EMITTANCE EXCHANGE R&D ACTIVITIES AND PLANS

MUTAC Presentation

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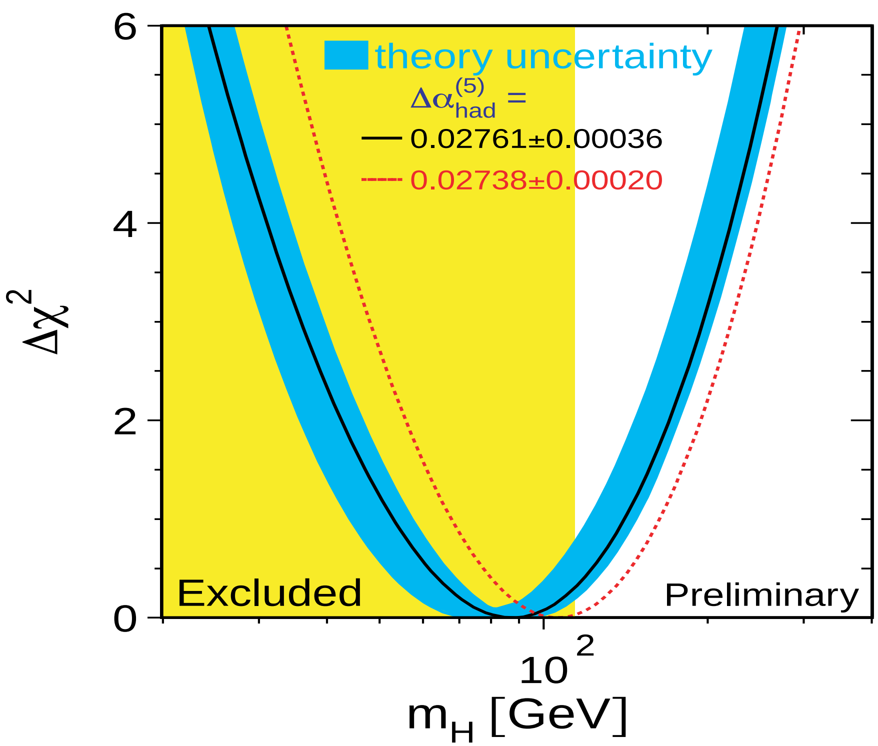
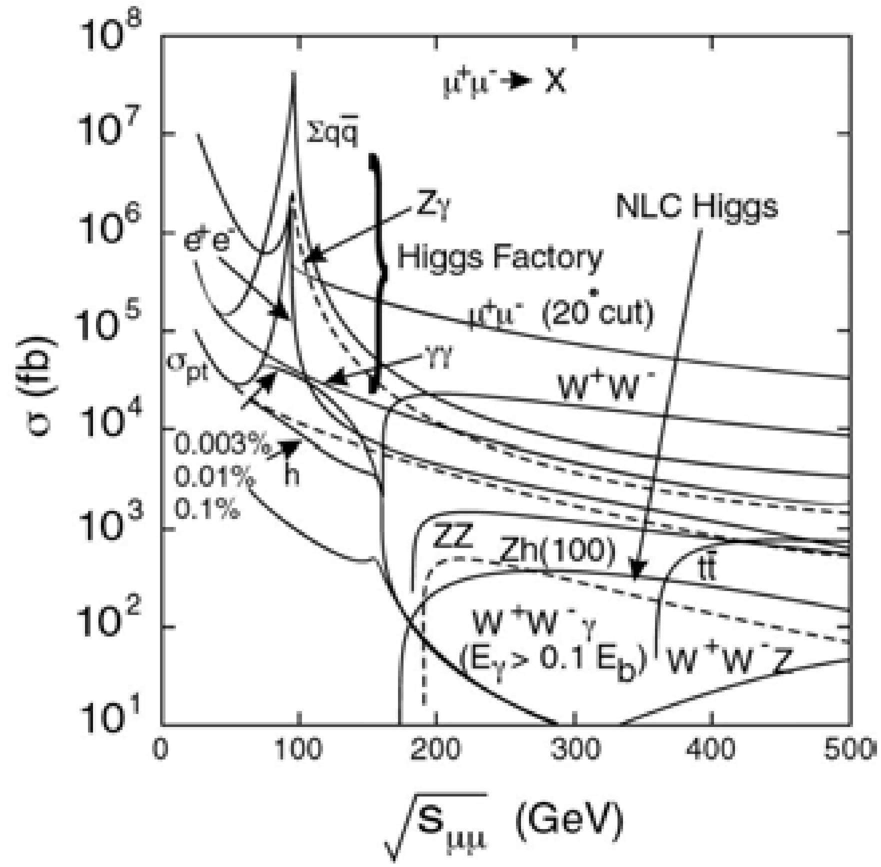
PHYSICS ISSUES

