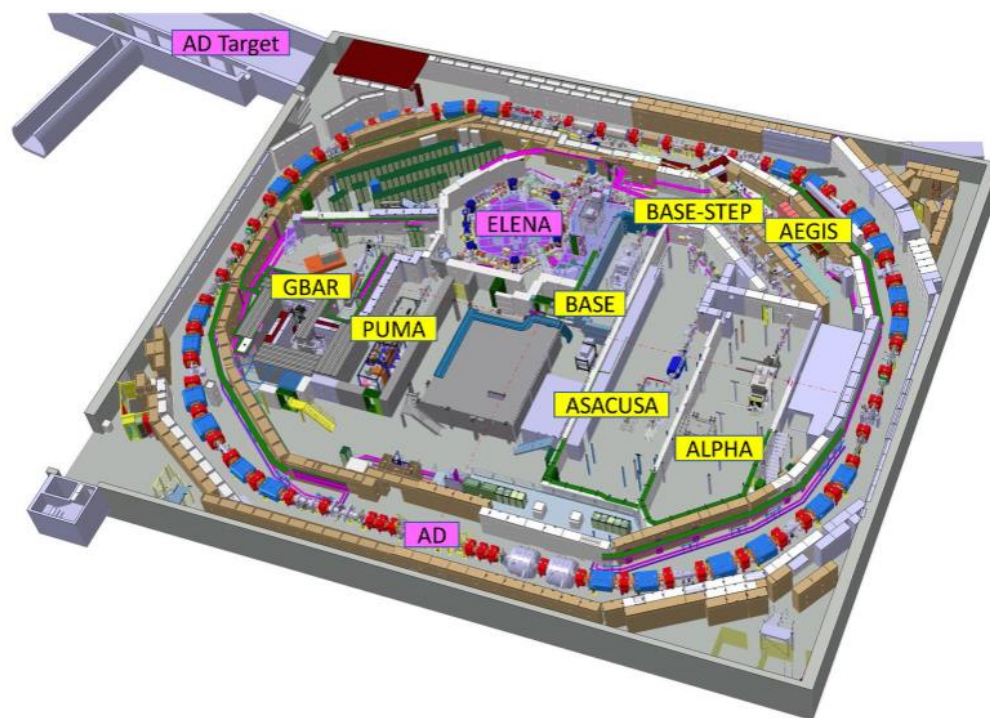
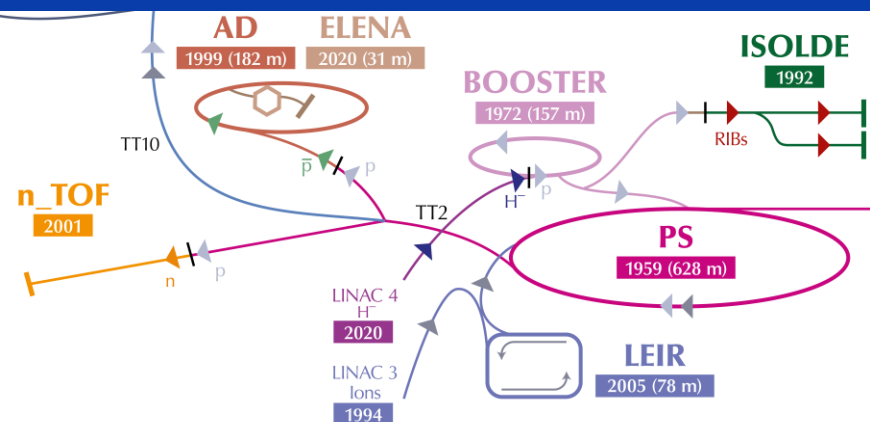


AD/ELENA run 2022 ...and Plans for 2023



- The Good and the Bad in 2022
- Plans for 2023

ACKNOWLEDGEMENTS: D. Gamba, F. Asvesta, Y. Dutheil, S. Albright, H. Damerau, A. Lasheen, R. Ramjiawan, S. Rey and many more colleagues for the material provided!

