DESIGN OF A PROTOTYPE EDM STORAGE RING

JEDI - Jülich Electric Dipole moment Investigation
CERN - cp Electric Dipole Moment

12. SEP. 2018 I SIG MARTIN
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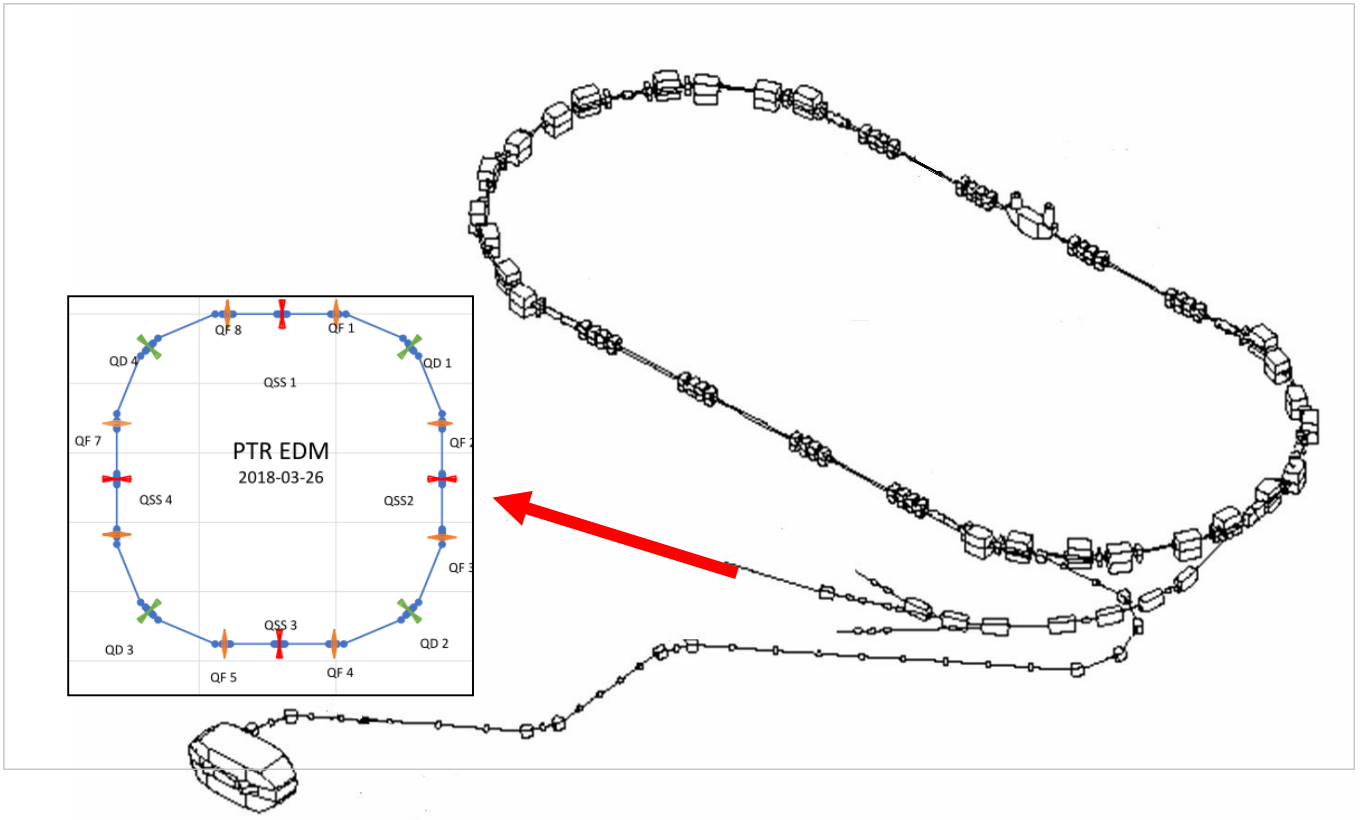
JEDI (JÜLICH ELECTRIC DIPOLE MOMENT INVESTIGATIONS)

