A complete 6D cooling channel for a Muon Collider

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Vacuum RF Meeting 3

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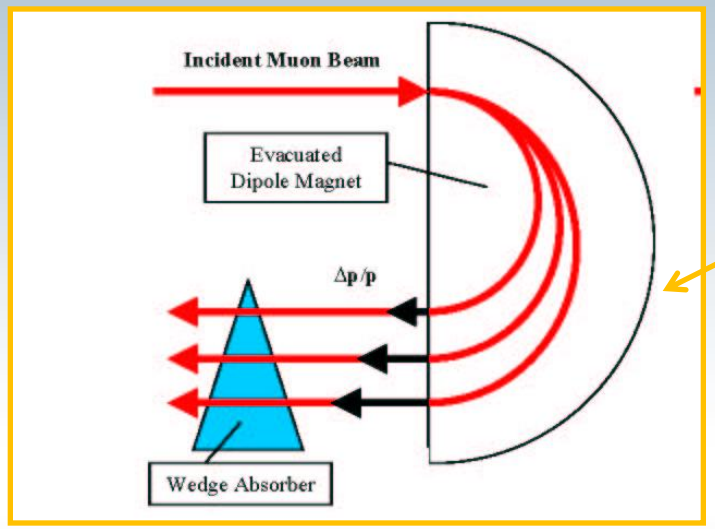
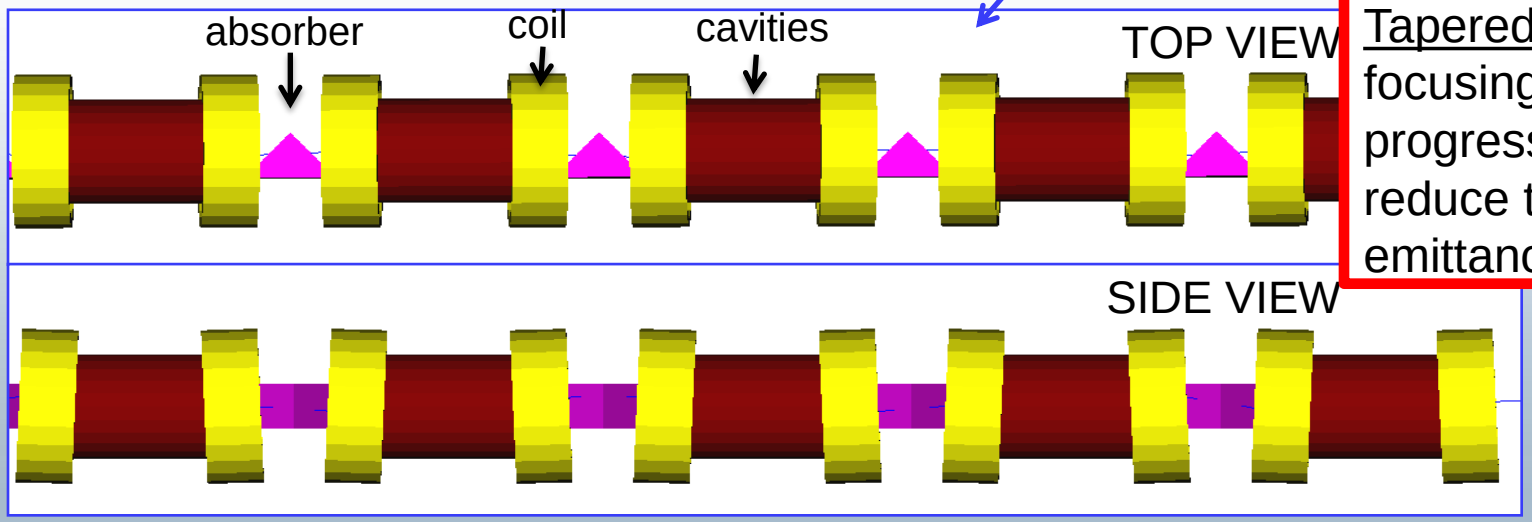
6D Vacuum RF Cooling Channel



Concept: Generate dispersion and cool via emittance exchange in a wedge absorber

Proposed solution: Rectilinear channel with tilted alternating solenoids and wedge absorbers