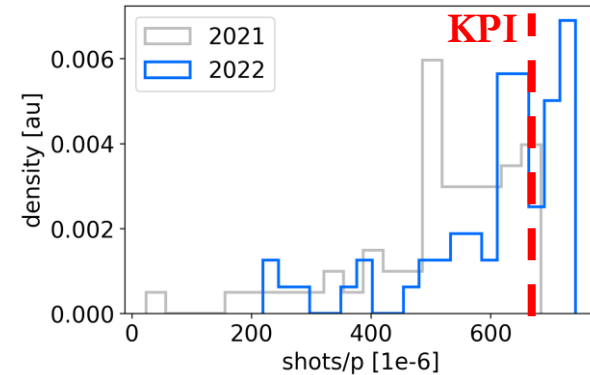
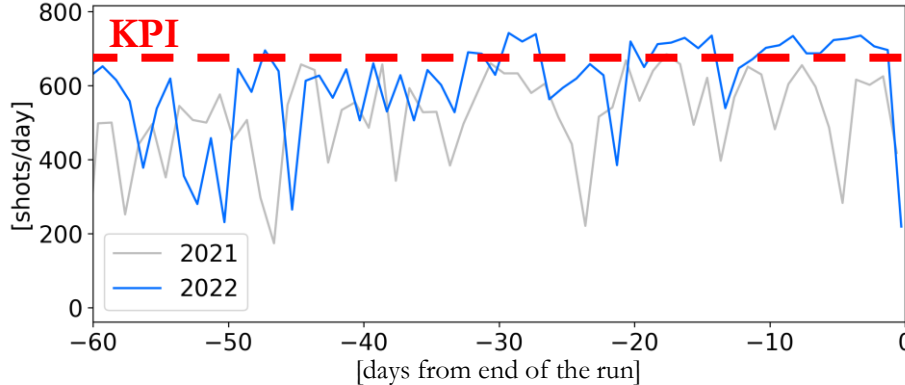
- Beams close to design values were delivered to happy users!
- Items that **required improvement**:
 - **Consolidate/improve instrumentation**: availability and **accuracy** a generic issue from FTA to AD/ELENA to LNE, e.g. BPMs in FTA line? IPM in AD? Intensity in ELENA?
 - **Monitoring/logging**: for detecting and promptly acting on **degradation**, e.g. PS extraction
 - **Collect/use references**: for critical systems such as **s-cooling**
 - **Tooling**: e.g. for **transport** optimization or for following hardware drifts
 - Reduce **radiation levels**: e.g. **p losses** in FTA, **shielding** of AEGIS experimental area
 - **Recover pre-LS2 pbar/p yield**
- **Hunting** for even **higher performance**:
 - **Increase p intensity/quality in PS**: coupled bunch instability in PS limited the **p intensity** to about 1500×10^{10} p/cycle. To check if p bunch length should be reduced (or not)
 - **Improve AD/ELENA deceleration efficiencies**
 - **Improve stability**: mainly at AD target and extraction, other sources to be found
 - **Improve repetition rate**: AD **cycle length**, improve PS **super-cycle composition**

2022 - AD/ELENA Repetition Rate



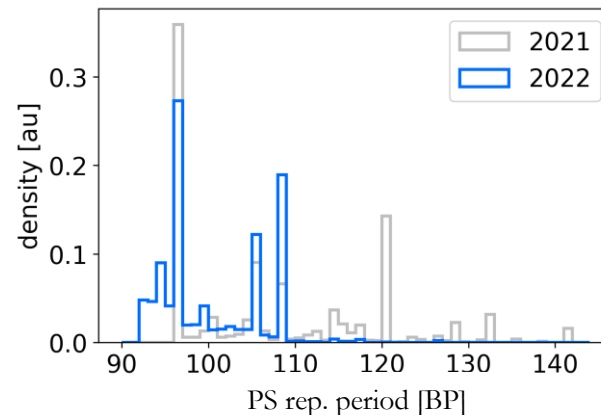
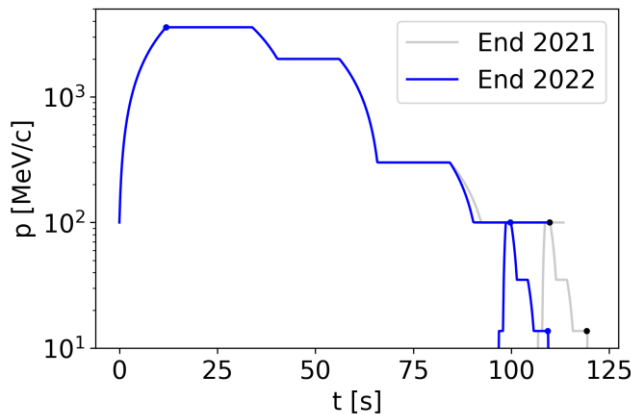
■ Number of daily good pbar shots (>10% than nominal intensity) per day extracted from ELENA

- On average, 514 shots/day in 2021, **606 shots/day in 2022**; to be compared to target of about 650 shots/day



