

# Coordinator's Report

S. Giovannella (INFN-LNF)



MUSE Mid-Term Meeting  
Frascati, 11 May 2017

# Outline

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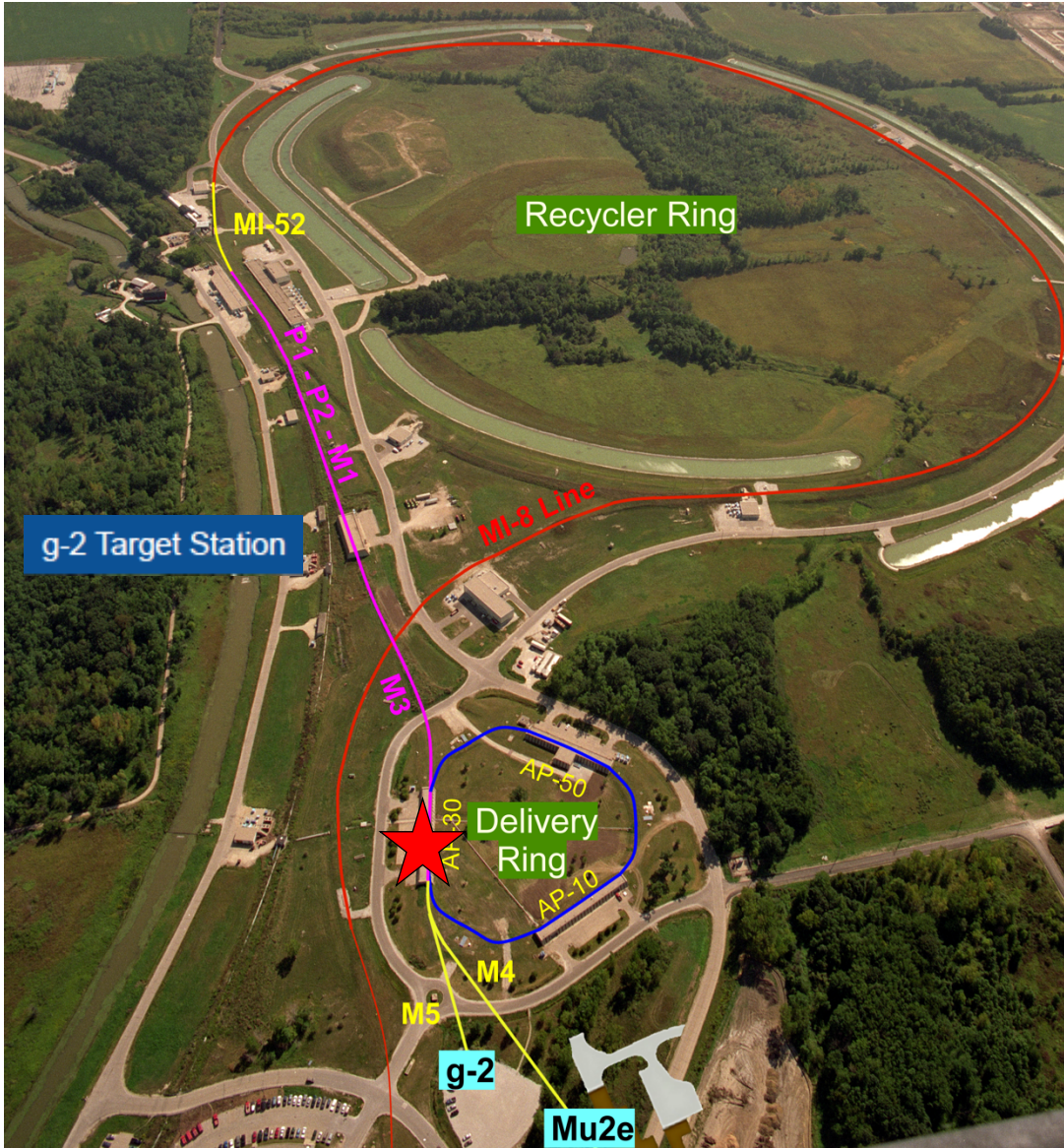
- X The MUSE project
- X Objectives
- X Organization
- X Scientific progresses
- X Networking, training and transfer of knowledge
- X Critical items and planned actions
- X Dissemination and outreach
- X Secondments: implementation and monitoring
- X Gender aspects
- X Impact on individual careers
- X Conclusions

# The MUSE project

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- ✗ H2020 Research and Innovation Staff Exchange program
- ✗ Hosting institute: Fermilab (Batavia, IL, US)
- ✗ Based on the activities connected to the Muon Campus experiments (Muon g-2 and Mu2e), where European research institutions have relevant roles in both detector design and construction and in the calibration and analysis of the data
- ✗ Aim: Establish new collaborations among European groups participating in the Muon Campus experiments at Fermilab (Batavia, IL, US)
- ✗ EU participants:
  - 4 research institutes [**HZDR** (DE), **INFN** (IT), **UCL** (UK), **Univ. of Liverpool** (UK)]
  - 3 SMEs [**ADVANSID** (IT), **CAEN** (IT), **PRISMA ELECTRONICS** (GR)]
- ✗ ~ 70 seconded researchers/technicians involved  
Total number of secondments: 385 person-months
- ✗ Time line: **1 Jan 2016** ⇔ **31 Dec 2019**

# Beam for Muon Campus



Recycler: fixed 8 GeV proton ring

Beams both to Muon Campus and neutrino experiments

Separate runs for g-2 and Mu2e

g-2: target before the delivery ring, 3.1 GeV  $\pi^+$  selected, clean, polarized  $\mu^+$  beam

Mu2e: 8 GeV protons to Mu2e hall

Accelerator Readiness Review took place in March 2017

Beam commissioning for g-2 started beginning of April  
Arrived up to ★

# The Muon g-2 Experiment

Differences between experiments and SM predictions to search for New Physics

⇒ **high precision measurement of  $a_\mu$**

Current status:  $> 3 \sigma$ 's between  $a_\mu$  BNL measurement and SM prediction

Goal: **factor of 4 reduction of the current exp. uncertainty**

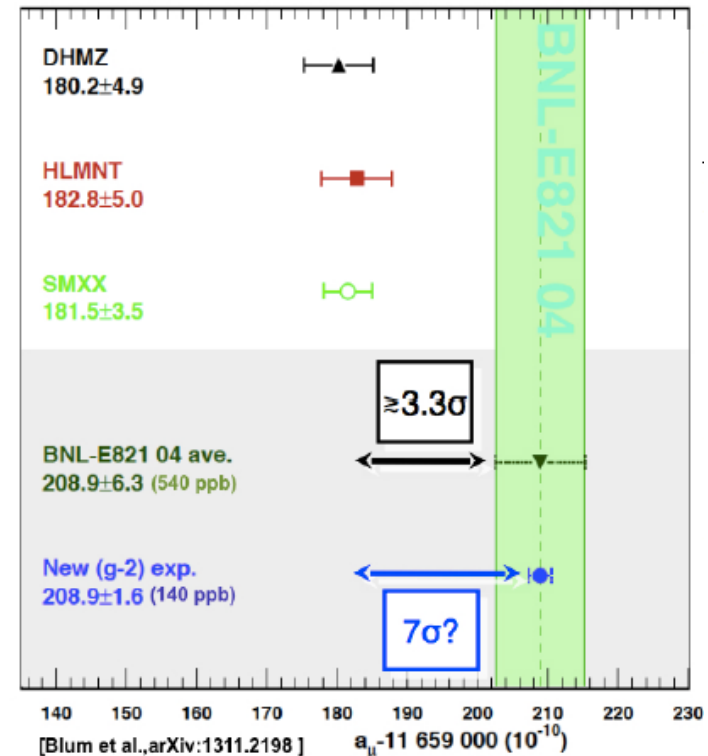
$$a_\mu^{\text{exp}} = (11\,659\,2089 \pm 54_{\text{stat}} \pm 33_{\text{syst}}) \times 10^{-11}$$

$$a_\mu^{\text{SM}} = a_\mu(\text{QED}) + a_\mu(\text{EW}) + a_\mu(\text{Had}) = (116591802 \pm 49) \times 10^{-11}$$

