

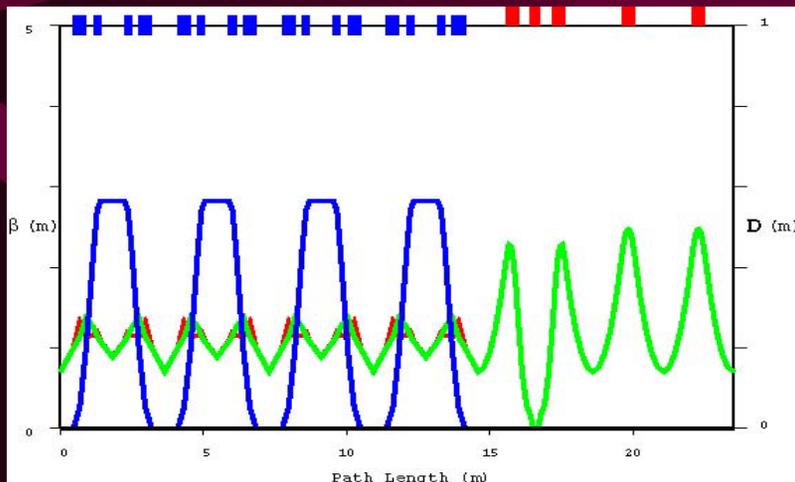
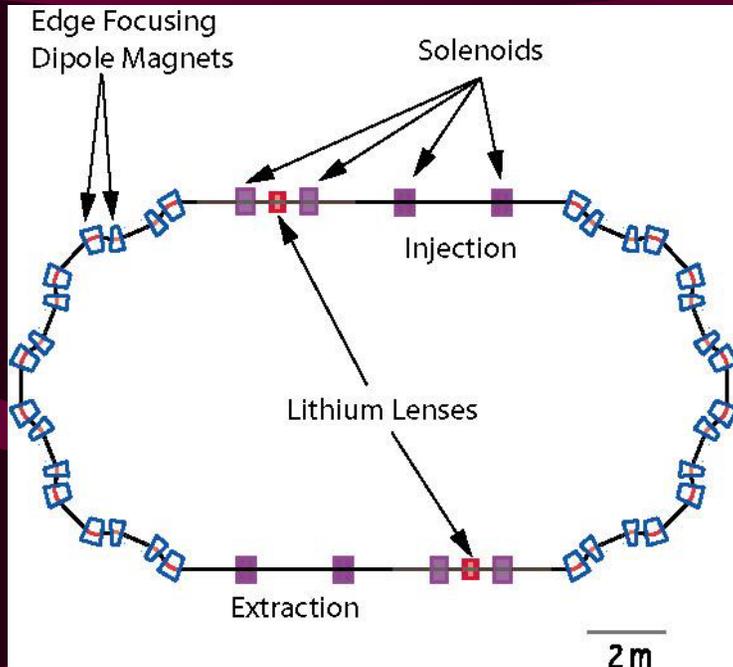
# Lithium Lens Cooling Ring

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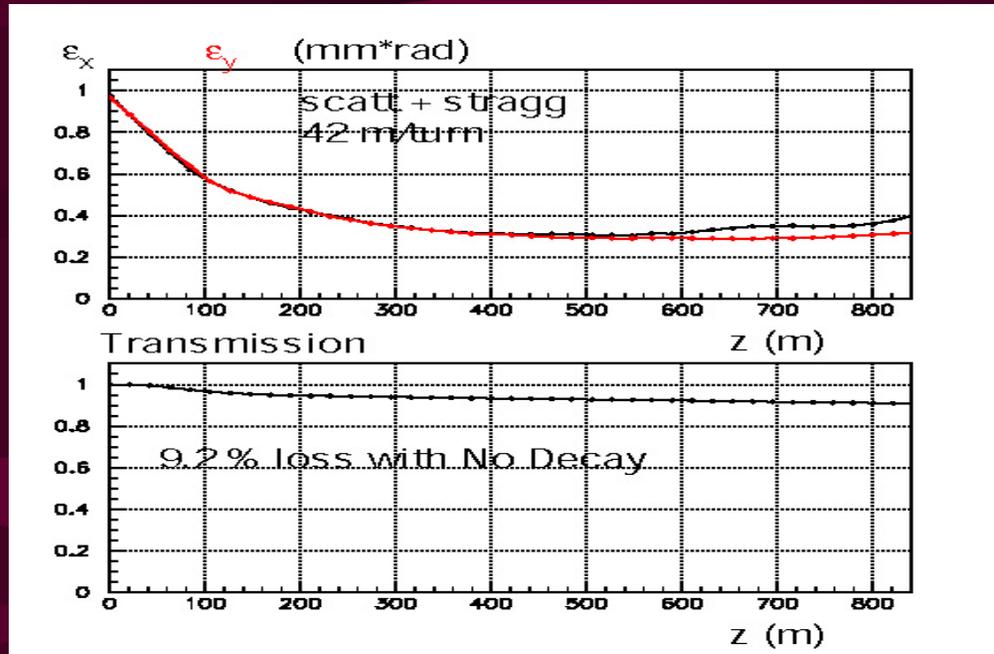
- ❑ Cooling Ring with straight Lithium Lenses
- ❑ A toy cooling ring with curved Lithium Lenses

