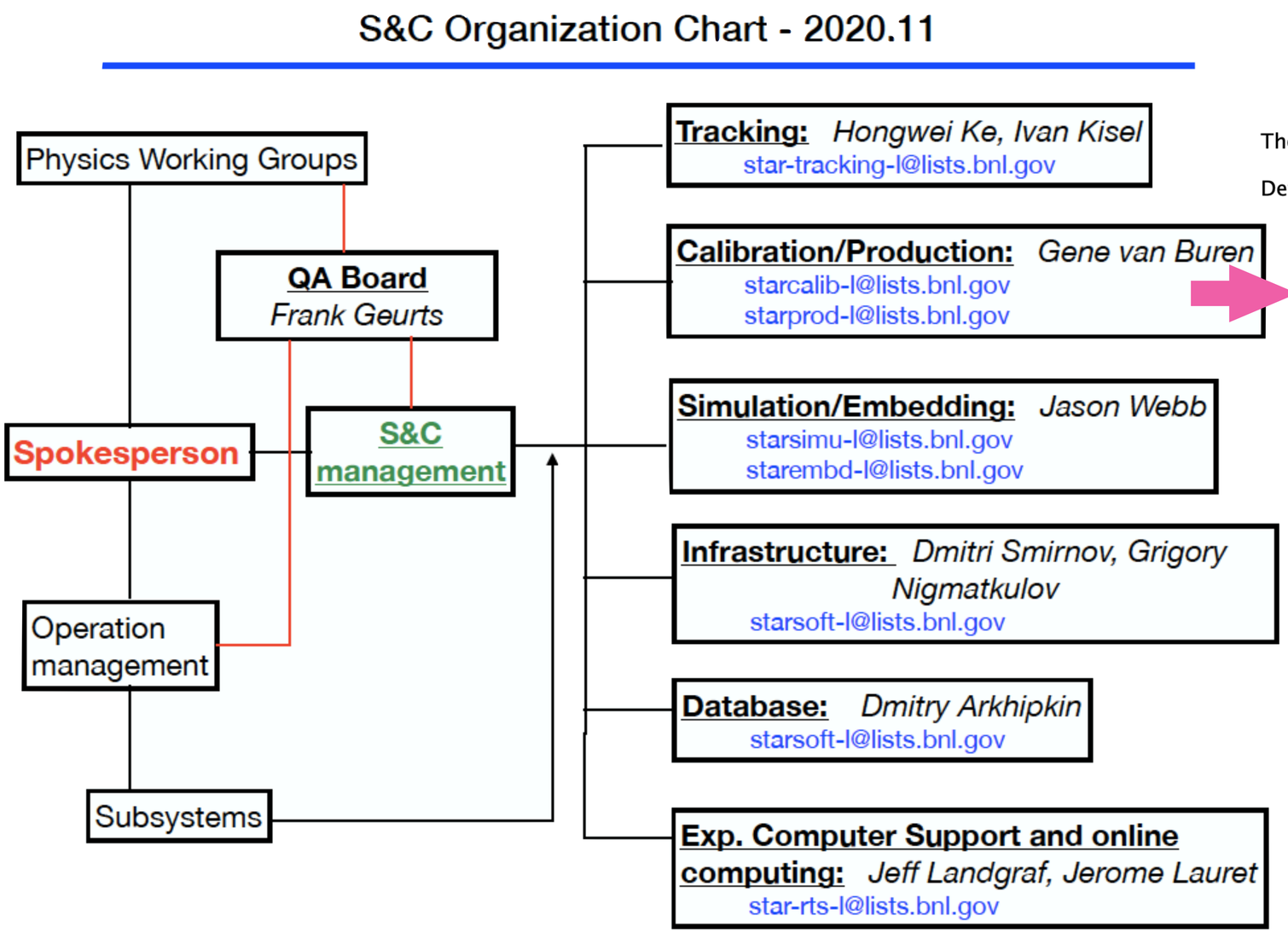
TPC Calibration Organization

G. Van Buren, for the STAR TPC Group

STAR TPC Calibration Review

February 2021

S&C Organization



The **Software Sub-system coordinators** (+) in each specialized area are as follows :

