FAST / IOTA Run 4

After-Action Review

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Post-Run Retreat

Thursday, 0830

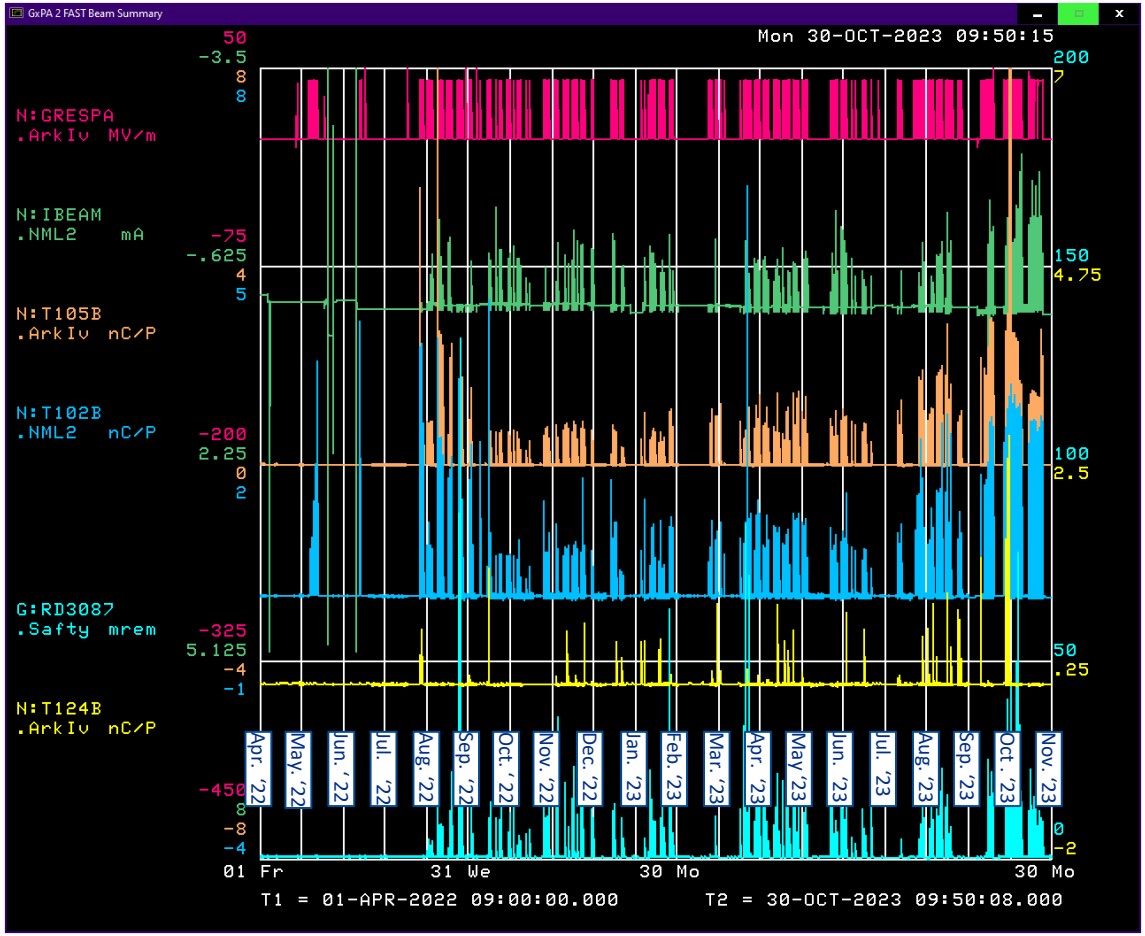
2-November-2023

Overview

- 18 months, 22 days, ~1 hour
  - Planned runtime: ~6 months
- Very difficult Run
- Long stretches of downtime → massive rush towards the end w/crews running 24/7
- In spite of this, we managed to accomplish a great deal and deliver on ~*majority* of promised beam time
  - IOTA150-CLARA – *1st experimental crew to complete shifts this Run: late-May 2023*
  - IOTA150-NIO – *John took >35,000 scans throughout the Run*
  - Installed & commissioned new stripline BPM + kicker system at C-Left in IOTA for IOTA150-NIOLD
