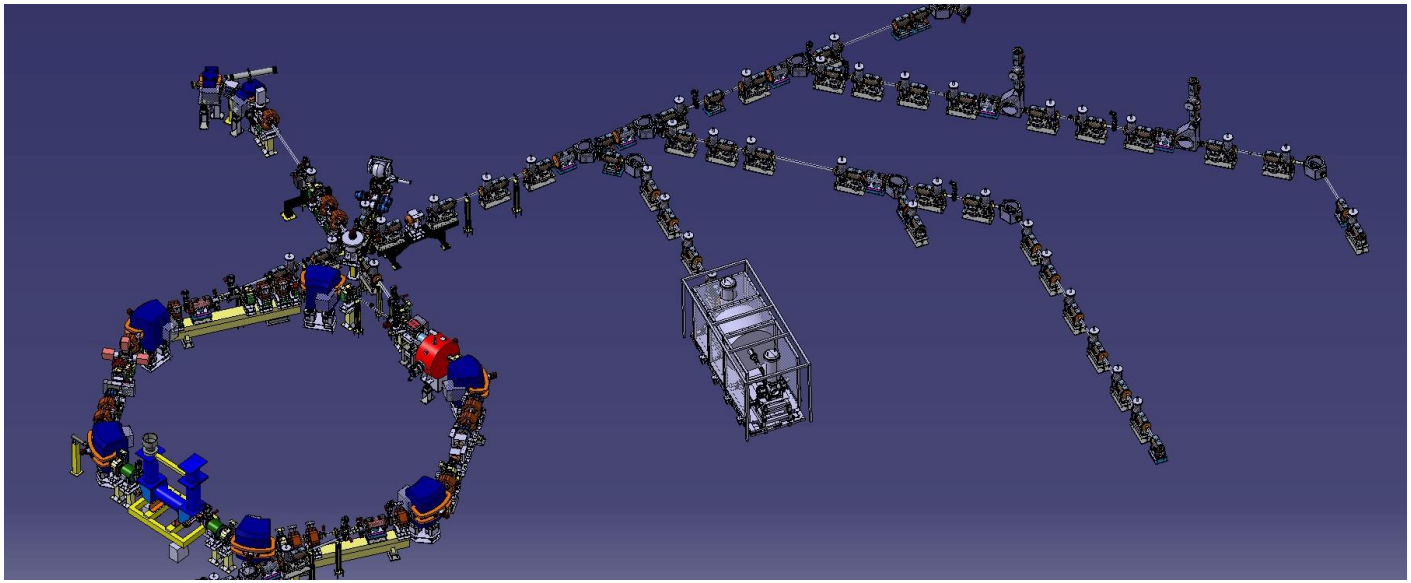
ELENA Project Status

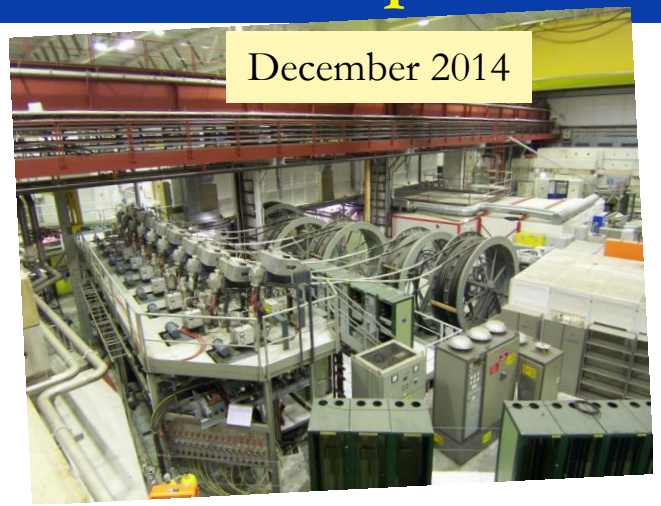
C. Carli on behalf of the AD and ELENA teams

