THE HIE-ISOLDE FACILITY AT CERN

World-leading facility in radioisotope production and acceleration

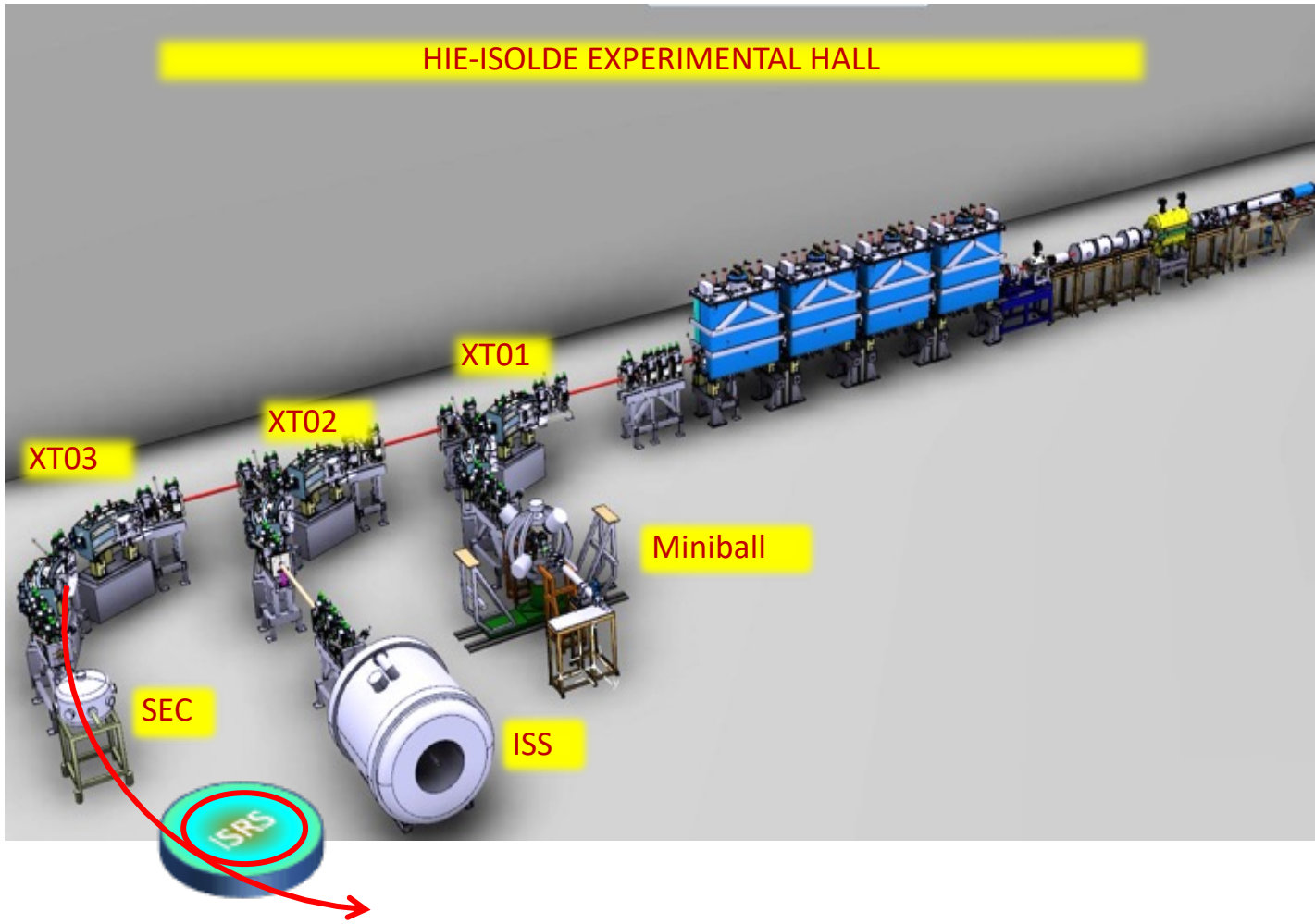
- Large range of radioactive beams from ^{6}He – ^{234}Ra
- Wide energy range 0.45 -~ 10 MeV/A

- A Recoil Separator will benefit ISOLDE physics program.

