
# Achievements and challenges

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Telluride

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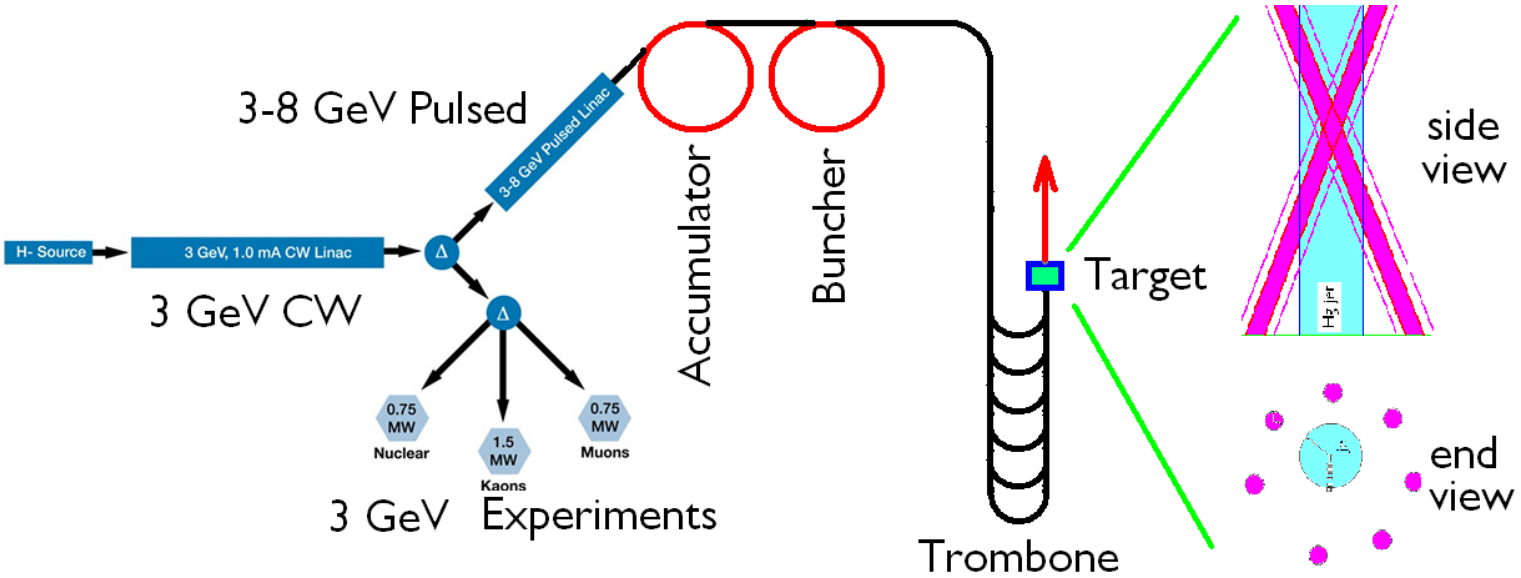
## There are several punishments for making progress:

- You find new challenges
- You need to turn to new experts
- You need to expand the collaboration

- And trust that the new Director will be appointed and the needed funding will be found