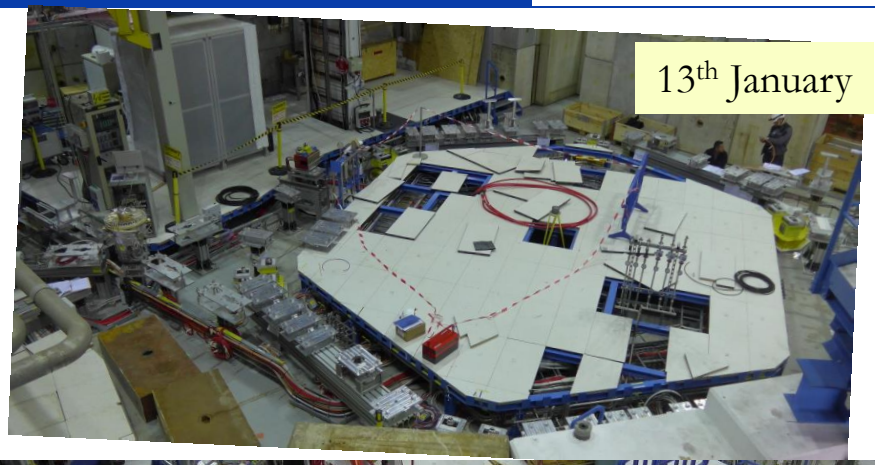
ADUC, 17th January 2017



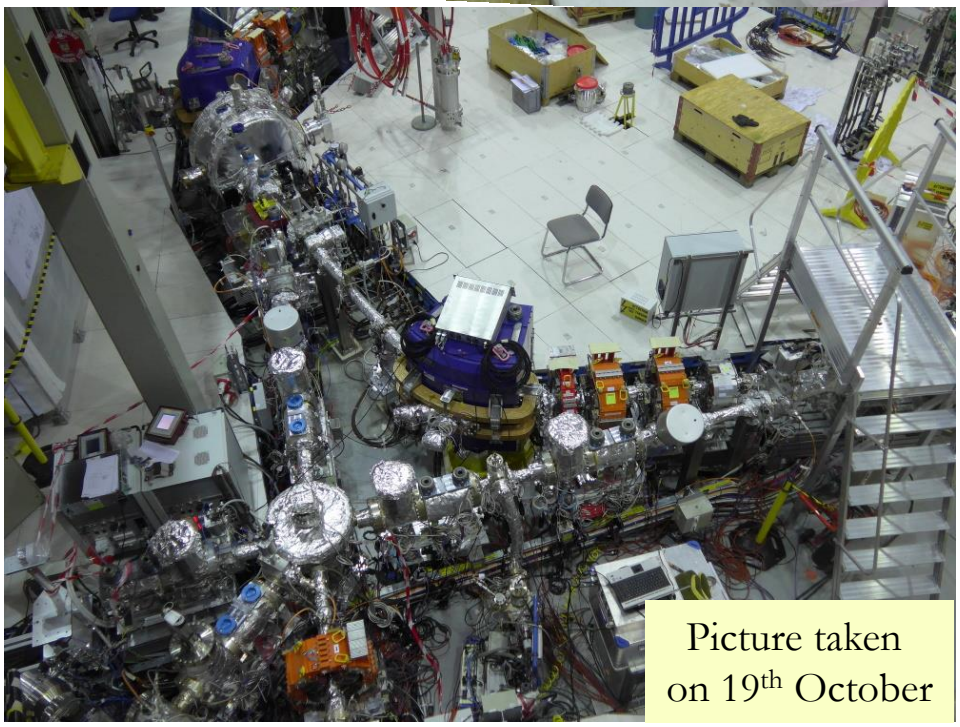
- Installations up to Start of Commissioning
- Commissioning with (brief) and without Beam
- Plans for 2017
- Summary

Installations up to Start of Commissioning (more details in presentation by F. Butin)