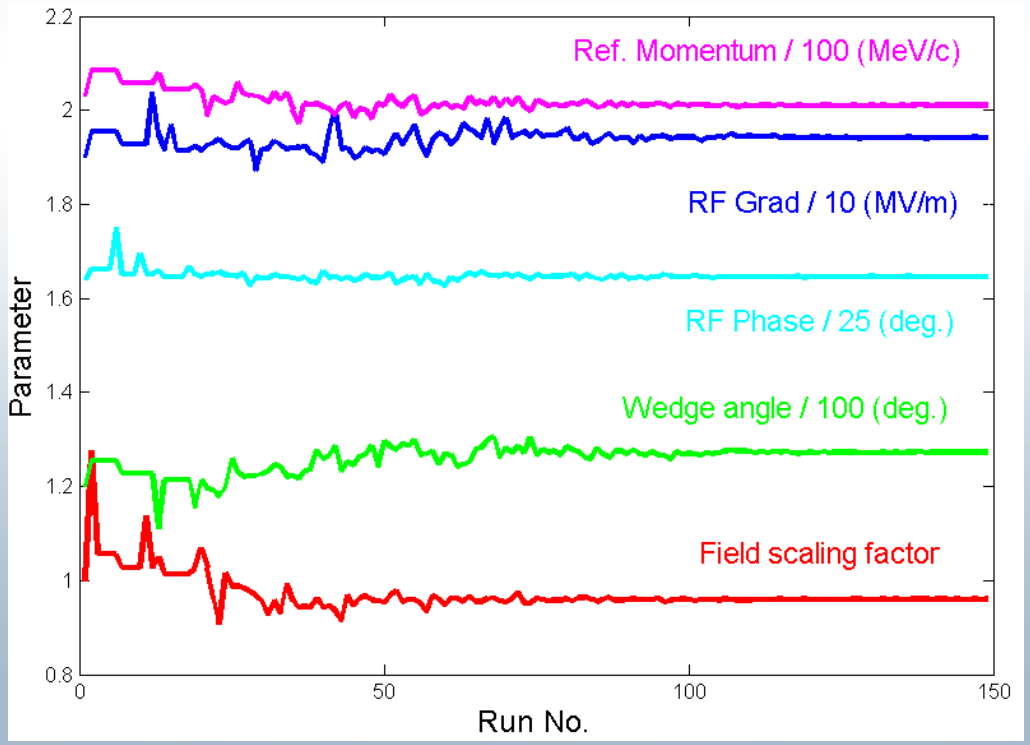


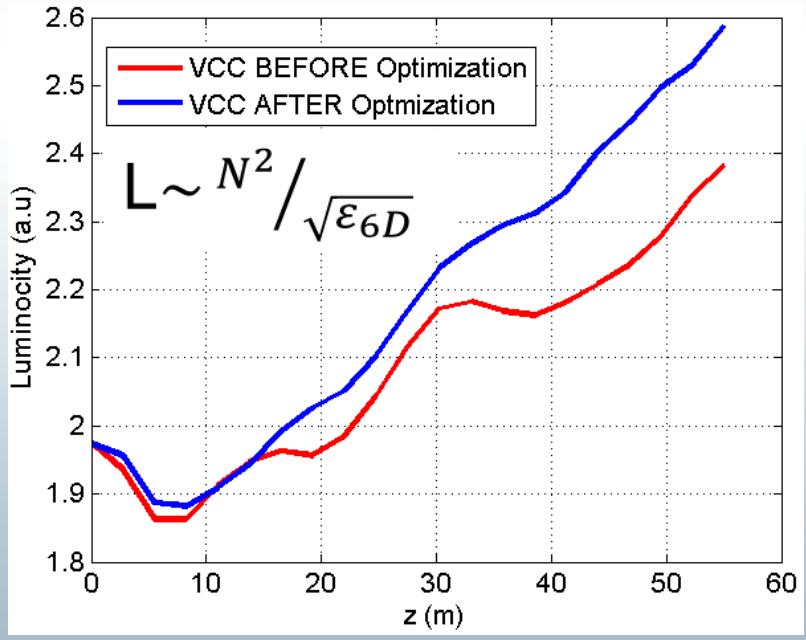
Tapered channel: The focusing field becomes progressively stronger to reduce the equilibrium emittance.

