Proposed Contributions to the Muon Accelerator R&D Program

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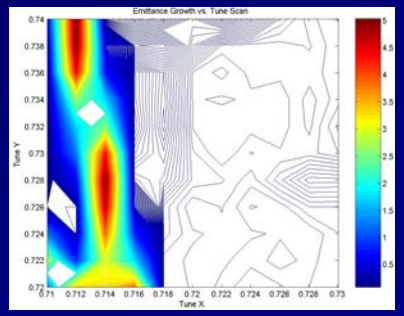
LBNL Expertise for Muon Accelerator R&D

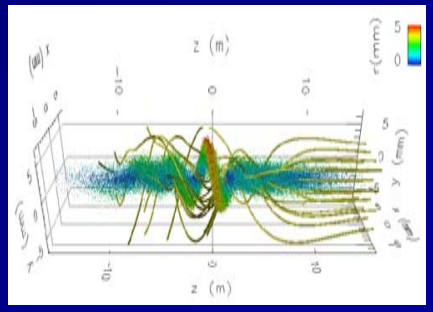
- Coordinating activities drawing on resources from AFRD and ENG
  - Superconducting Magnet program (*GianLuca Sabbi*)
  - Center for Beam Physics (*John Corlett*)
  - Accelerator Physics group at the Advanced Light Source (*David Robin*)
  - Fusion Program (*Grant Logan*)
  - Engineering Division (*Kem Robinson*)
- Use existing expertise in critical accelerator theory, modeling, design, and prototyping
- Generic tools and capabilities developed and already applied to several other projects
- Open and effective collaborators within the US and internationally
- Attracting and training talented students and post-docs

Center for Beam Physics

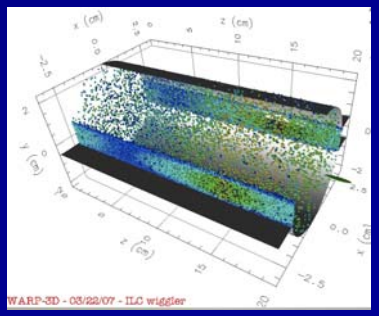
- Beam emittance control
  - Collective effects
  - Beam-beam interactions
  - Instability thresholds and growth rates
  - Integrated machine design
- Beam cooling, manipulations, and position control
  - RF component hardware
  - Instrumentation and diagnostics
  - Feedback and cooling systems



Beam-beam tune shift



3-D ion hose instability model



3-D electron cloud model

Muon cooling RF and solenoid

Superconducting Magnet Program

- LBNL is the worldwide leader for advanced accelerator magnets
- Consistent success in both materials and magnet development
  - *Nb_3Sn Conductor Development Program Management*
  - *Advanced modeling, instrumentation and diagnostic*
  - *Record breaking dipoles (RD, HD series) up to 16 T*
  - *HTS wind-and-react technology for fields above ~18*
  - *Advanced structure development and scale-up (LR, LQ)*
  - *Large aperture quadrupoles (TQS) surpassing LARP goal*
  - *HTS wind-and-react technology for very high field*
- Core R&D provides required basis for LHC upgrades and MC
- LARP program specifically directed at LHC Phase 2 quadrupoles

GianLuca Sabbi

Proposed resources to support Muon Accelerator R&D

[FTEs]

	Year 1	Year 2	Year 3	Year 4	Year 5	Sum
MICE	2	2.5	1.5	0.5	0.25	6.75
NF-RDR	0	0	0	0.25	0	0.25
Des. Simul. Report	1.85	1.85	3.35	4.1	4.6	15.75
RF R&D	0.5	1	2	2.25	2.25	8
Magnet R&D	0.7	2	2	3.5	5.4	13.6
Cooling components R&D	0	0	0	0	0	0
Management	0.25	0.25	0.25	0.25	0.25	1.25
Sum	5.3	7.6	9.1	10.85	12.75	45.6

	Now	Year 1	Year 2	Year 3	Year 4	Year 5
BNL	6.5	7	8	10	10	10
FNAL	20.8	23	28	30	33	33
LBNL	2.5	5	8	9	11	13
Other	7 [a)]	13 [b)]	35 [b)]	32 [b)]	32 [b)]	32 [b)]
TOTAL	36.8	48	79	81	86	88

[[a), b)] Steve Geer's presentation]

