HV pulsed power converters for H^- extraction

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Linac4 Ion Source Review
Thursday 14th Nov. 2013

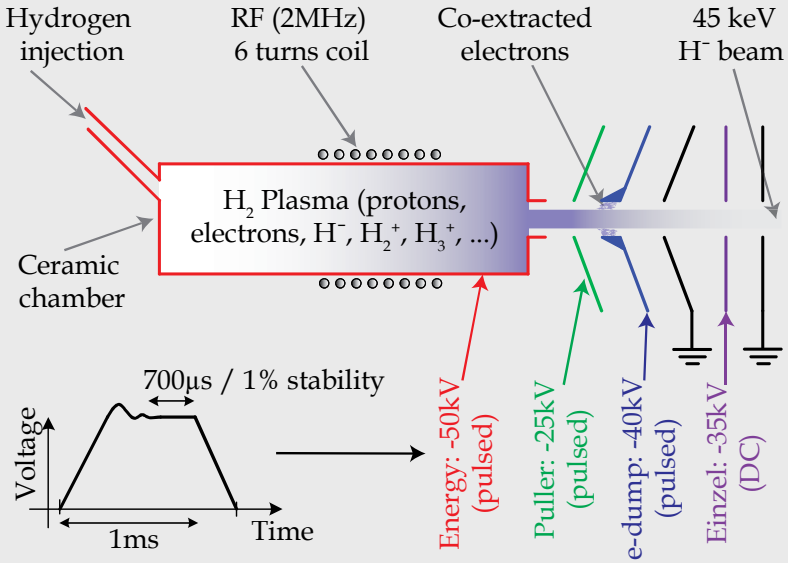
Outline

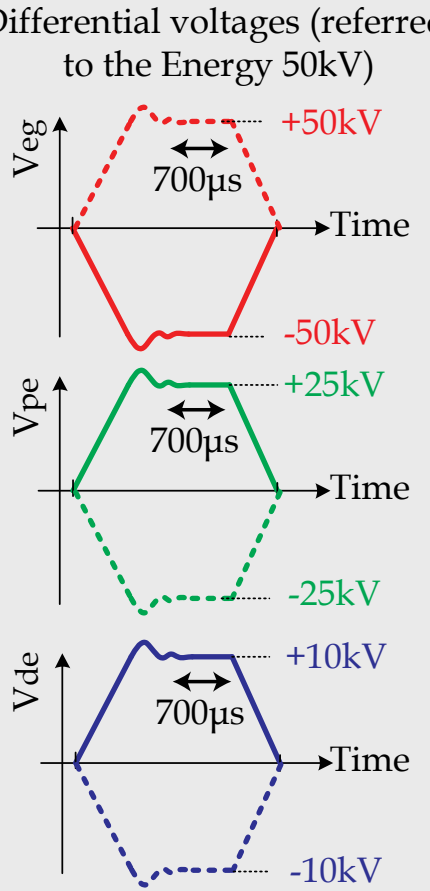
- Achievements & Status
  - System overview
  - Achievements
  - Status
- Future work
  - Control electronics upgrade
- Magnetron power converter
  - Technical solutions
  - Required resources