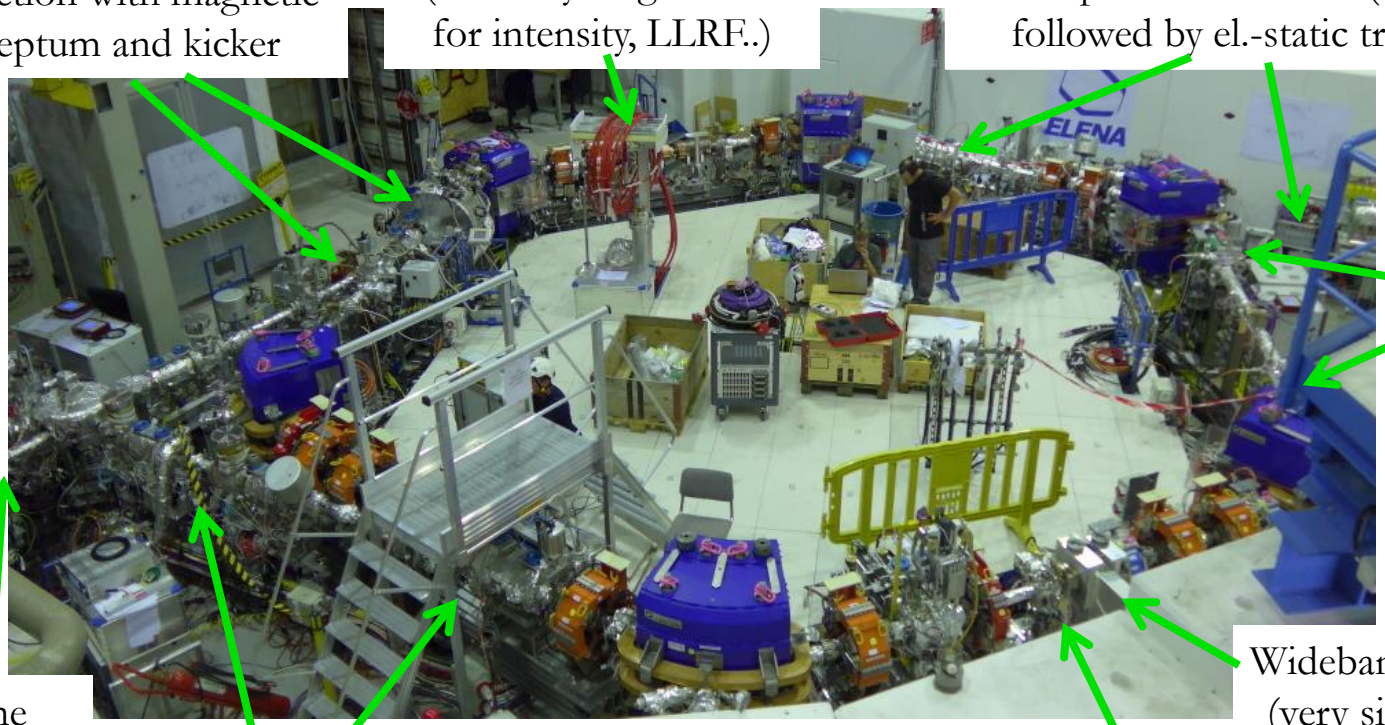




- Hardware (most of the Ring and a few Lines) needed for Ring Commissioning installed, baked and tested
- Ready to start Commissioning with Beam around mid-November
- (Electron Cooler temporarily replaced by simple Tube, will be installed in Spring 2017)



Installations up to Start of Commissioning (more details in presentation by F. Butin)



- Short 30.4 circumference Ring, Challenges due to low (100 keV) Energy and Intensity (low magnetic Fields, Rest Gas Interactions, Beam Instrumentation with weak Signals …)