# Lithium Lens Rod Cooling Ring



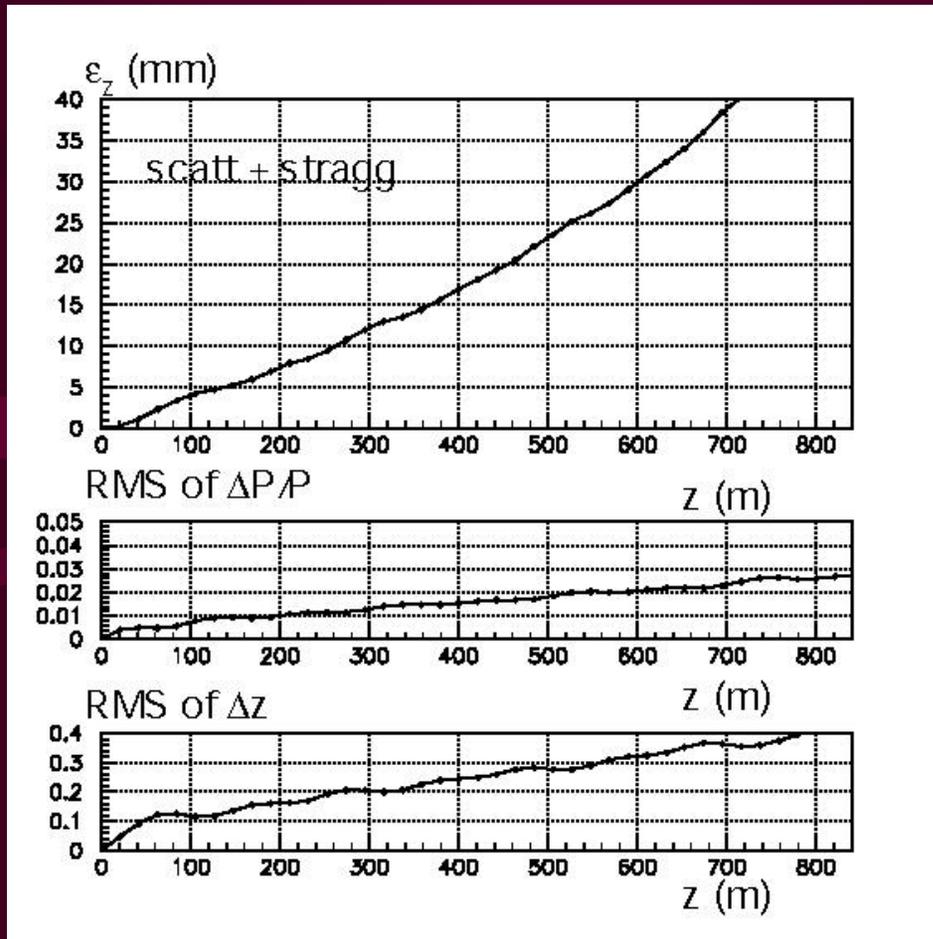
muon momentum	250 MeV/c
Circumference	42.1 m
straight section length	5.9 m (x 2)
Structure of half cell	2 dipoles with edges
number of bending cells	8
bend cell length	3.6 m
length of Lithium lens	34.5 cm (x 2)
Lowest/highest $\beta$ in Li	1.0 cm / 16 cm
$dE/dx$	35 MeV/turn (x 2)
dipole bend angles	44.2, -21.7 degree
dipole edge angles	30/-3, -11/-11 degree
dipole magnetic field	6.5, -3.2 tesla
Cell tunes bend cell	0.72/0.70
Cell tunes straight cell	4.0

# Lithium Lens Rod Cooling Ring



- ❑  $\epsilon_t$  gets down to 300  $\text{mm}\cdot\text{mrad}$ , which is expected by average  $\beta * 79 \text{ mm}\cdot\text{mrad}/\beta$  (coeff. of Lithium)
- ❑ transmission is better than 90% after 10 turns.