■ AD extraction anticipated by 10 s! but AD cycle total length reduced by ~4 s

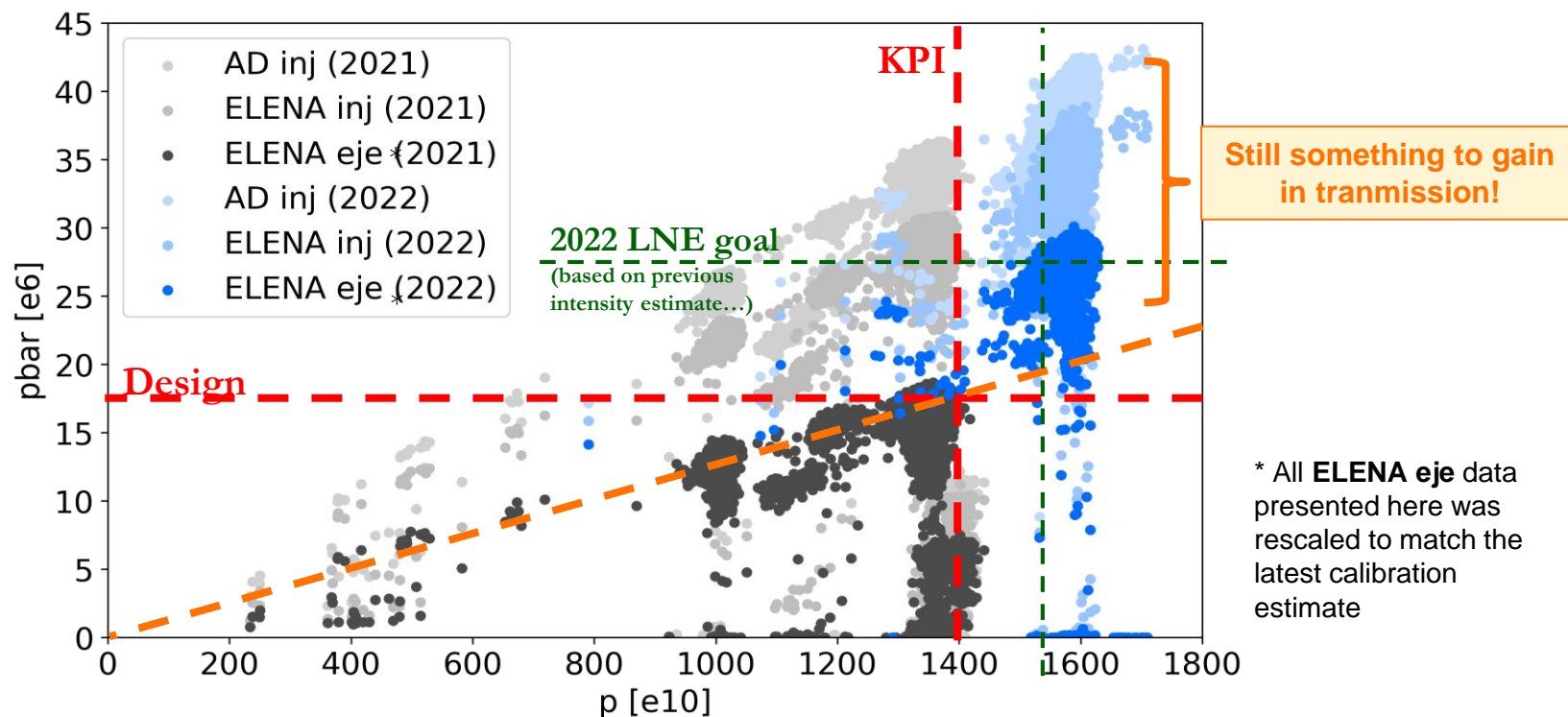
- Had to wait for ELENA ejection before new AD cycle: **experiments sensitive to AD magnetic field ramping up!**



■ On the PS side, still some room for improvement:

- **~10% potential cycles lost in 2021**, and **~7% in 2022** (computed over the last 60 days of operation). **Experiments ask also for regular repetition rate**

- Overall performance: pbar per proton on target
 - Looking last ~20 days of operation for 2021 and 2022



- **Warning!** In 2021 (and most of 2022) we were fooled by ~40% overestimate of beam intensity at ELENA ejection! Still uncertainties on pbar intensity measurement!

- Overall: another excellent year for AD/ELENA with performance improvements!

- Still need to work on stability, repetition rate, and transmission...

■ AD Dipole Trim (BHZ-Trim) PC failure end of April

- EPC did not manage to get it back online

- **Old equipment, difficult to diagnose**

- (See details at [IEFC meeting #306](#))

- Found a **patch using all orbit correctors**

- **Managed to conclude the run in this state, but we should get back to the nominal setup!**

■ Main Quadrupoles (QMAIN)

- **Several trips especially during summer time**

- **Interventions to improve reliability often resulted in different machine**

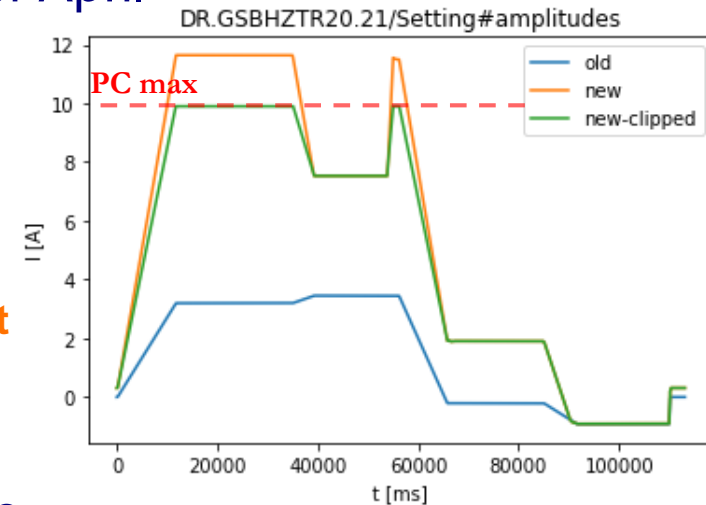
- (typically, different tune): not straightforward to debug

■ Horn power converters not able to sustaining max voltage (sparks!)

- Weakness in the design identified, but probably just a single bad cubicle.

