

Mu2e-II Workshop (xi) Introduction

Frank Porter
February 22, 2022
DocDB-40998

This meeting will be recorded

Mu2e-II workshops

Recent past workshops

For earlier workshops, see the Mu2e-II calendar at:

https://mu2eii-internal-wiki.fnal.gov/wiki/Main_Page#Calendar

Workshop dates	Links to recordings
Wednesday, March 3, 2021 https://indico.fnal.gov/event/47787/	https://caltech.zoom.us/rec/share/po6RL9ZZL27yeF8sjUZ9Wk9xcBw-wqm-TYgRmSNjn6yUYBE5mvb5Myza-ez2k3tFV.deUj8dQcDWOVSqAU
Wednesday, April 28, 2021 https://indico.fnal.gov/event/48516/	https://caltech.zoom.us/rec/share/NM_b0LyWSJopNa_YAu9LXmfjJ05XrCmjXkmfwCoqj9VtBqVFKeA0N4pouLDKGMz.1f96W6EOVkyUsnT4
Wednesday, July 21, 2021 https://indico.fnal.gov/event/49360/	https://caltech.zoom.us/rec/share/Lm8mhRjuLVcAVvyvWYmIWUNaLu-WlwRSB-uGvxncQBz0TAHTUWKHiipsi7LMwUt.F8VaPWZ49mhflB9w
Wednesday, September 15, 2021 https://indico.fnal.gov/event/50719/	https://caltech.zoom.us/rec/share/-bUabAznmOAlod7qg9e7ae_Zp1NDGdm7nmoe3XjVxEy3bXHYJD-kR4bSIEu2Fp4I.UPHlnKpp90ZMyMjg
Tuesday, February 22, 2022, 10AM-2PM CT https://indico.fnal.gov/event/52851/	Discussion of contributed paper contents

Purpose of this Mu2e-II Workshop

Review of draft contributed paper

Draft Snowmass22 contributed paper on Overleaf (read link):

<https://www.overleaf.com/read/mrbgttkmfgvq>

(Let me know if you need edit link)

Mu2e-II contributed paper author list

- Status as of Feb 17, 2022
- Please check!!!!
- Let me know if you want to be added
- If you think people are missing, let them know so they can ask to be added

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Mu2e-II collaboration/author list

- Please respond (to fcp@caltech.edu)
 - Philosophy is people need to sign on
 - So please send me an email if you haven't already
 - Also, please check that I got your information right!
- I will make sure anyone on the list is also on the Mu2e-II email list
 - That is: mu2eii@listserv.fnal.gov
 - The email list is a superset of the collaboration list
- Collaboration/author list is available from the internal Mu2e-II wiki page
 - https://mu2eii-internal-wiki.fnal.gov/wiki/Main_Page#Mu2e-II_Collaboration_and_Author_list
- Also directly accessible with link
 - <https://caltech.app.box.com/file/793439425745?s=gkidbcqykvhrmfnl85rfct3z6ybhftqb>

Mu2e-II Snowmass Schedule

March 15, 2022 deadline for submission of Mu2e-II contribution to arXiv

That is, we need to be done in 0.7 months!!

Plan to submit a day or two early

Please take a look and transmit comments as soon as possible

Draft Snowmass22 contributed paper on Overleaf (read link):

<https://www.overleaf.com/read/mrbgttkmfgvq>

- This will serve as the input to the Topical Group Convenors
 - Their deadline for preliminary reports is May 31, 2022

Mu2e-II Working Groups

Mu2e-II working groups	Convenors
Theory mu2eii-theory@fnal.gov	Lorenzo Calibbi Julian Heeck
Accelerator (including PS, production target, extinction) mu2e-ii-accelerator@fnal.gov	Karie Badgley David Neuffer Eric Prebys
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Trigger and DAQ mu2eii-tdaq@listserv.fnal.gov	Antonio Gioiosa Giani Pezzullo

Mu2e-II Working Groups

Email convenors if you wish to participate
Anyone can subscribe to email lists

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Manolis Kargiantoulakis, FNAL

