Emittance

Can we make 6D equilibrium emittance smaller in a Cooling Ring? (with the same β_{min})

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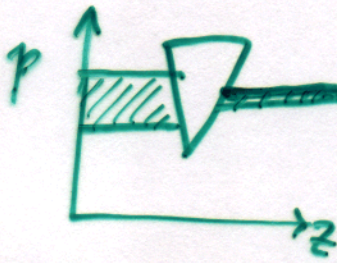
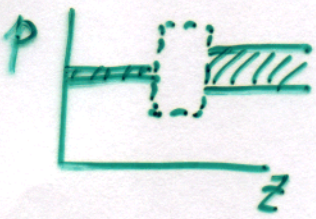


[longit. Cooling
longit. Heating] wedge absorber

$\left(\frac{d}{dp}\frac{dE}{dx}\right)\Delta p$ + straggling ($\propto E^2$) + $\frac{dE}{dx}$

$\frac{dE}{dx}$ slope



↓ Emittance Exchange

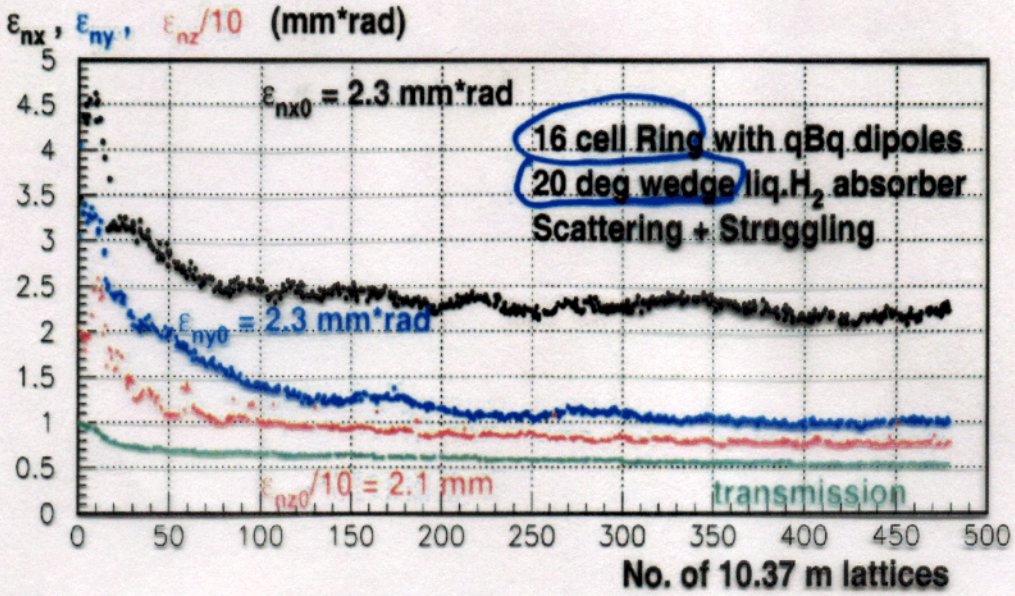
Orbit change in the Bending

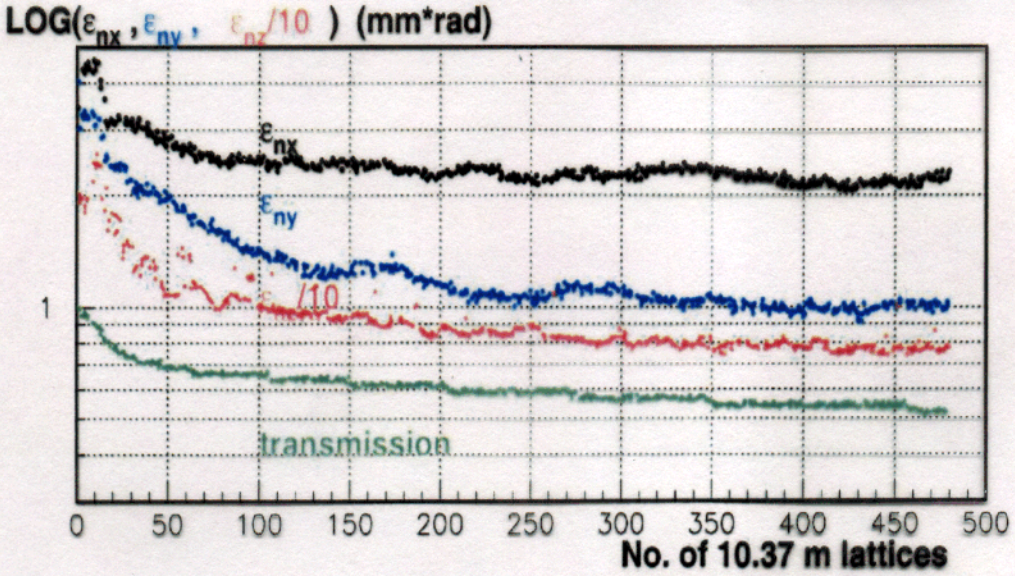
⇒ Excite ε_{nx}