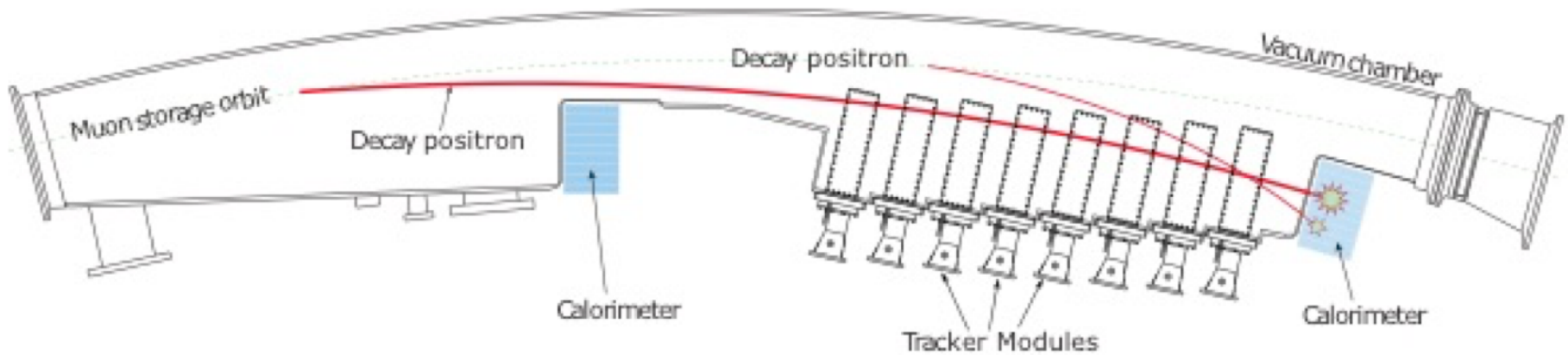
$$a_\mu = \frac{\frac{\omega_a}{\omega_p}}{\frac{\mu_\mu}{\mu_p} - \frac{\omega_a}{\omega_p}}$$

Experimental technique:

- ✗ Polarized  $\mu^+$  beam in 14 m storage ring
- ✗ Uniform magnetic field of 1.45 T, average field stable at 50 ppm level
- ✗ Anomalous precession frequency from  $\mu^+ \rightarrow e^+ \nu \nu$  decays, counting  $e^+$  above  $E_{\text{thr}}$



# The Muon g-2 Experiment



## Muon g-2 detector:

- **Trackers**
- Calorimeters
- **Laser calibration system**

**Trackers:** measurement of the muon beam profile with an accuracy in the vertical plane of better than 10 mrad and efficient identification of pileup and lost-muon events

**Laser calibration system:** accuracy at the sub-per mil level to monitor the gain of photosensor

- ☞ Ring powered and shimmed
- ☞ 24/24 EMCs, 1/3 trackers installed
- ☞ Detectors under commissioning
- ☞ First beam in the ring expected in June (no target)

# The Mu2e Experiment

CLFV strongly suppressed in Standard Model:  $BR \leq 10^{-50} \Rightarrow$  **its observation indicates New Physics**

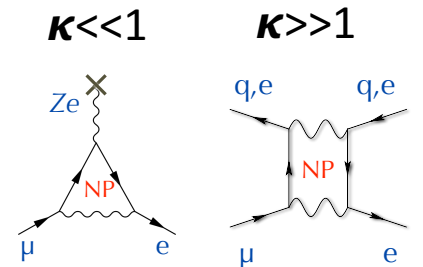
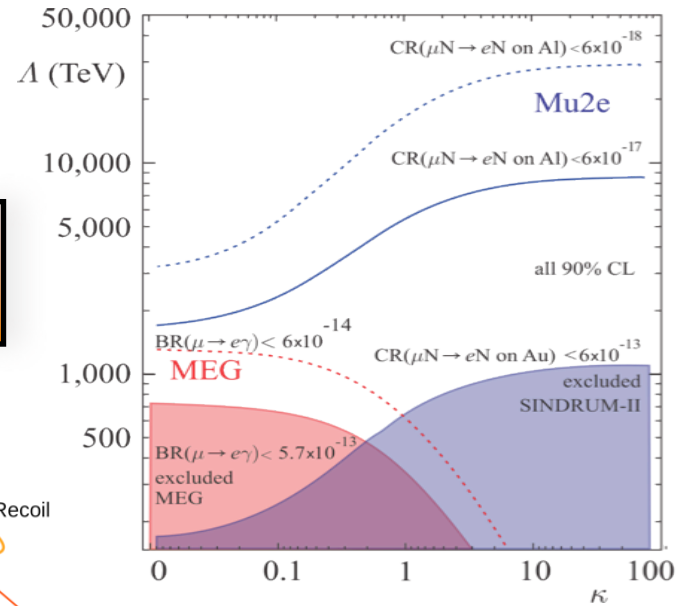
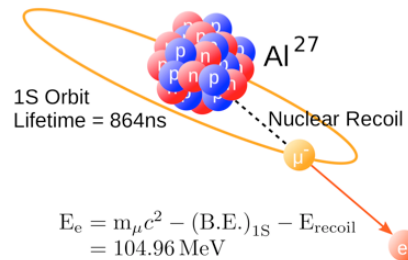
CLFV@Mu2e: coherent neutrinoless conversion of a muon to an electron in the field of a nucleus  $\Leftrightarrow$  discovery sensitivity on several NP models

Goal:  **$10^4$  improvement w.r.t. previous conversion experiment**

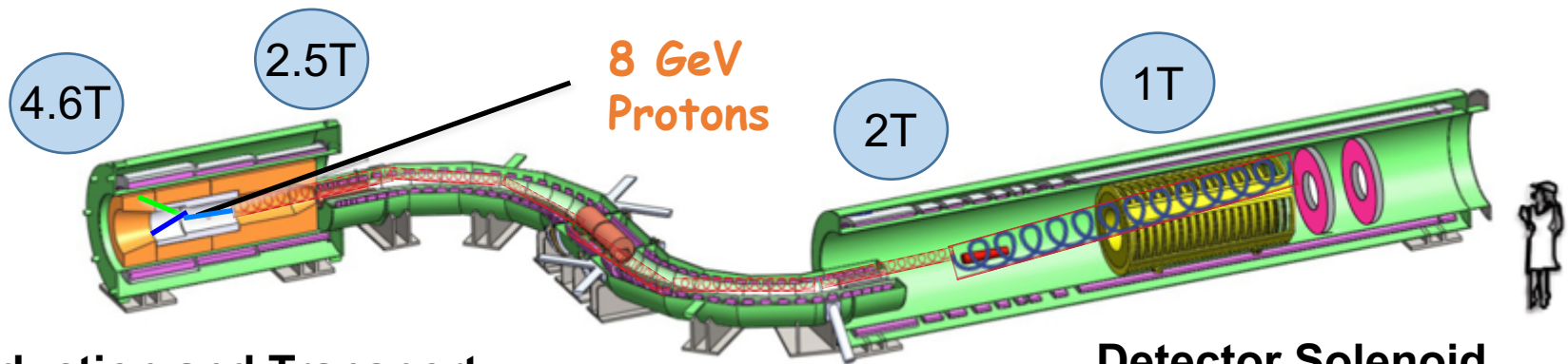
$$R_{\mu e} = \frac{\Gamma(\mu^- + N(A, Z)) \rightarrow e^- + N(A, Z)}{\Gamma(\mu^- + N(A, Z) \rightarrow \text{all muon capture})} \leq 6 \times 10^{-17} \text{ (@90\%CL)}$$

Experimental technique:

- ✗ Beam of low momentum muons
- ✗ Muons stopped in Al target
- ✗ Muons trapped in orbit around the nucleus
- ✗ Look for  $\mu^- N(A, Z) \rightarrow e^- N(A, Z)$  events: mono-energetic  $e^-$  with  $E \sim M_\mu$ , produced with  $\tau_\mu^{\text{Al}} = 864 \text{ ns}$



# The Mu2e Experiment



## Production and Transport Solenoids

Production, selection and transport of low momentum muon beam

**EMC:** unprecedented timing performance for low energy electrons in the presence of a strong magnetic field, vacuum and high radiation environment, exploiting solid state photo-sensors;

**STM:** High Precision Germanium detector (HPGe) to record X-rays emitted during the muon stopping process at rates and in radiation levels surpassing previous experiments

## Detector Solenoid

- Muon capture on Al target
- Tracker, **EM Calorimeter**
- Cosmic Ray Veto system

**Out of DS:** **Stopping Target Monitor**

- 👉 Experimental hall completed @ FNAL Muon Campus
- 👉 Magnets and detectors under construction
- 👉 Commissioning: half 2020



# MUSE objectives

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- X Establish new collaborations among European groups participating in the Muon Campus experiments
- X Increase our presence and visibility at Fermilab, strengthening the already existing partnership with the lab
- X Exploit the existing European infrastructures to create a network of radiation hardness tests and characterization of detector components
- X Transfer of knowledge among partners, exploiting specific competences of MUSE partners
- X Promote inter-sectoral collaborations
- X Use EU funds to increase
  - ✓ training, skill development of personnel
  - ✓ dissemination activities
  - ✓ science communication

