Muon Cooling Rings Using Quadrupoles and Dipoles

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A Quadrupole/Dipole Ring Cooler

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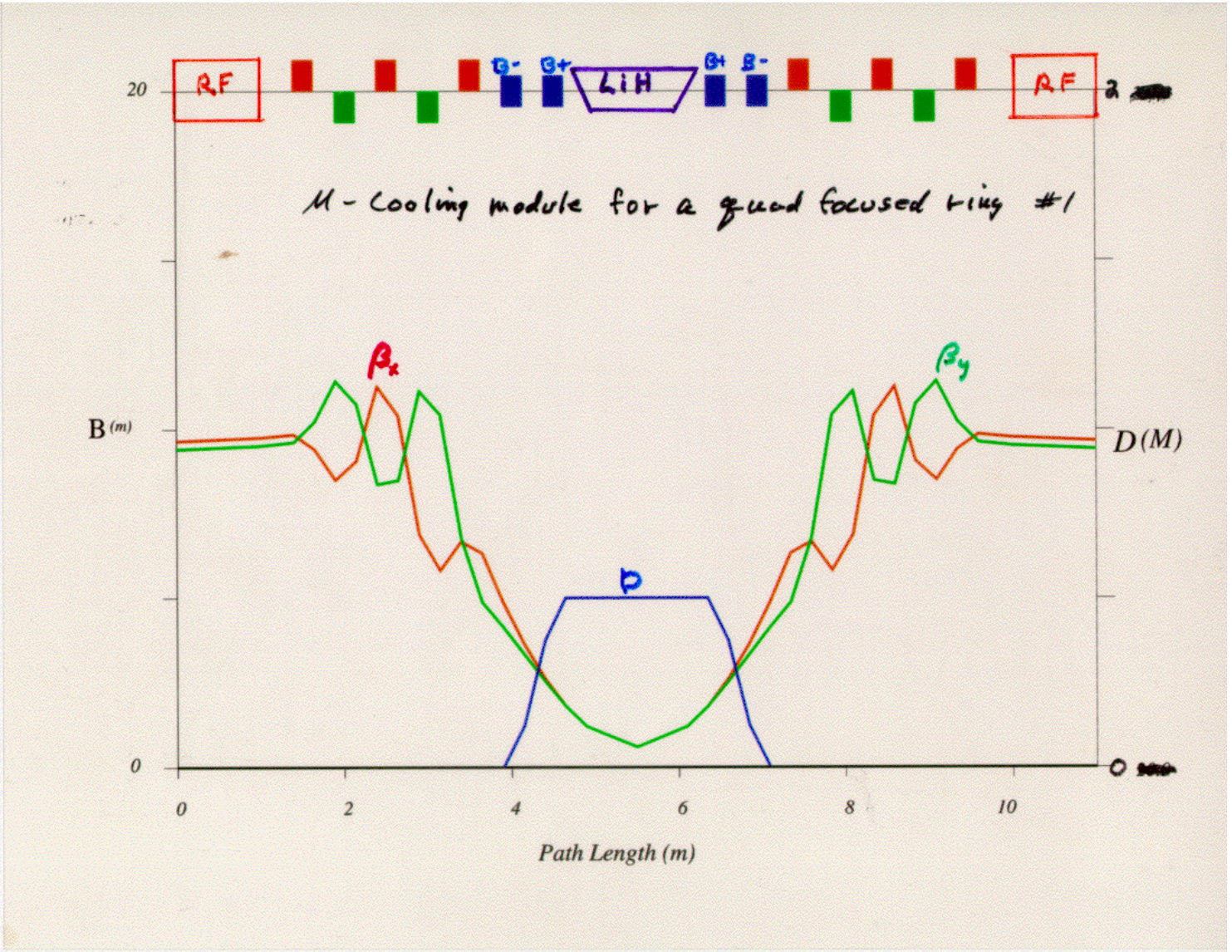
