Patras 2021 in Trieste

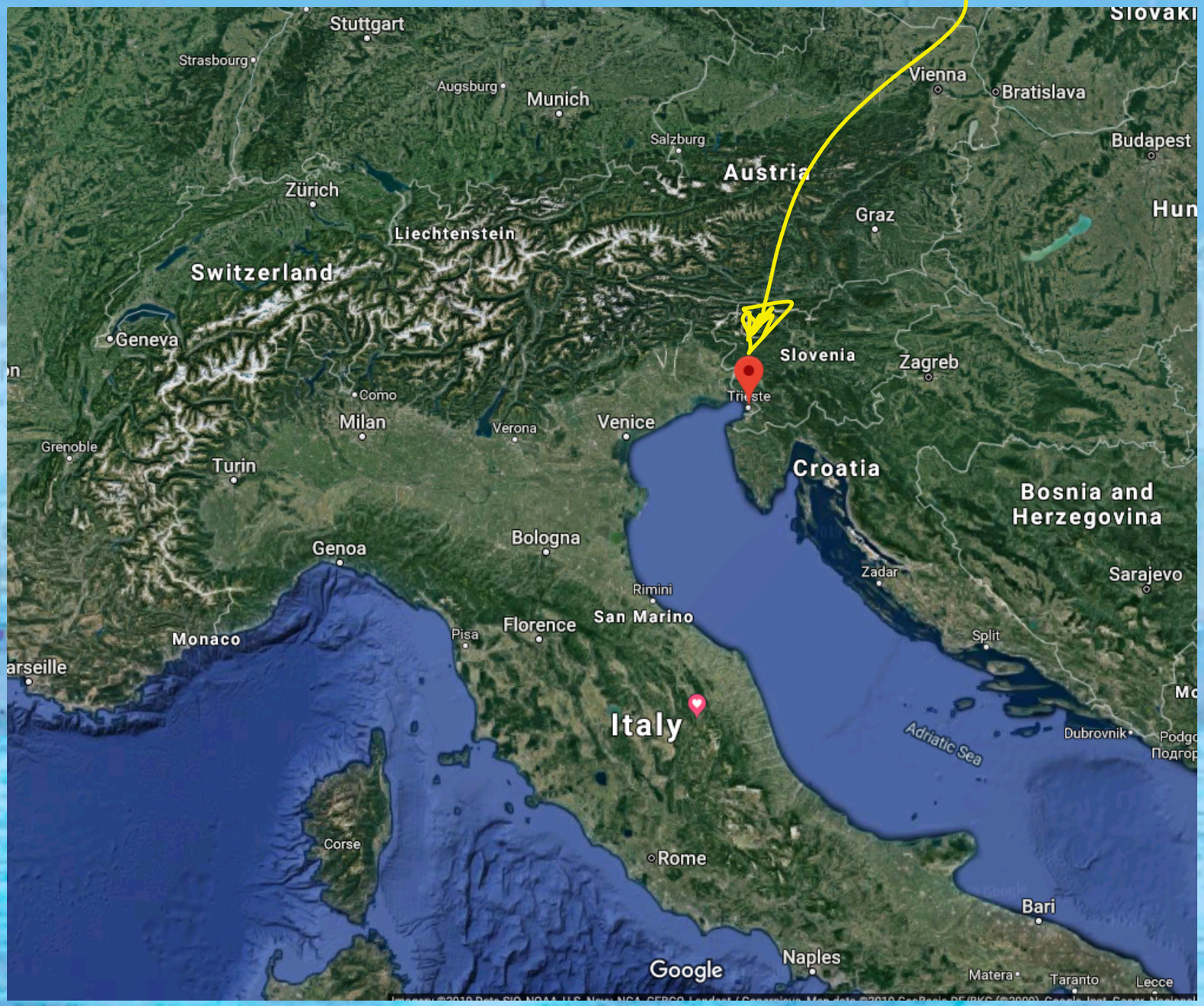
...finally

G. Cantatore - Università and INFN Trieste

Trieste 2021 Local Organizing Committee

G. Cantatore - Uni. and INFN Trieste
A. Cuccarollo - INFN Trieste
A. Filippi - INFN Trieste
M. Karuza - Uni. Rijeka and INFN Trieste
F. Longo - Uni. and INFN Trieste
T. Tenze - INFN Trieste
R. Valandro - Uni. and INFN Trieste

WE ARE HERE !!


Stuttgart
Strasbourg
Augsburg
Munich
Vienna
Bratislava
Budapest
Salzburg
Austria
Zürich
Graz
Liechtenstein
Switzerland
Geneva
Slovenia
Zagreb
Como
Milan
Verona
Venice
Grenoble
Turin
Croatia
Bosnia and Herzegovina
Genoa
Bologna
Zadar
Sarajevo
Rimini
San Marino
Florence
Pisa
Split
Monaco
Italy
Adriatic Sea
Dubrovnik
Corse
Rome
Bari
Naples
Google
Matera
Taranto
Lecce

Trieste 2021

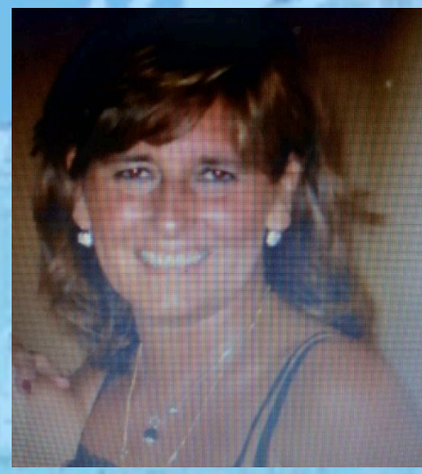
- **WELCOME TO THE PATRAS WORKSHOP FIRST EVER ONLINE EDITION!**
- **The Patras Workshop comes to Italy for the first time**
- **Host institutions**
- **INFN Trieste**
- **University of Trieste**
- **University of Rijeka, Croatia**

