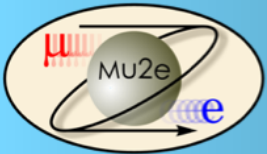
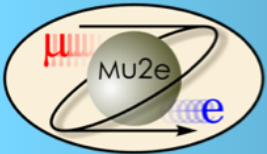


# Sensitivity updates

Lisa Goodenough, Michael MacKenzie,  
Sophie Middleton, Yuri Oksuzian  
July 21, 2021

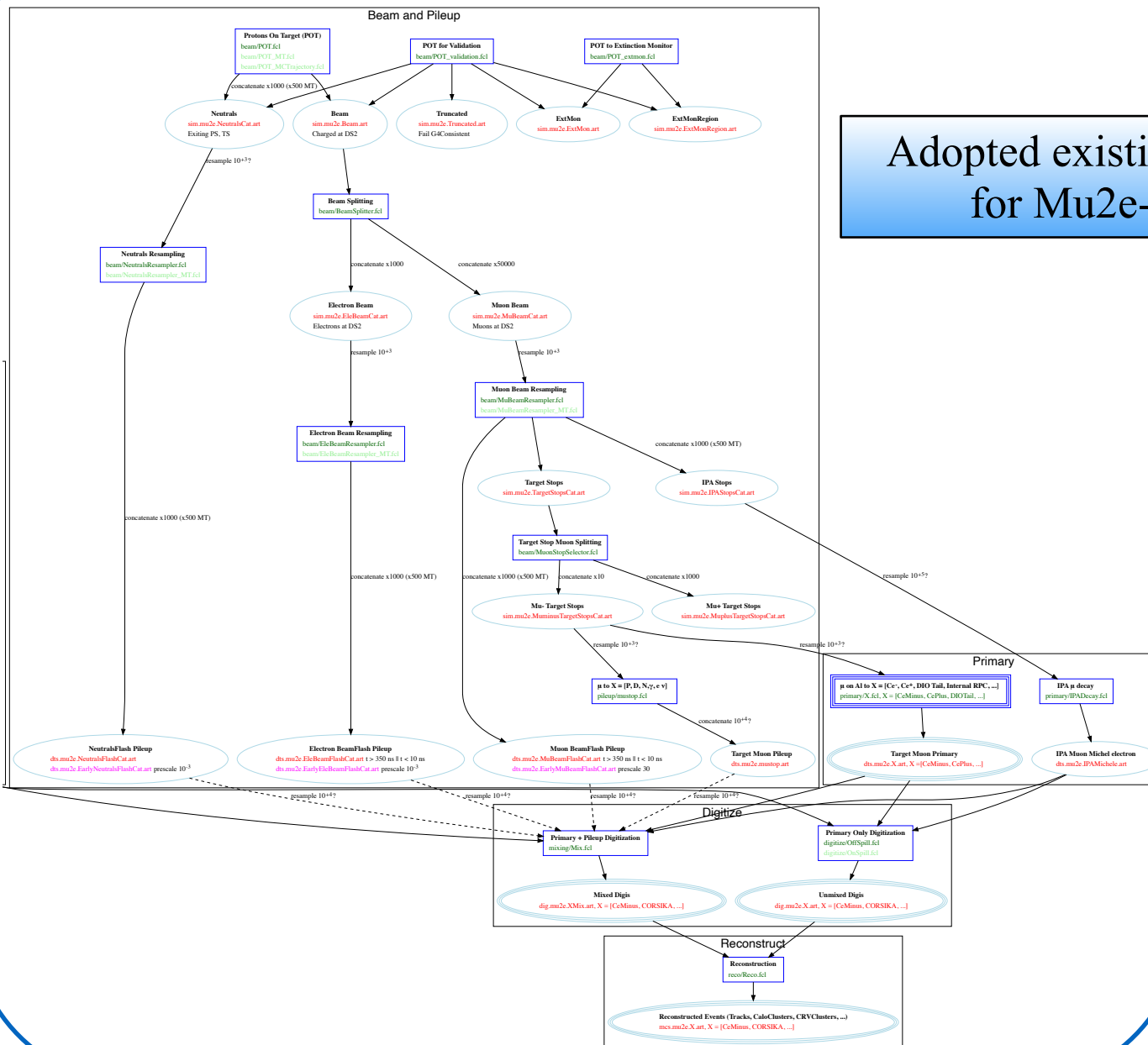


- We have updated current Mu2e geometry:
  - ▶ Carbon balls target
  - ▶ No pbar windows
  - ▶ Updated CRV shielding
  - ▶ Latest STM shielding
- Updated Offline code to the latest version
- We have produced a small sample of CE overlaid with background frames