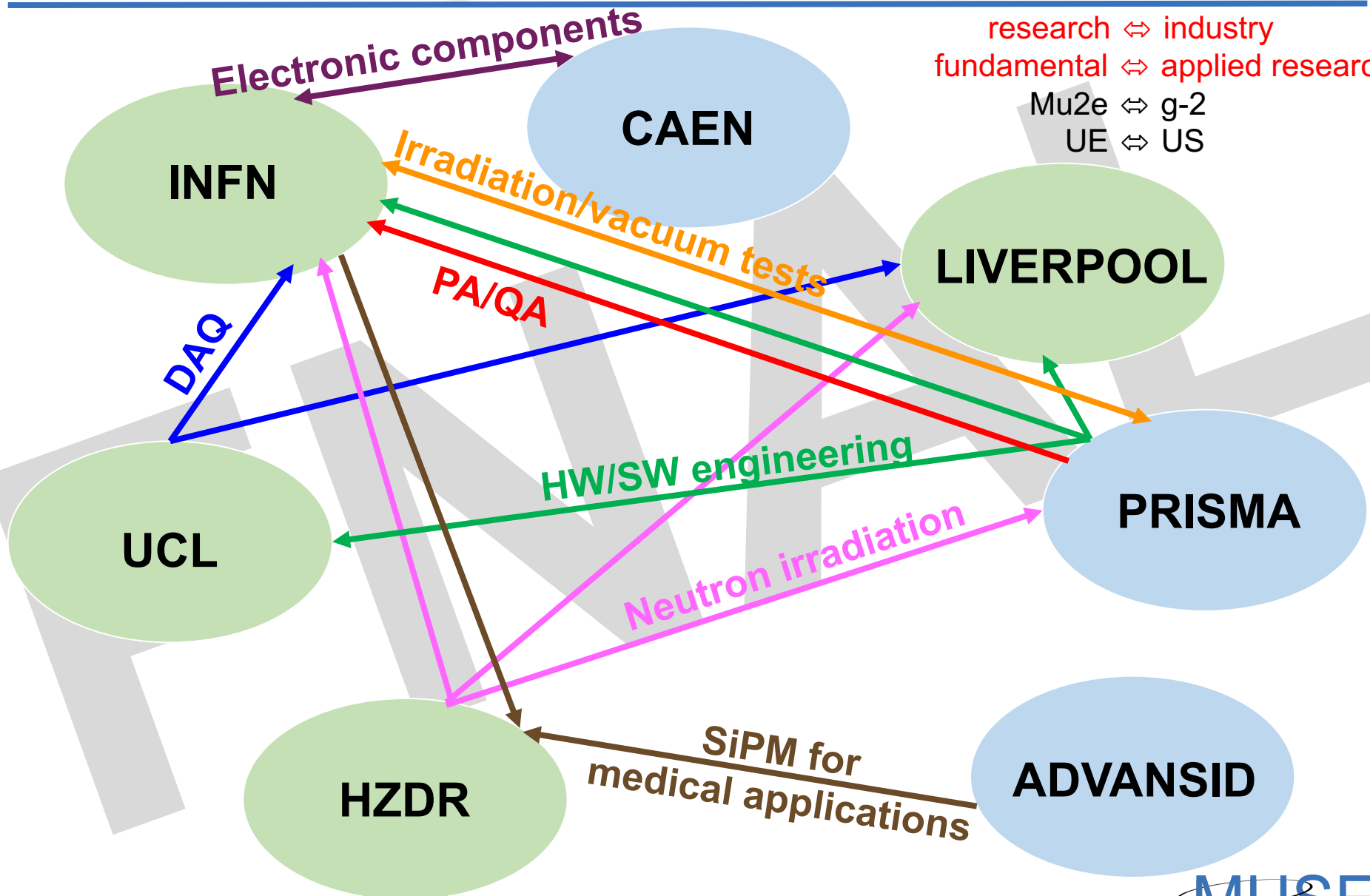
# MUSE at a glance

1/2016 → 12/2019

research ⇔ industry  
fundamental ⇔ applied research

Mu2e ⇔ g-2

UE ⇔ US



# Project organization

MUSE activities organized in seven Work Packages (WP):

WP1	WP2	WP3	WP4	WP5	WP6	WP7
g-2 detectors	Mu2e detectors	Calibration	Software tools	Dissemination & outreach	Transfer of knowledge	Management

WPs 1, 2 include the activities related to detector R&D, design and construction for Mu2e and Muon g-2 experiments, where European groups are directly involved and have important high-level responsibilities. The separation of these two packages is justified by the different schedule of the experiments: g-2 will be in a running phase when Mu2e is being constructed. This provides a simple and clear organization of the packages in terms of tasks and deliverables

All the other scientific activities are organized to exploit as much as possible the network, including contributions from different experiments, institutions and competences

“Dissemination and outreach”, “Transfer of knowledge” take information from the previous WPs

WP7 coordinates and supervises activities across all the WPs

**Two conveners for each WP: one from “Lead Beneficiary”, co-convenor selected among experienced researchers**

# Management

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Project Coordinator: responsible for the day-to-day management and coordination of the MUSE project and is the contact person with the Research Executive Agency of the European Commission

A management support team assists the project coordinator in financial and administration matters and in the development of the web site

Two boards for running the project:

**X MANAGEMENT BOARD (meets each 3 months)**

- Administrative aspects of the project
- One member for each main department + the coordinator (chair)

**X SCIENTIFIC BOARD (meets each 2 months)**

- Coordination of the network scientific activities
- WP conveners

# Management Board

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- X Four MB meetings per year. Extra meeting if needed
- X Responsible of administrative activities
- X Provides the means to operate the project efficiently
- X It is responsible, in close contact with the SB, for:
  - ✓ revision and authorization of secondments
  - ✓ organization of General Meetings
  - ✓ monitoring of the progresses towards the completion of deliverables
- X Guarantee maximization of the knowledge sharing among the involved institutions, equal opportunity for all participants and the visibility of the project

# Scientific Board

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- ✗ Two conveners for each of the seven Work Package: one from "Lead Beneficiary", the other one selected among experienced researchers
- ✗ Six SB meetings per year. Extra meeting if needed
- ✗ SB responsibilities:
  - ✓ Coordination of network activities
  - ✓ Secondment supervision
  - ✓ Monitoring of the progresses of the scientific program
  - ✓ Periodic written report (each 6 months) on network activities
  - ✓ Develop mitigation plans in case of problems
- ✗ Regular SB meetings with reports from WP coordinators to monitor progress of tasks and status of deliverables and milestones

# Sharing information

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Several communication channels to distribute information among participants:

- X Specific mailing lists ensure the distribution of information among participants, both for scientific and administrative activities
- X MUSE website: <http://muse.inf.infn.it>
  - ↗ private section to share documents and information among participants
    - minutes and slides of each MUSE meeting (MB/SB included) available to all participants
  - ↗ section for the general public to maximize the visibility of the project
- X Periodic reports (6 months)
- X General Meetings (one per year)

# Web site: <http://muse.inf.infn.it>

MUSE

HOME THE PROJECT DISSEMINATION OUTREACH PARTNERS ORGANIZATION CONTACTS



### ABOUT MUSE PROJECT

The MUSE project coordinates the activities of about 70 researchers from various European research institutes and industries for the participation to the experiments at the Muon Campus of the Fermi National Laboratory, USA. It promotes international and intersectoral collaboration by means of secondments of personnel, thus enhancing European contribution and visibility in this activity.

The duration of the MUSE project is of four years, thus well adapting to the Muon Campus schedule that will host in the same period two world class experiments dedicated to the search of new physics: Muon g-2, for a ten-fold improvement on the measurement of the muon magnetic anomaly, and Mu2e, for the search of the yet unobserved conversion of a muon to an electron.

#### TALKS

TIPP 2017 – Design, status and perspectives for the Mu2e crystal calorimeter

May 22 - May 26 @ Beijing International Convention Center

Speaker: G. Pezzullo (INFN Pisa)

[VIEW ALL](#)

#### OUTREACH

2017 MUSE General Meeting: Outreach Event

May 15 - May 17 @ University of Rome "Tor Vergata"

[VIEW ALL](#)

#### MEETINGS

MUSE General Meeting

May 10 - May 12 @ Laboratori Nazionali di Frascati

[VIEW ALL](#)





## Muon Campus in US and Europe contribution

Public section for the general public to maximize the visibility of the project:

- General information on the project and its organization
- Dissemination and outreach events being kept updated on the web site  
As of today: 34 talks/posters/seminars, 17 publications, 10 outreach events

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## INTERNAL MENU



Grant Agreement

Deliverables

Milestones

Meetings

Internal

Management Board

Scientific Board

Mailing lists

Reports

MUSE logo

Acknowledgements

Templates

Logout

## Muon Campus in US and Europe contribution

Private section to share documents and information among participants:

- ↯ Grant Agreement
- ↯ Status of deliverables and milestones
- ↯ Meetings with presentations and minutes
- ↯ Mailing lists
- ↯ Biannual reports
- ↯ Useful tools

# General scientific progress

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Scientific activities connected to the R&D, design, construction, commissioning of detectors of the Muon (g-2) and Mu2e experiments organized in WPs 1-4

Progresses of some tasks depends on the completion of Muon Campus infrastructure (accelerator complex, storage ring of g-2, Mu2e solenoidal systems). Possible delays mitigated by separating as much as possible the MUSE deliverables from their fulfilment

Inevitable risks exist for the installation and integration tasks in the project. In the event of delays on the delivery of items to which we need to integrate, we will ensure that our deliverables are expedited and the integration tasks prioritised such that they can be performed quickly when the late items arrive.

