200 MHz Cooling Experiment Design

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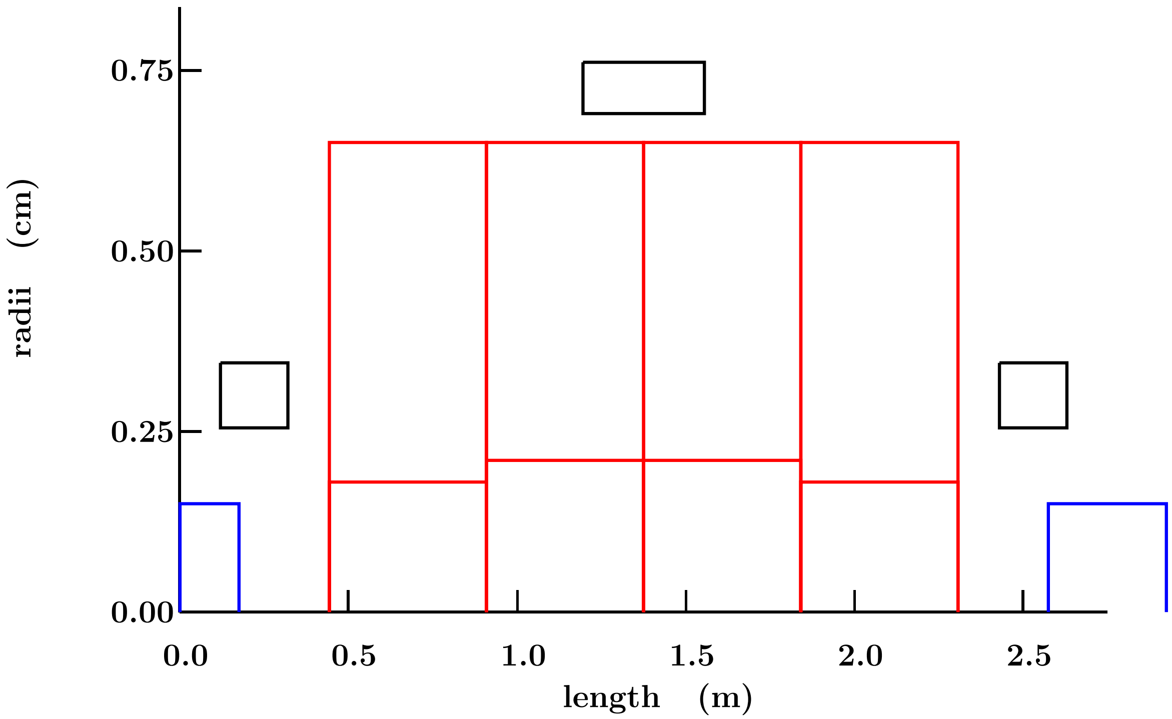
1. Performance of long lattice with MICE cooling cells
2. Simulated Performance of MICE with narrow momentum spread
3. Deduced Performance in 6D
4. Methods for Experiment analysis

