Acceleration Status
ν Factory μ Collider Collaboration Meeting

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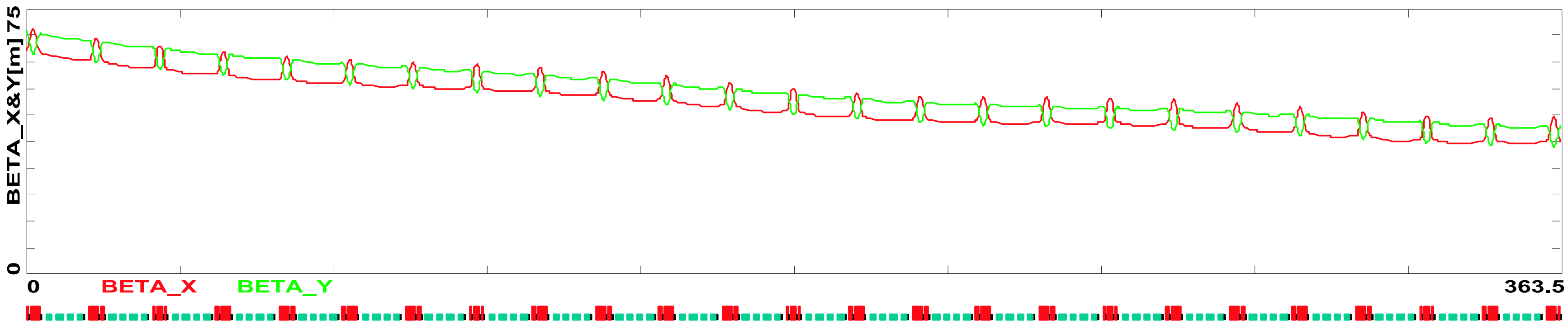
People

- Recirculating linacs: Alex Bogacz
- Synchrotrons: Al Garren, Bob Palmer, Don Summers
- Non-scaling FFAGs: Scott Berg, Carol Johnstone, Eberhard Keil, Shane Koscielniak, Bob Palmer, Andy Sessler, Dejan Trbojevic
- RF Cavity research: P. Barnes, S. Calatroni, E. Chiaveri, R. Geng, Don Hartill, Steve Kahn, R. Losito, Hasan Padamsee, H. Preis, J. Sears
- Scaling FFAGs: Masamitsu Aiba, Shinji Machida, Yoshiharu Mori, Takasi Obana, C. Ohmori, Toru Ogitsu, T. Yokoi, Masahiro Yoshimoto
- European effort: Bruno Autin, Klaus Bongardt, Jean-Marie De Conto, Jie Gao, François Méot, Luigi Palumbo, Jaroslaw Paswternak, Graham Rees, Bruno Spataro, Franco Tazzioli, André Verdier

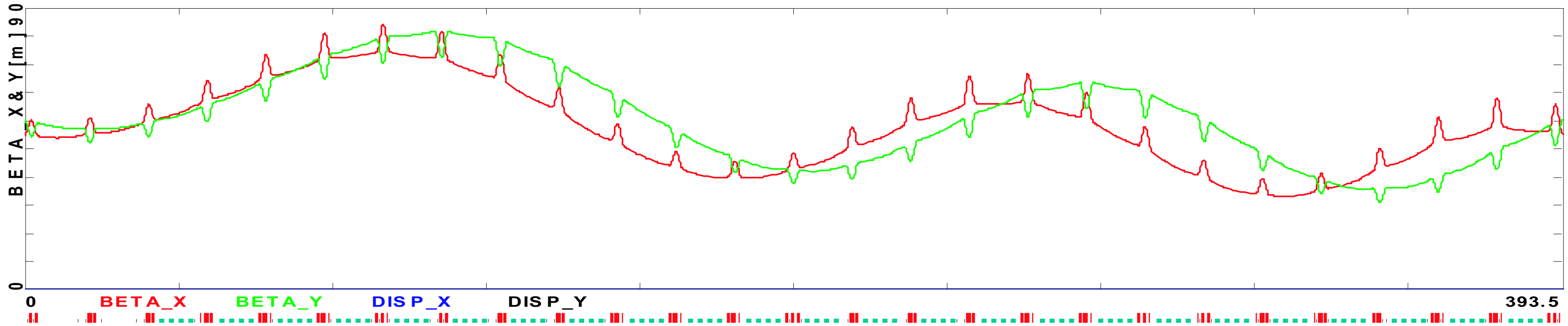
Recirculating Linac

- Improvements from Study II
- In Study II, factor of 2 emittance blow-up
- This has been eliminated
  - Linacs now have a beta-beat; this reduces the severity of matching from linac to arc
  - Improved sextupole correction scheme in arcs
- Work on design for smaller longitudinal emittance from ring cooler
- Europeans may be looking into polytrons
  - Multiple coils in single aperture