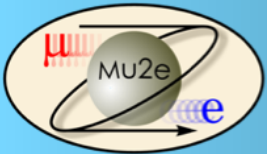


# MDC style workflow

## Mu2e Simulation Workflow



Adopted existing workflow for Mu2e-II needs

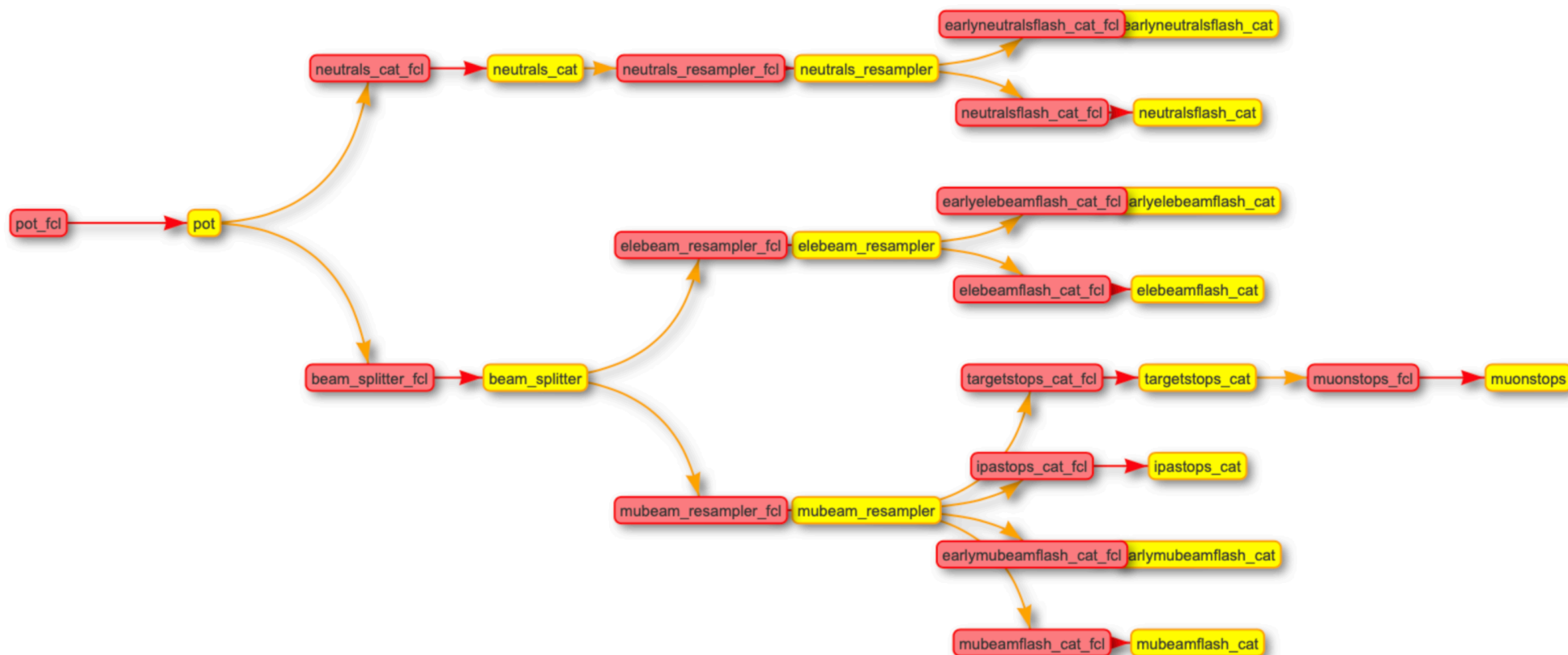


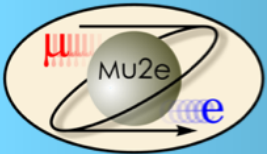
# POMS workflow

The simulated is automated using  
Production Operations Management System

<https://pomsgpvm01.fnal.gov/poms/index/mu2e/production>

Mu2ell2021b\_beam





# POMS workflow



## Campaigns ?

Luri Oksuzian

mu2e

production



Active  
 Inactive

Mine  
 Others

Analysis  
 Production

Update View

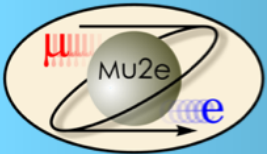
Mark Campaign Active/Inactive

Tag/untag Campaigns

Add

Pick .ini file and Upload

Select All	Campaign Name	id	Active	Submissions Running	Submission History	Files Report	Launch	Dependencies	GUI Editor	Clone Campaign	.ini File	Delete Campaign	Tags	Creator
<input type="checkbox"/>	MDC2020_CORSIKAF	5450	Yes	2										srsoleti
<input type="checkbox"/>	MDC2020f_beam	5443	Yes	2										srsoleti
<input type="checkbox"/>	Mu2eII2021a_beam	5484	Yes	0										oksuzian
<input type="checkbox"/>	Mu2eII2021b_beam	5496	Yes	1										oksuzian



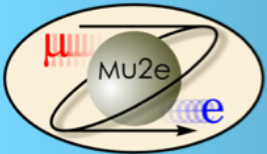
# POMS workflow



Active  
 Inactive
  Mine  
 Others
  Analysis  
 Production
 Update View

Queue future/Release Queued job launches
Show Stage Statistics

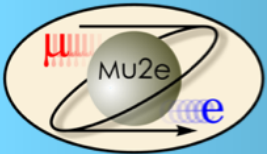
Select All	Campaign Name	c_id	Campaign Stage	s_id	Active	Queued By	Creator	Created	Updater	Updated
<input type="checkbox"/>	Mu2ell2021b_beam	5496	muonstops	10576	Yes		oksuzian	2021-07-13 18:07:08		never
<input type="checkbox"/>	Mu2ell2021b_beam	5496	muonstops_fcl	10575	Yes		oksuzian	2021-07-13 18:07:08		never
<input type="checkbox"/>	Mu2ell2021b_beam	5496	earlyneutralsflash_cat	10574	Yes		oksuzian	2021-07-13 18:07:08		never
<input type="checkbox"/>	Mu2ell2021b_beam	5496	earlyneutralsflash_cat_fcl	10573	Yes		oksuzian	2021-07-13 18:07:08		never
<input type="checkbox"/>	Mu2ell2021b_beam	5496	neutralsflash_cat	10572	Yes		oksuzian	2021-07-13 18:07:08		never
<input type="checkbox"/>	Mu2ell2021b_beam	5496	neutralsflash_cat_fcl	10571	Yes		oksuzian	2021-07-13 18:07:08		never
<input type="checkbox"/>	Mu2ell2021b_beam	5496	targetstops_cat	10570	Yes		oksuzian	2021-07-13 18:07:08		never
<input type="checkbox"/>	Mu2ell2021b_beam	5496	targetstops_cat_fcl	10569	Yes		oksuzian	2021-07-13 18:07:08		never
<input type="checkbox"/>	Mu2ell2021b_beam	5496	ipastops_cat	10568	Yes		oksuzian	2021-07-13 18:07:08		never
<input type="checkbox"/>	Mu2ell2021b_beam	5496	ipastops_cat_fcl	10567	Yes		oksuzian	2021-07-13 18:07:08		never
<input type="checkbox"/>	Mu2ell2021b_beam	5496	earlymubeamflash_cat	10566	Yes		oksuzian	2021-07-13 18:07:08		never
<input type="checkbox"/>	Mu2ell2021b_beam	5496	earlymubeamflash_cat_fcl	10565	Yes		oksuzian	2021-07-13 18:07:08		never
<input type="checkbox"/>	Mu2ell2021b_beam	5496	mubeamflash_cat	10564	Yes		oksuzian	2021-07-13 18:07:08		never
<input type="checkbox"/>	Mu2ell2021b_beam	5496	mubeamflash_cat_fcl	10563	Yes		oksuzian	2021-07-13 18:07:08		never
<input type="checkbox"/>	Mu2ell2021b_beam	5496	earlyelebeamflash_cat	10562	Yes		oksuzian	2021-07-13 18:07:08		never
<input type="checkbox"/>	Mu2ell2021b_beam	5496	earlyelebeamflash_cat_fcl	10561	Yes		oksuzian	2021-07-13 18:07:08		never
<input type="checkbox"/>	Mu2ell2021b_beam	5496	elebeamflash_cat	10560	Yes		oksuzian	2021-07-13 18:07:08		never
<input type="checkbox"/>	Mu2ell2021b_beam	5496	elebeamflash_cat_fcl	10559	Yes		oksuzian	2021-07-13 18:07:08		never
<input type="checkbox"/>	Mu2ell2021b_beam	5496	neutrals_resampler	10558	Yes		oksuzian	2021-07-13 18:07:08		never
<input type="checkbox"/>	Mu2ell2021b_beam	5496	neutrals_resampler_fcl	10557	Yes		oksuzian	2021-07-13 18:07:08		never
<input type="checkbox"/>	Mu2ell2021b_beam	5496	elebeam_resampler	10556	Yes		oksuzian	2021-07-13 18:07:08		never
<input type="checkbox"/>	Mu2ell2021b_beam	5496	elebeam_resampler_fcl	10555	Yes		oksuzian	2021-07-13 18:07:08		never
<input type="checkbox"/>	Mu2ell2021b_beam	5496	mubeam_resampler	10554	Yes		oksuzian	2021-07-13 18:07:08		never
<input type="checkbox"/>	Mu2ell2021b_beam	5496	mubeam_resampler_fcl	10553	Yes		oksuzian	2021-07-13 18:07:08		never
<input type="checkbox"/>	Mu2ell2021b_beam	5496	neutrals_cat	10552	Yes		oksuzian	2021-07-13 18:07:08		never
<input type="checkbox"/>	Mu2ell2021b_beam	5496	neutrals_cat_fcl	10551	Yes		oksuzian	2021-07-13 18:07:08		never
<input type="checkbox"/>	Mu2ell2021b_beam	5496	beam_splitter	10550	Yes		oksuzian	2021-07-13 18:07:08		never
<input type="checkbox"/>	Mu2ell2021b_beam	5496	beam_splitter_fcl	10549	Yes		oksuzian	2021-07-13 18:07:08		never
<input type="checkbox"/>	Mu2ell2021b_beam	5496	pot	10548	Yes		oksuzian	2021-07-13 18:07:08		never
<input type="checkbox"/>	Mu2ell2021b_beam	5496	pot_fcl	10547	Yes		oksuzian	2021-07-13 18:07:08		never