Highlights of the scientific progresses will be addresses in the afternoon. Now a brief description of objectives/tasks of WP 1-4

# WP1: g-2 Detectors

**Objectives:** The objectives of this WP are the development, construction, test and commissioning of the tracking detector and of its back-end readout electronics and DAQ, the laser DAQ interface boards and the SiPM Bias Voltage Supply

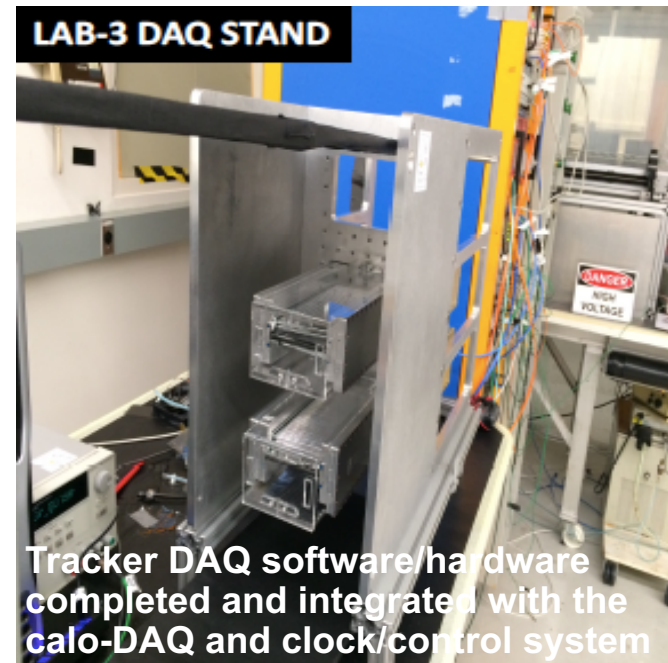
**Task 1.1:** Development, construction and commissioning of Laser-DAQ boards  
D1.2 (M24) – Report on laser integration

**INSTALLED  
COMMISSIONING  
IN PROGRESS**

**Task 1.2:** Development, commissioning and maintenance of SiPM bias voltage supply **MODIFIED**

**Task 1.3:** Design and construction of the straw trackers  
D1.2 (M24) – Report on g-2 trackers **INSTALLATION  
IN PROGRESS**

**Task 1.4:** Readout system for the straw trackers  
MS1 (M17) – Tracker-DAQ integration **ACHIEVED**



# WP2: Mu2e Detectors

**Objectives:** Development, design, construction, test and commissioning of the crystal calorimeter and HPGe monitor systems for the Mu2e experiment

Mu2e-doc-8429, December 2016

**Task 2.1:** Technological choice and calorimeter design

D2.1 (M12) – Technical Design Report **COMPLETED**

## The Mu2e Calorimeter Final Technical Design Report

N.Atanov<sup>a</sup>, V. Baranov<sup>a</sup>, J. Budagov<sup>a</sup>, S.Ceravolo<sup>b</sup>, F. Cervelli<sup>b</sup>, F. Colao<sup>b</sup>, M. Cordelli<sup>b</sup>, Di Falco<sup>c</sup>, S. Donati<sup>d</sup>, E. Diociaiuti<sup>d</sup>, R. Donghia<sup>e,h</sup>, V. Glagolev<sup>f</sup>, F. Gracagnolo<sup>f</sup>, F. Hoppacher<sup>g</sup>, Miyashita<sup>i</sup>, L. Morescalchi<sup>j</sup>, P. Murat<sup>k</sup>, D. Pasciuto<sup>l</sup>, F. Raffaelli<sup>m</sup>, M. Ricci<sup>n</sup>, A. Saputi<sup>o</sup>, I. Sarra<sup>o</sup>, Sielli<sup>o</sup>, V. Tereshchenko<sup>o</sup>, Z. Usubov<sup>o</sup>, R.Y. Zhu<sup>o</sup>

Title: Calorimeter TDR

Type: Report

Dissemination level: Public

WP number: WP2

Lead Beneficiary: INFN

<sup>a</sup> Nuclear Research, Dubna, Russia  
<sup>b</sup> INFN Sezione di Frascati, Frascati, Italy  
<sup>c</sup> Fermi National Laboratory, Batavia, Illinois, USA  
<sup>d</sup> INFN Sezione di Lecco, Lecco, Italy  
<sup>e</sup> Dipartimento di Fisica dell'Università di Roma Tor Vergata, Rome, Italy  
<sup>f</sup> Dipartimento di Fisica dell'Università degli Studi Roma Tre, Rome, Italy  
<sup>g</sup> Technology, Pasadena, United States  
<sup>h</sup> Guglielmo Marconi, Roma, Italy  
<sup>i</sup> INFN Sezione di Pisa, Pisa, Italy  
<sup>j</sup> INFN Sezione di Pisa, Pisa, Italy  
<sup>k</sup> INFN Sezione di Pisa, Pisa, Italy  
<sup>l</sup> INFN Sezione di Pisa, Pisa, Italy  
<sup>m</sup> INFN Sezione di Pisa, Pisa, Italy  
<sup>n</sup> INFN Sezione di Pisa, Pisa, Italy  
<sup>o</sup> INFN Sezione di Pisa, Pisa, Italy

**Task 2.2:** Test and characterization of crystals

D2.2 (M36) – Production DB

**Task 2.3:** Test and characterization of silicon photosensor

D2.2 (M36) – Production DB

**Task 2.4:** Design, construction and test of EMC FEE

**Task 2.5:** Assembly of the first calorimeter disk

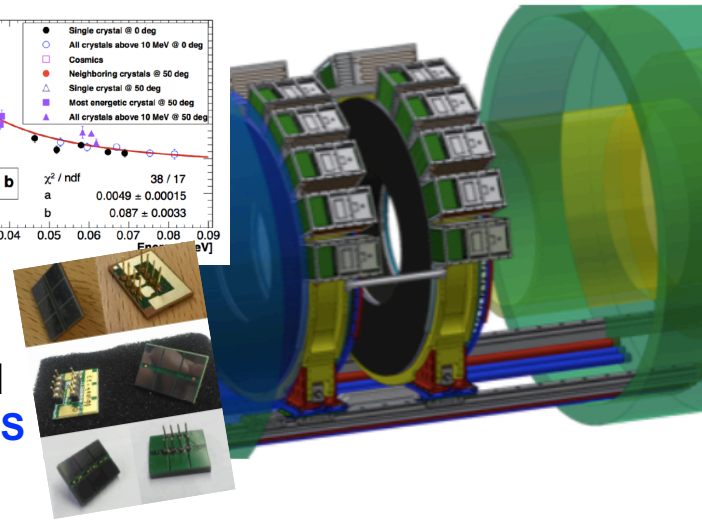
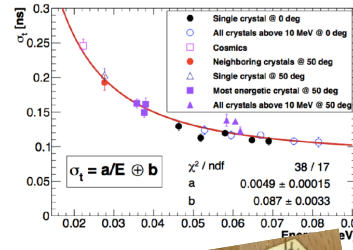
MS2 (M42) – First EMC disk assembled

**Task 2.6:** Prototyping and design of HPGe monitor

D2.3 (M27) – Design of HPGe detector completed

**Task 2.7:** Construction of the HPGe monitor

MS3 (M48) – HPGe detector installed



**IN PROGRESS**

128 pages, description of all EMC components

IN PROGRESS

NOT YET STARTED

NOT YET STARTED

# WP3: Calibration

**Objectives:** Development, construction, and assembly of the calibration systems developed for g-2 and Mu2e detectors; calibration and alignment of the g-2 straws