# Lithium Lens Rod Cooling Ring



# Lithium Lens Rod Cooling Ring

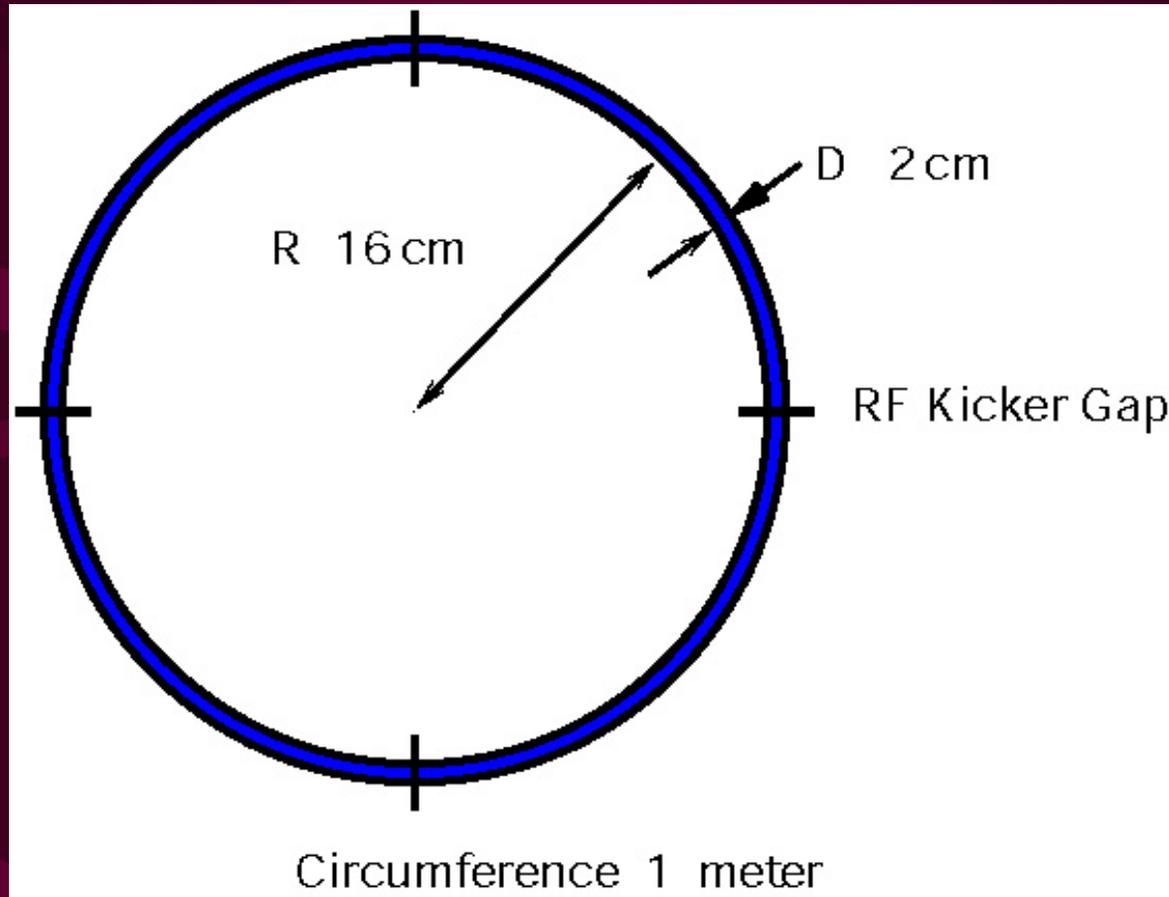
□  $\varepsilon_z$  reaches 15 mm after 10 turns and keeps growing , with the initial cold beam. So far, the model is only for the transverse phase space cooling ring.

To develop 6D cooling,

Need creating the dispersion in the Lithium inserts to use Lithium lens wedge(tapered end plates), to test the emittance exchange.  $\beta$  must be very low( $\sim 1$  cm) in the wedge section.

