# International Design Study
# Front End

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# Front End Workplan (draft)

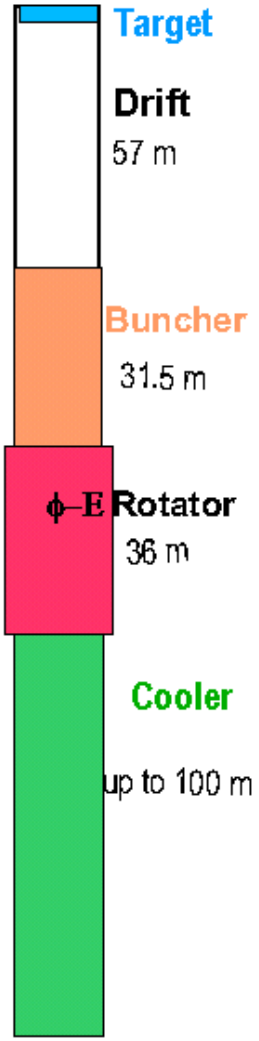
| EUROnu Milestone | Month* |
|---|---|
| Evaluation of baseline front-end | 15 |
| Evaluation of performance of alternative cooling and acceleration | 24 |
| Benchmark costing for muon front-end (and acceleration) | 30 |
| Cost and performance evaluation complete | 40 |
| Comparison of physics performance of all facilities | 43 |

*Month from 1st Sept 2008 - April is month 8

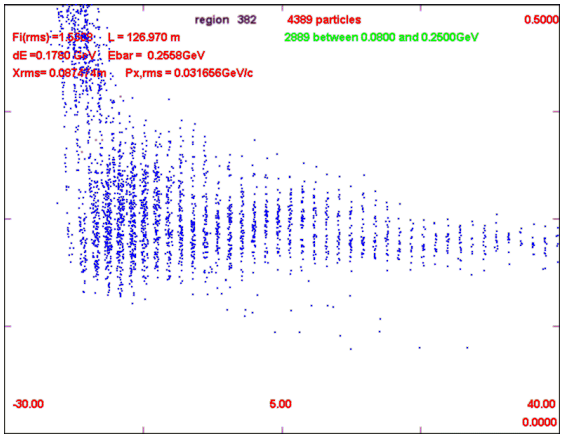
- Bearing in mind the Neutrino Factory International Design Study
  - Interim Design Report (IDR) 2010
    - Re-baseline front end if necessary
    - Preliminary engineering work (~50% accuracy costing)
  - Reference Design Report (RDR) 2012
- In this talk I will discuss front end progress in the scope of the IDS
  - Evidence for RF problem
  - Lattice redesign efforts in the light of this issue
  - Other optimisations

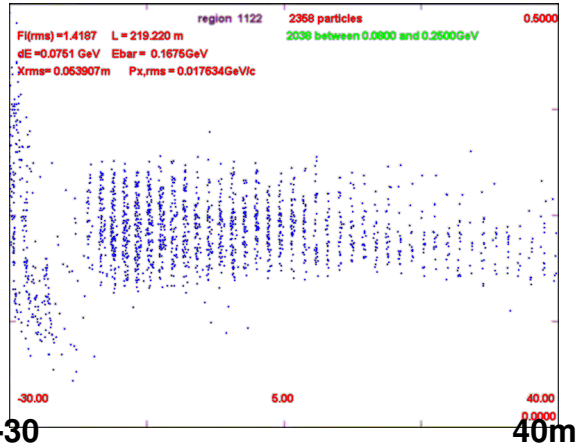
# IDS - Shorter Version

- **Reduce drift, buncher, rotator to get shorter bunch train:**
  - **217m ⇒ 125m**
  - **57m drift, 31m buncher, 36m rotator**
  - **Rf voltages up to 15MV/m (×2/3)**
- Obtains **~0.26 μ/p$_{24}$** in ref. acceptance
  - **Similar or better than Study 2B baseline**
- **Better for Muon Collider**
  - **80+ m bunchtrain reduced to < 50m**
  - **▲n: 18 -> 10**