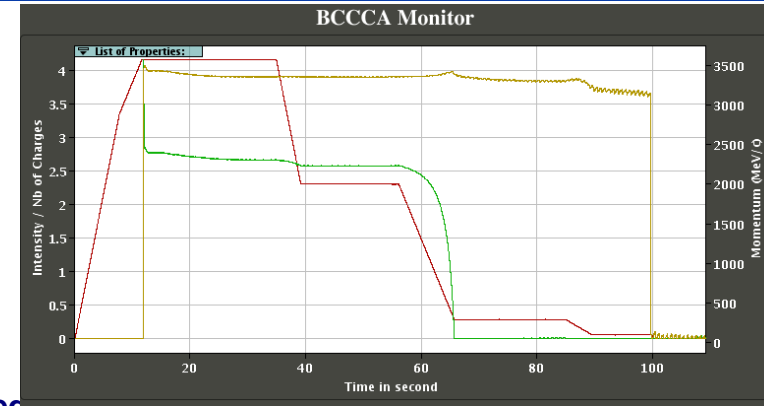
- Issues with communication/trips being investigated

■ **More and more urgent to think about anticipating(?) the powering consolidation?**



■ AD BCCCA stopped working

- Started the year in **degraded** mode
 - Had to find a workaround to make it work
- Finally **unusable in October**
 - **Cross-calibrated** an **RF signal** using historical data as temporary replacement
 - **Only works for bunched beam**, and is **not self-calibrated**

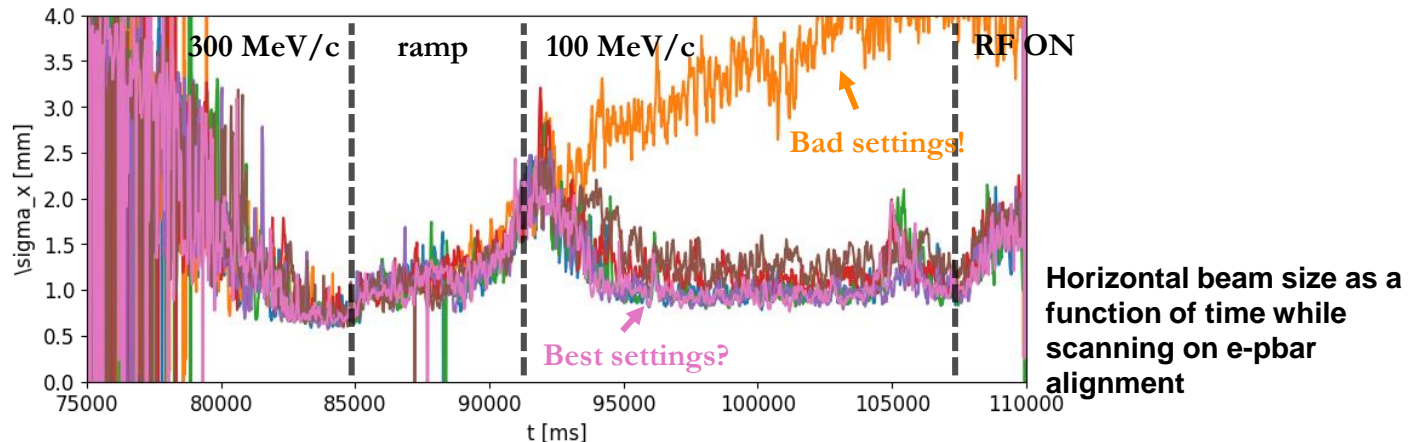


■ Intensity monitor in ELENA ejection line turned out to be **wrong by ~40%**!

- **We must improve! This is the primary information we provide to our users.**

■ AD IPM only **partially operational**

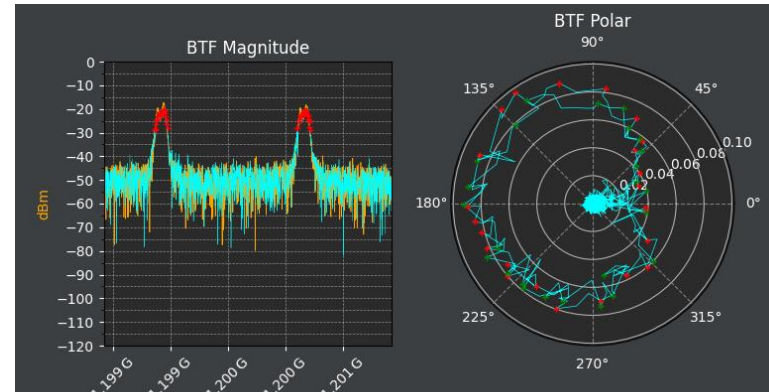
- Still, it allowed us to see that **transverse cooling at 100 MeV/c is done in 5 s instead of 15 s**
- **We should get this instrument fully operational: it will be a game changer!**