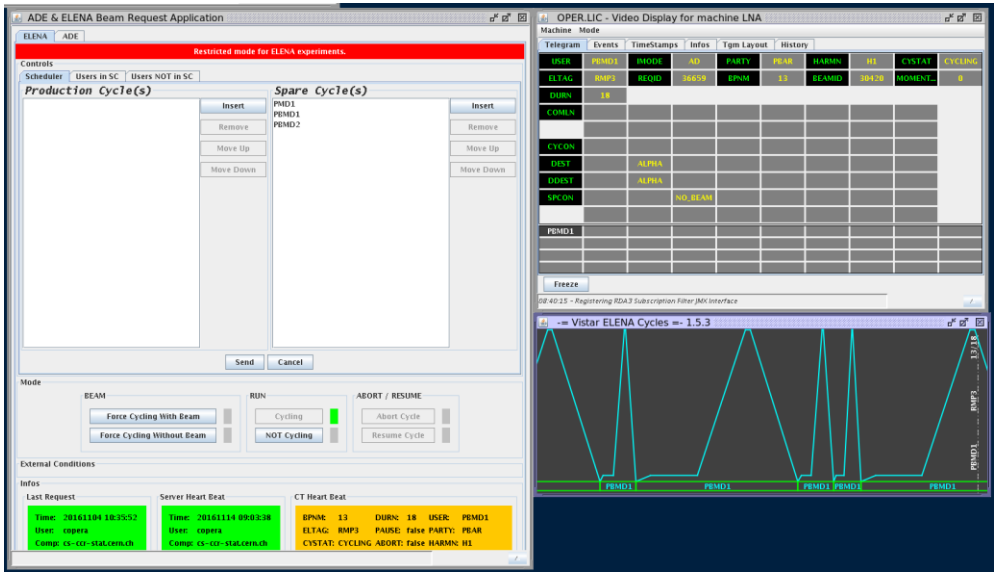
Commissioning with (brief) and without Beam

Last Preparations

- Ring Installations completed around end of September, kicker with "internal leak" (no other short term solution)
- Bake-outs completed end of October for Ring and Beginning of November for Line from Source
- Hardware Tests, Inspections with Safety Unit, Test of the Access System …
- Circuit tests
  - 7th to 11th for magnet circuits (magnets, interlock system and converters)
  - 4th to 11th November for electro-static circuits for transfer lines

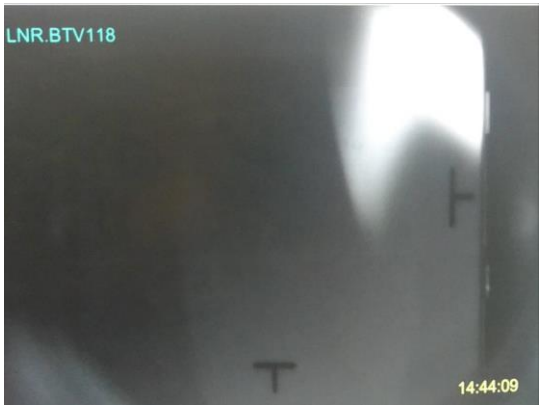
Machine available for Commissioning (with Beam) Team on 14th November

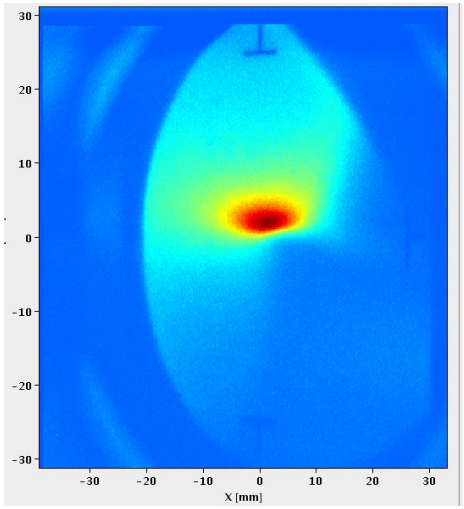
- Still a few Issues to by Solved
- General Sequencing and Timing to be understood



Commissioning with (brief) and without Beam

- On 16th November, Beam observed on "TV Station" between Septum and Kicker
  - Instrumentation (two profile monitors) in Line from Source to Ring not yet available
  - Empirical Adjustments leading to surprising Settings of Line
  - Line Settings to be readjusted often