500MeV/c

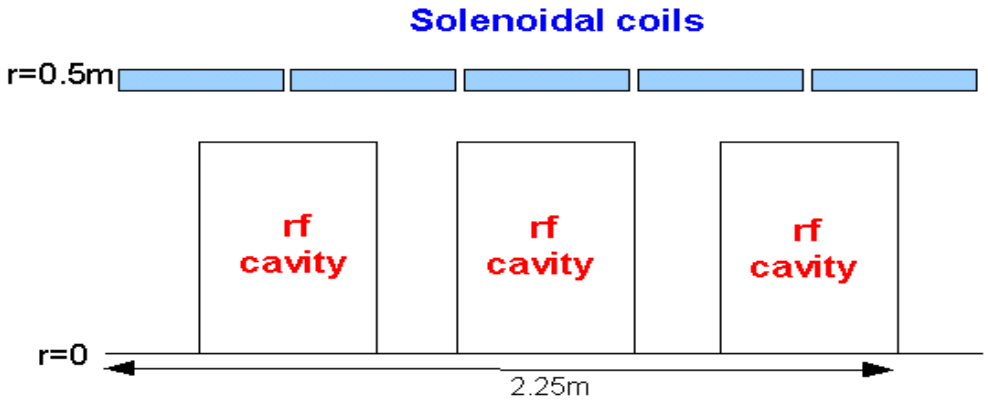


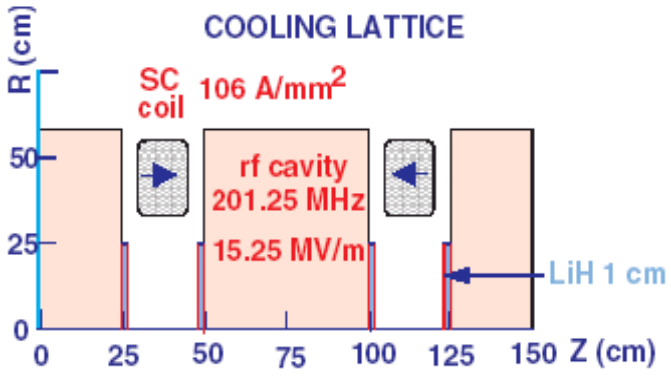

-30 40m

# Shorter Buncher-Rotator settings

- **Buncher and Rotator have rf within ~2T fields**
  - rf cavity/drift spacing same throughout (0.5m, 0.25)
  - rf gradient goes from 0 to 15 MV/m in buncher cavities
- **Cooling same as baseline**
  - ASOL lattice
  - 1 cm LiH slabs (3.6MeV/cell)
  - ~15MV/m cavities
  - **also considered $H_2$ cooling**
- Simulated in G4Beamline
  - **optimized to reduce # of frequencies**
- Has 20% higher gradient