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Mete Yucel, FNAL

Tracker meetings every two weeks on Tuesdays 12AM CT

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Rebecca Chislett, UCL

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Cole Kampa, Northwestern

Manolis Kargiantoulakis, FNAL

Michael MacKenzie, Northwestern

Mu2e-II Communication Links

- Public wiki page: <https://mu2eiiwiki.fnal.gov>
 - Please email Lisa or Frank if you wish to have write access
- Private wiki page:
https://mu2eii-internal-wiki.fnal.gov/wiki/Main_Page
 - SSO log-on
 - May need to contact Lisa or Frank to request access
 - This page has the Mu2e-II calendar with links to zoom, indico, etc.
- Mu2e-II mailing list: mu2eii@listserv.fnal.gov
- Mu2e-II Slack channel link:
 - <https://Caltech-tka1525.slack.com>

Additional Material

September 15, 2021 Mu2e-II workshop agenda

Indico timetable at: <https://indico.fnal.gov/event/50719/>

When (CT)	Who	What
10:00-10:20	Frank Porter	Introduction
10:20-10:45	Daniel/Gianfranco	Tracker
10:45-11:10	David/Luca/Ivano	Calorimeter
11:10-11:35	Antonio/Giani	TDAQ
11:35-12:00	Craig/Yuri	Cosmic ray veto
12:00-12:20	All	Break
12:20-12:45	Michael/Stefan/Vitaly	Radiation studies
12:45-13:10	Karie/David/Eric	Accelerator
13:10-13:35	Lisa/Sophie/Yuri	Sensitivity
13:35-14:00	Lorenzo/Julian	Theory
14:00	All	End

Mu2e-II Parameters

“Complete” parameter list on public Wiki:

https://mu2eiwiki.fnal.gov/wiki/Learn_about_Mu2e-II

Recent modification to follow Mu2e assumptions, 3rd year (DocDB-26289, “Mu2e staging options”)
 Note that this implies 1.5×10^7 s/yr for CE data
 Hence 4 years for total run time of 6×10^7 s

Wiki has been updated
 Also need to update PIP-II parameters to reflect current understanding (accelerator talk)

Parameter	Value	Units	Value	Units
Accelerator beam	40	week/yr	2.4×10^7	s/yr
Accelerator up time	90	%	2.2×10^7	s/yr
Calibration, background studies, other special runs	30	% of delivered beam	6.5×10^6	s/yr
Mu2e efficiency	100	%		
CE data	70	% of delivered beam	1.5×10^7	s/yr

Mu2e-II talks

- If you plan to submit an abstract or give a Mu2e-II talk, or are invited to give such a talk, please
 - Email [Kevin Lynch](#) and [Frank Porter](#)
 - If you have an invitation, please email us even if you do not wish to accept – we may be able to suggest someone else
- Fermilab requirements – writeups
 - Acknowledgment should usually include:
 - This document was prepared by members of the Mu2e-II Collaboration using the resources of the Fermi National Accelerator Laboratory (Fermilab), a U.S. Department of Energy, Office of Science, HEP User Facility. Fermilab is managed by Fermi Research Alliance, LLC (FRA), acting under Contract No. DE-AC02-07CH11359.
 - Fermilab preprint number
 - <https://mu2e-docdb.fnal.gov/cgi-bin/private/ShowDocument?docid=4083>
- With byline, include:
 - “For the Mu2e-II Collaboration”
 - Optionally as applicable; “For the <appropriate group name> working group of the Mu2e-II Collaboration”

Thinking about “when”