Work on Machine Understanding and Documentation during 2022



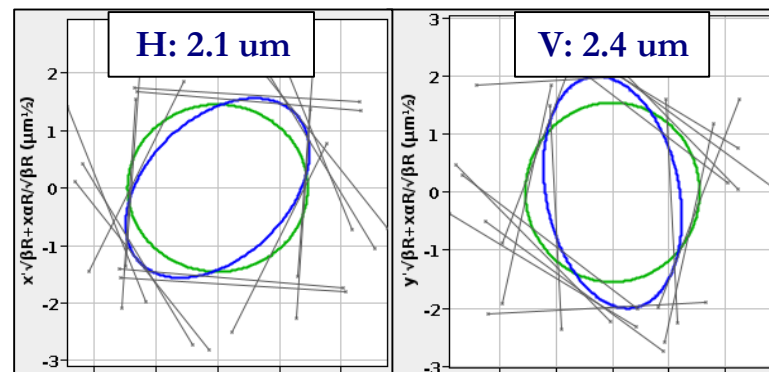
- **Weekly MDs** with biweekly discussions (see [wikis](#))
 - Investigate **hardware issues/limitations**
 - E.g. **AD bunch rotation**
 - **LSA tools debugging**
 - E.g. LLRF makerules, **cycle setting** management
 - **Setup of new beamlines**
 - **Successfully sent beam to PUMA and STEP!**
 - Take machine references
 - E.g. **s-cooling**
 - **Improve performance**
 - ... still, **mainly to follow hardware drifts**
- **Improve logging** of machine performance
 - **Setup of [BPT page](#) for AD/ELENA**
- **Still missing** (among others)
 - **Improve emittance at ELENA extraction**
 - **Still x2 bigger than design values**
 - **Very limited time invested on this**
 - **ELENA B-Train** (operational, but not used):
 - No time, but also **doesn't seem to be a limitation**



S-cooling automatic BTF measurements

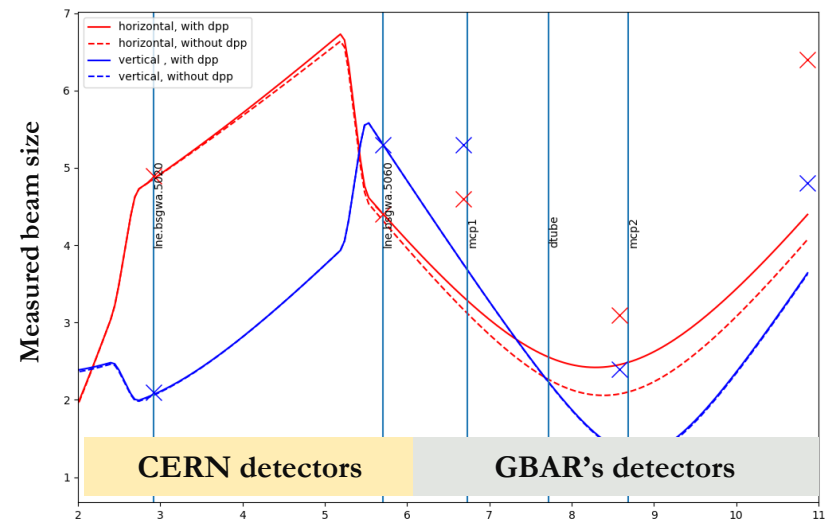
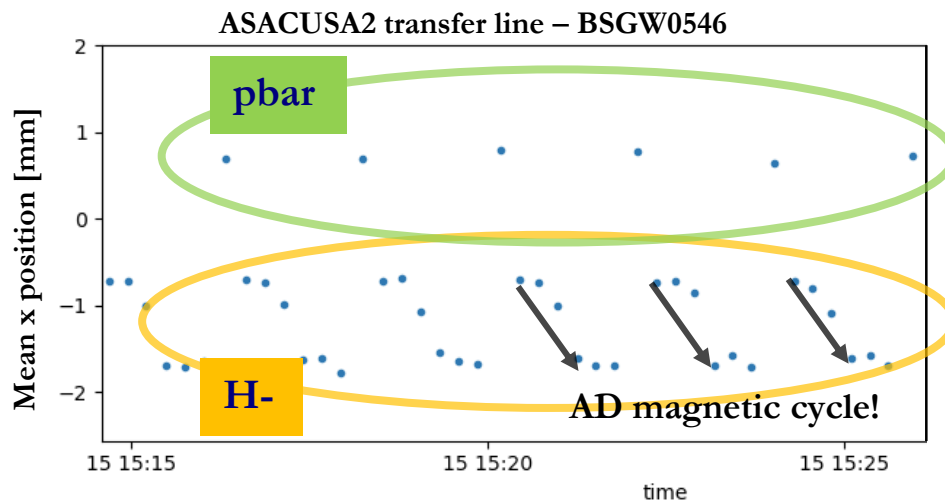


Trombone disconnection during scans










Emittance measurement in LNE lines





- Transport through the LNE lines is very **stable and reproducible**
 - Only minor cabling mistakes on new lines commissioned this year: once fixed, using design optics
- Impact of stray magnetic fields:
 - From other experiments:
 - We **would benefit** from **magnetic shielding** of some transfer lines
 - **ABT effort** on the **modelling** and **possibly automatic correction**
 - From AD:
 - **“wasting” ~5% of AD cycling time** to wait for ELENA ejection before starting a new cycle, such as **to ensure reproducible transport**
- Close collaboration with users to respond to their needs
 - Experiments benefit from support by **CERN expertise beyond the delivery point!**



■ Areas that require improvement:

-  Consolidate/improve instrumentation: **Many steps done, still work to do, +BCCCA reliability must be addressed!**
-  Monitoring/logging: **BPT** put in place, opening the room for **easier performance analysis**
-  Collect/use references: **work on s-cooling ongoing**, several **references taken** for efficient 2023 restart?!
-  Tooling: mainly concentrating on **status/diagnostics** (new Vistar, Live Schottky, Inspector panels,...), still **need to spend more time on “correction” (eventually feedback) tools**
-  Reduce radiation levels: plans to improve **RP shielding around AEgIS**
-  Recover pre-LS2 pbar/p yield: **some improvement**, probably **not yet there**
-  **+Hardware Reliability!: Powering!, Instrumentation!**

