Introduction to Guggenheim simulations

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Cooling Mini-Workshop
FNAL

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Outline

- use of guggenheims in Palmer's cooling scenario (this talk)
  channel topology
- beam physics considerations (Bob on phone)
- modeling the helical nature of the channel in ICOOL (RCF)
- G4Beamline modeling of the channel (Pavel's talk)
  shielding, windows, magnetic insulation
- work that needs to be done

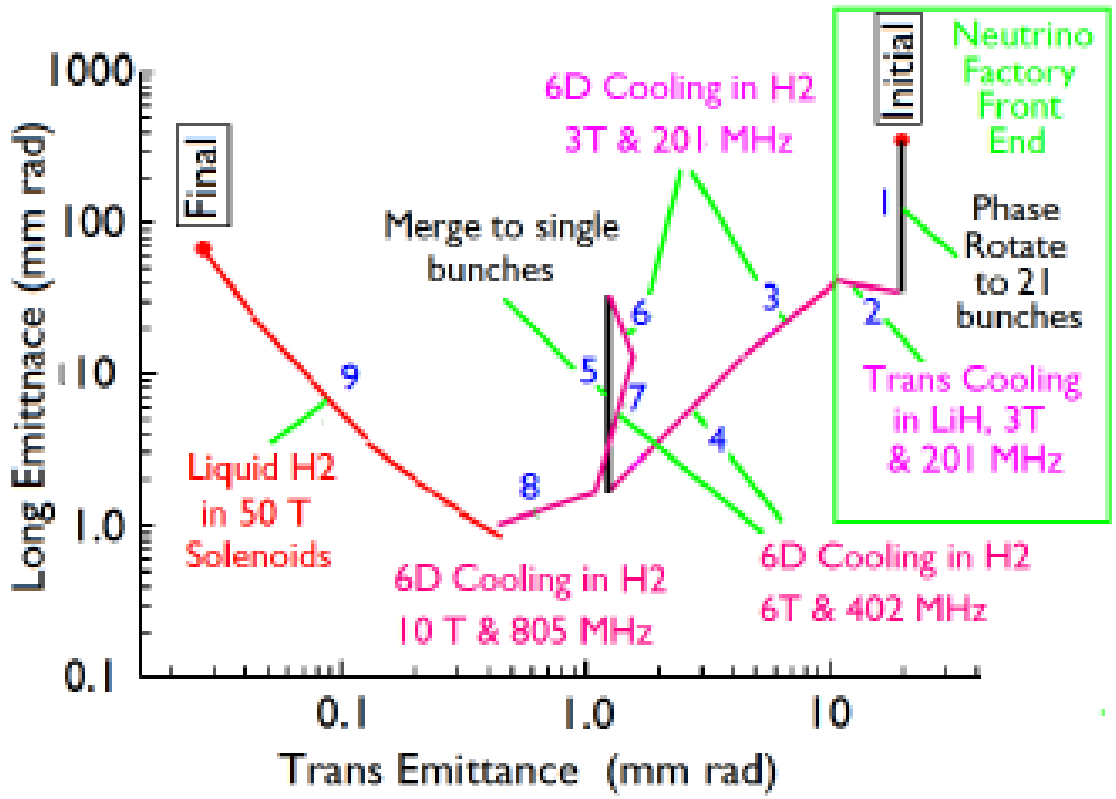
Our inspiration

Palmer cooling scenario

- Gugs are used to do intermediate cooling in Palmer's scenario
- provides <u>all</u> the longitudinal cooling

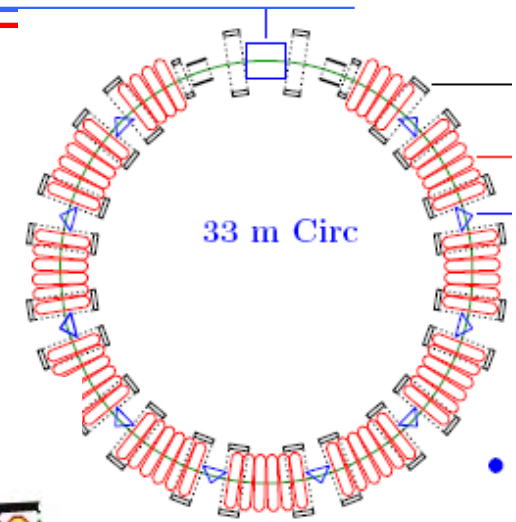
  goal: single bunch with ε_{TN} = 0.4 mm and ε_{LN} = 1 mm