# Mu2e-II samples

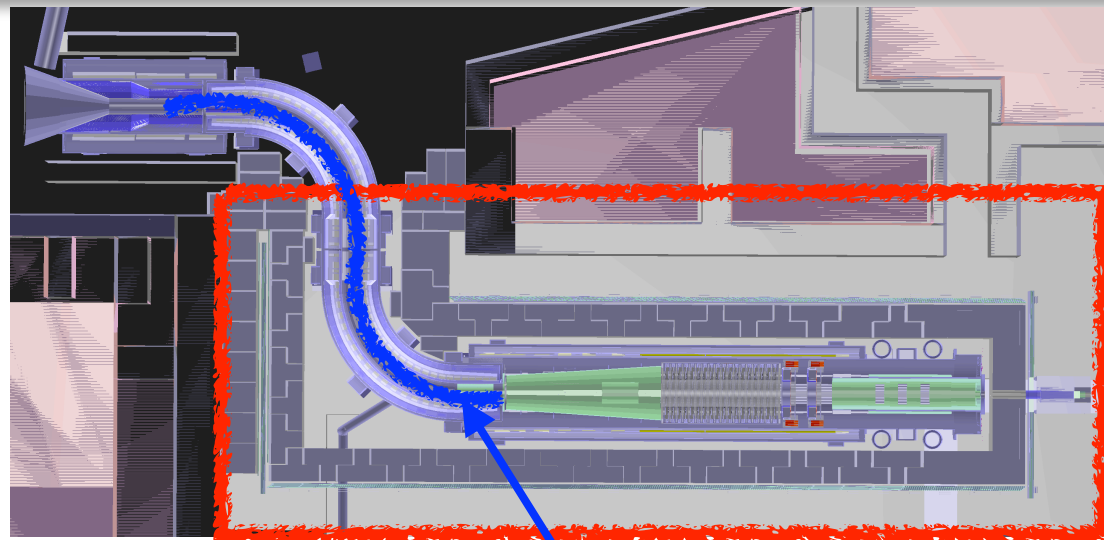
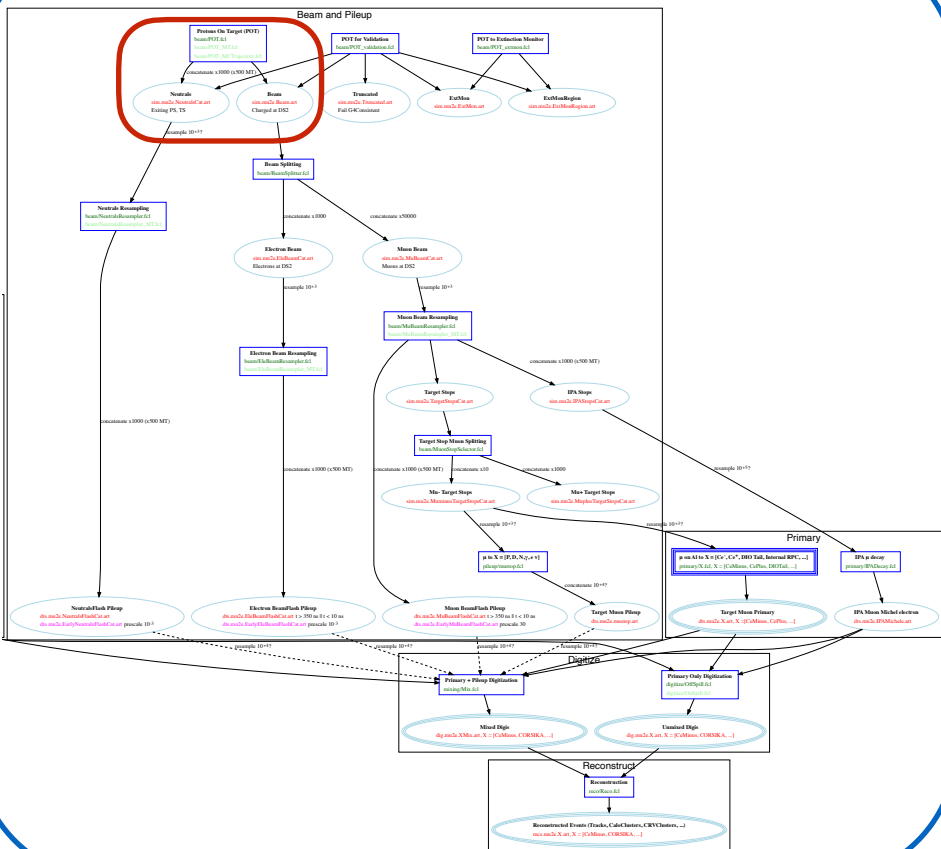
- The samples below were produced over few days using POMS
- Previously, this production would've taken at least a month due to a 'manual' submission and post-processing
- `samweb list-definitions --exp=mu2e --user=mu2epro | grep Mu2eII2021b`

```
sim.mu2e.Beam.Mu2eII2021b.art  
sim.mu2e.Neutrals.Mu2eII2021b.art  
sim.mu2e.NeutralsCat.Mu2eII2021b.art  
sim.mu2e.EleBeamCat.Mu2eII2021b.art  
sim.mu2e.MuBeamCat.Mu2eII2021b.art  
dts.mu2e.Cat.Mu2eII2021b.art  
sim.mu2e.IPASTops.Mu2eII2021b.art  
dts.mu2e.EleBeamFlash.Mu2eII2021b.art  
dts.mu2e.EarlyEleBeamFlash.Mu2eII2021b.art  
sim.mu2e.TargetStops.Mu2eII2021b.art  
dts.mu2e.MuBeamFlash.Mu2eII2021b.art  
dts.mu2e.EarlyMuBeamFlash.Mu2eII2021b.art  
dts.mu2e.NeutralsFlash.Mu2eII2021b.art  
dts.mu2e.EarlyNeutralsFlash.Mu2eII2021b.art  
dts.mu2e.EarlyNeutralsFlashCat.Mu2eII2021b.art  
dts.mu2e.NeutralsFlashCat.Mu2eII2021b.art  
dts.mu2e.EarlyEleBeamFlashCat.Mu2eII2021b.art  
dts.mu2e.EleBeamFlashCat.Mu2eII2021b.art  
sim.mu2e.TargetStopsCat.Mu2eII2021b.art  
sim.mu2e.IPASTopsCat.Mu2eII2021b.art  
dts.mu2e.MuBeamFlashCat.Mu2eII2021b.art  
sim.mu2e.MuminusStops.Mu2eII2021b.art  
sim.mu2e.MuplusStops.Mu2eII2021b.art
```



# POT simulation

## Mu2e Simulation Workflow



**Protons On Target (POT)**  
 beam/POT.fcl  
 beam/POT\_MT.fcl  
 beam/POT\_MCTrajectory.fcl

concatenate x1000 (x500 MT)