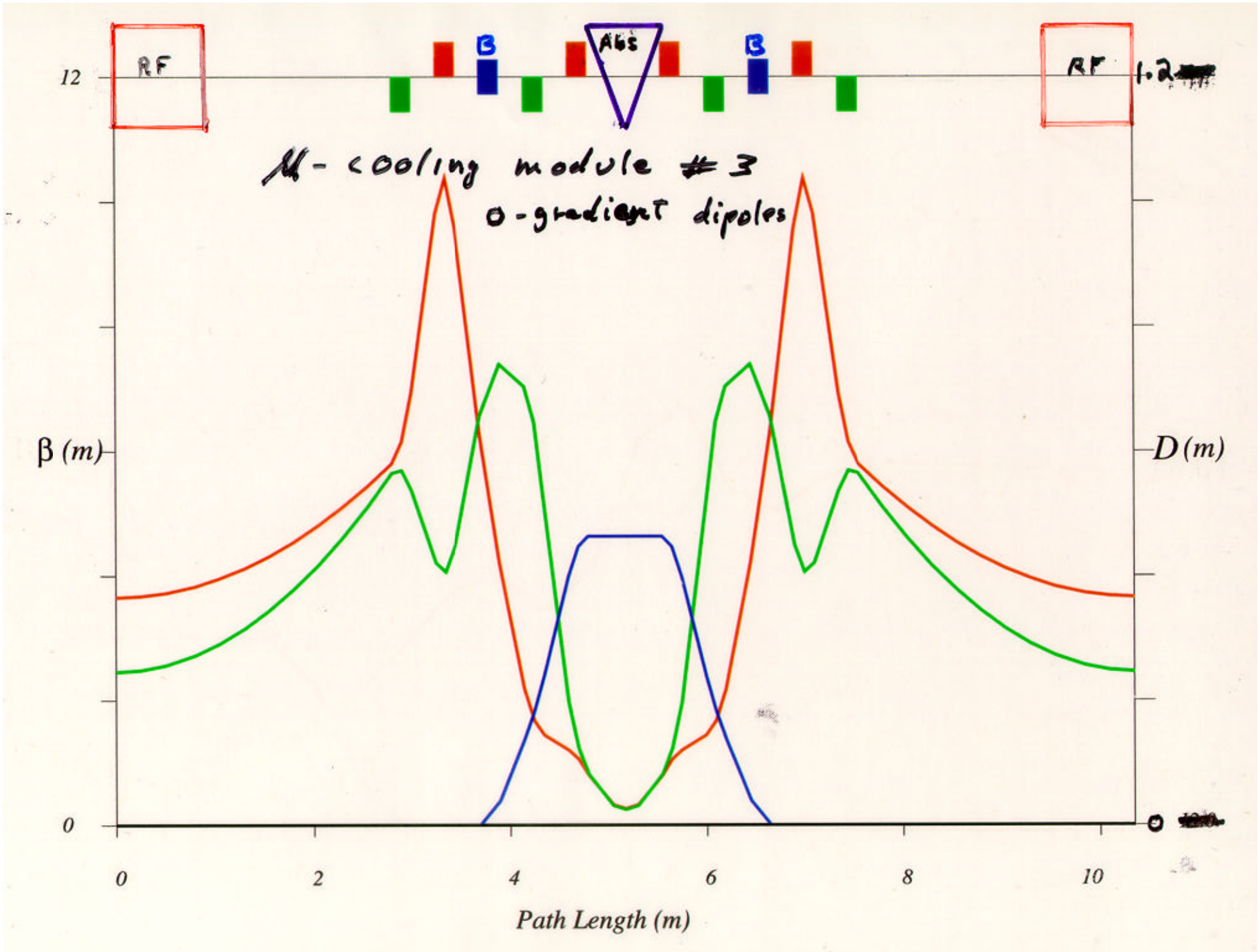
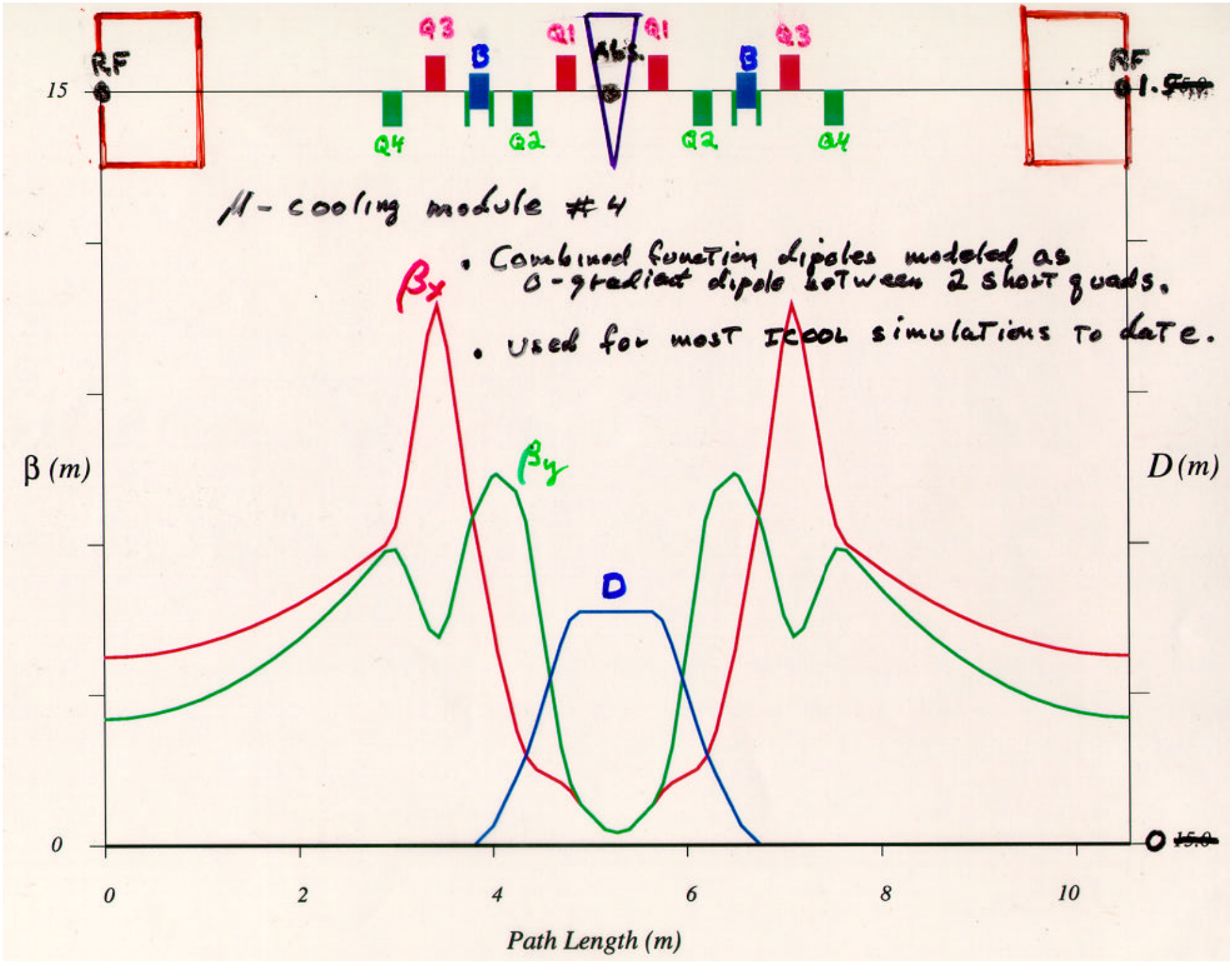
Strategy