1) Performance of lattice with MICE cooling cells

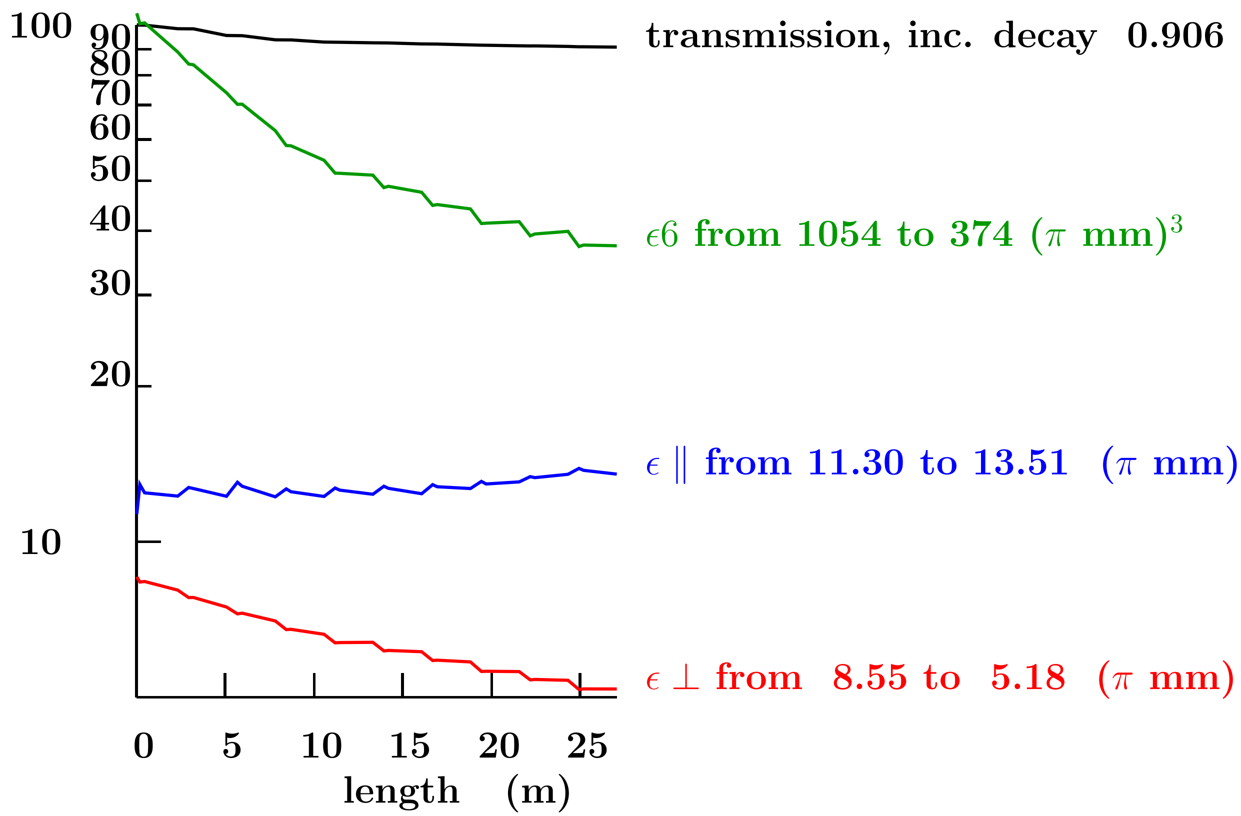
Cell Parameters

len1 m	gap m	dl m	rad m	dr m	I/A A/mm^2	n I A	n I l A m
0.120	0.120	0.200	0.255	0.090	-105.60	1.90	3.58
1.195	0.875	0.360	0.690	0.071	-104.58	2.67	12.18
2.430	0.875	0.200	0.255	0.090	-105.60	1.90	3.58