Table 1: Comparison of an electron damping ring and the Muon Cooling ring

	e **Damping Ring**		
phase space	x	y	z
Damping	x' synch.rad. +RF	y' synch.rad. +RF	synch.rad. $\Delta E \propto E^4$
Excitation	x-x' orbit change		quantum fluct. $\propto E^{3.5}$
Partition #	$(1-\mathcal{D})$	1	$2+\mathcal{D}$

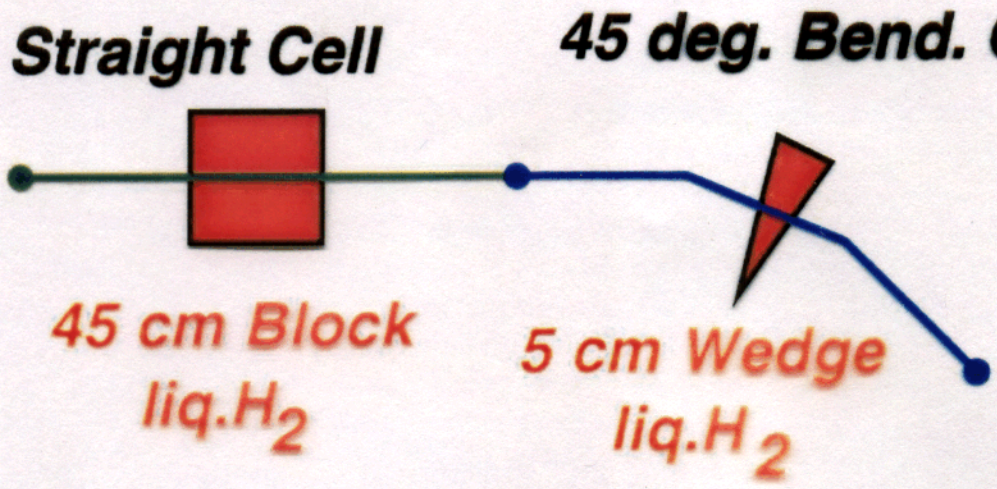
	μ **Cooling Ring with Wedge Absobers**		
phase space	x	y	z
Damping	x' Ion.Cooling	y' Ion.Cooling	$\Delta E \propto$ E in Wedge
Excitation	x-x' orbit change mult.scat.	mult.scat.	$\frac{dE}{dx}$ straggling $\propto E^2$
Partition #	2-d	2	d