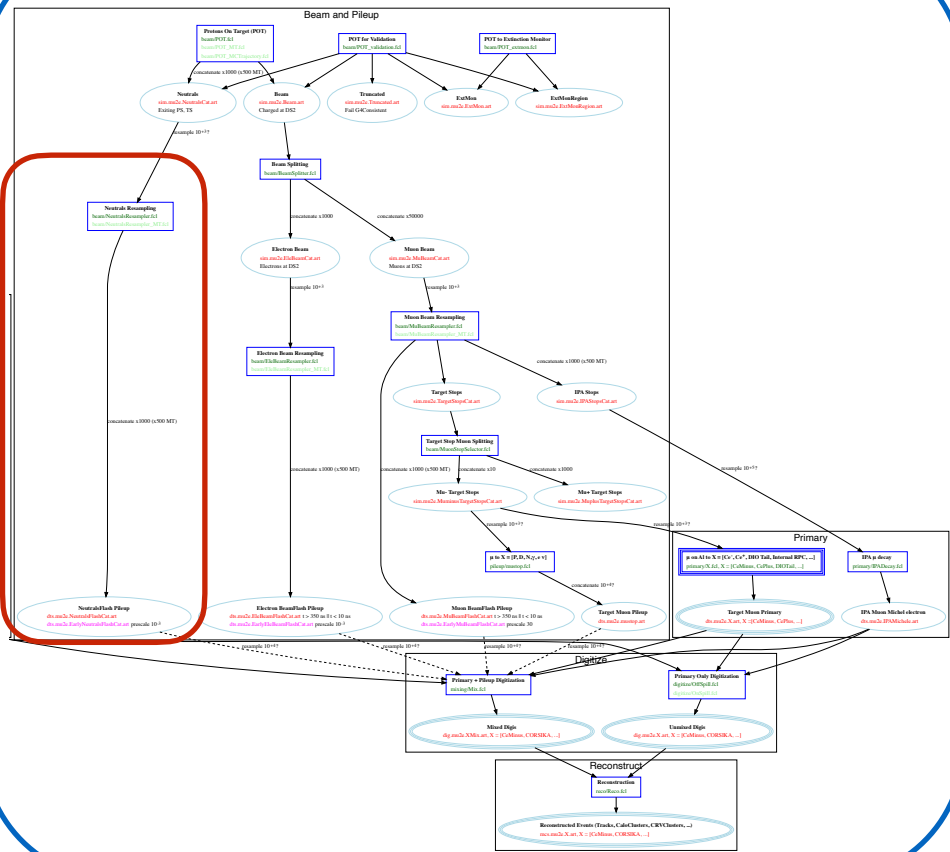
**Neutrals**  
 sim.mu2e.NeutralsCat.art  
 Exiting PS, TS  
 sim.mu2e.NeutralsCat.Mu2ell2021b.art

**Beam**  
 sim.mu2e.Beam.art  
 Charged at DS2  
 sim.mu2e.MuBeamCat.Mu2ell2021b.art

resample  $10^3$ ?



### Mu2e Simulation Workflow



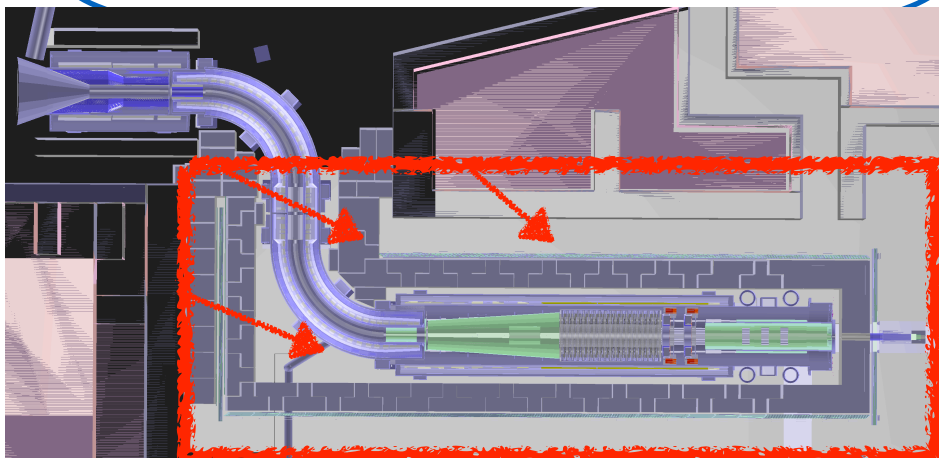
sim.mu2e.NeutralsCat.Mu2eII2021b.art

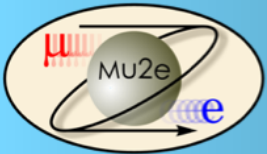
Neutrals Resampling  
 beam/NeutralsResampler.fcl  
 beam/NeutralsResampler\_MT.fcl

concatenate x1000 (x500 MT)

NeutralsFlash Pileup  
 dts.mu2e.NeutralsFlashCat.art  
 dts.mu2e.EarlyNeutralsFlashCat.art prescale 10<sup>-3</sup>

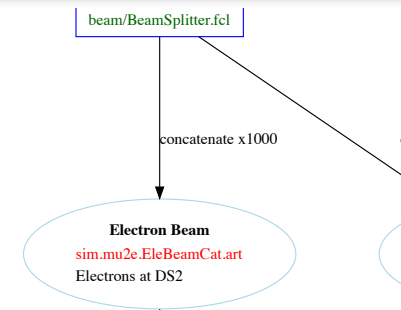
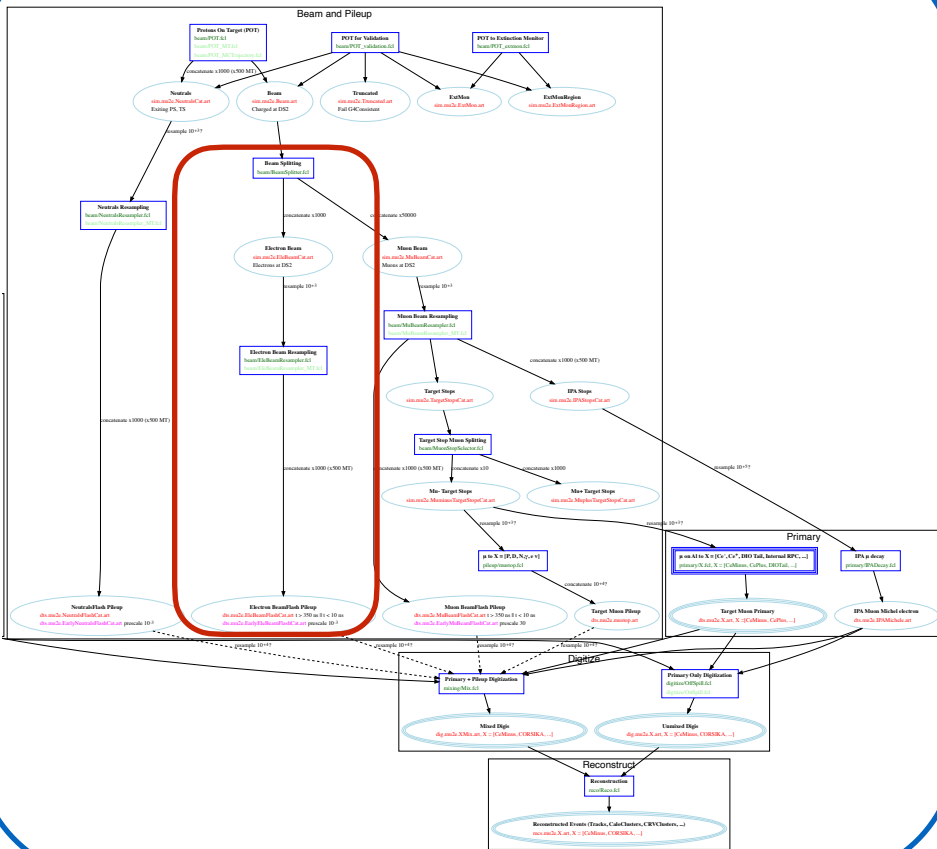
dts.mu2e.NeutralsFlash.Mu2eII2021b.art