The LOC team

Giovanni

Anna Paola

Marin



Tiziana

Francesco

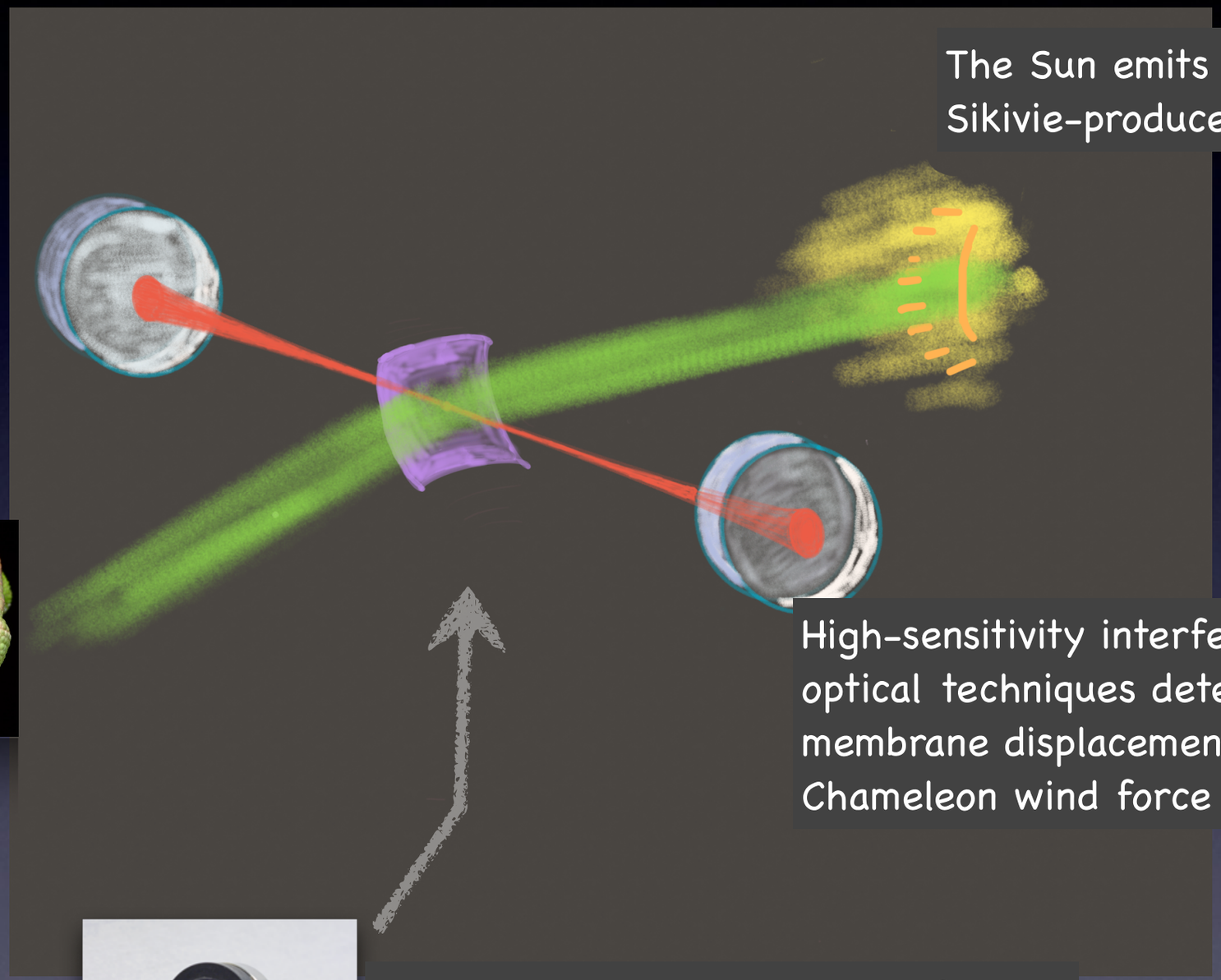
Alessandra

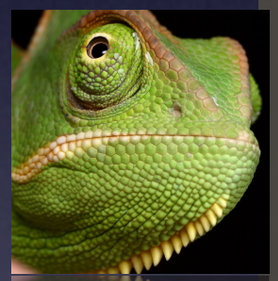
Roberto

“Dark sector” in Trieste

- Past
  - axion searches with precision polarimetry (1992 -2010)
  - axions and dark photons at CAST (2010-2013)
- **Present**
  - **Dark energy searches with KWISP at CAST (2014 ->)**
  - **Beyond the standard model: Muon G-2 at FNAL (2014 ->)**
  - **New initiatives: MUonE (2018->)**

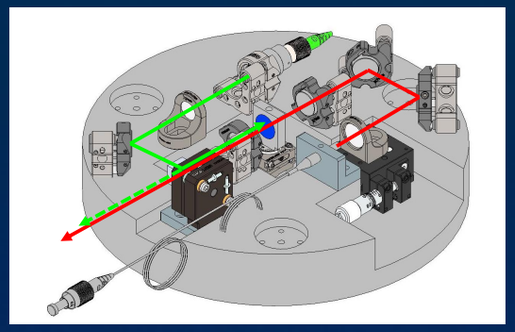
The Kinetic WISP detection principle

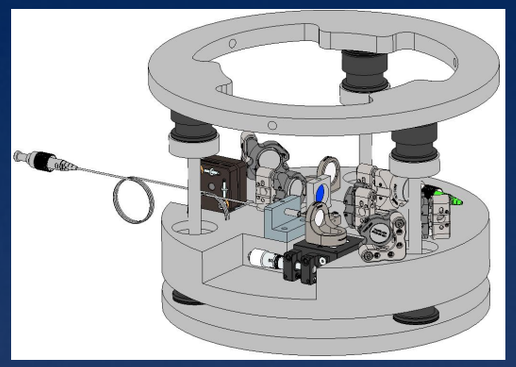




Curious? See January-February 2016 CERN Courier http://cerncourier.com/cws/article/cern/63705

KWISP current overview

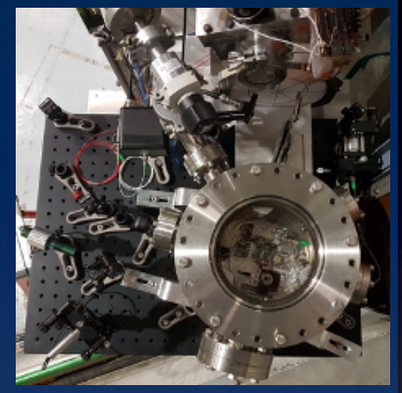


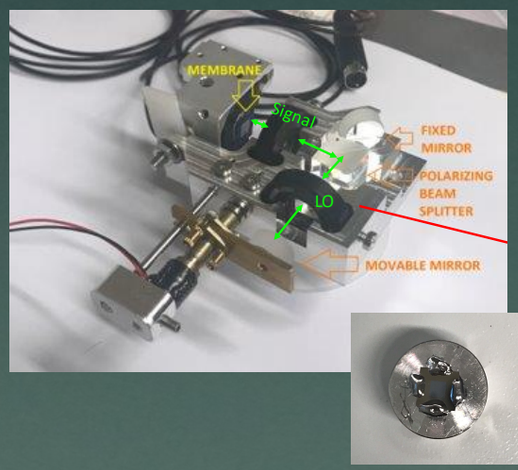


KWISP 3.5

- Fabry-Pérot interferometer with full fiber-optic beam transport
- improved monolithic optics design
- uncoated membrane
- "sandwich-type" passive vibration isolation
- built-in force calibration with auxiliary beam
- Pt-coated chopper wheel

- Taking data on CAST at CERN

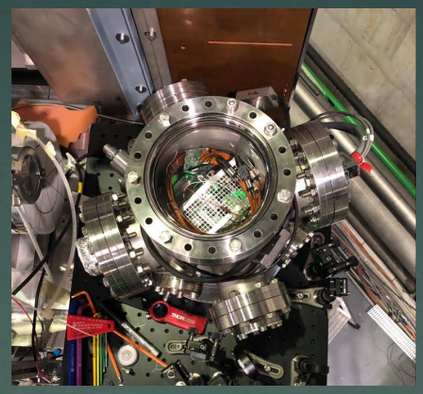




KWISP 1.5

- Michelson interferometer
- monolithic design
- high density Pt coated membrane
- "sandwich-type" passive vibration isolation
- "chopper-less" detection