Also need to use realistic edge field of the dipoles, and realistic model of RF cavities.

# Curved Lithium Lens Ring (example)



# Curved Lithium Lens Ring (example)

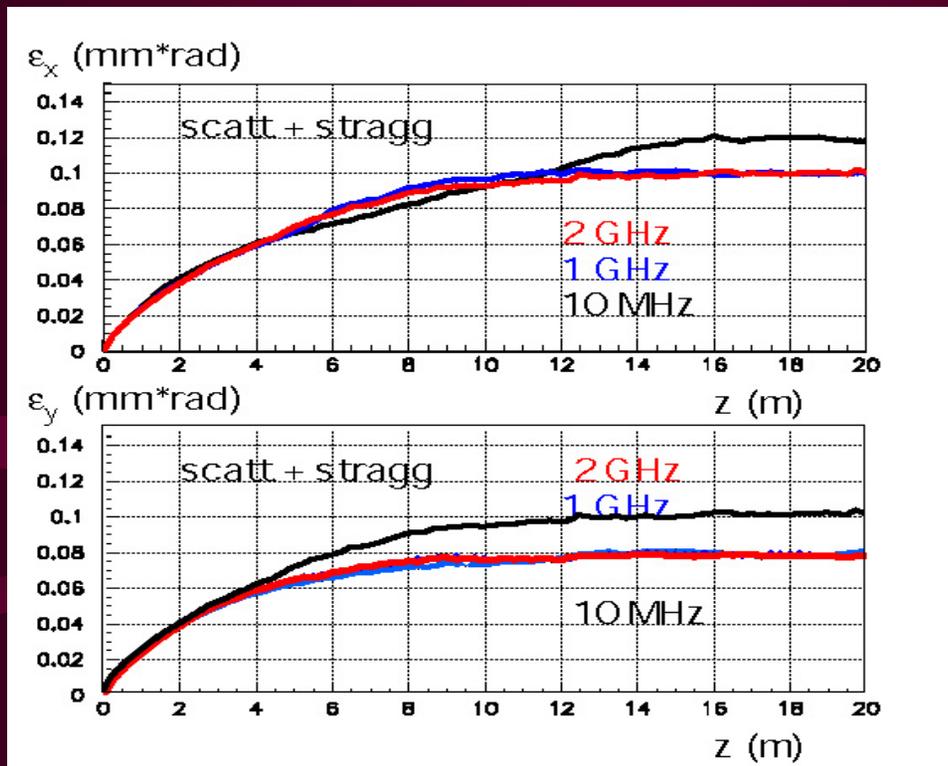
- A toy model, curved Lithium lens ring, should work as a 6D cooler in the same way as the gas-filled ring cooler.

