NEWS

H2020-MSCA-RISE-2016 – Grant Agreement N° 734303

WP 6, FNAL μ-campus

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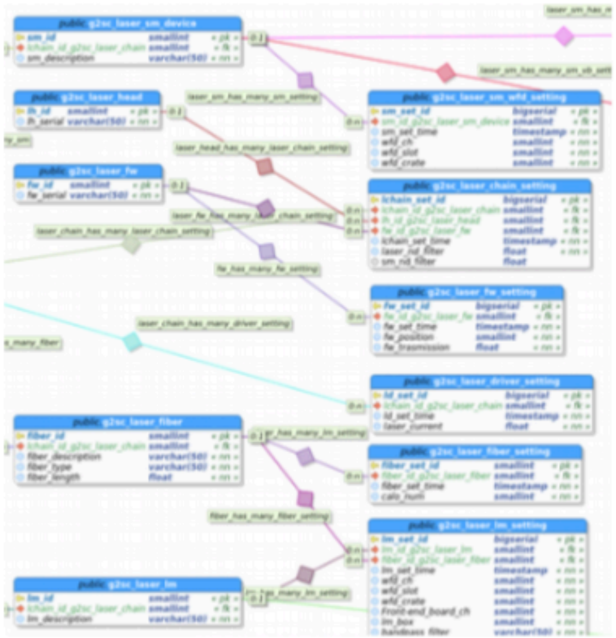
WP 6 Co-leaders

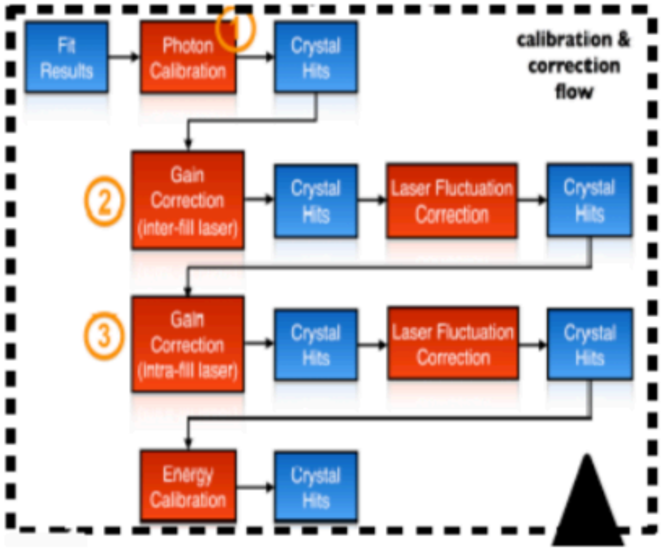
Objectives

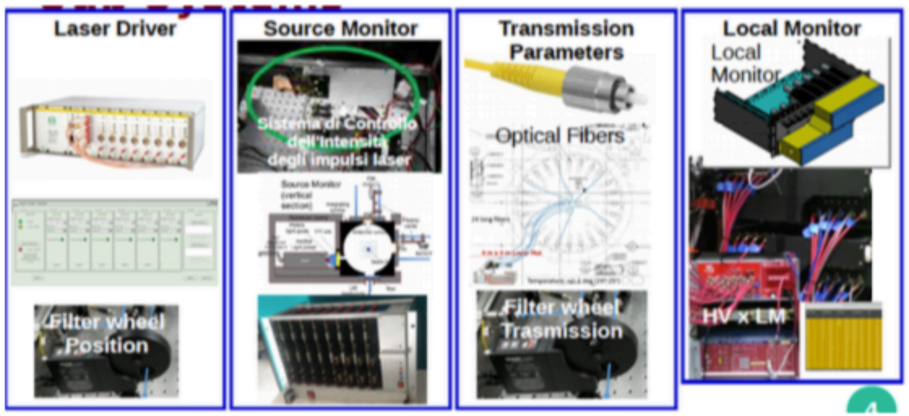
- **O6.1: Develop analysis tools and computing infrastructure to participate in the Muon (g-2) experiment data analysis.**
- O6.2: Perform precision measurement of the anomalous muon magnetic moment with the full Muon (g-2) experiment collected data sample.
- **O6.3: Develop neutron transport simulation code and computing infrastructure for the Mu2e experiment.**
- O6.4: Develop GEANT4 simulation of the upgraded radiation-hard BaF2 crystal calorimeter for the Mu2e-II experiment.
- O6.5: Design the upgraded BaF2 crystal calorimeter for the Mu2e-II experiment. Test of a BaF2 crystal matrix on test beam.

O6.1: Latest progresses

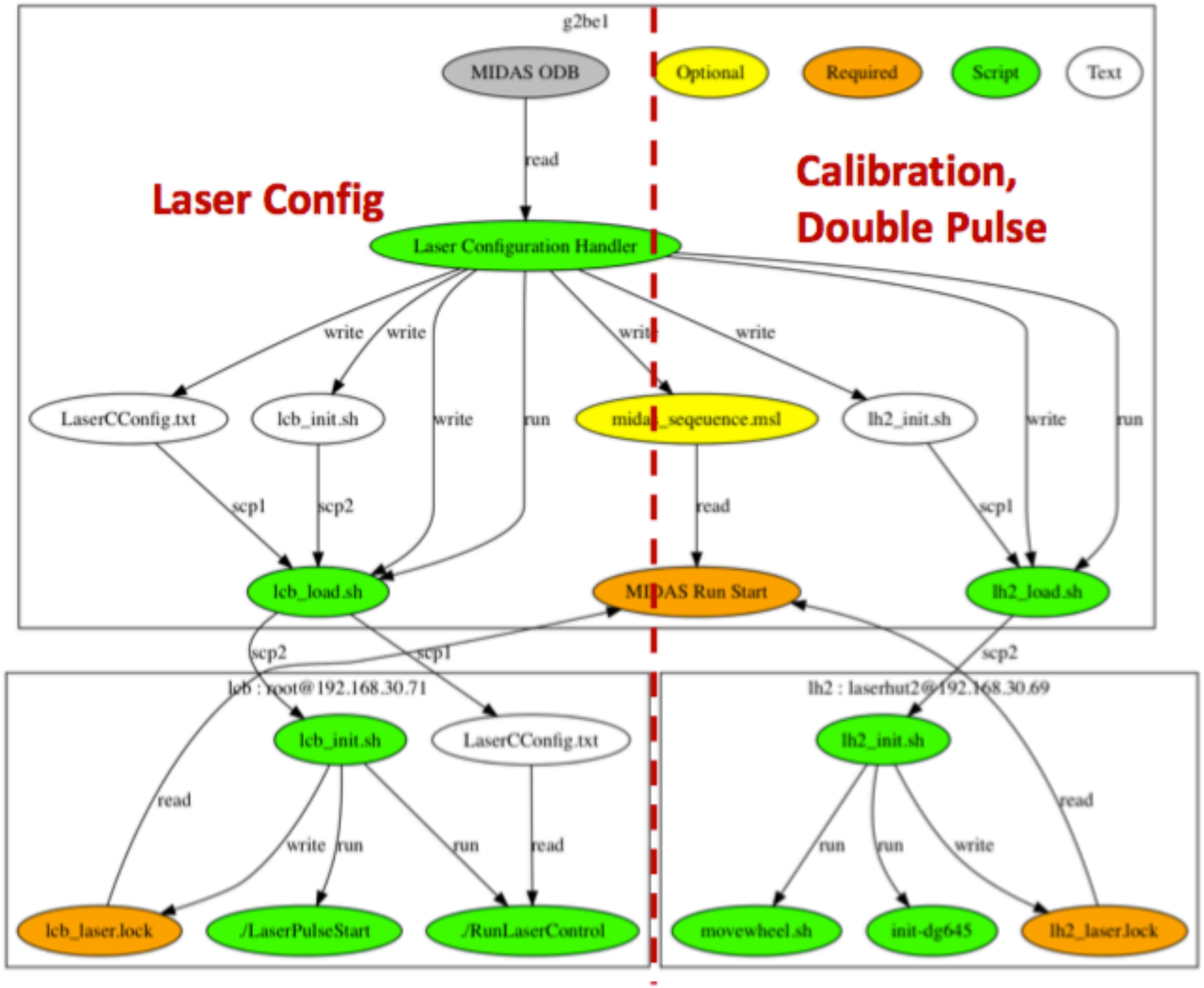
- Gain corrections (In fill out of fill)
- DB & DQM Updates
- Slow control for all the subsystems
- Wiki Page with a lot of information







