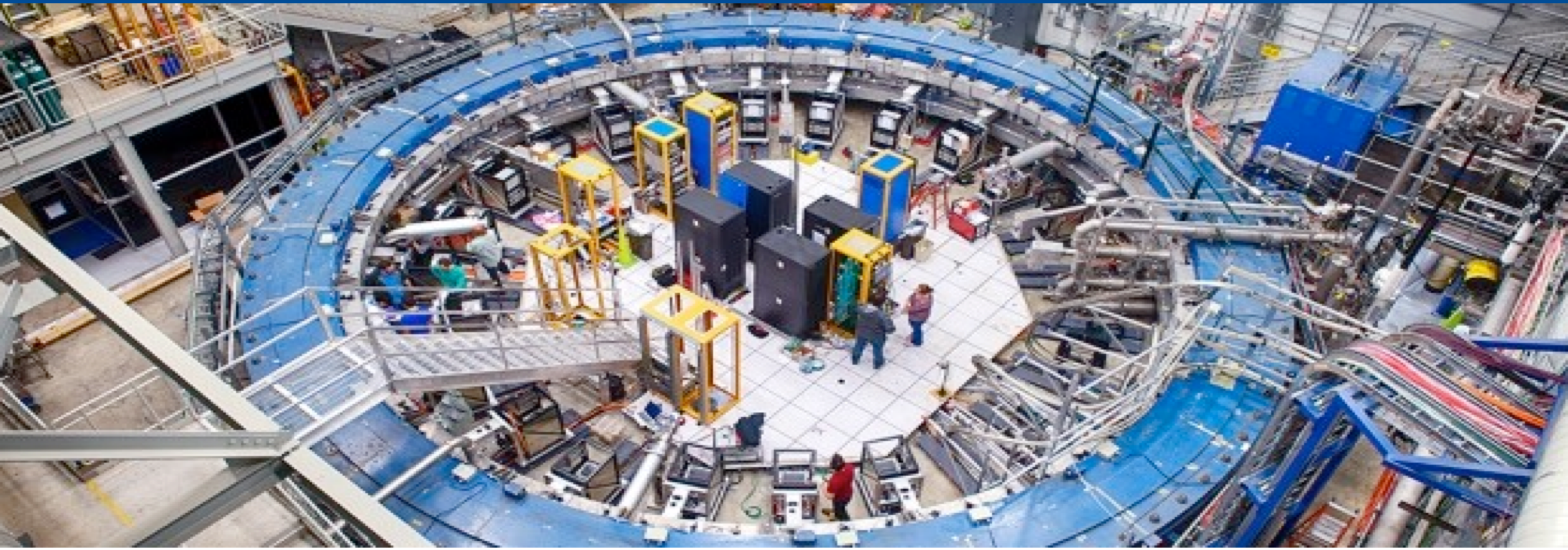


Stato dell'esperimento, richieste sblocco SJ 2019 e richieste 2020

Graziano Venanzoni– INFN Pisa

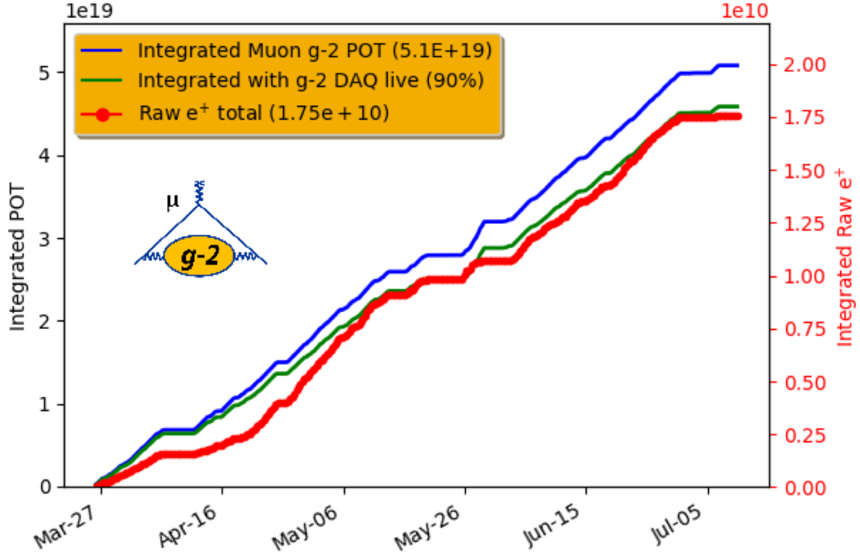
11/set/2019

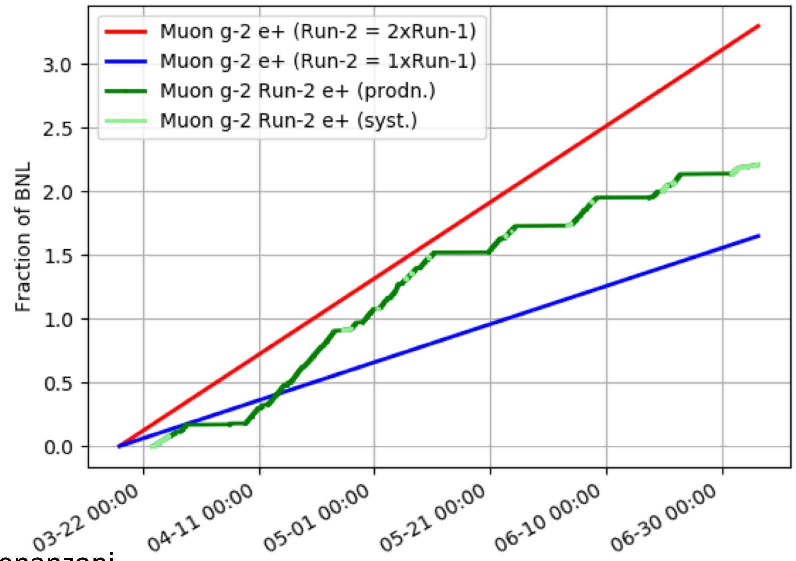
Outline

- Stato dell’esperimento (aggiornamento rispetto a Luglio)
- Attivita’ Italiana
- Richieste sblocco SJ 2019
- Richieste 2020
- Conclusioni

Data accumulated so far

- Run 1 (FY18): Accumulated 1.9 × BNL in raw statistics
  - ~1 × BNL after DQ cuts and removing systematic runs → 410 ppb stat
  - Anticipate 150-250 ppb systematic error...analysis well underway
  - Conditions not stable, fragmented data sets
- Run 2 (FY19): Accumulated 2.2 × BNL in raw statistics
  - ~2 × BNL after DQ cuts and removing systematic runs → 350 ppb
  - Reduced systematics (TBD)
  - Ran very stably collecting 1 BNL for about every 25 days of runtime