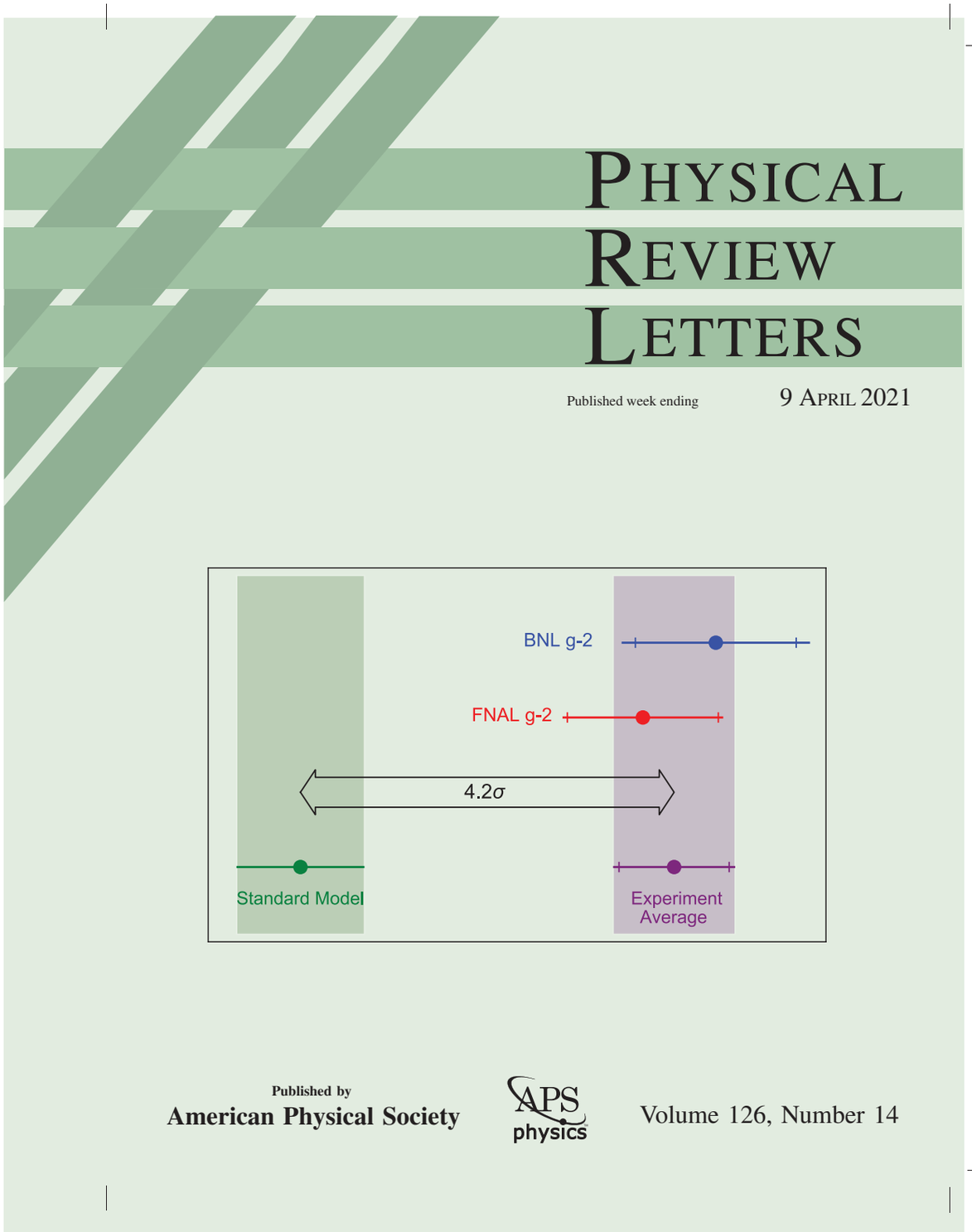
- Two running twin detectors, one in Rijeka and one in Trieste



More on KWISP

- **Presentation by J. Baier on Tuesday**

Cover story…


PHYSICAL
REVIEW
LETTERS
Published week ending
9 APRIL 2021
BNL g-2
FNAL g-2
4.2σ
Standard Model
Experiment
Average
Published by
American Physical Society
APS
physics
Volume 126, Number 14

Muon g-2 collaboration

USA

- Boston
- Cornell
- Illinois
- James Madison
- Kentucky
- Massachusetts
- Michigan
- Michigan State
- Mississippi
- North Central
- Northern Illinois
- Regis
- Virginia
- Washington

USA National Labs

- Argonne
- Brookhaven
- Fermilab

China

- Shanghai Jiao Tong

Germany

- Dresden
- Mainz

Italy

- Frascati
- Molise
- Naples
- Pisa
- Roma Tor Vergata
- Trieste
- Udine

Korea

- CAPP/IBS
- KAIST

Russia

- Budker/Novosibirsk
- JINR Dubna

United Kingdom

- Lancaster/Cockcroft
- Liverpool
- Manchester
- University College London

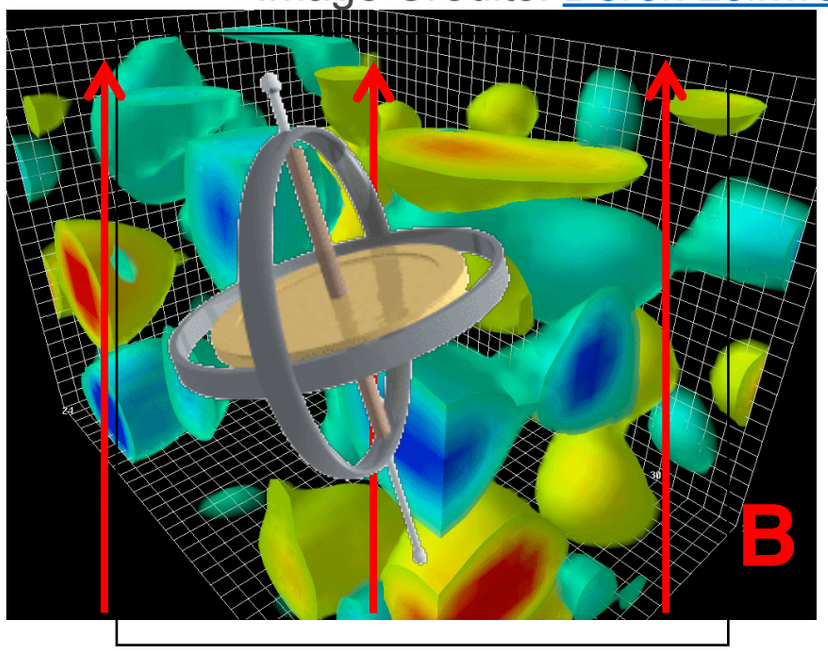
>200 collaborators
35 Institutions
7 countries

New physics search

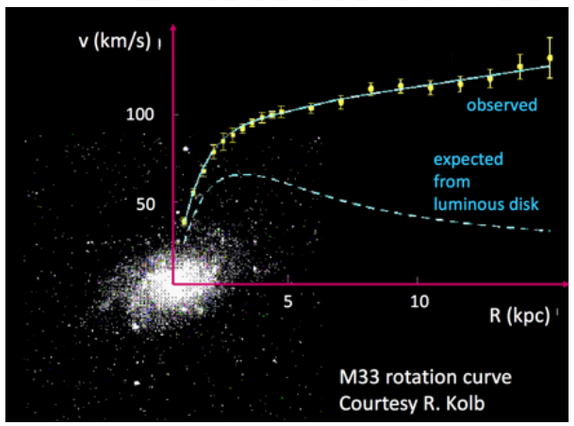
- Measuring the precession tells us the muon magnetic moment
- The high precision allows us to ‘see’ if new particles or forces are contributing to the anomaly!