O6.1: ODB Structure for Laser Configuration, Calibration and Double Pulse



Examples: Double Pulse & Calibration Defaults

Online Database Browser

Find | Create | Delete | Create Elog from this page

/ Settings / Laser / double-pulse-mode /

Key	Value
OutFillBit	n
FI2Bit	n
FI1Bit	n
FillBit	y
BofBit	n
EofBit	n
RunBit	y
RESET	19 (0x13)
Time2BOF	10 (0xA)
Time2T0	15 (0xF)
Time2EOF	32 (0x20)
NShiftRep	19 (0x13)
TimeInFillPeriod	0 (0x0)
NPulseInFill	1 (0x1)
Time2T0OutFill	255 (0xFF)
TimeOutFillPeriod	255 (0xFF)
NPulseOutFill1	47 (0x2F)
NPulseOutFill2	47 (0x2F)
NPulseOutFill3	47 (0x2F)
NPulseOutFillSim	79 (0x4F)
ConfigFilePath	/home/debian/LaserCtr_ver2/data/OutFRAME_FIFO_Nhit96_Nevt500k_tw2_650us.txt
InitialDelay	0 (0x0)
FinalDelay	40000 (0x9C40)
DeltaDelay	2000 (0x7D0)
EvenRun	y

Online Database Browser

Find | Create | Delete | Create Elog from this page

/ Settings / Laser / calibration-mode /

Key	Value
OutFillBit	n
FI2Bit	n
FI1Bit	n
FillBit	y
BofBit	y
EofBit	y
RunBit	y
RESET	19 (0x13)
Time2BOF	16 (0x10)
Time2T0	64 (0x40)
Time2EOF	64 (0x40)
NShiftRep	1 (0x1)
TimeInFillPeriod	0 (0x0)
NPulseInFill	1 (0x1)
Time2T0OutFill	255 (0xFF)
TimeOutFillPeriod	255 (0xFF)
NPulseOutFill1	47 (0x2F)
NPulseOutFill2	47 (0x2F)
NPulseOutFill3	47 (0x2F)
NPulseOutFillSim	79 (0x4F)
ConfigFilePath	/home/debian/LaserCtr_ver2/data/OutFRAME_FIFO_Nhit96_Nevt500k_tw2_650us.txt
Placeholder	n

O6.1: Wiki page

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Muon g-2

Search: [ ] Muon g-2

Overview | Activity | Roadmap | Issues | New issue | Calendar | News | Documents | Wiki | Forums | Files | Repository | HTML | Settings

Wiki » Laser » Laser Double Pulse »   Edit Watch History

Short Time Double Pulse

- Sequence of operations (details below):
    1. Set the laser configuration mode
    2. Load the laser configuration mode
    3. Set the mirrors
    4. Launch the sequencer
    5. Iterate steps 3 and 4 for ODD and for EVEN lasers
    6. Unset mirrors

1. Set the laser pulse configuration mode

- In the MIDAS window select **ODB** and then **/ Equipment / AMC1325 / Laser / Configuration**
- In the key **LaserMode** write **4** (check from the list above that this number corresponds to *short-double-pulse-mode*)
- If explicitely instructed, select mode **4** and modify *delays* or *filter wheel positions* at the bottom of the screen

2. Load the laser configuration mode

- In the MIDAS window select **Programs**
- *Make sure the run is in **STOP** condition*
- Restart laser crate frontend by pressing *STOP AMC1325* and then *START AMC1325*
- Restart CCC crate frontend by pressing *STOP AMC1300* and then *START AMC1300*

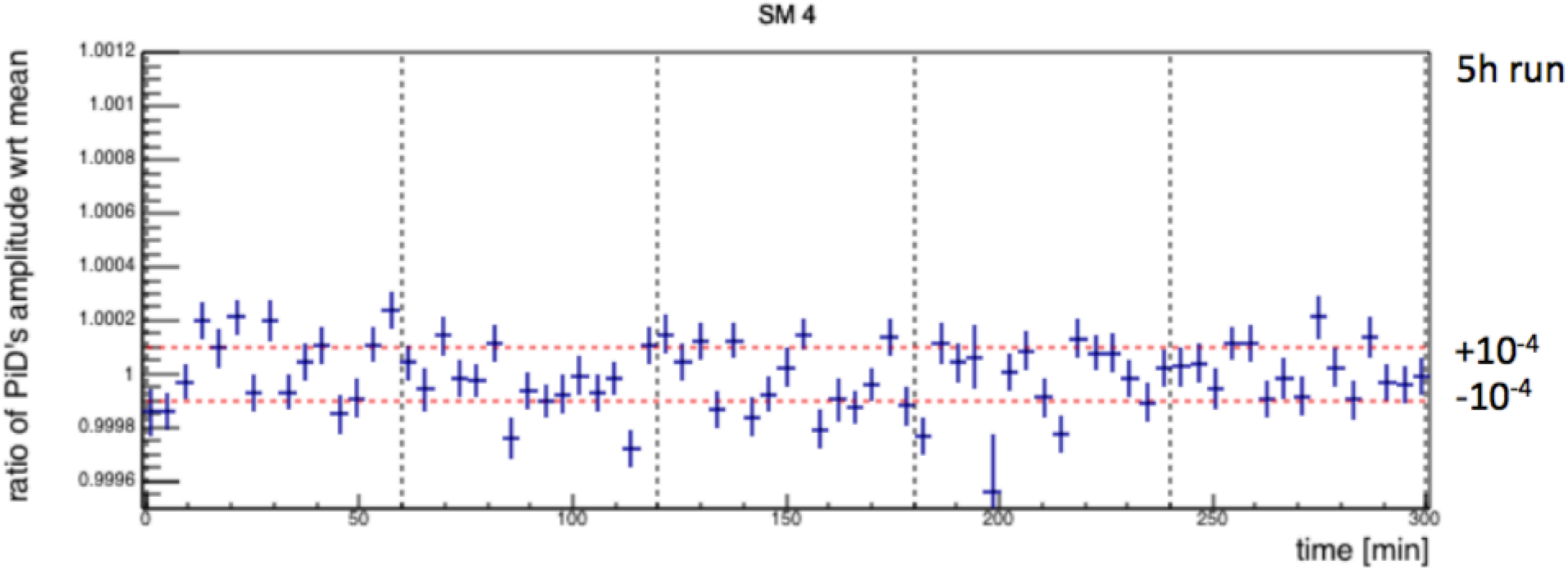
3. Set the mirrors

Wiki

Start page
Index by title
Index by date

O6.1: Laser system stability monitor

- Since the end of October we are running the laser in a stable configuration
  - ➢ Allow to study the long term performance of our system