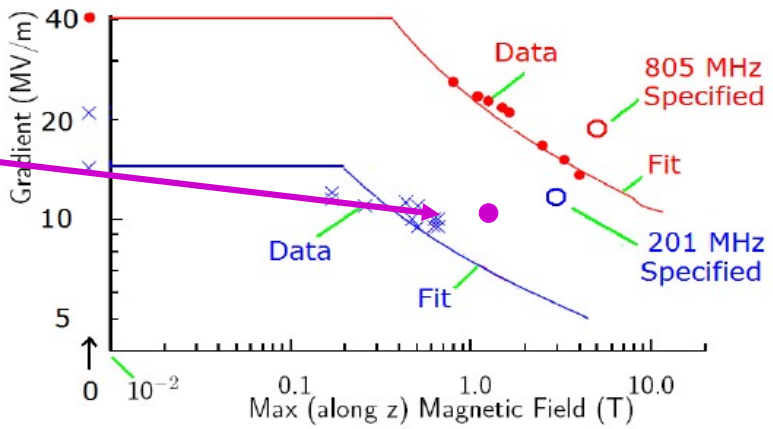


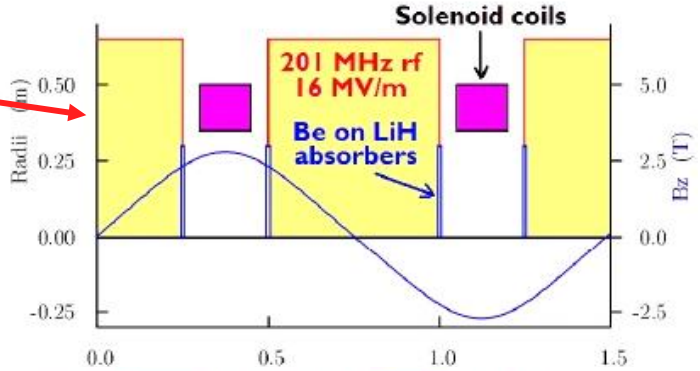

**ASOL lattice**

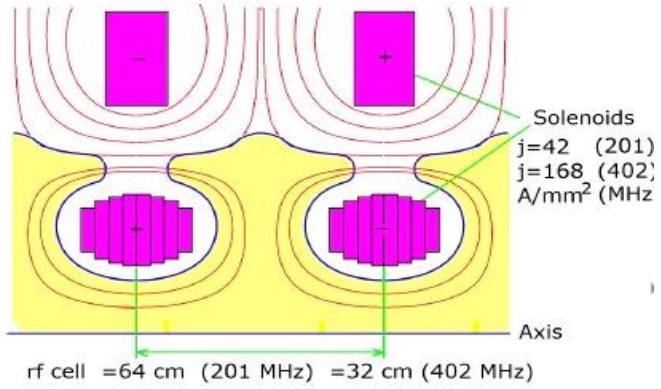


# Solutions to possible rf cavity limitations

- **For IDS, we need an rf cavity + lattice that can work**
- **Potential strategies:**
- **Use lower fields (V', B)**
- **Use non-B = constant lattices**
  - alternating solenoid
- **Magnetically insulated cavities**
  - Is it really better ???
  - Alternating solenoid is similar to magnetically insulated lattice
- **Shielded rf lattices**
  - low B-field throughout rf
- **Use gas-filled rf cavities**
  - but electron effects?