  - Preliminary characterization of the LINAC for FAST-GREENS – *Eric. Cropp, November 2022*
  - Trained 5 new Qualified Operators – *John, Brandon, Steve, Mike, Trey*
  - IOTA150-LADR crew demonstrated the ability to run IOTA in Low-α mode
  - Construction of FAST-GREENS Stage-0 beamline underway, despite challenges / delays
  - NEB crew consistently able to accelerate 32 MeV beam using both Capture Cavities and transport it to X121 / LEA
- Many points to consider, impossible to cover in entirety here: this is merely a survey

Run 4.

- 1-April-2022 to 23-October-2023



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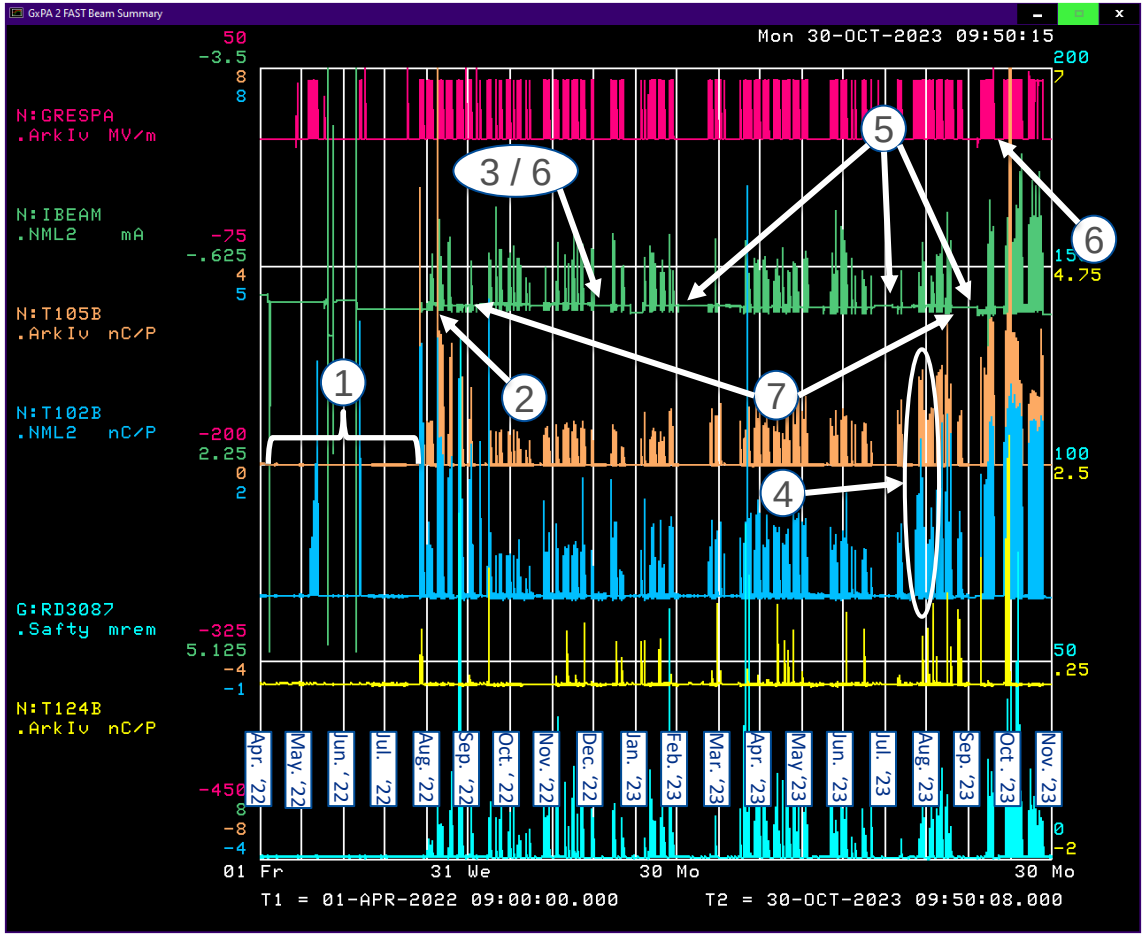
Run 4.