- Is there a light Higgs boson? Data suggests "yes"
- If only one light Higgs boson, crucial to measure properties – SM or SUSY?
- At muon collider, Higgs produced through *s*-channel
- Can measure *CP* properties of Higgs bosons through asymmetries with transversely polarized beams



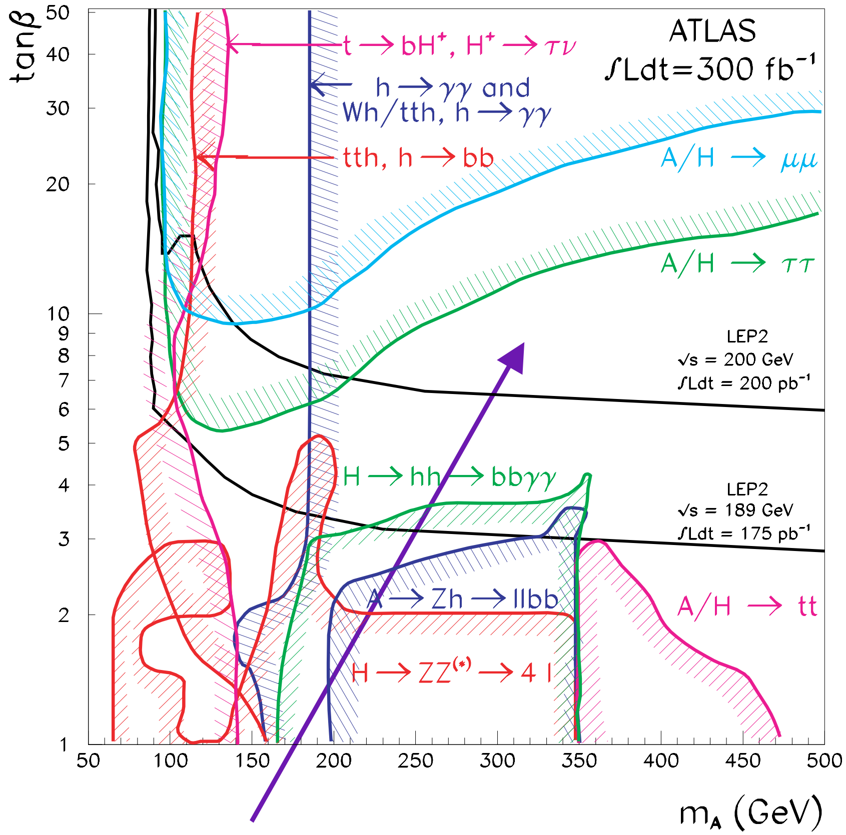


$m_H = 88^{+53}_{-35}$ GeV

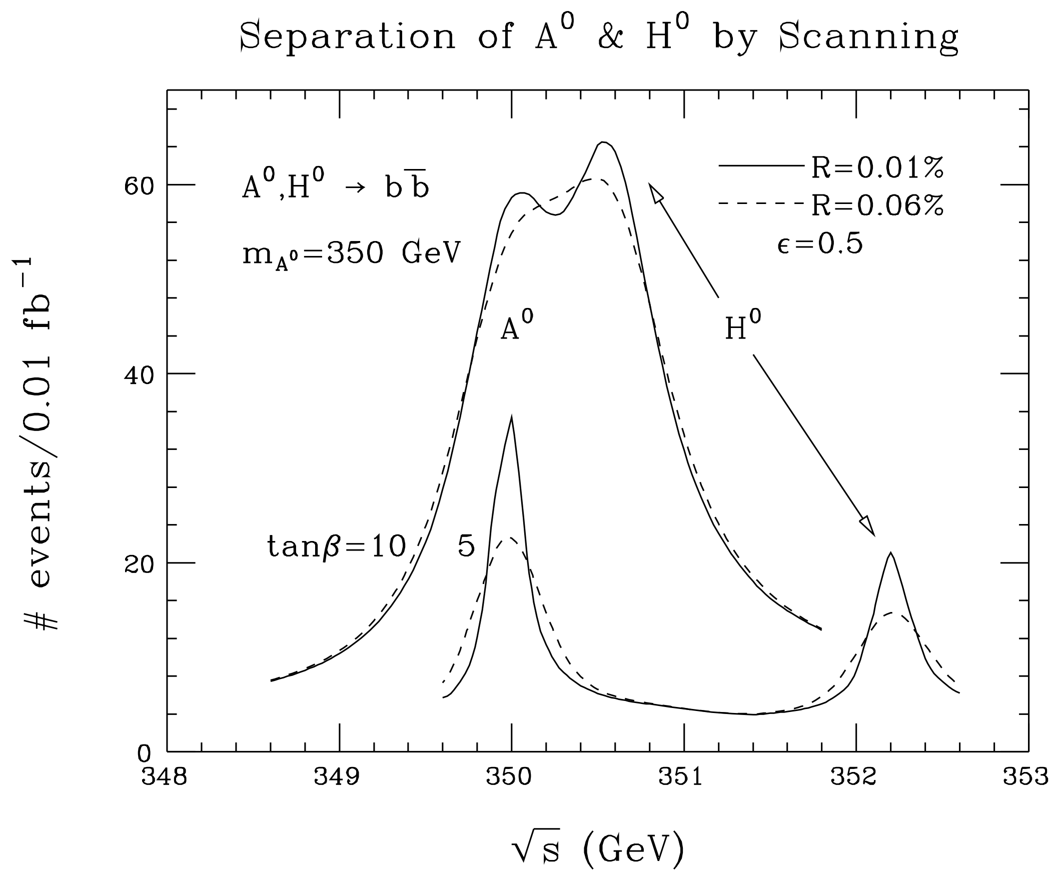
$m_H < 196$ GeV, 95% C.L.

IMPLICATIONS FOR SUPERSYMMETRY

- Light Higgs boson (m_h ~ 120 GeV) indicates large value of tan β
- Disagreement of muon anomalous magnetic moment $(g-2)_\mu$ with SM prediction also indicates large tan β
- In decoupling limit, lighter Higgs boson h^0 has couplings like SM Higgs, but heavier Higgses H^0, A^0 have non-SM couplings: coupling to gauge bosons is suppressed
- For larger values of tan β there is a range of heavy Higgs boson masses (H^0, A^0) for which discovery at LHC or e^+e^- linear collider is not possible
- Heavy Higgs bosons are largely degenerate in MSSM



Muon collider?



A MUON COLLIDER AS A HIGGS FACTORY

- A beam energy spread as small as ~ 10^{-5} may be possible, allowing a measurement of m_H to a few hundred keV and a direct measurement of the width to about 1 MeV

- A Higgs factory muon collider is also a step towards a high energy (3–4 TeV) muon collider.

HIGGS FACTORY PARAMETERS

Muon Collaboration

Baseline parameters for Higgs factory muon collider. Higgs/year assumes a cross section of 5×10^4 fb, Higgs width of 2.7 MeV, 1 year = 10^7 s. From "Status of Muon Collider Research and Development and Future Plans," Muon Collider Collaboration, C. M. Ankenbrandt *et al.*, *Phys. Rev. ST Accel. Beams* **2**, 081001 (1999).