Next step: demonstrator for charged-particle EDM search

- Storage time
- CW/CCW operation
- Spin coherence time
- Polarimetry
- μ-moment effects
- (pEDM measurement)
- Stochastic cooling



PBC (CERN) and ESPP-Update; possible host sites: COSY (see above) or CERN

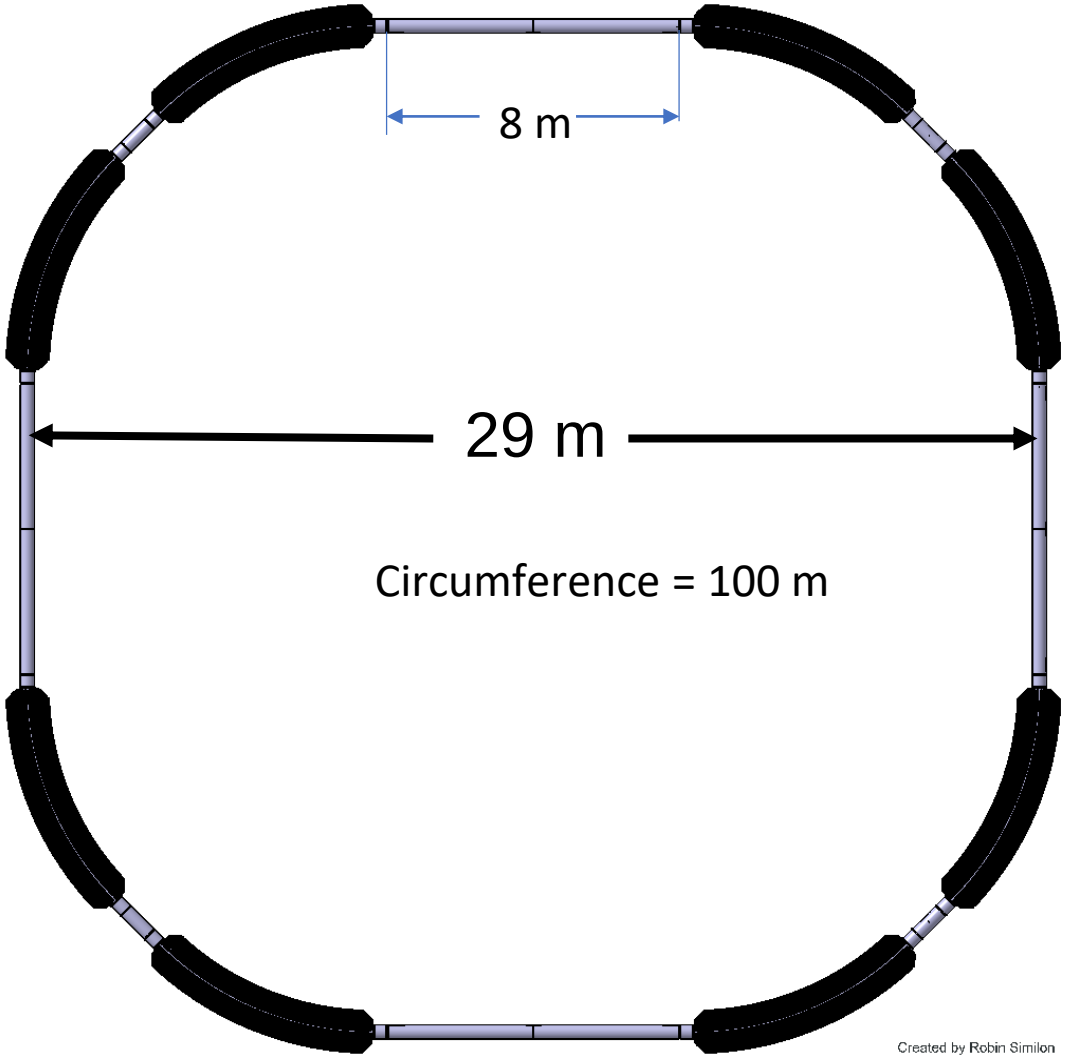
PRT RING REQUESTS

- Study case for a variable betatron tune $0.1 \leq Q_{x,y} \leq 1.9$