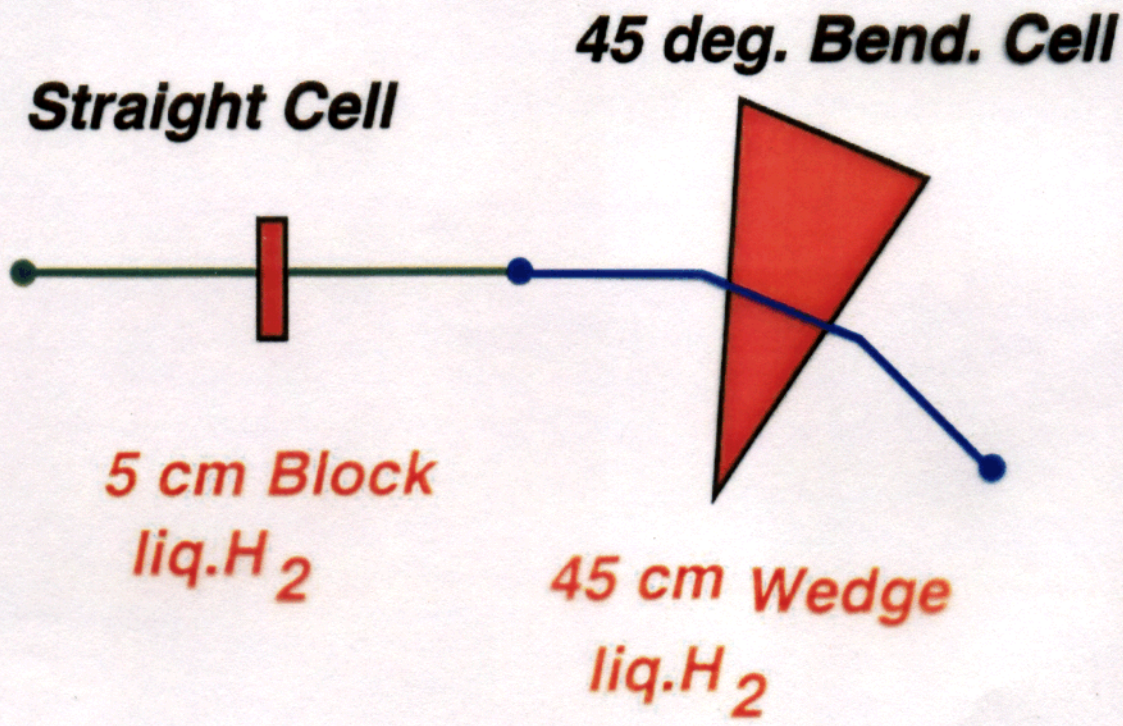




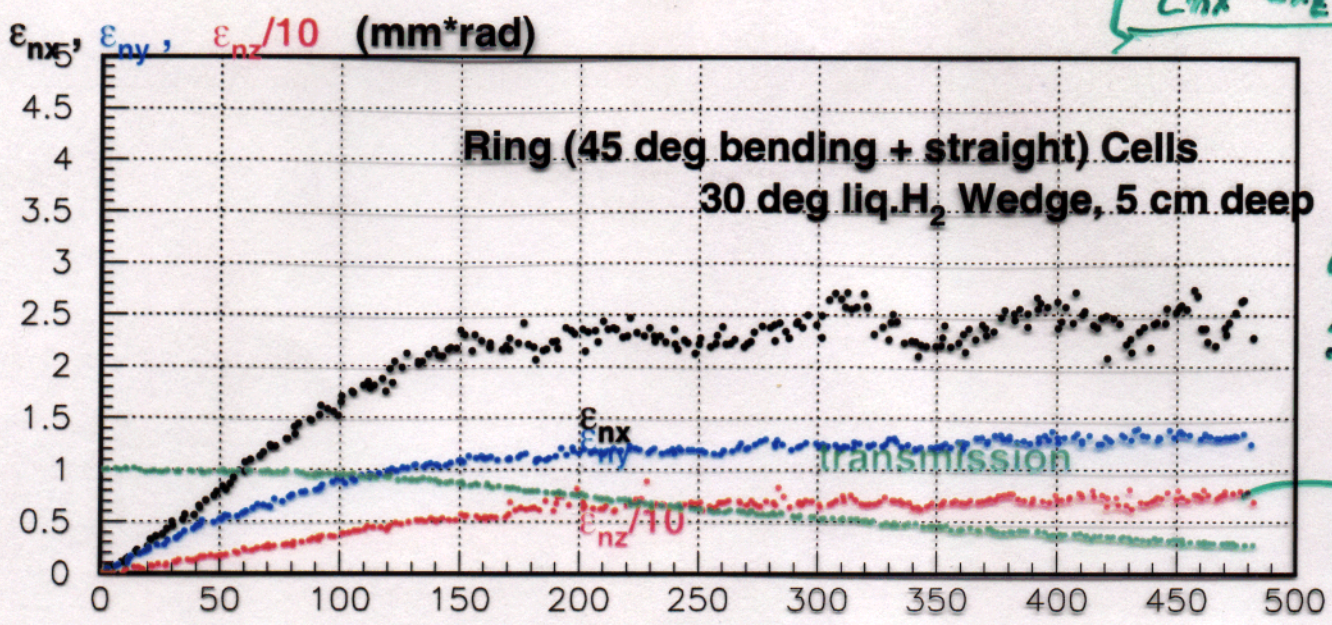
Wedge <L> = 25 cm Liq H_2 Wedge Opening Angle

