The Extra Low ENEnergy Antiproton facility

**Aim:** to extend the antimatter factory at CERN

- Further decelerate the 5.3 MeV antiprotons coming from the AD down to 100 keV
- Increase experiment trapping efficiency up to two order of magnitude

**Timeline:**

- Approved at CERN in June 2011
- First H- beam circulating in the ring by end 2016
- First pbar beam with parameters relatively close to nominal by end 2018
- Installation of electrostatic transfer lines toward experiments 2019-2020
- Commissioning of transfer lines with H- 2020-2021
- Pbar delivered to experiments by mid 2021

ELENA Ion Source: Parameters / Wish list

**Aim:** to mimic antiproton beam for ring and transfer line commissioning

- H- and p beam pulses: ~100 uA amplitude, ~1 us length, 100 keV energy
- Note: only <650 ns-long pulses injectable in ELENA ring by injection kicker
- r.m.s. physical emittance of ~1 mm mrad
- Good shot-to-shot stability and repeatability:
  - order of a few % intensity and emittance
  - order of 0.1% or better energy stability
- Low vacuum contamination to preserve ~10^{-14} mbar in ELENA ring

Intra-pulse and shot-to-shot H+ intensity stability issue

- Original setup had poor instrumentation also due to delays on SEM profile monitors, only now almost operational
- The original Pearson BCT was not sensitive enough to perform single shot acquisition due to background noise
- BPMs in the ELENA ring first revealed this instability, then confirmed with the ring longitudinal pickup (LPU) and finally also on the source BCT thanks to ultra-low-noise amplifier developed at CERN

- Multi-parameter scan revealed that H+ pulse is more stable for very low arc voltages (at the limit of the plasma switching off), but it also provides lower average intensity
- During first tests, a small increase on gas pressure did not seem beneficial
- No higher pressure were attempted not to risk ring vacuum contamination

HV Insulation Transformer Breakdowns

- Designed to run at ±100 kV DC, with 400 Hz power supplies
- No commercial solution for a reliable insulation transformer (several breakdowns)
- In-house driven development may have found a solution (oil insulation, larger tank)
- Also updated the control system to work in pulsed mode (no issues experienced)

Recent Improvements and Future Plans

- Added and improved several instruments for online diagnostics
  - A more sensitive (±100) BCT after the source with the possibility to hold a screen for direct beam spot characterisation and optimisation
  - Online and high bandwidth measurement of e current dumped on the puller
  - Faraday cage HV measurement to allow for HV pulsed operation
- Vacuum leak test of the source was performed showing no major issues
  - Estimated plasma chamber pressure: 4e-5/1.2e-3 mbar for 0/1 sccm gas
- Beam quality and stability in the ring with new settings to be evaluated
- Plans to investigate if H production can be stabilised in other ways:
  - Could a different filament shape be beneficial?
  - Is something wrong with the magnetic configuration of the magnet?