- Previous project: HIE-Isolde Fragment Identifier (HIFI) – 2011.

ISOLDE Superconducting Recoil Separator (ISRS):

- First studies in 2019 (Huelva – Liverpool).
- First paper 2020 NIMA 969 (2020) 164048.
- ISOLDE LoI INTC-I-228 approved, INTC-2021.
- Funding for R&D – RRF (2023/2025).

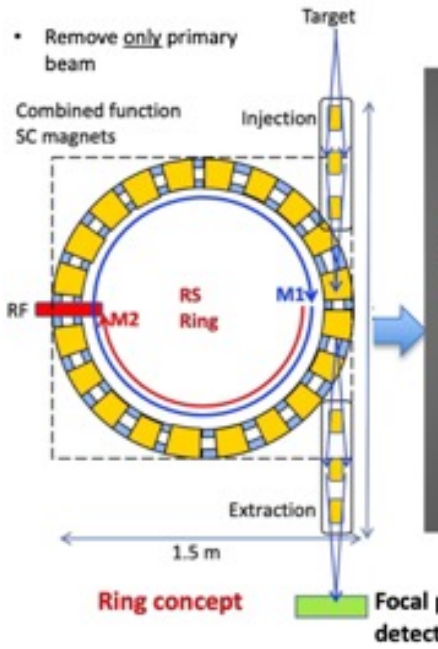


BEAM DYNAMICS

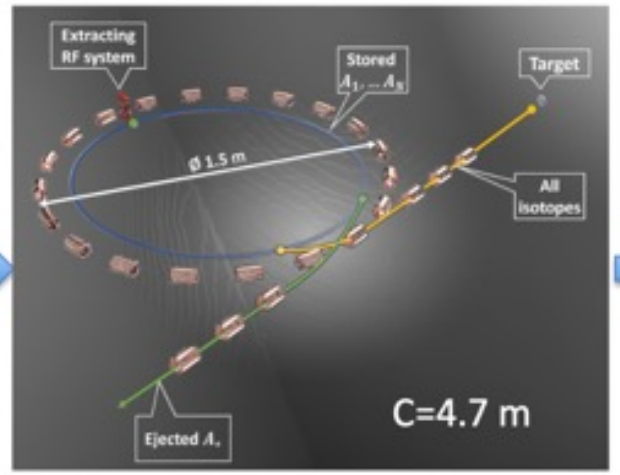
Based on *Design of a superconducting gantry for protons*, IPAC2015, TUPWI014
C. Bontoiu, J. Sánchez, R. Berjillos, J. Pérez, I. Martel → Fixed Field Alternating Gradient (FFAG) + Superconducting Multifunction Magnets

ISRS beam dynamics: *Conceptual design of a novel and compact superconducting recoil separator for radioactive isotopes*
C. Bontoiu, J. Resta, V. Rodin, I. Martel, C. Welsch, Nucl. Inst. Meth. A 969 (2020)164048

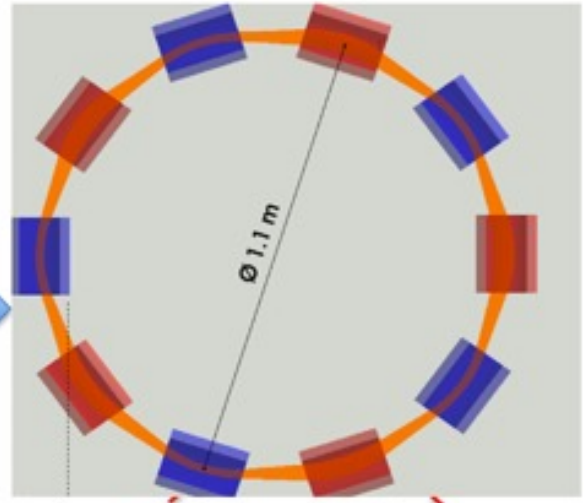
Conceptual design
I. Martel. 84th ICC meeting. CERN, March 2019.