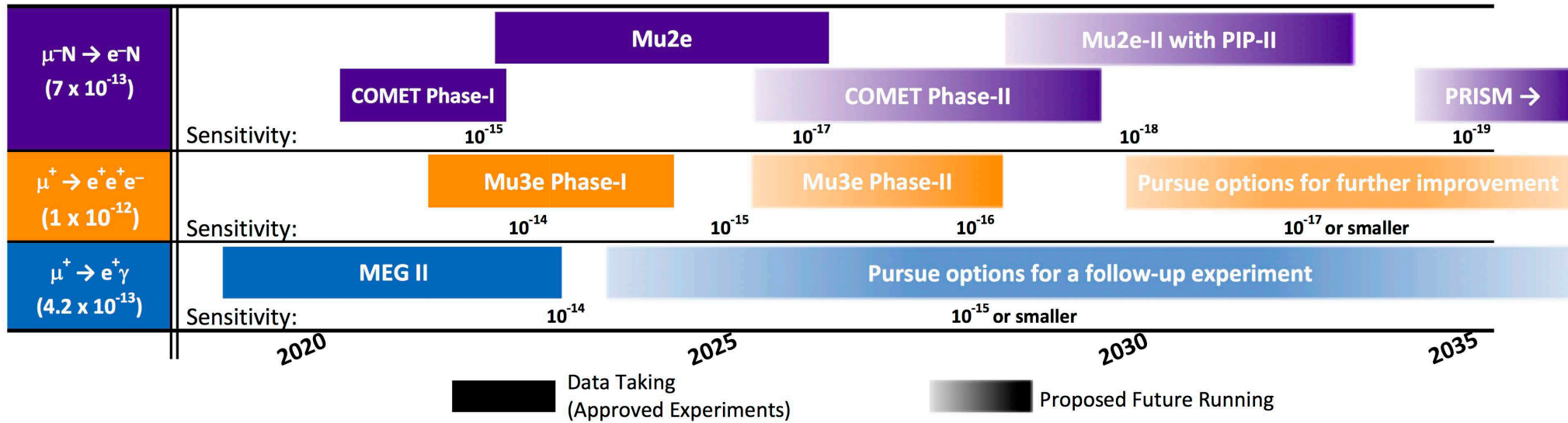
If Mu2e runs until end of 2030, when does Mu2e-II run?

- Mu2e experience useful to have in designing Mu2e-II
- Significant construction could happen in parallel with Mu2e run, long shutdown
- Major installation cannot begin until Mu2e is complete
 - Except perhaps portions of beamline from PIP-II
- Sticky question: When/how can work happen in PS area?
 - Residual radiation

Thinking about “when”