- All electric at 30 MeV or less
- Frozen spin at 45 MeV
- Injection of a cooled, polarized, and bunched beam
- Beam of 10^9particles in an emittance of 1 mm mrad
- Polarimeter measure pol. – spin manipulation(RF solenoid, feedback control,etc.
- Confirm control of CW/CCW mode simultaneously

PRT RING LAYOUT

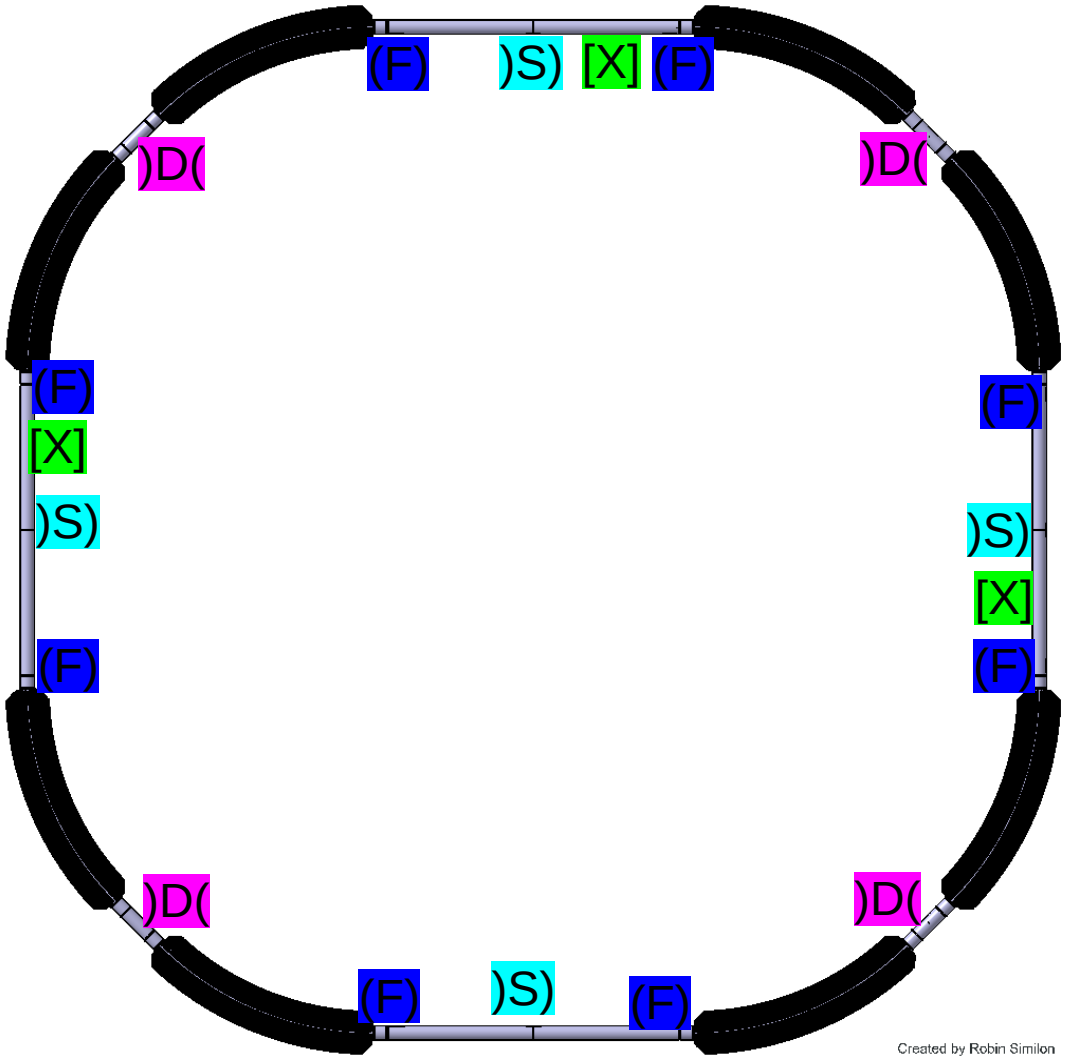
- Electric Bend
  parallel plates
  gap – 60 mm ± 200 KV

