Production in g-2
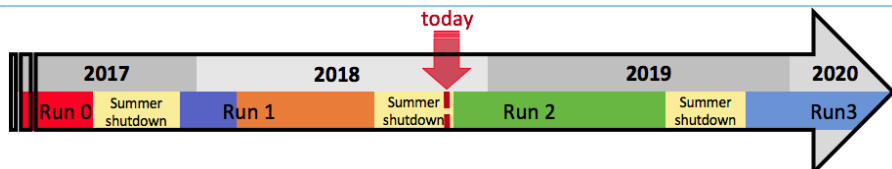
Anna Driutti

University of Udine & INFN
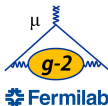
Muon g − 2 Timeline

Run 0 : commissioning run with 1-4 fills/min and beam dominated by protons.

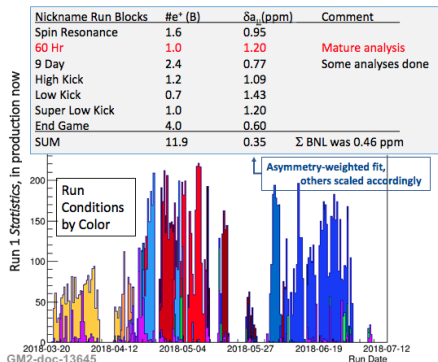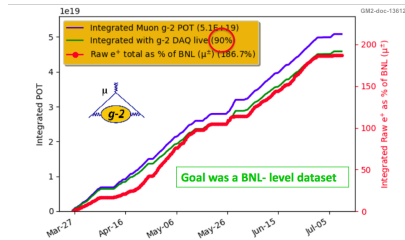**Run 1 :** commissioning + physics run achieved 50% of design flux and recorded **2×BNL stat.**

Run 2 : summer shutdown work to increase muon flux by a factor of 1.5 ⇒ expect to reach **10×BNL stat.** by summer 2019

Run 3 : increase muon flux by an additional factor of 1.4 during the summer shutdown ⇒ expect to reach **20×BNL stat.** by summer 2020 (TDR goal)
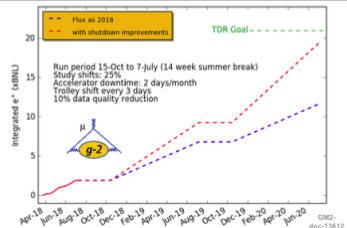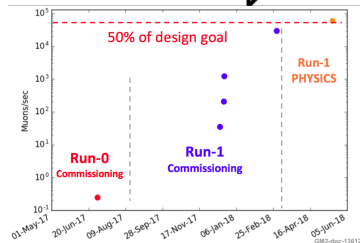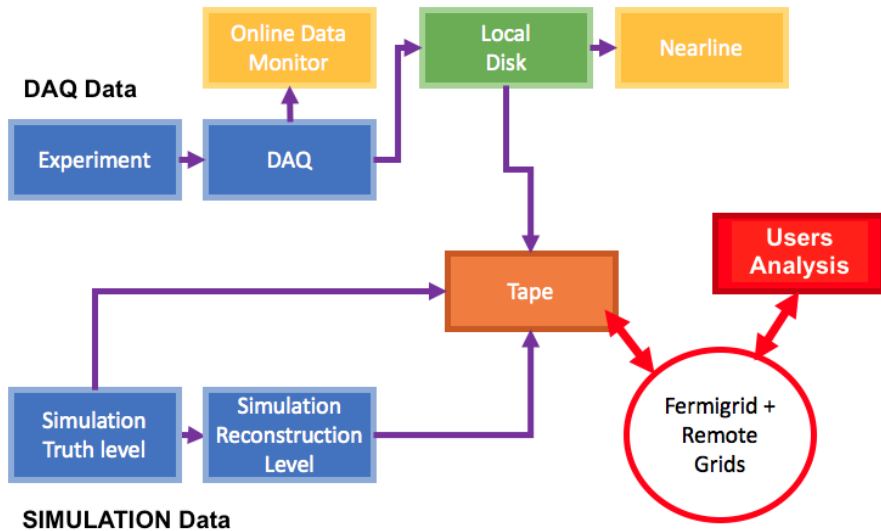
- collected $\sim 2 \times$ BNL statistics of physics data
- different experimental conditions $\Rightarrow$ 7 datasets
- offline reconstruction workflow that embeds also data quality conditions and includes data size reduction (accomplished by dropping most of the raw data)
- needed simulation for Run 1 studies (*e.g.*, lost muons)