	20°	30°	40°	
ε_{N0X} 3 mm	$\varepsilon_{N.eq.X}$	2.3	2.8	4.2	mm.rad
ε_{N0Y} 3 mm	$\varepsilon_{N.eq.Y}$	1.00	1.00	0.90	mm.rad
ε_{N0Z} 20 mm	$\varepsilon_{N.eq.Z}$	7.8	6.0	4.8	mm.rad
	$\varepsilon_{N.eq.X} * \varepsilon_{N.eq.Z}$	18	17	20	(mm.rad)^2
6D Cooling Factor		10.1	10.7	9.9	


Straight Cell
45 deg. Bend. Cell
45 cm Block
liq.H2
5 cm Wedge
liq.H2

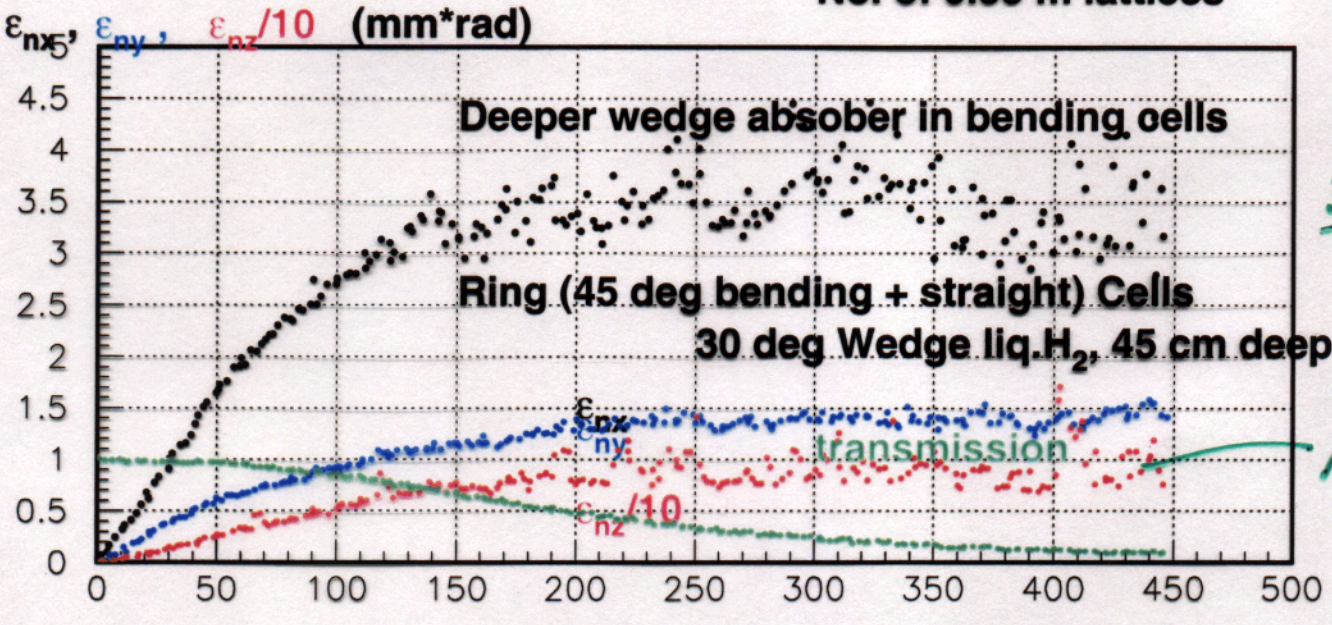