D. Stratakis et al., Phys. Rev. ST AB 16, 091001 (2013)

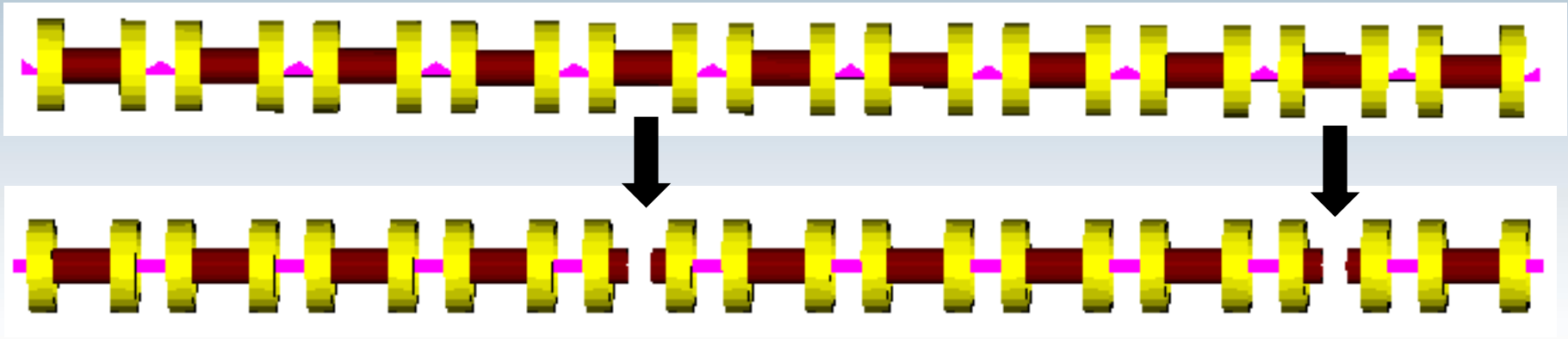
Multivariable Optimization for 6D

- Nelder-Mead algorithm
- Integrated in NERSC with ICOOL-MPI
- Applied for VCC optimization (Stg 1): 8 parameters



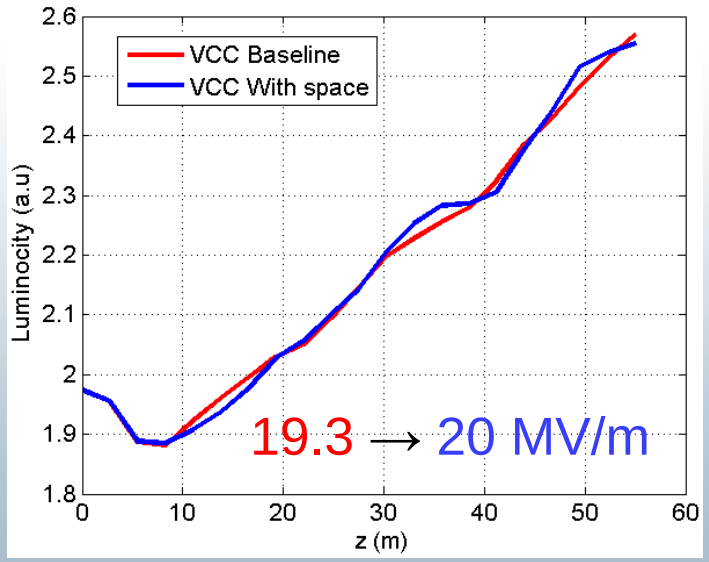


Lattice Space (Stg. 1)

