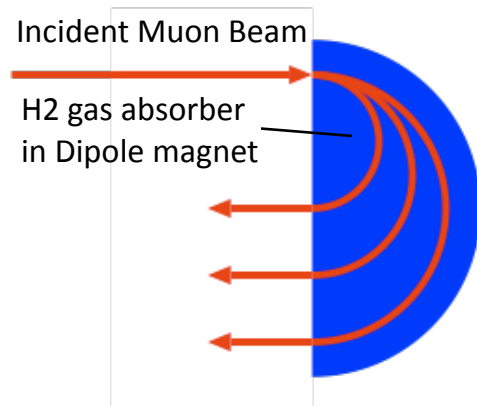
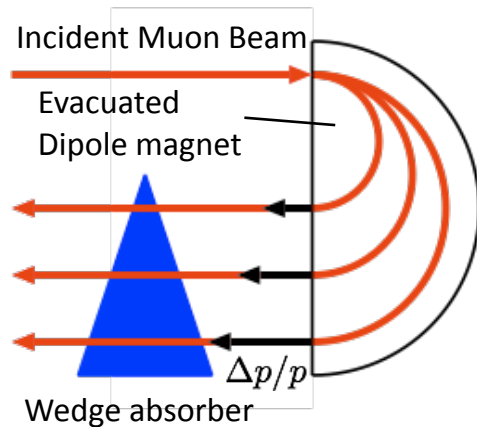


Study of Helical Cooling Channel for Neutrino Factory

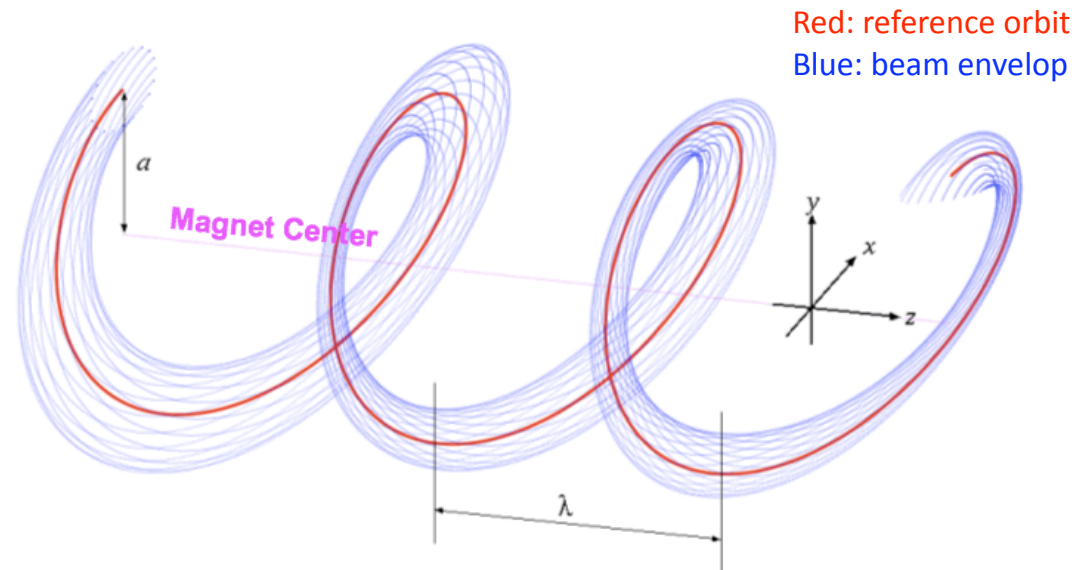
K. Yonehara

Concept of Helical Cooling Channel (HCC)



Emittance exchange

(HCC)
 Combined function magnet (invisible in this picture)
 = Pure solenoid + Helical dipole + Helical quadrupole

