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How to run ions in the future?

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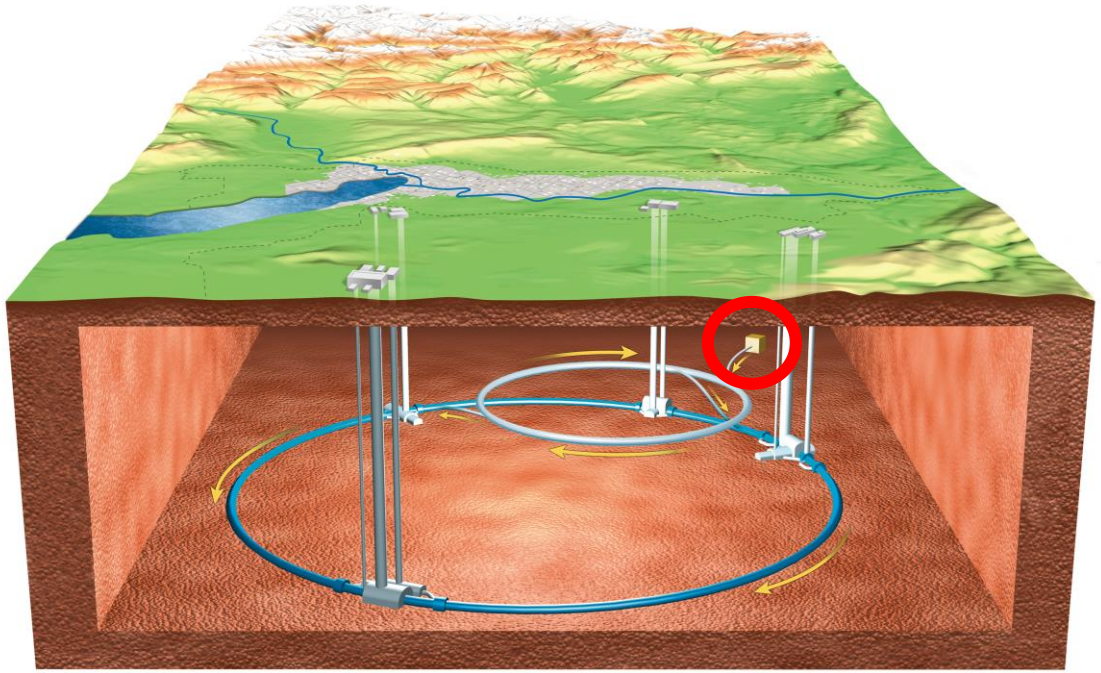
based on discussions with R. Scrivens and D. Manglunki

Outline

- The present performance of the machine
- What could we do to improve the performance?
- The oven for the lead production
- The daily operation
- Final remarks

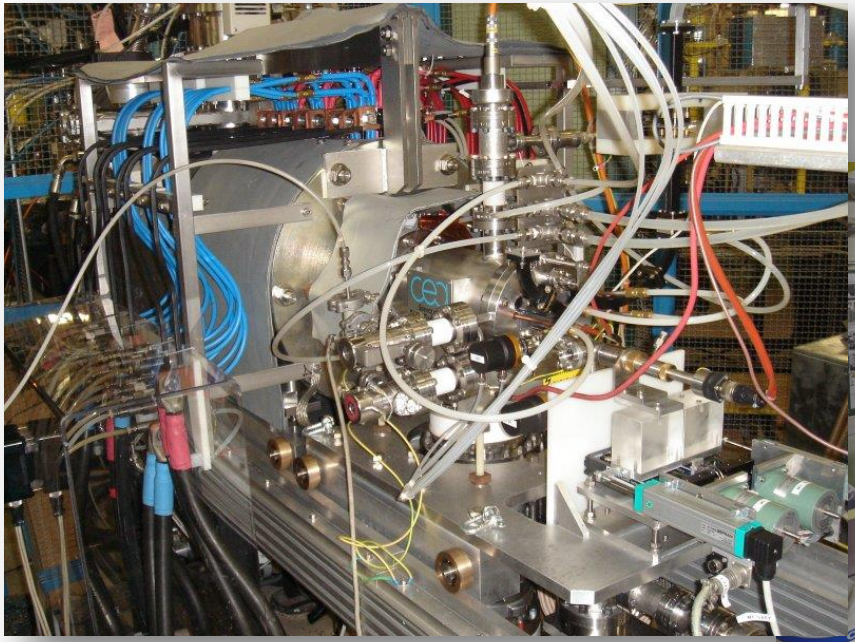
From where the ions start?