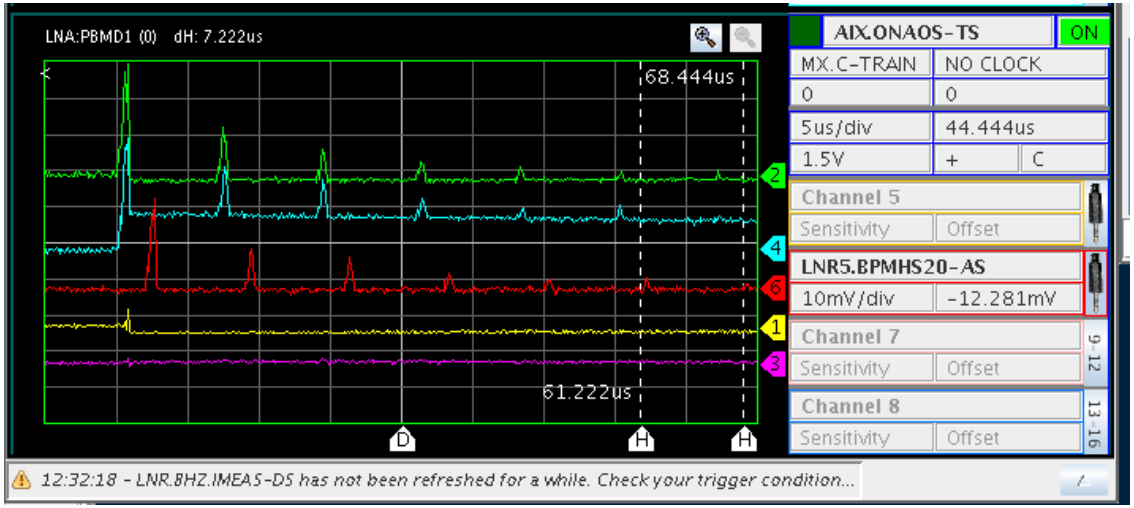
- On Friday 18th November, low intensity remaining for at least a few turns
  - "Only" injection steering
  - No Orbit Correctors required

Position pick-up sum signals
(beam seen a few times spaced by revolution 7 us)

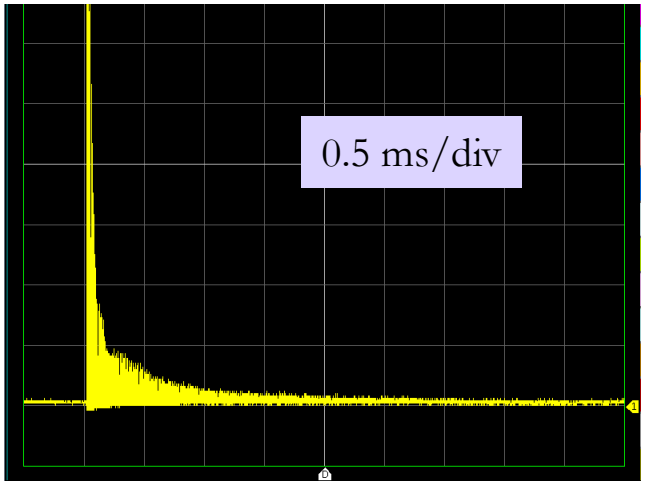
Signal due to losses on Pus
(charging up plates and leading to a signal, which is difficult to interpret)