1. Initial Nitrogen shortage
2. 150 MeV beam into orbit
3. ICW pipe break
4. Photocathode conditioning
5. Cryo thermal bumps
6. RF Gun oil processing
7. Outage recovery
8. Sitewide security stand-down*

Will discuss Downtime in more detail on a forthcoming slide

**concurrent w/Thermal bump in July '23*



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In general: things that worked well…

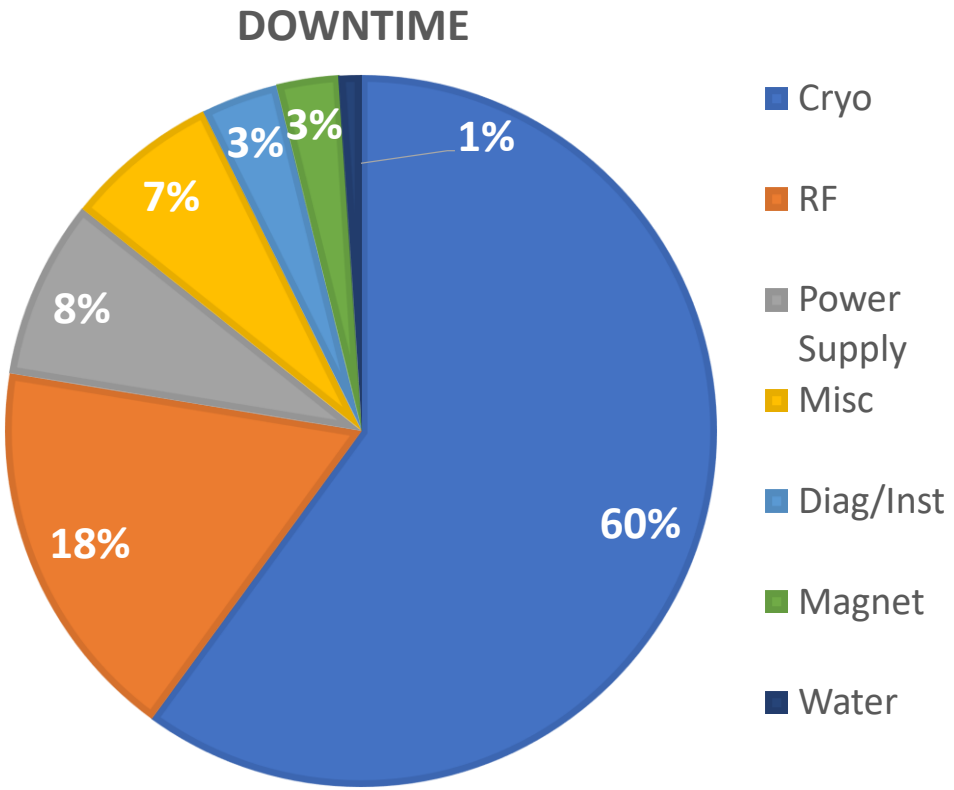
- John Wieland.
- FAST-Ops Personnel
  - Communication was generally strong throughout Run between EPs / FAST operators & crews for experiments
  - Willingness to push: >>40 hrs/week, weekends, off-hours, remote support
  - Early-on: instruction from more senior EPs was invaluable to me, personally, being brand new in June ’22
  - Implemented new shift/access scheduling system, attempted to improve inter-departmental communication
- Consistent support / effective cooperation between FAST Facility Ops. & Accelerator Research Dept.
  - IOTA150-LADR crew willing to take primarily off-hours shifts at 11th hour of Run
  - Machine studies were never an issue to fit into the schedule (e.g. PMT calibrations, 1e^{-} lifetime measurements, LINAC characterization)
  - Communications from the rest of the Lab to the Dept. at AD-ARD meetings
- EE Support
  - Nick Gurley, Eric Claypool & Co. for 5 MW systems *– extremely effective, clear communication, consistent availability*
  - Pete Dimovski & Co. for IOTA kickers, bulks supplies *– willing to assist on issues not even under their jurisdiction*
- Commitment to Safety: no major injuries or incidents involving harm to personnel

… and things that didn't.