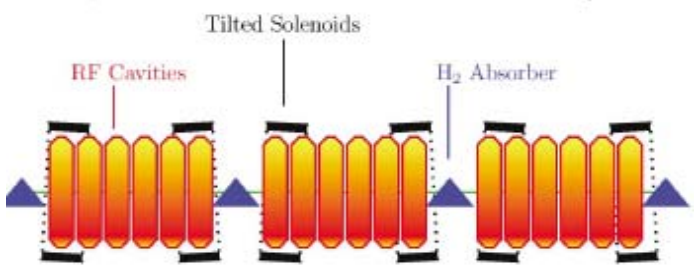
Cooling scenario plot



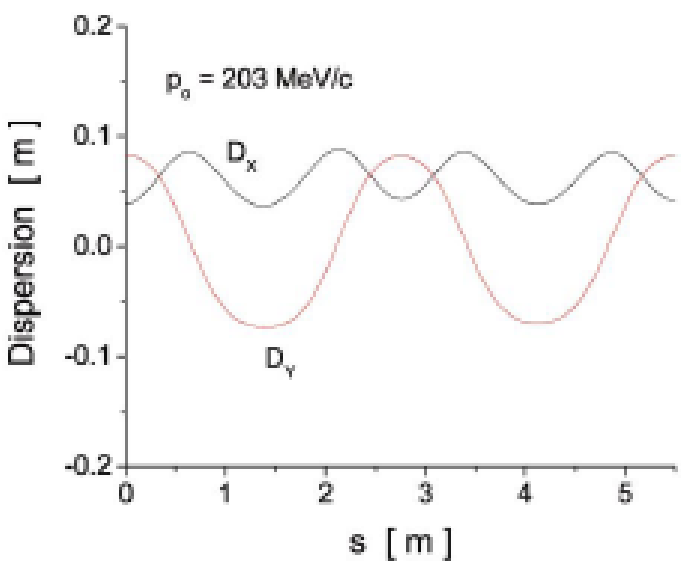
RFOFO ring

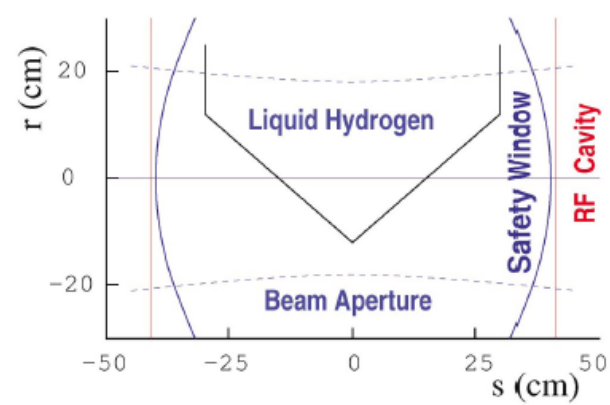
- channel based on turning RFOFO ring into helix
- focusing using alternating solenoid lattice
- bending from tipping the solenoids
- used 201 MHz, 12 MV/m
- wedge-shaped LH_2 absorbers