$$a_\mu = \frac{g-2}{2}$$

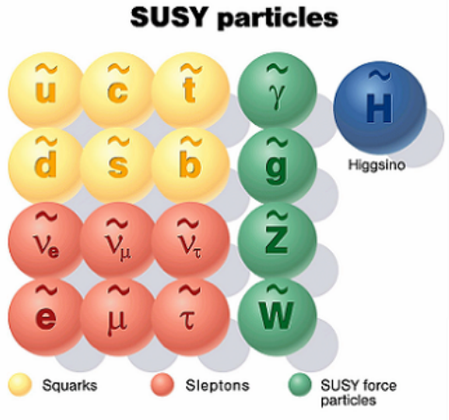
Image Credits: Derek Leinweber



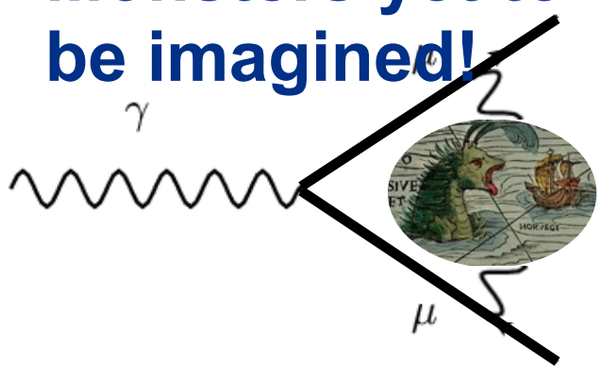
Dark matter!



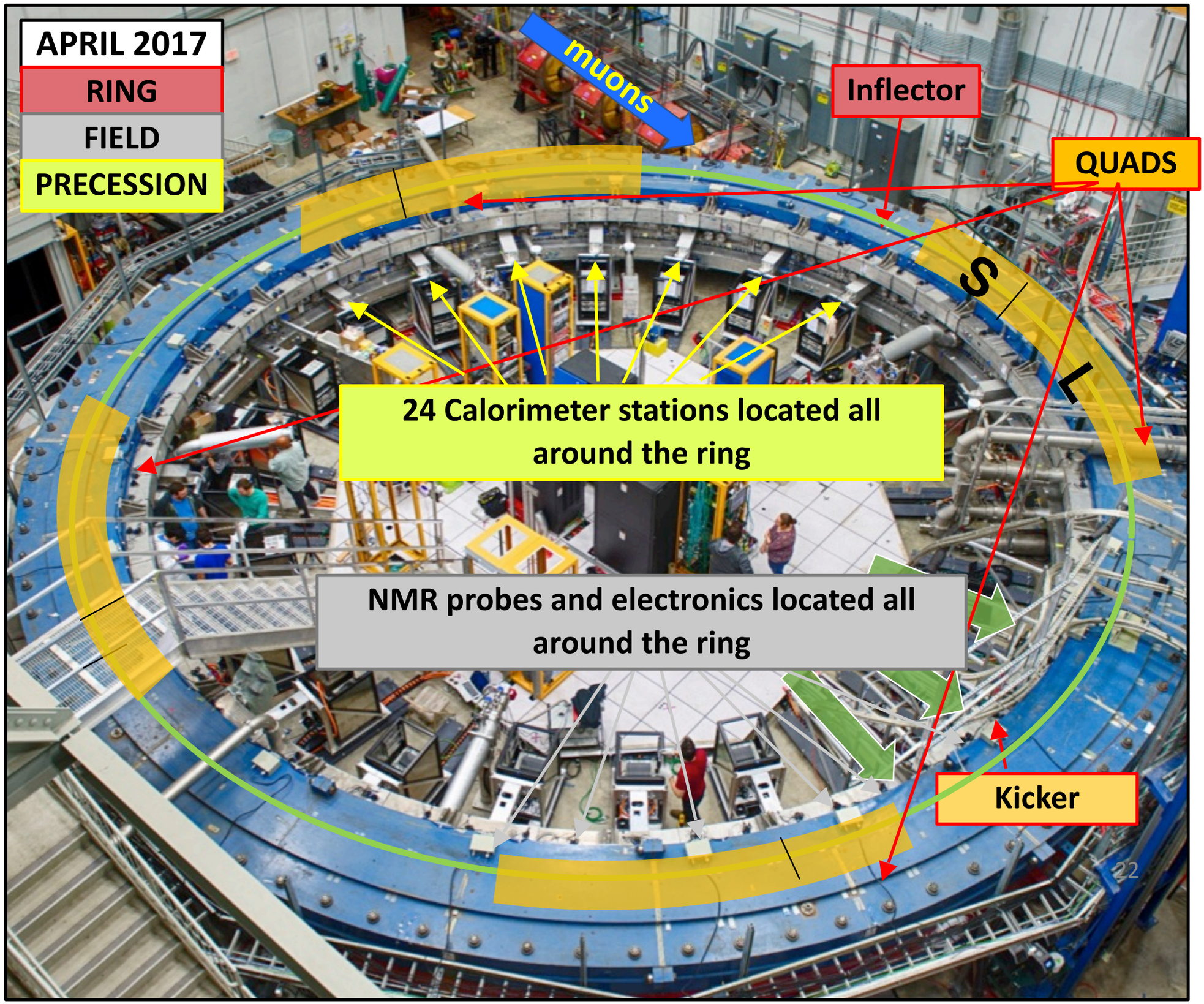
SUSY!



Monsters yet to be imagined!



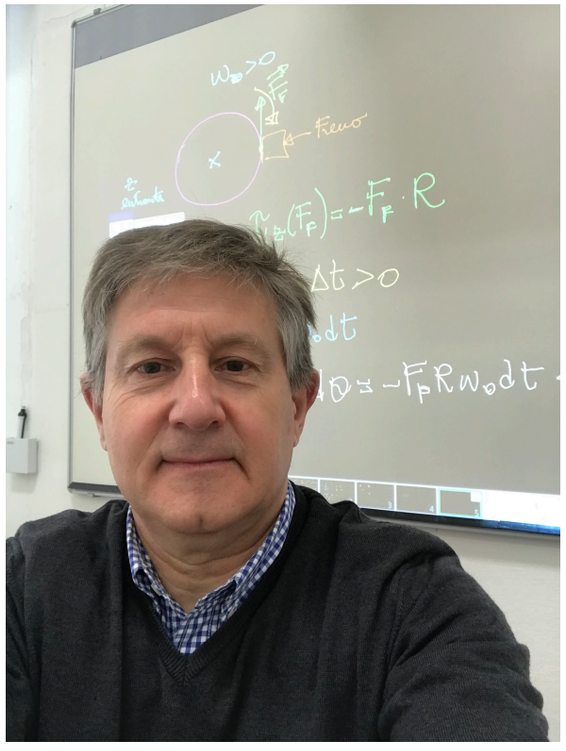
Fermilab


APRIL 2017
RING
FIELD
PRECESSION
muons
Inflector
QUADS
S
L
24 Calorimeter stations located all around the ring
NMR probes and electronics located all around the ring
Kicker

INFN Trieste/Udine Group

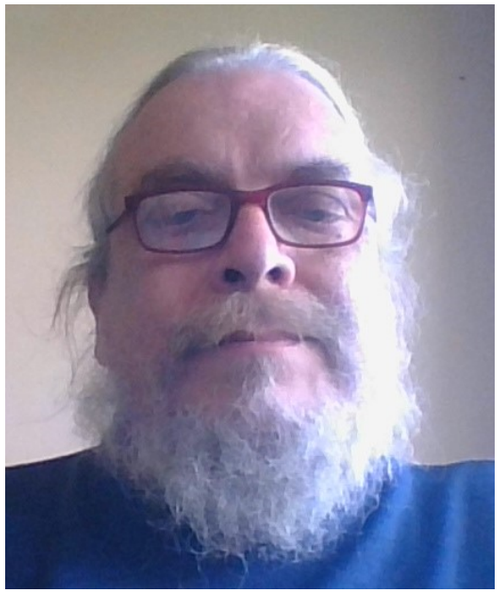
Muon g-2

Anna Driutti



Giovanni Cantatore

Marin Karuza



Lorenzo Santi

Diego Cauz

Giovanni Pauletta

The laser calibration system

The **laser calibration system** is a key element of Muon g-2, it was practically absent in the previous Brookhaven Lab experimen

BNL (2001) **Muon g-2 at FNAL**

Table 5.2: The largest systematic uncertainties for the final E821 ω_a analysis and proposed upgrade actions and projected future uncertainties for data analyzed using the T method. The relevant Chapters and Sections are given where specific topics are discussed in detail.

