RAL +
Front End Studies
International Design Study

David Neuffer
FNAL

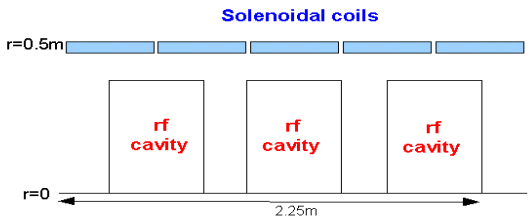
(January 5, 2009)

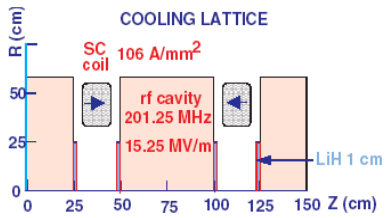
Outline

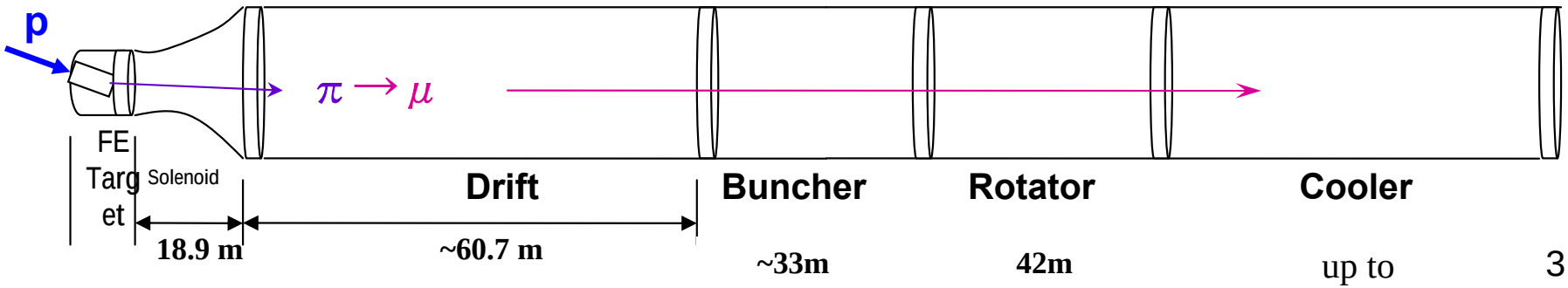
- **Front End for the Neutrino Factory/MC**
  - Concepts developed during study 2A
- **Concern on V_{rf}' as function of B_{sol}**
- **Need baseline design for IDS**
  - need baseline for engineering study
    - ~lower fields; medium bunch length

Front End ReOptimization

- **Change reference B-field to 1.5T**
  - constant B to end of rotator
- **changing to n_B ="12" example**
  - A bit longer than n_B = 10
  - optimize with lower fields
    - V'_{rf} < 12 MV/m
- **Will see if we can get "better" optimum**