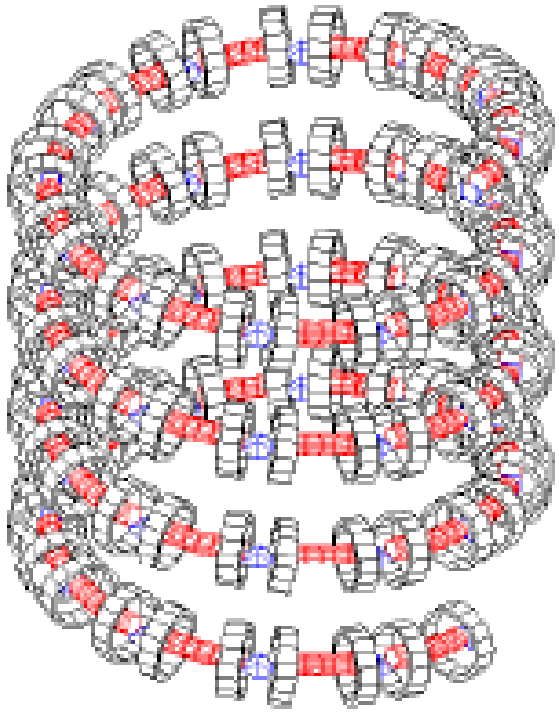
Coils outside RF





Guggenheim layout

- advantages over ring configuration
  - no restriction on bunch train length
  - no injection or extraction
  - tapering is possible
  - relieves heat load on absorber
- disadvantages
  - more hardware needed ($)
  - may need magnetic shielding

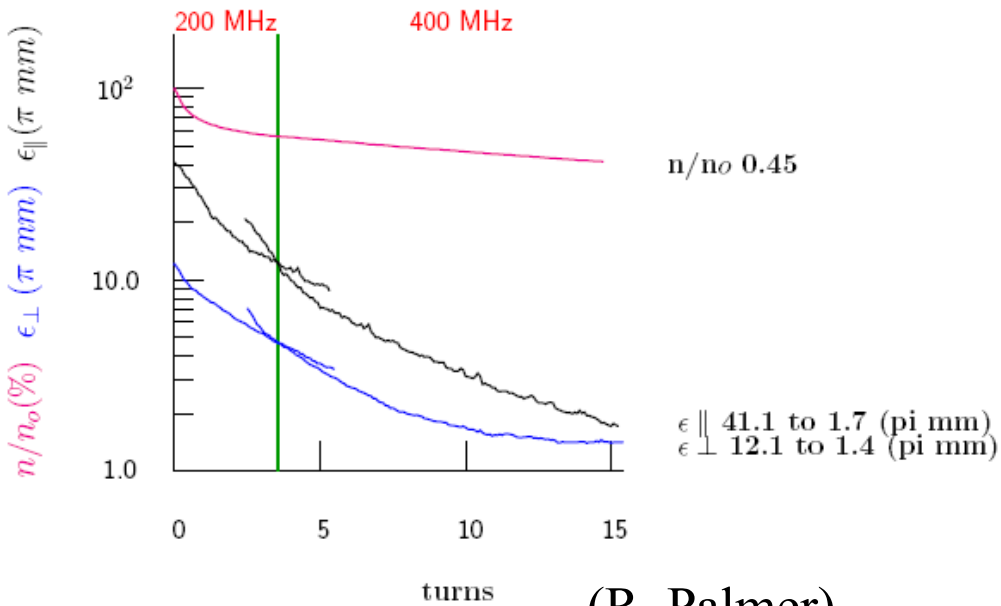


Reference 201 MHz simulation

- reference simulations used to estimate cooling performance
- used twice in the scenario
- could be same channel with different initial beam conditions (?)
- simulation used same parameters as the RFOFO ring