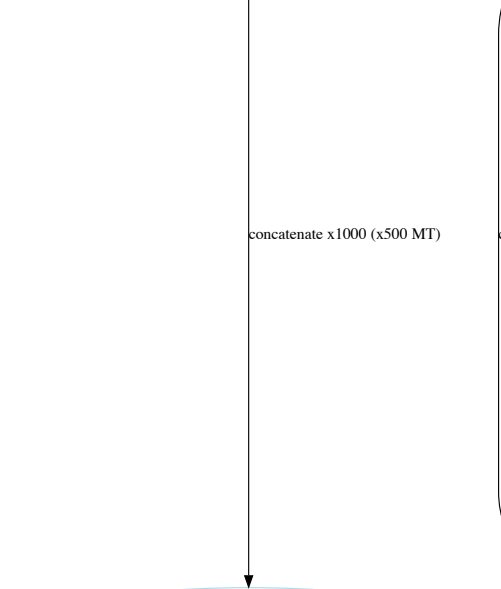
# Beam non-muons

## Mu2e Simulation Workflow

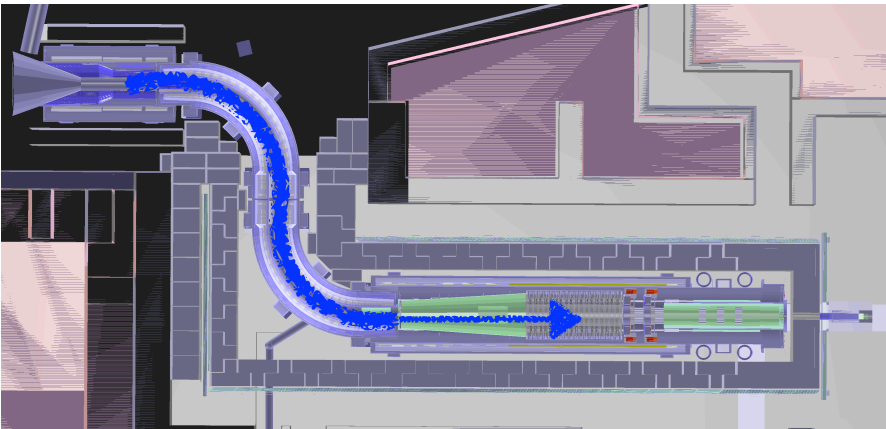


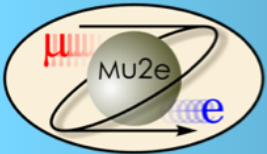
sim.mu2e.EleBeamCat.Mu2eI12021b.art

Electron Beam Resampling  
beam/EleBeamResampler.fcl  
beam/EleBeamResampler\_MT.fcl



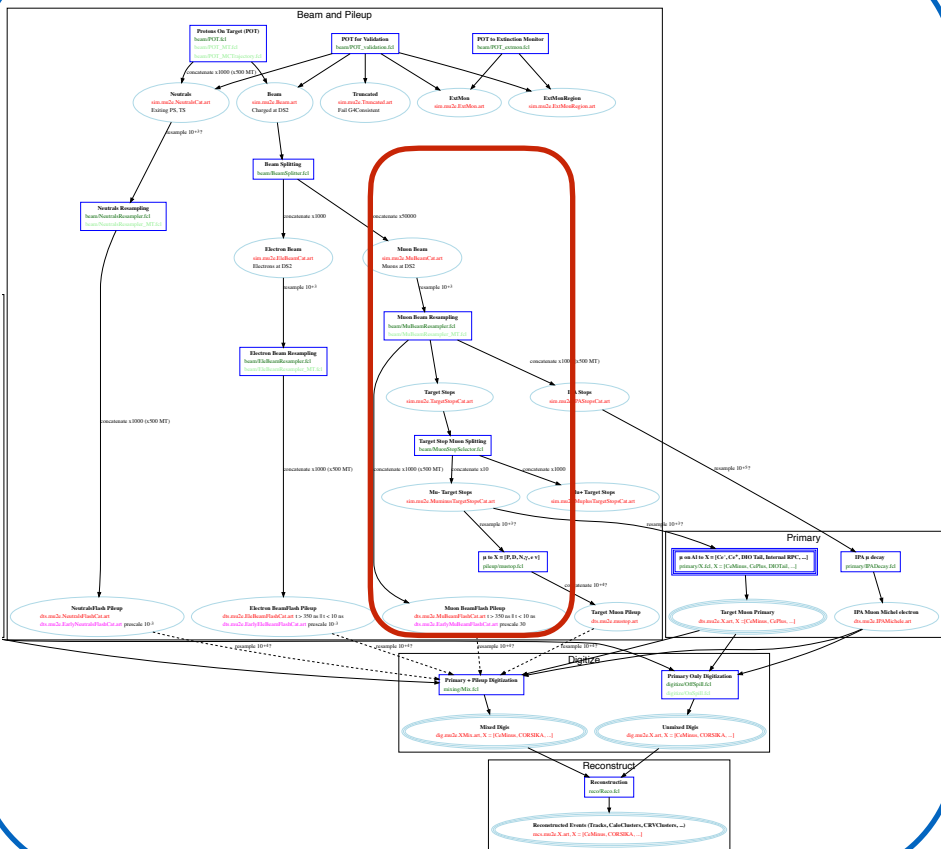
dts.mu2e.EleBeamFlashCat.Mu2eI12021b.art



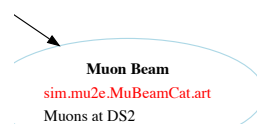


# Beam muons

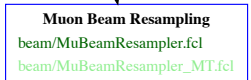
## Mu2e Simulation Workflow



concatenate x50000



sim.mu2e.MuBeamCat.Mu2ell2021b.art

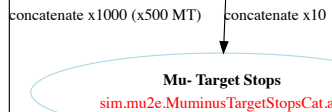


sim.mu2e.TargetStopsCat.Mu2ell2021b.art

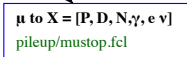
Target Stops



sim.mu2e.MuminusStops.Mu2ell2021b.art



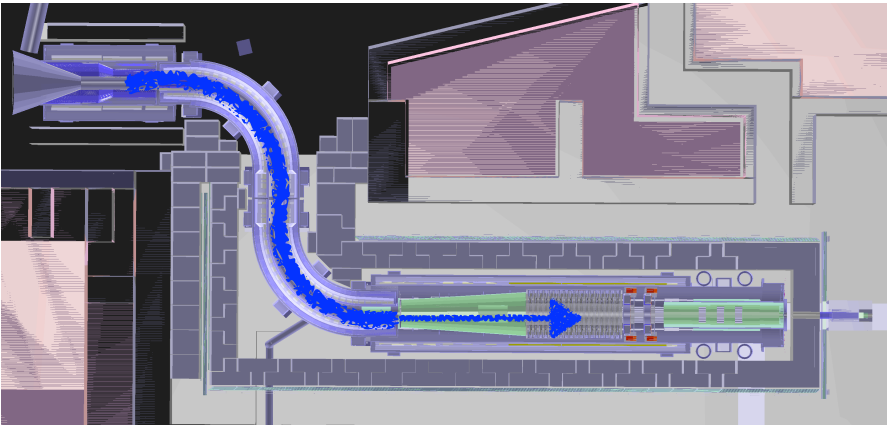
concatenate x1000 (x500 MT) concatenate x10