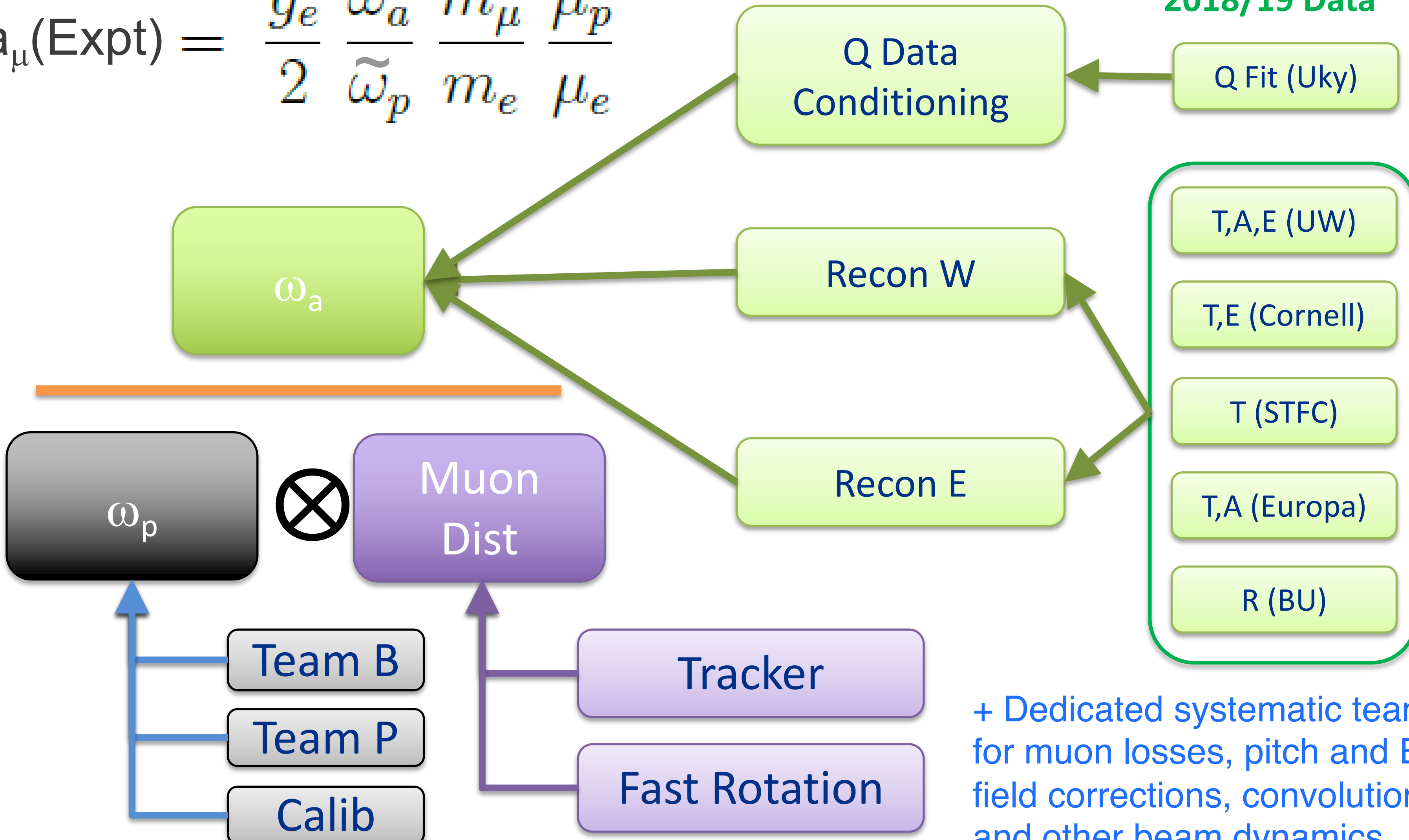


Analysis is in progress on Run1 data!

Overview of analysis structure

$$a_\mu(\text{Expt}) = \frac{g_e}{2}\frac{\omega_a}{\tilde{\omega}_p}\frac{m_\mu}{m_e}\frac{\mu_p}{\mu_e}$$

2018/19 Data



+ Dedicated systematic teams for muon losses, pitch and E-field corrections, convolution, and other beam dynamics

ω_a Analysis (RUN1)

- In Run1, data have been taken in different Quad and Kicker conditions, while optimizing Storage Ring operations (Run2 data are much more uniform)
- Six datasets identified:

Name	Date acquired	Quad n	Kicker [kV]	Positrons
60 hour	22-25 / 4	0.108	128-132	1.0B
High Kick	26/4 - 2/5	0.120	136-138	1.2B
9 day	4-12 / 5	0.120	128-132	2.4B
Low Kick	17-19 / 5	0.120	123-127	1.2B
Superlow Kick	2-6 / 6	0.108	117-119	0.5B
End Game	6-29 / 6	0.108	122-127	4.0B

Relative unblinding

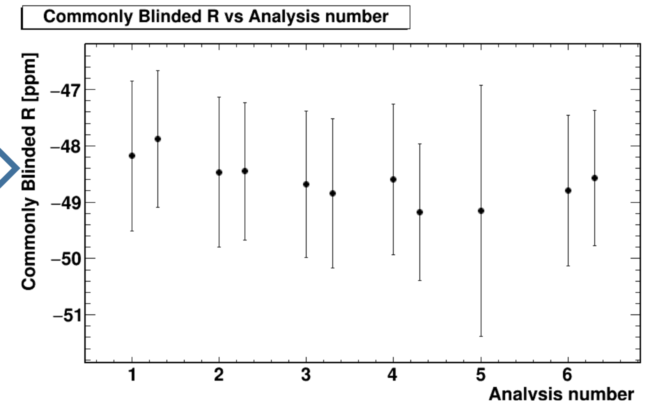
10% stat BNL

TOT=10B~1 stat BNL

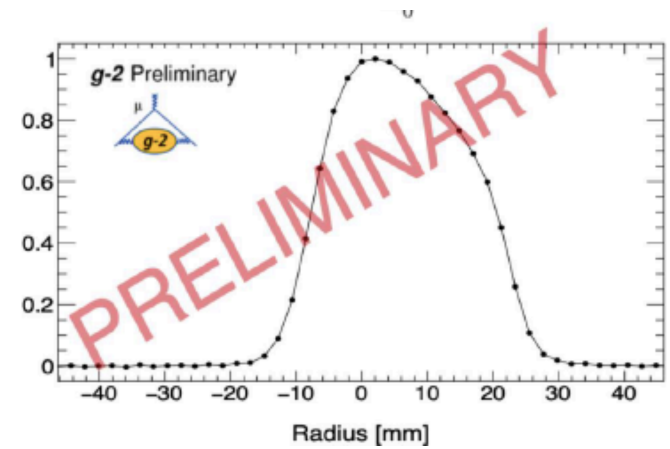
Per lo stato dell'analisi vedi presentazione di Luglio di M. Incagli

Examples of many positives intermediate results.

- **Relative *un*blinding of 60 H data** set confirmed 6 precession analyses consistent
  - 3 Reconstruction methods
  - Pileup techniques
  - CBO function accounts for beam motions
  - Gain Corrections
  - Muon loss
- **Absolute magnetic field calibration** accurate
- **Relative *un*blinding of Field Tracking** of 60+ H sample finds good agreement and led to better understanding of field tracking between Trolley runs
- **Muon momentum distribution** – while not ideall centered – is very well determined by several independent methods.
  - This leads to **accurate and precise E-field corrections**.
  - Significant systematic error checking on this correctio has taken place so in very good shape

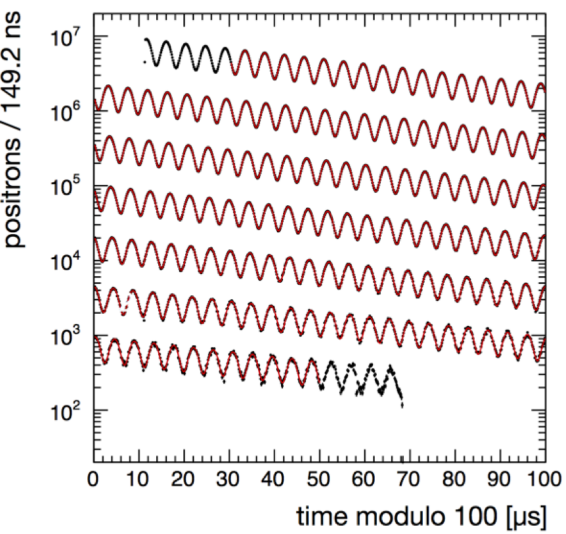


6 different precession analyzers

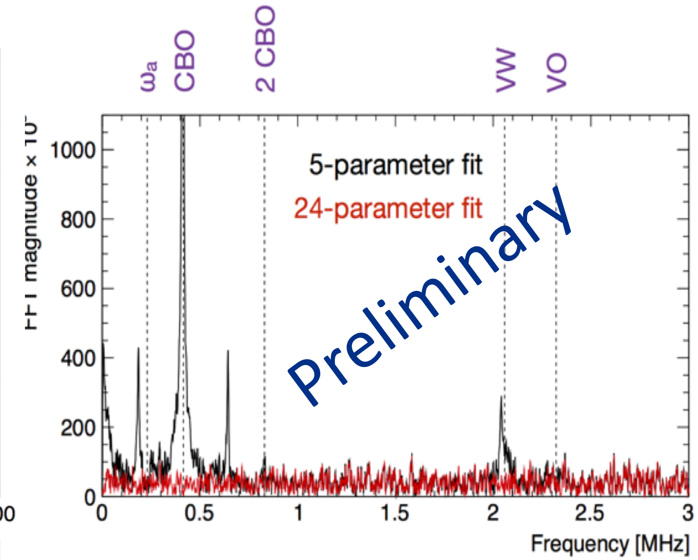


An example of just one of the Precession Analyses intermediate reports

$$N(t) = N_0 \cdot \Lambda(t) \cdot N_{1\mathrm{CBO}}(t) \cdot N_{2\mathrm{CBO}}(t) \cdot N_{VW}(t) \cdot N_{VO}(t)$$
$$\cdot e^{-t/\tau} \left[1 + A_0 \cdot A_{1\mathrm{CBO}}(t) \cdot \cos(\omega_a(R) \cdot t + \phi_0 + \phi_{1\mathrm{CBO}}(t))\right]$$