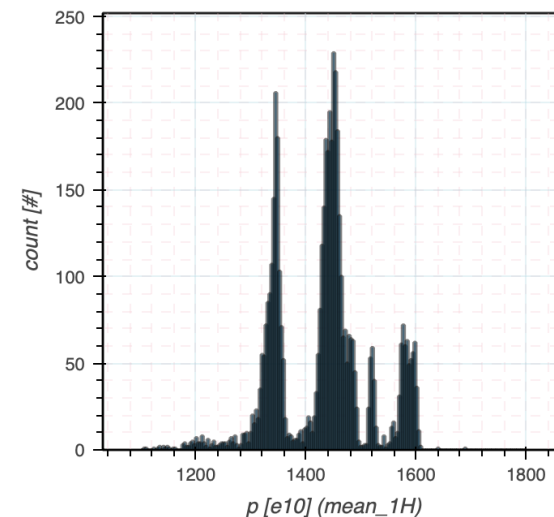
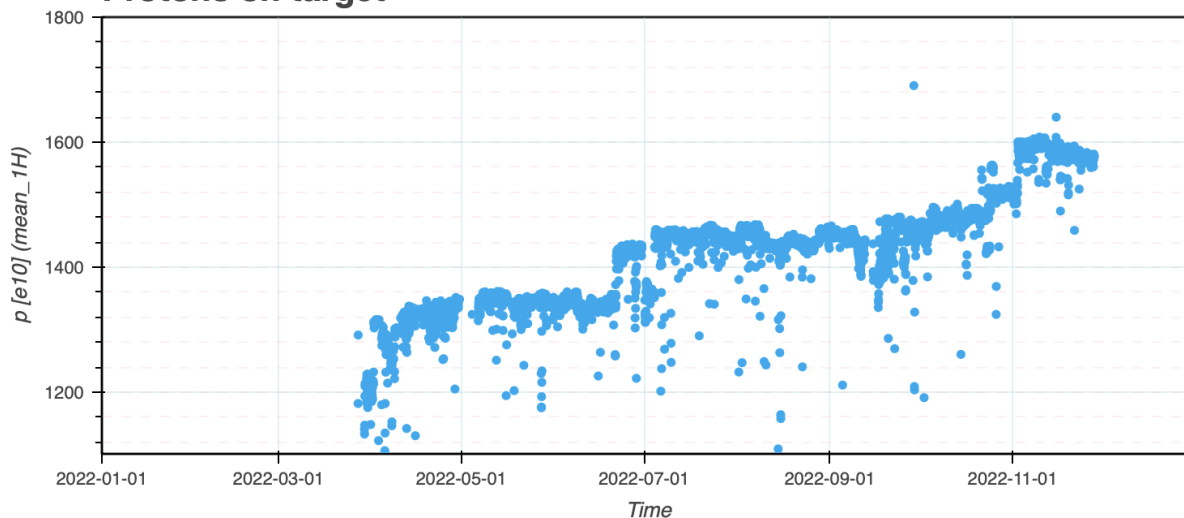
■ Hunting for even higher performance:

-  Increase p intensity/quality in PS: **limited by radiation levels in AEgIS**
-  Improve AD/ELENA deceleration efficiencies: **>80% reached, but difficult to maintain it!**
- Improve stability: **too little time available to work on this**
-  Improve repetition rate (**+stability**):
 -  **10% AD cycle length reduction!**
 - Ideally, **better matching with PS super-cycle** could be improved, or at least **stabilized!**

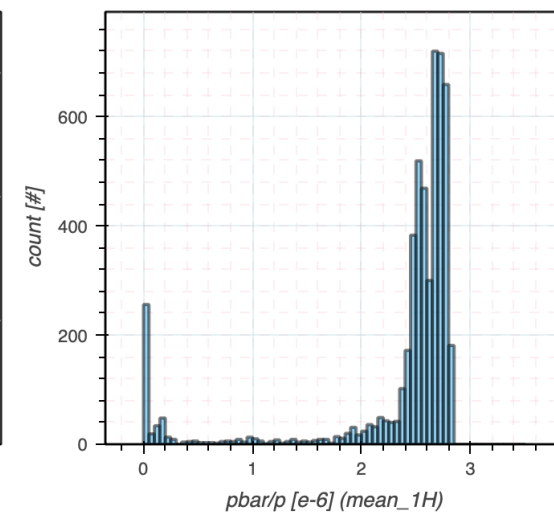
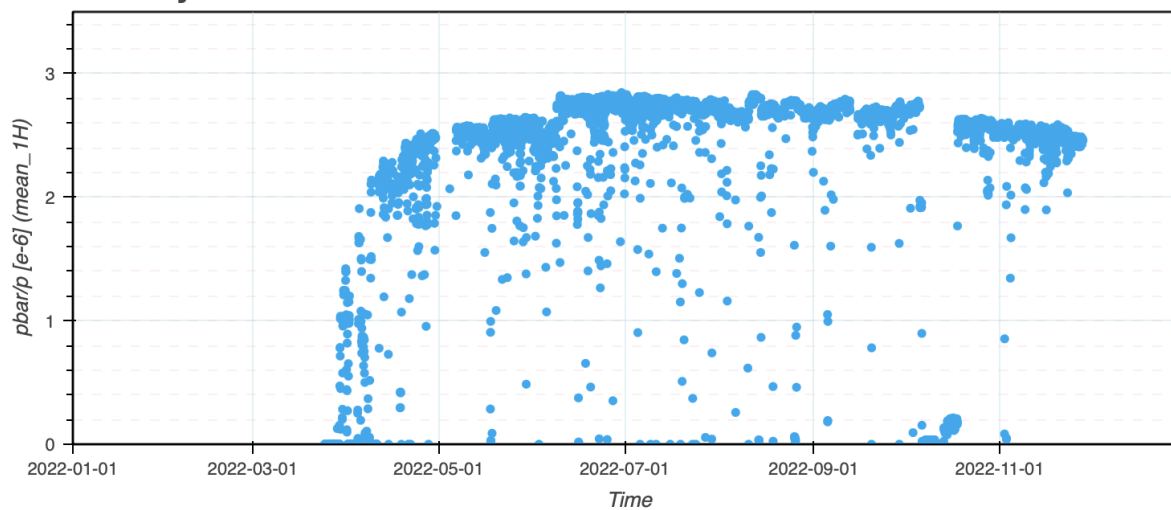
BPT Plots Selection (2022 target)