  C=33 m, B_S=3 T, G=12 MV/m, $\beta_\perp$= 40 cm

Before merge

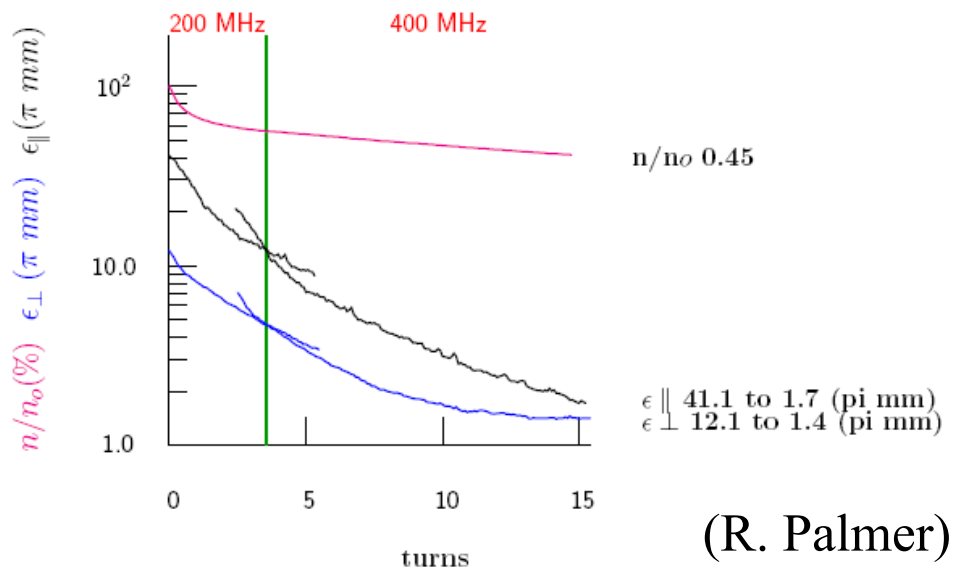


(R. Palmer)

Reference 402 MHz simulation

- also used twice in the scenario
- could be same channel with different initial beam conditions (?)
- scaled dimensions of 201 MHz ring by ½

  C=17 m, B_S=6 T, G=14 MV/m?, $\beta_\perp$= 20 cm
- assumed smooth transition from 201 → 402 channels

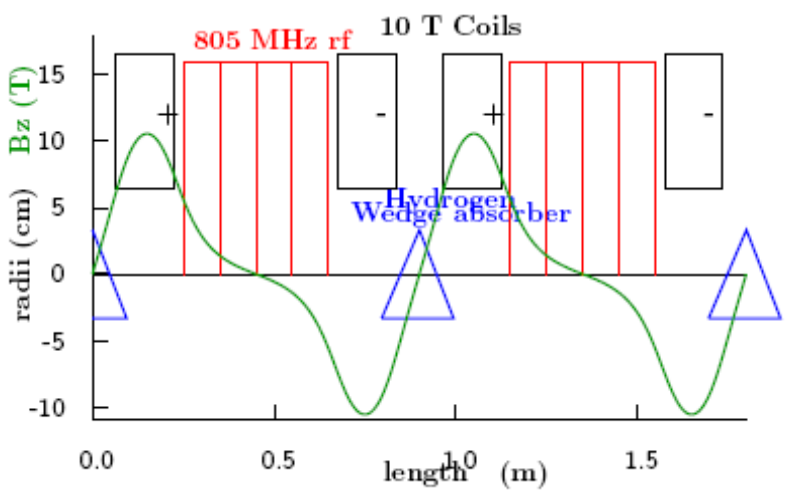


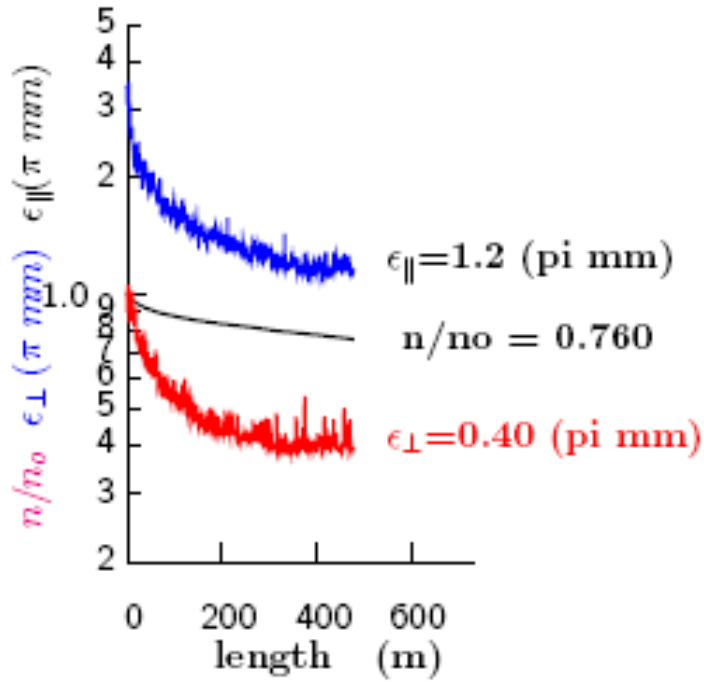
(R. Palmer)

Reference 805 MHz simulation

- had to design modified lattice ("1/3 scale")
- coils moved closer to axis

$$C=11\text{ m},\ B_S=10\text{ T},\ G=16\text{ MV/m},\ \beta_\perp=5\text{ cm}$$





(R. Palmer)

