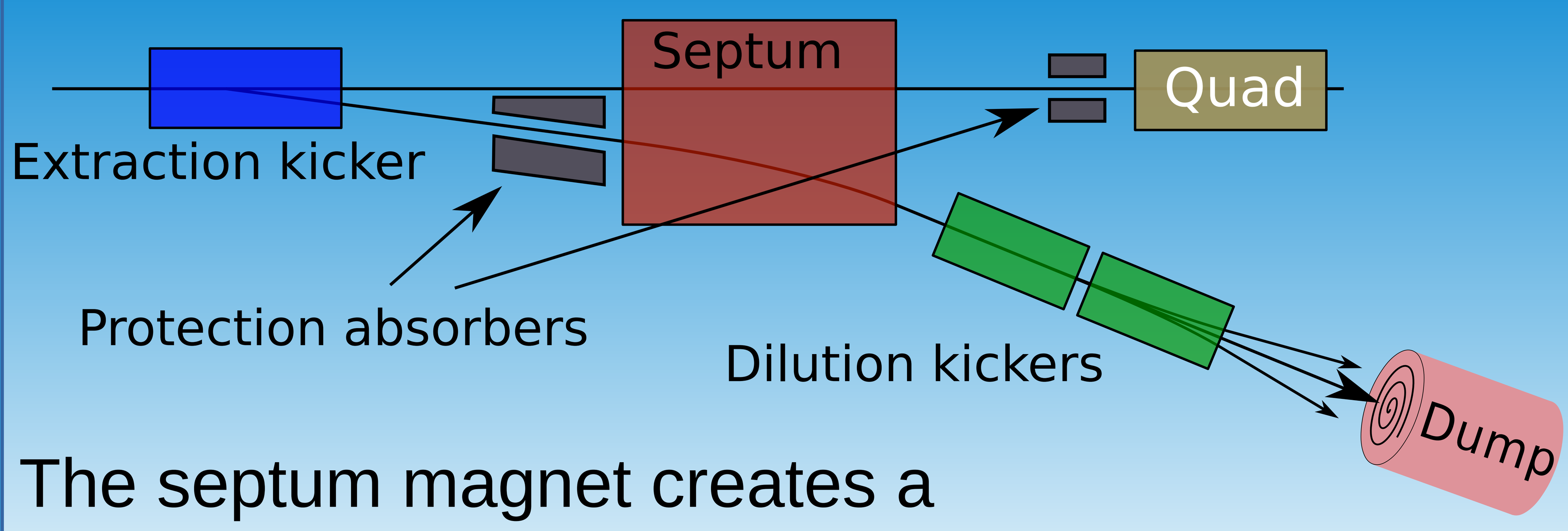
# The SuShi Septum for FCC

Dániel Barna (barna.daniel@wigner.mta.hu)
Wigner Research Centre for Physics
Budapest, Hungary

**1) Abstract:** The parameters of the planned Future Circular Collider hadron-hadron ring (FCC-hh) at CERN – an 80-100 km circumference, 50+50 TeV collider – require new materials, technologies and ideas for many of its components, including the beam extraction system: kickers, septa and beam dump. The concept of realizing a high-field septum magnet using a superconducting magnetic shield will be presented

## 2) Extraction system layout



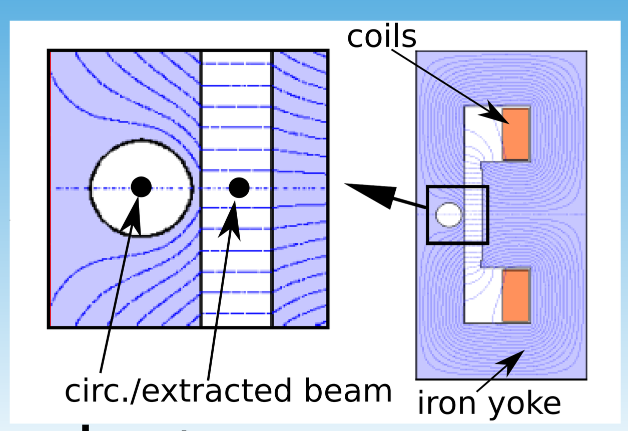

The septum magnet creates a field-free channel for the circulating beam very close to a high-field region

## 3) Parameters

| FCC-hh | Injection | Extraction | Unit |
|---|---|---|---|
| Beam energy | 3.3 | 3.3-50 | TeV |
| Deflection by septum | 7.3 | 3.04 | mrad |
| Integrated field ∫B·dL | **80.4** | **35-508** | T·m |
| Available length (changing) | **100** | **260...360** | m |
| Effective septum thickness | | ~25 | mm |
| Physical septum thickness | ~6 | ~15 | mm |