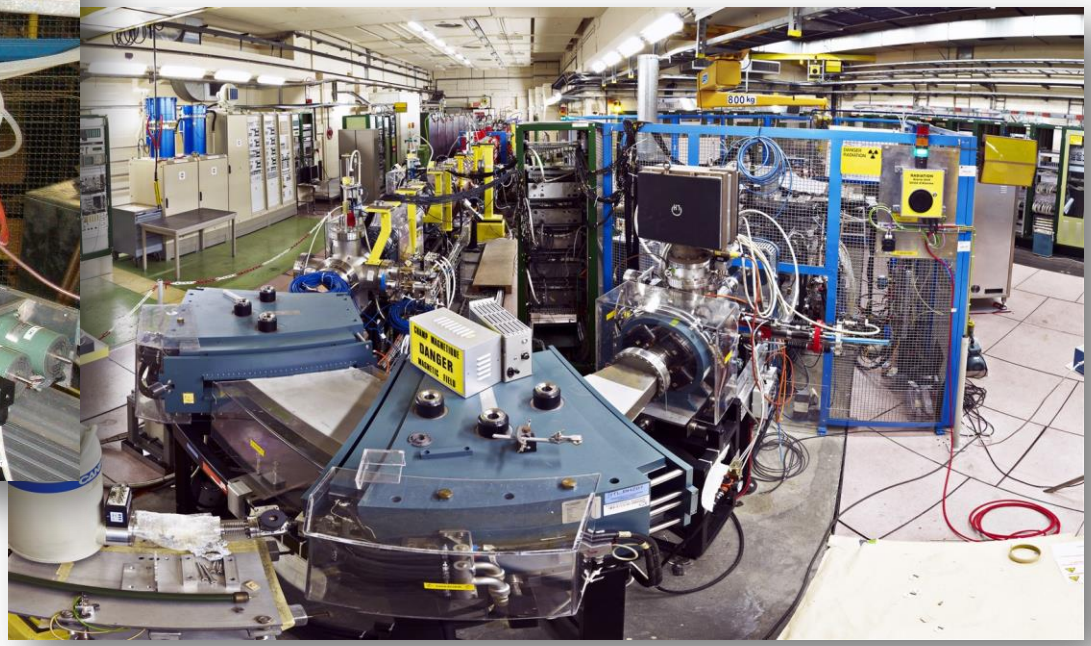
A black box somewhere …



From where the ions start?

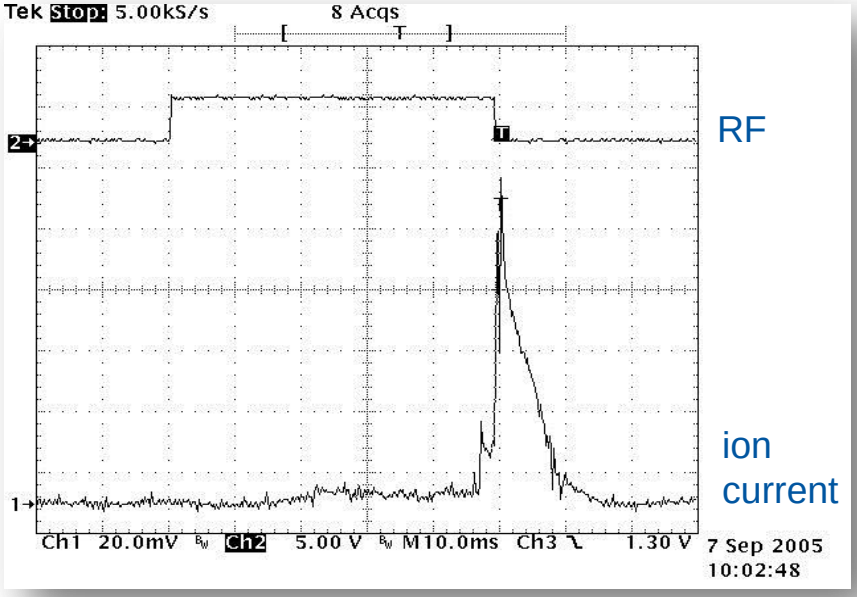
The lead ions are delivered by the GTS-LHC ion source connected to Linac3.