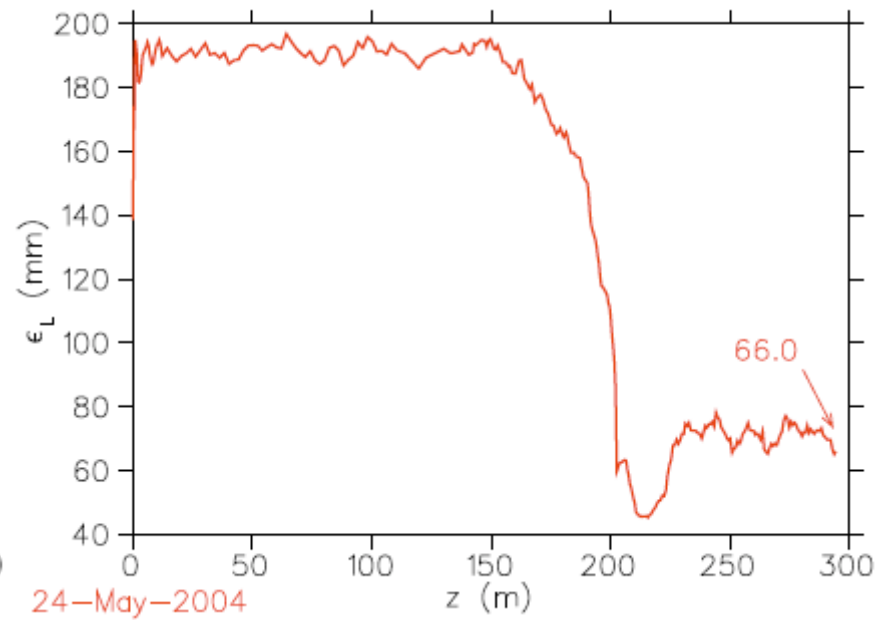
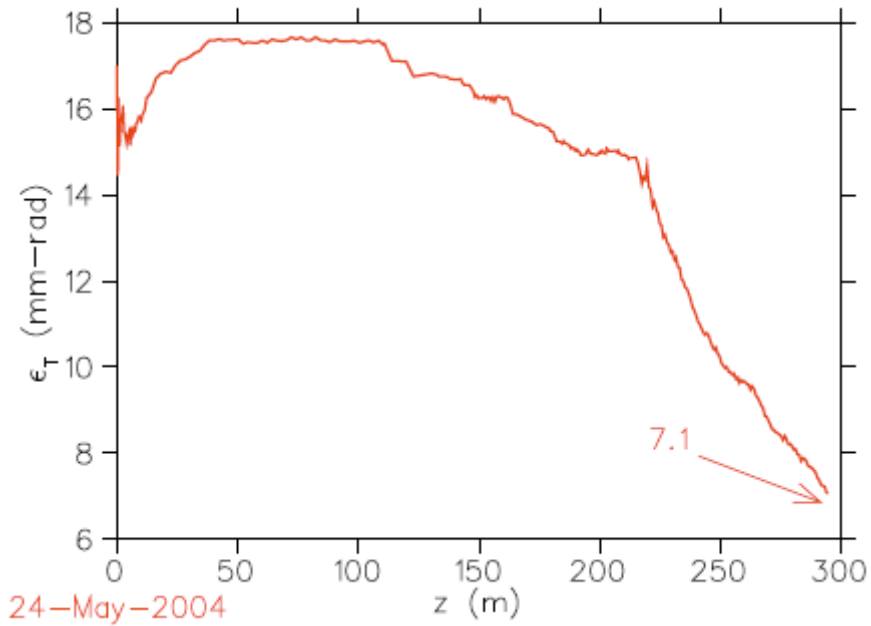


- Dispersive component makes longer (shorter) path length for higher (lower) momentum particles
 → Continuous emittance exchange
- Homogeneous field (no periodic structure) makes minimal resonant losses
- This fact makes large phase space acceptance

Initial thoughts

- HCC acceptance
 - 20 mm rad or more in transverse
 - 20 mm in longitudinal
- Chris gave me the numbers for NF;
 - 30 mm rad (fine)
 - 150 mm (Ops! It's too long!)
 - Cooling factor 2~3 for each direction
- Anyway, let us test an HCC for NF

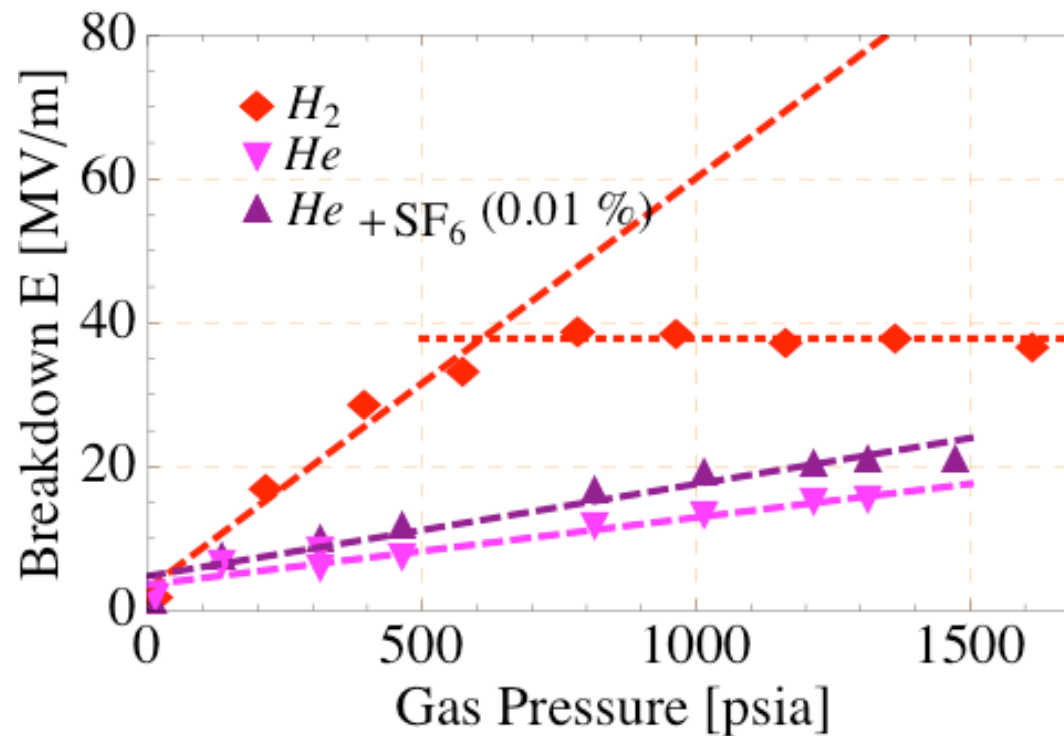
Conventional cooling channel in study2a beam line



