
Muon Collider Accelerator Simulations: 5-year plan (2)

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NFMCC Friday Meeting

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Outline

1. Simulation action items
2. Adjustments due to present activities
3. Help from Others (continued)
4. Figures of merit
5. Announcement

1. Simulation action items

Action list to be addressed for next simulation & design session:

1. Assess whether our present activities making a dent in Year 1 of the plan.
2. Make the next step in iterating on the “Other“ effort distribution by including negotiated contributions from more institutions (eating away at the Other category).
3. Assess what has and has not been done in defining performance versus figure of merit for various subsystem parameters, and suggest what further could be done before we get reviewed.

2. Adjustments due to present activities

- used task lists and discussion with other study participants to estimate work accomplished in past year
- made adjustments for target, FE, accelerator, collider ring activities
- we still don't have a detailed task list for the proton driver work !
Muons, Inc activity with Project X ?
- total effort required for MC DFS: 101 → 95 FTE-years
- however, I still think we still need 5 more years to complete this activity

2. Possible FTE by subject

	year 1	year 2	year 3	year 4	year 5	total
PD	2	5	6.2	7	2.6	22.8
Target	1	1.7	1.7	0.2	0.1	4.7
FE	5	7.5	10.3	8.3	3	34.1
μ Acc	2	3.3	3.5	2.1	0.7	11.6
CR	2	3.5	4.9	4.7	1.5	16.6
DFS	0	0	0	1.3	4.1	5.4
total	12	21	26.6	23.6	12	95.2

Scenario
RF09b

adjusted effort for accomplished work
made faster start to μ acceleration & collider ring effort
delay build up in FE effort to give MuCool time to get RF results
this scenario requires adding ~5 FTEs in year 1

2. Possible timeline & milestones

Year 1

- study proposed alternatives for accelerator subsystems
- specify baseline target & collider ring designs (M1)

Year 2

- simulate subsystem performance using defensible parameters
- specify μ accelerator baseline design (M2)

Year 3

- cross-check most promising subsystems with ≥ 2 codes
- specify front end & proton driver baseline designs (M3)

Year 4

- optimize baseline, minimize work on alternatives
- simulate representative matching sections
- carry out representative tolerance studies
- freeze accelerator design (M4)

Year 5

- complete design of all remaining matching sections (M5)
- do end-to-end simulation of accelerator systems (M6)
- do detailed tolerance studies (M7)
- finish all necessary simulations for the MC DFS report (M8)

pressure to
set milestones
& down-select early !

3. Simulation help from Others

Present University Partners (PUPs)

UC Riverside, Mississippi, UCLA, Princeton, Stony Brook, UC Berkeley



Present Industrial Partners (PIPs)

Muons Inc, Particle Beam Lasers, Tech X



Assume that, given additional funding,

Princeton, Stony Brook can handle targetry

UCR, Miss, UCLA, UCB could each devote or add up to 1 person to work on this

PBL could supply 1 person to work on this

Muons Inc could supply up 2 persons to work on this

Tech X could supply up to 3 persons to work on this

3. Possible FTE by institution

	year 1	year 2	year 3	year 4	year 5	total
FNAL	3.6	8	10	12	5.4	39
BNL	3.5	4	4.5	5	3	20
LBNL	1.9	1.9	3.4	4.1	2.6	13.9
Others	3	7.1	8.7	2.5	1	22.3
pup	1	3	4	2	0.9	10.9
pip	2	4.1	4.7	0.5	0.1	11.4
total	12	21	26.6	23.6	12	95.2

Scenario
RF09b

more fully utilize Others thru whole project
seems feasible with our present partners

3. Possible FTE from Others

	year 1	year 2	year 3	year 4	year 5	total
PD	0.5	0.5	0.5	0.5	0.1	2.1
Target	0.5	1.2	1.5	0.1	0	3.3
FE	0.6	3.8	5.8	1.7	0.5	12.4
μ Acc	0.6	1	0.1	0.1	0.1	1.9
CR	0.8	0.6	0.8	0	0	2.2
DFS	0	0	0	0.1	0.3	0.4
total	3	7.1	8.7	2.5	1	22.3

Scenario
RF09b

Others play major role in target & FE simulations

4. Figures of merit – editorial comments

- have always included tolerance studies (including FOM) as part of 5-year plan currently scheduled for years 4 and 5
 - modify plan to do a study right before a subsystem baseline is selected?
 - is it really worthwhile to spend a lot of time on this now?
- this is potentially a huge subject
 - every machine parameter potentially affects $N_{\mu A}$ and luminosity
 - until down-select we have lots of possible subsystems to consider
 - some parameters depend on type of RF cavity used in the subsystem
- tolerance studies are closely related to optimization studies
- a lot of these studies have been done
 - e.g. PD bunch length, target parameters, capture B profile, FFAG design, current variations on lattice B, ...?
- what else is essential to do now?
 - e.g. density fluctuations in mercury jet
 - effect of gradient on μ acceleration
 - final focus quad gradient in collider?