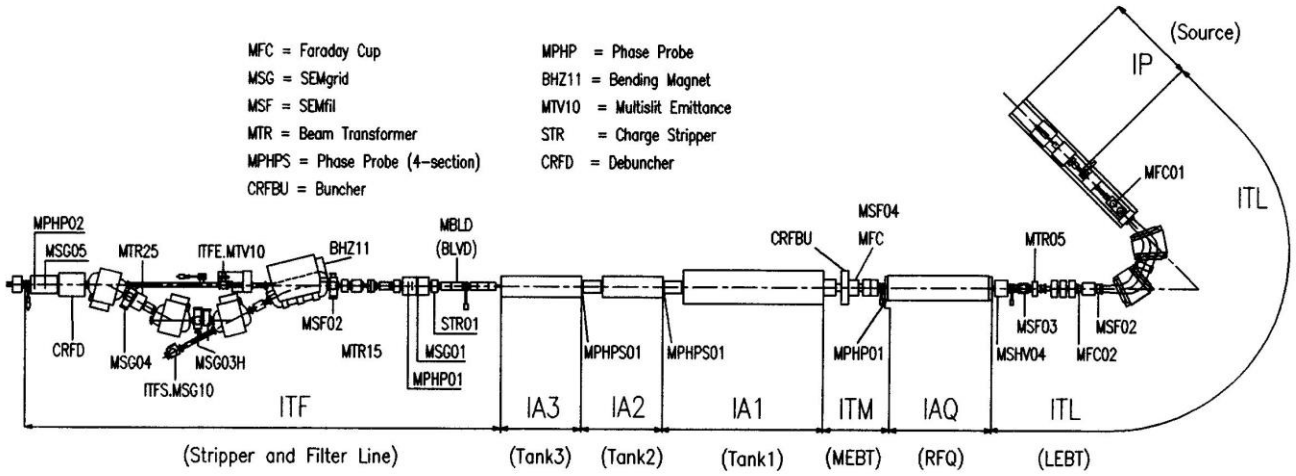
Present operation conditions

- isotope: ^{208}Pb (isotopically enriched material)
- charge states: Pb^{29+} in the linac, Pb^{54+} after stripping
- source type: electron cyclotron resonance ion source (ECRIS)
- source runs in afterglow mode (10 Hz, 50% duty cycle)
- pulse length in the linac 200 µs, up to 5 Hz for LEIR filling



Present performance

- records
  - 215 eμA Pb^{27+} out of the spectrometer
  - 31 eμA Pb^{54+} at the end of the linac
  - but not at the same time!
- operational
  - 100-120 eμA Pb^{29+} out of the RFQ
  - 20-25 eμA Pb^{54+} at the end of the linac (TRA25)
  - ≈ 50% of the design value



Options to study

- improved source extraction system
  - new extraction electrodes and/or adding an einzel lens may improve the source emittance
  - higher extraction voltage may give more beam and improve the transmission, but would need a new RFQ
- improved or new Low Energy Beam Transport (LEBT)
  - reducing the space charge before the charge state separation may improve beam quality and reduce losses
  - the present LEBT is very long resulting in a low transmission
  - a new shorter LEBT adapted to the present source may have a higher transmission