Recirculating Linacs
Final-Pass Linac Beta Functions



Original



New

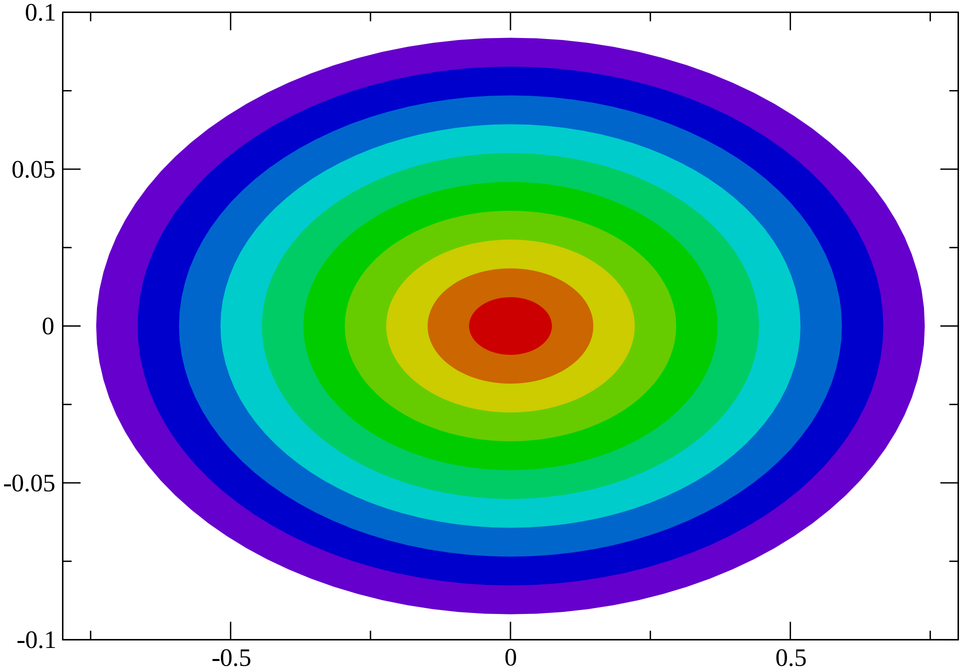
Synchrotrons

- Design work being done on fast-ramping synchrotrons
- Long 26.5 m magnets with alternating gradient combined-function focusing by changing lamination profile
- 4–20 GeV, 917 m ring, 12 turns, 37 μs
- Low acceptance (4 mm, compared to 30 mm): need more cooling
  - Stored energy increases drastically otherwise
- 4600 Hz, 18 26.5 m magnets with 110 kJ stored in each
- Power supplies: 180 @ 6 kV, 52 kA
- Grain-oriented silicon steel, thin laminations
  - Eddy current losses: 350 kW
- Eddy current losses in copper conductor: 170 kW (only 8 kW I^2R)