- Let me go through some of our successes and challenges

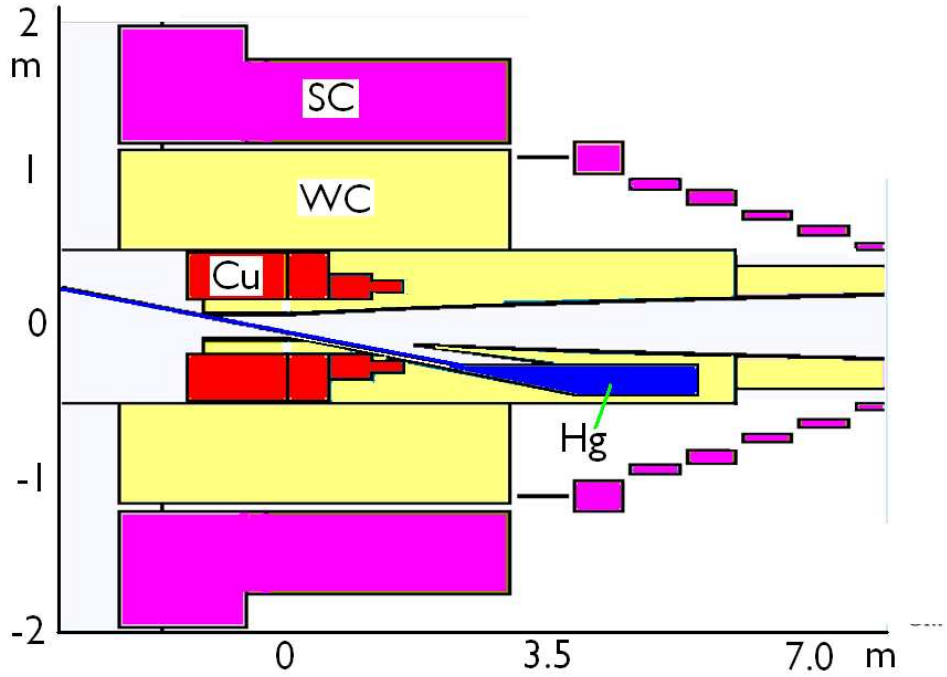
# 1) Proton Driver and target




- Achieved: a plausible Project X upgrade for MC
- But now the hard part, including:
  - Kicker system for Ankenbrandt's trombone
  - Target area design to allow multiple beams
  - And lots of details

# 2) Target and Capture

- Achieved:
  - A design with shielding for a 4MW Hg target




- Task: Simulate extrapolation from MERIT to MC parameters
  - 200 Tp at 8 GeV vs 30 Tp at 24 GeV in MERIT
  - Will Hg boiling be cause higher velocity splash ?
  - We are dependent on simulation
  - Should we consider Pb/Bi ?

# 3) 6D cooling lattices

Before down-selecting, we need, for each:

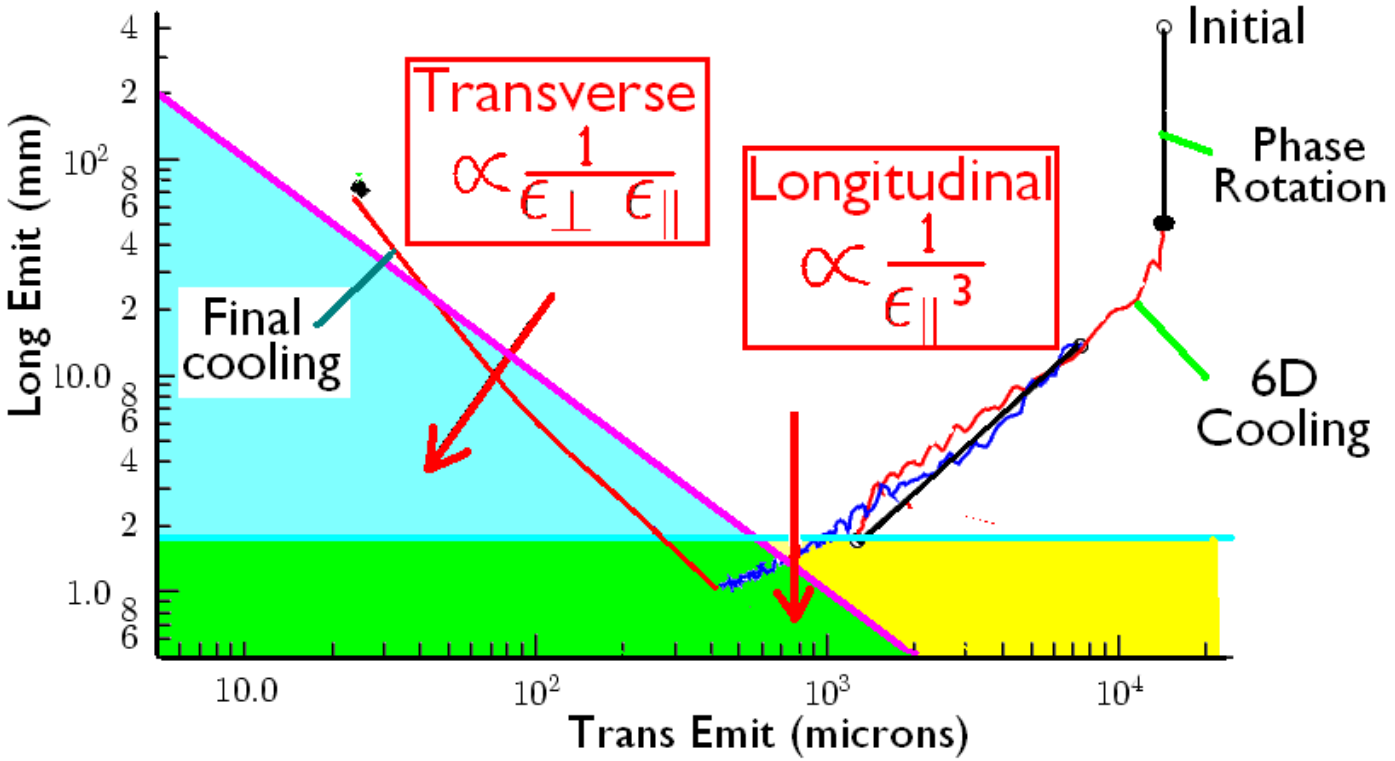
- Design of tapered systems
- Define coil parameters for all stages
  - especially the last one
    (as RoI emphasized)