  -> size of machine
- Electric Quadrupoles
  Hyperbola plates
  bore 80 mm ± 30 KV



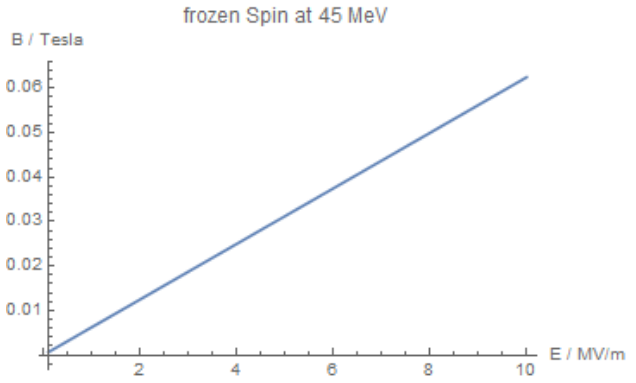
PRT RING FOCUSING STRUCTURE

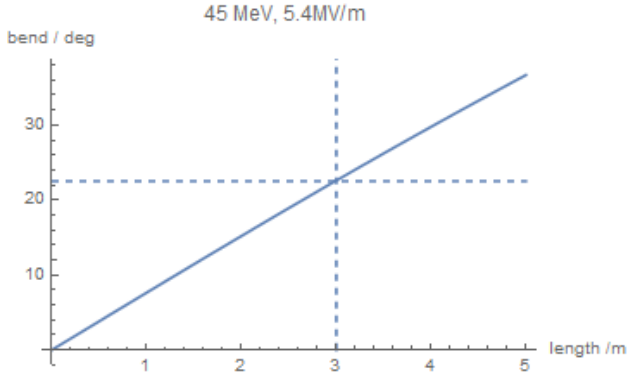
- Focusing Quads (F)
- Defocusing Quads)D(
- Straight Section Quads)S)
- Sextupoles [X]



PRT RING FROZEN SPIN

- Spin along momentum vector
- For any sign of G, in a combined electric and magnetic machine