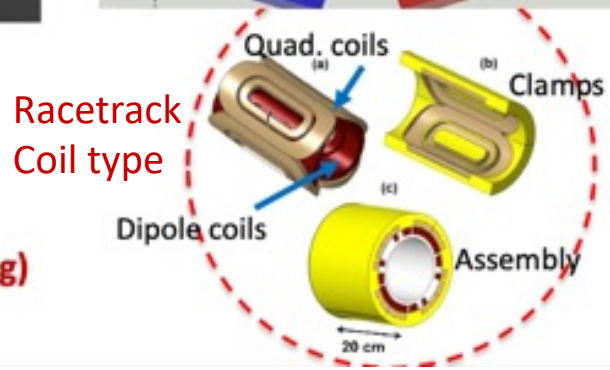


3D G4beamline model (20 multifunction magnets)



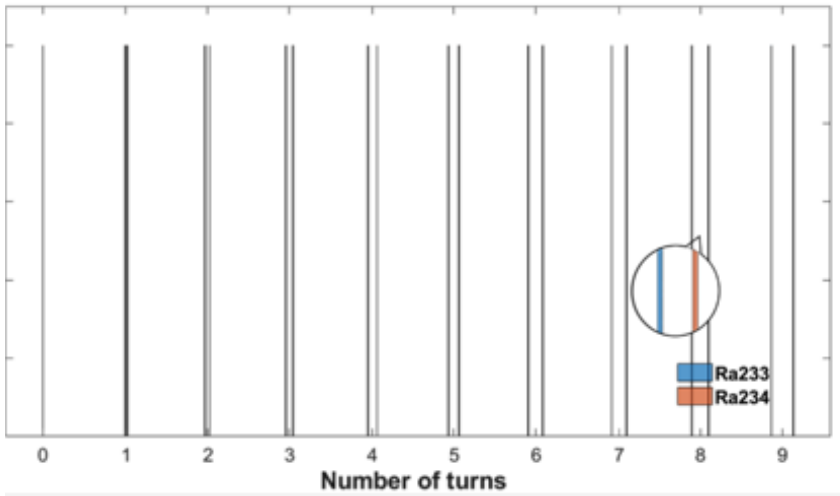
First optimization (10 multifunction magnets)
C. Bontoiu et al., NIMA 969 (2020) 164048





- Particle storage mini-ring
- Fixed Field Alternating Gradient (FFAG)
- Multifunction SC magnets (mini-LHC); D+Q (20 cm long)
- 1.5 meters diameter! – "Tabletop" spectrometer