"Wiggle" Plot + Fit



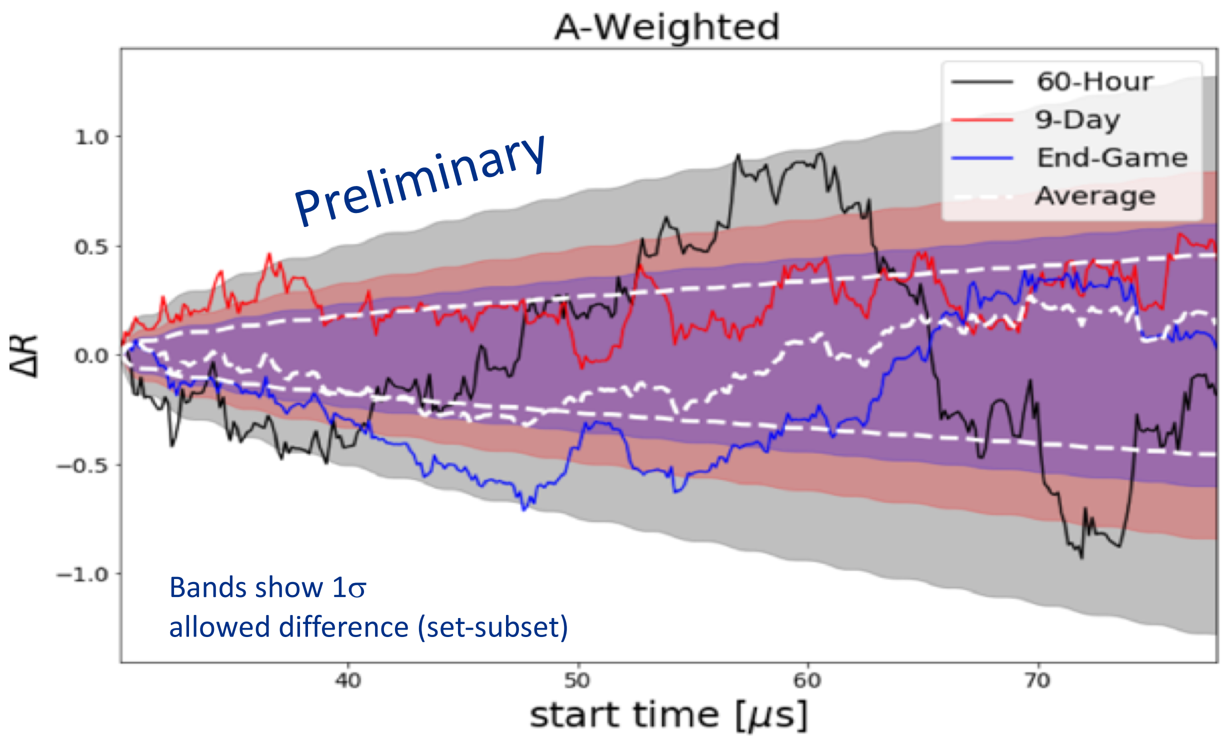
With correct function, the residuals are flat (as they must be) and the χ^2 is good and fit results are stable

non-negligible [≥ 0.1 ppb] systematic source	60 h. σR [ppb] T-method	9 d. σR [ppb] T-method
pileup amplitude	23.7	2.7
pileup time	1.3	2.8
unseen pileup	≤ 3.2	≤ 1.9
in-fill gain amplitude	9.3	8.9
in-fill gain lifetime	12.5	7.8
short-term double-pulse gain amplitude	~ 15.2	~ 2.5
short-term double-pulse gain lifetime	~ 7.6	~ 6.6
muon-loss statistics	1.1	0.7
muon-loss deuteron correction	≤ 1.1	≤ 0.4
CBO frequency model	4.7	11.0
CBO time shift	0.9	5.5
CBO decoherence-envelope model	32.3	2.1
CBO lifetimes	6.3	12.9
vertical-oscillation lifetime	1.5	2.7
fiber length	≤ 28.0	≤ 1.6
time randomization	12.3	7.6
quadrature sum =	56.1	24.4

Preliminary

An insane amount of checking of any biases is taking place.. This is just showing; net ~25-35x lower than statistical here! (but not all listed)

And, one example of a typical consistency test
The result (in blinded ppm) vs time of fit start for 3 data sets



T-Method
60-Hour: 1.33 ppm
9-Day: 0.88 ppm
EndGame: 0.63 ppm
HighKick: 1.33 ppm

Combined: **0.450 ppm**

A-Weighted
60-Hour: 1.22 ppm
9-Day: 0.80 ppm
EndGame: 0.57 ppm
HighKick: 1.22 ppm

Combined: **0.410 ppm**

410 ppb is probably the best we can achieve out of the Run-1 Statistical data set (does not include systematics)

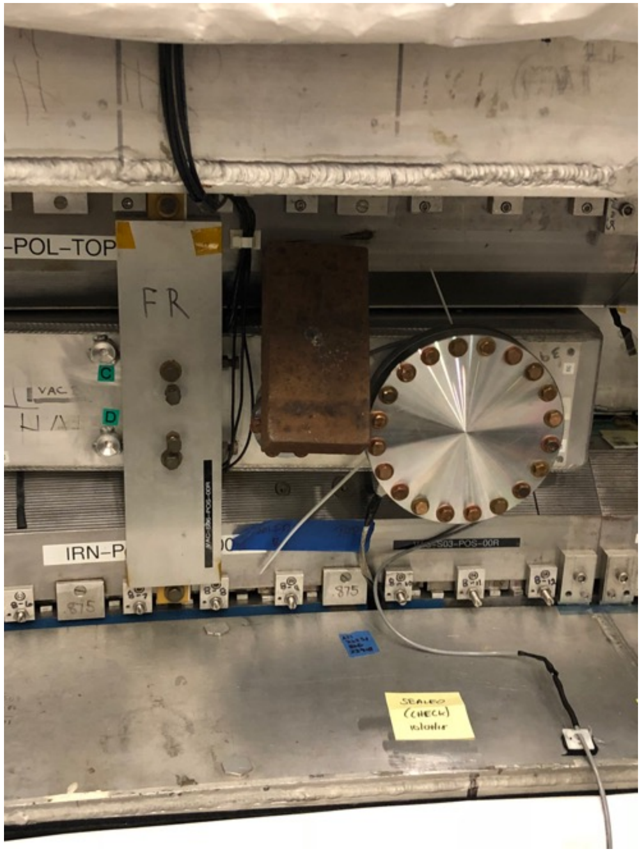
4 main technical issues in Run 1

- Had a few storage ring quenches and battled impurities in He
  - No impact on analysis, but created downtime. Upgrade work had to be completed before starting Run 2 due to "0 quench" policy
- Kickers were unable to meet full voltage spec
  - Parts burned up → down time to repair, unstable running conditions, leaks spoiled vacuum quality
  - Running at reduced kick strength increases systematic errors since beam is not well centered
  - Required complete redesign, fabrication, and installation of key components...critical path for Run 2
- Lost control of hall temperature in May, HVAC could not keep up with internal + external heat loads
  - Larger systematics from field tracking (magnet gap not stable) due to diurnal variations, calorimeter SiPM gains less stable, and laser monitoring not as good
  - Higher electronic failure rate
- Some resistors used in the electrostatics quads failed
  - Changed time constant for pulsed quads to turn on → beam not stable in gap, larger muon losses
- Overall, these issues are driving systematics up to the 150-250 ppb range
  - Ok for publishing 410 ppb stat result from Run 1, but needed to be addressed prior to Run 2

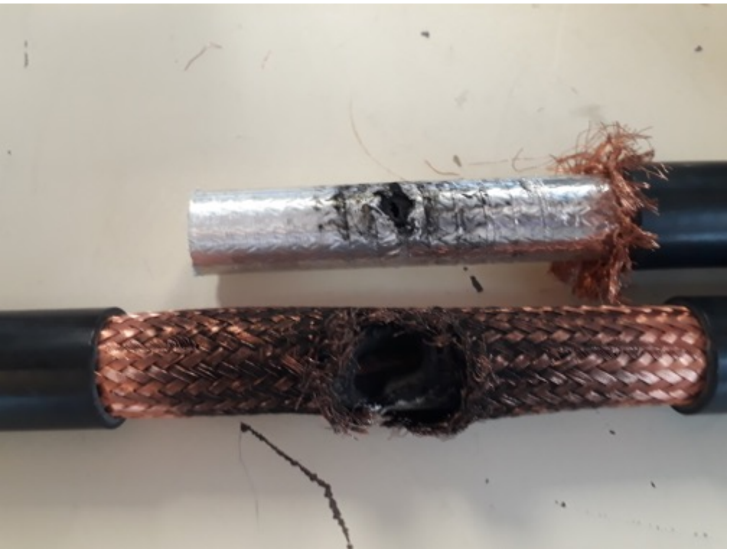
All issues were addressed between Runs 1 & 2. Exception: Augmenting hall HVAC finishing now, but thermal blankets were added to the storage ring to improve diurnal variations.