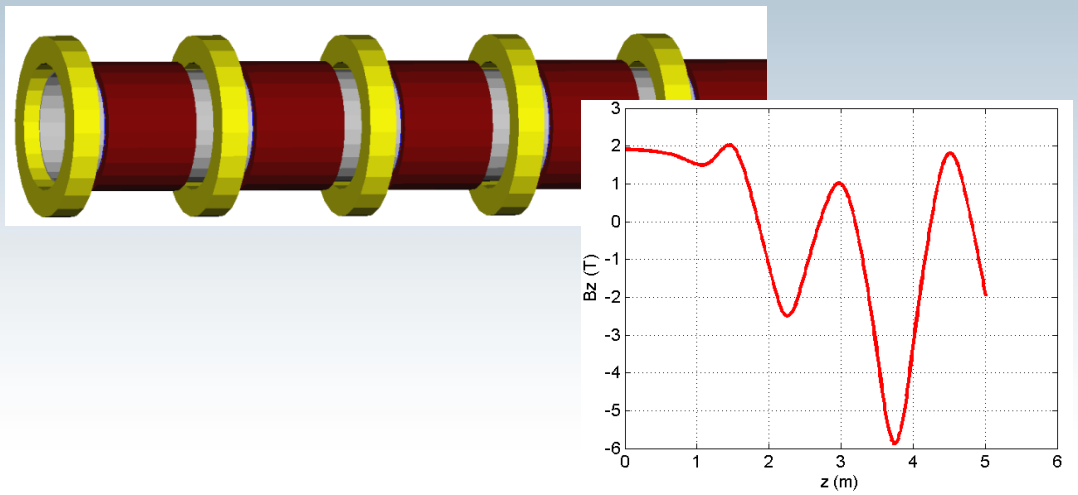


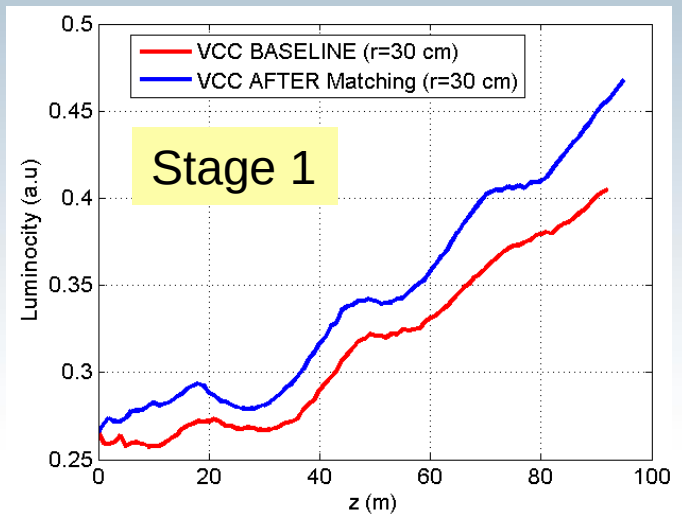
- Space generated for:
  - Diagnostics, separate cryostats
- Remove two rf after 4 cells

Parameter	Baseline	With Space
Cool rate (trans.)	1.49	1.49
Cool rate (long.)	1.30	1.35
Transmission	87.2%	86.4%