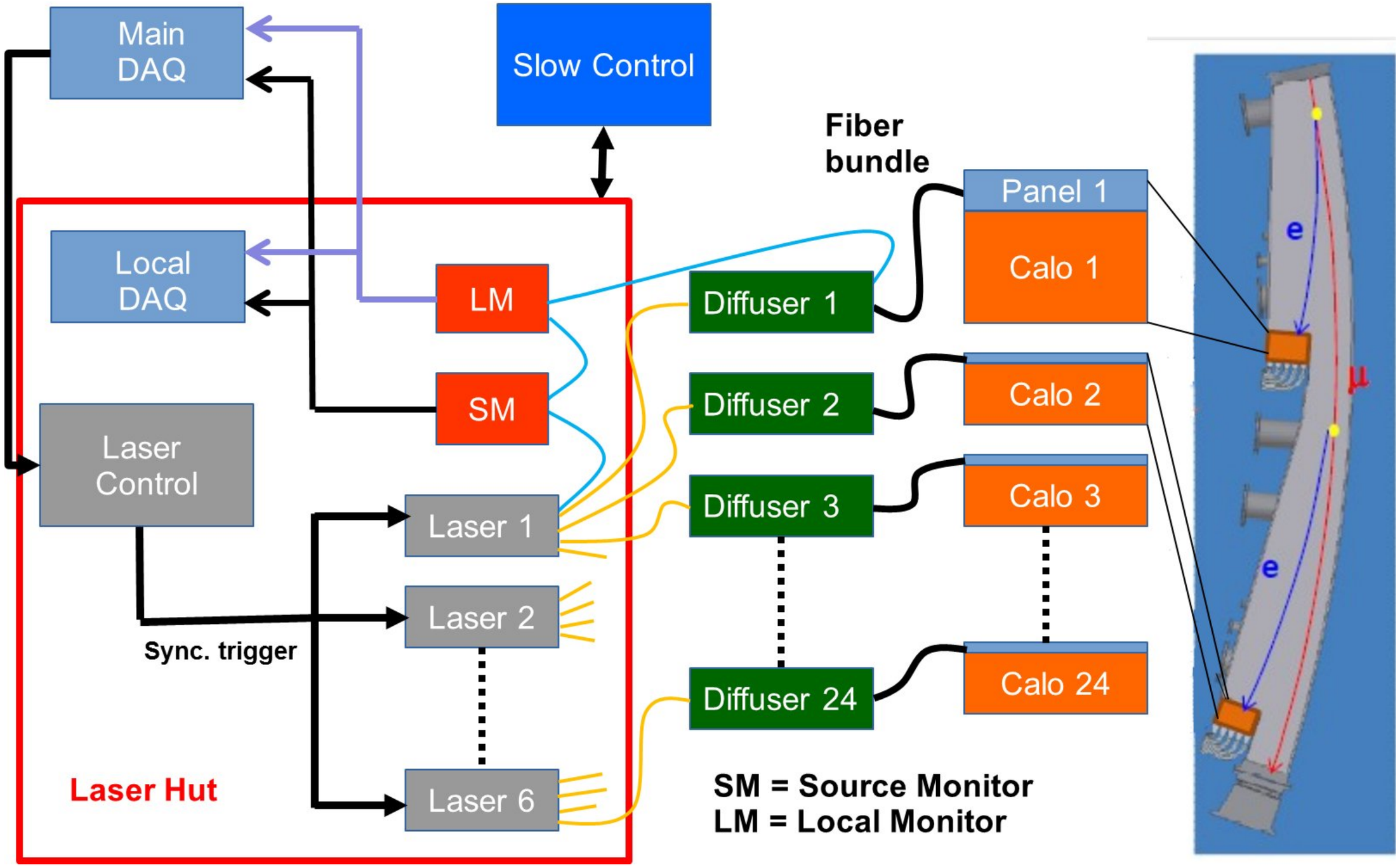
Category	E821 [ppb]	E989 Improvement Plans	Goal [ppb]	Chapter & Section
Gain changes	120	Better laser calibration low-energy threshold	20	16.3.1
Pileup	80	Low-energy samples recorded calorimeter segmentation	40	16.3.2
Lost muons	90	Better collimation in ring	20	13.10
CBO	70	Higher n value (frequency) Better match of beamline to ring	< 30	13.9
E and pitch	50	Improved tracker Precise storage ring simulations	30	4.4
Total	180	Quadrature sum	70	

from Muon g-2 "TDR"

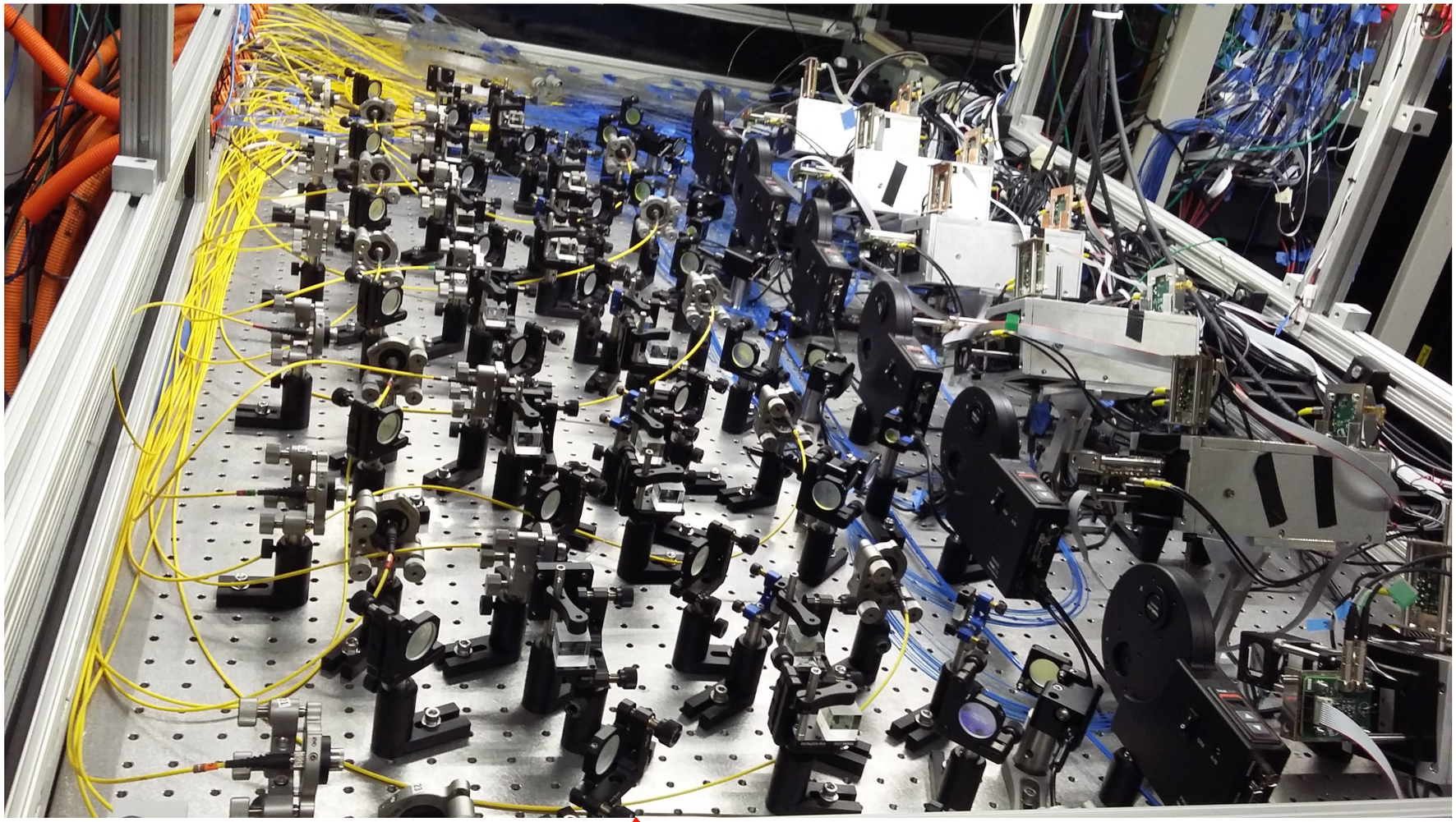
Simple working principles:

- a **"source monitor"** employing a ^{241}Am source as reference gives the absolute calibration of laser pulse amplitudes
- laser pulses are distributed to the calorimeter crystals through a fibre optic network monitored by **"local monitor"**
- laser pulses illuminate the calorimeter crystals through a **"diffuser"**, and several pulse sequences are used in order to obtain the gain corrections to be applied to the SiPMs

Laser calibration system layout

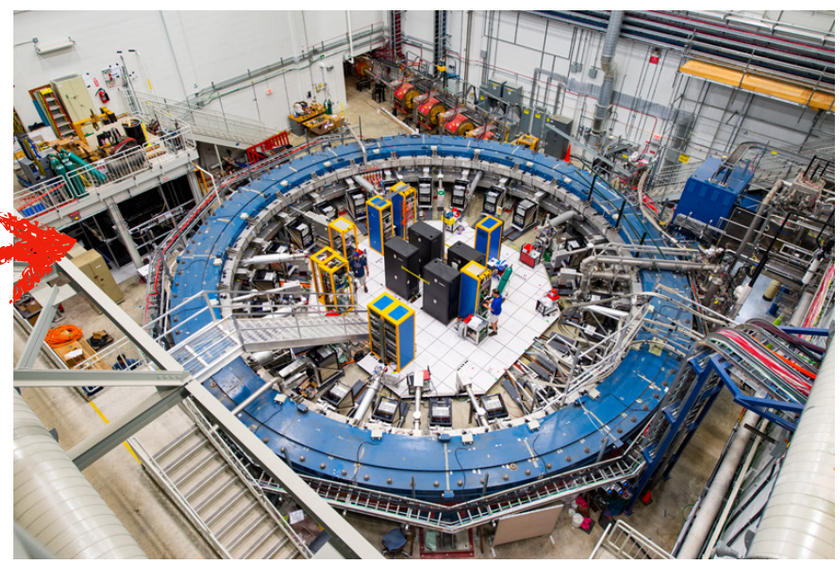


Optical bench and "Laser Hut"



Optical bench

"Laser Hut"



In action…

Muon g-2

Muon g-2 DQM Run **13593** Event **672** **2018-03-15 01:13:44** **100%** of events processed Subsystem

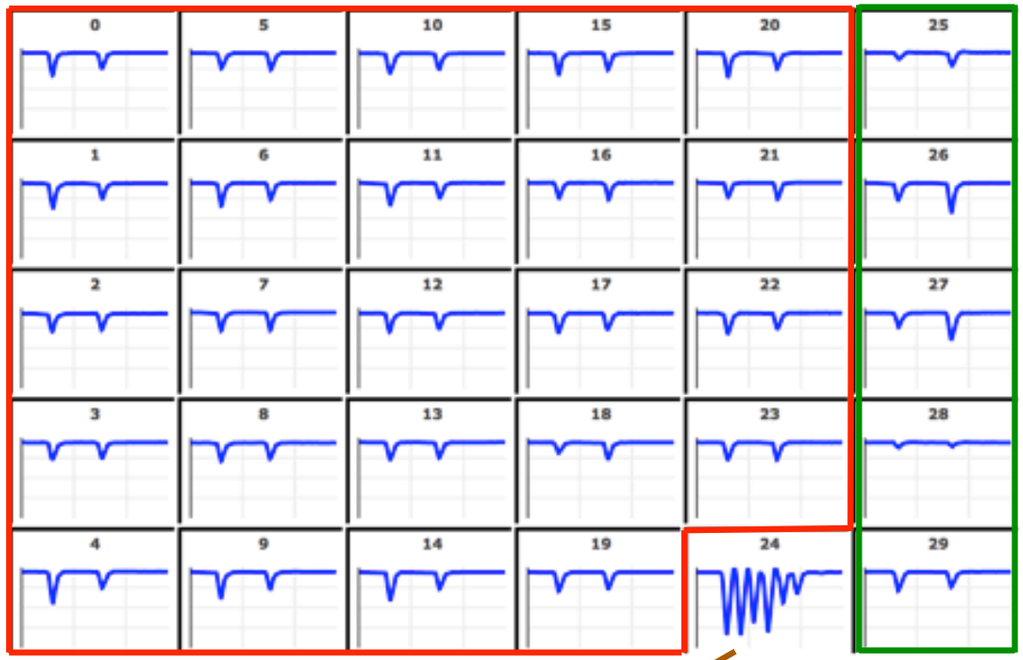
current laser mode: 1, standard mode Connected