45 deg. Bend. Cell
Straight Cell
5 cm Block
liq.H2
45 cm Wedge
liq.H2

$\varepsilon_{nx} \cdot \varepsilon_{nz} = 20$ mm^2



ε_{nx} 2.5 mm

ε_{nz} 8 mm



ε_{nx} 3.5 mm

ε_{nz} 10 mm

$\varepsilon_{nx} \cdot \varepsilon_{nz} = 35$ mm^2

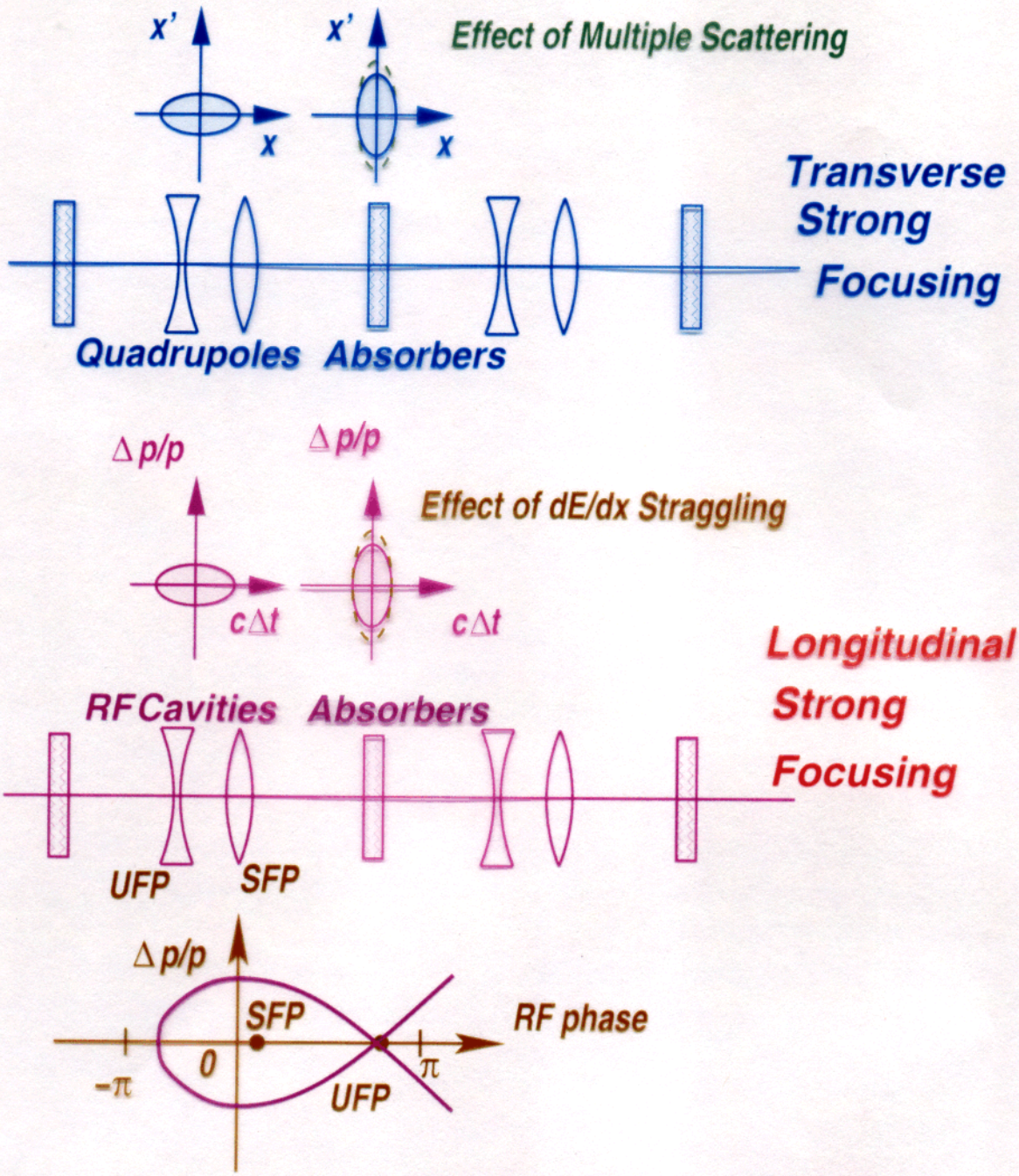


Figure 1: Schematic diagrams of the transverse and longitudinal strong focusing lattices