Protons on target



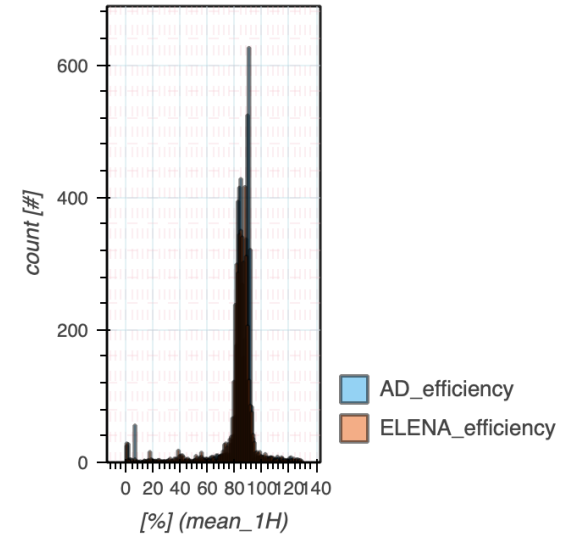
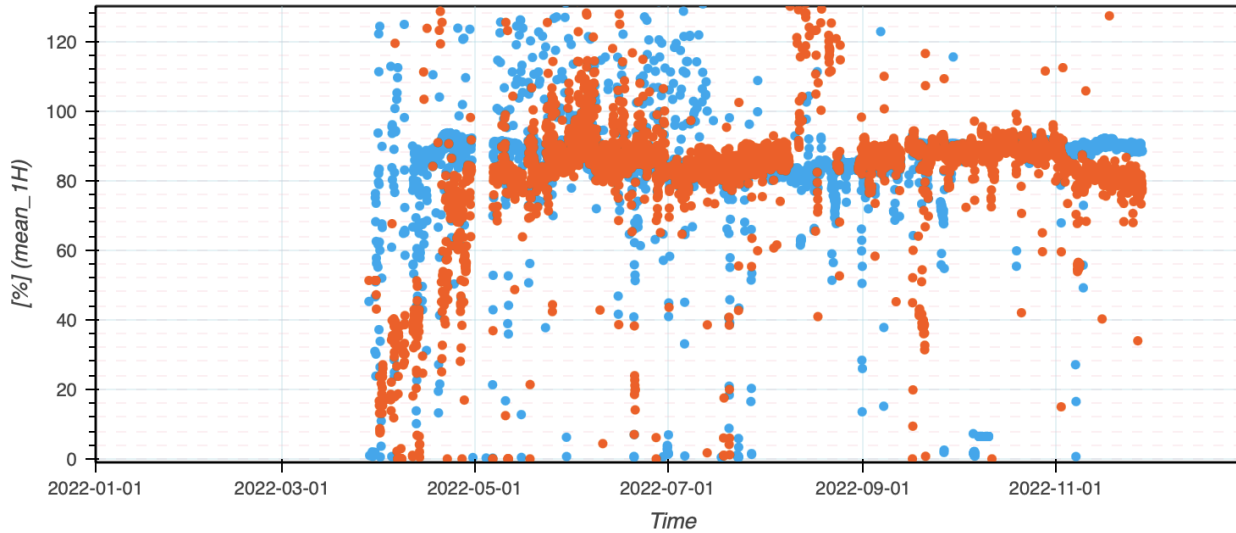
Pbars yield