## 4) LHC technology: Lambertson septum

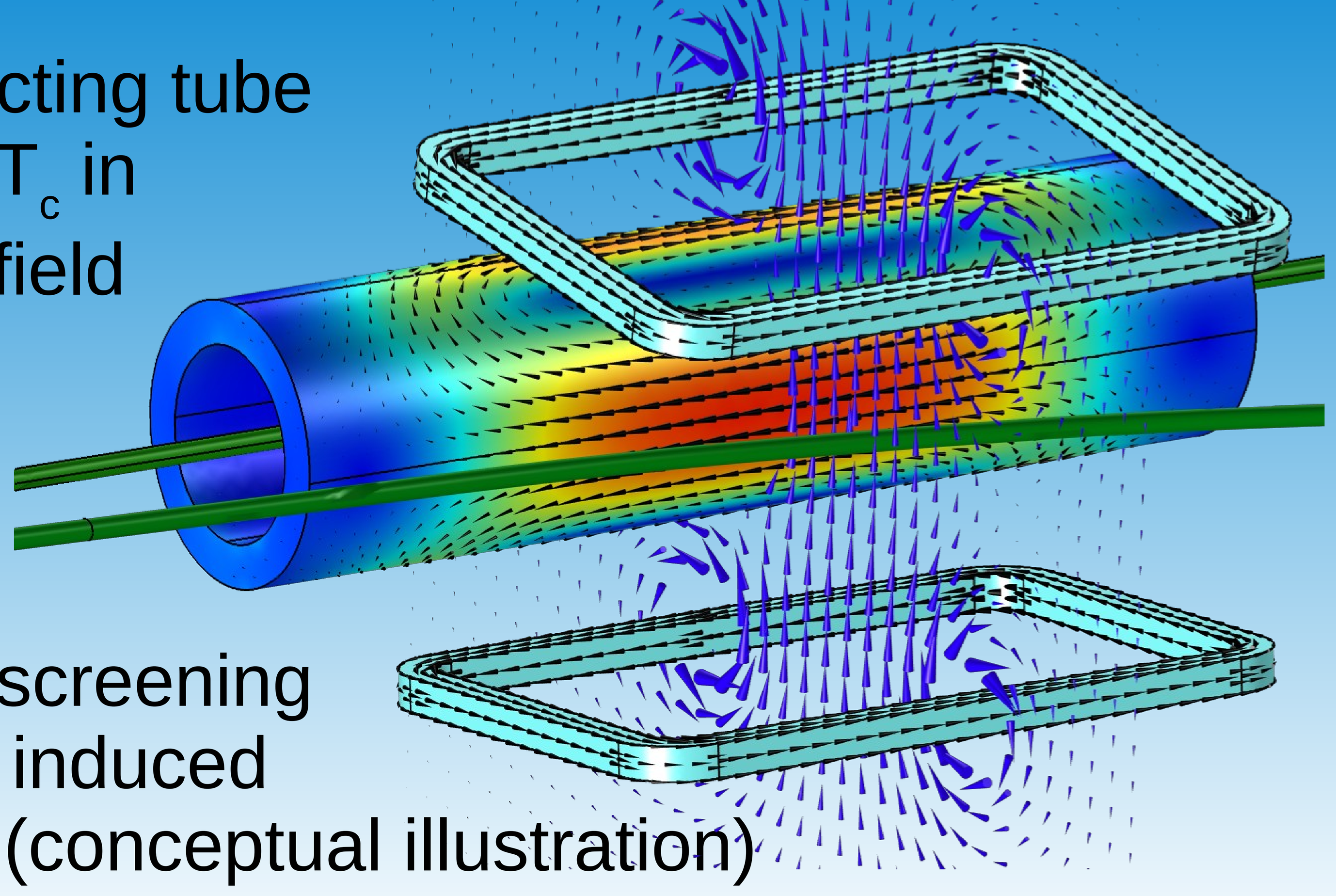
- 1T field, would need >500 m for FCC. Doesn't fit!
- Need higher fields, at least 2T
- Iron yoke would saturate at higher fields
- 6 MW losses




Need superconductors

## 5) Superconducting Shield (SuShi)

A superconducting tube cooled below $T_c$ in zero external field will shield its interior from a ramped-up magnetic field via long-lived screening eddy currents induced on its surface (conceptual illustration)



## 6) Pros & Cons

✔ Perfect arrangement of currents by nature

✔ Continuous 2D current distribution, perfect shielding (in constrast to discrete wires in magnets)

✔ No windings in the tight space around the beam, no insulations between them. Contiguous block, good heat conduction and mechanical stability

✔ Automatically the highest possible current density, thinnest field transition

✗ Large volume in critical state. Flux jumps?