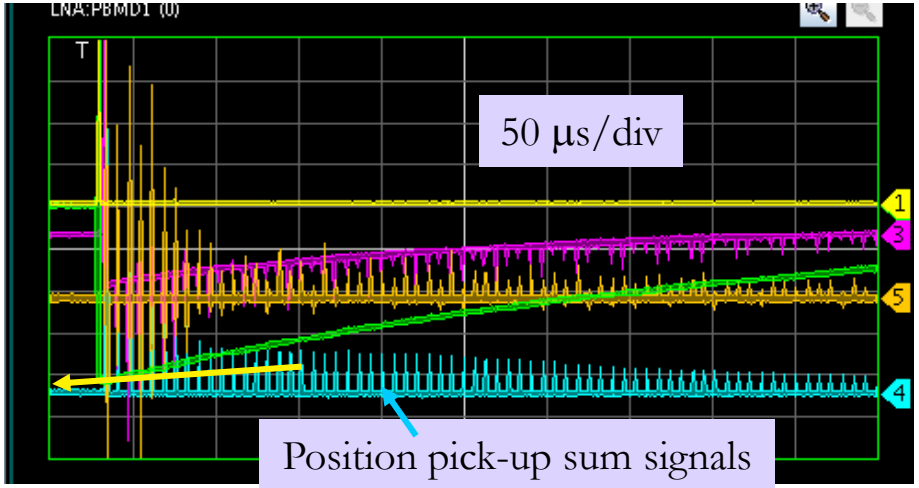
Commissioning with and without Beam

- On 22nd November, Beam observed for a few more turns



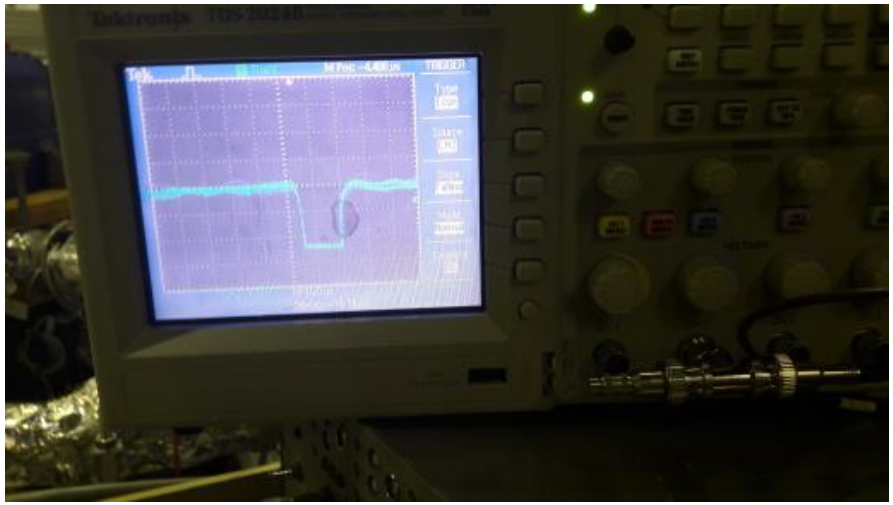
- On 23rd November, beam for 10s of turns and likely a few ms



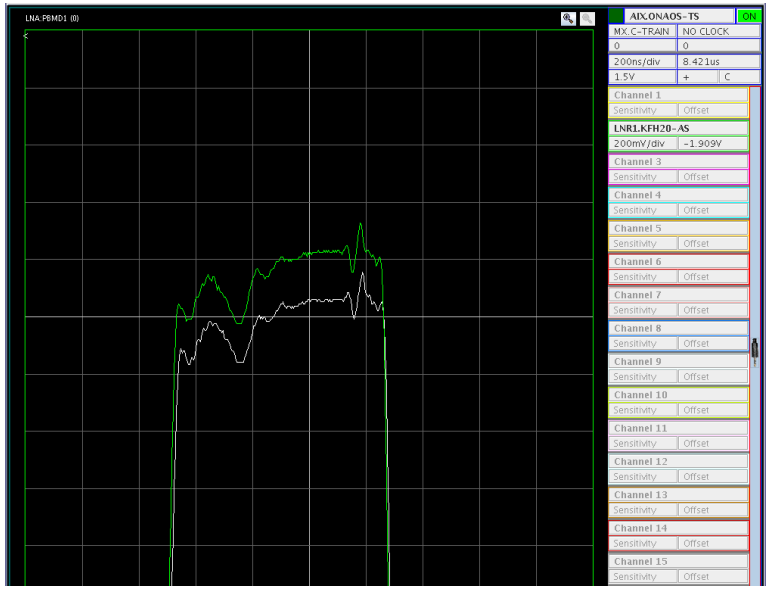


Commissioning with and without Beam

- First tests of the prototype profile in Line from Source to Ring on 24th Nov.
  - Only temporary Head Amplifier connected to Scope
  - Saturation even with lowest H^- Beam Intensities
  - Promising, but still a lot of Work to be done
  - Horizontal Offset seen?