Detector sub-systems:

- TPC Software - Yuri Fisyak (BNL)
- GMT Software - [vacant]
- DAQ Software - Jeff Landgraf (BNL)
- EMC2 Software - (co-lead / historically in two groups)
  - Raghav Kunnawalkam Elayavalli (WSU)
  - Nicholas Lukow (Temple)
- FMS/FPS Software - Oleg Eyser (BNL)
- bTOF/VPD Software - Frank Geurts -> Zaochen Ye (Rice)
- eTOF Software - Florian Seck (Darmstadt)
- MTD Software - Rongrong Ma (BNL)
- Trigger Detectors (BBC, FPD, CTB, ZDC, MWC, ...) - Akio Ogawa (BNL)
- HFT Software - Xin Dong (LBNL)
- HLT Software - Hongwei Ke (BNL)
- PP2PP/RP Software - Yip Kin (BNL)
- EPD - Prashant Shanmuganathan (Lehigh)
- Forward Upgrade - Daniel Brandenburg (BNL). Forward Upgrade includes FCS, s
  - FCS - Akio Ogawa (BNL)
  - sTGC - Daniel Brandenburg (BNL)
  - FST - Shenghui Zhang/Zhenyu Ye (UIC)

TPC "Group"

- General outline of the history:
  - TPC primarily built by LBNL, with smaller contributions by other institutions, and then handed over to the collaboration to operate
  - Calibration work handled by LBNL and a few scattered collaborators for the first ~7-8 years
  - Whenever any long term experts from non-BNL institutions left, there was little interest from outside BNL to take up long term expertise (2-3 years max)
  - The experts eventually all came to be BNL-affiliated personnel, with shorter term helpers from other collaborating institutions
- Weekly meetings
  - Currently chaired by *Flemming Videbaek* [interim]
  - Attended by experts, calibration helpers, interested PWG members

TPC Roles: Experts

- I don't know/remember the names of all the people who contributed in the very early years, but let's identify *Howard Wieman* (LBNL) as the expert on nearly all things TPC
  - Some former experts don't mind being called for advice, not for work
- Still-active specialty experts:
  - Hardware & Controls: *Alexei Lebedev*, *Prashanth Shanmuganathan* (relatedly, iTPC: *Flemming Videbaek*)
  - Electronics: *Tonko Ljubicic*, *Tim Camarda*
  - Distortions: *Gene Van Buren* (relatedly, B-field Map: *Yuri Fisyak*)
  - Alignment: *Yuri Fisyak*, *Irakli Chakaberia*, *Gene Van Buren**
  - T0s: *Yuri Fisyak*, *Irakli Chakaberia*‡
  - dE/dx: *Yuri Fisyak* (relatedly, Gains: *Tonko Ljubicic*)
  - Drift velocity: *Yuri Fisyak*
  - Reconstruction & Simulation: *Yuri Fisyak*, *Irakli Chakaberia*, (relatedly, Hit-finder: *Tonko Ljubicic*)
- TPC Software Coordinator:
  - Many years without an explicit coordinator
  - *Richard Witt* (Yale/Naval Academy) took the role administratively (chair meetings, manage database, minor calibration tasks) for several years before leaving to DOE work
  - *Irakli Chakaberia*‡ (BNL/Kent) past few years (carried out significant iTPC software integration)
  - *Yuri Fisyak* now

* Worked on alignment ~10 years ago, not with current tools
‡ Already expected to reduce TPC activities

TPC Roles: Helpers

- Helpers come from two places:
  - Interested in helping to get their PWG's analyses to completion
  - Institutions offering service work to the Collaboration, with loosely-defined credit (e.g. talks committee considers such service, but there is no official reward mechanism)
    - Minor involvement to serve HLT
- Nearly all juniors (students & postdocs) who are also doing analyses
- Contributions span a few weeks or months of work, for 1-2 Run years of the experiment
  - Some turn the crank: *not much expertise gained*
  - Some get in some R&D: *potential expertise*
- Few stay in the Collaboration: *potential expertise* is typically lost for the collaboration (someone else's gain? leave the field?)