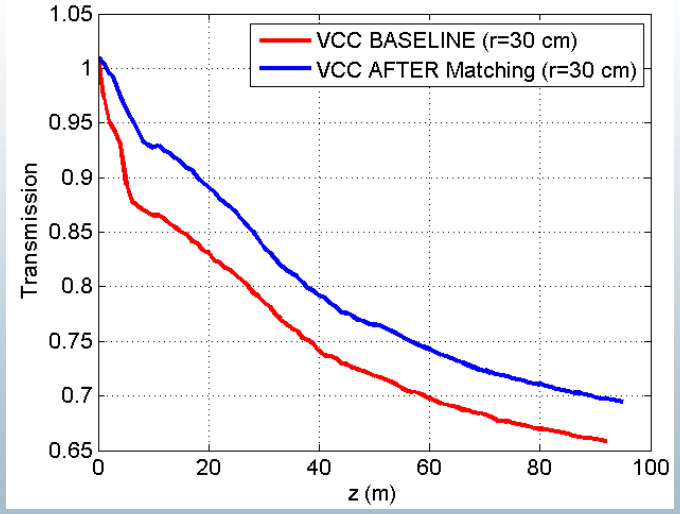
Matching from Phase-Rot. To 6D



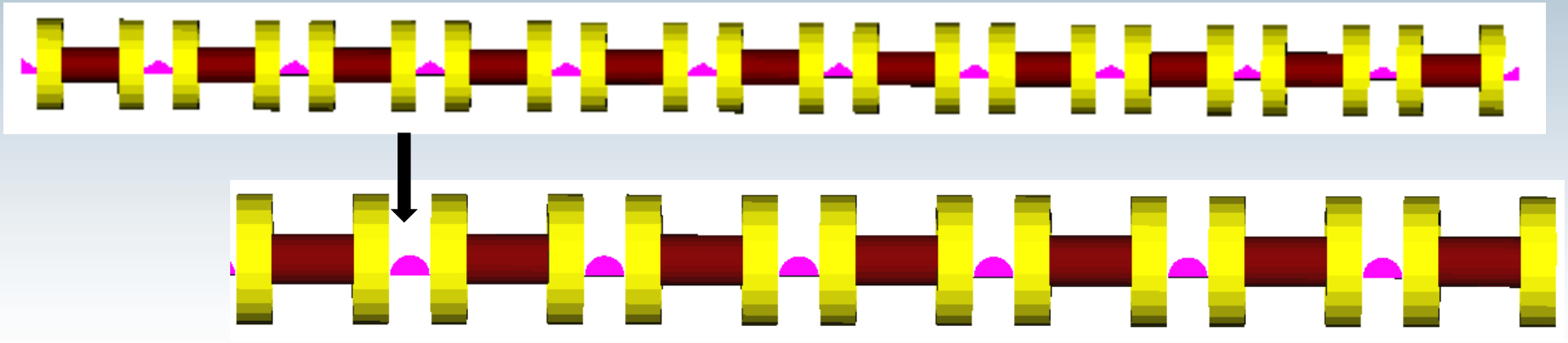


- 9 matching coils, in 9, 75 cm cells
- Objective: Maximize luminosity
- **New channel has 30 cm aperture**

Parameter	Baseline	With Matching
Cool rate (trans.)	2.13	2.19
Cool rate (long.)	2.76	2.81
Transmission	65.2%	68.8%



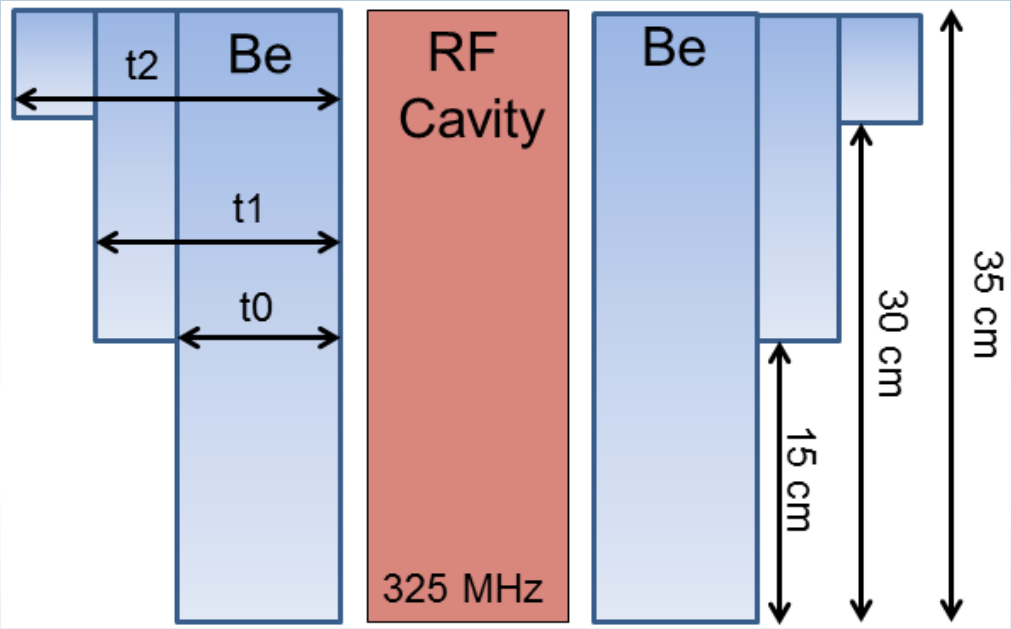
Wedges vs. Cylinders



- Liquid Hydrogen absorbers:
  - Wedges vs. cylinders
- Optimized for performance