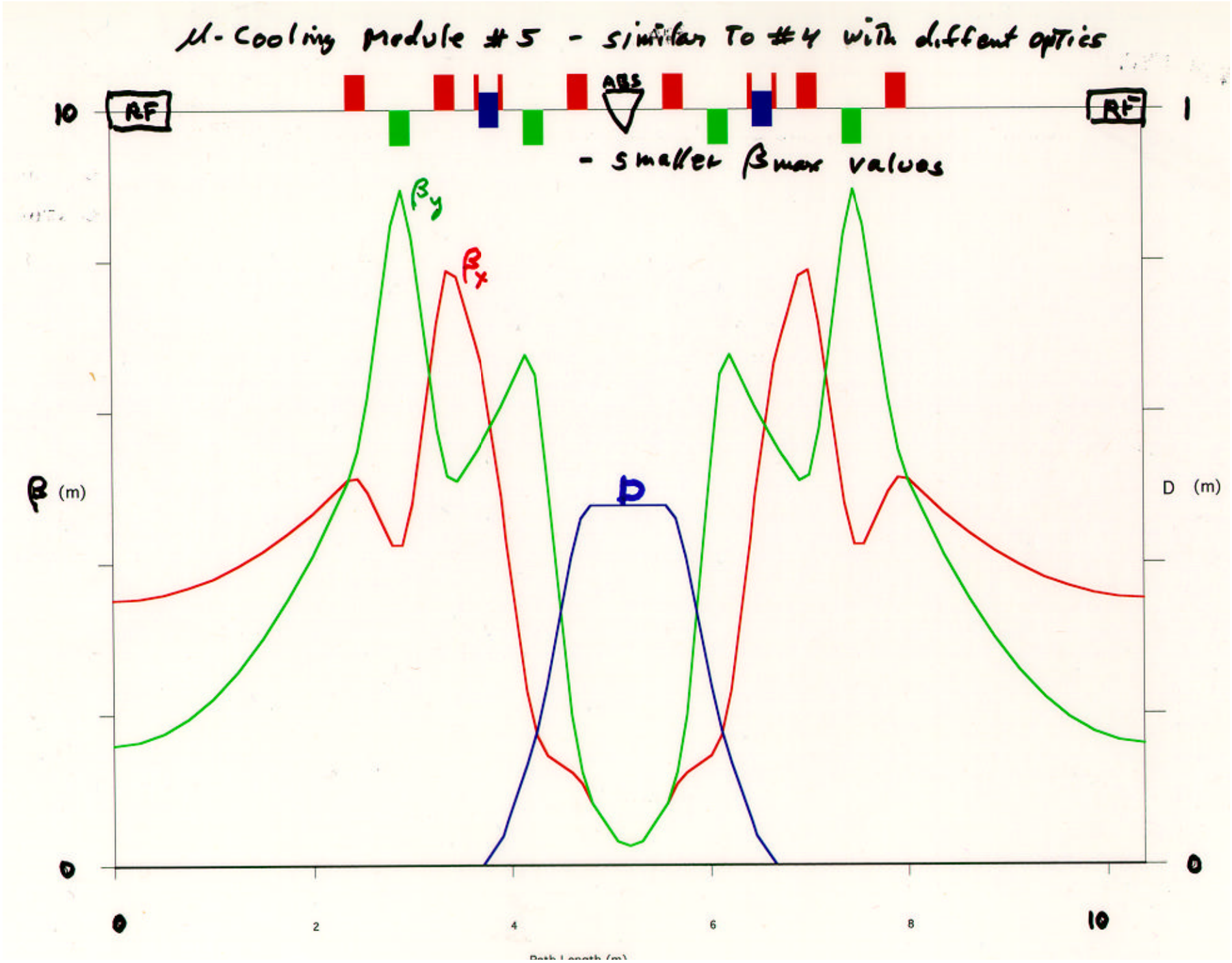
- Explore Ring Cooling Designs
- Use only Quadrupoles and Dipoles
- Obtain Longitudinal Cooling
- Maintain/Reduce Transverse Emittance
- Linear Lattice Design (SYNCH)
- Cooling Simulation (ICOOL)