Laser Crate 25 Muon Fill summary plots

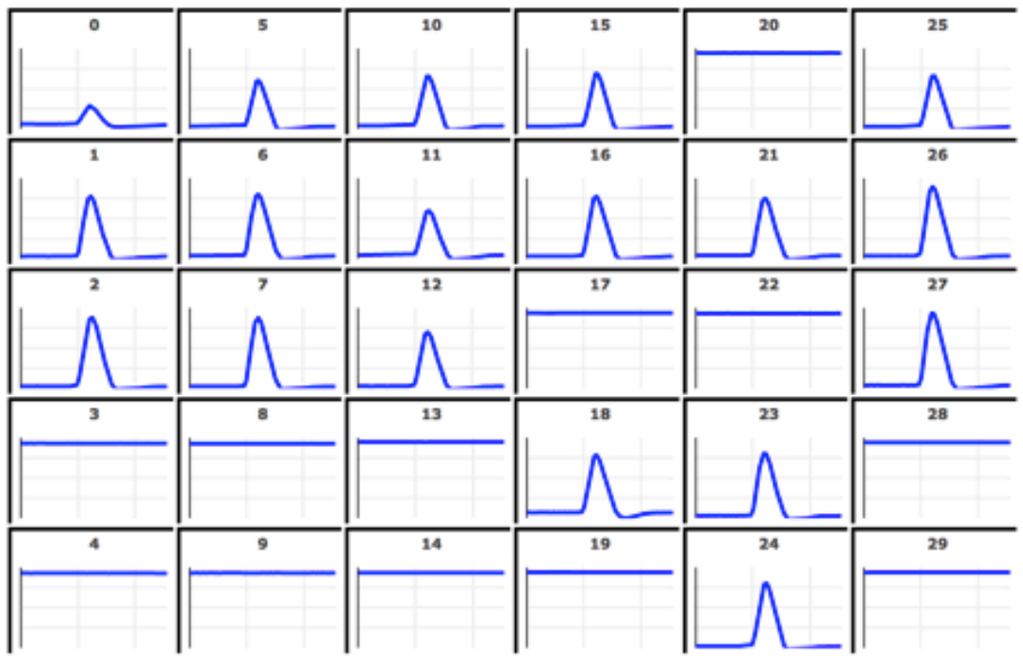
Laser Fill view | Laser Slow Control | Laser 1 | Laser 2 | Laser 3 | Laser 4 | Laser 5 | Laser 6

NUMBER **13593** EVENT **671** N. LM ISLANDS (for each channel)**3** N. SM ISLANDS (for each channel)**3**

LOCAL MONITORS click on channel to select the trace



SOURCE MONITORS click on channel to select the trace



24 LOCAL MONITORS

5 REDUNDANT OLD MONITORS

6(X3) SOURCE MONITORS

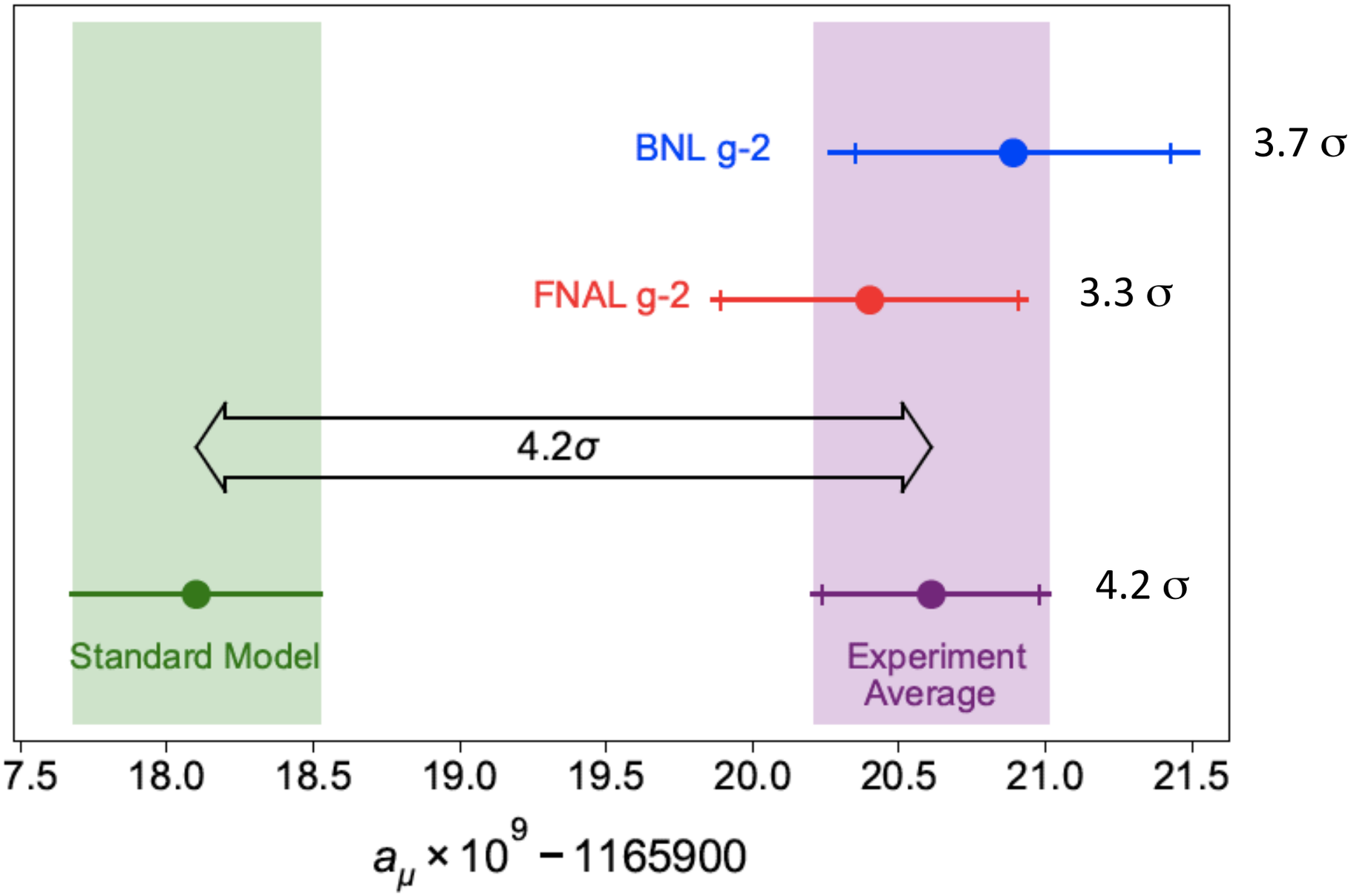
SPECIAL PMT (see later)