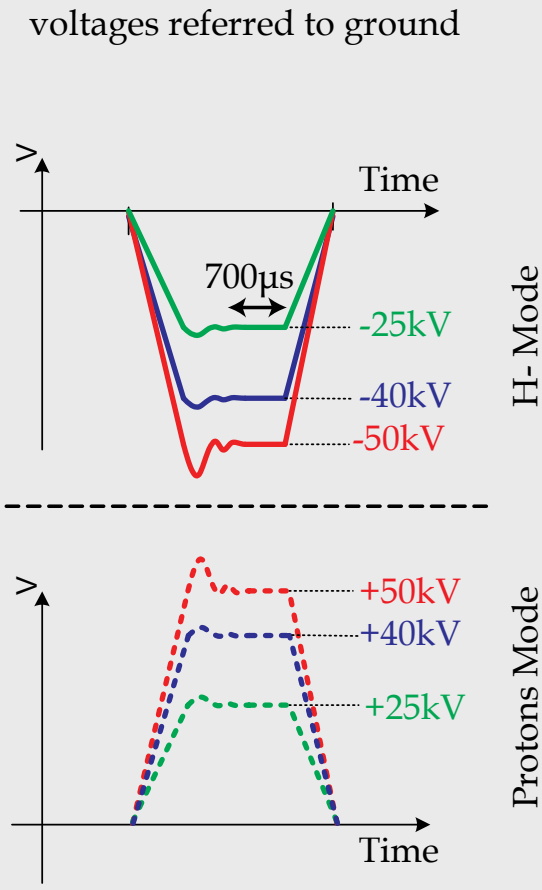
Achievements & Status

System overview

3 HV pulsed power converters for H^- & protons operation (±50kV, ±25kV, ±40kV)
+ 1 DC HV supply for EINZEL lens (±50kV)



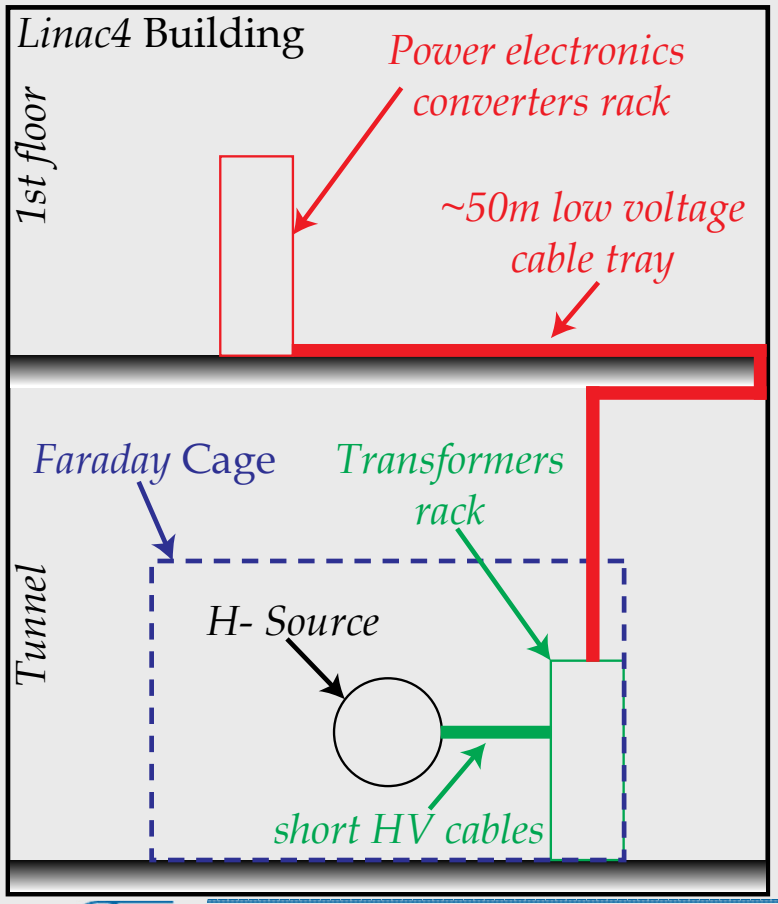


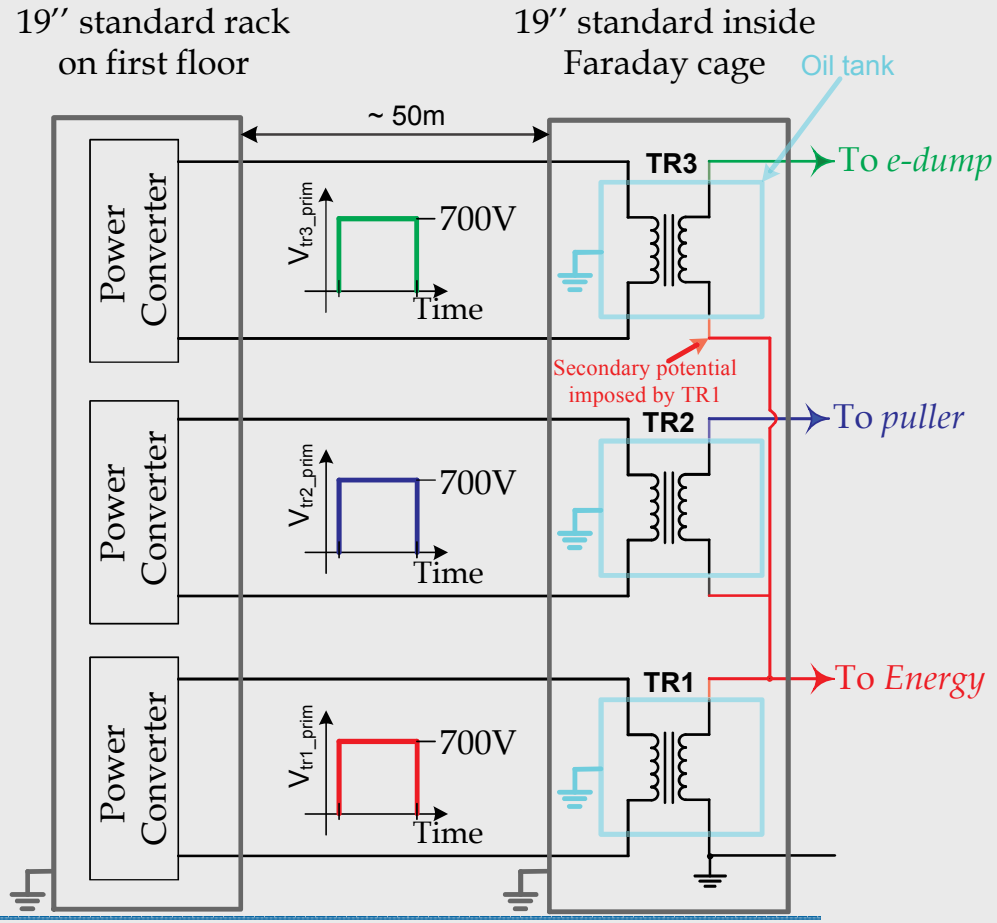


Achievements & Status

System overview

Integration considers fast interventions and passive components only in Faraday cage

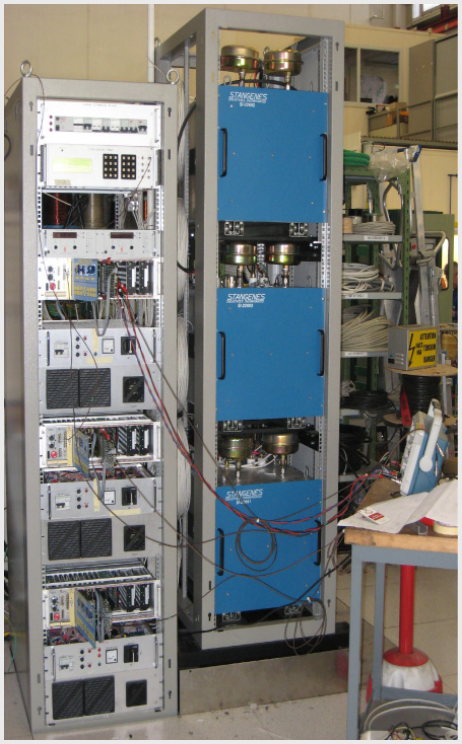