| Nickname Run Blocks	#e$^+$ (B)	δa_μ(ppm)	Comment
Spin Resonance	1.6	0.95	
60 Hr	1.0	1.20	Mature analysis
9 Day	2.4	0.77	Some analyses done
High Kick	1.2	1.09	
Low Kick	0.7	1.43	
Super Low Kick	1.0	1.20	
End Game	4.0	0.60	
SUM	11.9	0.35	Σ BNL was 0.46 ppm

Muon $g-2$ data flow

Muon g-2 Offline Reconstruction Chain

- Production team provides the reconstructed and simulated data to analyzers using the following fully automated chain (using Fermilab's SCD tools):
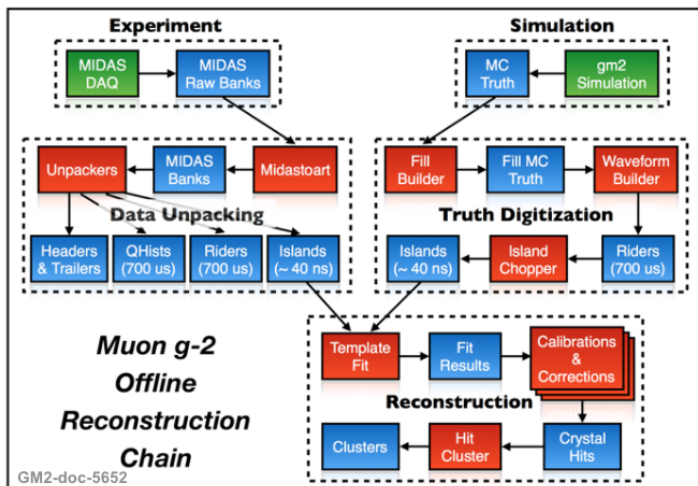
First Step: Data-Acquisition and Truth-Simulation

Experiment

Simulation
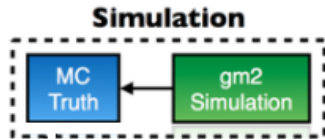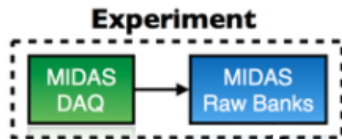
- MIDAS for data acquisition
- backend machines collect data from:
    - 24 calorimeters and laser calibration monitoring system
    - 3 (2) tracking stations
    - 4 fiber harps
    - Inflector Beam Monitoring System (IBMS) and T0
    - 4 quadrupoles and 3 kickers
- expected 20 GB/s of data
- "island chopping" in the GPUs to reduce the amount of data

- performed with GM2Ringsim (a GEANT based model of the storage ring)
- includes all of the detectors (but not laser system)
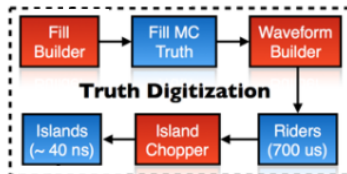- includes different particle guns *e.g.*, GasGun, BeamGun

Second Step: Data-Unpacking and Truth-Digitization

Experiment	**Simulation**
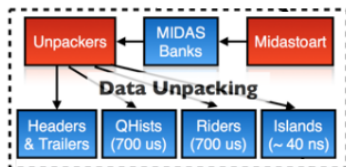
- unpacking stage: read the raw MIDAS file and store the information as an art event structure

- digitization stage:
  - a fill builder aggregates the muon decay events and converts them into a single g-2 fill event
  - waveform building module simulated the SiPM waveforms (responses + digitizer behaviors)
  - "island chopping" similar to the one done GPUs in the frontend machines

Third Step: Calorimeters' Reconstruction

- Reconstruction stage:
  - process the raw data using low level analysis
  - identical for simulation and experiment - exception calibrations/corrections only for DAQ data.