Muon survival

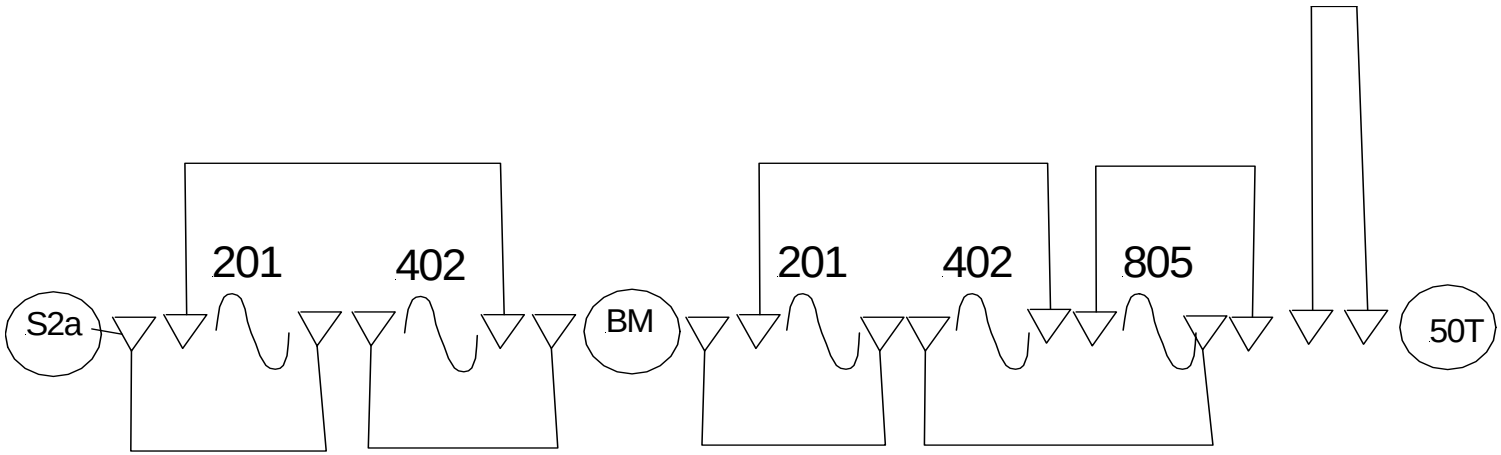
	Transmission	Cumulative
21 vs 54 bunches	.7	.7
Pre-merge RFOFO cooling	$\approx$ .5	.35
Merging	0.8	0.28
Post-merge RFOFO cooling	$\approx$ 0.5	0.14
Final 50 T solenoid cooling	.7	0.1
Acceleration to 2 TeV	0.7	0.07

(R. Palmer)

- guggenheim channels must have total Tr $\geq$ 25%
- in 5-channel scenario → Tr$\geq$76% for each channel including decays
- 1/e decay length ~1.89 x 659 m ~ 1250 m
- channels with Tr~76% have <u>not</u> been demonstrated yet including windows

Can we use same channel for both signs?

- we have to handle both signs of μ
- injection at opposite ends of the channel is theoretically possible