O6.3: Neutron shielding in Mu2e

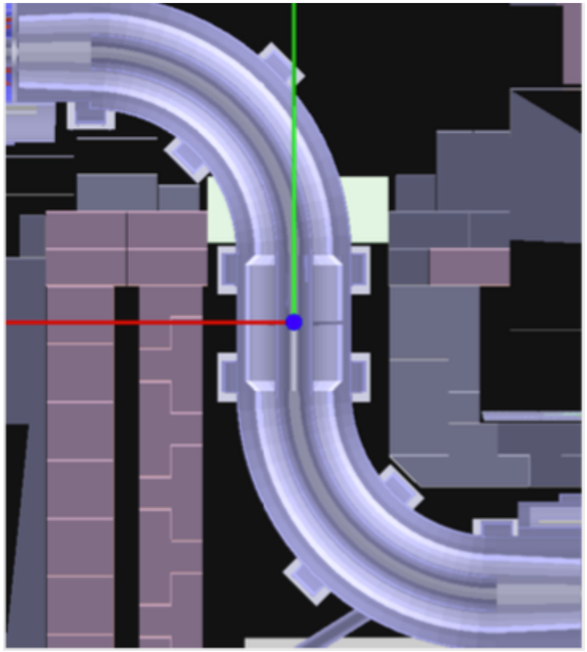
- Shielding surrounding the Cosmic-ray veto (CRV) is necessary to:
  1. Reduce the flux of neutral particles coming from the PS
  2. Keep the neutron flux in the CRV SiPMs below 10^{10} n/cm$^2_{1MeV\ eq}$

Why?

R-1. High rate in the CRV induces large dead time

R-2. Above 10^{10} n/cm$^2_{1MeV\ eq}$ SiPMs cannot provide single PE

- Current design is based on GEANT4 & MARS sim

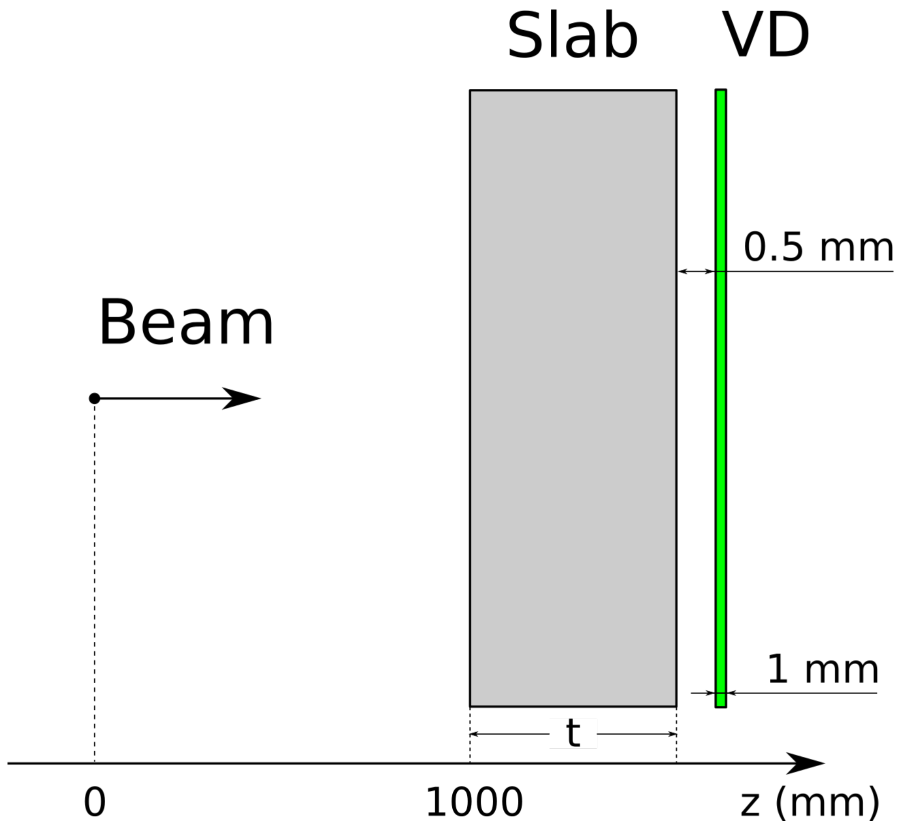


NEWS contribute:

- Development of FLUKA and MCNP6 model of the Mu2e apparatus will allow to improve the design
  - Completely independent from GEANT4
  - MCNP6 is "data" based