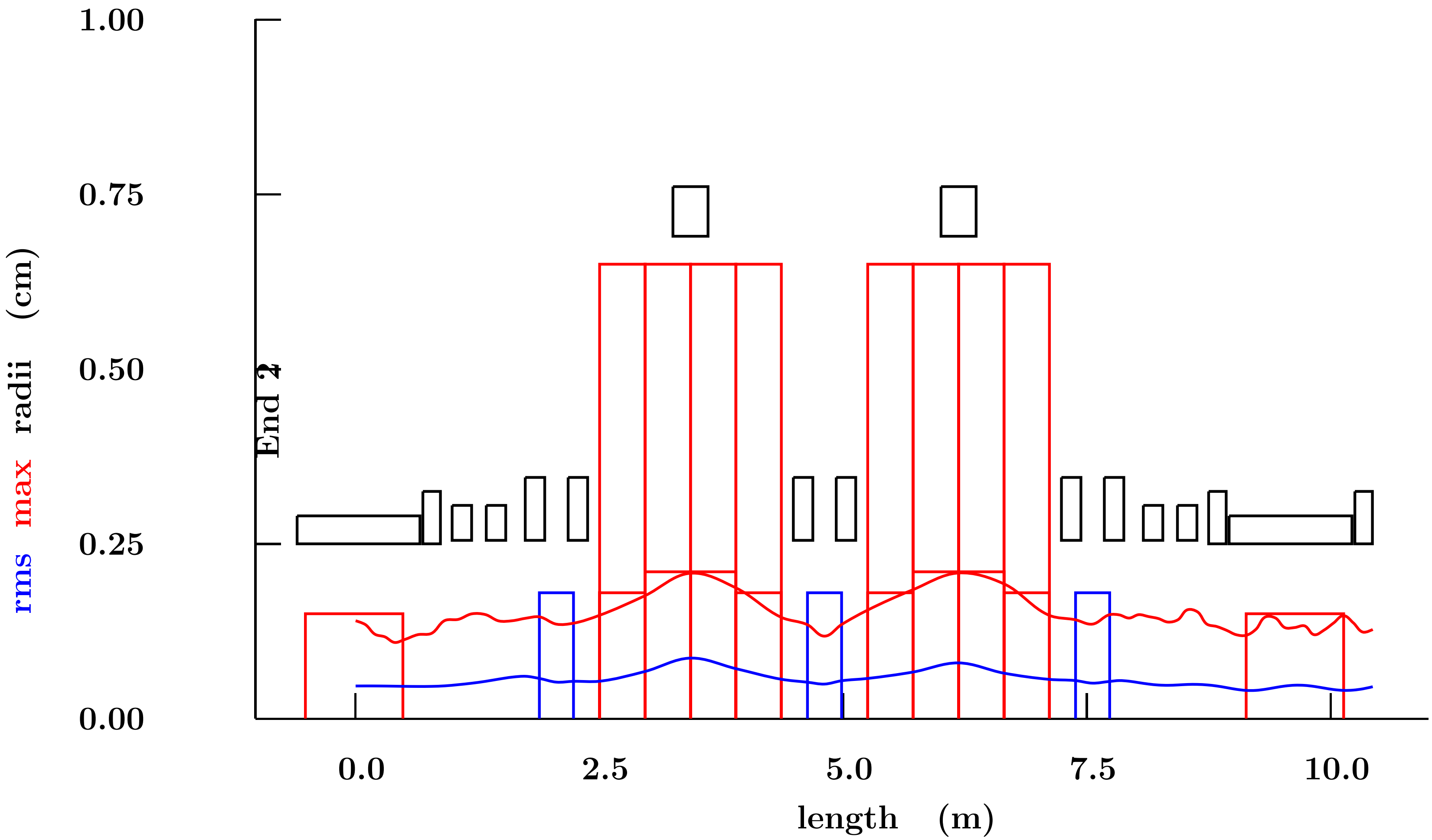
Initial parameters

$\sigma_{x,y}$	cm	5
ϵ_n	π mm	5
nominal ave. mom.	MeV/c	200
Mom-Amp Correllation	MeV/radian	0.45
actual ave. mom.	MeV/c	211
σ_p	%	6.5
σ_{ct}	cm	9.5



Experiment Layout

With rms and maximum raddii from following simulation



Standard Experiment Parameters

	len1	gap	dl	rad	dr	I/A	n I	n I l
	m	m	m	m	m	A/mm^2	A	A m
end	0.000	0.000	0.180	0.250	0.075	-85.93	1.16	2.10
sol	0.210	0.030	1.260	0.250	0.040	-80.95	4.08	6.92
end	1.500	0.030	0.180	0.250	0.075	-66.67	0.90	1.63
match	1.800	0.120	0.200	0.255	0.050	-99.35	0.99	1.75
match	2.150	0.150	0.200	0.255	0.050	-64.25	0.64	1.13
focus	2.550	0.200	0.200	0.255	0.090	-106.67	1.92	3.62
focus	2.990	0.240	0.200	0.255	0.090	106.67	1.92	3.62
coupling	4.065	0.875	0.360	0.690	0.071	105.63	2.70	12.31
focus	5.300	0.875	0.200	0.255	0.090	106.67	1.92	3.62
focus	5.740	0.240	0.200	0.255	0.090	-106.67	1.92	3.62
coupling	6.815	0.875	0.360	0.690	0.071	-105.63	2.70	12.31
focus	8.050	0.875	0.200	0.255	0.090	-106.67	1.92	3.62
focus	8.490	0.240	0.200	0.255	0.090	106.67	1.92	3.62
match	8.890	0.200	0.200	0.255	0.050	64.25	0.64	1.13
match	9.240	0.150	0.200	0.255	0.050	99.35	0.99	1.75
end	9.560	0.120	0.180	0.250	0.075	66.67	0.90	1.63
solenoid	9.770	0.030	1.260	0.250	0.040	80.95	4.08	6.92
ens	11.060	0.030	0.180	0.250	0.075	85.93	1.16	2.10