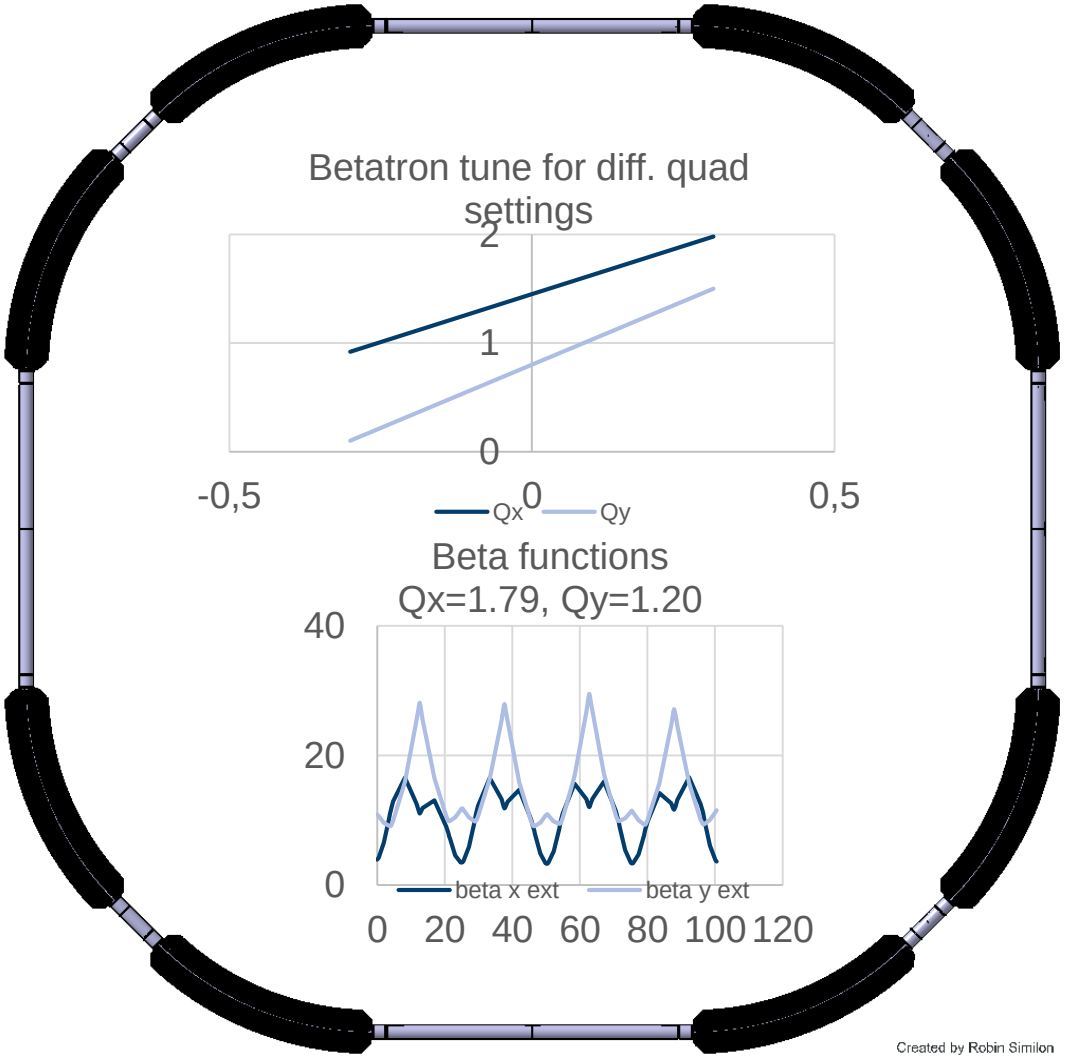


- $E = \frac{GBc\beta\gamma^2}{1-G\beta^2\gamma^2} \approx GBc\beta\gamma^2,$
- where $E = E$ radial
  $B = B$ vertical