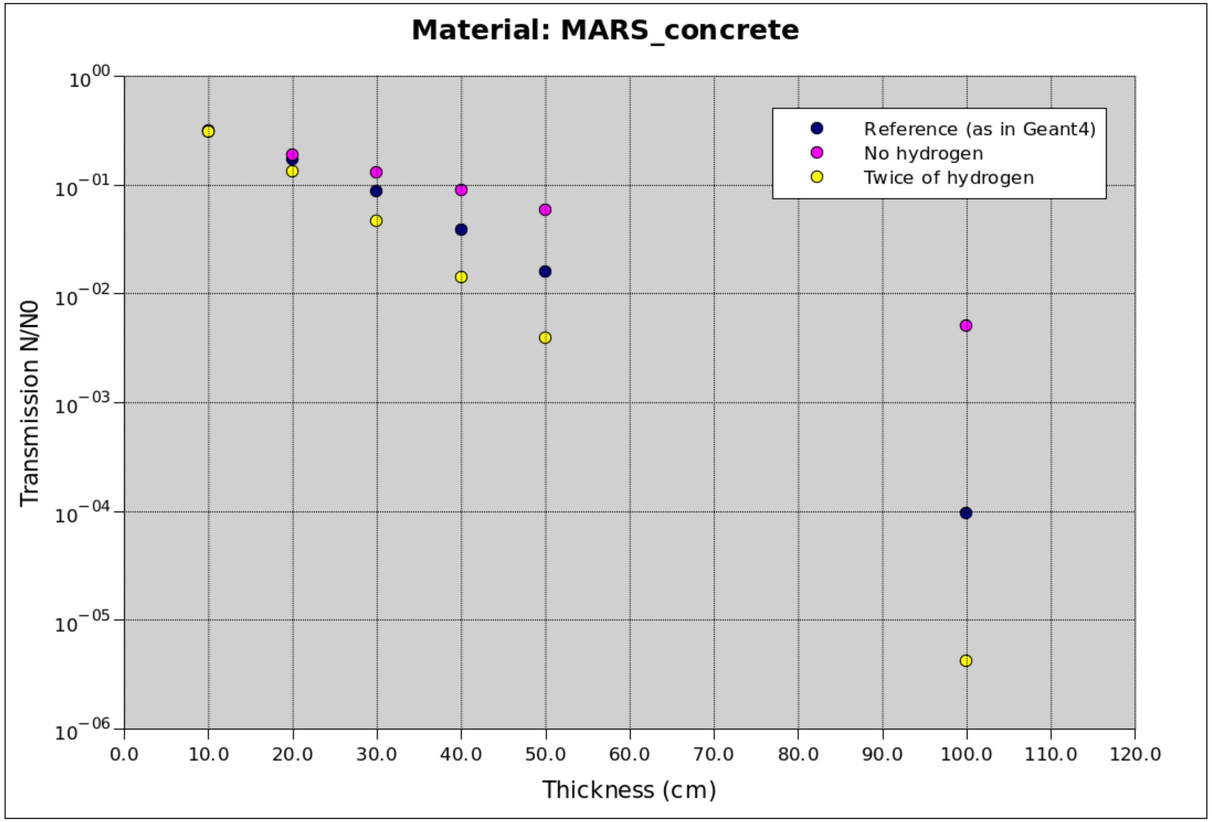
O6.3: Neutron shield study

- Adopting the same geometry used to compare MCNP6 with previous FLUKA and Geant4 simulations, the effect of the hydrogen content in the concrete have been firstly investigated.



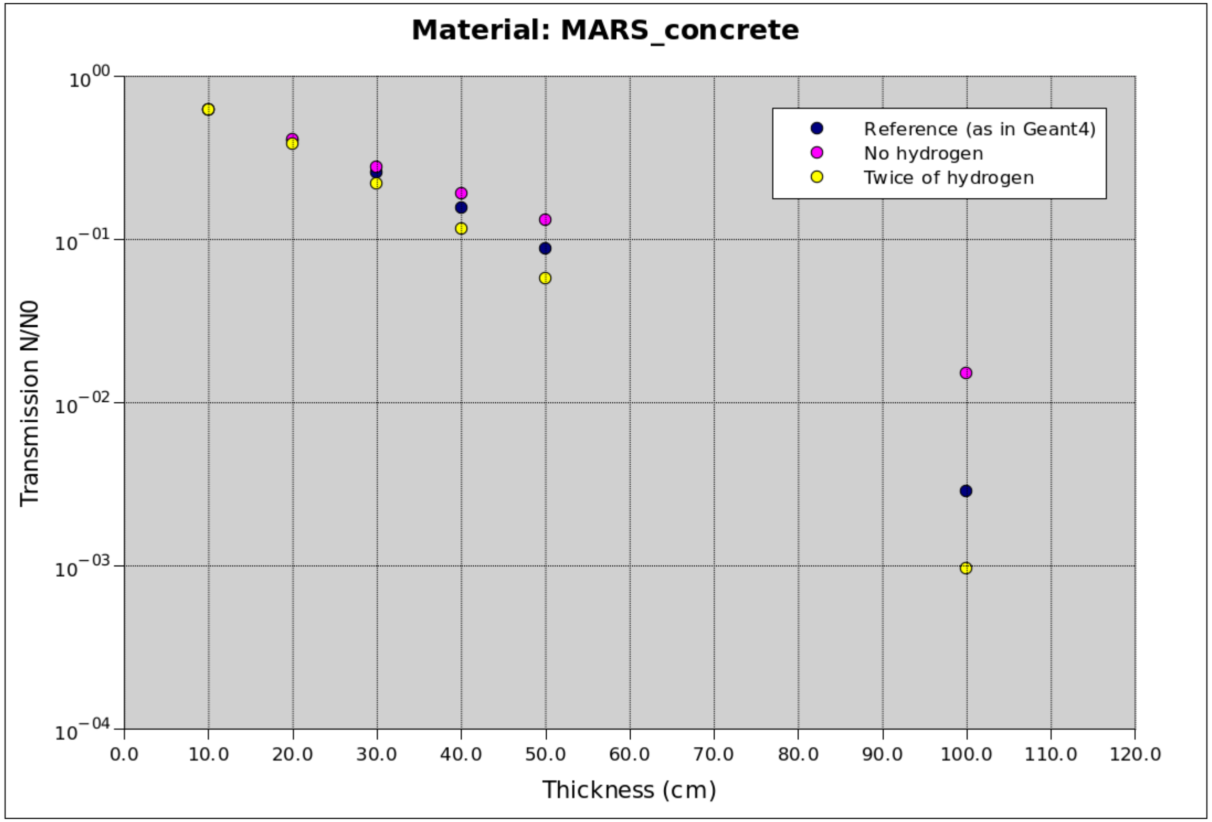
O6.3: Neutron shield study

- Here below the results for a shield thickness of 100 cm and neutron energy of **1 MeV** are shown



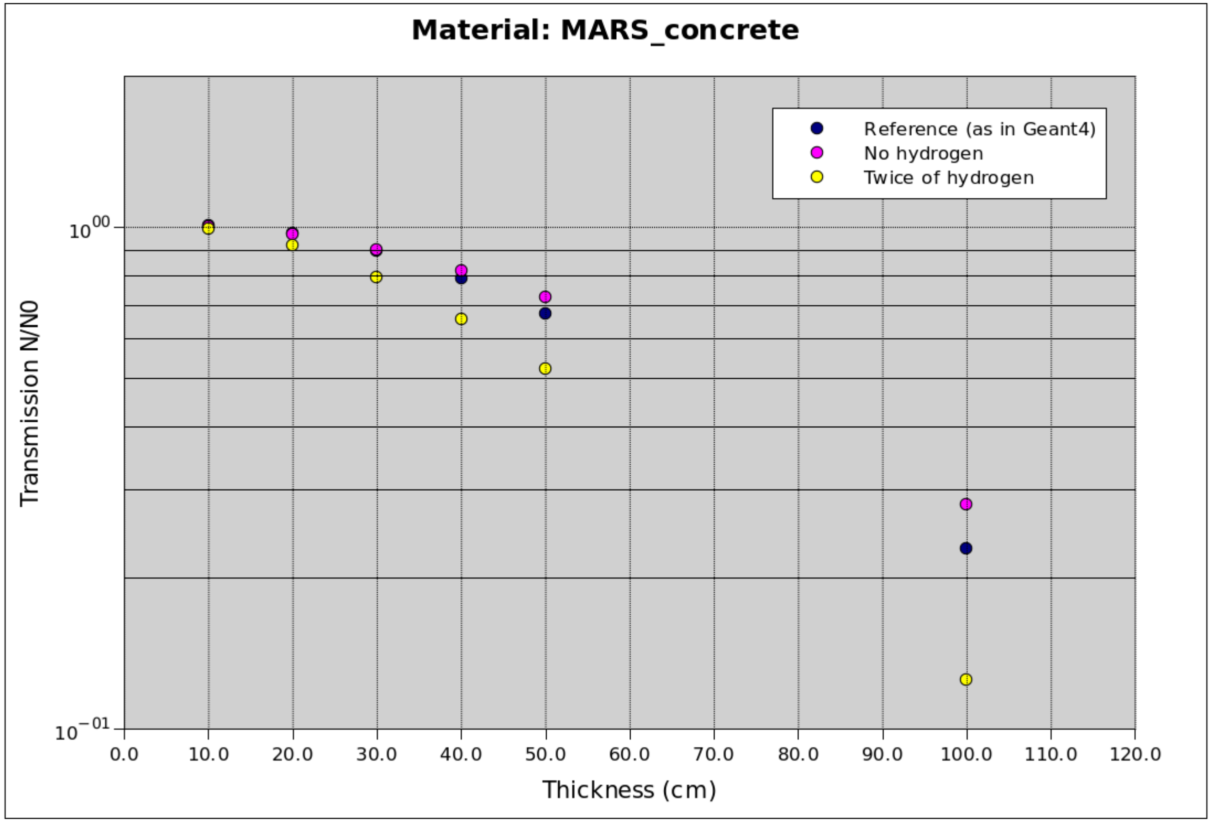
O6.3: Neutron shield study

- Here below the results for a shield thickness of 100 cm and neutron energy of **10 MeV** are shown