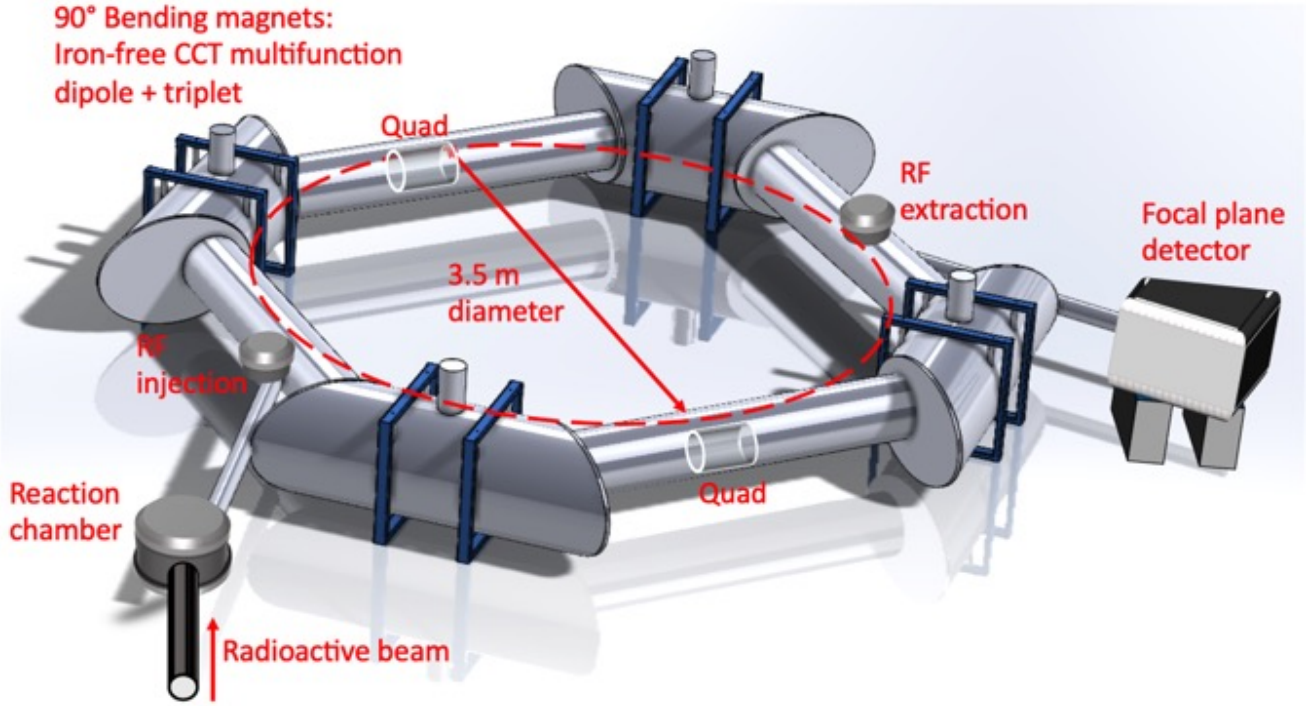
$^{2}\mathrm{H}(^{233}\mathrm{Ra},\ ^{234}\mathrm{Ra})\mathrm{H}$



- E = 10 MeV/A, ΔP = 30%
- ToF separation ~ 40 ns (~10 turns/ 2.5 μs)
- ~ 100% transmission

PRESENT CONFIGURATION

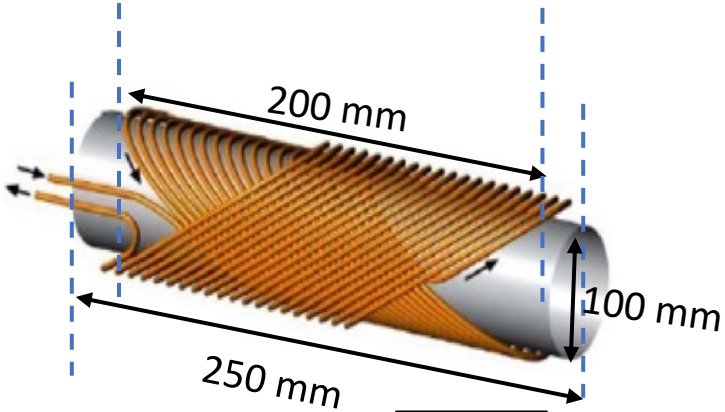
LoI INTC-I-228: *Design study of a Superconducting Recoil Separator for HIE-ISOLDE.*
Spokespersons: I. Martel, O. Tengblad, J. Cederkäll