Additional thoughts

- GHe may work instead of using GH2
 - 35~40 MV/m will be available at 200 atm GHe

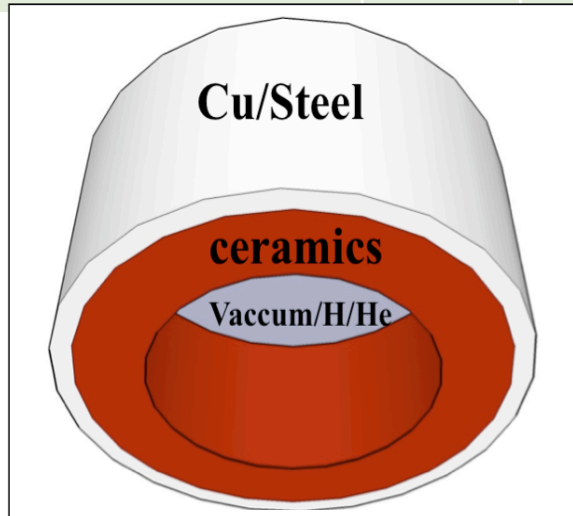
Maximum electric field gradient in dense hydrogen gas filled RF cavity



HCC for NF, 8/19/09

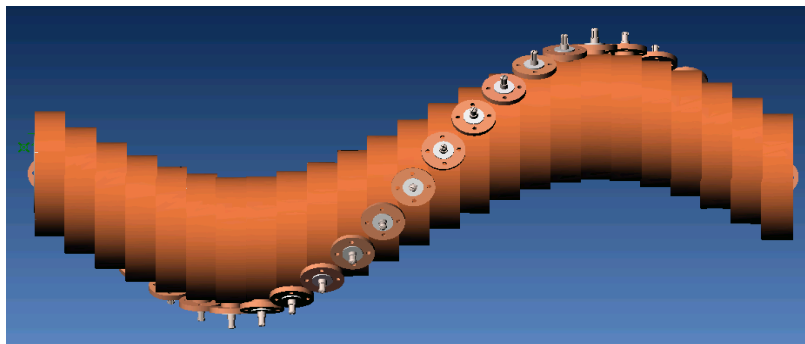
HCC parameter list

	λ (m)	κ	b (T)	b' (T/m)	bz (T)	E_{rf} (MV/m)	ϕ_{rf}	L_{rf} (mm)
200 MHz GHe HCC	1.6	1.0	0.80	-0.17	-2.65	20.71	150	160



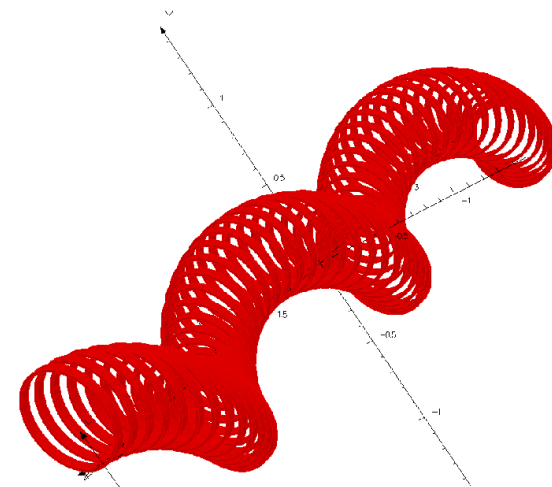
Dielectric loaded RF cavity

- GHe pressure = 200 atm at room temperature
- Peak field $E_{rf} = 20$ MV/m will be sufficiently lower than the breakdown field at $p = 200$ atm
- Assume that RF is integrated into helix magnet