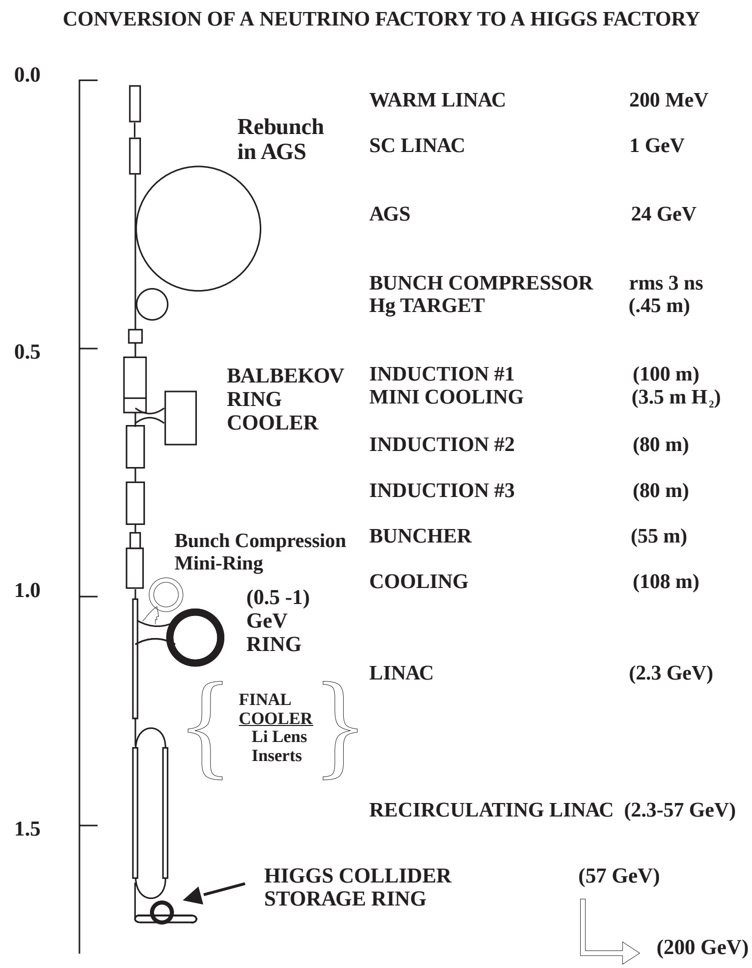
COM energy (TeV)		0.1	
p energy (GeV)		16	
p's/bunch		5×10^{13}	
Bunches/fill		2	
Rep. rate (Hz)		15	
p power (MW)		4	
μ/ bunch		4×10^{12}	
μ power (MW)		1	
Wall power (MW)		81	
Collider circum. (m)		350	
Ave bending field (T)		3	
rms $\delta p/p$ (%)	0.12	0.01	0.003
6D $\varepsilon_{6,N}$ $(\pi m)^3$	1.7×10^{-10}	1.7×10^{-10}	1.7×10^{-10}
rms ε_n (π mm mrad)	85	195	290
β^* (cm)	4.1	9.4	14.1
σ_z (cm)	4.1	9.4	14.1
σ_r spot (μm)	86	196	294
σ_θ IP (mrad)	2.1	2.1	2.1
Tune shift	0.051	0.022	0.015
n_{turns} (effective)	450	450	450
Luminosity (cm^{-2} s^{-1})	1.2×10^{32}	2.2×10^{31}	10^{31}
Higgs/yr	1.9×10^3	4×10^3	3.9×10^3