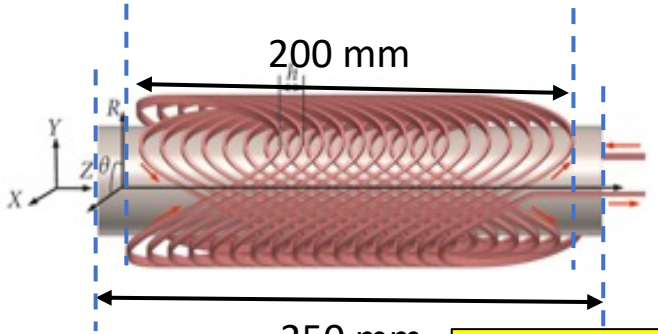
- Fixed Field Alternating Gradient → accepts large divergence and momentum spread
- Superconducting magnets → reduced size, mass, large fields
- Multifunction magnets (dipole, quad., sextup.) → compact magnets
- Canted Cosine Theta (CCT) → reduce field errors, easier design/ fabrication
- Iron free (magnetic shield) → reduced thermal mass, weight, non-linearities
- Cooling by cryocoolers → easier operation, displacement (rotation)

Canted Cosine Theta (CCT) coils

Straight models



Dipole



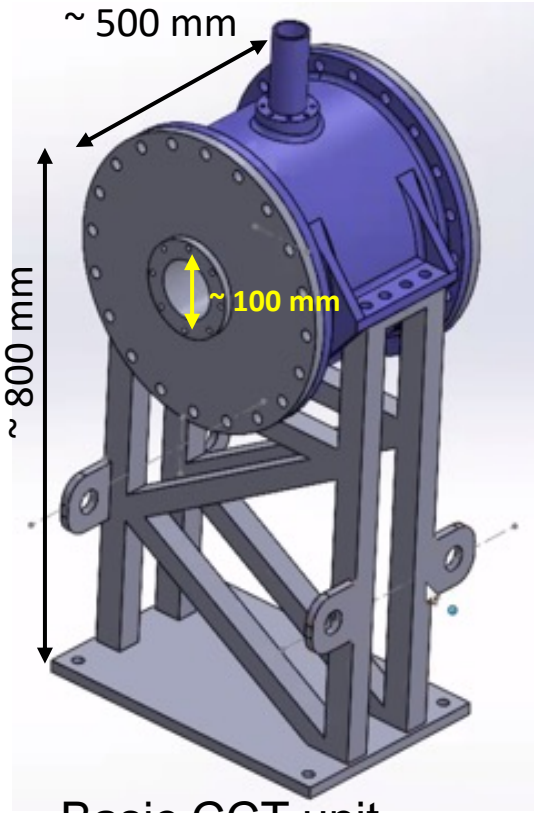
Quadrupole

Based on