New challenges in Run 2 – Brick safety incident

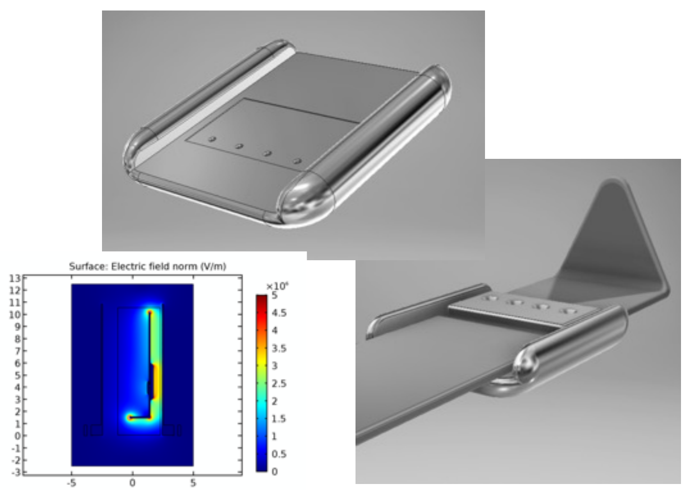
- On Oct 20, we had an incident where an iron brick, that had been mixed into a pile of Pb bricks used for shielding, was pulled into the magnet gap taking worker's hand with it.
- Luckily, there was no injury to the worker and damage to ring was only superficial, but it was a close call → work pause to revamp procedures
- Collaboration worked with ES&H to develop better (MRI industry standard) magnetic material controls, revamped the work request authorization process, created two new training programs for personnel, implemented 2-key system to control access to hall and the magnetic field region
- Implemented staged approach that allowed some work to resume in November, critical path for kickers in December, and magnet back up to full power in January

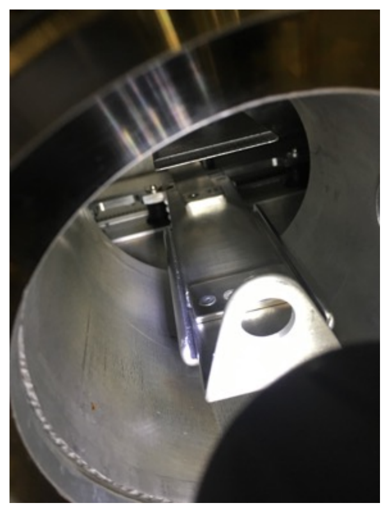


New (yet old) challenges in Run 2 – kicker issues



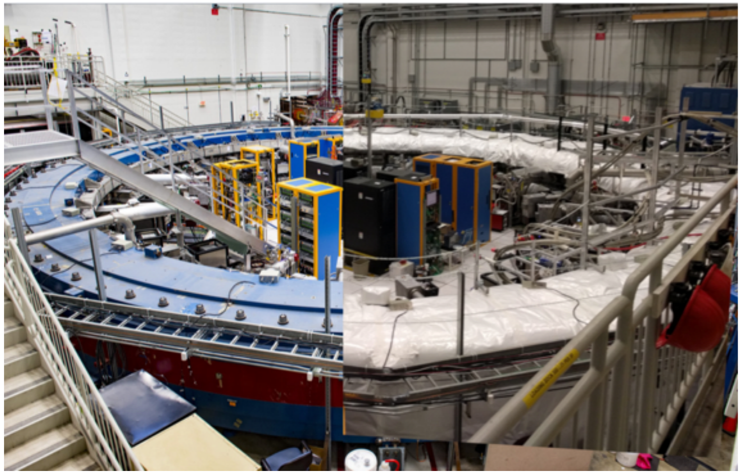
- With Run 1 kicker failure modes addressed, we started running at full 55kV spec
- Lost two cables, so backed kicker voltage down to 48 kV
- Found arcing inside vacuum chamber that required addition of corona shield
- Ran stably for 3 months in Run 2



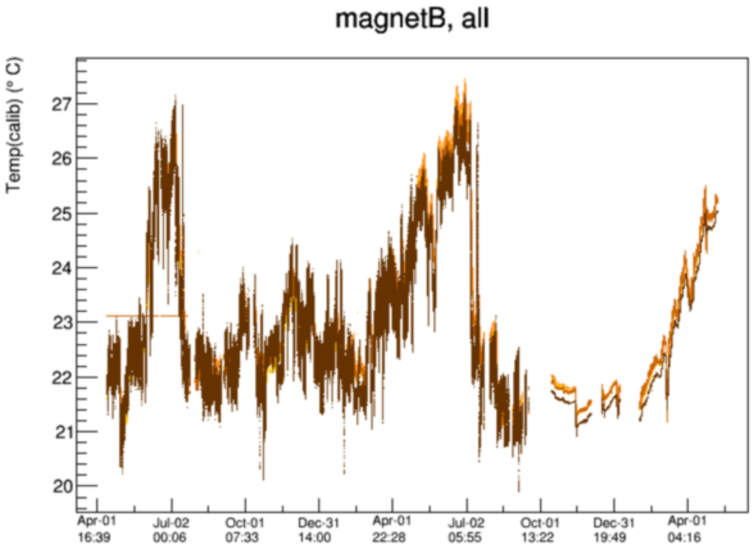


New (yet old) challenges in Run 2 – hall temperatures

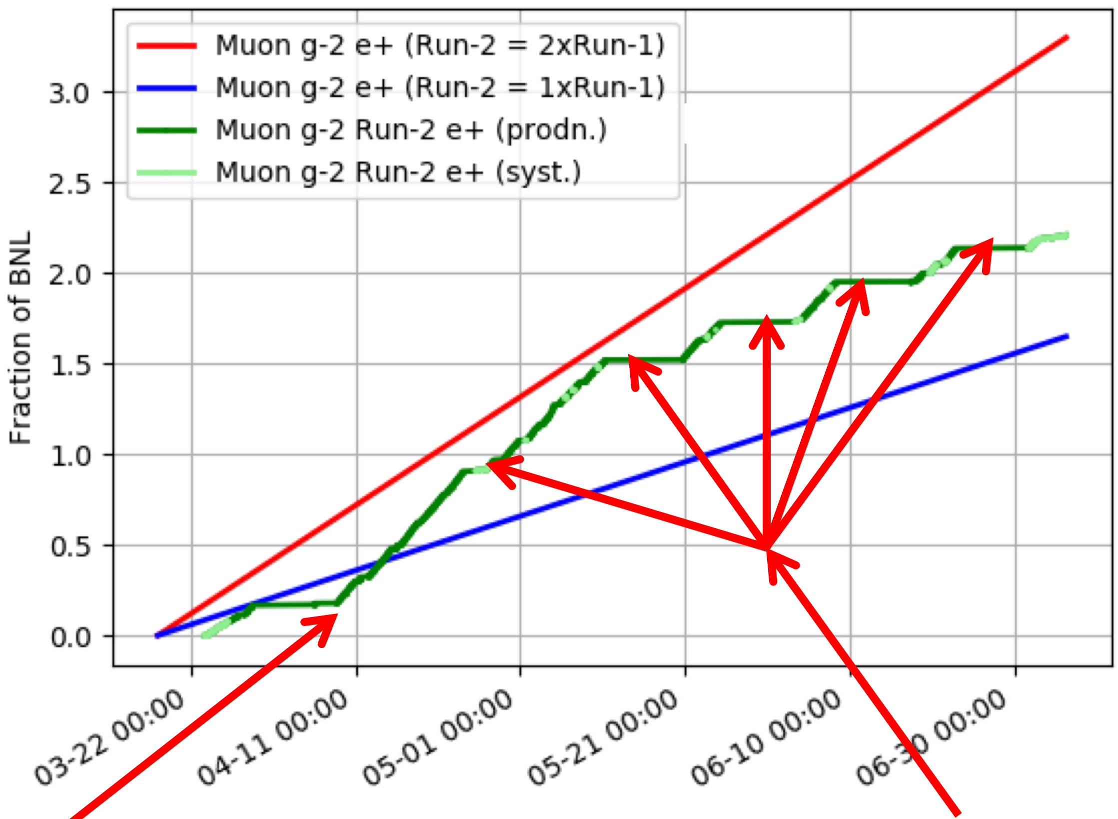
- Added thermal insulation to magnet reduces large diurnal variations that make field hard to track
- Still need to add additional cooling to prevent slow rise in temps... nearing completion now