Parameter	Baseline	With Space
Cool rate (trans.)		
Cool rate (long.)		
Transmission		

Be Windows Simulation Model



Stage	f (MHz)	rWin (cm)	rStep (cm)	t0 (mm)	t1 (mm)	t2 (mm)
1	325	35	15/30	0.35	1.4	3.9
2	325	25	15	0.2	0.8	
3	650	19	10	0.2	0.6	
4	650	13.2	11.4	0.125	0.38	

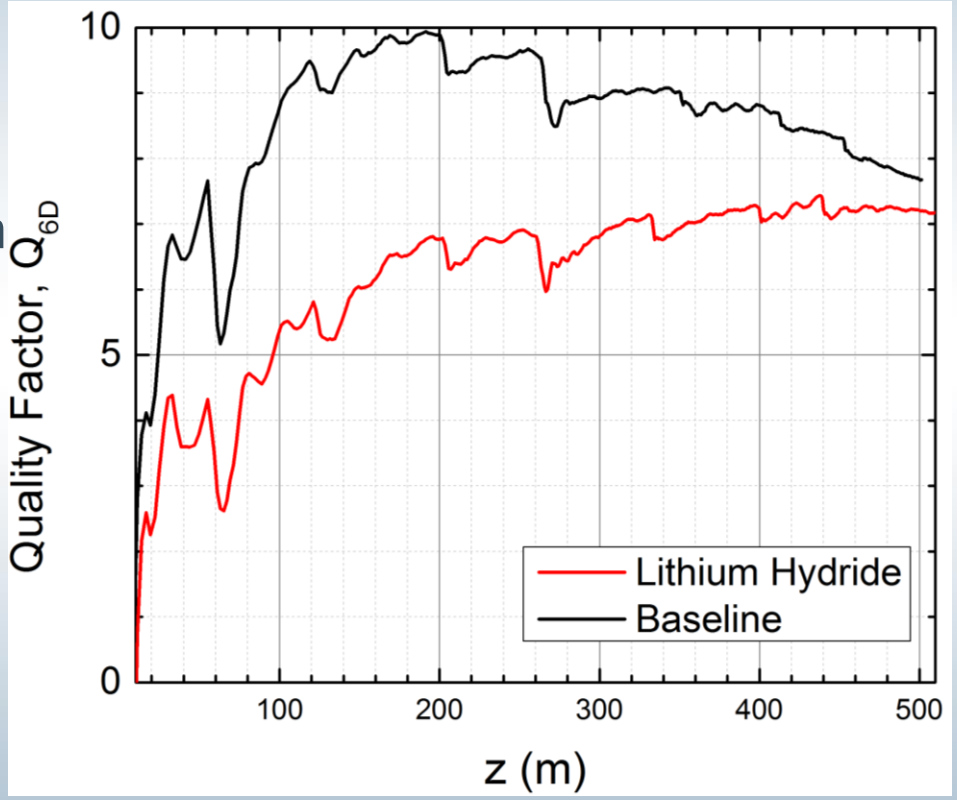
- Stepped Be window: All stages have two steps, except Stg 1 which has three

Channel before merge, ONLY!

Parameter	Baseline	With Be
Cool rate (trans.)	11.90	10.87
Cool rate (long.)	20.83	17.85
Transmission	51.9%	49.3%

Lithium Hydride Absorbers

- Post-Merger has 8 stages
- Two alternative cases:
  - First 4 stages with liquid hydrogen (LH) and last 4 with Lithium Hydride (LiH)
  - All stages with LiH
- Quality factor, Q is used for lattice evaluation
- Both lattices reach MAP goal for the emittances



Summary

- Matcher into 6D has designed
- Matches from a constant 2T
- Now aperture 35 cm → 30 cm.
- Now use optimizer to tune Stage 1: Pref, Grad, phase, etc…
- Same concept can be used for matching from Bunch Merger to Post 6D