O6.3: Neutron shield study

- Here below the results for a shield thickness of 100 cm and neutron energy of **100 MeV** are shown



O6.3: neutron transport simulation

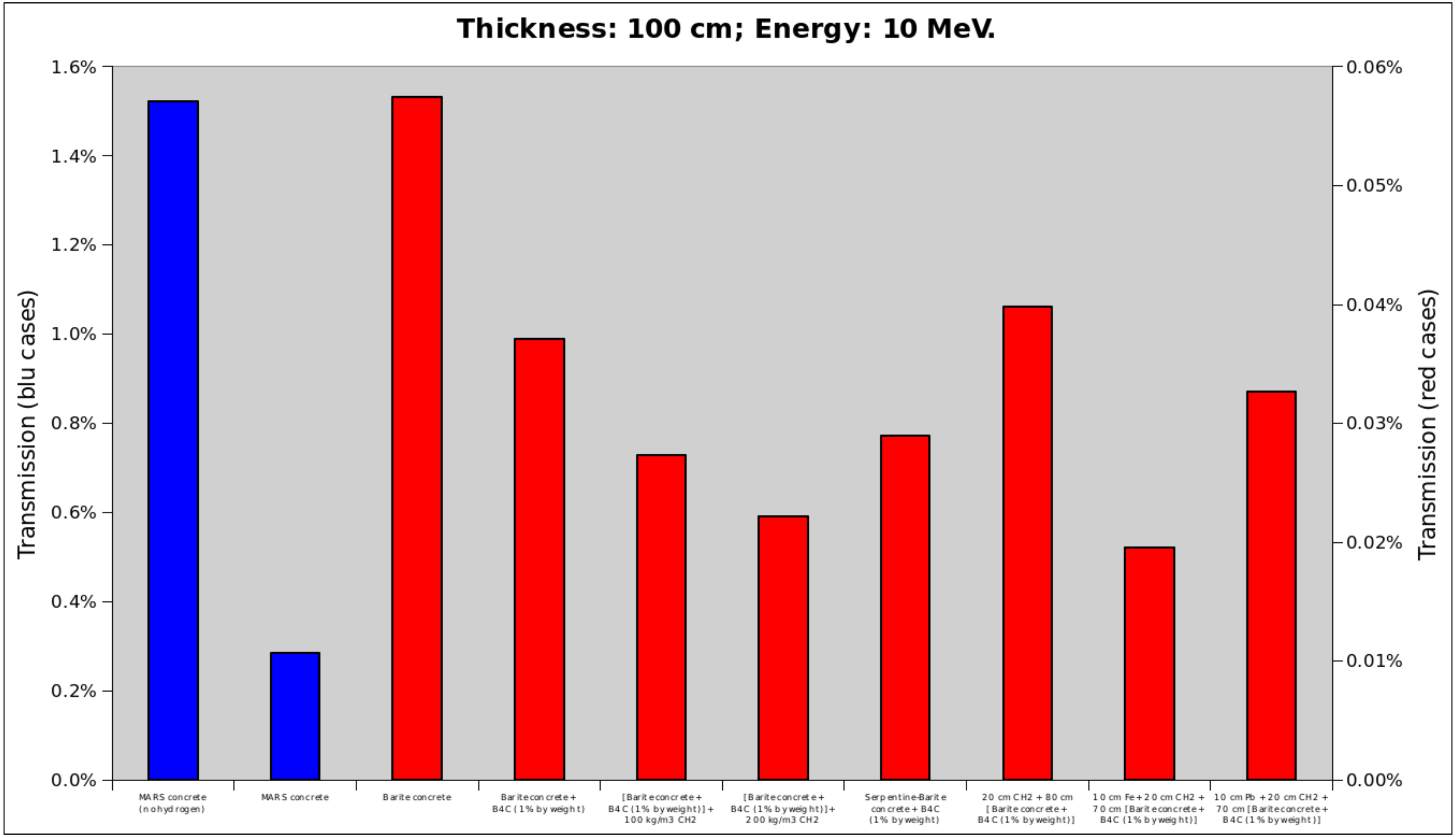
- Hydrogen content is important in order to enhance the neutron shielding capabilities: it efficiently slows down the high energy neutrons which can then be removed by the addition of a neutron absorber like ^{10}B (e.g. B_4C)

- At the same time a high mass density is also desirable to shield the gamma rays

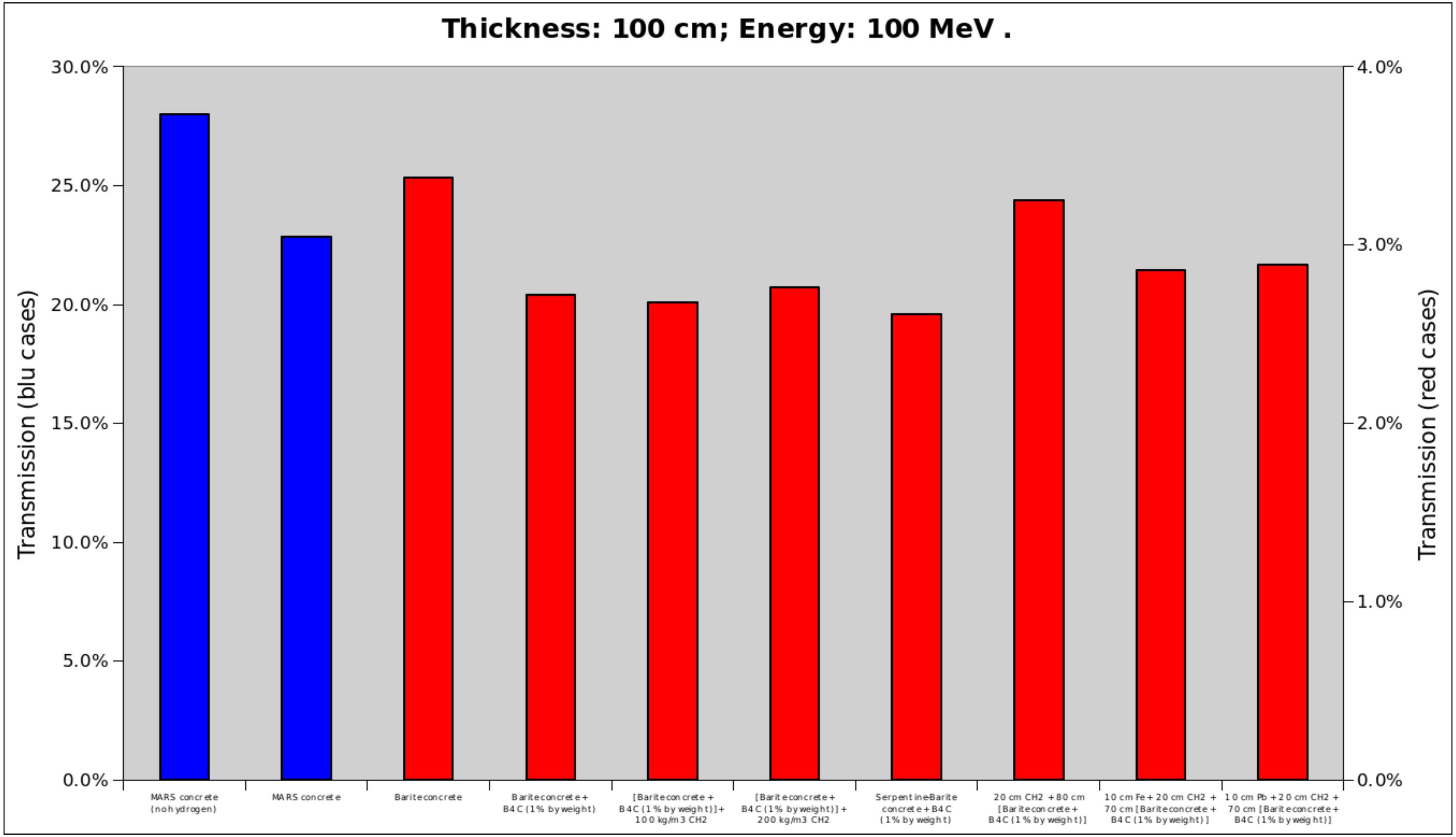
- Among the different concrete compositions tested there are:

Concrete	Hydrogen content (% by weight)	Density (g/cm3)
Barite concrete	0,690	3,500
Barite concrete + B4C (1% by weight)	0,683	3,486
[Barite concrete + B4C (1% by weight)]+ 100 kg/m3 CH2	1,108	3,221
[Barite concrete + B4C (1% by weight)] + 200 kg/m3 CH2	1,610	2,957
Serpentine-Barite concrete + B4C (1% by weight)	1,054	3,009

O6.3: neutron transport simulation



O6.3: neutron transport simulation



Summary

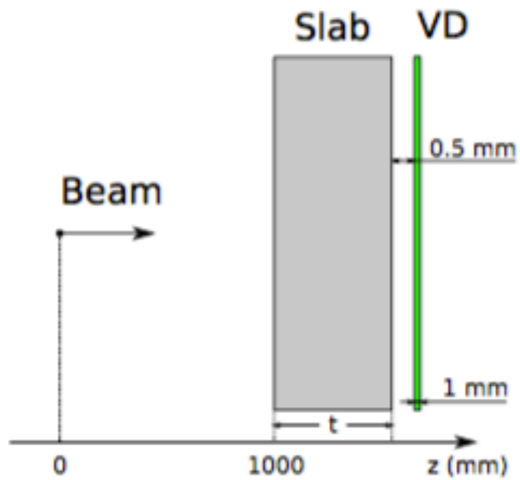
- New g-2 experiment data taking is well proceeding:
  - Implemented algorithms for Gain correction
  - Database & Data-quality monitor for laser system ready and running
  - Laser system is running in stable condition since the end of Oct 2017
- Neutron MCNP6 studies of shielding materials started:
  - Interaction with Mu2e software & sim group to improve the design of the neutron shield is in progress
  - Preliminary results have shown a good agreement between MCNP6 and Geant4 in evaluating material properties
  - A new set of simulations aiming at testing the performance in terms of neutron shielding of different concrete compositions have been started

Back up slides

O6.3: Neutron shield study

Geometry

A pencil beam of monoenergetic neutrons strikes normally on a concrete slab. The neutrons entering the virtual detector (VD) positioned 0.5 mm downstream the slab are counted.



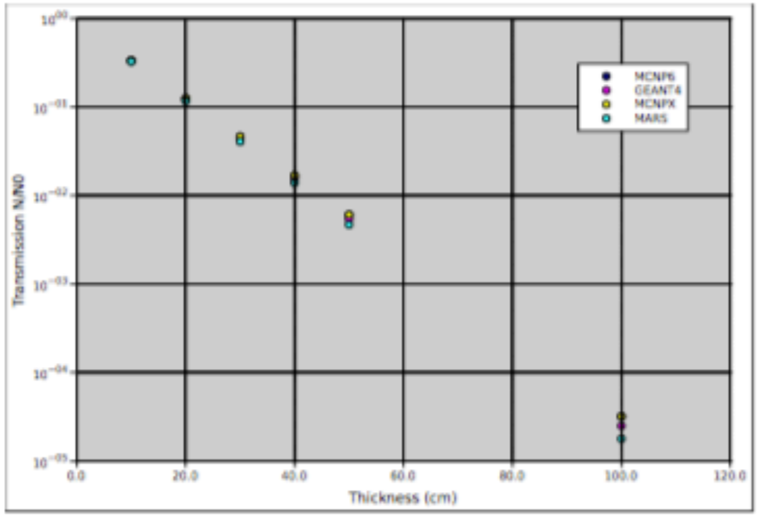
Slab material	Slab thickness (cm)	Beam energy (MeV)
MARS_concrete	10, 20, 30, 40, 50, 100	10^{-6}, 10^{-3}, 1.0, 10.0, 100.0

O6.3: neutron transport simulation

Neutron energy: 1 eV

	MCNP6	(1σ)	GEANT4	Δ%[a]	MCNPX	Δ%[a]	MARS	Δ%[a]
10	3.328E-01	0.04%	3.35E-01	0.6%	3.33E-01	0.1%	3.27E-01	-1.8%
20	1.245E-01	0.07%	1.23E-01	-1.2%	1.25E-01	0.4%	1.16E-01	-7.3%
30	4.596E-02	0.10%	4.39E-02	-4.7%	4.61E-02	0.3%	4.06E-02	-13.2%
40	1.673E-02	0.16%	1.55E-02	-7.9%	1.68E-02	0.4%	1.39E-02	-20.3%
50	6.013E-03	0.26%	5.40E-03	-11.4%	6.05E-03	0.6%	4.68E-03	-28.5%
100	3.187E-05	3.41%	2.49E-05	-28.0%	3.18E-05	-0.2%	1.78E-05	-79.1%

[a] Relative difference with respect to MCNP6.