L. Zhou et al., Hindawi Shock and Vibration 2021, 8895136

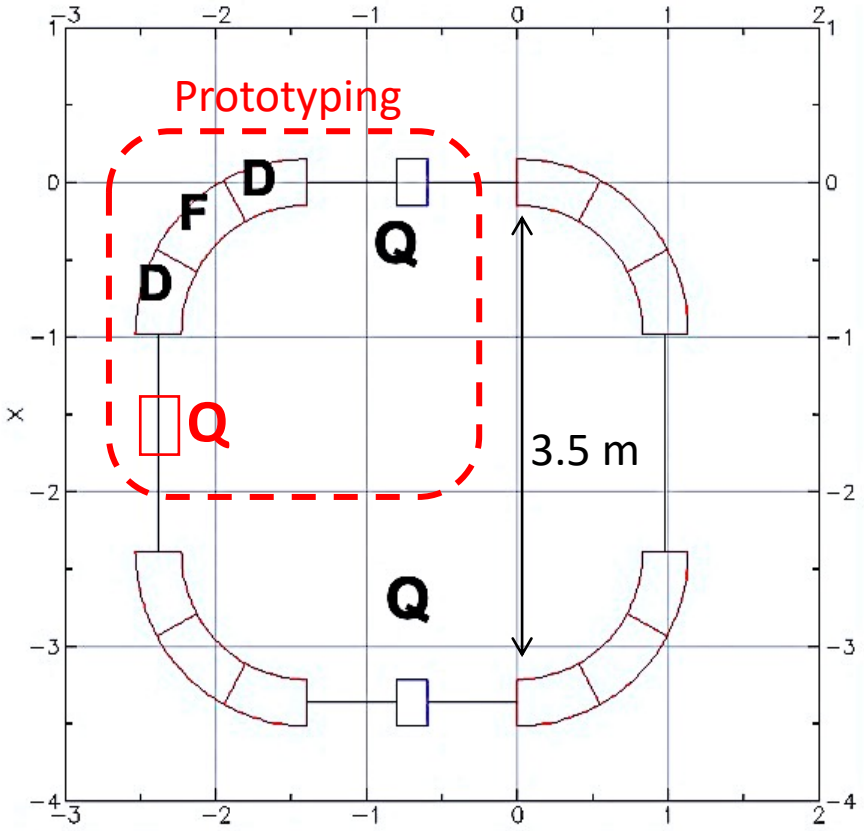
MAGNET PROTOYPES: STRAIGHT SECTIONS

- Combination of straight CCTs (as in NIM A969 (2020))
- Cryocooler cooling
- Multifunction solenoids: dipole (sextuples) + quadrupole
- Former in aluminium ~ 15 (bore) x 25 cm (length)
- Field specifications similar to 90° single unit model

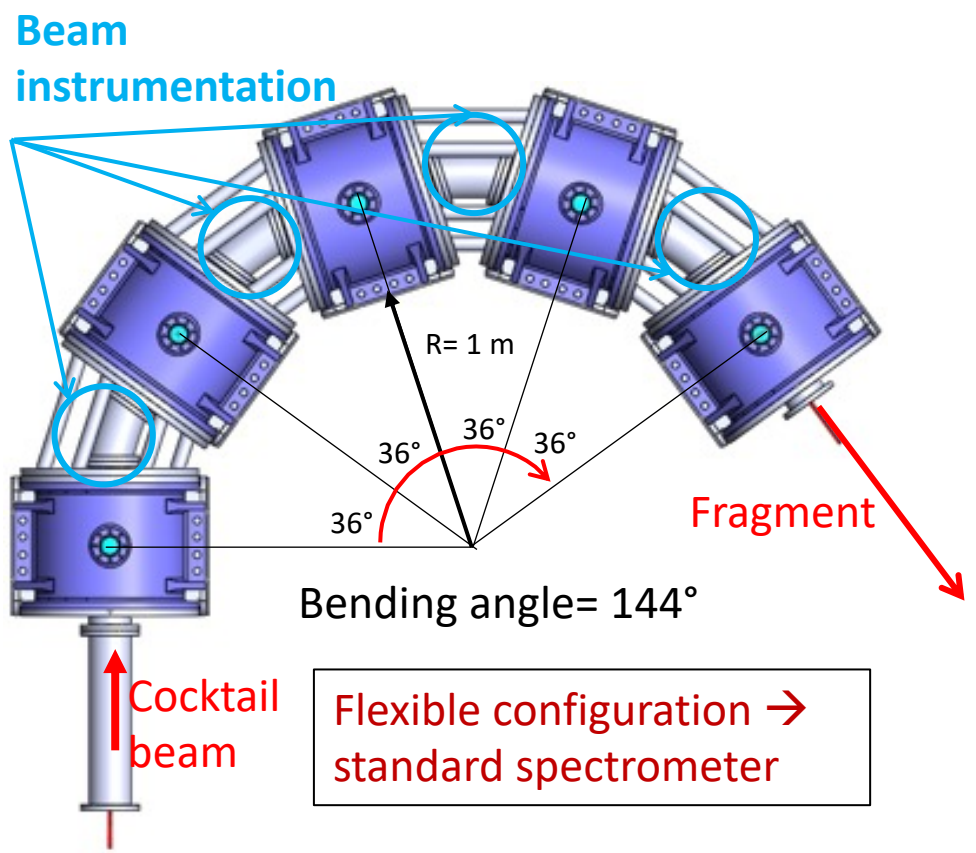
- Passive SC magnetic shield (NbTi/Nb/Cu alloy, Barna et al.)
- More accessible to industry
  - Test the ISRS working concept with ion beams
  - Obtain data to validate beam dynamics
  - Ready for experiments in 2026