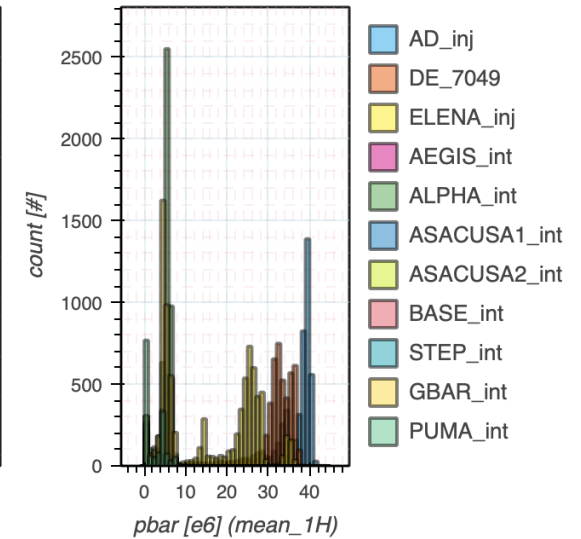
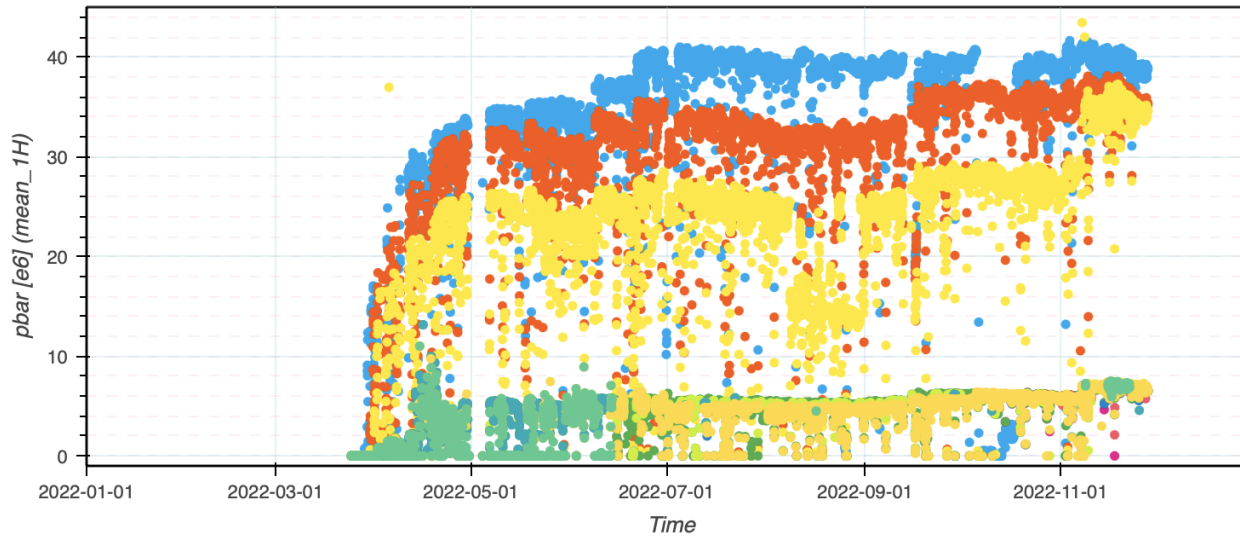
BPT Plots Selection (2022 pbar)



AD/ELENA deceleration efficiency



Goals in AD/ELENA/EXPERIMENTS



- Orbit drifts on AD target: considerable drifts observed
- Beam size and proton bunch length on AD target: not studies yet
- AD ejection orbit oscillation by septa (and/or other effect?)
- Compensation of field lag in AD
- Saturation of BPMs at 100 MeV/c in AD
- Issues with AD bunch rotation control
- AD e-cooler drifts due to vacuum condition and HV sparks
- AD e-cooler HV switches problem
- Water leaks problems (DI magnets, AD e-cooler)
- AD FINEMET cavity issues
- ...

- If Okay with experiments, we would like to keep the 8 hour MD every Wednesday?
- **Injectors Accelerator Schedule 2023:**
 - Beam on AD target – 27 March
 - Pbars to ELENA – 4 May
 - Physics start ELENA – 11 May
 - End Physics Run – 30 October @06:00

Questions for the users?



■ Intensity per bunch:

- Do you want more?
- How much more?
 - Minimum significant steps when increasing?
 - Tolerance on shot to shot variation?

■ Repetition rate:

- What is the minimum you can take, the max?
- Do you prefer reproducibility to shortest possible?
 - (i.e a fixed 135s repetition rate instead of 114s, then 120?)

■ Transverse emittance:

- We are not nominal there, is it critical?
- What is the max value?

■ Trajectory stability:

- Do we need to improve?

■ Bunch distribution:

- Special requests for longer term?
- Dedicated period for 4 users?

■ Another excellent year for AD/ELENA!

- Despite several **reliability issues** and **bad surprises**
- Thanks to **determined and motivated AD/ELENA teams** with **invaluable support** from **numerous colleagues** from the **PS-crew, BI, RF, EPC, MSC, ...**

■ A few parting thoughts:

□ Reliability:

- Need to (or aim to) **avoid working in degraded condition**
 - **key ingredient** if we want to profit of **feedback/automation tools**
- **Advancing consolidation plans? More support/time allocated** from equipment owners to **improve availability** (e.g. PC, instrumentation, ...)

□ Stability:

- Studying **transmission drifts** and find ways to **compensate/stabilize**
- It **includes rep-rate**, mainly from **PS super-cycle composition**

□ Understanding target/injection area:

- Must be a **joint effort STI-OP-ABT-ABP-BI**

- AD/ELENA Team and all the fantastic support teams will do our best to make the 2023 run the best year yet!

Thanks!