- Cryogenics
- Fallout from new safety policies, security shutdowns, administrative controls – *typically in the form of delays / downtime*
- HLRF – *primarily both 5 megawatt systems (RF Gun, Cryomodule)*
  - Besides Cryo, 2nd largest fraction of downtime
  - RF Gun klystron transformer tank oil, filtration campaigns
  - CC's had occasional issues however not to the same extent - *ESECON & SSA issues w/CC1, nightmare conditioning CC2*
- "Orphaned" systems without support/documentation – *eCool 2A supplies, ESECON, RF Gun H2O loop, ZUP supplies…*
- External support from…
  - Procurement – *punishingly long lead-times across the board, most relevantly w.r.t. contractors, IPI preparation in parallel w/Run*
  - Contractor coordination – *IOTA kicker & IPI cable pulls*
  - Controls - *w.r.t. pushing updates / taking frontends offline without forewarning*
  - Generally speaking: the feeling is that we are far out on the border of AD, usually are not prioritized or even considered in relevant decisions
- Enclosure access
  - Cryo access incident – *keys issued, pulled w/o communication w/FCR: crashed all RF systems & IOTA bend dipoles*
  - UCLA student access incident – *led to ~3 full days of downtime, restrictions on enclosure key distribution*

Downtime

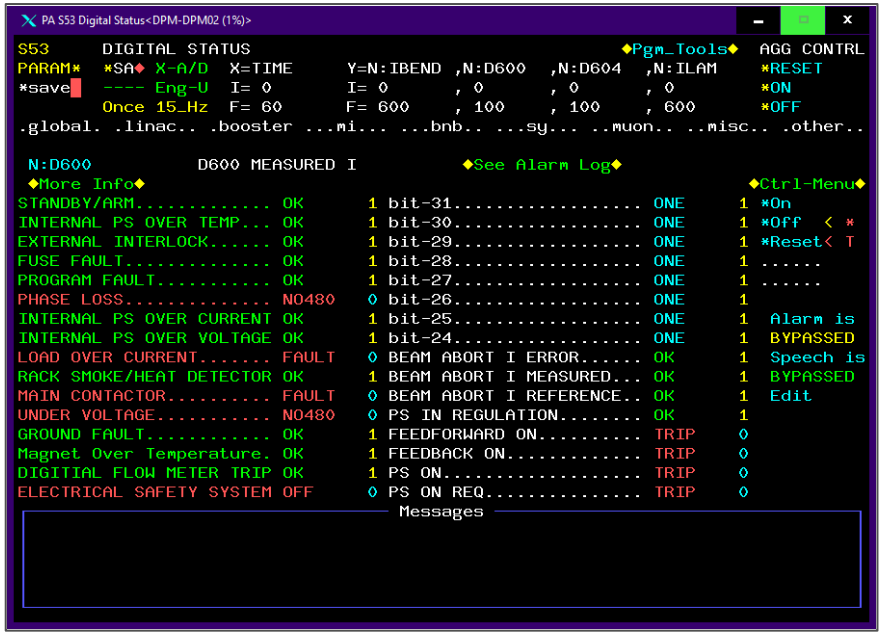
- Majority of downtime was on Cryo.
- RF made up most of the rest…
  - Specifically, HLRF – *EE Support effective in minimizing this*
  - RF Gun dielectric oil, Cryomodule c.s. phase controller
  - CC1 LLRF issues in late-July ’23 + Sept. ’23
- Power supplies:
  - 2 Amp eCool chassis
  - IOTA injection line (D600/604, Lambertson, IBEND)
  - 300 MeV Bulks can be touchy - *fictitious trips hide real trips*
- “Misc.” primarily composed of safety/security stand-downs
- Instrumentation: BPM hang-ups, Cameras, TPM actuators
- Water → primarily M4R leak, December ’22
- Graphic courtesy of Jamie Santucci