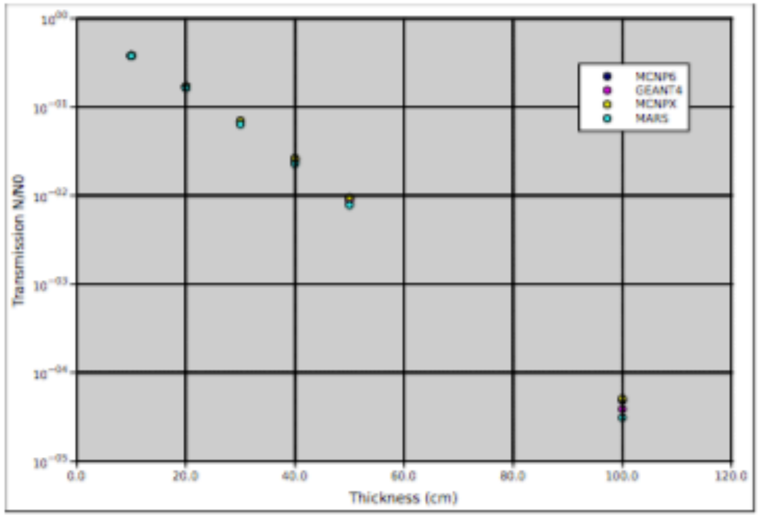


O6.3: neutron transport simulation

Neutron energy: 1 keV

	MCNP6	(1σ)	GEANT4	$\Delta\%^a$	MCNPX	$\Delta\%^a$	MARS	$\Delta\%^a$
10	3.811E-01	0.04%	3.80E-01	-0.3%	3.80E-01	-0.3%	3.77E-01	-1.1%
20	1.708E-01	0.06%	1.68E-01	-1.7%	1.70E-01	-0.5%	1.64E-01	-4.1%
30	6.937E-02	0.09%	6.68E-02	-3.8%	6.92E-02	-0.2%	6.37E-02	-8.9%
40	2.615E-02	0.14%	2.45E-02	-6.7%	2.61E-02	-0.2%	2.28E-02	-14.7%
50	9.466E-03	0.22%	8.70E-03	-8.8%	9.51E-03	0.5%	7.80E-03	-21.4%
100	4.859E-05	2.77%	3.87E-05	-25.5%	5.10E-05	4.7%	3.09E-05	-57.2%

[a] Relative difference with respect to MCNP6.

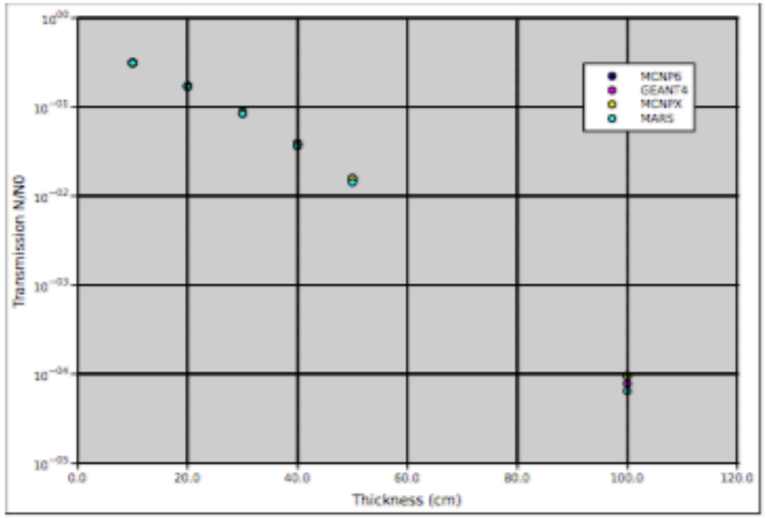


O6.3: neutron transport simulation

Neutron energy: 1 MeV

	MCNP6	(1σ)	GEANT4	$\Delta\%^a$	MCNPX	$\Delta\%^a$	MARS	$\Delta\%^a$
10	3.130E-01	0.05%	3.14E-01	0.3%	3.13E-01	0.0%	3.12E-01	-0.3%
20	1.715E-01	0.07%	1.71E-01	-0.3%	1.72E-01	0.3%	1.69E-01	-1.5%
30	8.693E-02	0.09%	8.52E-02	-2.0%	8.70E-02	0.1%	8.39E-02	-3.6%
40	3.883E-02	0.14%	3.73E-02	-4.1%	3.89E-02	0.2%	3.63E-02	-7.0%
50	1.575E-02	0.20%	1.49E-02	-5.7%	1.58E-02	0.3%	1.42E-02	-10.9%
100	9.622E-05	2.03%	7.81E-05	-23.2%	9.45E-05	-1.8%	6.45E-05	-49.2%

[a] Relative difference with respect to MCNP6.

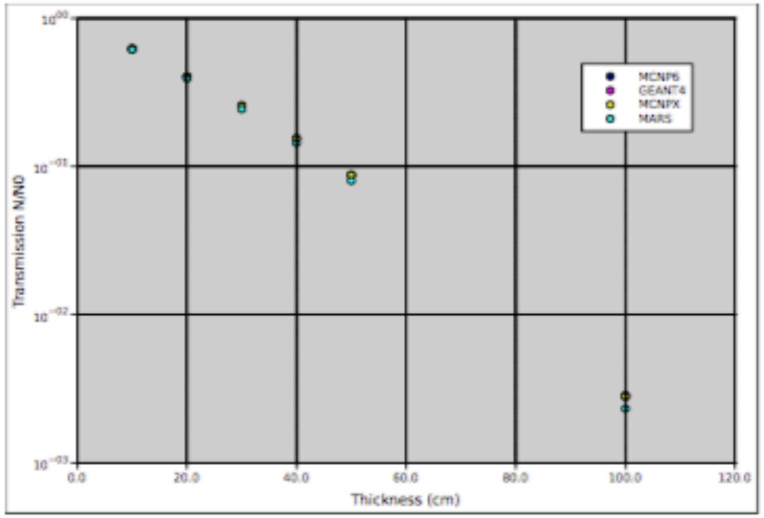


O6.3: neutron transport simulation

Neutron energy: 10 MeV

	MCNP6	(1σ)	GEANT4	Δ%[a]	MCNPX	Δ%[a]	MARS	Δ%[a]
10	6.242E-01	0.02%	6.23E-01	-0.1%	6.23E-01	-0.2%	6.14E-01	-1.7%
20	4.041E-01	0.03%	4.03E-01	-0.3%	4.03E-01	-0.3%	3.92E-01	-3.1%
30	2.572E-01	0.04%	2.56E-01	-0.5%	2.56E-01	-0.5%	2.44E-01	-5.4%
40	1.549E-01	0.06%	1.54E-01	-0.6%	1.54E-01	-0.6%	1.44E-01	-7.6%
50	8.806E-02	0.08%	8.72E-02	-1.0%	8.74E-02	-0.8%	8.01E-02	-9.9%
100	2.858E-03	0.41%	2.79E-03	-2.4%	2.81E-03	-1.7%	2.32E-03	-23.2%

[a] Relative difference with respect to MCNP6.