View from 2020 European Strategy Physics input on CLFV

<https://arxiv.org/pdf/1812.06540.pdf>

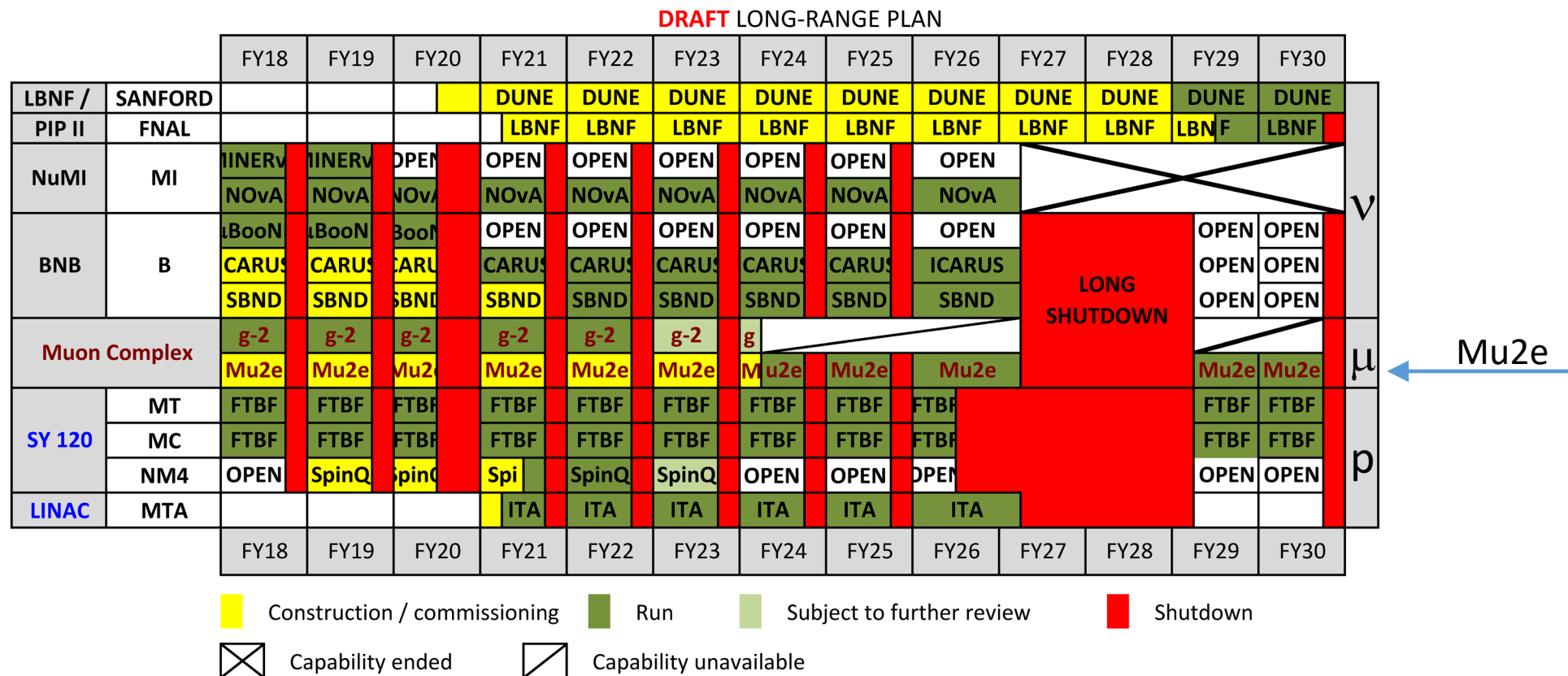


- Nice overview, but already wrong when it appeared (not only for Mu2e)
- Latest Mu2e is “Project Complete” April 2024 (R.Ray, DocDB-38699)

Thinking about “when”

FNAL draft long-range plan (Jan 2021, excluding accompanying notes)

<https://ppp-docdb.fnal.gov/cgi-bin/sso/RetrieveFile?docid=724&filename=10yr-PLAN-Current.pdf>