Input For Tasks

- Specialty data
  - Pedestal runs (pedestals)
  - Pulser runs (gains)
  - Cosmic ray runs (alignment, some T0s)
  - Lasers [standalone, or interleaved in physics data] (drift velocity)
  - Low luminosity data (static distortions, alignment)
- Data available at various stages:
  - Online event pool
  - Standardized fast processing [using any initial calibrations]
    - HLT
    - FastOffline
    - Express Stream (drift velocity)
  - Manually run productions (T0s, alignment, SpaceCharge & GridLeak, static distortions, **any R&D***)
  - Calibration productions (dE/dx‡)

* See final slide for (unexpected) R&D topics
‡ Recently done with manual productions

Typical Calibration Workflow

- Pedestals: online, quick, frequent, automatic (necessary for use in zero suppression)
- Gains: online, quick, a few times a year (necessary for use in online cluster-finding)
- Drift velocities: offline, quick, frequently, automatically
- T0s: shortly after data-taking begins, few days work (cosmics can be used for relative T0s between sectors, but global T0 may be specific to collisions)
- **any R&D***: whatever it is, usually a couple months or more
- SpaceCharge & GridLeak distortion corrections: usually once per colliding system dataset, takes a few weeks (often an initial [used by HLT and FastOffline] and final version)
- dE/dx: once per year, requires a large calibration sample of entire year, takes a couple weeks

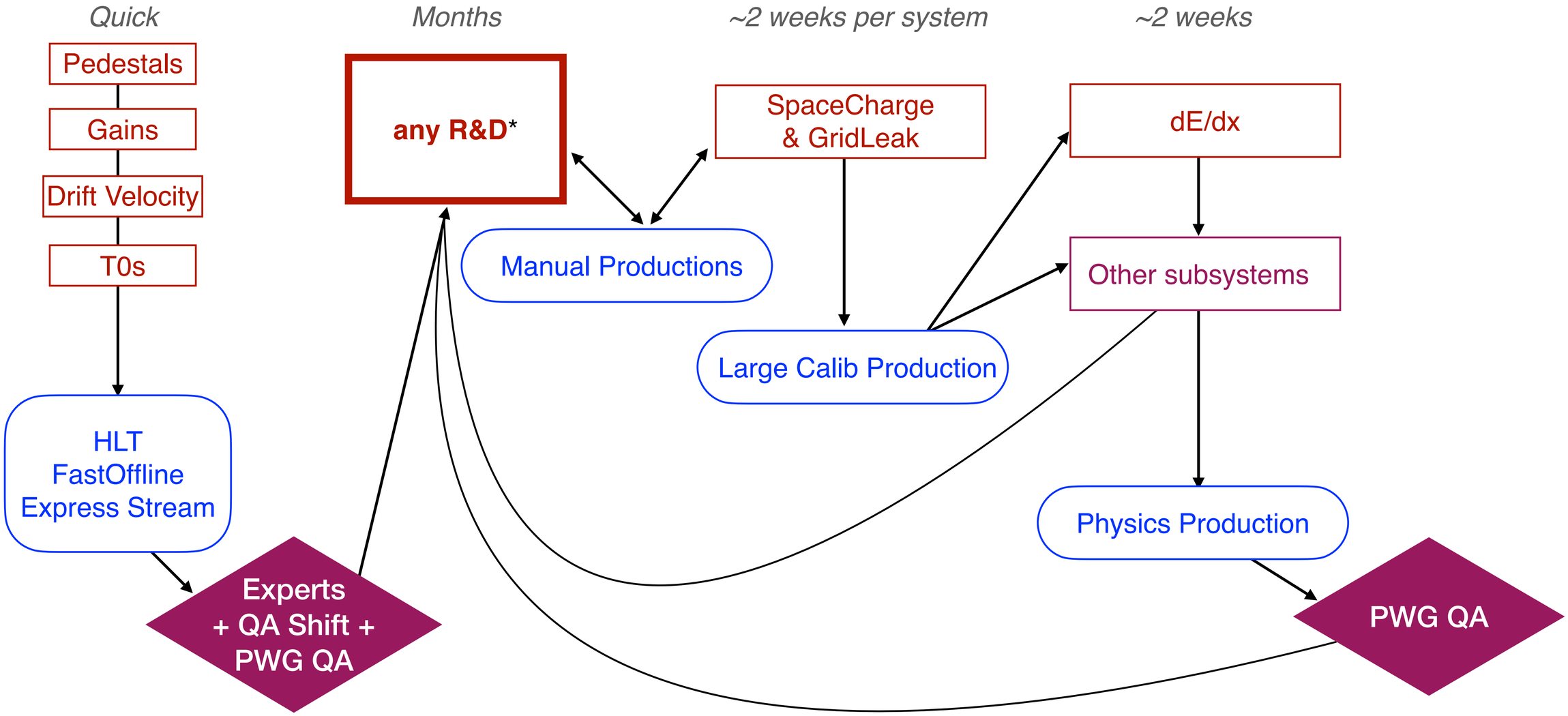
These follow a sequence with no parallelism