- Simulations should
  - use input from Neuffer, or Snake
  - use fields from coils (Not ideal fields)
    (remember Balbakov for RFOFO)
- Integrate rf, especially for last stage

And the same goes for any final cooling scheme

# Space charge and wake field questions

A gift of thinking one is almost done




- Transverse space charge reduced by stronger focus
- Longitudinal space charge reduced by stronger rf
- Most serious is longitudinal SC at end of 6D
- raising frequency is best fix, but increases loading &wakes
- Simulations started with U Maryland (& LBNL ?)

## Collimation

Obviously needed, but little discussed

- Reduces detector background
- Increases luminosity/neutrino radiation

- Best done at low energies
  and then done again and again

## Acceleration

- Transmission, transmission, transmission
- & Dilutions, dilutions, dilutions
- & Efficiency, efficiency, efficiency

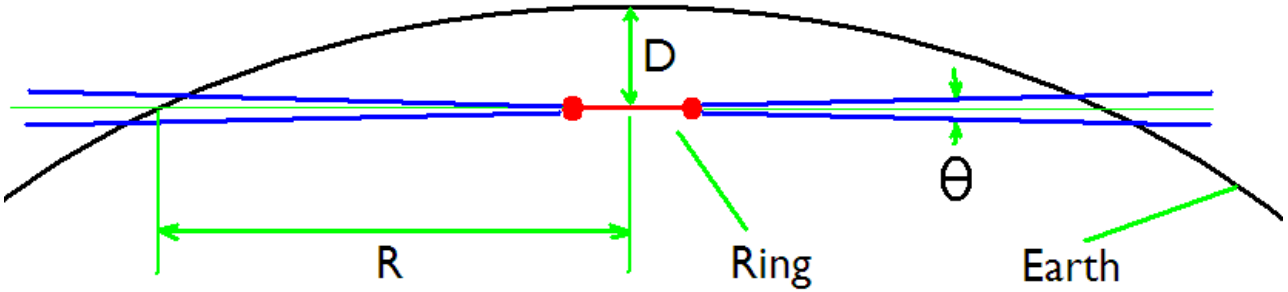
## Ring design

- Congratulations Yuri and Eliana for getting 5 mm $\beta^*$ at 3 TeV
- How about using triplets for 1.5 TeV ?
- Explore with MDI having small quads inside the cones

## Ring Dipoles

- Congratulations Nikolai on 4 deg heat leak down 45% $\rightarrow$ 5%
- But we need 1 %
- The two options seem to be
  1. shorten (to 3 m) magnets and collimate between them
  2. Use long magnets with continuous tungsten beam pipe