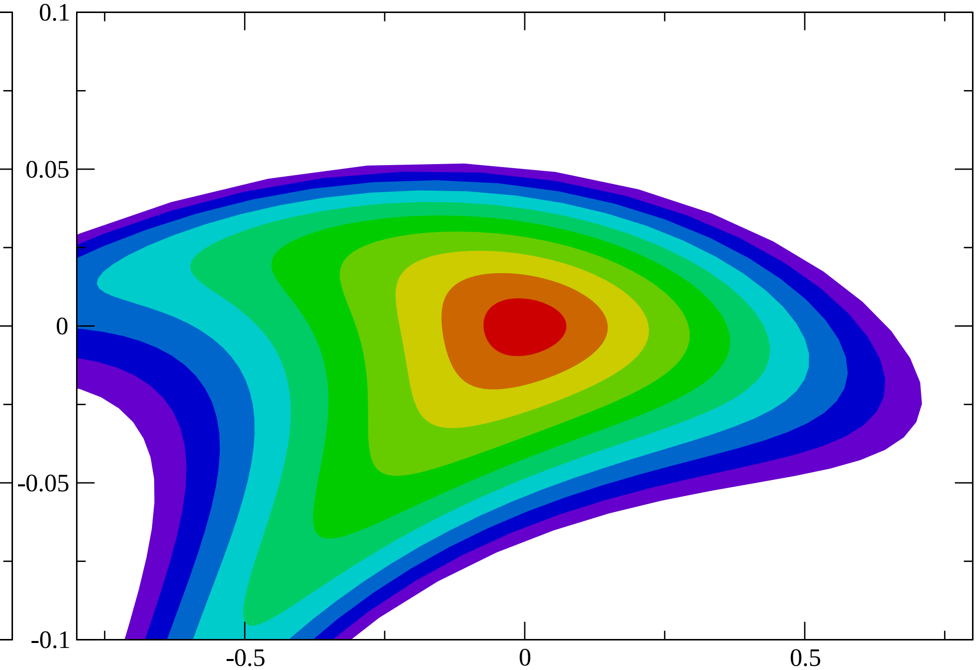
FFAGs: Non-Scaling

- Carol Johnstone did original FODO FFAG design long ago
- At FFAG workshop, others came to understanding of how to design these
  - Rapidly producing designs for cost optimization
  - RF requirements reduced with shorter cells, more cells
- Converging on triplet lattice
  - Carol suggested at FFAG workshop: only one gap per cell for RF, keeps cells short
  - Dejan's minimum emittance lattice has evolved toward these also
- Longitudinal phase space transmission limits amount of cost reduction
  - Longitudinal dynamics being studied: Berg, Koscielniak, Palmer
- Can use C-magnets for injection/extraction: lowest magnitude field at outside

Non-Scaling FFAG
Longitudinal Phase Space



Initial



Final

Cost Modeling

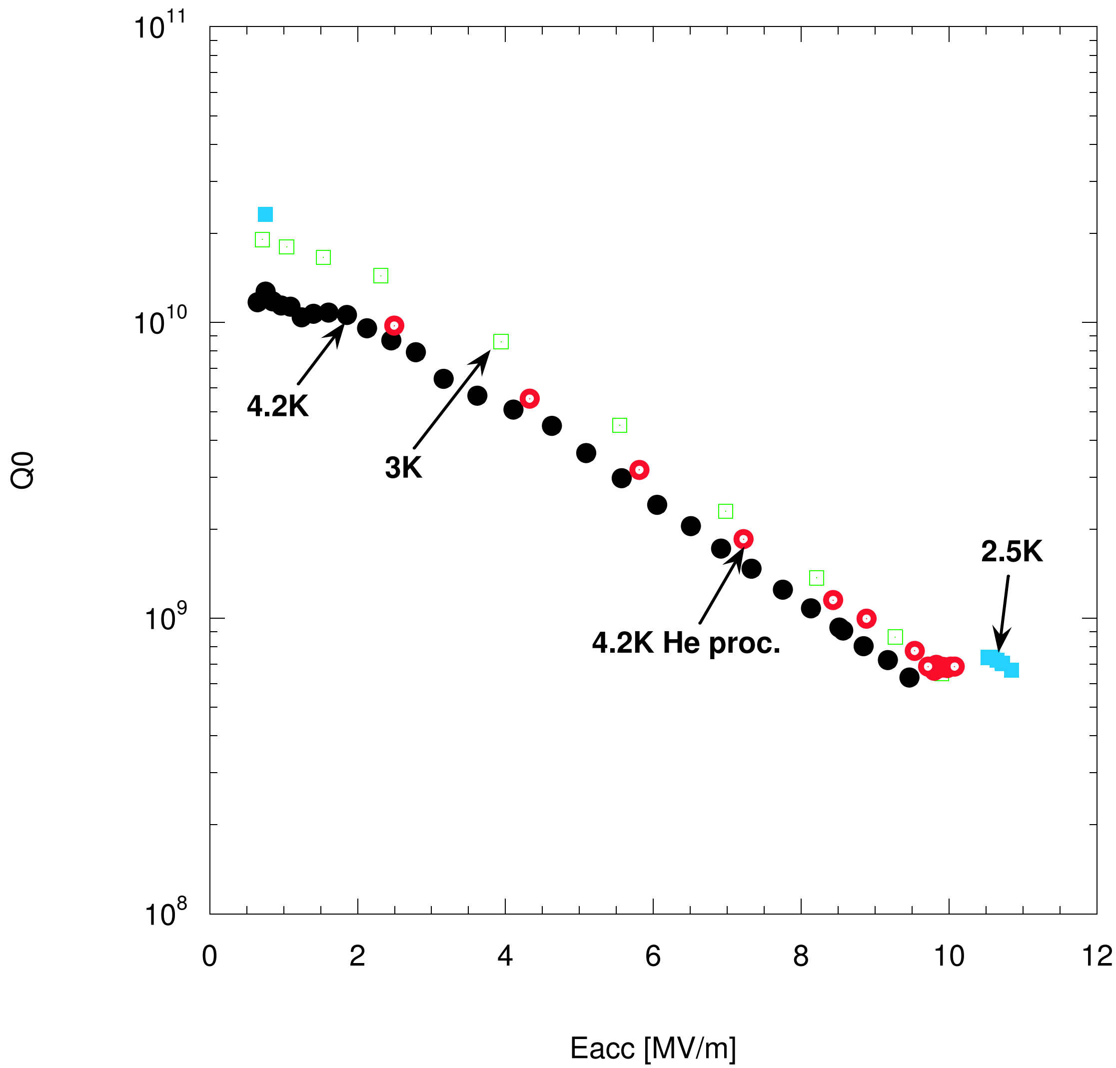
- Palmer has developed approximate cost formulas for magnets, RF
- Cost comparison between various FFAG schemes
  - Existing scaling FFAG designs are more costly than non-scaling
  - Cost per GeV much better for smaller energy range
  - Cost per GeV increases for lower energy ranges
- Racetrack may be cost effective alternative
  - Arc cells with almost no drift, RF in straights
  - Need adiabatic transitions: difficult
- Find that arc costs are sometimes reduced when ring gets longer
  - Smaller apertures and/or lower fields
- Relative results are independent of cost model
- Should give serious consideration to less cooling and larger acceleration aperture