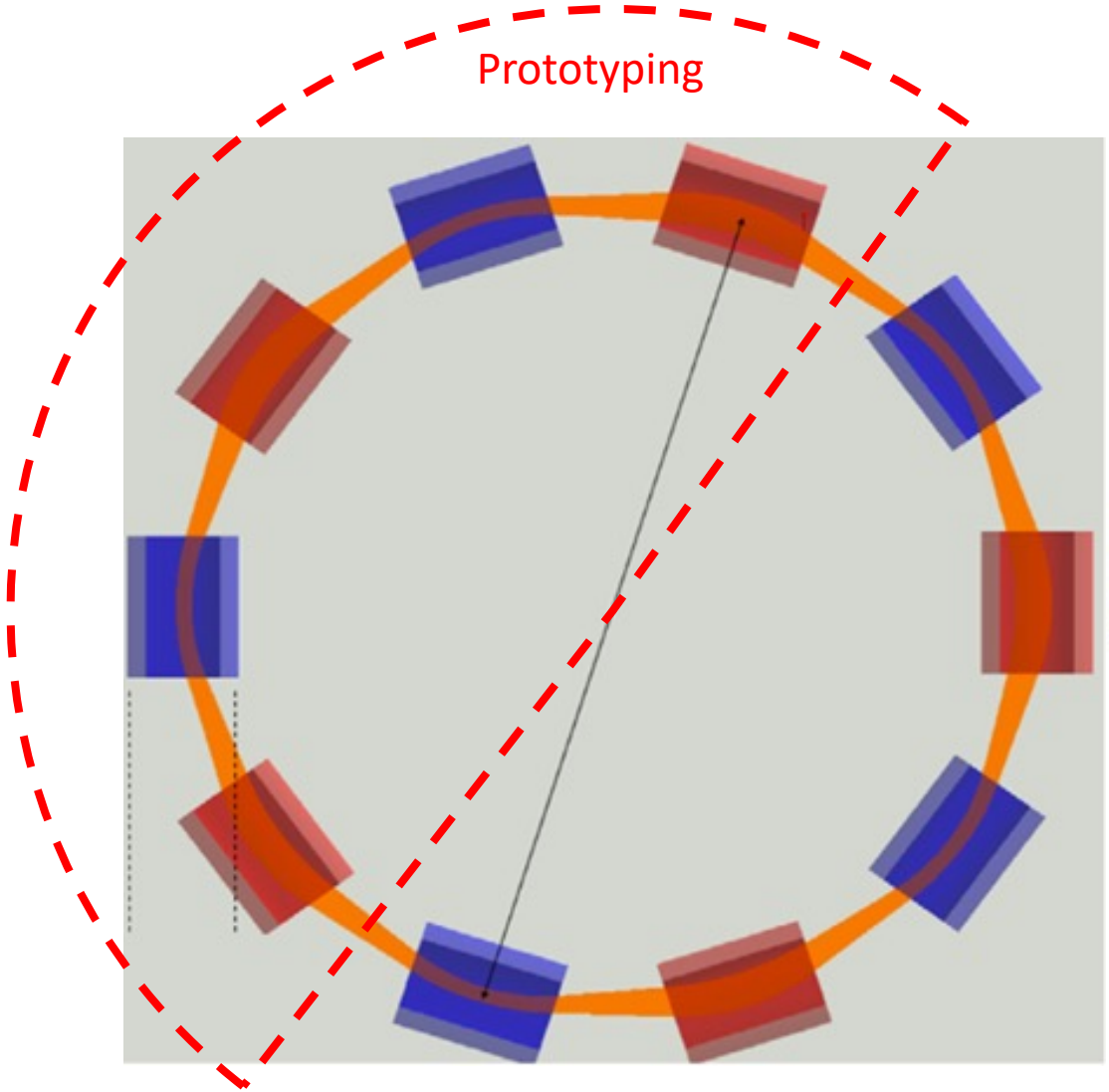
Basic CCT unit



Possible configuration with 5 units

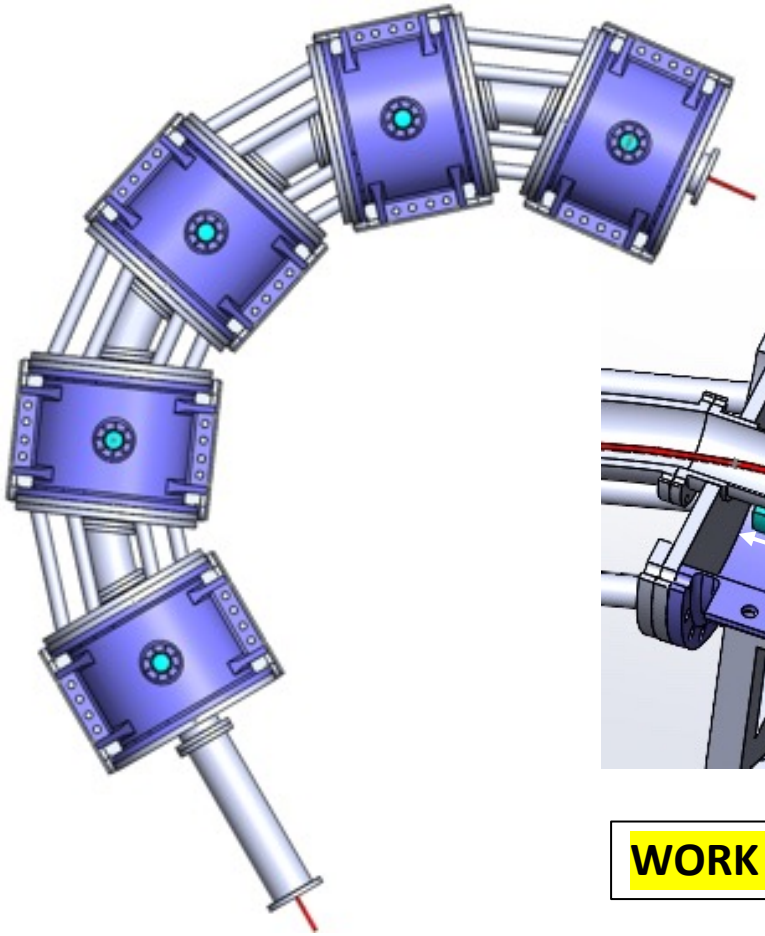


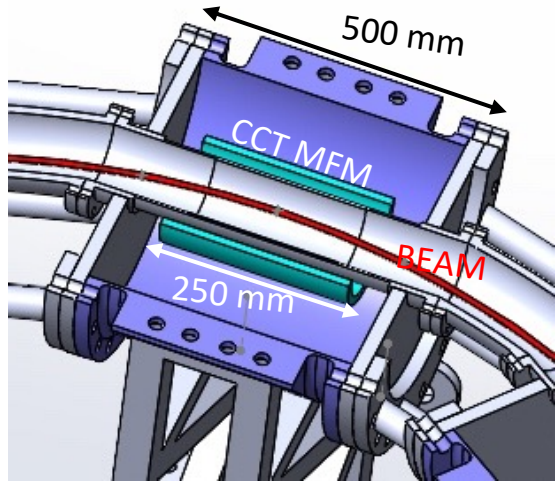
MAGNET PROTOYPES: STRAIGHT SECTIONS



Ring structure with 10 magnets (NIM A619 (2020))

- Dipole, Quad
- Solenoidal, Sextupol ?





WORK IN PROGRESS!