# Neutrino radiation



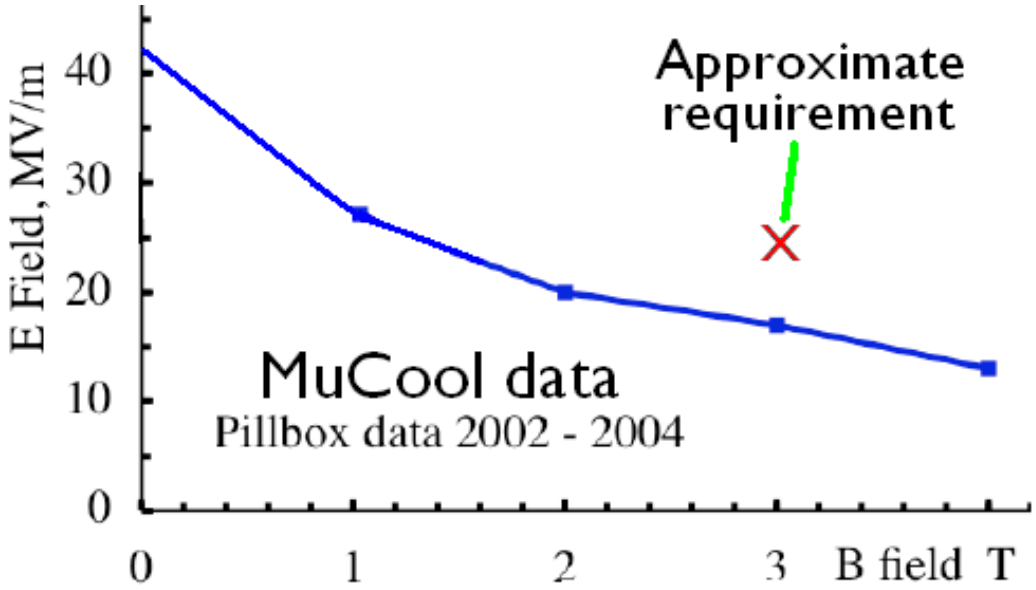

First, we have to know to what radiation limit should be design ?

For 10% of Federal limit, 3 TeV & 125 m deep
Maximum straights = 28 cm !

- Incorporate mitigation in ring designs
- Study FNAL geology for deeper locations
- Collimate at 1.1 sigma: 89% of lum., radiation/luminosity = 0.61
- Extract at 1.1 tau: 89% of lum., radiation/luminosity = 0.79

# Technical challenge: rf breakdown in magnetic fields

Vacuum rf needed for final cooling whether 40T, Li lenses or PIC/REMX. Even if gas is used for 6D




- Theory and simulations of effect
- Fixes under study:
  - Magnetic Insulation Tried but not sufficient
  - High pressure gas Works, but not yet with beam & not for Final
  - Beryllium surfaces Some evidence, but definitive tests soon

Some safety concerns with Be but with high pressure hydrogen too

# Compare with CLIC

| | $\mu^+\mu^-$ | $\mu^+\mu^-$ | | $e^+e^-$CLIC |
|---|---|---|---|---|
| C of m Energy | 1.5 | 3 | TeV | 3 |
| Luminosity | 1 | 4 | $10^{34}$ cm$^2$sec$^{-1}$ | $2^{(1)}$ |
| Ring <bending field> | 6 | 8.4 | T | - |
| Accelerator circ./length | 6 | 12 | km | 48 |
| rms bunch height | 6 | 4 | $\mu$m | 0.001 |
| Proton Driver power | 4. | 3.2 | MW | - |
| Lepton power | 7 | 11 | MW | 28 |
| Wall power | $\approx$147 | $\approx$159 | MW | 560 |

- 3 TeV luminosity comparable or above CLIC's (for dE/E $<$ 1%)
- 3 TeV accelerator is much smaller than CLIC's
- Spot sizes and tolerances much larger than CLIC's
- 3 TeV Wall power $\approx$ 1/3 CLIC's
  because lepton power $\approx$ 1/3 it is not magic

# Conclusion 1

- Much progress in simulations
  - capture magnet, phase rotation, charge sep. & merge, 6D cooling, acceleration, tungsten shield pipe, Detector background
- Estimated Performance
  - 3 TeV Luminosity 2 times CLIC's
  - Wall power $\approx 1/3$ of CLIC
- MERIT liquid mercury target experiment
  - requirements for Neutrino factory established
  - extrapolation to 20 T suggests Collider requirements also ok (see above)
- HTS testing at FNAL
- HTS testing at BNL

## Conclusion 2

- Muon Test area
  - magnetic insulation tested
  - all Seasons cavity tested
  - beam to test location
  - Be button test after beam tests
- MICE
  - target problem fixed
  - beam line commissioned
- Yes, we have magnet procurement problems for MICE
- Yes, rf breakdown in magnetic fields is a challenge
- Yes, space charge and rf loading must be included in the design
- Yes, neutrino radiation cannot be forgotten, even at 1.5 TeV

But, as Mike says: "if it were easy, it would already be done"
and we would not be having fun

# Thank you Mike

# Thank you steve