G. Venanzoni, CSN1, 22 Maggio 2018

19

G. Cantatore, “Muon g-2” Collaboration, Università di Trieste, 13 Aprile 2021

Muon anomaly: state of the art

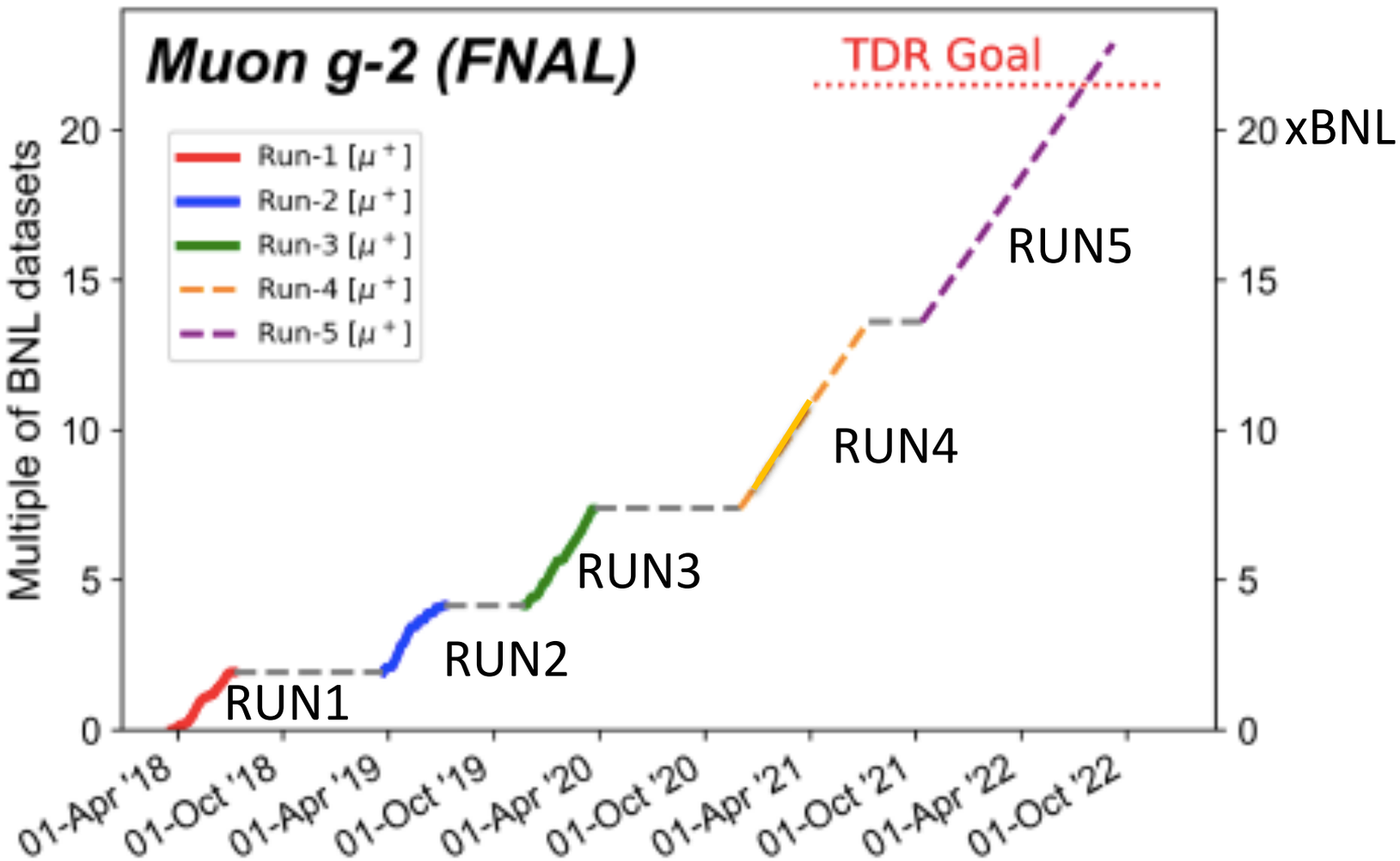


References

https://doi.org/10.1103/PhysRevD.103.072002
https://doi.org/10.1103/PhysRevLett.126.141801
https://doi.org/10.1103/PhysRevA.103.042208

Future

- RUN1 is only 6% of the final dataset
- Analysis of RUN2/3 (expect an improvement of a factor ~2 in precision)
- RUN4 (November 2020-July 2021) is expected to bring the statistics to ~13 BNL
- RUN5 in 2021-2022 should allow to achieve the x20 BNL project goal



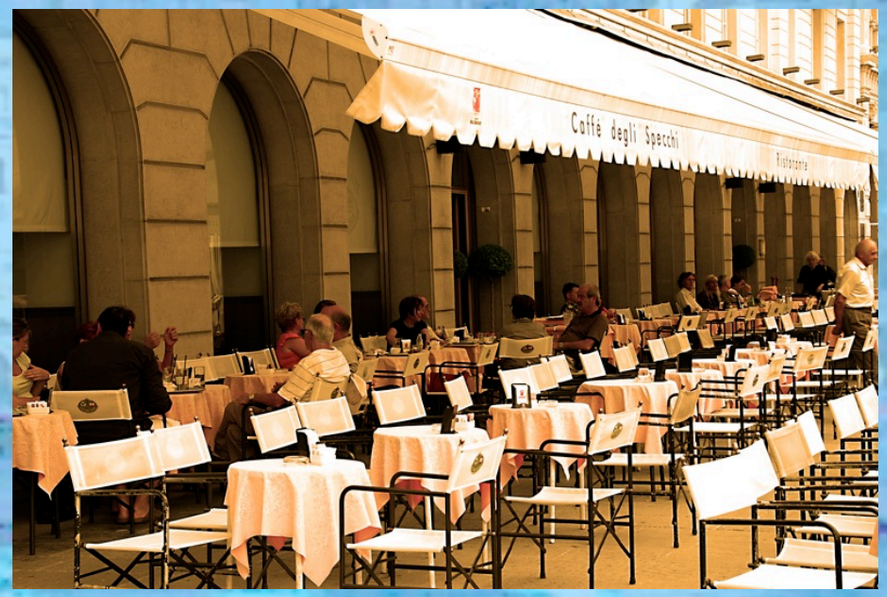
Conclusions:

Online vs. Airline

- **Sitting in front of your computer is quite comfortable …**

Conference venue

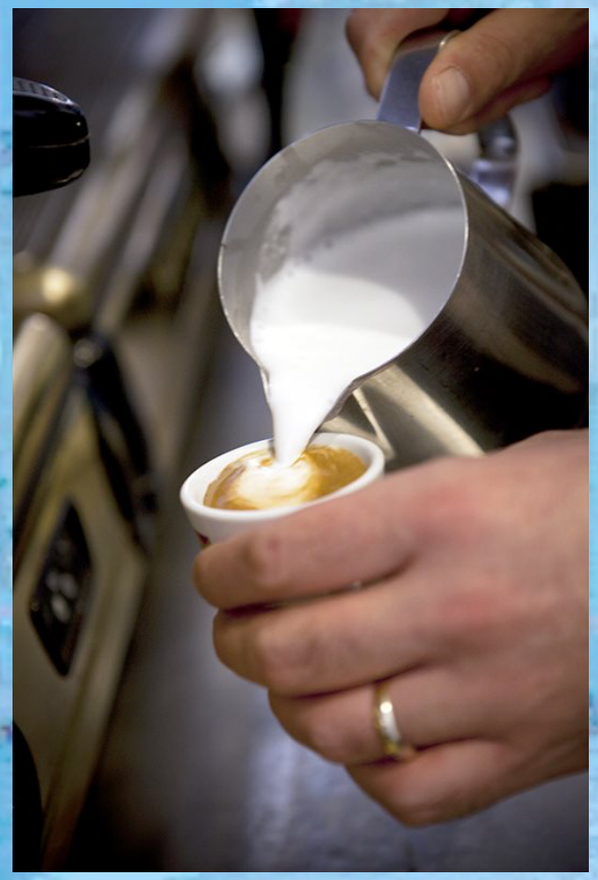
Historic cafes in Trieste



How to order a coffee in Trieste…

- for an espresso in an espresso cup, order a **NERO**
- for an espresso in a glass, order a **NERO IN B**
- for a decaffeinated espresso in an espresso cup, order a **DECA**
- for a decaffeinated espresso in a glass, order a **DECA IN B**
- for an espresso macchiato (espresso with a splash of frothed milk) in an espresso cup, order a **CAPO**
- for an espresso macchiato (espresso with a splash of frothed milk) in a glass, order a **CAPO IN B**
- for a decaffeinated espresso macchiato (espresso with a splash of frothed milk) in an espresso cup, order a **CAPO DECA**
- for a decaffeinated espresso macchiato (espresso with a splash of frothed milk) in a glass, order a **CAPO DECA IN B**
- for an espresso with a drop of frothed milk, order a **GOCCIA**
- for a cappuccino, order a **CAFFELATTE**

- **WARNING!! The above holds only for the city of Trieste. If you go to nearby Monfalcone and ask for a NERO, they will bring you a glass of red wine… so be careful!**




NEXT YEAR!
SEE YOU