low  $\beta$  ,

Ring , and

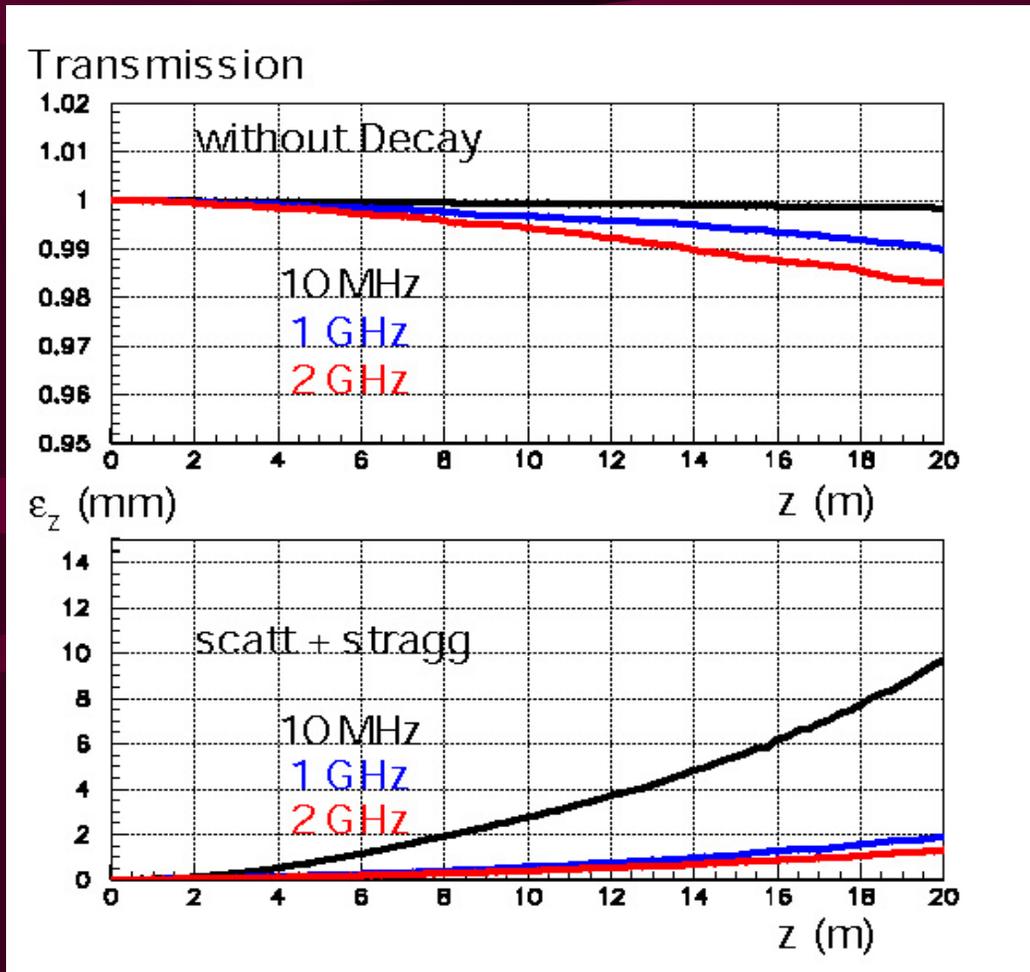
$p_z$  kick at (RF) gaps to compensate energy loss(1 MeV/cm)

# Curved Lithium Lens Ring



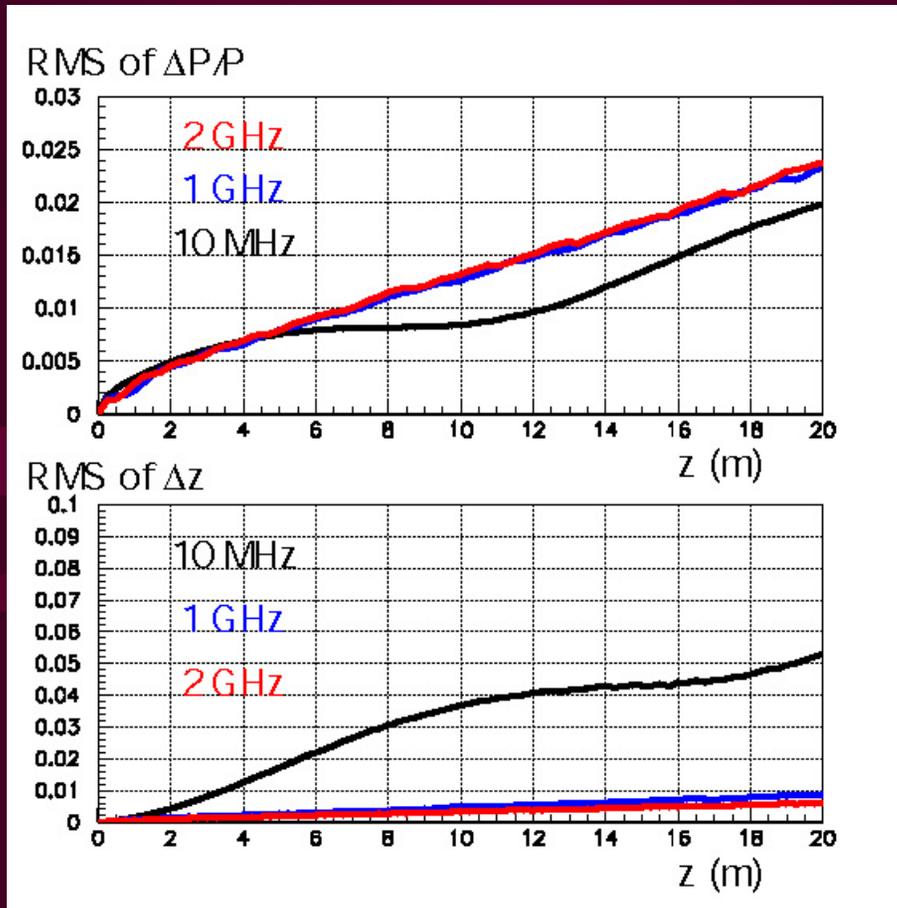
- $\epsilon_y$  reaches to 80 mm\*mrad as expected.
- $\epsilon_x$  is slightly higher at 100 mm\*mrad, after 10 turns