CONVERTING A NEUTRINO FACTORY TO A HIGGS FACTORY

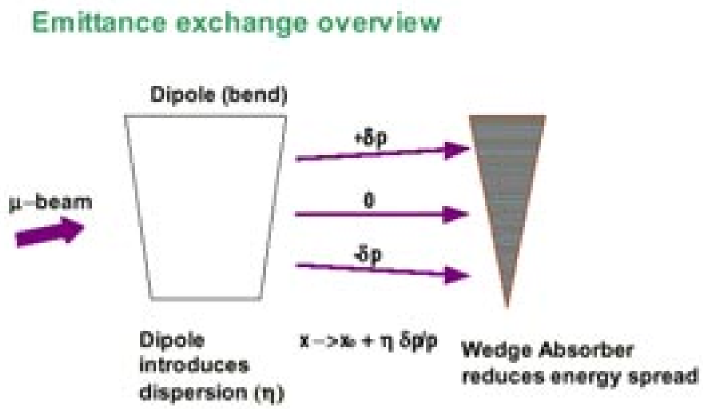
Muon Collaboration

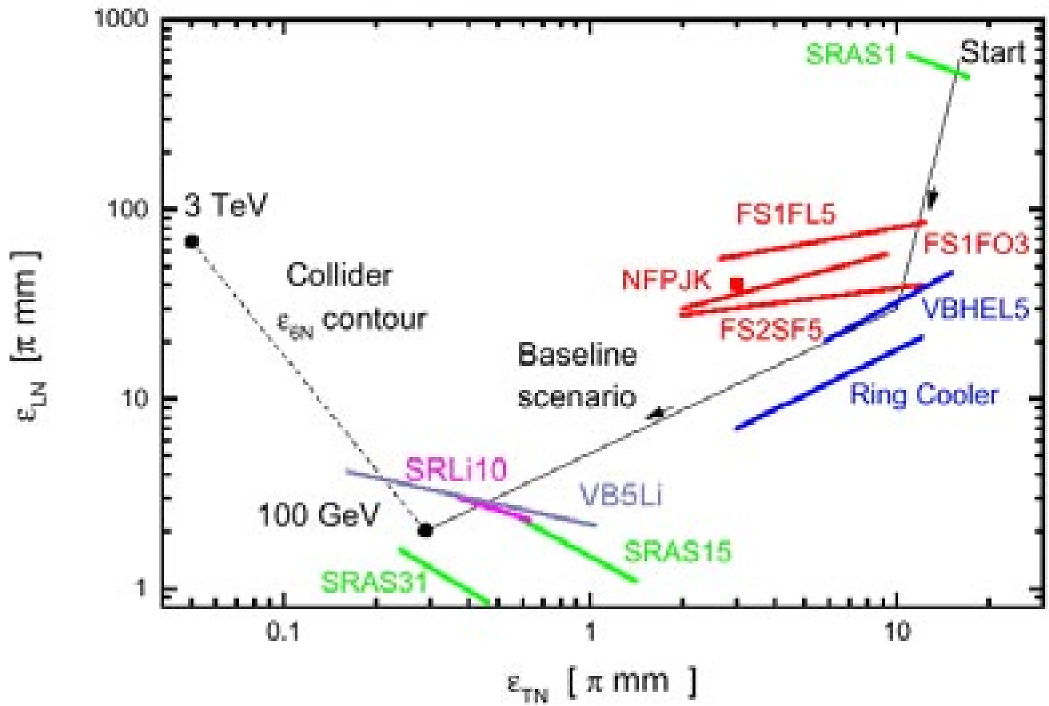
A muon collider requires the muon beams to be cooled by several orders of magnitude compared with a neutrino factory.

All the muons must be in one bunch.



COOLING

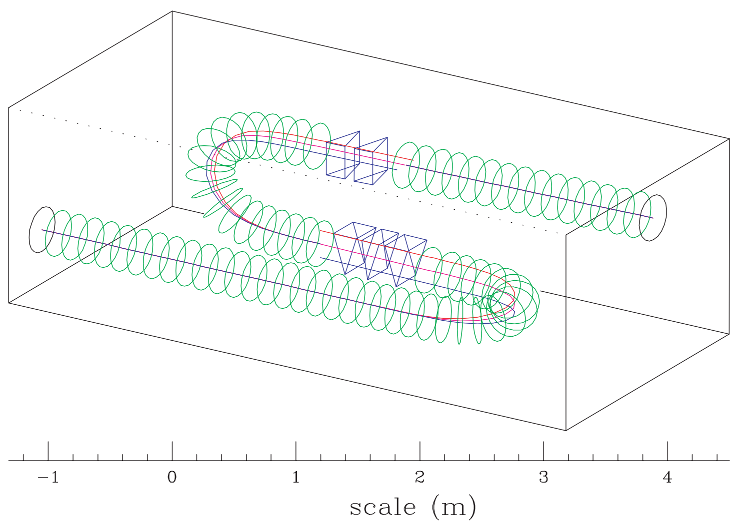




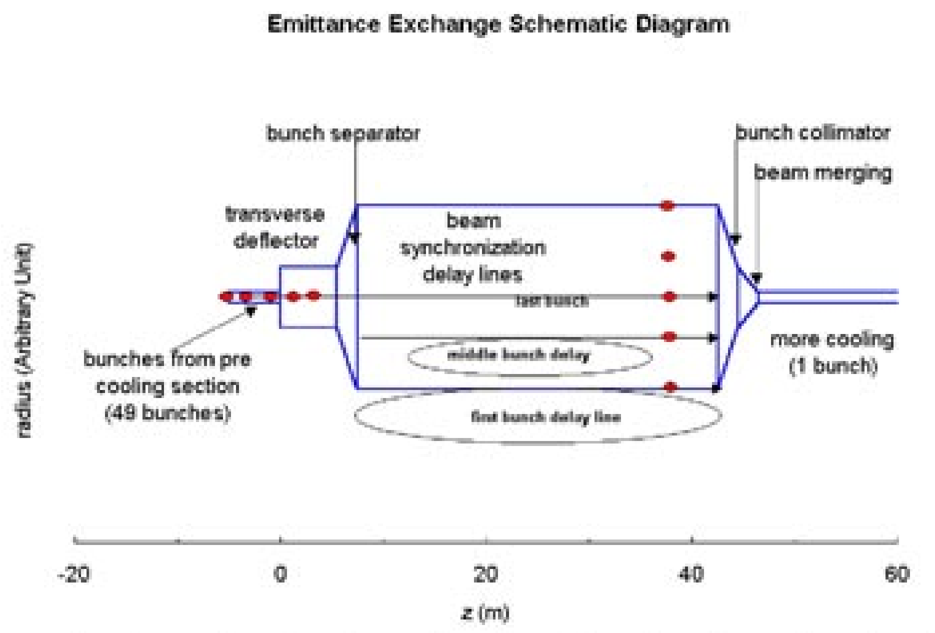
× 100 cooling needed in each transverse and in longitudinal direction (~10^6 in 6D emittance) compared with μ's from π decay.