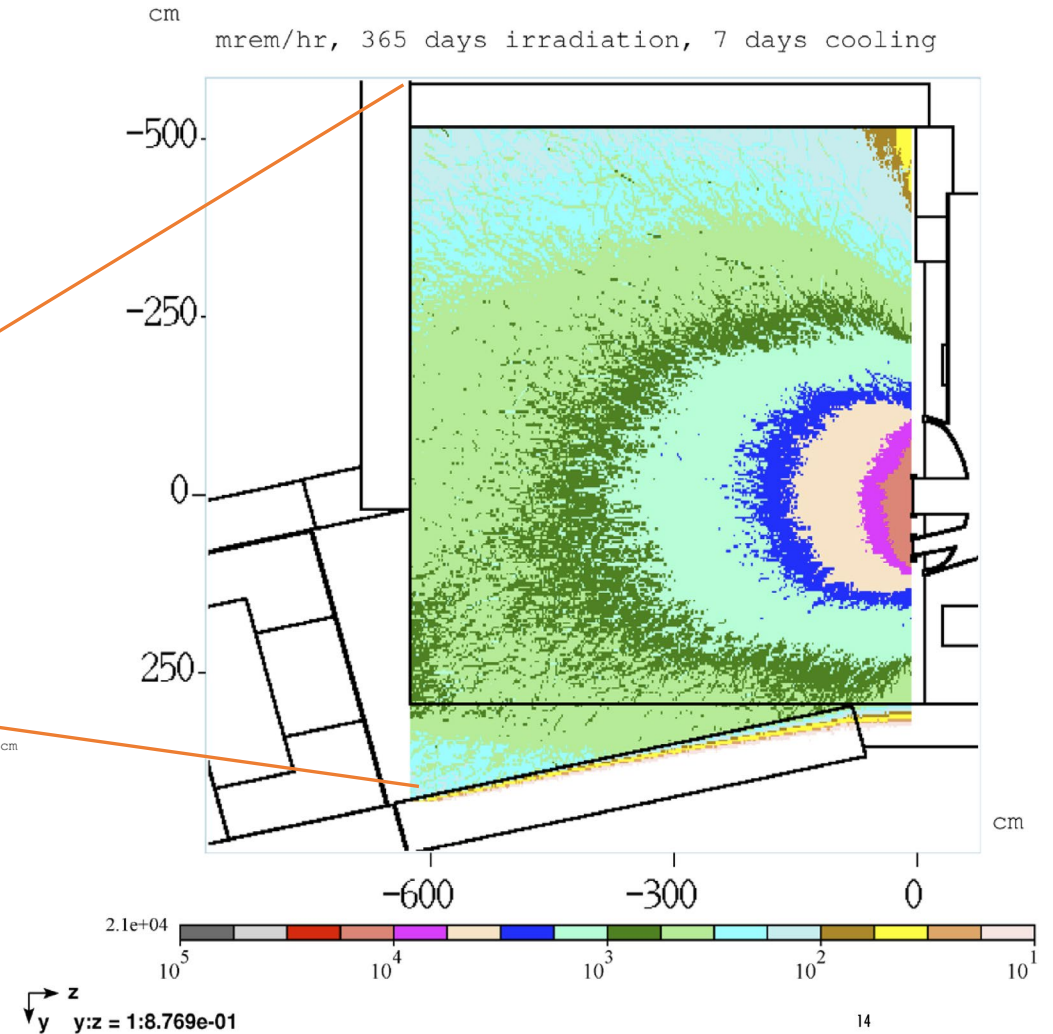
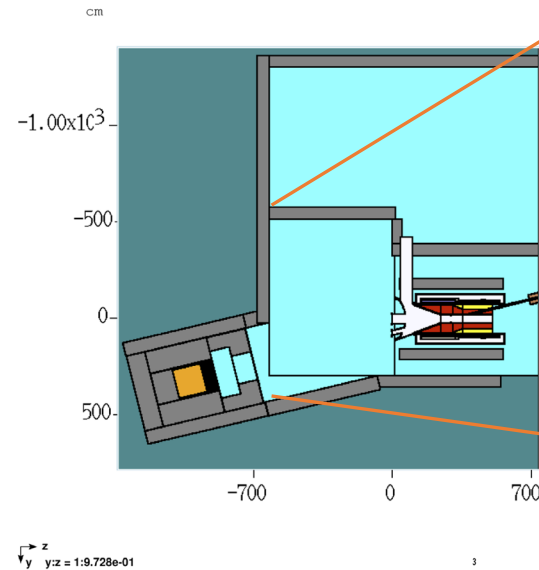
Shows Mu2e running until end of FY30

Shows PIP-II operation beginning mid FY29 (PIP-II CD4 December 2028)

Thinking about “when”

Residual dose at production solenoid

- 365 days irradiation
- 8 GeV
- 8 kW
- **after 1 week cooldown**
- mid-plane of PS



DocDB-5629 (Leveling)

See also:

<https://www.sciencedirect.com/science/article/abs/pii/S0168900217309415> (FermiCORD paper)

Hottest point in this region: 21 rem/hr

Muon stops

Quantity	Mu2e	Mu2e-II (nominal)	Units
Stopped μ /POT	1.5×10^{-3} (37571)*	8.9×10^{-5} (37571)	
Beam kinetic energy	8000	800	MeV
Beam power	8	100	kW
POT (3 yr)	3.6×10^{20} (12014)	4.5×10^{22}	
Stopped μ	5.4×10^{17}	4.0×10^{18}	
SES	3.7×10^{-17} (12014)*		

numbers in () are DocDB references

POT = Protons On Target
SES = Single Event Sensitivity

$$\text{POT} = 3 \text{ yr} \times 1.92 \times 10^7 \text{ (s/yr)} \times \text{power(W)} / E_{\text{beam(J)}}$$

*DocDB 7464 says 0.00187 stopped mu/POT (corresponds to SES 3×10^{-17});
SES here is scaled from this using 0.0015 stopped mu/POT

$$\text{Stopped mu(Mu2e-II)} / \text{Stopped mu(Mu2e)} = 40 / 5.4 = 7.4$$

Muon stops

This means that for a SES of 10x better than Mu2e, or $SES = 3.7 \times 10^{-18}$, the beam power should be 135 kW

In other words,

$$SES(\text{Mu2e-II}) = 5 \times 10^{-18} \times \frac{100 \text{ kW}}{P}$$

(We assume the efficiency to observe a conversion electron is the same in Mu2e-II as in Mu2e)

Comment: These are early results and will change!