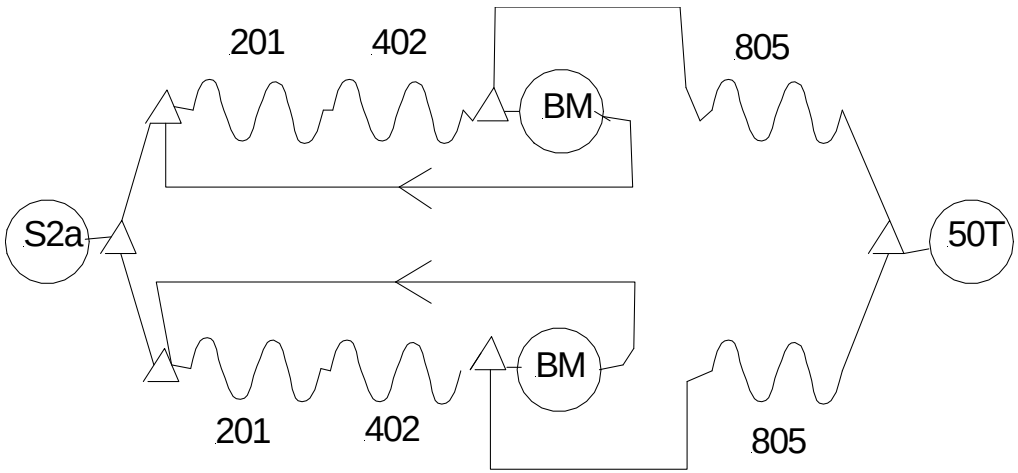


- we think <u>tapering is essential</u>, but not possible with this topology

=> each charge needs to go thru a separate guggenheim channel

Can we reuse the 201 & 402 channels?

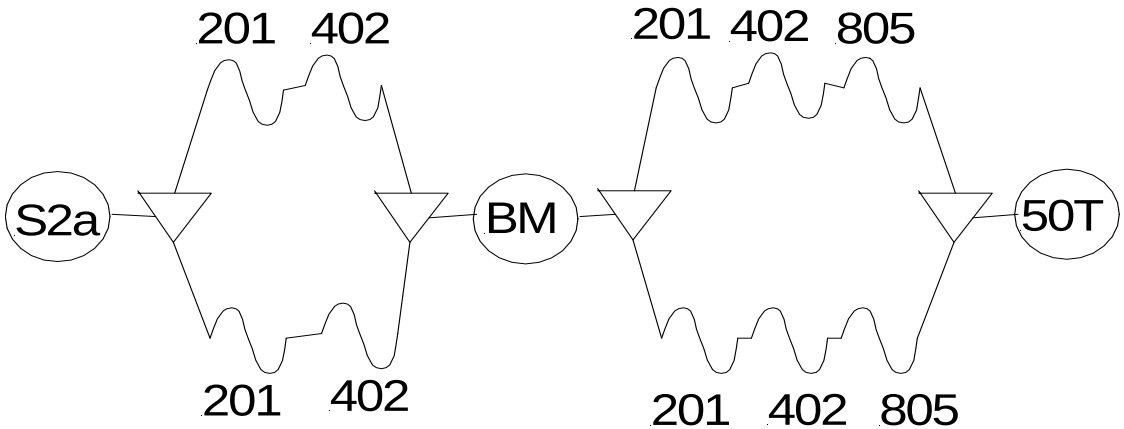
- still trying to save some money

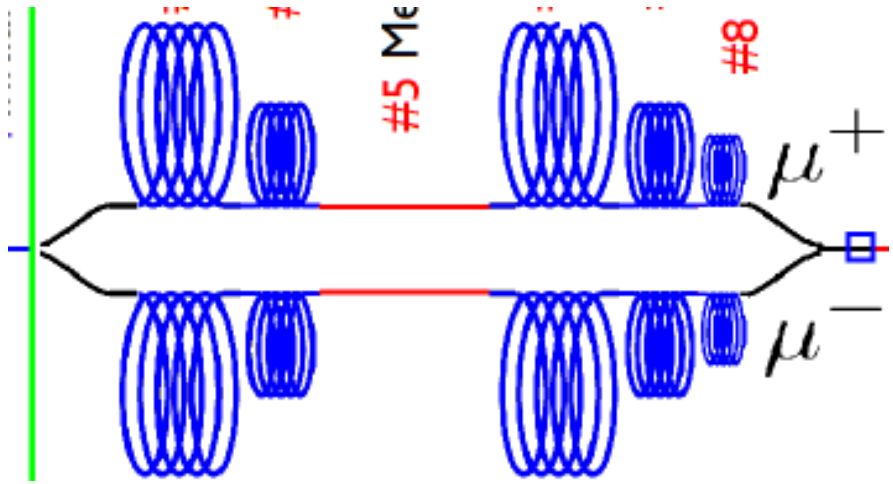


- needs 6 switchyards (2 time-dependent), 4 long transfer lines
- 201 & 402 tapering not optimal, 805 is OK
- complicated layout, but may be possible

More practical layouts

- separate guggenheim channels, but use the same bunch merging for both signs



Needs 2 extra switchyards

- if not, then we're left with