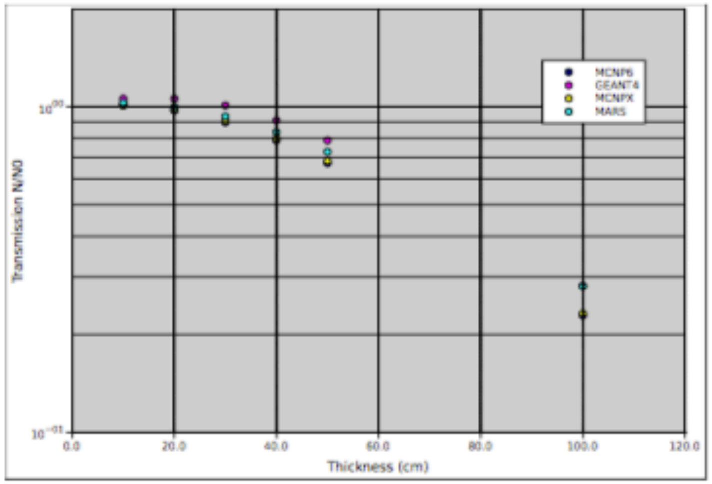


O6.3: neutron transport simulation

Neutron energy: 100 MeV

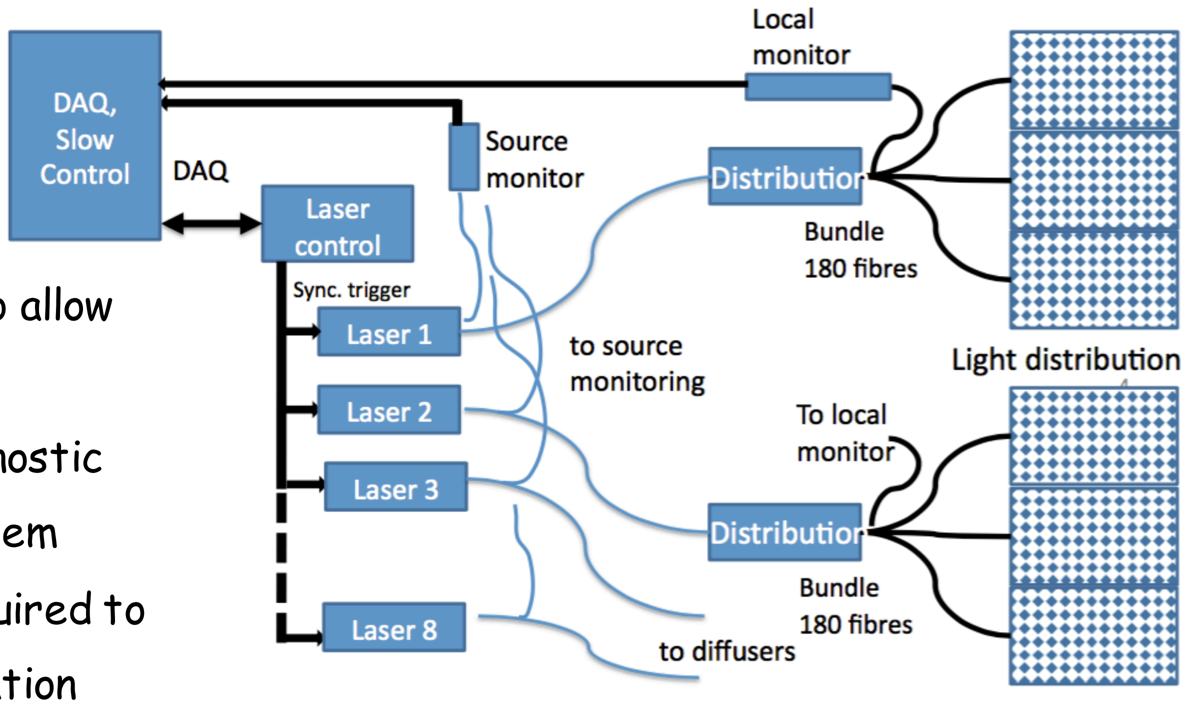
	MCNP6	(1σ)	GEANT4	$\Delta\%^a$	MCNPX	$\Delta\%^a$	MARS	$\Delta\%^a$
10	1.010E+00	0.01%	1.06E+00	4.7%	1.01E+00	0.0%	1.03E+00	1.9%
20	9.739E-01	0.01%	1.06E+00	8.1%	9.82E-01	0.8%	1.00E+00	2.6%
30	8.957E-01	0.02%	1.01E+00	11.3%	9.06E-01	1.1%	9.35E-01	4.2%
40	7.887E-01	0.02%	9.08E-01	13.1%	7.99E-01	1.3%	8.37E-01	5.8%
50	6.713E-01	0.03%	7.89E-01	14.9%	6.82E-01	1.6%	7.28E-01	7.8%
100	2.284E-01	0.06%	2.82E-01	19.0%	2.32E-01	1.6%	2.81E-01	18.7%

[a] Relative difference with respect to MCNP6.



Muon g-2 experiment: laser system

- Laser system operated successfully during the commissioning run



8 single "laser+diffuser+monitoring" units

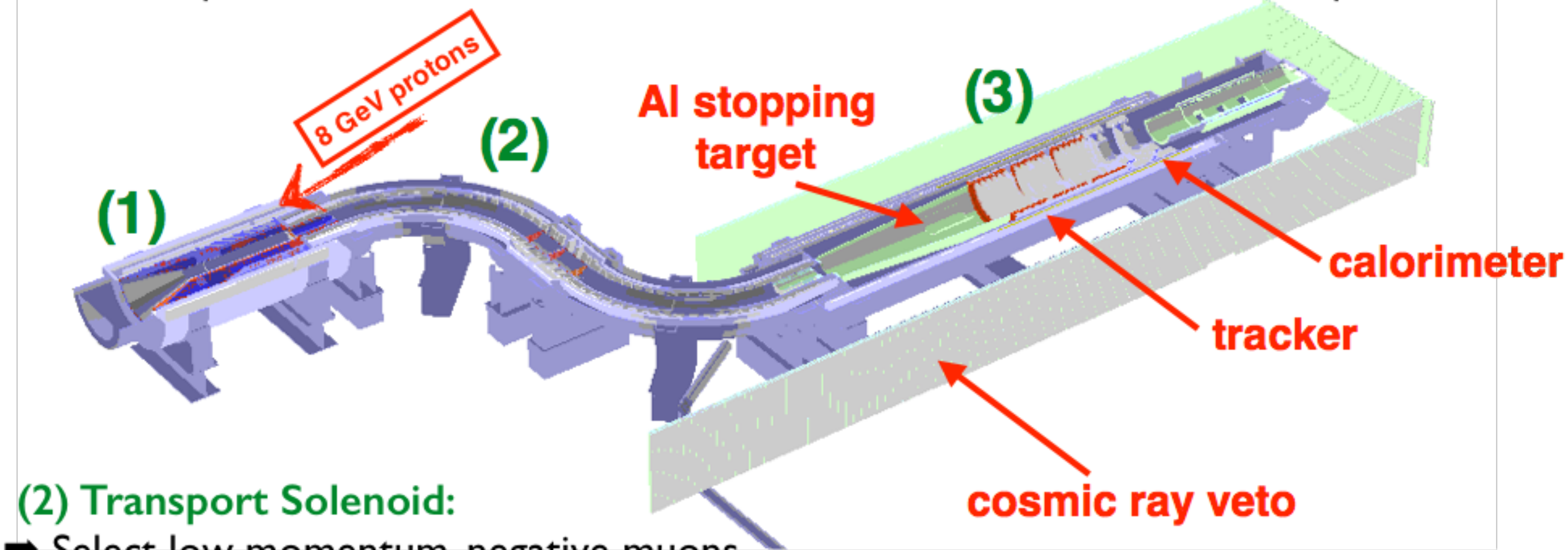
NEWS contribute:

- Upgrade the hardware to allow double pulse generation
- Implement/improve diagnostic tools to monitor the system
- Implement software required to provide long-term calibration

Mu2e experiment

(1) Production Solenoid:
➡ Proton beam strikes target, producing mostly pions
➡ Graded magnetic field contains backwards pions/muons and reflects slow forward pions/muons

(3) Detector Solenoid:
➡ Capture muons on Al target
➡ Measure momentum in tracker and energy in calorimeter
➡ Graded field "reflects" downstream conversion electrons emitted upstream



(2) Transport Solenoid:
➡ Select low momentum, negative muons
➡ Antiproton absorber in the mid-section