- Injection Kicker shot-to shot Fluctuation found and cured
  - As an example of technical Problems encountered and solved



- On 25th November, Isolation Transformer of Source broke

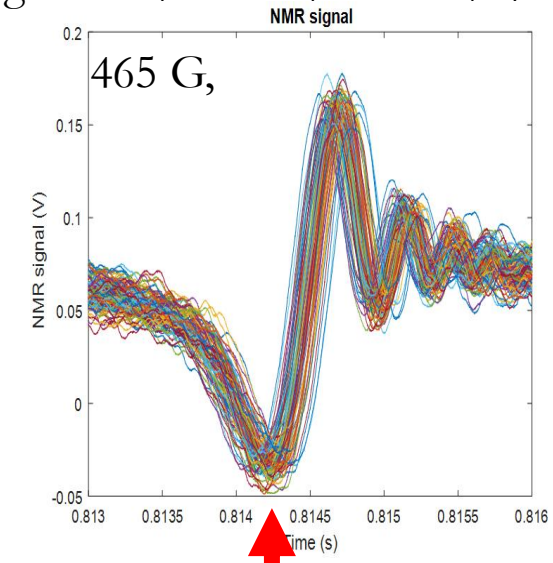
=> No Beam any more before annual CERN shutdown

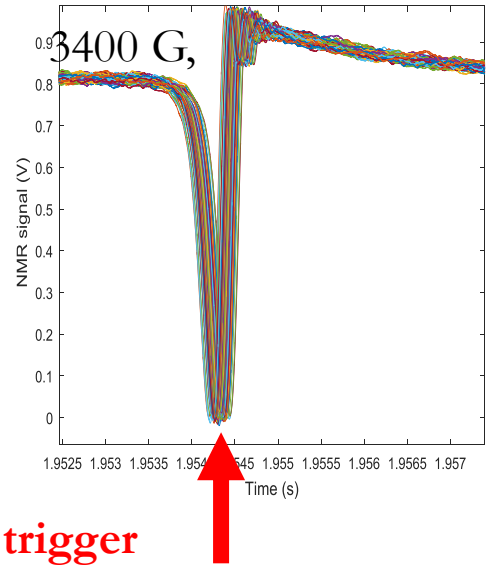
Commissioning with and without Beam

B-train (real time magnetic Field Measurement distributed e.g. to RF)

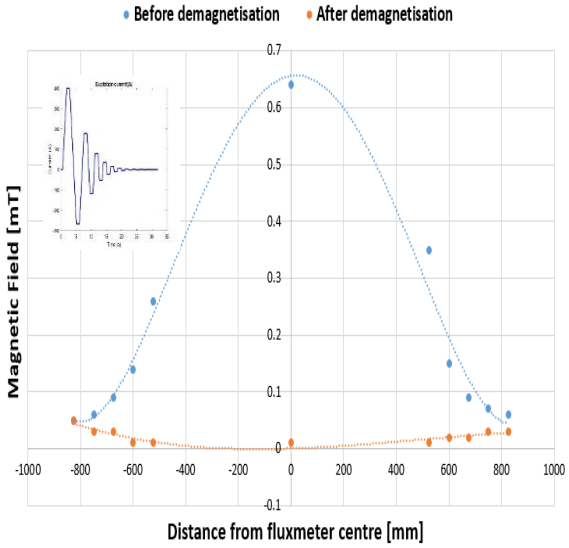
- The B-train system is installed, electronic components are being checked. White Rabbit output is available at the RF rack.
- Nominal calibration coefficients are applied for the time being.
- The reproducibility of the NMR markers was evaluated over 100 repetitions:
  - Low field (465 G, up to 581 G/s): better than 0.15 G
  - High field (3400 G, 2800 G/s): better than 0.15 G

Slide provided by B-train Team





TTL marker trigger



Degaussing reduces the the integrated remanent field from 153 to 0.03 mTm.