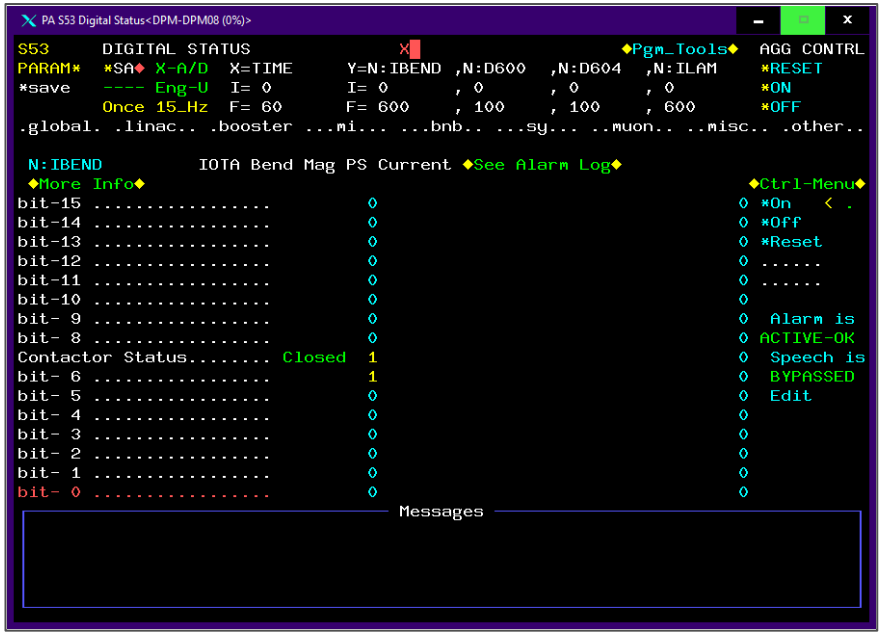
Inconsistencies, Workarounds, and “Magic Wands”

- Most common issues faced daily by FAST-Ops, experiment crews
- System-to-system variation
- Examples:
  - Digital Statuses of some devices very clear w/explicit trip indications, some completely opaque w/raw bits
  - Alarm handling / reporting – *causes frequent interface & confusion w/MCR-Ops*
  - BiRa / MCOR supplies – *work fine for IOTA quads, nightmare to deal with for IOTA octupoles*
  - CC2 & Cryomodule Cavity #5 tuner motor temp monitors dead; no feedback during motor moves
  - MPS randomly enabling Moveable Devices, holds-off reset
  - CC klystron solenoid power supplies – random trips (in principle, fixed for CC2…)
  - Unintuitive behavior, “Magic Wands” – *e.g. CC modulators require “RESET” then “OFF” then “ON” to clear trips…*
- Oftentimes issues of this class are not severe enough to warrant immediate attention
  - To a degree, this is understandable – *“If we are running, then we are running” mentality*
  - Issues often then go unaddressed because “that is just how it is” – *I am perhaps more guilty of this than anyone else*
  - In some cases however, unaddressed issues deteriorate further to the point of inhibiting beam operations (e.g. CC klystron solenoid faults)
  - On the other hand, oftentimes there is truly not much we can do (not our system, orphaned system, experts unavailable)

Example:



Digital Status for N:D600



Digital Status for N:IBEND

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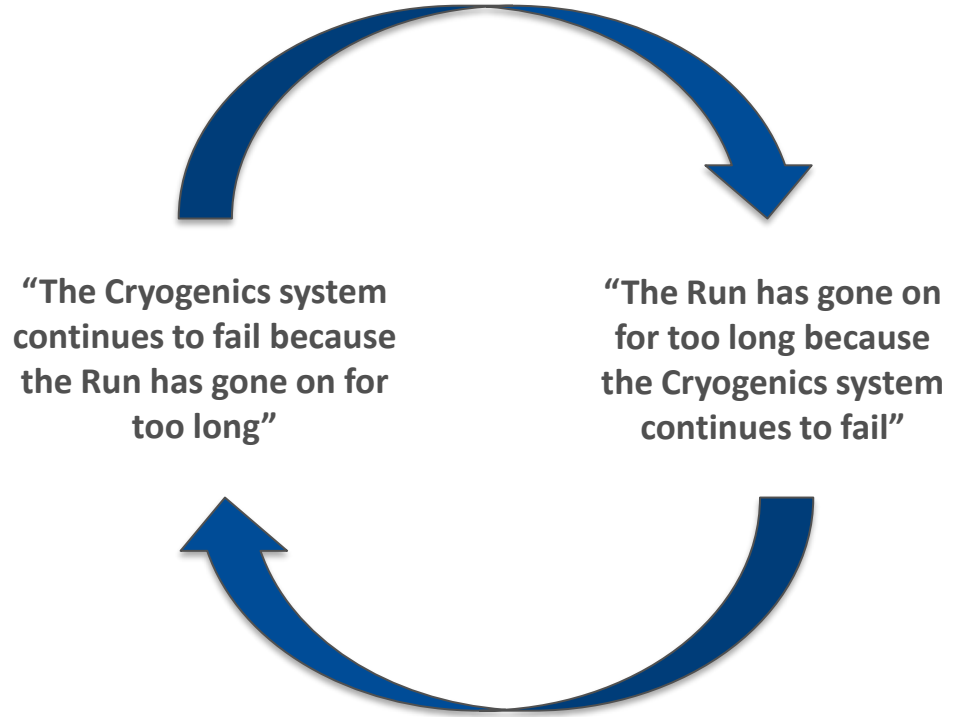
Communication (1/2)

- Much broader than any hardware or machine issues, arguably the most important aspect of Operations
- Successes & failures throughout the Run: definitely room for improvement
- Failures occur primarily on the border between FAST-Ops & Support Departments & MCR
  - Coordinating work inside of the enclosure / scheduling accesses
  - Lapses in understanding about which systems are maintained by which group - *e.g. EE Support w/D600/D604/ILAM supplies*
  - Communications w/MCR regarding enclosure access *– e.g. keys issues in April '23 w/o MachineCo. Authorization (post-incident)*
  - Back & forth between Cryp Dept. & FAST-Ops w.r.t. system failures, Run end-date *(see next)*
- Early-on: frequent "empty shifts" with machine running but no experiment crew available to take beam
  - In context of the 24/7 marathon at the *end* of the Run, somewhat painful to consider retrospectively: wasted time
  - Could be improved by having rigid shift schedule setup from the beginning, fixed roster of experiments earlier in Run
- Towards end-of-Run, lack of unified & concerted direction on
  - Conflicting understandings on Run end-date & conditions within Dept.
  - Confusion between FAST-Ops & Support Departments w.r.t. continuously shifting Run end date

Communication (2/2)

- A familiar example:
  - Not a great way way to run things
  - Unproductive, does not lead to solutions
  - Failure on **both ends**; requires improved planning & coordination



Summary

- The expertise & dedication of FAST Facility Ops. personnel always outweighs the challenges that we face
- That said, there are lessons to be learned
- Shutdown 2023 provides an excellent opportunity to accomplish critical tasks, carryout well-needed upgrades
  - Carryout Preventative Maintenance on critical systems
  - Update / generate documentation, procedures
  - Improve critical ACNET device descriptions / statuses
  - Work w/Support Departments ahead of next Run to improve communication & understanding: convey how important their assistance is
  - See: Shutdown Fixlist maintained by Chip, Jamie, and myself
- The challenges presented by Run 4 should not be viewed negatively: they have perfectly exposed areas of our Facility/Operations that require attention, and should be understood as a tool more than anything else

"The willow submits to the wind and prospers until one day it is many willows - a wall against the wind."

— Frank Herbert, Dune