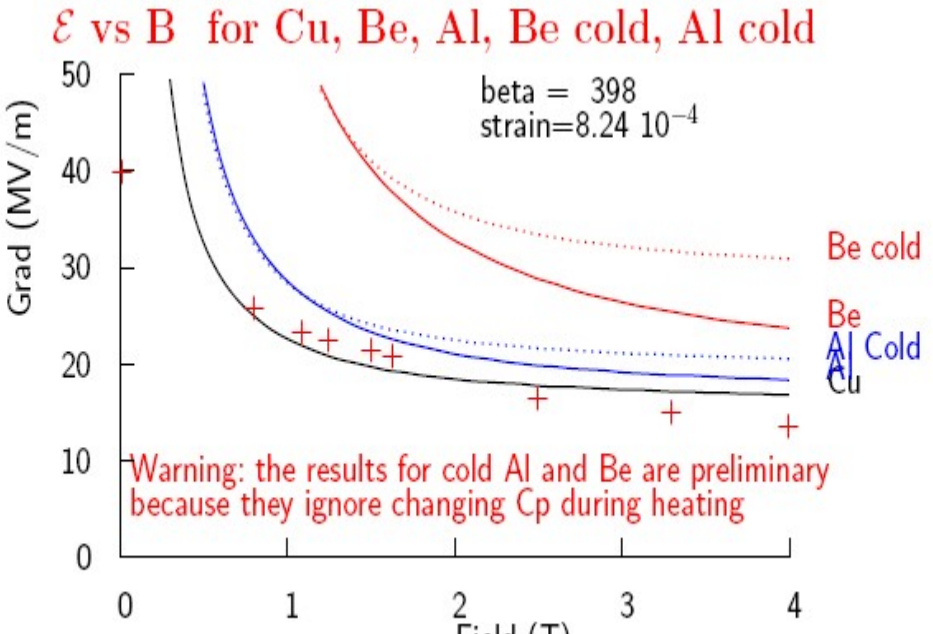


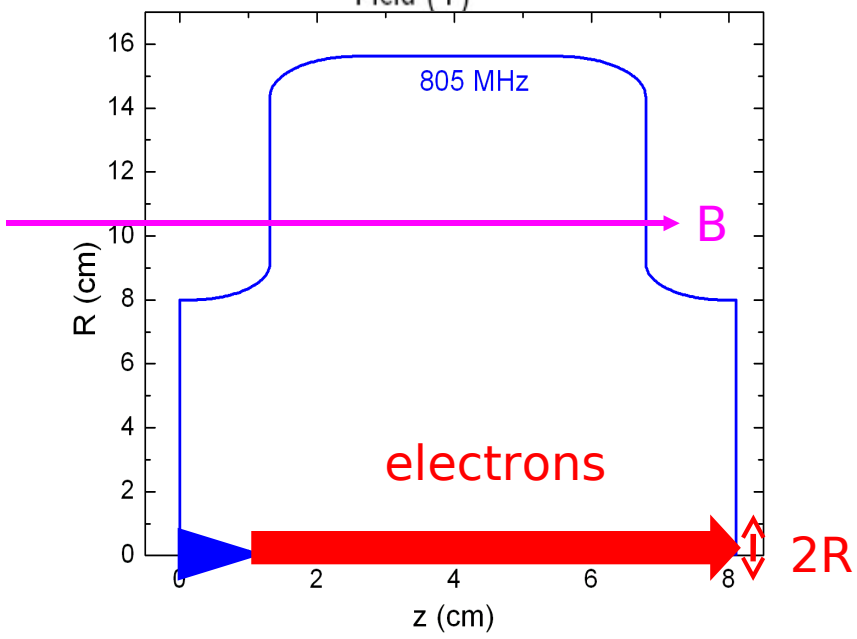



# Change cavity material-Palmer

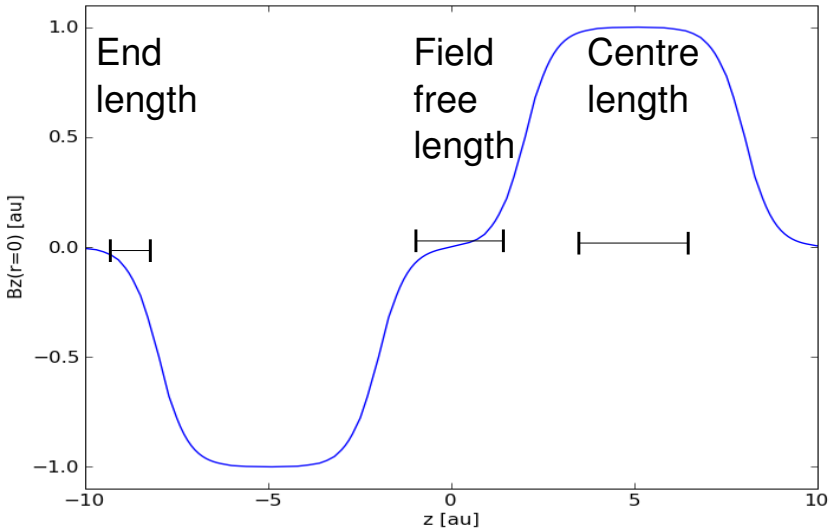
- **Be windows do not show damage at MTA**
  - no breakdown?
- **Model: Energy deposition by electrons crossing the rf cavity causes reemission on the other side**
- **less energy deposition in Be**
  - higher rf gradient threshold
- **~2× gradient possible with Be cavities ??**
  - calculated in model
  - extrapolation to 200MHz ?

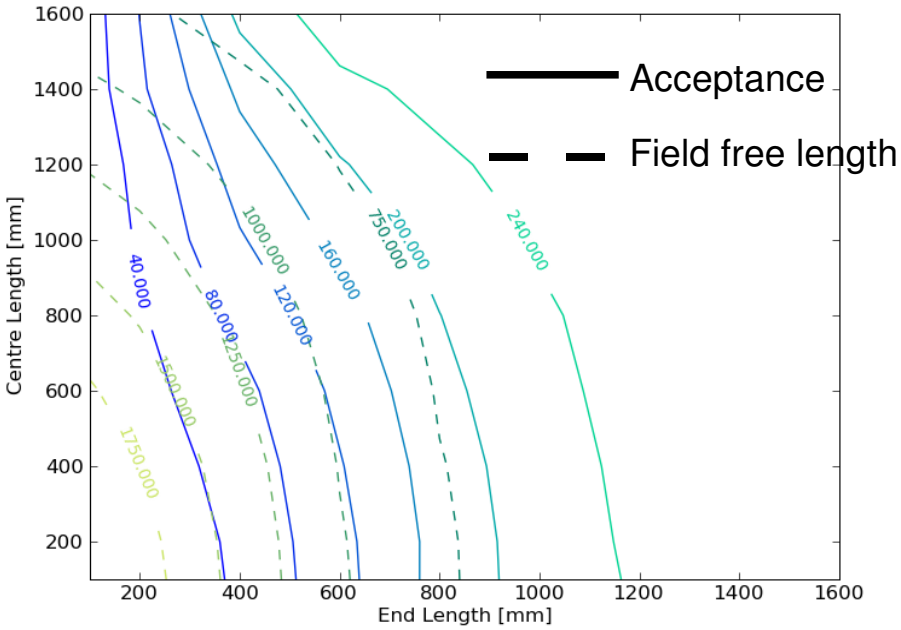


# Lower B-field on RF cavity

- **Can shield RF**
- **Acceptance limited by short end field**
  - Non-linear terms ~ $d^2B/dz^2$
- **How bad?**
  - tanh model for solenoid
  - Strong dependence of acceptance on “end length”
  - Slightly mitigated by making magnets longer
- **Working solution**
  - Talk at CERN IDS meet
  - Talk at NuFact09 WG3



