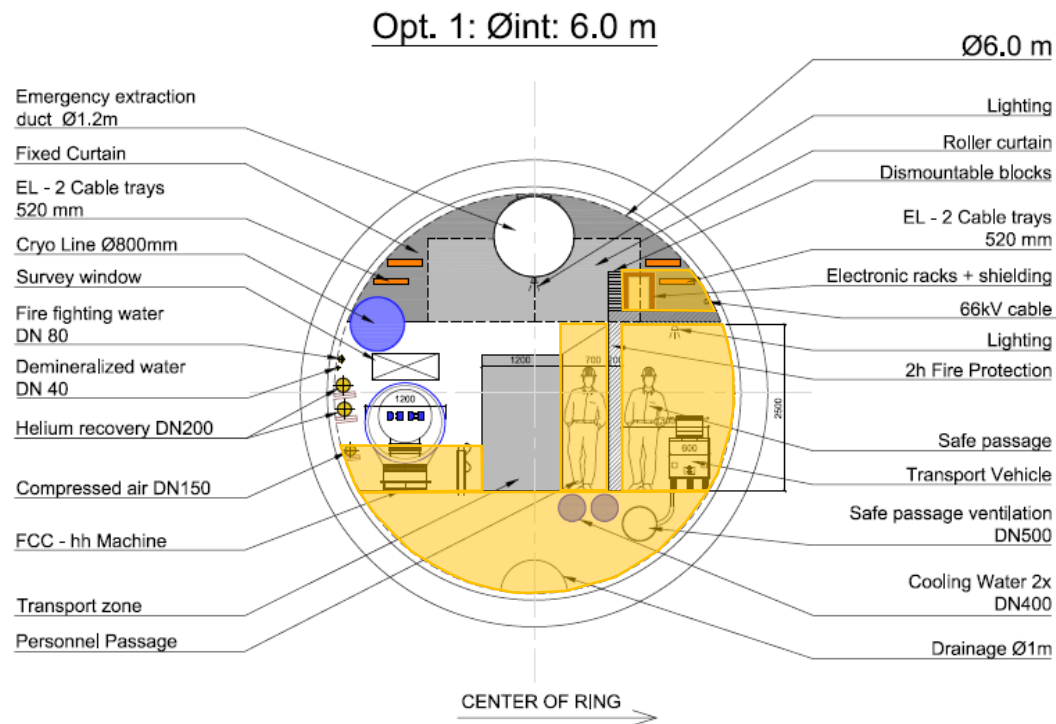
- Scaling for Beam-Gas interaction assuming a constant residual gas density between LHC/FCC.
- FCC data from FCC-ACC-SPC-0001

FCC Scaling in the ARC section

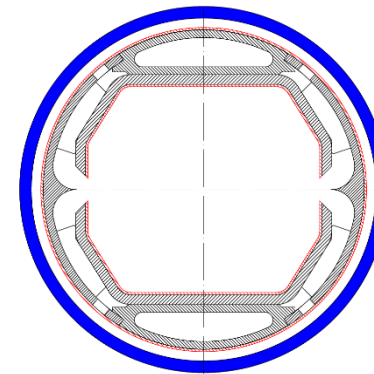


FLUKA MC Simulations

- Considerable amount of work done in the past within the FLUKA team in the FCC framework (energy deposition in the triplet, detector design).
- We are currently updating the FLUKA model of the arc section in terms of tunnel (as in CE preliminary drawings), beam screen, optics.
- Simulations will be used to accurately evaluate the HEH fluence and doses in different locations of the tunnel.



FCC Beam Screen



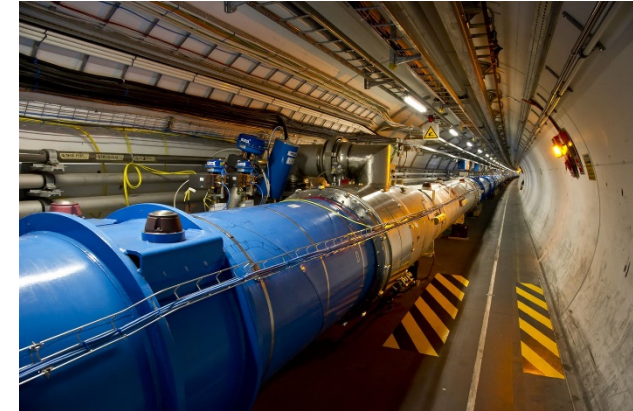
Original technical drawing



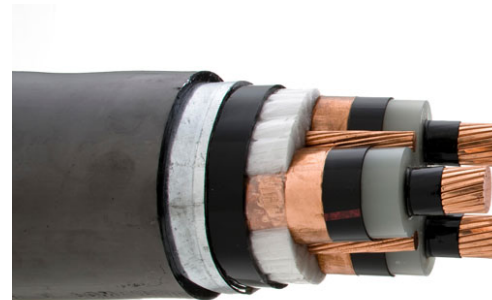
FLUKA MC Simulations: Requests



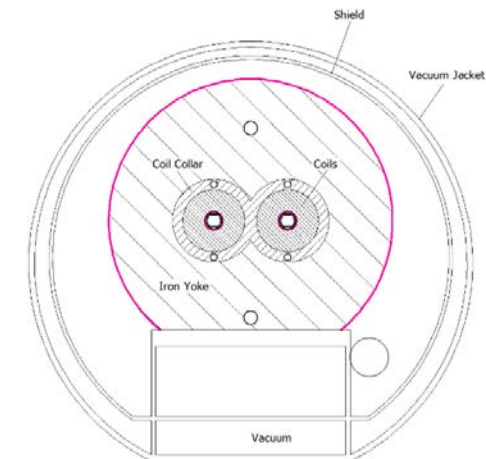
- Radiation levels in the tunnel & (first) design of critical areas for electronics
 - Request from: R2E
 - Main person in charge: Angelo



- Radiation damage of HV-cables
 - Request from: Volker Mertens (FCC IOWG)
 - Main person in charge: Angelo



- FCC Cold Mass Cooling: Heat load & distribution due to beam-gas scattering
 - Request from: Claudio Kotnig (TE/CRG)
 - Main person in charge: Ilaria/Angelo



Source: C. Kotnig (TE/CRG)

Take-Home Message:

- We don't know the technology that we will use in +20 years but we know that:
 - The trend in electronic components is to be much more integrated (increasing sensitivity to radiations)
 - The number of electronic components in FCC will be \gg that in LHC (increasing probability of SEE)
 - Considering the arc (only), the radiation levels are evaluated to be ~ 15 times higher (increasing probability of SEE)
- To increase FCC reliability and to reach FCC performance goals, R2E-studies must be performed and maintained during the entire design/construction/physics time of the accelerator
- The (rough) assessment of the dose levels in the arc section is a good starting point for studying possible “a-priori” relocation/mitigation solutions (dedicated alcoves, redundancy, etc).
- An accurate MC FLUKA modelling is necessary due to the complexity of the physical phenomena and level of detail to be reached
- Inputs from other groups are necessary/appreciated given the strong interconnections of the R2E-related studies with the work of other groups (RP, Civil Engineering, etc)



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