PRT RING TUNE VARIABILITY

- Betatron tune
  $0.9 \leq Q_x \leq 2$
  $0.1 \leq Q_y \leq 1.5$

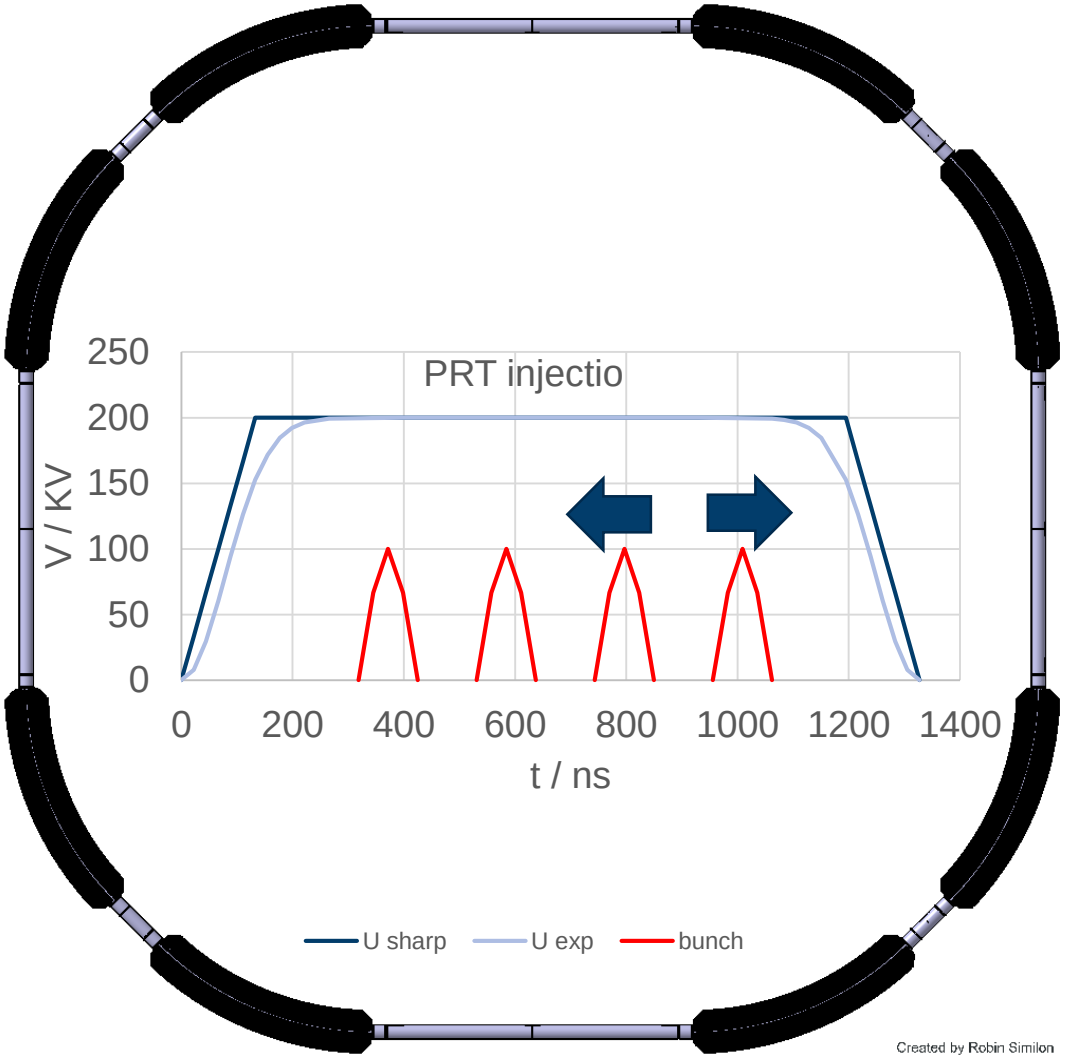
- $\beta_y \leq 200$ m
  $\beta_X \leq 20$ m