# Target, CERN work

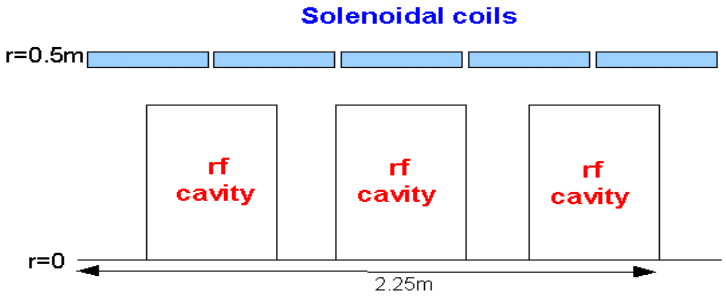
- **Target interface**
  - Target group want to use FS2 as baseline
  - Baseline front end uses FS2A fields for pion capture
  - Re-baseline front end using FS2 fields?
- **CERN work**
  - CERN is looking at 44/88 MHz scheme
  - CERN is looking at using SPL for pion target, considering HARP data
  - No conclusive results yet

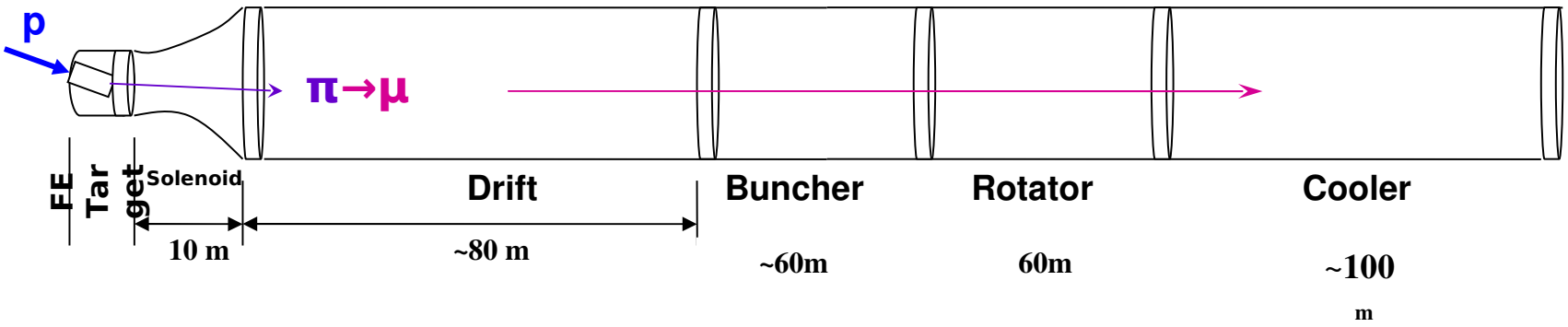
# Plan for IDS

- **Need one design likely to work for $V_{rf}$/B-field**
  - rf studies are likely to be inconclusive
- **Hold review to endorse a potential design for IDS**
  - – likely to be acceptable ($V_{rf}$/B-field)
  - April 2010 ?
- **Use reviewed design as basis for IDS engineering study**
- **Further meetings/studies**
  - NuFACT 2010
  - miniworkshop at Fermilab (July 27-29)
  - Front End Review

# "88" MHz Front end

- **Drift ~90m**
- **Buncher ~60m**
  - 166→100 MHz, 0→6MV/m
- **Rotator ~58.5m**
  - 100→86 MHz, 10.5 MV/m
- **Cooler ~100m**
  - 85.8MHz, 10 MV/m
  - 1.4cm LiH/cell ASOL



# “ 88 MHz” example

- **Performance seems very good**
- **smaller number of bunches**
  - > ~80% in best 10 bunches
- **Gradients used are not huge, but probably a bit larger than practical**
  - up to ~10 MV/m
  - ~2T magnetic fields
- **With 10 MV/m (0.75m cells) probably not free of breakdown problems**
- **redo with realistic gradients**