Before
After



New challenges in Run 2 – diminished runtime

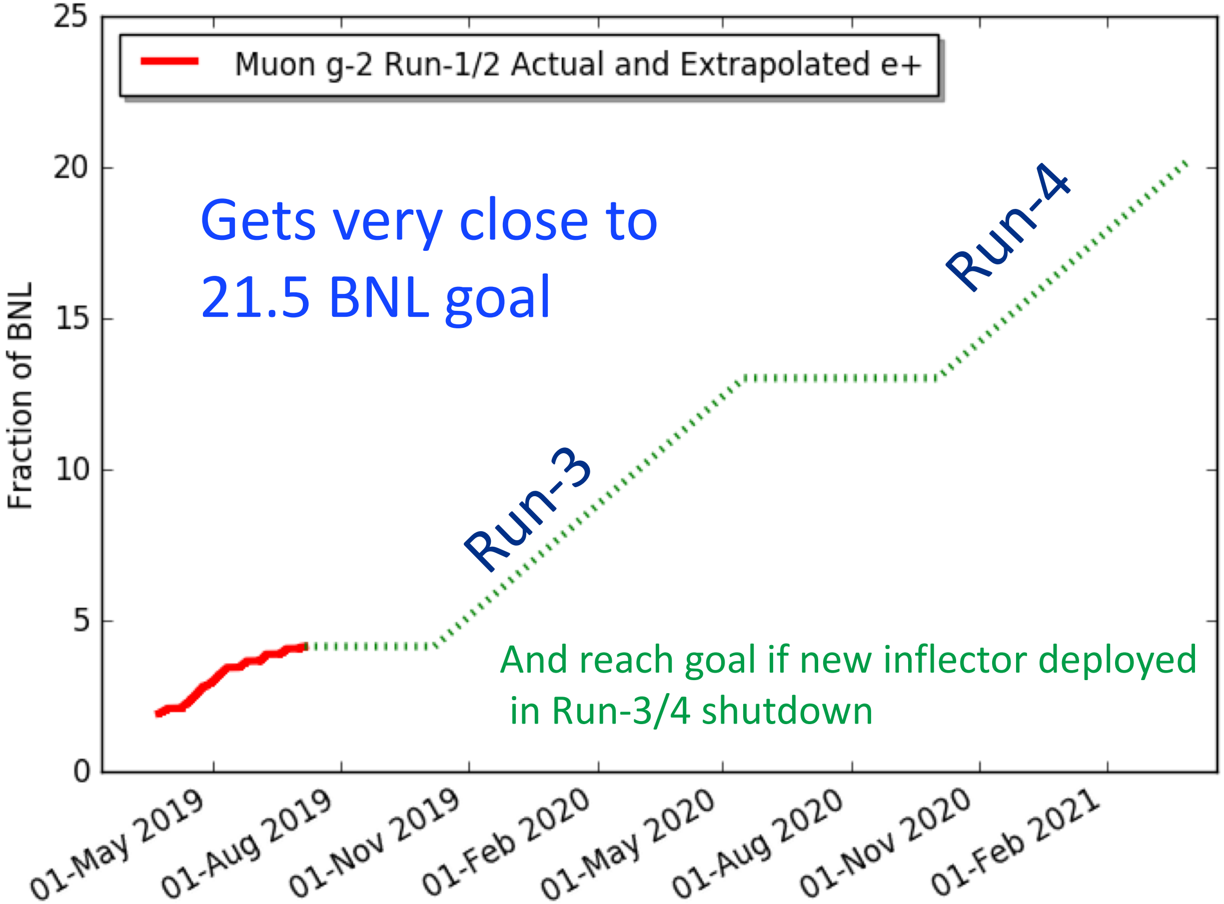


- Start date pushed out to April to fix Run 1 technical issues and address a safety incident
- Accelerator downtime, primarily $ driven, then reduced runtime by ~40 days on back end

So, where are we now …

- **Run-1**
  - Completing production of last ω_a data set
  - Finishing Field analyses
  - Several Beam Dynamics Task Forces working on the selected systematics.
  - Making a few magnetic field measurements that can only be done without beam (eddy currents, etc)
- **Run-2**
  - Production and analysis to begin very soon.
  - Teams assembled
- **Next Collaboration meeting** is mid November
- **MEANWHILE:** RUN-3 Starts in October !!!

Expectation for Run3 and 4



- Beamtime assumptions
  - Run 3 (FY20) starts Oct 7 and ends May 15
  - Run 4 (FY21) 6 mos g-2, 3 mos Mu2e commissioning

RUN3 expectations assumes RUN2 performance→ 1 BNL/25 days (4% BNL/day)→ ~9 BNL in RUN3

- Running beyond FY21 contingent on how Mu2e schedule evolves and initial g-2 results

Summer shutdown activity

- Hall and Laser Hut Cooling: mechanical, electrical, controls
- Work on Kicker (inspected and repaired); improve reliable ops
- Commissioning of a new RF system (possible reduction of CBO)
- Other minor interventions

Italian shutdown activity

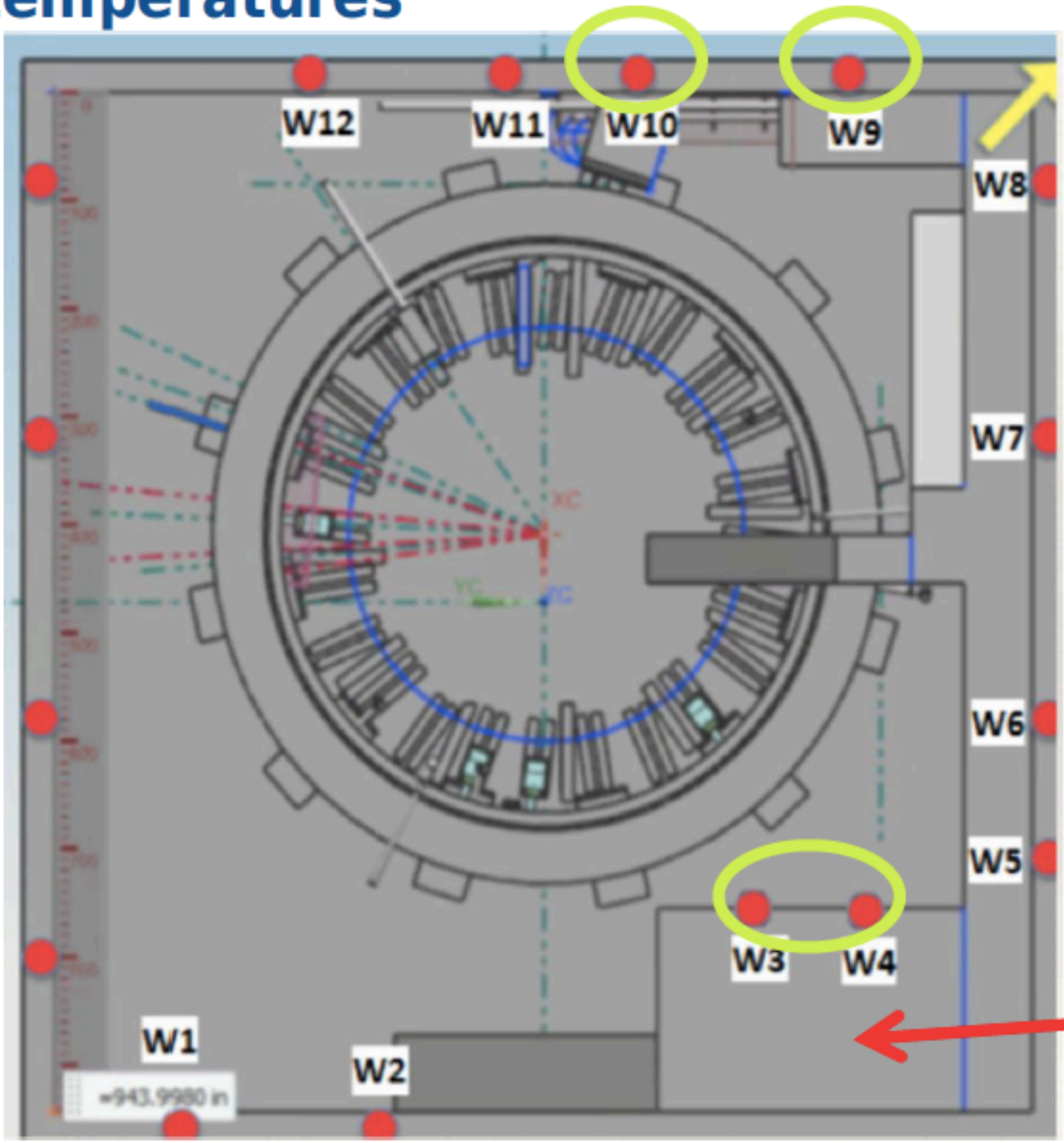
- Replacement of a laser (which was malfunctioning). This was probably a consequence of the elevated temperatures (>35^{o}C in the laser hut).
- Replacement of the filters of the laser hut
- Tests of the asynchronous readout of the Source Monitor
- Replacement of the NIM crate electronics with the new CAEN logic (FPGA-based) remotely programmable

Richiesta sblocco SJ 2019 apparati PI

- A PI disponibili sotto apparati:
  - 43kE SJ Dischi per analisi dati 150 TB + 100 TB SJ (0.17 kE/TB)
  - 15 kE SJ per Manutenzioni impreviste
- Richiediamo lo sblocco di:
  - 16 kE per acquisto workstation a fermilab con 100 TB disco (vedi presentazione di Alberto)
  - 15 kE per condizionamento laser hut
- Restituiamo 27kE alla CSN1