2) Simulated Performance of MICE with narrow momentum spread

- **RF Phases = On Crest**
- **RF Gradients = 8.4 MV/m**
- **Initial trans emittance = 6.04 (π mm)**
  Gaussian in x, y, px, py
- **Initial dp/p = 3 %**
- **p-amp Correlation = 0.45 GeV/c /radian**
- **ct-p correlation 1.8 m/(dp/p)**
- **beta = β_o of Solenoid Field**
- **Added Angular momentum = p_{angular} for Sol Field**

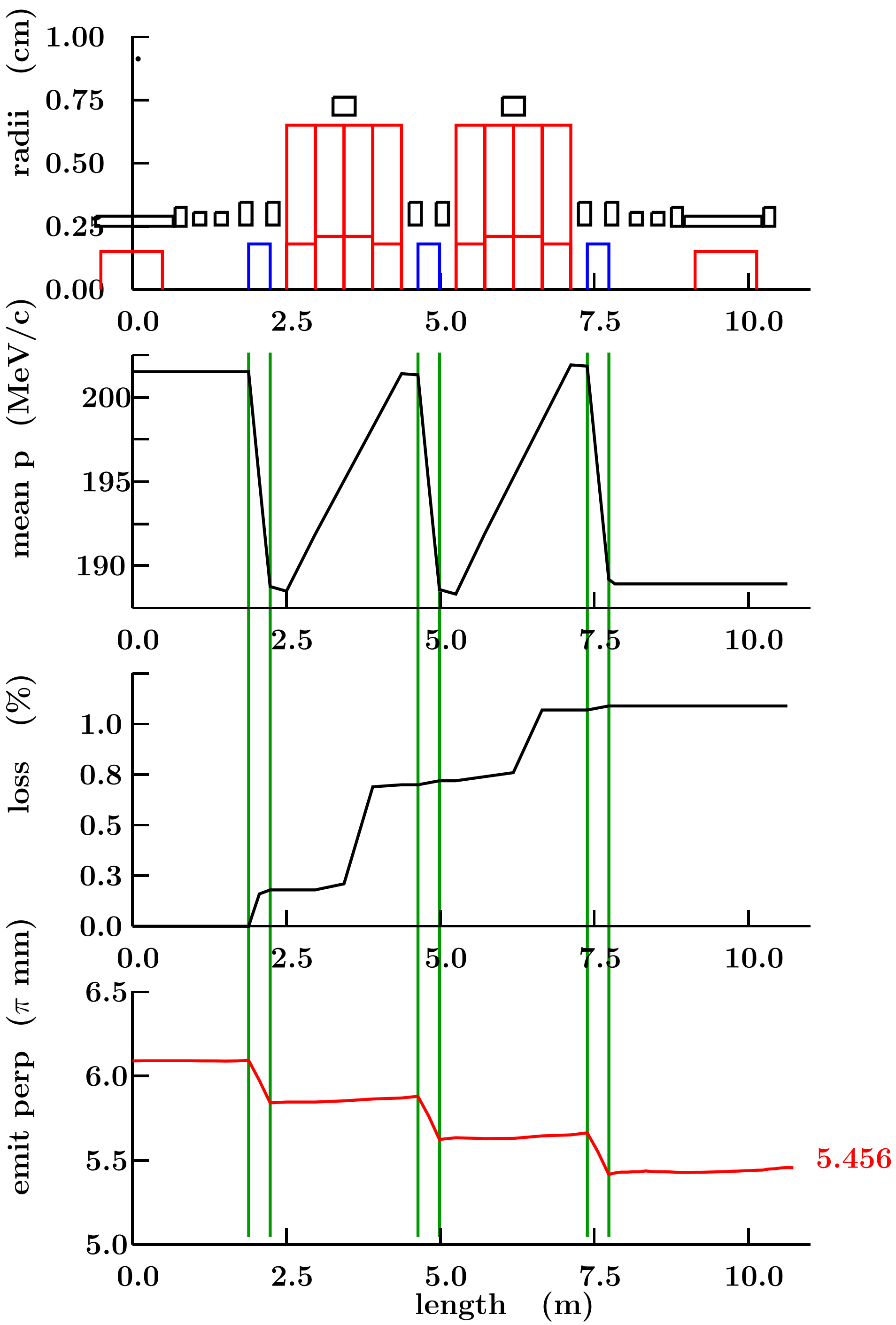
where

$$A = \left(\left(\frac{p_x}{p_z}\right)^2 + \left(\frac{p_y}{p_z}\right)^2 + \frac{x^2 \;+\; y^2}{\beta^2} \right)$$