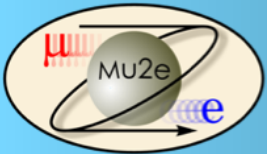


dts.oksuzian.MuStopPileupCat.Mu2ell2021b.art



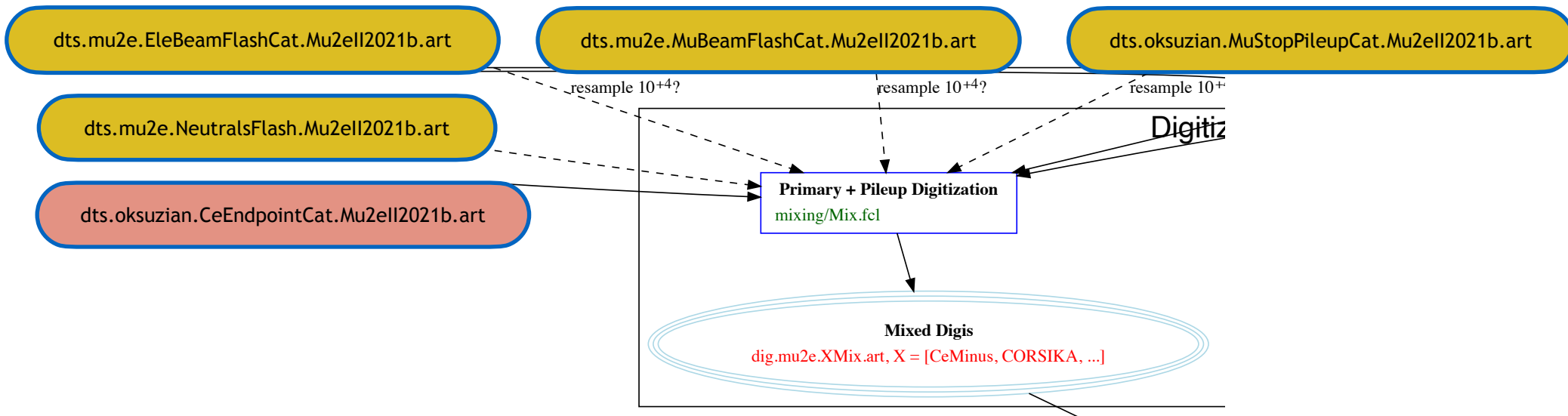
dts.mu2e.MuBeamFlashCat.Mu2ell2021b.art

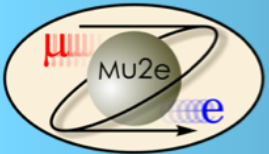




# Mixing and Digitization

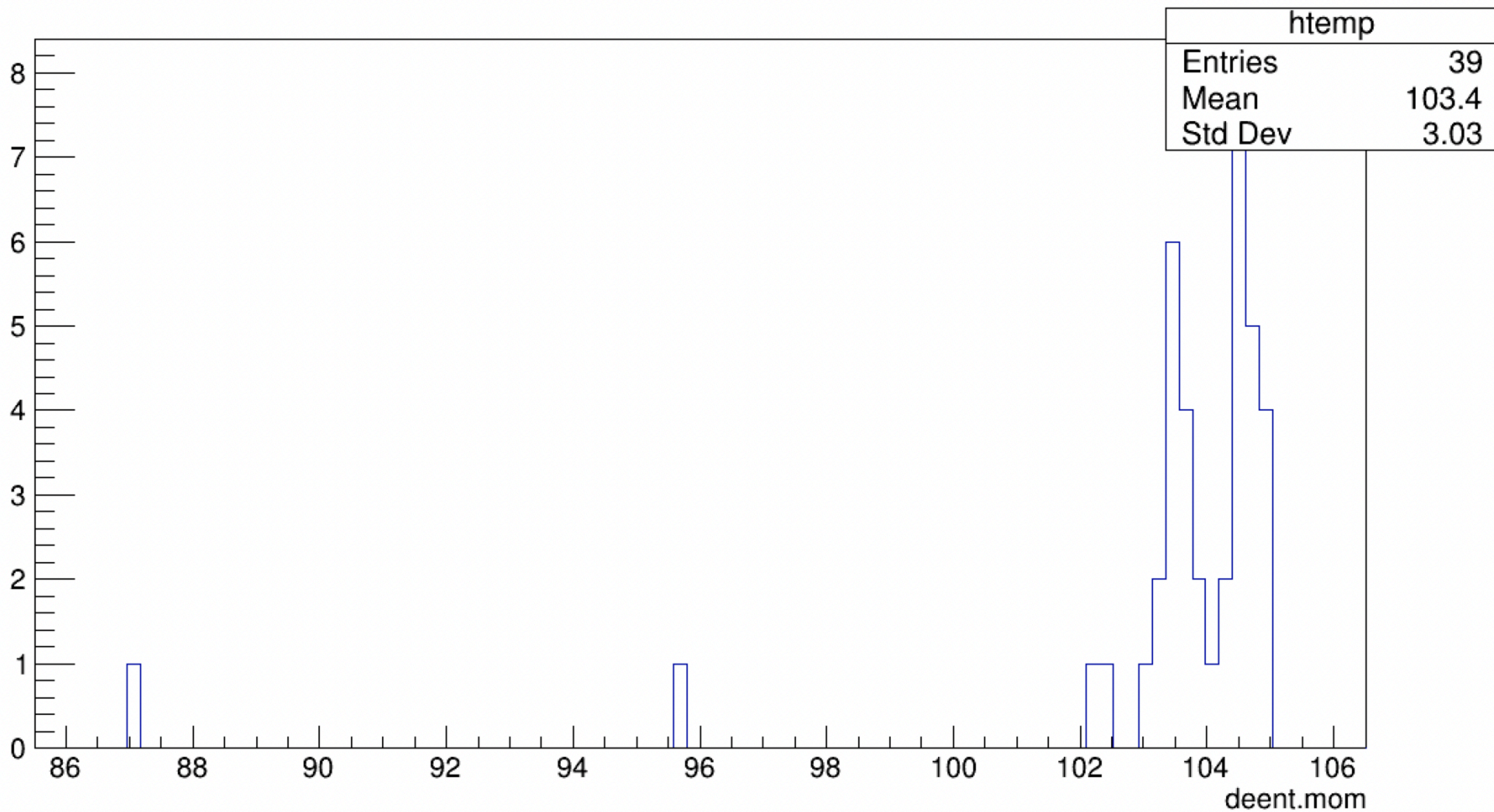
- /mu2e/data/users/oksuzian/dig.oksuzian.CeEndpointMixTriggered.Mu2eI2021b.001205\_00000000.art
- /mu2e/data/users/oksuzian/dig.oksuzian.CeEndpointMixUntriggered.Mu2eI2021b.001205\_00000000.art
- /mu2e/data/users/oksuzian/mcs.oksuzian.CeEndpointMixTriggered.Mu2eI2021b.001205\_00000000.art
- /mu2e/data/users/oksuzian/mcs.oksuzian.CeEndpointMixUntriggered.Mu2eI2021b.001205\_00000000.art
- /mu2e/data/users/oksuzian/nts.owner.trkana-reco.CeEndpointMixTriggered.Mu2eI2021b.root