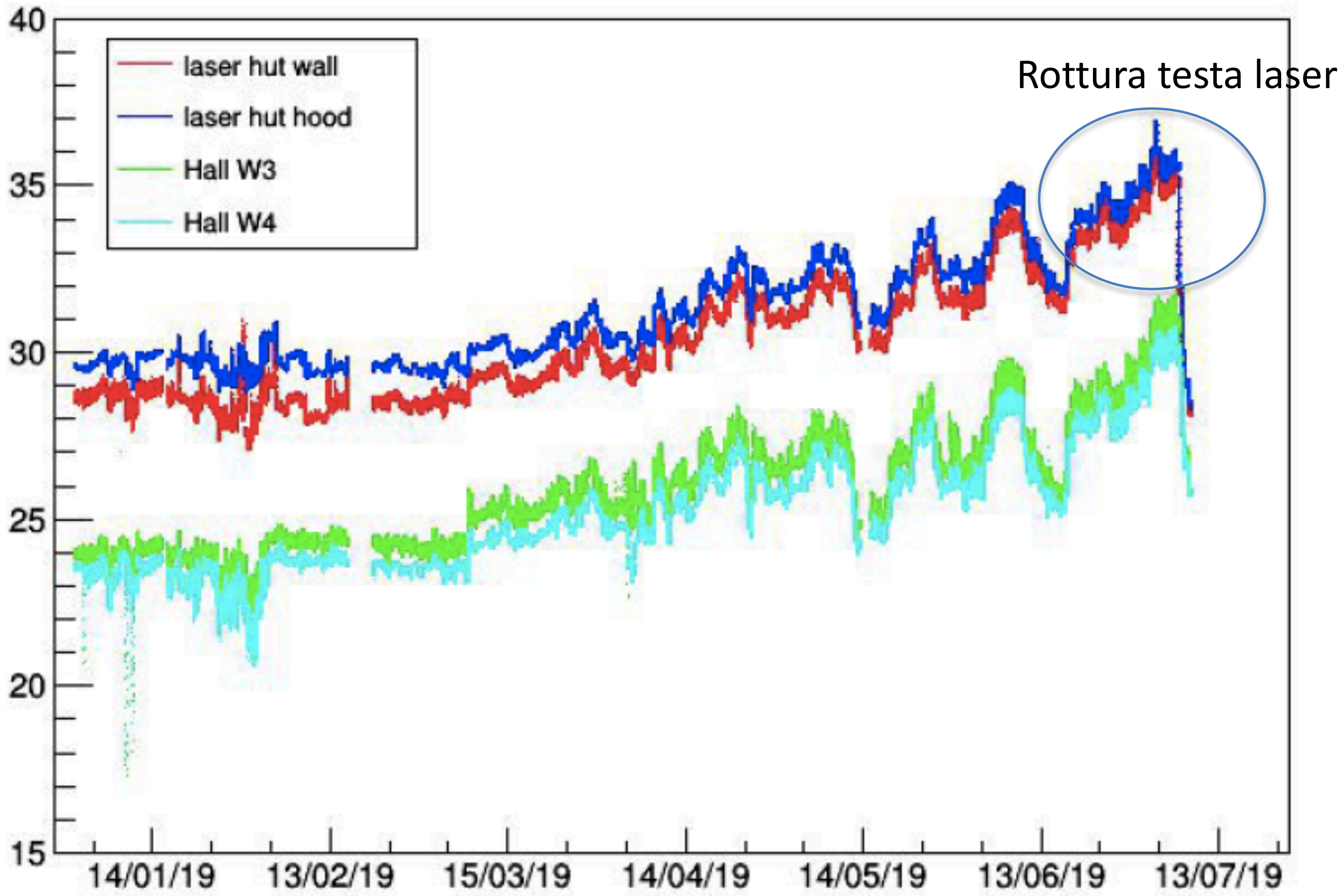
Laser Hut temperatures

locations and naming scheme

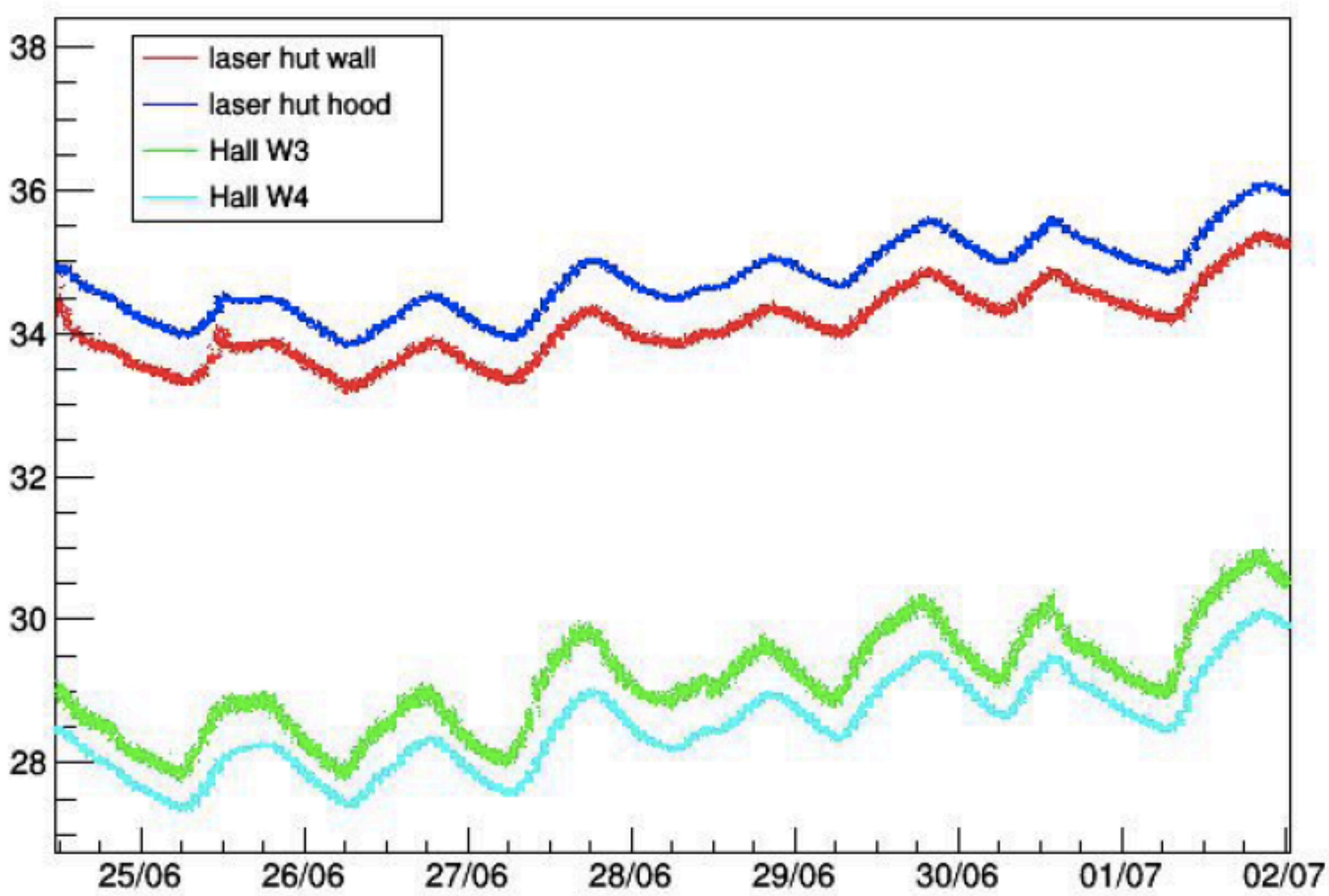


Laser Hut

Laser Hut temperatures



Laser Hut temperatures



Condizionamento Laser Hut

laser hut cooling upgrade

Messaggio 2 di 412

Mittente Brendan C Casey
Destinatario Graziano Venanzoni
Data Ven 17:01

Dear Graziano,
Here are the costs for the upgrades to the cooling for the laser hut. This should keep the temperature within the specifications of the laser system.

Heat exchanger: $4870
heat exchanger piping: $1027
running more electrical power for the heat exchanger: $6350
HEPA filters: $1553

Have a good weekend,
Brendan

Tot:~ 14k$

Richiesta sblocco SJ missioni 2019

Per poter far fronte alle esigenze di missioni per l'ultima parte dell'anno (principalmente per turni a Fermilab Ottobre-Dicembre). Stiamo valutando in questi giorni le necessita'. Saremmo orientati a chiedere lo sblocco di 17 kE dal SJ missioni 2019 a Pisa (restituendo il resto alla CSN1). Vi confermeremo questo numero non appena possible.

.

RICHIESTE g-2 2020

Sezione	Ric	Tec	FTE	<FTE>	MISS	CON	APP	(SJ)	TRA
LNF	2	0	0.9	0.45	16	2	-		0
PI*	10	0	5.9	0.59	117	10	71	25	0
NA	6	1	3.6	0.51	65	6	7.5		0
TS*	5	0	3.0	0.6	45	5	10		2
RM2*	5	0	3.8	0.75	55	5	0		0
TOT	**28**	**1**	**17.2**	**0.59**	**298**	**29**	**88.5**	**25**	**2**

TS*: Giovanni P 0 FTE
RM2*: Nanni 0 FTE
PI*: Bottalico e Girotti 0 FTE (dottorandi ciclo 2019-2022)

Per consumi ~1.5kE/FTE

Anagrafica 2020: 17.2FTE, 29 persone 0.59 FTE/persona
nel 2019 : 20.7FTE, 33 persone 0.62 FTE/persona:

A. Driutti (postdoc UD) → U. Kentucky; M. Smith (postodoc PI) → Seattle) O. Escalante (dottorando Na) →America

Anagrafica G-2

Sezione	Ric	Tec	FTE	<FTE>
LNF	S. Dabagov 0.5, D. Hampai 0.4		0.9	0.45
PI	F. Bedeschi 0.2, A. Lusiani 0.3 C. Gabbanini 0.7, A.Fioretti 0.7 C. Ferrari 0.5, M. Incagli 0.6 S. Di Falco 0.6, S. Donati 0.3, N. Raha 1, G. Venanzoni 1, E. Bottalico 0, P. Girotti 0		5.9	0.59
NA	M. Iacovacci 0.5, R. Di Stefano 0.8, Marignetti 0.4 G Gagliardi 0.3, S Avino 0.3 A. Nath 1.0	S. Mastroianni 0.3	3.6	0.51
TS	G.Cantatore 1, M. Karuza 1., D. Cauz 0.5, G. Pauletta 0, L. Santi 0.5		3	0.6
RM2	G. Di Sciascio 0.9, Piacentino 0, Gioiosa 1. Miozzi 0.85, Sorbara 1		3.8	0.75
TOT	28 (+2 a PI)	1	17.2 (+2)	0.59 (0.64)