$$\beta_o = \frac{2\ p}{B\ c}$$

$$p_{\mathrm{angular}} = \frac{B\ r\ c}{2}$$

p in Volts, c in m/s, B=4 T

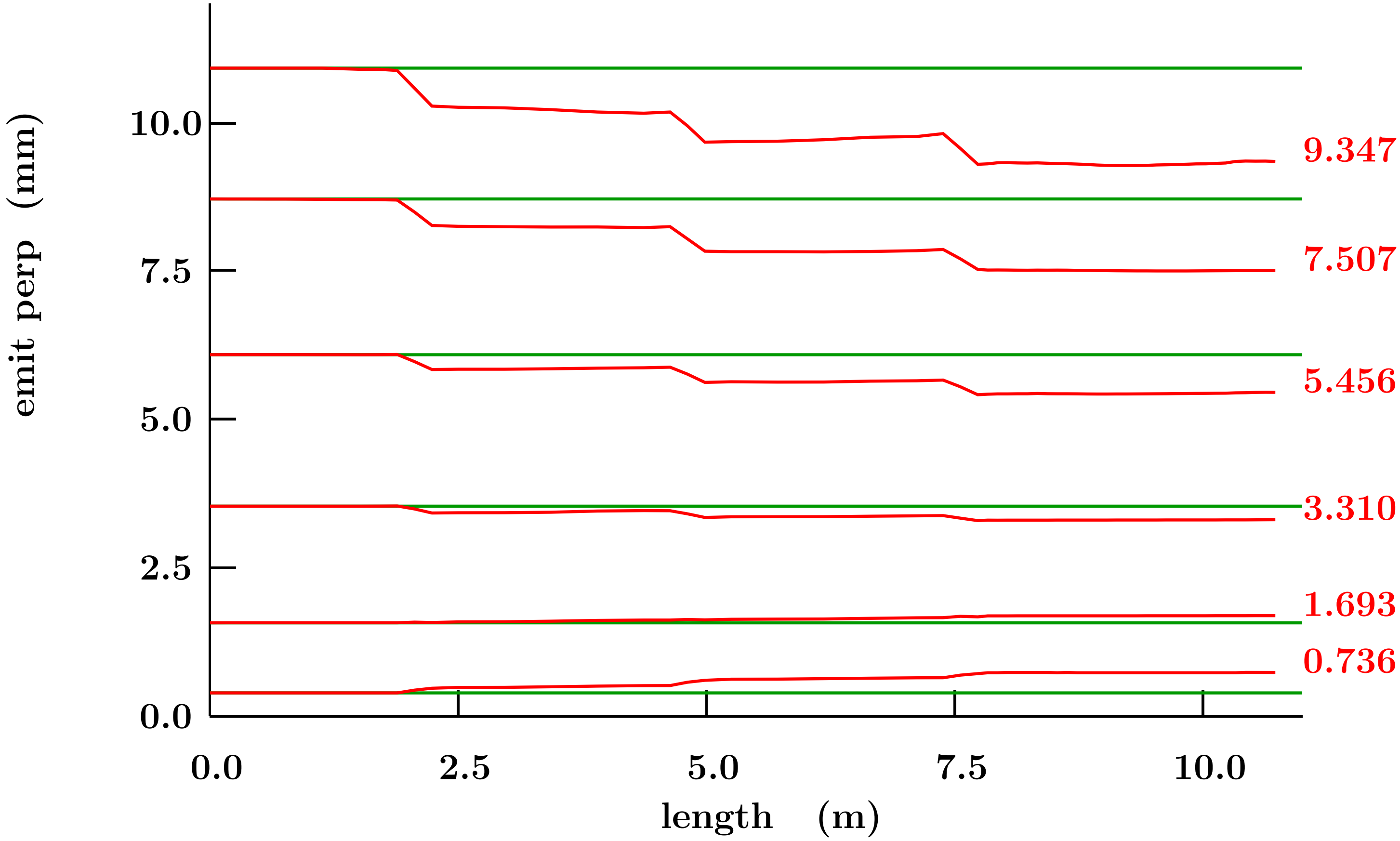


Note:

- Momentum falls in absorber, rises in RF
- Losses occur by scraping at central RF iris
- Emittances are Normalized and only for Transmitted Muons
- Transverse Cooling only in absorbers
- Longitudinal emittance not easily defined because acceleration on crest is not longitudinally stable.