Snowmass 22 - Endgame Schedule

- **White Paper submission to arXiv: no later than March 15, 2022**
 - Late submissions and updates unlikely to be incorporated in the working group reports
- Preliminary reports by the Topical Groups due: no later than May 31, 2022
- Preliminary reports by the Frontiers due: no later than June 30, 2022
- Snowmass Community Summer Study (CSS): July 2022 at UW-Seattle
- Final reports by Frontiers due: no later than September 30, 2022
- Snowmass Book and on-line archive documents due: October 31, 2022

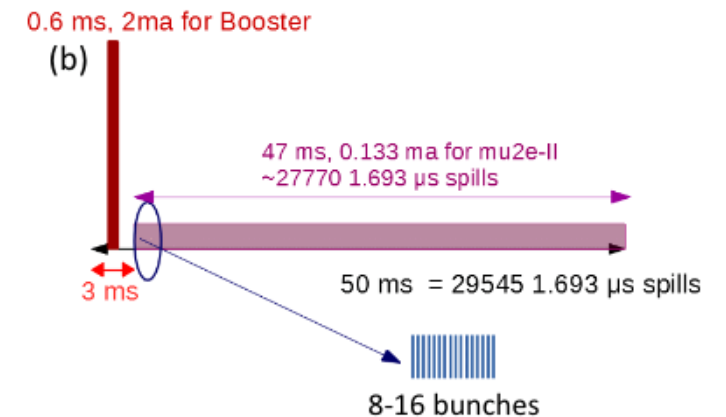
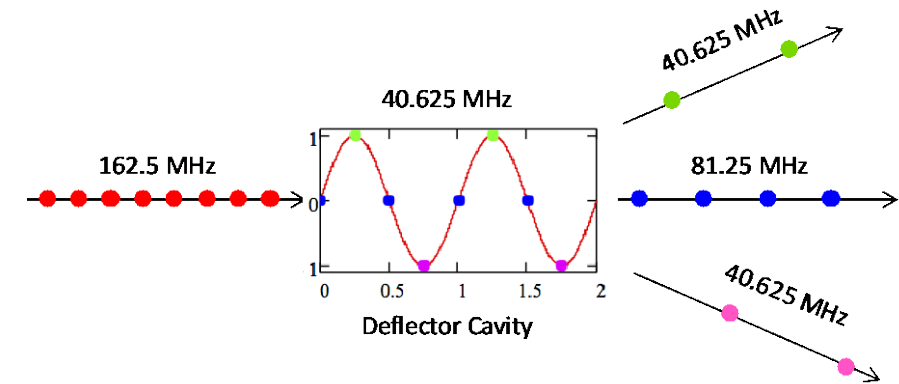
Proposed Mu2e-II beam nomenclature

- Follow accelerator group usage
- Beam delivery is different than Mu2e

Quantity	Name
Beam in one PIP-II RF bucket (162.5 MHz)	Bunch
PIP-II pulse (20 Hz/0.55 ms)	Pulse (but see below)*
Mu2e-II repetition (e.g., 1693 ns)	Spill (also pulse, but see above)**
Set of bunches in one spill (e.g., 8)	Burst (also pulse, but see above)**

*One PIP-II pulse is about 27770 Mu2e-II spills; suggest saying “PIP-II pulse” to avoid confusion.

**“Pulse” may be used when distinction is not important



Eric Prebys

<https://indico.fnal.gov/event/44997/>

David Neuffer, DocDB 33896

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