# Curved Lithium Lens Ring



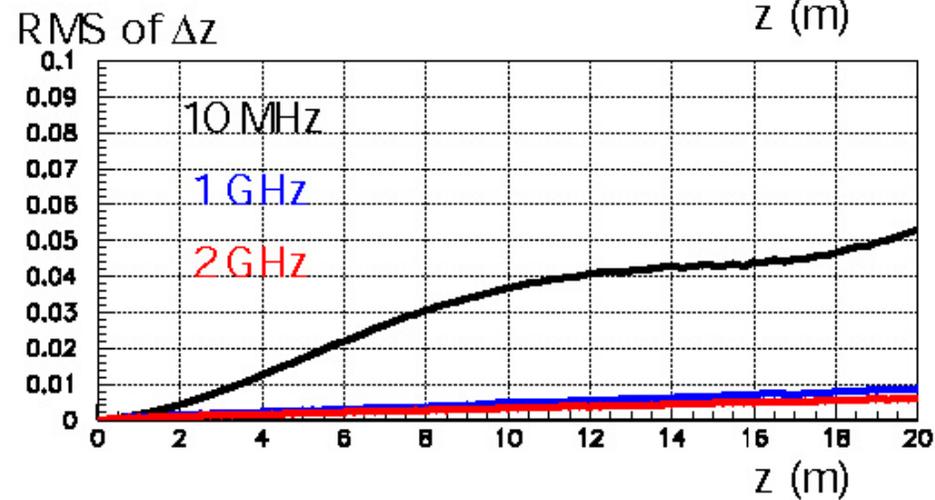
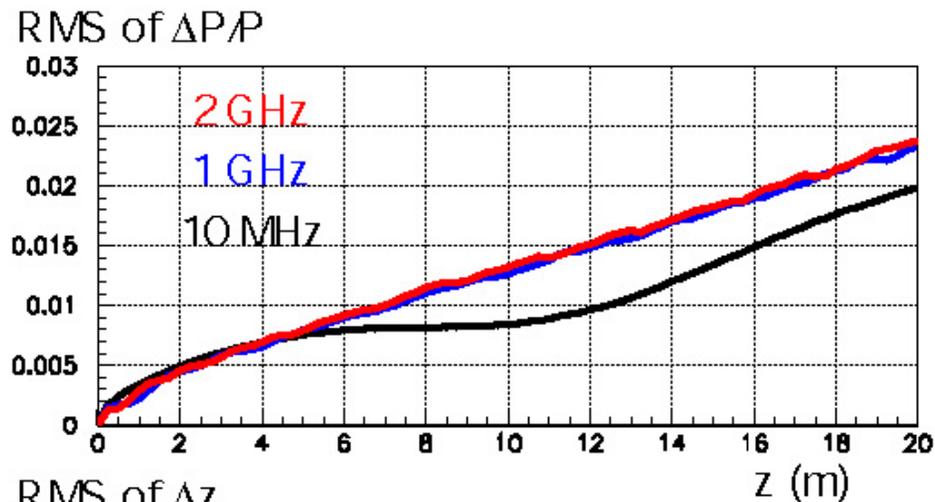
- $\epsilon_z$  increases much slower than that in the straight Lithium lens cooling ring, less than 1 mm (compared to 15 mm) after 10 turns

# Curved Lithium Lens Ring



□ Need investigation on the  $\Delta p_z$  increase

# Curved Lithium Lens Ring



# Summary

- ❑ Curved Lithium Lens Ring Cooler with (Straight Lithium Lend Field +Dipole Field) showed better performance in  $\epsilon_z$ .
- ❑  $\epsilon_y$  is around 80 mm\*mrad as expected.  
 $\epsilon_x$  is around 100 mm\*mrad.  
 $\epsilon_z$  seems to be slightly increasing at around 0.5 mm after 10 turns. (15 mm in straight Li lens ring)
- ❑ Need investigate on emittance exchange in this model. (Use tapered end plates for more wedge function?)
- ❑ Need installation of matching section and realistic RF cavities, with curved Lithium lenses at corners.