Options to study (cont'd)

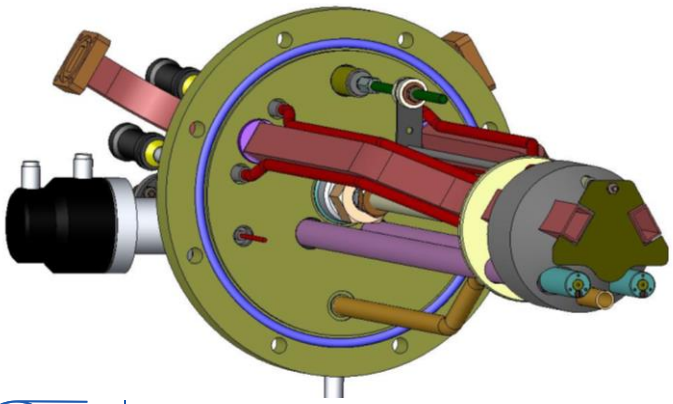
- 10 Hz repetition rate of the linac
  - source runs already at 10 Hz, most of the linac elements designed for 10 Hz, only some power converters in the ITF and the transfer line need an upgrade
  - all foreseen consolidations of the transfer lines take the 10 Hz operations into account
- multi-charge acceleration
  - several charge states in the linac (2 or 3) by "weakening" the charge stage separation in the spectrometer
  - after stripper only one charge state (Pb^{54+})
  - need a test with linac and LEIR in an operational (!) state

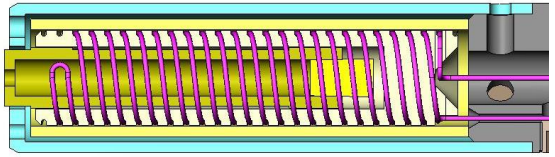
Would a new source solve all problems?

- probably not
- present 3rd generation ECRIS (superconducting magnets, frequencies up to 28 GHz)
  - took more than 10 year to reach the peak performance
  - big emittance
  - unstable beams
- present electron beam ion sources (EBIS) do not deliver enough current
  - but for HIE-ISOLDE a project is ongoing to develop a source based on the RHIC EBIS which could deliver enough current
  - an EBIS has the advantage to switch in principle pulse to pulse the ion species
- new developments do not guarantee the success (e.g. the superconducting magnets for the MS-ECRIS never reached the specifications due to technological issues)

The oven

- two ovens are available during operation
- there are around 1.5 g of lead in the sample, consumption ~2 mg/h
- the 1st oven is good for around two weeks, the 2nd only for an other week (sees some plasma during the first two weeks), flexibility of some days
- at the end of the life time usually the tip of the oven is blocked
- an oven refill takes around 8 h (down time for all machines)





Improving the oven operation

- several filling methods were tested
- only the use of a fresh lead sample in an unused crucible gave some improvements concerning the source stability
- all other methods (e.g. molten lead) even shortened the life time
- an oven test stand is foreseen to study the oven (temperature distribution, relation between oven power and the evaporation of lead)
- the result of the studies may help to improve the oven and source tuning to get long term a more stable beam
- the oven redesign is not excluded, but may include a redesign of the whole source injection side (due to the present constraints)

The daily operation

- 3 experts able to tune and operate the Linac3 source, which needs daily tuning
- they also serve as Linac supervisors
- 4 weeks of LHC running are covered through careful planning, but longer times will need more trained staff (to operate the ion source one needs several years of practical experience!)
- higher operation workload as several parameters with tight limits have to be monitored carefully and request follow-up

Final ~~remarks~~ requests

- need a dedicated lead operation period in 2015 to make tests and verify simulations
- oven test stand in preparation
- dedicated source test stand needed (refused in Chamonix 2006)
  - can be used to test source modifications
  - can be used to train additional source specialists
  - would be roughly 5 MCHF (1.5 MCHF the source itself + test stand infrastructure, LEBT and some partial man power) + 10 man years (for the installation and commissioning)

Thank you for your attention!