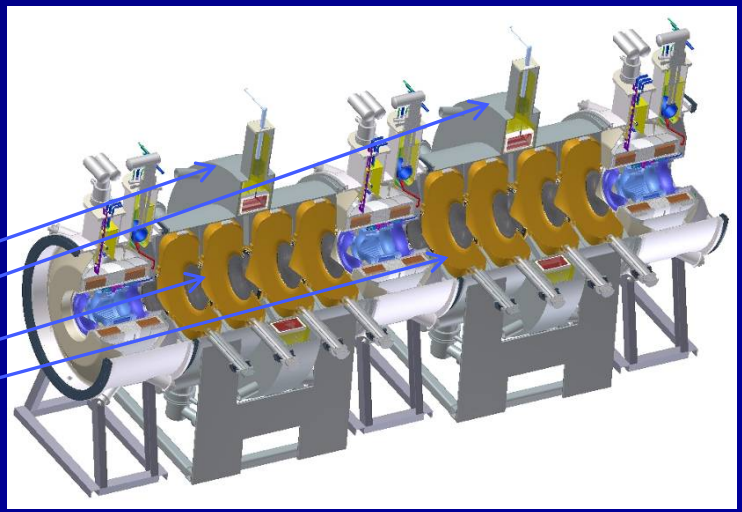
RF R&D, and MICE

- RF gradient limitations
  - High-gradient accelerating structures operating in high magnetic field
- MICE
- RF cavities
- Superconducting solenoid design
  - Cooling channel coupling coils
  - Spectrometer
- Integration
  - RF and superconducting magnets
    Collaboration with HIT
- Exploitation
  - Commissioning and operations

LBNL RF cavities and solenoids under test at Fermilab

Superconducting solenoids

201-MHz RF cavities



RDR, and Management

Neutrino Factory – Reference Design Report (RDR)

- Integrated national/international study to deliver a reference design report
- Costing study

Management

- NFMCC
  - Program Manager
- MICE
  - Deputy spokesperson
  - WBS level 2 & 3 responsibilities

Design Feasibility Study (DFS)

Collider – Accelerator design & simulations

- Beam-beam interactions
  - Strong-strong Gaussian approximation + high-order map representation of machine lattice for preliminary assessment of luminosity (**TRS** code)
  - Refined, fully 3D self-consistent modeling using **BeamBeam3D**
- Space charge
  - Monitor space-charge effects along accelerator chain (beam losses, emittance degradation)
  - Main tools: **IMPACT** and **MaryLie/IMPACT**
- Single-bunch instabilities
  - Determine instability thresholds in low-alpha lattices
  - Analytical and numerical methods (including time-domain **Vlasov solver**)
- Electron-cloud effects
  - Assess relevance of e^- accumulation and related instabilities (if any)
  - Numerical tools: **POSINST**, **WARP/POSINST**
- Lattice design
  - Small ß*, small $\alpha\lambda\pi\eta\alpha$, small circumference
  - Large momentum acceptance, large dynamic aperture
  - Genetic algorithm for optimization

Magnet Systems

Magnet R&D

- Collider ring magnets
  - Development of arc dipoles and quadrupoles
    - *Design options: conductor, coil layout, mechanical support*
    - *Radiation load: internal absorbers vs. open mid-plane*
  - IR quadrupole R&D (in coordination with LARP program)
  - RDR support: feedback on magnet design, cost envelopes
- HTS Technology
  - *Applications to both collider ring and cooling channel*
  - Materials: Bi-2212 (wind and react); YBCO
  - Specific R&D issues: cable, insulation, reaction process

Summary
LBNL Proposals for Muon Accelerator R&D

- Coordinated resources from AFRD and ENG
  - Superconducting Magnet program
  - Center for Beam Physics
  - Accelerator Physics group at the ALS
  - Fusion Program
  - Engineering Division
    - Use existing expertise in critical accelerator theory, modeling, and design
    - Generic tools and capabilities developed and already applied to several other projects

Applied in support of the Muon Accelerator R&D Program

Backup slides

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#Emeritus

LBNL resources to solve challenges for a Muon Collider

	NOW	Year 1	Year 2	Year 3	Year 4	Year 5	Integrated
CBP							
Zisman	1	1	1	1	1	1	5
Li	0.5	0.5	0.5	0.5	0.5	0.5	2.5
Wurtele		0.25	0.25	0.25	0.25	0.25	1.25
Furman		0.25	0.25	0.25	0.5	0.5	1.75
Penn		0.6	0.6	0.6	0.6	0.6	3
Venturini		0.25	0.25	0.5	0.5	0.5	2
Wan		0.25	0.25	0.25	0.25	0.25	1.25
Postdoc-1			1	1	1	1	4
Postdoc-2				1	1	1	3
Supercon							
Scientists		0.4	1	1	1	1.2	4.6
Engineers		0.3	0.8	0.8	1.2	1.5	4.6
Postdocs					0.3	0.8	1.1
Technicians			0.2	0.2	1	1.9	3.3
Engineering							
Virostek	0.25	0.25	0.25	0.25	0.25	0.25	1.25
DeMello	0.75	1	1	1	1	1	5
Eng-1		0.25	0.25	0.5	0.5	0.5	2
Total	2.5	5.3	7.6	9.1	10.85	12.75	45.6

Figures in red not presently funded by HEP