NB: Girotti, Bottalico vincitori dottorato a Pisa (non posso figurare nell’anagrafica)
Pauletta, Piacentino 0FTE (ma turni a Fermilab)

Missioni g-2 2020

SEZIONI	RIC+TECN	FTE	<FTE>	Numero shifter (autori)	MU a FNAL presa dati/ shifter (20gg/1Mese)	MU a FNAL on call/shifter (8m)	Total MU (Shifts+oncall)/shifter	Total MU Fermilab	MU Italia (2kE/FTE)	MU a FNAL Coll Meet.+working group (1MU/FTE)	EXTRA FERMILAB (RAP NAZIONALE +RUOLI DI COORDINAMENTO)	TOT MU (FERMILAB+ITA)	Costo MU=5kE	TOT KE	KE/FTE
LNF	2,00	0,90	0,45	2,00	0,67	0,28	0,95	1,89	0,36	0,90		3,15	5	15,76	17,51
PISA	12,00	7,90	0,66	12,00			0,00	11,35	3,16	7,90	1	23,41		117,05	14,82
NA	7,00	3,70	0,53	5,00			0,00	4,73	1,48	3,70	3	12,91		64,55	17,45
TS	5,00	3,00	0,60	5,00			0,00	4,73	1,20	3,00		8,93		44,65	14,88
RM2	5,00	3,80	0,76	5,00			0,00	4,73	1,52	3,80	1	11,05		55,25	14,54
TOT	31,00	19,30	0,62	29,00			0,00	27,43	7,72	19,30	5,00	59,45		297,25	15,40

- Nel calcolo delle missioni sono stati conteggiati anche Bottalico e Girotti per turni a Fermilab
- Si e' seguito l'algoritmo utilizzato negli anni passati.
- Richieste di Missioni tengono conto di: Venanzoni (PI, 1MU a FNAL per management), Nath (NA, 3 MU a FNAL per Run coordinator Run 3), Gioiosa (RM2, 1 MU a FNAL per responsabilita' Slow Control dell'esperimento)

Consumi 2020 G-2

Sezione	Richieste
LNF	2 kE (metabolismo)
PI	10 kE (Minuteria e consumi vari)
NA	6kE (Metabolismo di laboratorio. Manutenzione e sostituzione parti SM e LM)
TS	5 kE (materiale ottico e elettronico, metabolismo)
RM2	6 kE (Minuteria e consumi vari)

Richieste apparati 2020 (e motivazioni)

Sezione	VOCE	Commenti
PISA	51kE per Computing (300 TB):	Richiesta basata sul costo disco a Pisa 17kE/100 TB; Richiesta aggiornata: **36 kE** per 450 TB disco RAID a FNAL (300 TB per data +150TB per simulazione), vedi presentazione di Alberto
	20kE+25SJ per 3 teste laser di cui 2 SJ a rottura; 1 driver SJ; 1 crate spare	Ad oggi abbiamo solo 1 testa laser di riserva. La rottura di luglio ci insegna che altre potrebbero rompersi. Vorremmo averne almeno 3 a disposizione. Abbiamo 1 driver di riserva. Non abbiamo create spare
TRIESTE	10 kE imprevisti manutenzione, guasti di Source e Local Monitor	manutenzione apparato, rotture impreviste

Richieste apparati 2020 (e motivazioni)

Sezione	VOCE	Commenti
NAPOLI	4.5 kE Sostituzione alimentatori switching di SM e LM con alimentatori lineari (abbattimento rumore). 3 alimentatori (2 + 1 spare) con 4 tensioni - non commerciali.	Gli attuali alimentatori operanti sui due crate SM e LM (II, crate-Na) sono del tipo switching; forniscono 4 tensioni di alimentazione e operano a frequenze di circa 50 kHz e 250 kHz. Durante i test e le misure fatte per capire e risolvere l'origine del sagging dei segnali SM, si è visto che il rumore prodotto dall'alimentatore non è trascurabile. Sebbene i segnali siano del tipo differenziale, questo puo' indurre asimmetrie sulle due linee. Analogo problema, ed in misura maggiore, è stato riscontrato sul crate LM nella fase di montaggio dell'elettronica. In questo caso il problema è stato evidenziato dallo studio del segnale unipolare. La maggiore entità del rumore sulla linea unipolare si spiega con il fatto che l'elettronica genera e gestisce due segnali differenziali separati da 220 ns e quindi la maggiore complessità aumenta i punti di captazione del rumore. Test fatti con alimentatori lineari da banco hanno evidenziato la scomparsa del rumore. Riteniamo quindi che, per i livelli di precisione richiesti dall'esperimento, la sostituzione degli alimentatori rappresenti un passo importante al fine di contenere le sistematiche
	3 kE Modifica preamplificatori SM per evitare sagging segnale: 20 (preamp) x 150 (Euro/pream)	I test fatti a Napoli con preamplificatori e schede SM hanno evidenziato un fatto importante, ovvero che è necessario ridurre la durata del segnale prodotto dal preamplificatore. Sulla SM stiamo valutando l'opportunità di piccoli interventi, ma ad oggi l'impressione è che , se necessari, essi siano confinati alla sostituzione pochissime componenti facilmente sostituibili.

Milestones 2020

Descrizione	Data
Implementazioni correzioni di guadagno per Run 2	31-7-2020
Implementazione e utilizzo computing dedicato a fermilab per analisi omega_a	31-10-2020
Unblinding risultato a_mu con statistica equivalente a 1 BNL	31-12-2020
Raggiungimento errore 30 ppb correzioni di guadagno	31-12-2020

Conclusioni

- Nonostante vari problemi sono stati conclusi con successo RUN1 (2018) e RUN2 (2019). Acquisiti ~ 3BNL di cui 2BNL in un unico punto di lavoro (RUN2).
- Analisi RUN1 in corso. Risultato atteso per la fine dell'anno con errore totale ~ 0.5ppm.
- Ci aspetta un RUN3 (da Ott 20119-Maggio 2020) molto impegnativo. Goal: migliorare significativamente la statistica finora acquisita (~x9 statistica di BNL).
- Attivita' gruppo Italiano molto intensa non solo sull'HW ma anche sul software/analisi dati.
- Lavoro estivo «minimale» (piccole modifiche al setup)
- Anagrafica del gruppo GMINUS2 pressoche' inalterata (considerando l'ingresso di 2 nuovi dottorandi)

Richieste

- Richiesta sblocco SJ 2019:
  - Apparati @PI:
    - 16 kE (su 43 per il computing) per acquisto workstation a fermilab con 100 TB (per dettagli vedi presentazione di Alberto)
    - 15 kE (su 15 per manutenzione apparato) per condizionamento laser hut

    TOT: 31 → restituiamo 27 kE alla CSN1
  - Missioni @PI: 17 kE (TBC) su 47 per missioni a FNAL (principalmente turni Ottobre-Dicembre 2019) → restituiamo 30 kE (TBC) alla CSN1
- Richiesta 2020:
  - Modifica Apparati @PI: 51kE per Computing → 36 kE (minor costo dovuto all'acquisto di disco RAID a Fermilab rispetto a disco GRID a PI)
- Il resto come da DB

Preventivi 2020

Sez. & Suf.	MISS				CON				ALTRICONS				SEM			
		Sj	Dot.	Ant.		Sj	Dot.	Ant.		Sj	Dot.	Ant.		Sj	Dot.	Ant.
LNF.DTZ	16.0				2.0											
	0.0				0.0											
NA	65.0				6.0											
	0.0				0.0											
PI	117.0				10.0											
	0.0				0.0											
RM2	55.0				6.0											
	0.0				0.0											
TS	45.0				5.0											
	0.0				0.0											
TOTALE	298				29											
	298				29				0				0			
	0		0	0	0		0	0								
	0.0				0.0				0.0				0.0			

Sez. & Suf.	TRA				PUB				LIC-SW				MAN			
		Sj	Dot.	Ant.		Sj	Dot.	Ant.		Sj	Dot.	Ant.		Sj	Dot.	Ant.
LNF.DTZ																
NA																
PI																
RM2																
TS	2.0															
	0.0															
TOTALE	2															
	2				0				0				0			
	0		0	0												
	0.0				0.0				0.0				0.0			

Sez. & Suf.	INV				APP				SPSERVIZI				TOTALE			
		Sj	Dot.	Ant.		Sj	Dot.	Ant.		Sj	Dot.	Ant.		Sj	Dot.	Ant.
LNF.DTZ													18			
																0
NA					7.5								78.5			
					0.0											0
PI					71.0	25							198	25		
					0.0	0.0										0
RM2													61			
																0
TS					10.0								62			
					0.0											0
TOTALE					88.5	25							417.5	25		
	0				113.5				0				442.5			
					0		0	0					0		0.0	0.0
	0.0				0.0				0.0				0.0			

Richiesta per Apparati a PI 71+ 25SJ → **56** +25 SJ

THE END

SPARES

Richiesta spazio disco Pisa 2019

- 100TB gia’ assegnato per dati 2018 (~ 1.5 BNL Stat)
- Assumendo 10% of reconstructed data (110TB)+10% of simulation (100TB)+~40TB of raw data to tune/exercise the calibration → 250 TB per 2019

Assunzioni:
2018: 3 BNL per la fine dell’anno (~2 gia’ raccolti)
2019 e 2020: ½ luminosita’ TDR (1.5BNL/month)

Tabella presentata a Marzo ai referee

Year	N. detected positrons	BNL Statistics	Raw Data [TB]	Full Reconstructed Data [TB]	Simulated Data [TB]
2018 (6 m)	21×10^9	3	750	600	200
2019 (9 m)	105×10^9	15	1250	1100	1000
2020 (3 m)	35×10^9	5	400	350	400

Table 1: Expected space resources required for data storage in year 2018, 2019 and 2020.