EMITTANCE EXCHANGE

BENT SOLENOID

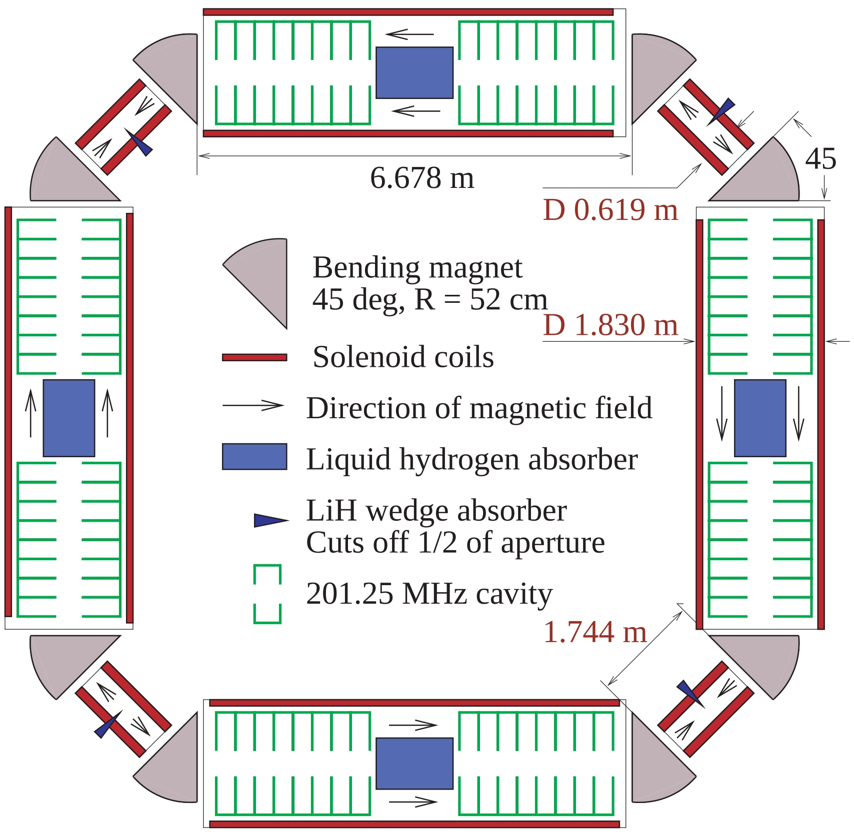


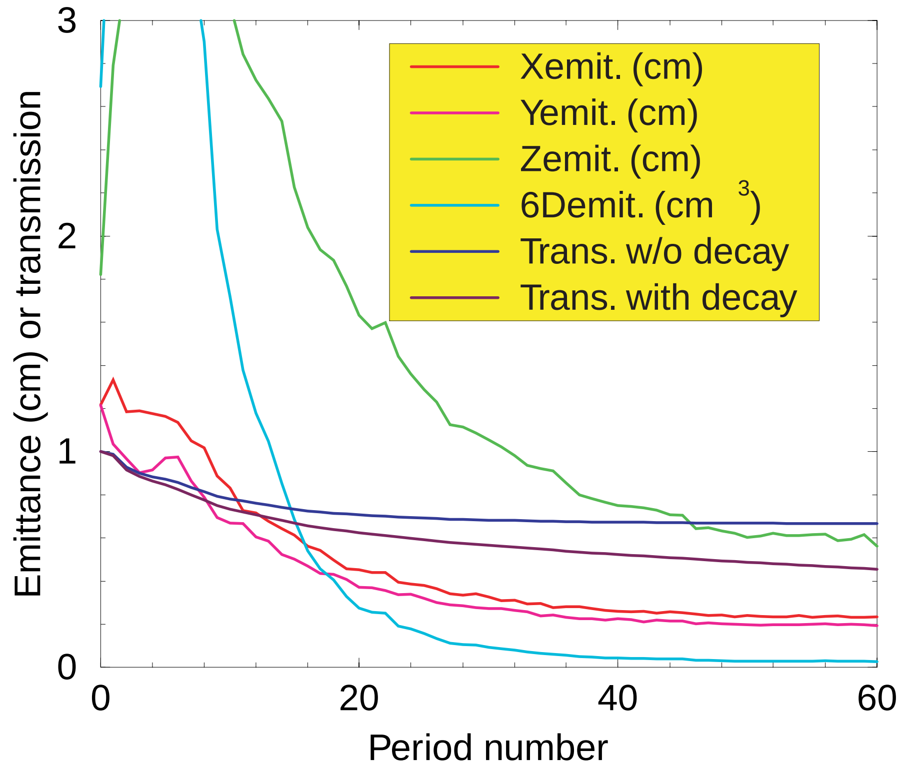
BUNCH STACKING



EMITTANCE EXCHANGE

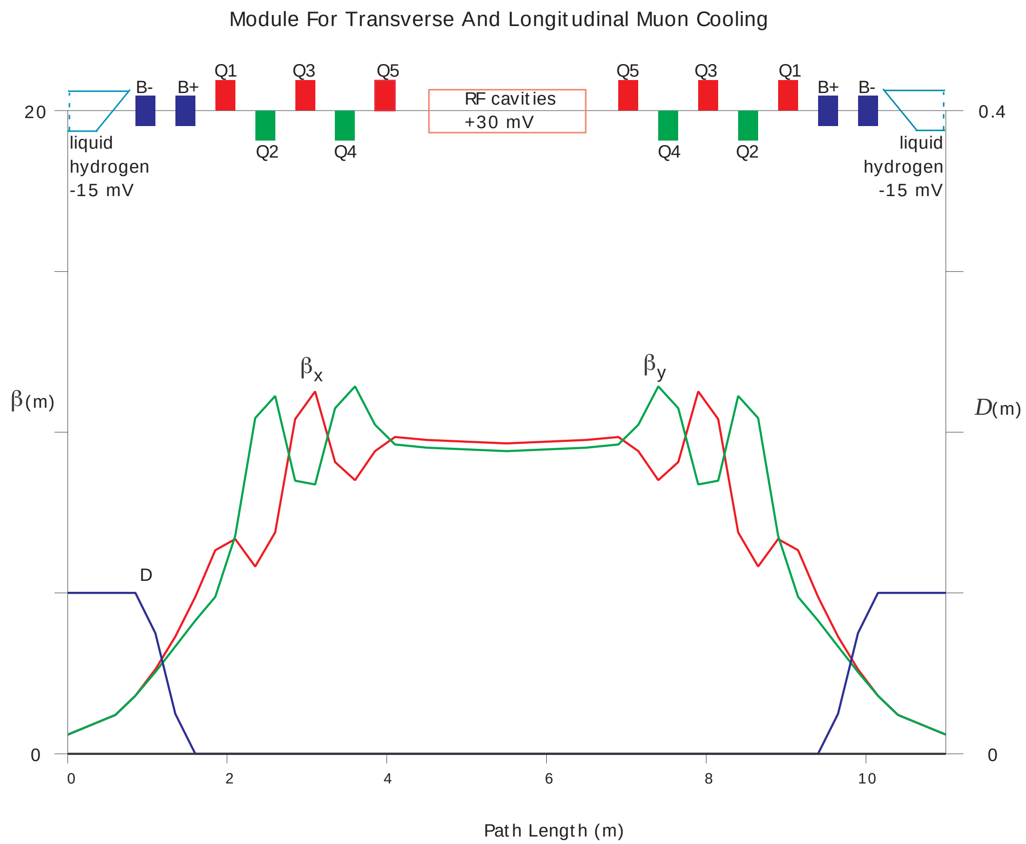
BALBEKOV RING COOLER





EMITTANCE EXCHANGE

Cooling module of a storage ring cooler (Garren).



SUMMARY

- Neutrino factory feasibility study simulations show cooling to ε_{TN} = 2 πmm and ε_{LN} = 30 πmm (bunched!)
- Ring Cooler cools ~ × 5 transverse, × 2 longitudinal
- Lithium lens (or other?) needed to cool ~ × 10 to sub-mm in ε_{TN}
- Details – next talk!