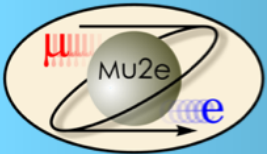




# Reconstructed momentum

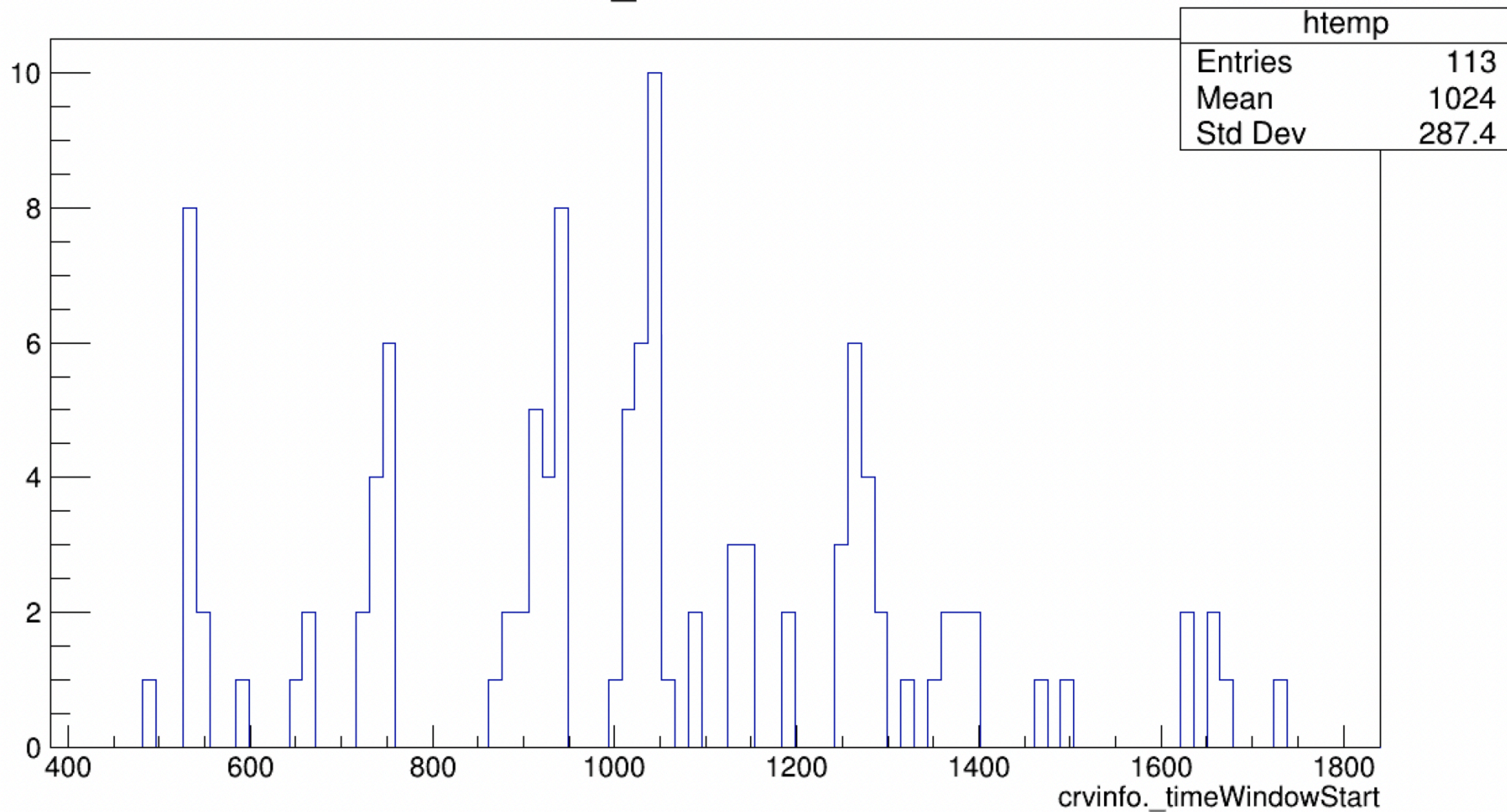
deent.mom

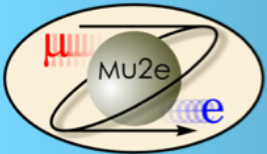




# Fake CRV vetoes

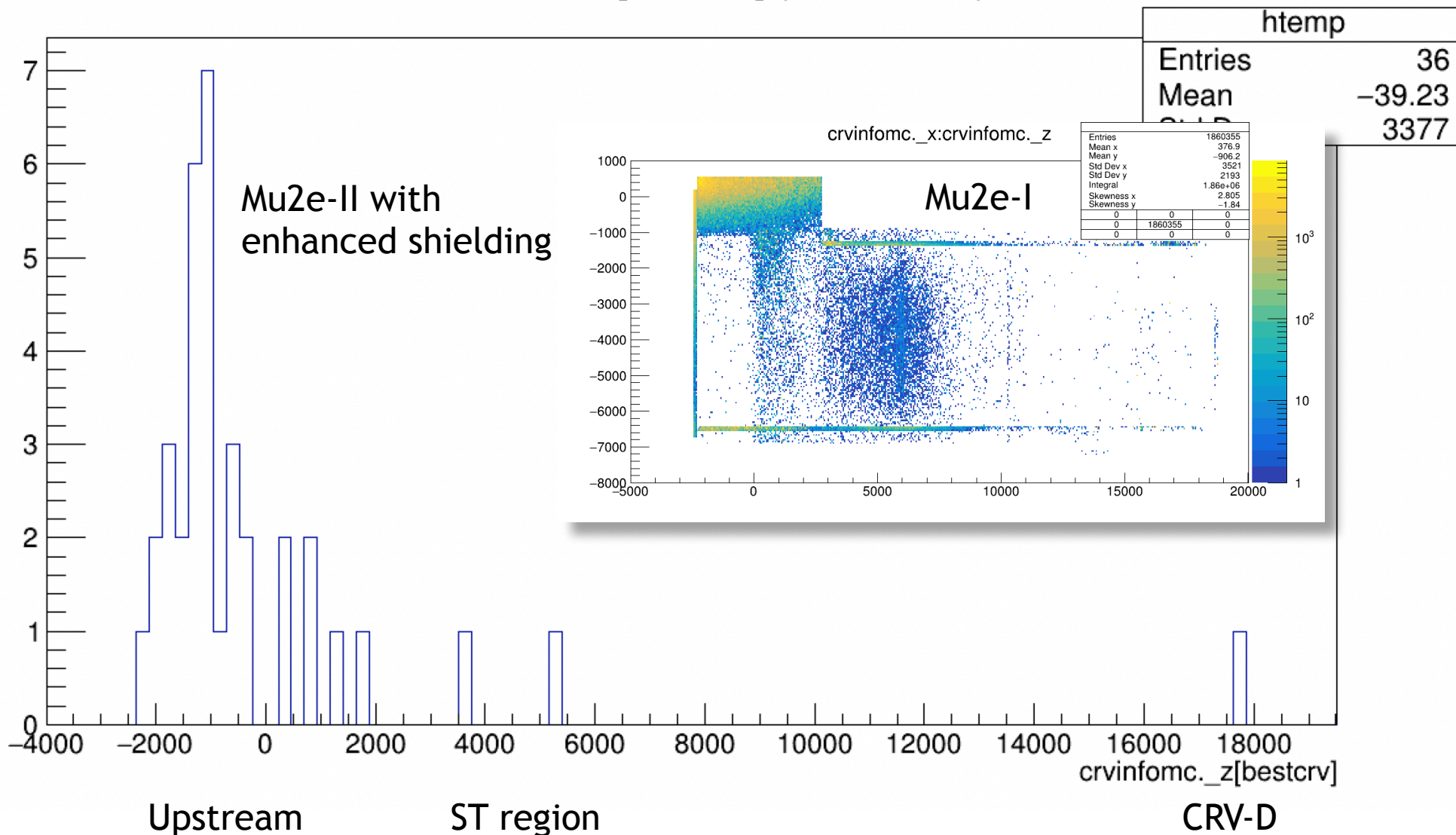
crvinfo.\_timeWindowStart

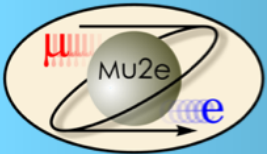




# Fake CRV vetoes: Z-position

`crvinfomc._z[bestcrv] {bestcrv>-1}`

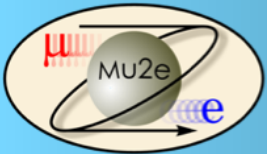




# Mixing proportions: Mu2e-I

Dataset name	Files	Event/file	Tot events simulated	Events trig	Prescale	Trig rate	Eff POT	Resampling rate	meanEventsPerProton	meanEventsPerBunch
sim.mu2e.Beam.MDC2020i.art	500	4000	2000000	350422		17.52%				
sim.mu2e.Neutrals.MDC2020i.art	500	4000	2000000	1333124		66.66%				
sim.mu2e.NeutralsCat.MDC2020i.art	1	1333124	1333124	1333124		100.00%				
sim.mu2e.MuBeamCat.MDC2020i.art	1	8640	8640	8640		100.00%				
sim.mu2e.EleBeamCat.MDC2020i.art	1	341782	341782	341782		100.00%				
sim.mu2e.TargetStopsCat.MDC2020i.art	1	71288	2.0E+8	71288	1000	30.99%	4.63E+07	23	1.54E-03	6.01E+04
sim.mu2e.MuminusStops.Mu2ell2021b.art	1	70934	2.0E+8	70934	1000	30.96%	4.63E+07	23	1.53E-03	5.98E+04
<hr/>										
dts.mu2e.NeutralsFlashCat.MDC2020i.art	500	400000	2.0E+8	45233		0.02%			<b>1.51E-04</b>	5.88E+03
dts.mu2e.EarlyNeutralsFlashCat.MDC2020i.art	500	400000	2.0E+8	2876		0.00%			9.59E-06	3.74E+02
Sum	500	400000	2.0E+8	48109		0.02%	3.0E+8	150		
<hr/>										
dts.mu2e.MuBeamFlashCat.MDC2020i.art	500	400000	2.0E+8	1126981	1	0.56%			<b>2.43E-05</b>	9.49E+02
dts.mu2e.EarlyMuBeamFlashCat.MDC2020i.art	500	400000	2.0E+8	60788	1	0.03%			1.31E-06	5.12E+01
Sum	500	400000	2.0E+8	1187769	1	0.59%	4.6E+10	23,148		
<hr/>										
dts.mu2e.EleBeamFlashCat.MDC2020i.art	500	400000	2.0E+8	26111		0.01%			<b>2.23E-05</b>	8.70E+02
dts.mu2e.EarlyEleBeamFlashCat.MDC2020i.art	500	400000	2.0E+8	1266		0.00%			1.08E-06	4.22E+01
Sum	500	400000	2.0E+8	27377		0.01%	1.2E+9	585		
<hr/>										
dts.brownd.CeEndpoint.MDC2020i.art	100	4000	4.0E+05	218574	1	54.64%				
dts.brownd.MuStopPileupCat.MDC2020i.001205.art	93	200000	1.9E+7	406794	1	2.19%	1.21E+10	262	<b>3.35E-05</b>	

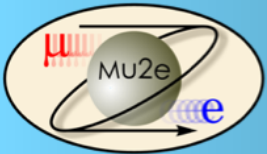




# Mixing proportions: Mu2e-II

- Target stop rate at Mu2e-II is factor of 2.3 higher
- Hit rates from:
  - ▶ neutrons is almost the same due to the enhanced shielding