**Task 3.1:** Development and assembly of the g-2 laser system  
D3.1 (M10) – Design of g-2 laser calibration system

**COMPLETED**

**Task 3.2:** g-2 straw calibration system  
D3.2 (M18) – g-2 tracker tools

**IN PROGRESS**

**Task 3.3:** Commissioning of calibration systems in g-2  
MS5 (M36) – g-2 calibration commissioned

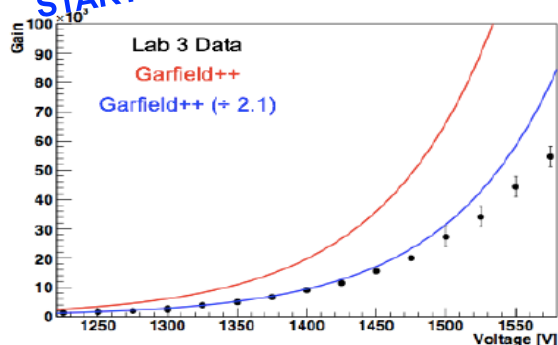
**STARTED**

**Task 3.4:** Development of the laser calibration system for Mu2e  
D3.3 (M18) – Design of Mu2e laser system



**IN PROGRESS**

**Task 3.5:** Installation/test of Laser calibration system in Mu2e  
MS4 (M30) – Mu2e laser assembled

**NOT YET STARTED**



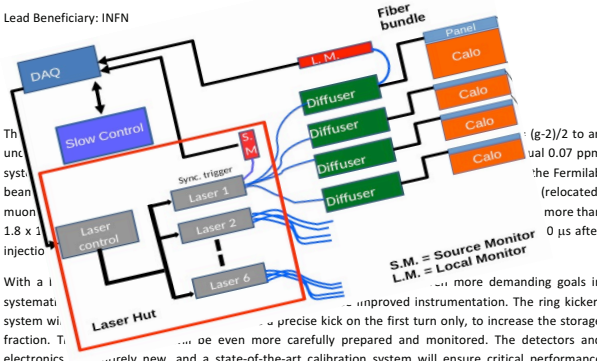
Implemented significant changes to Garfield++  
Model of electronics and drift-time & efficiency being developed based on Lab-3 data  
Implementing Millipede alignment algorithms

H2020 Grant Agreement N° 690835

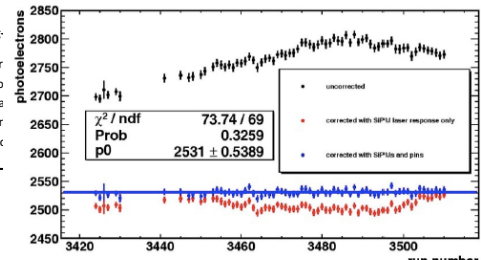
**Deliverable D3.1 – WP3 – Due date: 31 October 2016**

Title: g-2 laser calibration system  
Type: Other  
Dissemination level: public  
WP number: WP3  
Lead Beneficiary: INFN



The Muon g-2 experiment is a precision experiment to measure the muon's anomalous magnetic moment. The experiment is currently under construction at Fermilab (relocated) and is expected to start in mid-2017. The experiment will use a 3.094 GeV muon beam and a 1.8 x 10^11 muons per bunch. The experiment is a precision experiment to measure the muon's anomalous magnetic moment. The experiment is currently under construction at Fermilab (relocated) and is expected to start in mid-2017. The experiment will use a 3.094 GeV muon beam and a 1.8 x 10^11 muons per bunch.

2. The Muon g-2 experiment  
The Muon g-2 experiment may vary over a period of more than a year due to gain fluctuations. The experiment is currently under construction at Fermilab (relocated) and is expected to start in mid-2017. The experiment will use a 3.094 GeV muon beam and a 1.8 x 10^11 muons per bunch.



# WP4: Software Tools

**Objectives:** Development and commissioning of the software packages needed to simulate the detectors and to perform data reconstruction

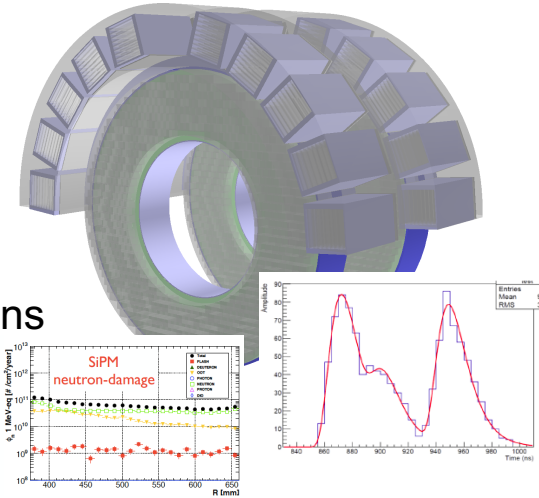
**Task 4.1:** Development of g-2 simulation and reconstruction code  
MS6 (M12) – New release of the g-2 software **ACHIEVED**

**Task 4.2:** Development of Mu2e simulation code **IN PROGRESS**  
D4.1 (M32) – Mu2e code for calorimeter, HPGe and neutrons

**Task 4.3:** Commissioning of g-2 analysis code  
D4.2 (M12) – g-2 full muon simulation **COMPLETED**

**Task 4.4:** Commissioning of Mu2e reconstruction code with cosmic ray events  
MS7 (M40) – Mu2e software running on cosmic ray data

*First studies with MC events*

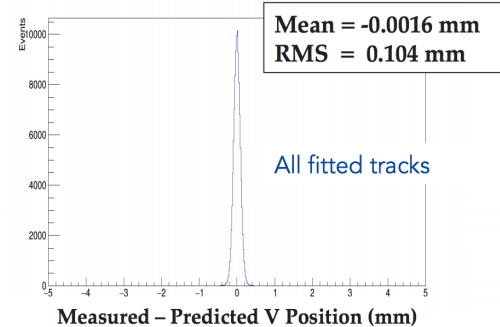


H2020 Grant Agreement N° 690835



**Deliverable D4.2 – WP4 – Due date: 31 December 2016**

Title: g-2 full muon simulation  
Type: Report  
Dissemination level: Public  
WP number: WP4  
Lead Beneficiary: UCL



# WP6: Transfer of Knowledge

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- X Objectives:** coordination of the activities dedicated to the training of research and industry personnel to achieve a substantial ToK among participants and to increase the quality of the research and the competitiveness of the partners
- X Tasks:** (6.1) research-industry ToK; (6.2) medical applications; (6.3) training
- X Activities:**
  - ↻ QA procedures for crystals during the production phase, from delivery to FNAL to QA tests and including crystal traceability and storage (INFN/PRISMA)
  - ↻ HW database for the test of the Mu2e electromagnetic calorimeter crystals and photo-sensors in the pre-production phase (INFN/PRISMA)
  - ↻ Design of the electronic cards for the test station of photo detectors mass production for the Mu2e calorimeter, operating in vacuum (INFN/PRISMA)
  - ↻ QA tests for g-2 straws (LIVERPOOL/PRISMA)
  - ↻ FEE test and design for g-2 tracker (LIVERPOOL/PRISMA)
  - ↻ Design of laser calibration systems for high energy experiments, Fermilab, 2-4 Aug 2016 (Muon g-2/Mu2e)



# MUSE irradiation network

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Existing European infrastructures used to carry on an irradiation program among MUSE participants (HZDR, INFN, LIVERPOOL, PRISMA), aiming to test radiation hardness and characterize detector components of the Mu2e detectors

The ELBE accelerator complex at HZDR provides both high dose neutron flux (pELBE) and high-intensity Bremsstrahlung radiation (gELBE)

- ☞ 18 Jan 2016: Meeting @ LNF - Plans for irradiation tests @ HZDR
- ☞ April 2016: Mu2e EMC SiPMs irradiation test @ pELBE (HZDR/INFN)
- ☞ May 2016: Mu2e EMC crystals irradiation test with thermal neutrons @ HOTNES, ENEA-INFN, Frascati (INFN/PRISMA)
- ☞ 2 Feb 2017: Meeting @ LNF - HZDR irradiation plans for Mu2e detectors
- ☞ March 2017: Mu2e EMC SiPMs/crystals neutron irradiation test @ pELBE (HZDR/INFN) + Liverpool researcher (HPGe) visiting the ELBE infrastructure

New beam time request submitted for the second half of 2017:

- ✗ pELBE: EMC electronics/SiPM
- ✗ gELBE: EMC electronics/SiPM + HPGe

# Training

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Secondments give a unique opportunity to MUSE participants in improving their individual skills and career perspectives enhancing:

- ↻ work in high-level environment in international laboratories, with research activities at the cutting-edge of technology
- ↻ involvement in different activities, from design to prototyping, construction and commissioning phases
- ↻ opportunities to come in contact with colleagues from other institutions

MUSE provided also the opportunity to:

- ↻ increase attendance of schools for PhD and postdocs
  - ↻ attend training courses (management, science communication, language...)
- } 31 events listed

We have also organized specific training courses during General Meetings on specific advanced topics from research development in HEP or industry

# Critical items: Task 6.2

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WP6, Task 6.2: “Medical Applications” – Involved institutes: HZDR, ADVANSID, INFN

Goal: transfer of the INFN and ADVANSID expertize on SiPM to the HZDR group working on medical applications, both in PET nuclear imaging and in-vivo-dosimetry at proton and ion beams

Planned secondments: 2 months/year HZDR → ADV + 1 month ADV → HZDR

- + 21 April 2016: training session on latest generation SiPM @ HZDR
- **Delays in the collaborating activities between HZDR and ADVANSID** due to:
  1. parental leave of two key researchers of the HZDR medical group
  2. reorganization of the medical physics group @ HZDR

## **New work plan is being developed**

- First short visit of HZDR ERs to Advansid on May 22<sup>nd</sup>
- Starting point of the secondments shifted to the second half of 2017
- Limited number of secondments involved → planned activity can be completed
- Deliverable D6.2, M36, should not be affected

# Critical items: Task 1.2

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WP1, Task 1.2: “Development, commissioning and maintenance of SiPM bias voltage supply” – Involved institutes: CAEN, INFN, FNAL

Goal: design and construction of a high precision Bias Voltage Supply for the SiPM of the Muon g-2 electromagnetic calorimeter

Planned secondments: 2 months CAEN → FNAL

- + Produced CAEN power supplies work well for an average fixed current
- Requirement of a fast bias recover for a rapidly changing current not satisfied

## Delays in the completion of the R&D and in the start of the secondment

**The tight Muon g-2 schedule required a different solution for the BVS system**

CAEN contribution re-discussed within the project: design, development, production and maintenance of custom Low/High Voltage supplies for the Mu2e calorimeter

- New plan approved by the Project Officer, same institutes involved
- INFN-CAEN meeting to define LV requirements, HV still to be discussed
- CAEN secondment to FNAL will start in June

# WP5: Dissemination and Outreach

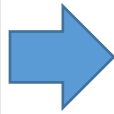
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- X Lot of effort in dissemination and outreach activities
- X List of public events on the MUSE web site
- X MUSE results disseminated to the international scientific community through the participation to physics and instrumentation international conferences and the publication in professional journals:
  - ↪ 34 talks delivered
  - ↪ 17 publications produced (all gold/green open access)
- X Outreach events, promoting communication between MUSE scientific community and general public to increase science awareness and to inspire the next generations of scientists:
  - ↪ Training courses for FNAL Summer Students
  - ↪ MUSE General Meeting: Outreach event for University students
  - ↪ Open Day and European Researchers' Night
  - ↪ Other specific events in different MUSE institutions



Home » News » The MUSE project approved in Horizon 2020

INFN News  
(in English and Italian)



INSIDER – Issue 20, April 2016  
(in German)



EUROPÄISCHE DETEKTOREN FÜR  
MYONEN-CAMPUS AM FERMILAB

Myonen sind so etwas wie ein zu wohl genährter Zwilling der Elektronen: Sie zählen ebenfalls zu den negativ geladenen Elementarteilchen, haben sogar die gleichen Eigenschaften, sind aber rund 200 Mal schwerer. Zwar sind die kleinen Schwergewichte nur eine von mittlerweile über zwei Dutzend Teilchenarten im Standardmodell der Teilchenphysik, doch sie haben das Potential, das bewährte Modell kräftig ins Wanken zu bringen. Sollte nämlich eine Umwandlung von Myonen zu Elektronen nachgewiesen werden, ohne dass dabei ein weiteres Tochterteilchen entsteht, könnte dies nicht mehr im Standardmodell erklärt werden.

Im neuen EU-Projekt *MUSE – Muon campus in US and Europe contribution* arbeiten deshalb europäische und US-amerikanische Forscher intensiv zusammen, um diese Myonen-Umwandlung zu erforschen. Diese Suche nach „neuer Physik“ erfolgt in der Nähe von Chicago am *Fermi National Accelerator Laboratory* – kurz: Fermilab. Mit insgesamt sechs weiteren europäischen Einrichtungen beteiligt sich auch das HZDR an MUSE. Die Experimente am Fermilab ergänzen die europäische Forschung im Bereich der Teilchenphysik. Das Projekt soll Netzwerke für Detektortechnologien in Europa aufbauen und Kooperationen mit den USA stärken. Es läuft über das EU-Programm für Personalaustausch

im Bereich Forschung und Innovation RISE und geht bis Ende 2019.

Für ihren Beitrag zu MUSE erhalten die HZDR-Wissenschaftler um Dr. Anna Ferrari EU-Fördergelder in Höhe von rund 110.000 Euro. Im Fokus steht dabei die Entwicklung und Charakterisierung hochsensibler Detektoren sowie die Auswertung der gewonnenen Daten. Am ELBE-Zentrum für Hochleistungs-Strahlenquellen gibt es dafür ideale Voraussetzungen: Eine starke Neutronenquelle ermöglicht es, die empfindlichen Detektoren auf Langlebigkeit zu testen. Diese Detektoren bestehen aus einem Kristall und einem Halbleiter-Fotosensor. Sie werden somit nicht von Magnetfeldern beeinflusst und lassen sich sehr gut verkleinern, weshalb auch ein Wissenstransfer in die medizinische Physik angestrebt wird: Bildgebungsverfahren wie die Positronen-Emissions-Tomographie könnten damit verbessert werden.

Parallel zur MUSE-Kooperation zwischen der EU und den USA entsteht mit *COMET* ein zweites Forschungsprojekt zur Myonen-Elektron-Umwandlung am japanischen Forschungszentrum *J-PARC*. Durch eine Kooperation mit dem Institut für Kern- und Teilchenphysik der TU Dresden unterstützen auch dieses Projekt Dresdner Forscher. CD

## THE MUSE PROJECT APPROVED IN HORIZON 2020

10 September 2015 News

The MUSE project, coordinated by Simona Giovannella, researcher at LNF, has been selected among the 363 proposals submitted to the EU in the framework of the call MSCA-RISE-2015 in Horizon 2020. The project goal is that of promoting the international and intersectoral collaboration by means of secondments of personnel.

Indeed, MUSE will allow to coordinate the activities of about 70 researchers from various European research institutes (INFN, University College London, University of Liverpool, Helmholtz-Zentrum Dresden-Rossendorf, Fermilab) and industries (PRISMA, CAEN, AdvanSid) for the participation to the experiments at the Muon Campus of the Fermi National Laboratory (FNAL), in USA.

The duration of MUSE is of four years thus well adapting to the Muon Campus schedule that will host in the same period two world class experiments dedicated to the search of new physics. The first one, Muon g-2, will improve of a factor of four the precision in the determination of the anomalous magnetic moment of the muon, that is now deviating of more than 3 sigma from the Standard Model prediction. The second one, Mu2e, will use a high intensity muon beam, interacting on an aluminum target, to increase of four order of magnitude the search for the conversion of a negative muon in an electron in the field of a nucleus: a process violating the conservation of the leptonic flavour that is forbidden in the Standard Model.



Home » News » Il progetto MUSE approvato da Horizon 2020

## IL PROGETTO MUSE APPROVATO DA HORIZON 2020

10 settembre 2015 News

Il progetto MUSE, coordinato da Simona Giovannella, ricercatrice del LNF, è stato selezionato tra le 363 proposte sottomesse alla Commissione Europea nell'ambito del programma MSCA-RISE-2015, il cui obiettivo è di promuovere collaborazioni internazionali e intersectoriali attraverso scambi di personale.

MUSE coordinerà le attività di circa 70 ricercatori di vari istituti (INFN, University College London, University of Liverpool, Helmholtz-Zentrum Dresden-Rossendorf, Fermilab) e industrie europee (PRISMA, CAEN, AdvanSid) per la partecipazione alle attività connesse agli esperimenti del Muon Campus del Fermilab.

La durata del progetto MUSE è di 4 anni, e ben si adatta allo schema di lavoro previsto al Muon Campus, che ospiterà in questo periodo due esperimenti di altissima precisione dedicati alla ricerca di segnali di nuova fisica. Il primo, Muon g-2, migliorerà di un fattore 4 la misura diretta del momento magnetico anomalo del muone che attualmente si discosta di più di 3 sigma dalle previsioni del Modello Standard.

Il secondo, Mu2e, userà un fascio di muoni di altissima intensità per migliorare di 4 ordini di grandezza la ricerca della conversione di un muone in elettrone nel campo di un nucleo: un processo di violazione della conservazione del sapore leptonic, proibito nel Modello Standard.