- Calibrations/Corrections:
  1. Photoelectron Equalization (from fitted pulse integral to *n.p.e.*);
  2. Out-of-fill Correction (long term gain variations);
  3. In-fill Correction (short term gain variations);
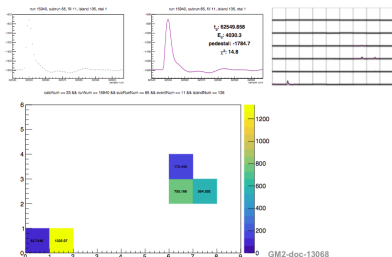 4. Energy Calibration (from *n.p.e.* to MeV) ;

↝ saved in the offline database
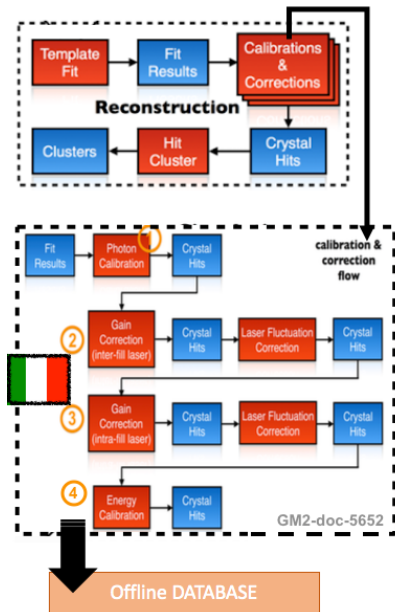
Reconstruction Alghoritms

- Recon West:
  - Local fitting
  - Each crystals digitized trace is fit independently
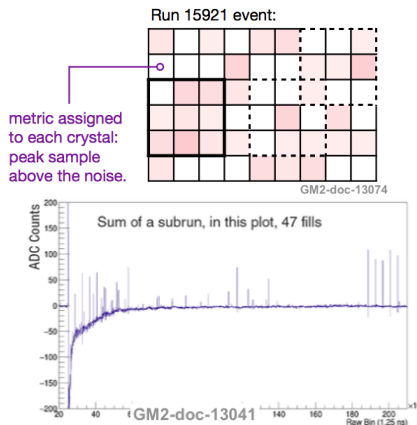 - Crystal fit results then clustered in time and space

- Q-Method:
  - no fitting: individual fill crystal traces summed
  - calo's integrated charge plotted vs. time

- Recon East:
  - Global fitting
  - Fit clusters of crystal traces simultaneously
 - Based on EM shower model and positron impact parameters

Run 15921 event:

metric assigned to each crystal: peak sample above the noise.

GM2-doc-13074

Sum of a subrun, in this plot, 47 fills
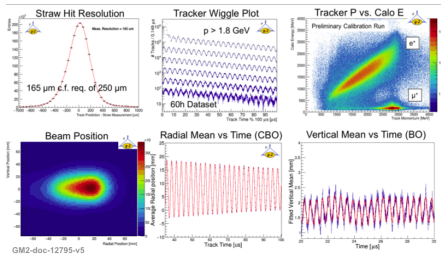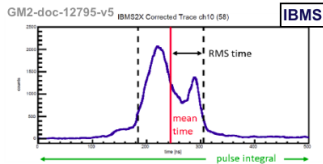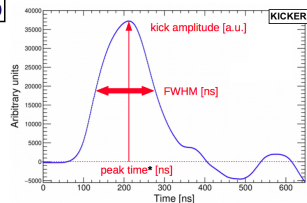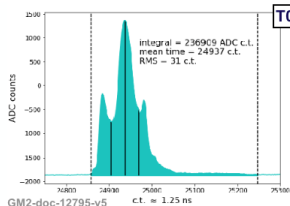
GM2-doc-13041

Third Step: Auxiliary Detectors & Tracker Reconstruction

- Auxiliary Detectors:
  - T0
  - IBMS
  - Quads
  - kickers
- for timing, data quality selection etc.

- Tracker:
  - Track finding and fitting for straw trackers
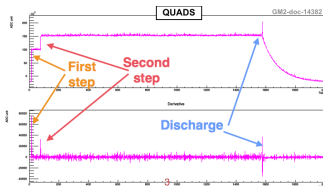
Summary & Conclusions

- **Production workflow** includes unpacking and reconstruction of the data acquired by the experiment.

- **Calibration/correction factors and data quality selection** are embedded.

- **Simulation sample** are generated and reconstructed with a similar workflow.

- A well-develop **production workflow** will be essential for future data-taking since it is planned to acquire about 10 times the amount of data of Run 1.

Thank You