RF Cavities

- Experiments at Cornell on 200 MHz SC RF
  - Have achieved 12 MV/m (goal: 17 MV/m)
  - Large Q-slope preventing getting to higher gradients
- Studies of gap needed between cavity and magnets
  - Keep gap as low as possible: improves performance in FFAG
  - Only need fields at 0.1 T at cavity once it is cooled
    - ⋆ 0.1 Gauss before cooled: watch residual magnetization
  - Looks like we can do this with 50 cm gap
- Room temperature cavities probably not OK for FFAGs
  - Need large stored energy due to beam loading
  - Requires very high peak power for room temperature: cost prohibitive

SCRF Testing at Cornell

- Achieved 11 MV/m
- Large Q-slope
  - Larger than predicted
  - Depends on temperature: surface characteristics
  - Nb film and Cu substrate
- Input power coupoler limits gradient



FFAGs: Scaling

- Work being done at KEK (Y. Mori *et al.*)
- Much study of 10–20 GeV ring
- At FFAG workshop, had a 200 m radius ring designed (FODO)
  - Have $\cos\theta$-like magnets designed, with slightly adjustable k
  - Using low-frequency RF (18–24 MHz), avoids buncher/phase rotation (no cooling)
  - Get 840 kW out of 150 kW tetrode due to low duty factor
- Have switched to a doublet ring: improved cost
  - Now has 55 m radius, slightly smaller orbit excursion
- Commissioning a scaling FFAG for protons (150 MeV)

Tasks to Come

- Maybe look at polytron techniques for RLA: easier switchyard?
- Real head-to-head comparison if types of lattices
  - Separately optimized for cost: look at triplet, FODO, doublet?
    - Right now: approximate scaling of designed lattices
  - Really do apples-and-apples comparison of scaling and non-scaling
- Continued study of longitudinal phase space dynamics
  - Find well-defined criteria for relationship between requred voltage and time-of-flight to transmit a given longitudinal phase space volume
- Push up SCRF gradients: deal with Q-slope problem
- Determine convincingly the gap between SCRF and magnets
  - Deal with residual magnetization issue
- Full simulation: 6-D, beam loading
- Injection/extraction!!!