# Outreach: 2016



MUSE outreach program for University students



## “The High Intensity Frontier at the Fermilab Muon Campus”



30 September 2016

Pisa University, Polo Didattico Fibonacci  
Building C – Room 131

### Program

- 14:30 D. Glenzinski (Fermilab)  
“A Rare Opportunity - the Mu2e experiment at Fermilab”
- 15:30 F. Bedeschi (INFN Pisa)  
“The Muon g-2 Experiment”
- 16:30 G. Taddei, I. Naranjo De Candido  
“Our experience as Fermilab Summer Students”



## “The Muon g-2 Experiment”

Training lectures for the students of the Summer School “Summer Students at Fermilab and other US laboratories” (Fermilab, INFN and the University of Pisa)

### Lectures

Tuesday, August 2 – Comitium – Wilson Hall

- 9:00 - 9:40 C. Polly, “Overview of the Muon g-2 experiment at FNAL”
- 9:40 - 9:50 questions and discussion
- 9:50 - 10:30 B. Casey, “The tracker of the Muon g-2 experiment at FNAL”
- 10:30 - 10:40 questions and discussion
- 10:40 - 10:55 Break
- 10:55 - 11:35 J. Kaspar, “The calorimeter of the Muon g-2 experiment at FNAL”
- 11:35 - 11:45 questions and discussion
- 11:45 - 14:30 Lunch break
- 14:30 - 15:00 C. Ferrari, “Calibration of the Muon g-2 calorimeter”
- 15:00 - 15:10 questions and discussion



### Visit to the labs

Wednesday, August 17 – Lab-3

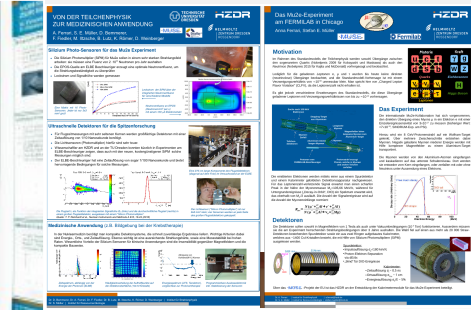
- 14:00 Visit to the UK activities in g-2
  - no training required
  - visitors must have covered footwear (no sandals)
  - visitors will be provided with clean room garments

Thursday, September 15 – MC-1

- 9:00 Visit to the Italian activities in g-2
  - required: MC-1 Hazard Awareness Training



### Tag des Offenen Labors (HZDR) – D5.1



Incontri di Fisica (INFN Frascati)



European Researchers' Night (INFN Pisa)

# Outreach: 2017 events

# MUSE

## The Mu2e Electromagnetic Calorimeter

MUSE outreach program for University students

15-17 May 2017

University of Rome "Tor Vergata"  
INFN - Laboratori Nazionali di Frascati



Monday 15 May 2017, 10:00 A.M.  
University of Rome "Tor Vergata" Aula Grassano

### Seminars:

- F. Happacher The Mu2e Experiment  
- S. Giovannella Scintillating Crystals  
- I. Sarra Silicon Photomultipliers

Wednesday 17 May 2017, 2:00 P.M.  
Laboratori Nazionali di Frascati

Hands-on laboratories  
Tutors: E. Diociaiuti, R. Donghia

14:00 Building 36, Room B1  
Introduction to laboratory measurements

14:30 Building 28  
- Measurement of Scintillation Properties for CsI Crystals  
- Measurement of Silicon Photomultiplier Properties



- ✗ March 2017:  
MUSE Masterclasses @  
UCL and Liverpool University
- ✗ 15-17 May 2017:  
General Meeting Outreach Event  
University of Rome "Tor Vergata"
  - ↪ seminars on Mu2e EMC
  - ↪ hands-on experiments @ LNF
- ✗ MUSE Event for 2017 FNAL  
Summer Students being organized
- ✗ October 2017:  
MUSE @ "Incontri di Fisica"  
(Deliverable D5.2)



# MUSE



# WP7: Management

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**Objectives:** efficient, transparent and productive organization of the project; supervision of secondments; monitoring of the the scientific activities and of the fulfilment of the deliverables; maximization of the knowledge sharing among the involved institutions; equal opportunity for all participants and maximization of the visibility of the project.

**Task 7.1:** Project supervision: planning, authorization and supervision of secondments; monitoring of the Work Packages activities and deliverables/milestones.

MS8 (M1) – Management structure in place → **ACHIEVED**

**Task 7.2:** Planning and organization of meetings: Management Board, Scientific Board and Annual General Meetings

D7.4/7.5/7.6/7.7 (M9/21/33/45) MUSE General Meetings → **2016/2017 COMPLETED**

**Task 7.3:** Periodic written reports on the ongoing WP activities and on the status of secondments and milestones/deliverables

D7.1 (M12) First progress report → **SUBMITTED**

D7.2 (M36) Second progress report

**Task 7.4:** MUSE web site, organized with a private section for the participants and pages for general public

D7.3 (M5) MUSE web site → **COMPLETED**

# General Meetings

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- X One MUSE General Meeting per years
- X First GM held in Pisa, 28-30 Sep 2016 (<http://agenda.infn.it/event/muse2016>)
  - ↪ More than 30 researchers from different institutions attended the meeting
  - ↪ First two days devoted to the review of the activities connected to the project
  - ↪ Some specific talk of general interest included in the agenda
  - ↪ Joint MB/SB meeting focused on an in-depth discussion on the running of the first months of the project
  - ↪ Training session for MUSE researchers
    - Writing for general public
    - Application of SiPMs in Positron Emission Tomography
    - Medical imaging processing using brain emulator
    - Reactor Physics Group Activities
  - ↪ Outreach activities for University students
    - Seminars on the experiments of the Muon Campus
    - Talks by two participants of the "Summer Students at Fermilab and other US Laboratories" program, describing their 9-week internship experience at FNAL

# 2017 General Meeting



## 2017 MUSE General Meeting

Annual meeting to review the activities supported by the Horizon 2020 MUSE project. The meeting hosts also the MUSE mid-term review.

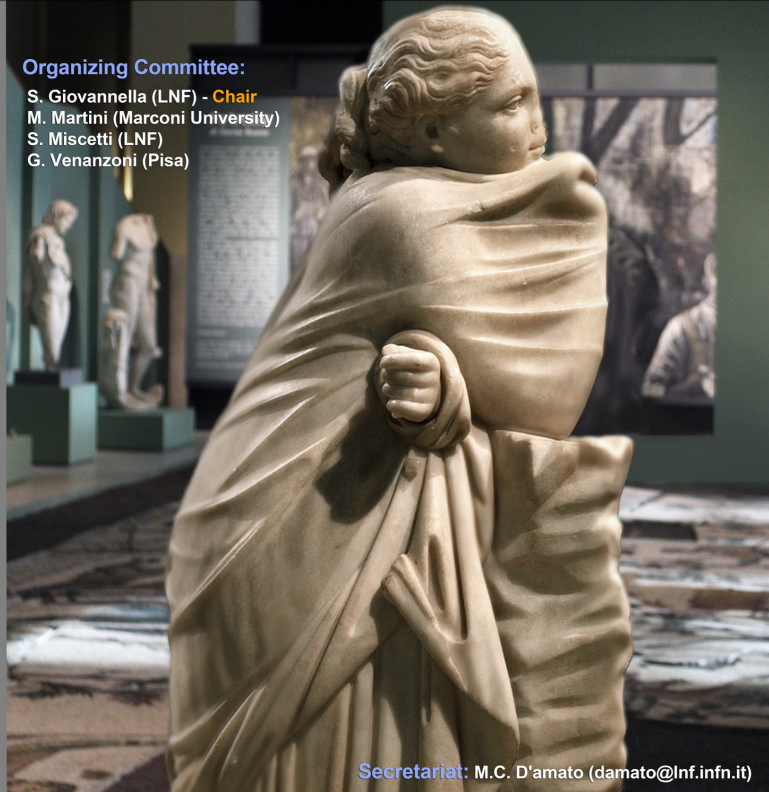
10-12 May 2017

INFN - Laboratori Nazionali di Frascati



### Organizing Committee:

S. Giovannella (LNF) - **Chair**  
M. Martini (Marconi University)  
S. Miscetti (LNF)  
G. Venanzoni (Pisa)



Secretariat: M.C. D'amato (damato@lnf.infn.it)

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- X Frascati, 10-12 May 2017  
(<http://agenda.infn.it/event/muse2017>)
- X Hosting this MTM meeting
- X Same scheme as 2016 edition:
  - ↪ Joint MB/SB Meeting
  - ↪ Training
    - Muon Colliders
    - Laser systems
    - Nanotechnology medical applications
    - Communicating Science
  - ↪ Young Scientists' Forum
  - ↪ Outreach event @ University of Tor Vergata and LNF