Parameters of candidate release

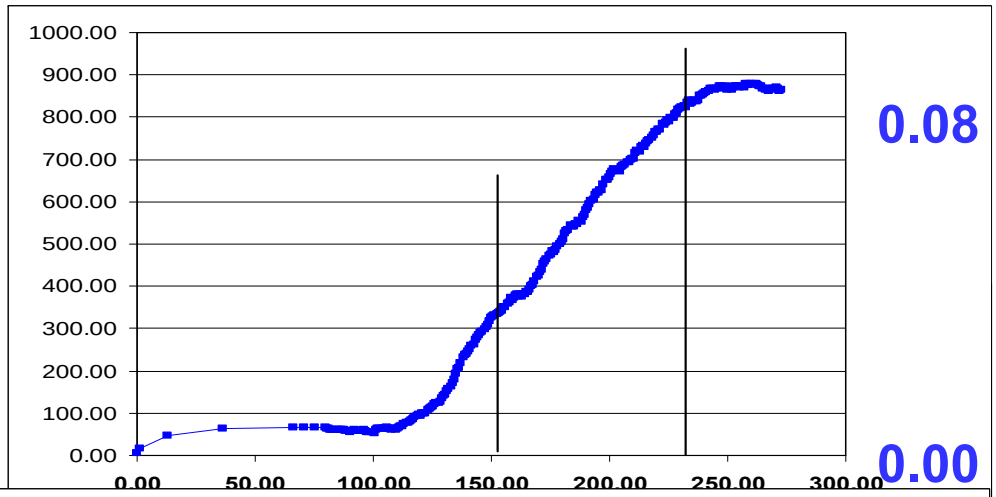
- **Initial drift from target to buncher is 79.6m**
  - 18.9m (adiabatic ~20T to ~1.5T solenoid)
  - 60.7m (1.5T solenoid)
- **Buncher rf – 33m**
  - 320 → 232 MHz
  - 0 → 9 MV/m (2/3 occupancy)
  - B=1.5T
- **Rotator rf -42m**
  - 232 → 202 MHz
  - 12 MV/m (2/3 occupancy)
  - B=1.5T
- **Cooler (50 to 90m)**
  - ASOL lattice, P_0 = 232MeV/c,
  - Baseline has 15MV/m, 2 1.1 cm LiH absorbers /cell

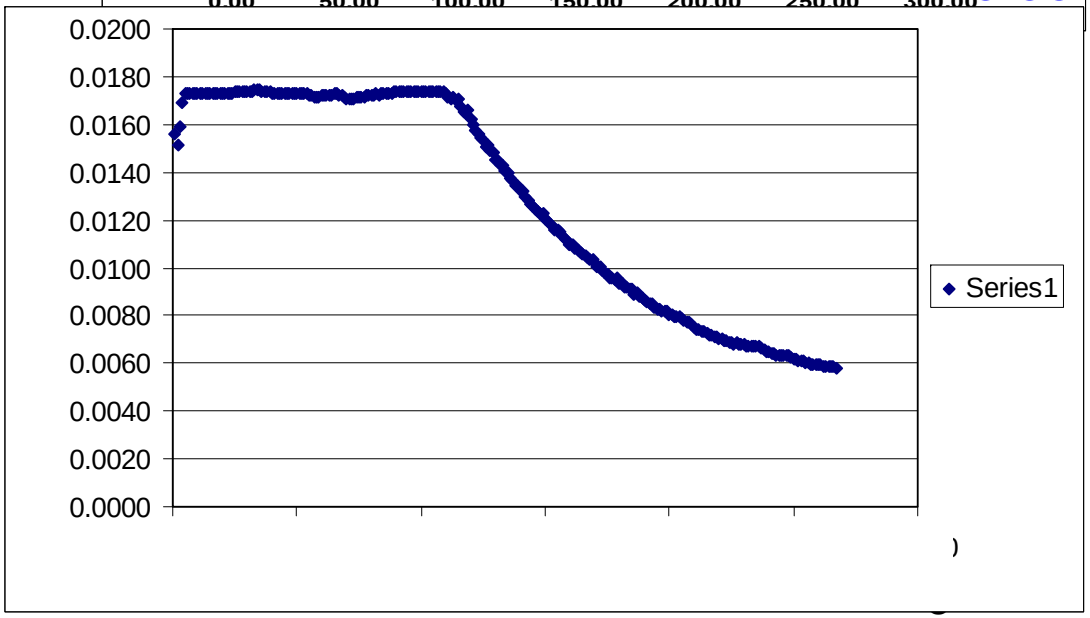
Some differences

- **Used ICOOL to set parameters**
  - ACCEL model 10,
  - Phase Model 0 –
  - zero crossing set by $t_{REFP\ 1}$
    - **refp 1 @ 233MeV/c,**
    - **2 at 154MeV/c, 10 λ**