R&D can be prompted by FastOffline QA during Run (Experts + QA Shift + PWG), by other calibrations (e.g. HFT, BTOF, EMC), by PWG Analyses

This is why we are not ready to start productions until some months after data-taking completes

* See final slide for (unexpected) R&D topics

Typical Calibration Workflow



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Documentation

- There is a central Drupal page for TPC Calibration links which I kept somewhat current up until ~2014
  - Some "how-to" instructions
  - Mostly results for various datasets' calibrations
  - A few broken links
- Much recent work is dispersed in individuals' blogs and not linked from here

- Clearly needs revisited!

1. **TPC survey instructions**
   - Should be done each time the TPC may be moved (e.g. STAR is rolled out and back into the WAH) (not done in years)
   - Must be done before magnet endcaps are moved in
   - Past workers: J. Castillo (Runs 3,4), E. Hjort (Runs 5,6), Y. Fisyak (Run 14)
2. TPC Pad Pedestals
   - Necessary for online cluster finding and zero suppression
   - Uses turned down anode HV
   - Performed by DAQ group frequently during Run
   - Past workers: A. Ljubicic
3. TPC Pad Relative Gains & Relative T0s
   - Necessary for online cluster finding and zero suppression
   - Uses pulsers
   - Performed by DAQ group occasionally during Run
   - Past workers: A. Ljubicic
4. TPC Dead RDOs
   - Influences track reconstruction
   - Monitored by DAQ
   - Past workers: A. Ljubicic
5. **Drift velocity**
   - Monitor continually during Run
   - Currently calibrated from laser runs and uploaded to the DB automatically
   - Past workers: J. Castillo (Runs 3,4), E. Hjort (Runs 5,6), A. Rose (Run 7), V. Dzhordzhadze (Run 8), S. Shi (Run 9), M. Naglis (Run 10), G. Van Buren (Run 12)
6. TPC Anode HV
   - Trips should be recorded to avoid during reconstruction
   - Dead regions may influence track reconstruction
   - Reduced voltage will influence dE/dx
   - Dead/reduced voltage near inner/outer boundary will affect GridLeak
   - Past workers: G. Van Buren (Run 9)
7. TPC Floating Gated Grid Wires
   - Wires no longer connected to voltage cause minor GridLeak-like distortions at one GG polarity
   - Currently known to be two wires in Sector 3 (seen in reversed polarity), and two wires in sector 8 (corrected with reversed polarity)
   - Past workers: G. Van Buren (Run 5)
8. **TPC T0s**
   - Potentially: global, sector, padrow
   - Could be different for different triggers
   - Once per Run
   - Past workers: J. Castillo (Runs 3,4), Eric Hjort (Runs 5,6), G. Webb (Run 9), M. Naglis (Runs 10,11,12), Y. Fisyak (Run 14)
9. You do not have access to view this node
   - Dependence of reconstructed time on pulse height seen only in Run 9 so far (un-shaped pulses)
   - Past workers: G. Van Buren (Run 9)
10. You do not have access to view this node
    - Known shorts can be automatically monitored and uploaded to the DB during Run
    - New shorts need determination of location and magnitude, and may require low luminosity data
    - Past workers: G. Van Buren (Runs 4,5,6,7,8,9,10)