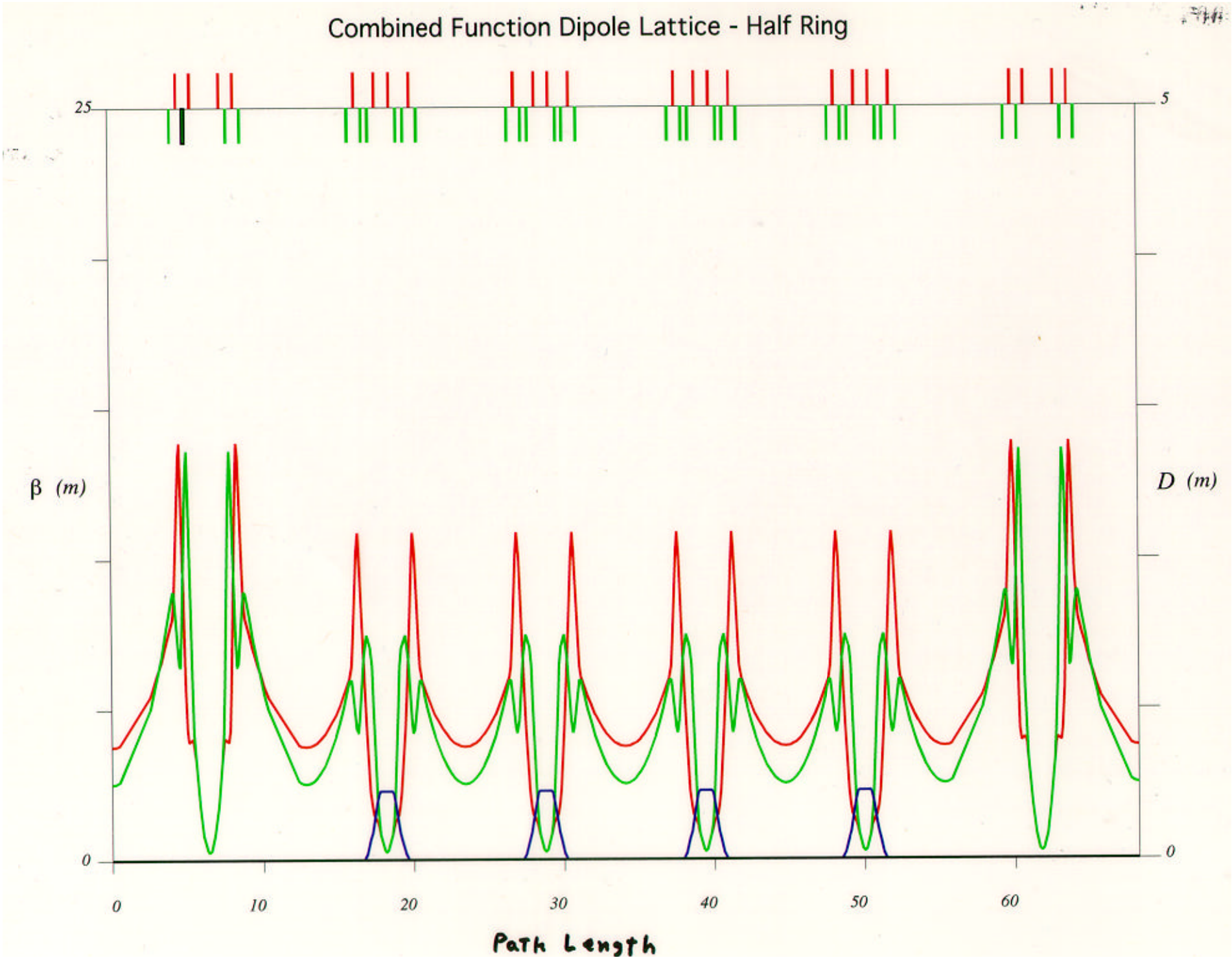

RF
B-
B+
LiH
B+
B-
RF
M - Cooling module for a quad focused ring #1
β_x
β_y
D
20
0
B (m)
D (M)
0
2
4
6
8
10
Path Length (m)


RF
B
Abs
B
RF
12
1.2
M - cooling module #3
0-gradient dipoles
β (m)
D (m)
0
0
2
4
6
8
10
Path Length (m)



RF
Q3
B
Q1
Abs.
Q1
B
Q3
RF
15
Q4
Q2
Q2
Q4
1.5
μ - cooling module #4
• Combined function dipoles modeled as 0-gradient dipole between 2 short quads.
• Used for most ICOOL simulations to date.
β_x
β_y
D
β (m)
D (m)
0
0
15.0
0
2
4
6
8
10
Path Length (m)


μ-Cooling Module #5 - similar To #4 with diffent optics
- smaller βmax values
RF
RF
ABS
10
1
β_y
β_x
D
β (m)
D (m)
0
0
0
2
4
6
8
10
Path Length (m)


Combined Function Dipole Lattice - Half Ring
25
5
β (m)
D (m)
0
0
0
10
20
30
40
50
60
Path Length

Parameters of a Muon Cooling Ring

Momentum	Pc	1	GeV
	beta*gamma	9.47	
	beta	0.9945	
	gamma	9.522	
Initial emittance	epsn	2000	mm-mr
Momentum width	sigmap/p	2.50%	
Muon lifetime	taumu	20.9	μs
Circumference	C	124.44	m
Revolution time	T	0.4174	μs
Number cooling cells		8	
Number straight cells		4	
Cell length	Lc	10.37	m
Number dipoles		16	
Bend angle		22.5	deg
Absorber length		0.25	m
Energy loss-absorber		-7.5	MeV
Energy gain -rf		7.5	MeV
Energy loss/gain-ring		60	MeV
Typical damping time		16.7	revs
		6.96	μs
Beta value in absorber		0.25	m
Dispersion in absorber		0.47	m
Wedge angle of absorber		~12	deg
Maximum betax, betay in cool cell		10.6/7.0	m
Cell phase advance	mu/2pi	0.75	
Dipole field	Bo	6.55	T
Maximum gradient	Gmax	24	T/m