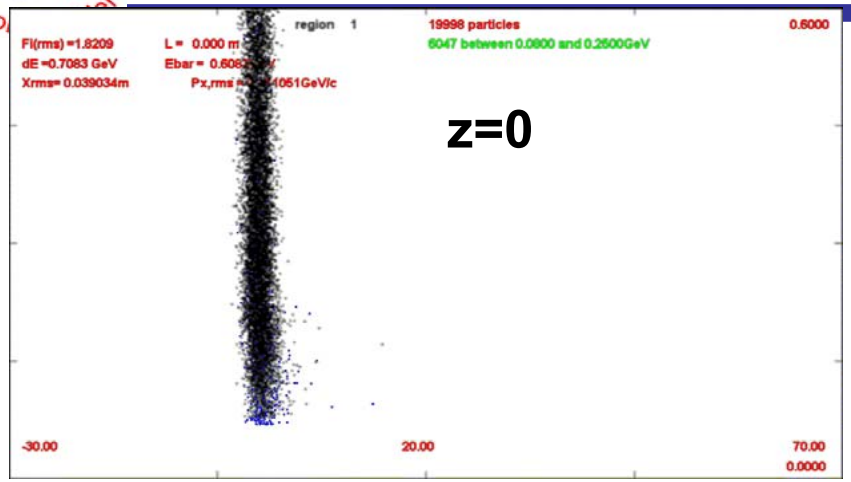
- **Cool at 232 MeV/c**
  - ~10% higher momentum
  - absorbers ~10% longer
  - Cools transverse emittance from 0.017 to 0.006m