Richiesta spazio disco Pisa 2020

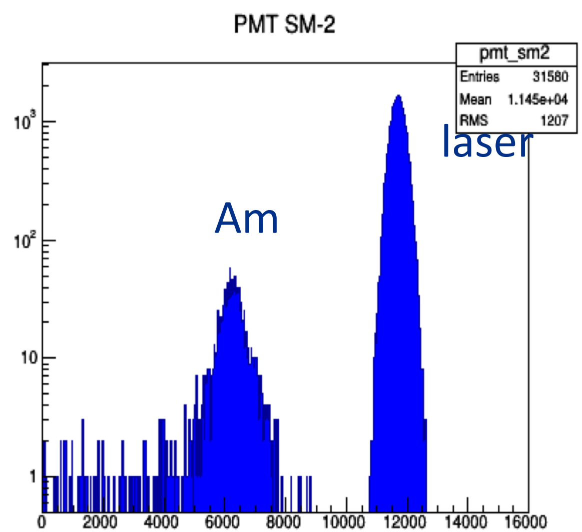
Table 4. Funding requests for computing resources.

year	requests	notes
2019	16 k€	from the release of part of the 43 k€ s.j. funds
		- 8 k€ for ∼250 HS06 workstation at FNAL
		- 8 k€ for 100 TB RAID disk space at FNAL, to analyze 3×BNL
2020	36 k€	
		- 24 k€ for 300 TB RAID disk space at FNAL, to analyze 9×BNL
		- 12 k€ for 150 TB RAID disk space at FNAL, for simulation production

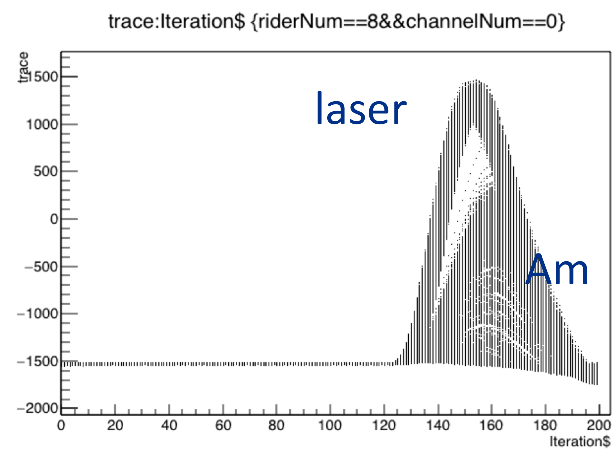
Test Run asincrono

- I SMs sono equipaggiati con dei PMTs per monitorare la stabilita' nella risposta dei PINs a lungo termine.
- la stabilita' assoluta dei PMT del SM puo' essere monitorata con la sorgente di Americio
- l'Americio puo' essere raccolto dai WFD solamente con il trigger "asincrono" (=non sincronizzato con il fascio)
- Un test della lettura asincrona del SM e' stata fatto con successo a fine Luglio

PM Amplitude distribution of Naples data

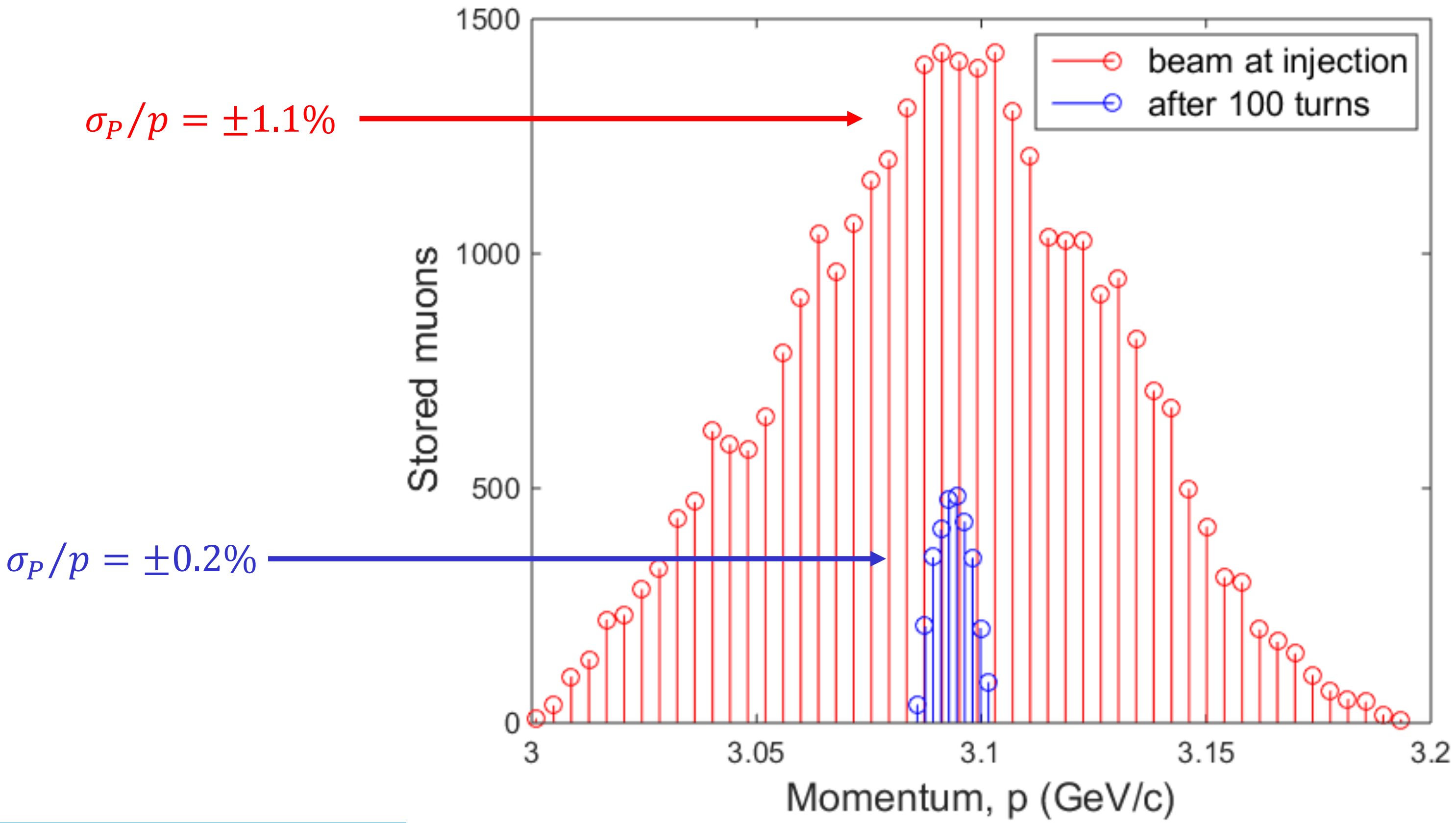


PM Amplitude distribution from WFD



Beamline Wedges

- Muon g-2 storage ring accepts particles only within $\sigma_p/p = 0.2\%$
- Incoming beam loss of 80%
- **Goal**: Reduce the beam at injection to better match the accepted beam



TDR Numbers

- 1.6 x 10^{11} good decay positrons (E>1.8GeV, t>30μs) for 22 BNL statistics (7x10^{9})
- Needs 1.5 x 10^{8} fills (=7 months)

→ 3BNL/month; ~10^{3} e^{+}/fill; 10^{4} μ/fill

Item	Factor	Value per fill
Protons on target		10^{12} p
Positive pions captured in FODO, $\delta p/p = \pm 0.5\%$	1.2×10^{-4}	1.2×10^{8}
Muons captured and transmitted to SR, $\delta p/p = \pm 2\%$	0.67%	8.1×10^{5}
Transmission efficiency after commissioning	90%	7.3×10^{5}
Transmission and capture in SR	$(2.5 \pm 0.5)\%$	1.8×10^{4}
Stored muons after scraping	87%	1.6×10^{4}
Stored muons after 30 μs	63%	1.0×10^{4}
Accepted positrons above E = 1.86 GeV	10.7%	1.1×10^{3}
Fills to acquire 1.6×10^{11} events (100 ppb)		1.5×10^{8}
Days of good data accumulation	17 h/d	202 d
Beam-on commissioning days		150 d
Dedicated systematic studies days		50 d
Approximate running time		402 ± 80 d
Approximate total proton on target request		$(3.0 \pm 0.6) \times 10^{20}$

Beam structure