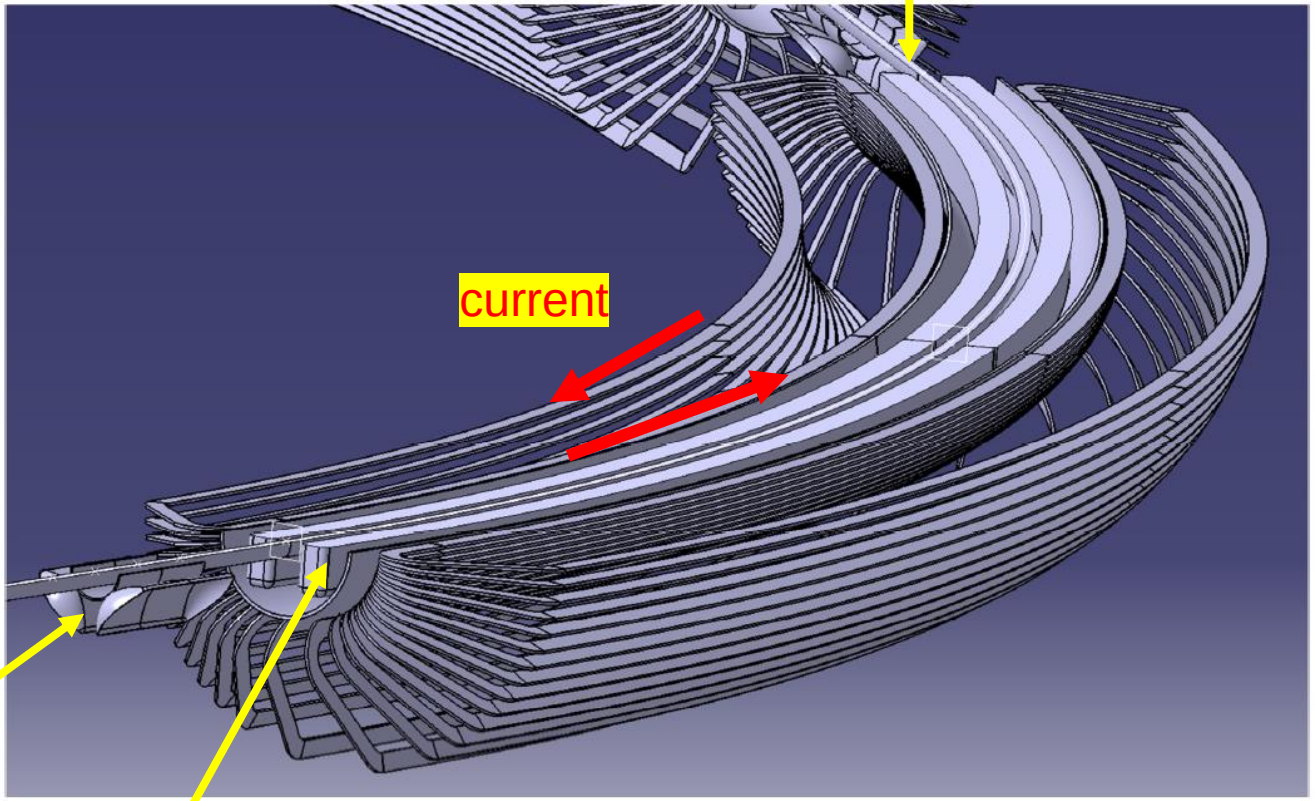
PRT RING INJECTION

- 4 Bunches
- Harmonic h=6
- $T_{rev} = 1.2$ µs
- Spin parallel – antiparallel
- Cavity to keep bunches

- Spin will be vertical at injection

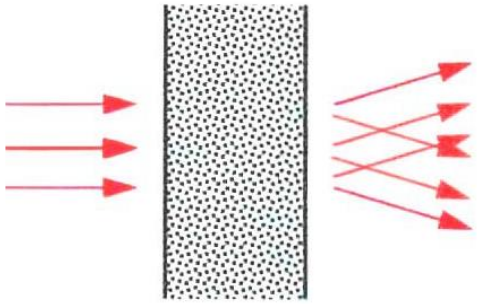


B-E BEND



LIMIT - MULTIPLE SCATTERING

$$\theta_{rms} = \frac{13.6\ MeV/c}{p \cdot \beta_p} \cdot \sqrt{\frac{L}{L_{rad}}} \cdot (1+\delta)$$



Emittance growth: -> 0.005 mm·mrad/s $N_2\ 10^{-12}\ Torr$
10 mm·mrad / 2000s

-> Stochastic cooling

PRT RING FINALS

Summary:

- Preliminary design of Prototype EDM Ring
- Technical developments (Deflector, RF Wien filter, BPMs, …)

Outlook:

- Push limit for EDM measurement at COSY
- R&D work and design study for dedicated EDM storage ring
- Commissioning of an *ExB* deflector
- new kind of experiments in the CW CCW mode: e-p, p-d,…

DELIVERABLES FOR EDM STORAGE RINGS:

- Scientific input for The European Strategy for Particle Physics (ESPP)
- Executive summary to CERN Physics Beyond Colliders (PBC)
- Design report for Proton EDM Ring