μ/8 GeV p

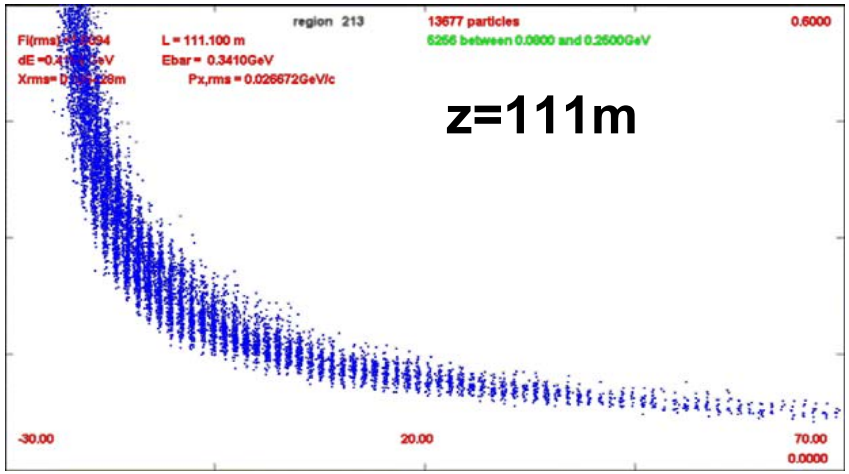




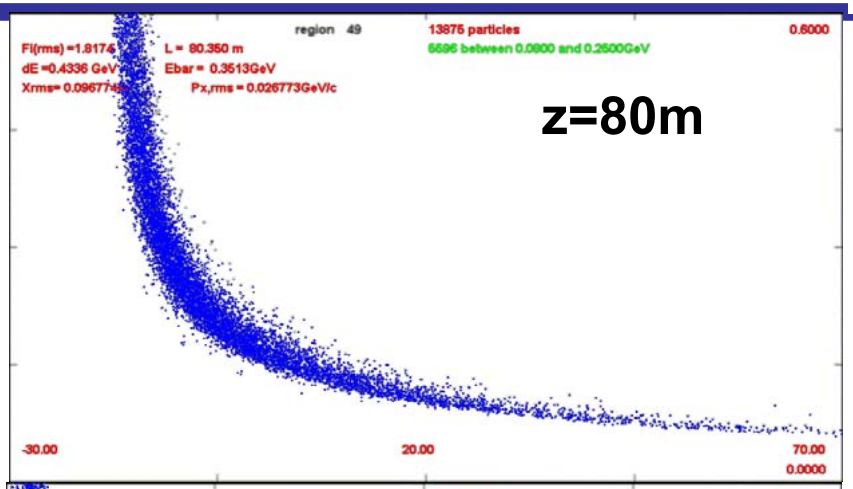
Beam Through System



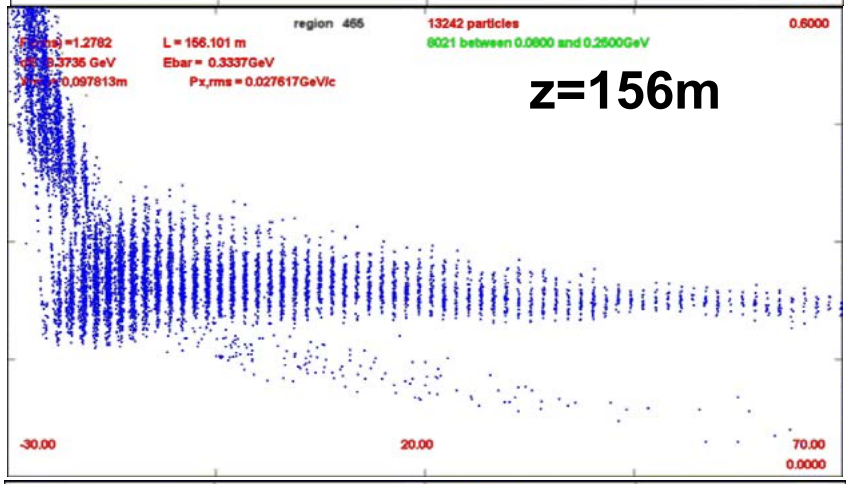
z=0



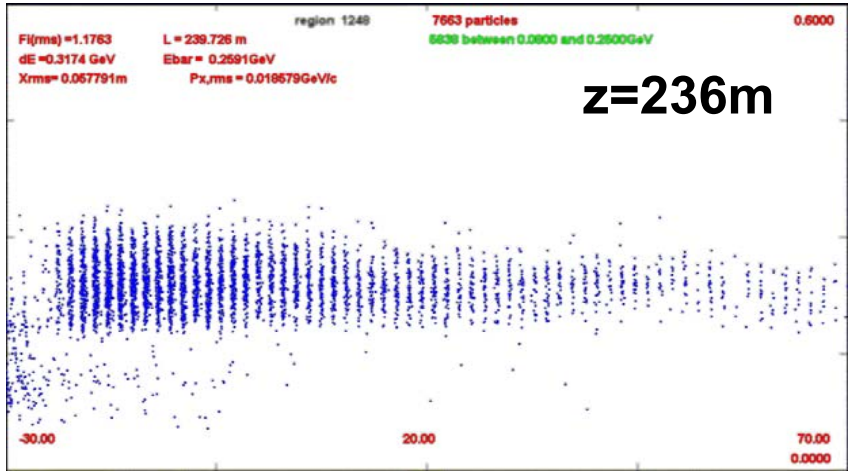
z=111m



z=80m



z=156m



z=236m

Varying Buncher/Rotator Voltage

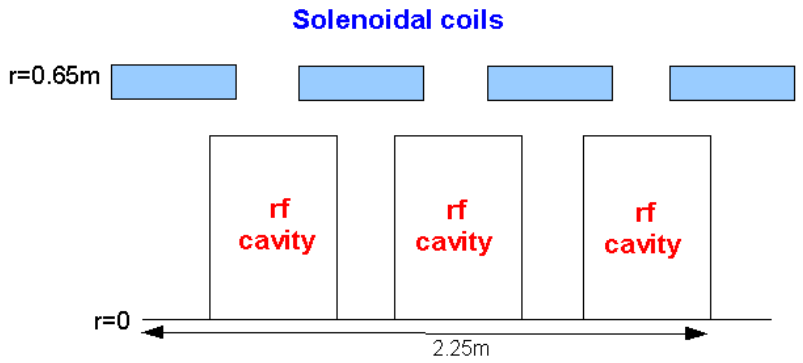
- **Vary buncher/rotator gradients from baseline to explore sensitivity to gradient limits.**
  - same baseline cooling channel (16MV/m, 1.15cm LiH)
    - 15 MV/m -> 1.1cm Li H