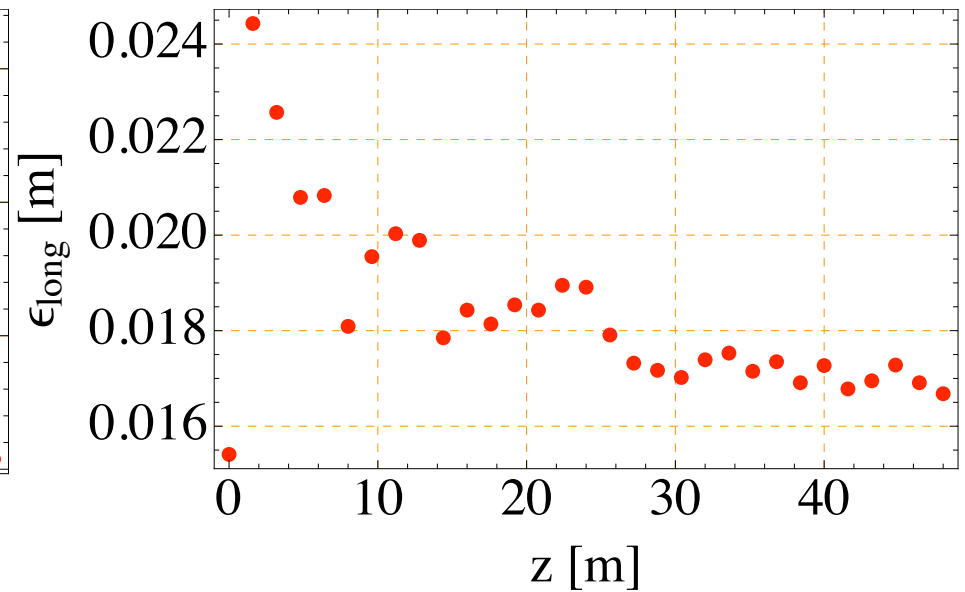
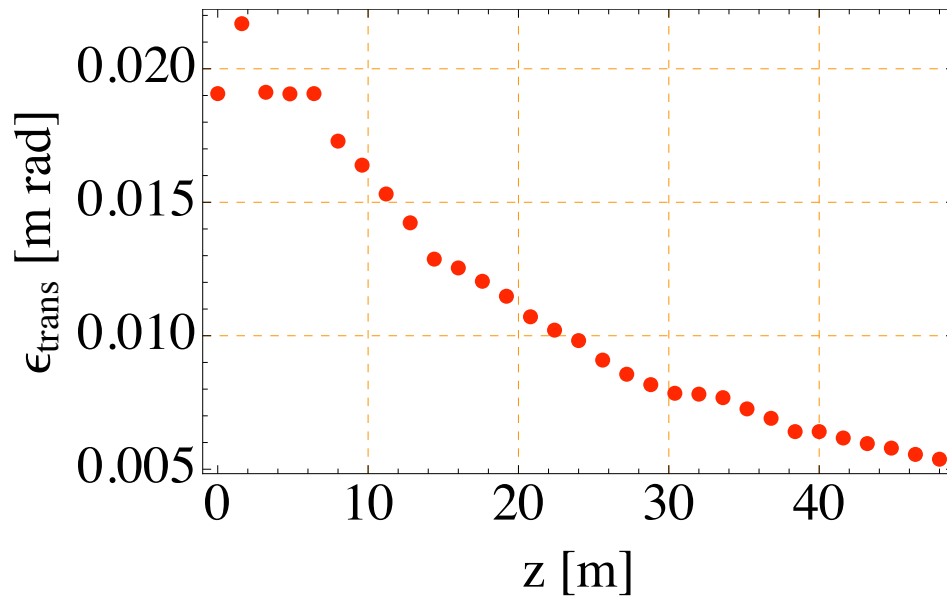
Dielectric loaded helical RF

or NF, 8/19/09



Helical magnet structure

Simulation result



- Transverse cooling factor 4 at $z = 48$ m
- Transverse acceptance is 20 mm rad
- Longitudinal cooling factor 1.5 at $z = 48$ m
- Longitudinal acceptance is 25 mm
- Just ignore the point at $z = 0$ m, that point would be lead by mismatching

Conclusion

- Initial transverse phase space is acceptable for HCC
- Initial longitudinal phase space is too long for HCC
- Rearrangement of initial phase space is needed if we use HCC for Neutrino Factory
- GHe works pretty well
- Transverse cooling factor 4 and longitudinal cooling factor 1.5 at 48 meters, respectively