# Secondments

Complex secondment plan:

↪ total number of secondments: **385 person-months**

↪ **271 different secondments** listed in GA

↪ **71 seconded fellows** listed in GA

**➔ A well structured organization needed!**

Staff Member		Sending Organisation				Seconded to Organisation				Work Package Number	Secondment Starting Month	Duration of Secondment (Researcher-Months)
ID	Profile	Short Name	Country	Region	Academic Sector	Short Name	Country	Region	Academic Sector			
8	ER	INFN	IT	EU/AC	yes	FRA	US	TC	no	2	2	2
8	ER	INFN	IT	EU/AC	yes	FRA	US	TC	no	3	6	1
8	ER	INFN	IT	EU/AC	yes	FRA	US	TC	no	3	16	1
8	ER	INFN	IT	EU/AC	yes	FRA	US	TC	no	2	19	2
8	ER	INFN	IT	EU/AC	yes	FRA	US	TC	no	2	26	2
8	ER	INFN	IT	EU/AC	yes	FRA	US	TC	no	3	30	1
8	ER	INFN	IT	EU/AC	yes	FRA	US	TC	no	2	38	2
8	ER	INFN	IT	EU/AC	yes	FRA	US	TC	no	3	43	1

# Secondments: MUSE handbook

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Before departures:

- ✗ sending organization will provide the information related to the secondment (NAME/FROM/TO/ARRIVAL/DEPARTURE/WP) to MUSE administration through a dedicated mailing list
- ✗ MUSE administration will send the complete list to the host institution(s)

During each secondment travel:

- ✗ seconded personnel must pick up the declaration issued from the host institution. This declaration states arrival/departure dates and WP number

At the end of each stay seconded personnel must:

- ✗ return the original copy of the declaration to their administration
- ✗ write a short report on the activity carried out
- ✗ send a copy of both documents to MUSE administration

# Rescheduling secondments

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As declared in the MUSE GA, the progress of MUSE activities and related tasks is ensured by a continuous re-arrangement the secondments schedule on a few-month basis

This is done by modifying the starting date of the planned secondments and distributing secondments to different researchers with the same profile and an equivalent professional experience, if needed

The goal is to follow as much as possible the secondments planned for the different WPs along the project, by taking also into account variations in the schedule of the planned activities

This procedure requires a close interaction between the Scientific Board, which is in charge for the monitoring of the scientific activities, and the Management Board, which is responsible of the revision and of the authorization of MUSE secondments

This strategy provides a smooth progress of most of the tasks and the in-time completion of the seven deliverables and the two milestones due in the first year of the project

# Secondments: Jan 2016 - Apr 2017

Institution	Scheduled in GA	Started	Fraction Started	Completion for started sec.
ADVANSID	1	0	0%	–
CAEN	2	0	0%	–
HZDR	12	3	25%	43%
INFN	90	79	88%	82%
LIVERPOOL	33	30	91%	45%
PRISMA	5	5	100%	100%
UCL	20	15	75%	48%
<b>Total</b>	<b>163</b>	<b>132</b>	<b>81%</b>	<b>69%</b>

- ✓ Fraction of started secondment was 83% at the end of 2016
- ✓ Some of the secondments will be spread on the whole project lifetime. The fraction of completed secondments does not directly provide the completion fraction for the considered period
- ✓ Delays in secondments from ADVANSID, CAEN and HZDR are connected to the delays previously discussed. The new planning of the related activities will provide a recovery of these secondments
- ✓ UCL (and LIV) had to delay secondments for technicians for visa problems and for a temporary vacancy of one of the positions
- ✓ **The overall high percentage value demonstrates that the project is progressing well, although the implementation delay of some secondments has to be monitored**

# Secondments: Jan 2016 - Apr 2017

WP	Scheduled in GA	Started	Fraction Started	Completion for started sec.
1	38	27	71%	62%
2	33	27	82%	74%
3	39	38	97%	76%
4	40	34	85%	59%
5	2	2	100%	60%
6	10	3	30%	66%
7	1	1	100%	53%
<b>Total</b>	<b>163</b>	<b>132</b>	<b>81%</b>	<b>69%</b>

- ✓ Fraction of started secondment for WP 1 was 60% at the end of 2016, due to the delay of the installation of the Muon g-2 detector. Now in line with the other WPs
- ✓ WPs 5 and 7 foresee few secondments to Fermilab for outreach and management activities
- ✓ The lower percentage of started secondments for WP 6 is due to the problems of the related tasks already discussed



# Gender aspects

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## Unbalanced gender population in Particle Physics

- MUSE: Fraction of female with permanent/temporary research positions: 15%  
Including PhD students and postdocs it increases to 25%

## Our goals:

### Increase female participation in the MUSE management

- Fraction of female in the MUSE management: 20% (18% MB, 21% SB)

### Promote female speakers

- Fraction of MUSE female speakers at conferences: 35%
- Invited female speakers at MUSE training events: 25%
- Tutoring activities in outreach events

### Organize specific events for female high school students

- Participation to Career Day @ Marconi University (October 2017), focused on the role of women in the era of smart working
- Working on other events to attract girls to STEM

# MUSE impact on individual careers

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We have already many examples of MUSE researchers who won grants or got new career opportunities after working in MUSE:

- X **S. Donati** (INFN Pisa) – MB member, SB chair, WP7 co-convener  
*Coordinator of NEWS, proposal submitted to H2020-RISE-2016, currently at Grant Agreement Preparation stage*
- X **I. Sarra** (INFN LNF) – SiPM expert  
*Proposal NAUSICAA, submitted to H2020-MSCA-IF-2016 (Global Fellowship), awarded with Marie Skłodowska-Curie Actions Seal of Excellence*
- X **E. Diociaiuti** (INFN LNF) – Ph.D. student  
*2016 ARAP award for outstanding university students on Elementary Particle Physics*
- X **O. Escalante** (INFN NA) – PostDoc  
*IFAE 2016: award for the best poster of the conference*
- X **T. Stuttard** (UCL) – Ph.D. student  
*postdoc position at The Niels Bohr Institute in Copenhagen on IceCube*

# 2016 Milestones and Deliverables

Number	WP	Name	Lead Beneficiary	Due date	Submitted/ Achieved
MS8	7	Management structure in place	INFN	31 Jan 2016	11 Jan 2016
D7.3	7	MUSE web site	INFN	31 May 2016	31 May 2016
D5.1	5	MUSE @ HZDR Open Day	HZDR	30 Sep 2016	30 Sep 2016
D7.4	7	First MUSE General Meeting	INFN	30 Sep 2016	30 Sep 2016
D3.1	3	g-2 laser calibration system	INFN	31 Oct 2016	30 Oct 2016
D2.1	2	Calorimeter TDR	INFN	31 Dec 2016	28 Dec 2016
MS6	4	New release of the g-2 software	UCL	31 Dec 2016	22 Nov 2016
D4.2	4	g-2 full muon simulation	UCL	31 Dec 2016	30 Dec 2016
D7.1	7	First Progress Report	INFN	31 Dec 2016	30 Dec 2016

**All deliverables and milestones due in 2016 completed on time**



# 2017 Milestones and Deliverables

Number	WP	Name	Lead Beneficiary	Due date	Type
<b>MS1</b>	<b>1</b>	<b>Tracker-DAQ integration</b>	<b>UCL</b>	<b>31 May 2017</b>	
D3.2	3	g-2 tracker tools	UCL	30 Jun 2016	Report/Public
D3.3	3	Mu2e laser system	INFN	30 Jun 2017	Report/Public
<b>D7.5</b>	<b>7</b>	<b>2<sup>nd</sup> MUSE General Meeting</b>	<b>INFN</b>	<b>30 Sep 2017</b>	<b>Other/Public</b>
D5.2	5	Annual Physics Meeting	INFN	31 Oct 2017	Other/Public
D1.1	1	Report on laser integration	INFN	31 Dec 2017	Report/Public
D1.2	1	Report on g-2 trackers	LIVERPOOL	31 Dec 2017	Report/Public

**MS1 achieved on April 10<sup>th</sup>**

**We do not expect problems in completing deliverables and milestones in due time**

# Conclusions

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- ✗ First 16 months of the project completed
- ✗ Despite some delays in two specific items, MUSE activities are progressing very well:
  - ↪ several achievements on the scientific side
  - ↪ a large fraction of the planned secondments started
  - ↪ deliverables and milestones completed in due time
  - ↪ very active networking and transfer of knowledge among different institutions
  - ↪ a lot of dissemination and outreach events done

We look forward for other two and a half years of fruitful activity with MUSE

# Rendering of Muon Campus



# 2017