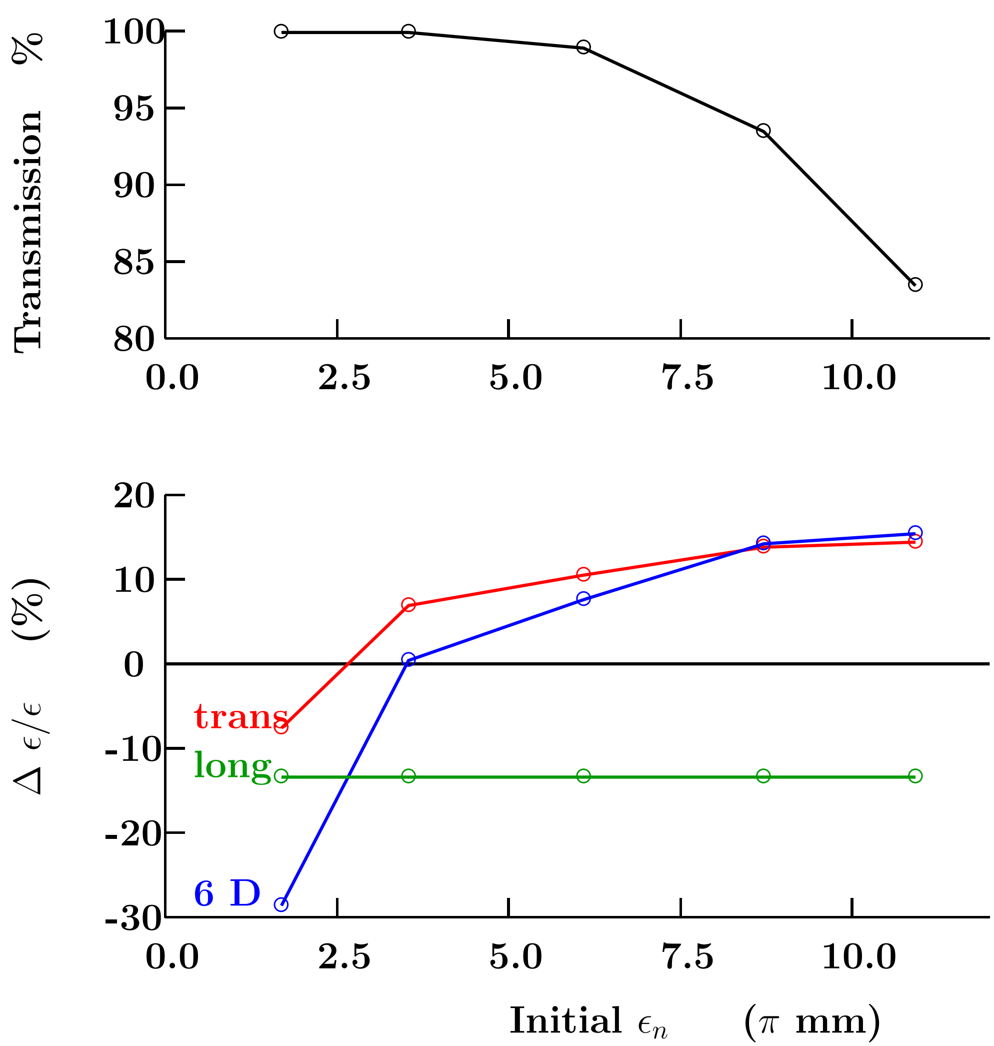
As above but starting with different emittances

- High Emittances are Cooled
- Low emittances are Heated
- There is an "Equilibrium Emittance"



Cooling/Heating vs. Initial Emittance

Longitudinal heating obtained from separate simulation of experiment with NO RF



Methods for Experiment analysis

- **Real Beam will have larger Emittnace**
- **Measure Real Beam Distribution and Correllations**
- **Calculate weights that will convert Real beam to Required Beam**
- **Use weights on beam before and after Cooling**
- **Calculate Cooling with these weighted distributions**