Plans for 2017

- Resumption of ELENA Commissioning with Beam expected on 13th February (with Beam from the Source, still without Electron Cooler)
  - Date determined by
    - Upgrades of CERN Control System
    - Maintenance of Cooling Water Station
    - Renovation and Modification of of Control Room
    - Installation of new Isolation Transformer for the Source followed by Source Re-commissioning
  - Activities, Milestones ..
    - Measure hopefully Beam Profile in Line
    - Improve Understanding and Setting of Source to ELENA Ring Transfer Line
    - Commissioning of the (low level) RF System
    - Improve Injection Efficiencies and Understand Beam Survival and Life-time (Easier with bunched Beam once the RF System is available)
    - Orbit Measurements and Correction, Tune Measurement and Correction
    - Orbit Response Measurements (Power H/V Corrector Magnets and Observe Position Changes with Pick-Ups) to understand Machine Optics
    - Test Acceleration, (Re-)Deceleration
    - Commission the Scraper to measure Emittances … .

Plans for 2017

- Installation of Electron Cooler
  - Scheduling depending on Progress and Status of ELENA Ring Commissioning and Availability of Cooler
  - (See Presentation by G. Tranquille for details on the Status of the Cooler)
- Completion of Vacuum Sector LNI-LNE and LNE50
  - Vacuum Sector LNI-LNE comprises lines needed to bring Beam from the Source to the ELENA ring and part of the AD to ELENA Line
  - LNE50 is the short Line towards GBAR
  - Magnetic pick-up (Measurement of extracted Intensity) to be repaired (delicate!!) for LNE50 Line
  - Missing Profile Monitors for both Vacuum Sectors
    - Four Monitors foreseen in Sector LNI-LNE
    - Two Monitors foreseen in LNE50
    - Three Monitors almost completely mounted, many more in the pipeline
    - Vacuum Tests after Mounting
  - Ideally, Installation of LNE-LNE and LNE50 at the same time than Cooler

Plans for 2017

- Commissioning of ELENA Ring with Cooler
  - Again, as much as possible with Beam from the Source
    - Possibly (probably?) with Protons, if H^- Life-Time too Short
  - Perturbation of circulating Beam by magnetic System of Cooler?
  - Optimization of Cooling, Estimates of Cooling Rates and final Beam Properties
- Setting-up of Antiproton Cycle
  - Based on Experience gained with Beams from the Source to reduce Time needed
  - Obtain Machine Cycle as needed for operations
- First Operation for GBAR
  - Beam from the Source to Test Deceleration to a few keV
    - GBAR possibly ready as early as April 2017
  - Later 100 keV Antiproton Beams

Plans beyond 2017

- In 2018 Operation for GBAR (Aim of Project "Phase 1")
  - 100 keV protons, H^- and Antiproton Beams possible

- Implementation of Project "Phase 2" during LS2 (2019 and 2020)
  - Replacement of the magnetic Lines from the AD to "old" experimental area by electro-static Lines from ELENA
    - Dismantling of the magnetic Transfer Lines
    - Installation of the electro-static Lines
    - Commissioning with H^- Beam (does not need to be cooled) from the Source possibly during LS2
  - ELENA Activities to be coordinated with other LS2 Activities (LHC, Injectors …)
    - Proposal from our Side: Installation Work in 2019 to have margi
    - All ELENA Activities communicated (using the "PLAN" tool) to LS2 Committee coordinating Interventions for all CERN Installations
    - Waiting for Confirmation or

- 100 keV Beams from ELENA for all Antiproton Experiments from 2021 on

Summary and Conclusions

- Status at the end of 2016
  - Installation of ELENA Ring (without Cooler) and Lines needed to start Commissioning completed
  - First successful and brief Commissioning Period
    - Beam transported from Source to Ring and circulating for many 10s of turns
- Plans for 2017
  - ELENA Ring Commissioning restarting mid-February interleaved with Installations (Electron Cooler, Completion of LNE50 Line and sector LNI-LNE)
  - Setting up of ELENA Cycles with Antiprotons
  - First 100 keV Beams (first from the Source and later Antiprotons) for GBAR
- Implementation of Project Phase 2 during CERN LS2
  - First ELENA 100 keV Antiproton Run for all Experiments in 2021