References

[1] E. D. Courant and H. S. Snyder, *Theory of Alternating-Gradient Synchrotron*, Annals of Physics, 3, 1-48 (1958)

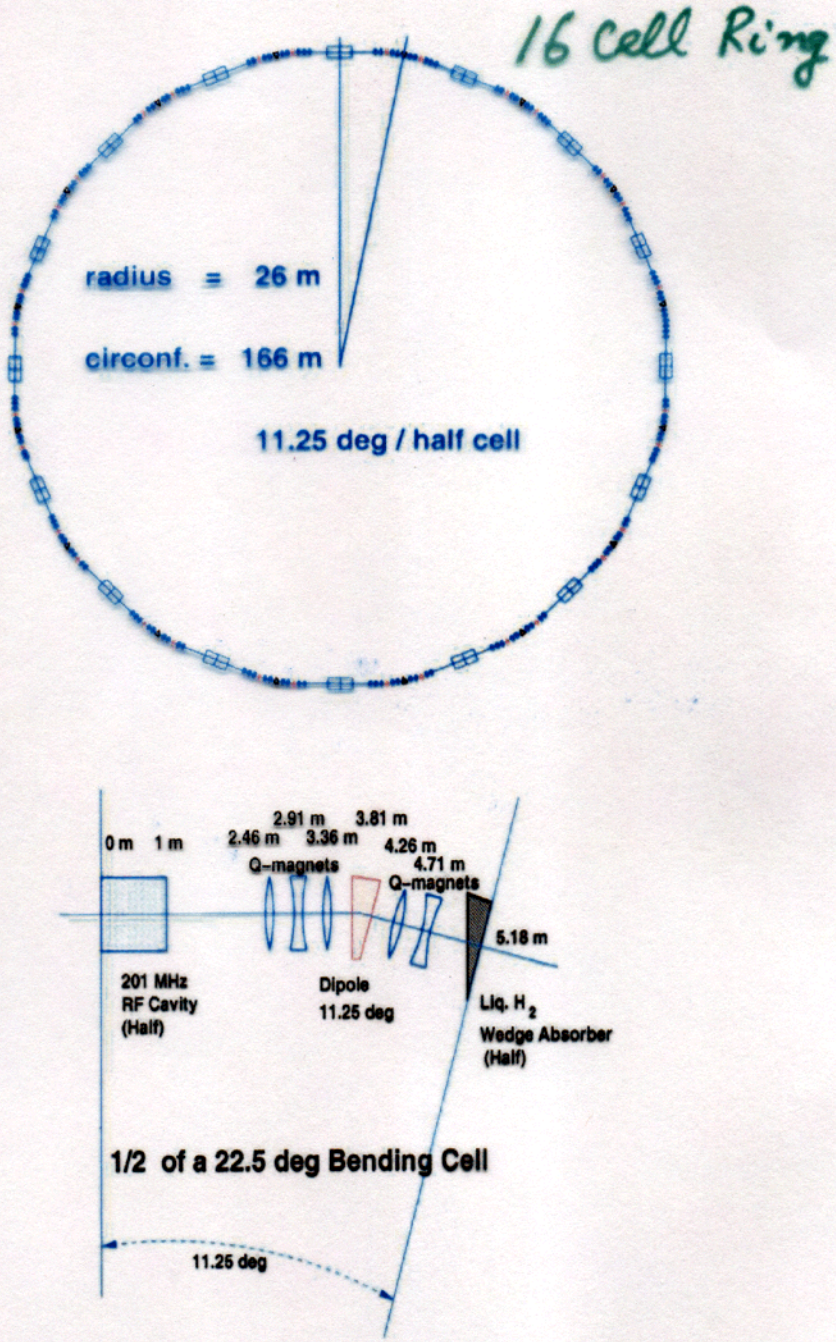
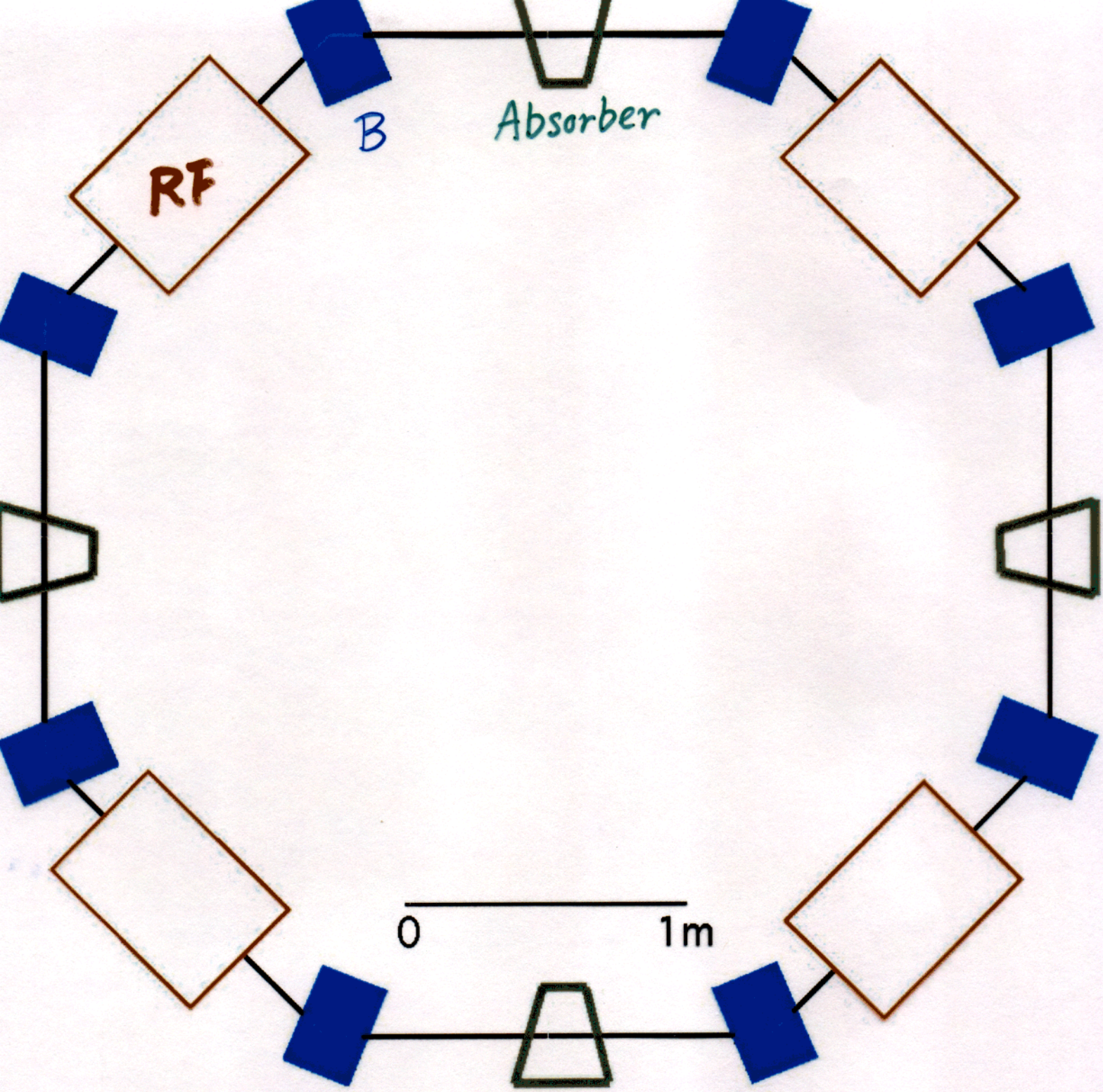


Figure 1: Top view of the 16 cell UCLA Emittance Exchange Ring, and a schematic drawing of a ring components in the 11.25 degree Half Cell section



Ten meter dipole cooling ring

Use extremely slow μ

phase-rotate μ bunchs to have

large ΔE & small σt at absorbers

WORK in Progress with ICOOL.

→ corresponds to have

low β in absorbers in TRANSVERSE

(large $\Delta x'$ / small σx)