4. Figures of merit – (G, B) problem

- practical gradient (G) in given magnetic field (B) is unknown at present
- different cavity designs will have different (G,B) dependences
- luminosity (L) is the ultimate FOM for machine performance
- real question is what is loss of L if you can't get design (G, B)
- three possible approaches
 1. theory
 - e.g. Bob has outlined method to calculate $L = f(G, B)$
 2. simulations of given design with decreased G
 3. simulations of redesigned channel to accommodate lower G
- simulations typically give $N_{\mu A}$ or μ/p_A , which can be easily related to L

4. (G, B) dependence of NF front end

1. Juan Gallardo ISS-NF design, 201 MHz
20% loss in $N_{\mu A}$ for 15 \rightarrow 10 MV/m
2. Dave Neuffer IDS-NF $N_B=10$ design, 360-201 MHz (MC-540)
design maximum G is 15 MV/m
7% loss in μ/p_A from reducing buncher G_B 15 \rightarrow 6 MV/m
looked at G in phase rotation & cooling channels
adjusted absorber lengths & total channel length

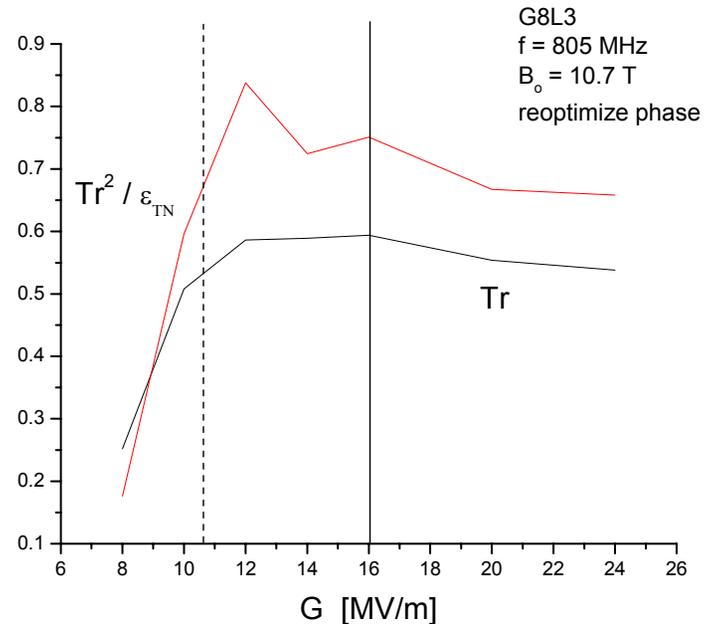
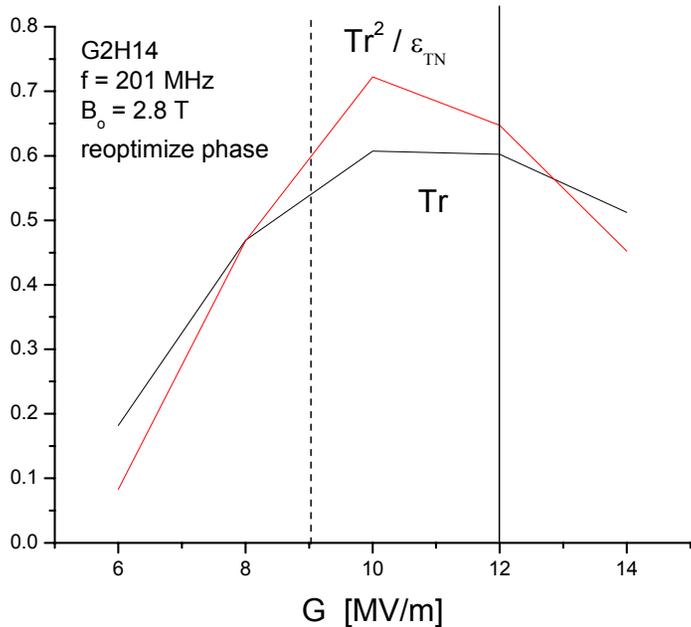
B	G_R	G_C	μ/p_A
2	15	15	0.081
	9	15	0.068
	9	9	0.057
1.25	15	15	0.076
	9	15	0.068
	10	10	0.061

at 2 T 30 % loss for $G_R=9$, $G_C=9$

at 1.25 T 20 % loss for $G_R=10$, $G_C=10$

4. Guggenheim G tolerance

- look at gradient dependence of 1st and last Guggenheims



$$FOM = L \sim N \sim Tr$$

$$\sim N^2/\epsilon \sim Tr^2/\epsilon$$

if we are tune shift limited

if not

results are similar for the two FOM

10% drop in L for 3 MV/m (5 MV/m) decrease in G at 201 MHz (805 MHz)

5. Cooling mini-workshops

- Alvin suggested we do a series of 1-day cooling mini-workshops
- each mini-workshop would be dedicated to a single cooling subsystem
- would like as many cooling simulators
and other interested parties as possible to attend
- a few talks presenting current status of simulations
- followed by lots of discussion on that topic
- hope other participants act as internal referees
- point out weaknesses in simulations before review of 5-year plan

- first topic will be the [Guggenheim](#) channels
Thursday October 22 at FNAL
(immediately following Project X Workshop) (Oct. 19-21)