11. **TPC Sector Alignment**
    - Two parts: Inner/Outer Alignment, and Super-Sector Alignment
    - Requires low luminosity data
    - In recent years, done at least once per Run, and per magnetic field setting (perhaps not necessary)
    - Past workers: B. Choi (Run 1), H. Qiu (Run 7), G. Van Buren (Run 8), G. Webb (Run 9), L. Na (Run 10), Y. Fisyak (Run 14)
12. TPC Clocking (Rotation of east half with respect to west)
    - Best done with low luminosity data
    - Calibration believed to be infrequently needed (not done in years)
    - Past workers: J. Castillo (Runs 3,4), Y. Fisyak (Run 14)
13. TPC IFC Shift
    - Best done with low luminosity data
    - Calibration believed to be infrequently needed (not done in years)
    - Past workers: J. Dunlop (Runs 1,2 [**here**, **here**]), J. Castillo (Runs 3,4), Y. Fisyak (Run 14)
14. **Twist (ExB) Distortion**
    - Best done with low luminosity data
    - At least once per Run, and per magnetic field setting
    - Past workers: J. Castillo (Runs 3,4), E. Hjort (Runs 5,6), A. Rose (Runs 7,8,9), Z. Ahammed (Run 10), R. Negrao (Run 11), M. Naglis (Run 12), J. Campbell (Runs 13,14), Y. Fisyak (Run 14)
15. **TPC OmegaTau**
    - Done with low (no) luminosity data from known distortions
    - Done once (but could benefit from checking again)
    - Past workers: G. Van Buren (Run 4), M. Mustafa (Run 4 repeated)
16. **SpaceCharge and GridLeak**
    - At least once per Run, and per beam energy & species, and per magnetic field setting
    - Past workers: J. Dunlop (Runs 1,2), G. Van Buren (Runs 4,5,6,7,8-dAu,12-pp500), H. Qiu (Run 8-pp), J. Seele (Run 9-pp500), G. Webb (Run 9-pp200), J. Zhao (Run 10), A. Davila (Runs 11,12-UU192,pp200,pp500), D. Garand (Run 12-CuAu200), M Vanderbroucke (Run 13), M. Posik (Run 12-UU192 with new alignment), P. Federic (Run 12-CuAu200 R&D)
17. **TPC de/dx**
    - Once per Run, and per beam energy & species, and per magnetic field setting
    - Past workers: Y. Fisyak (Runs 1,2,3,4,5,6,7,9), P. Fachini (Run 8), L. Xue (Run 10), Y. Guo (Run 11), M. Skoby (Runs 9-pp200,12-pp200,pp500), R. Haque (Run 12-UU192,CuAu200)
18. **TPC Hit Errors**
    - Once per Run, and per beam energy & species, and per magnetic field setting
    - Past workers: V. Perev (Runs 5,7,9), M. Naglis (Runs 9-pp200,10,11,12-UU193), R. Witt (Run 12-pp200,pp500, Run13)

Always Something...

- Run 2: SpaceCharge
- Run 4: fluctuating SpaceCharge
- Run 5: GridLeak
- Run 6: field cage shorts, sometimes varying
- Run 7: alignment
- Run 8: asymmetric SpaceCharge; floating gating grid wires
- Run 9: slewing; reduced voltages on some anodes; massive pile-up
- Runs 10-12: alignment again ("h^-/h^+" saga)
- Run 13: field cage current losses to ionized air
- Runs 14 & 16: need to account for SpaceCharge uncertainty for HFT
- Run 17: fill-by-fill SpaceCharge
- Run 18: abort gap cleaning; booster main magnet;
  humidity-induced field-cage conductivity; disconnected gating grid on a sector
- Run 19: GridLeak-mitigating "wall"
- Runs 19 & 20: iTPC alignment; booster main magnet again
- Runs 19 & 20 FXT: event-by-event T0s