  - ▶ beam muons is a factor of 3 higher
  - ▶ beam electrons is a factor of 5 higher
- Resampling rate for beam muons and electrons is too high
- Some mixing components will benefit from higher stats
- Target stops contain large (>10%) fraction on non-muons

Dataset name	Files	Event/file	Tot events simulated	Events trig	Prescale	Trig rate	Eff POT	Resampling rate	meanEventsPerProton	meanEventsPerBunch
sim.mu2e.Beam.Mu2eII2021b.art	500	10000	5000000	14201		0.3%				
sim.mu2e.Neutrals.Mu2eII2021b.art	500	10000	5000000	267201		5.3%				
sim.mu2e.NeutralsCat.Mu2eII2021b.art	1	267201	267201	267201		100.0%				
sim.mu2e.MuBeamCat.Mu2eII2021b.art	1	1266	1266	1266		100.0%				
sim.mu2e.EleBeamCat.Mu2eII2021b.art	1	12935	12935	12935		100.0%				
sim.mu2e.TargetStopsCat.Mu2eII2021b.art	1	78635	2.0E+8	78635	1000	39.3%	7.90E+08	158	9.96E-05	1.59E+05
sim.mu2e.MuminusStops.Mu2eII2021b.art	1	69471	2.0E+8	69471	1000	34.7%	7.90E+08	158	<b>8.80E-05</b>	1.41E+05
dts.mu2e.NeutralsFlashCat.Mu2eII2021b.art	500	400000	2.0E+8	17162		0.0%			<b>4.59E-06</b>	7.34E+03
dts.mu2e.EarlyNeutralsFlashCat.Mu2eII2021b.art	500	400000	2.0E+8	1033		0.0%			2.76E-07	4.42E+02
Sum	500	400000	2.0E+8	18195		0.0%	<b>3.7E+9</b>	749		
dts.mu2e.MuBeamFlashCat.Mu2eII2021b.art	500	400000	2.0E+8	1435948	1	0.7%			<b>1.82E-06</b>	2.91E+03
dts.mu2e.EarlyMuBeamFlashCat.Mu2eII2021b.art	500	400000	2.0E+8	59497	1	0.0%			7.53E-08	1.21E+02
Sum	500	400000	2.0E+8	1495445	1	0.7%	7.9E+11	<b>157,978</b>		
dts.mu2e.EleBeamFlashCat.Mu2eII2021b.art	500	400000	2.0E+8	228131		0.1%			<b>2.95E-06</b>	4.72E+03
dts.mu2e.EarlyEleBeamFlashCat.Mu2eII2021b.art	500	400000	2.0E+8	1027		0.0%			1.33E-08	2.13E+01
Sum	500	400000	2.0E+8	229158		0.1%	7.7E+10	<b>15,462</b>		
dts.oksuzian.CeEndpointCat.Mu2eII2021b.art	100	4000	400000	217144	1	54.3%				
dts.oksuzian.MuStopPileupCat.Mu2eII2021b.art	100	200000	20000000	432577	1	2.2%	2.27E+11	288	<b>1.90E-06</b>	
Early flash is prescaled by 1000										1.60E+09



- Have updated Mu2ell\_SM21 branch to the head of Offline (thanks to Michael)
  - ▶ This has provided an opportunity to use the latest code developments and piggy-back on MDC2020 POMS campaign
  - ▶ Produced a test sample of CE with mixed background frames
- Going forward:
  - ▶ Update detectors' geometry
  - ▶ Produce higher stat samples
  - ▶ Estimate sensitivity