- **Somewhat less sensitive than previous cases**

Buncher / Rotator	0/0	3/6	4/7	5/8	6/9	7/10	8/11	9/12	10/13	11/14
μ/8GeVp at 240m (×10)	.136	.508	.686	.753	.797	.800	.831	.857	.821	.839

More realistic model

- For buncher & rotator replace B=1.5T with "realistic" solenoid coils
  - (B ~1.5T)
  - 0.5 m long, 0.25m spacing
  - ~OK for rf feed in between



- ICOOL simulation shows no change in performance
  - (<~1%)

Recent Studies

- **From Juan G.'s studies**
  - 8GeV 20T beam from H. Kirk
  - Also 8GeV 30T beam

- **New H. Kirk initial beam**
  - 20 T, 8 GeV beam, Hg target
  - from more recent MARS (?)-
  - (subtract 2.9ns to get mean of 0)
  - more π/8GeV p (~10%)

- **Tried 30T initial beam**
  - scaled 20 to 1.5T to 30 to 2.25 to 1.5T
  - ~20 to 25% more than with 20T
  -

Case	μ/p @ z=245m	
old CY init beam	0.083	
new 20T HK beam	0.090	
new 30T HK (25cm)	0.107	
new 30T HK (30cm)	0.113	

rf requirements

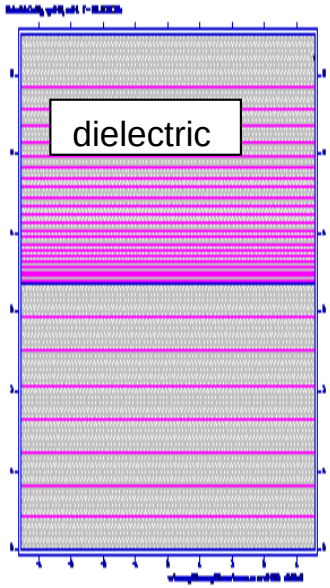
- **Buncher**
  - 319.63, 305.56, 293.93,285.46, 278.59, 272.05, 265.80, 259.83, 254.13, 248.67, 243.44, 238.42, 233.61 (13 f)
  - ~100MV total
- **Rotator**
  - 230.19, 226.13, 222.59, 219.48, 216.76, 214.37,212.28, 210.46,208.64, 206.90, 205.49,204.25, 203.26, 202.63,202.33 (15 f)
  - 336MV total
- **Cooler**
  - 201.25MHz –up to 75m ~750MV

Buncher rf cavity requirements

RF frequency	Total voltage	cavities	Gradient	Peak rf power
319.63	1.368	1 (0.4m)	4 MV/m	
305.56	3.915	2 (0.4m)	5MV/m	
293.93	3.336	2 (0.45m)	4 MV/m	
285.46	4.803	2 (0.45m)	5.5MV/m	
278.59	5.724	2 (0.45m)	6.4 MV/m	
272.05	6.664	3 (0.45m)	5MV/m	
265.80	7.565	3 (0.45m)	5.7MV/m	
259.83	8.484	3 (0.45m)	6.5MV/m	
254.13	9.405	3 (0.45m)	7MV/m	
248.67	10.326	4 (0.45m)	6MV/m	
243.44	11.225	4(0.45m)	6.5MV/m	
238.42	12.16	4 (0.45m)	7MV/m	
233.61	13.11	4 (0.45m)	7.5MV/m	
	98.085			

Plans etc.

- **Move toward "realistic" configuration**
  - add Be windows



- **Set up design for cost algorithm**
  - rf cavity design (pillbox, dielectric)
  - rf power requirements
  - Magnet design

- **Continuing front end IDS design study**
    - C. Rogers, G. Prior, D. Neuffer, C. Yoshikawa, K. Yonehara, Y. Alexahin, M. Popovic, Y. Torun, S. Brooks, S. Berg, J. Gallardo …
  - ~Biweekly phone Conference
  - Cost meeting at CERN March
  - April at Fermilab (IDS meeting)