✗ Strong hysteresis

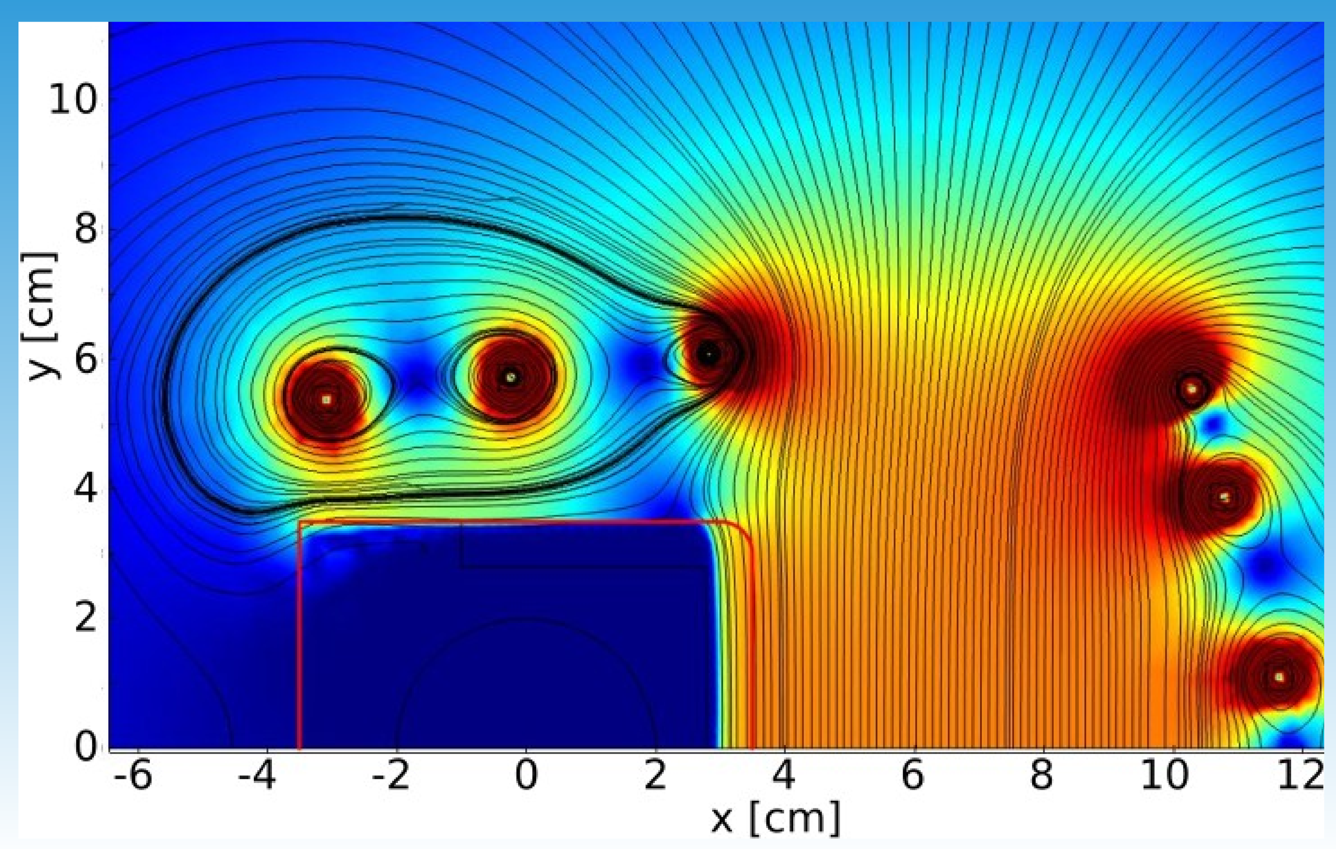
✗ SC material in high-rad zone (for all devices aiming to use superconductors)

✗ Screening current penetration geometry and hence field pattern is field-dependent.

## 7) Homogeneous field

Using a rectangular shield and an optimized coil geometry:

a field-independent homogeneous field can be produced




**8) Prototypes and tests:** About 50 mm outer diameter shields manufactured from different materials will be tested in one of the spare corrector dipole magnets (MCBY) of LHC, with a maximum magnetic field of about 5 Tesla on the shield surface.