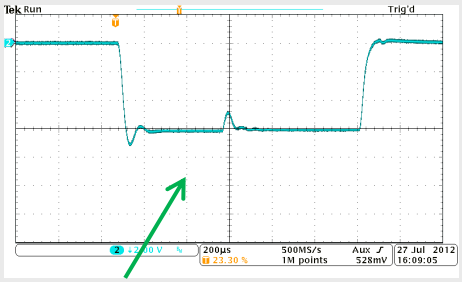


Achievements & Status

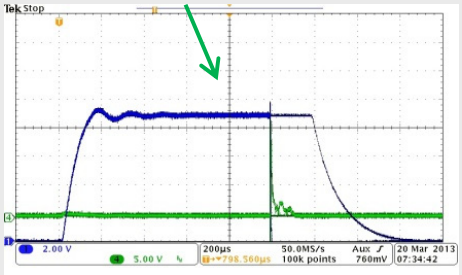
Achievements

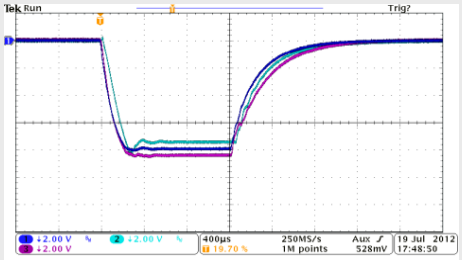
- Laboratory tests concluded in June 2012 as expected.
- Tests included full load and short-circuit tests thanks to a triggerable spark-gap.
- System holds 8 arc events in a row at 2*Hz* rep. rate. Maximal arc energy transferred to the source in the *J* range.
- Beam image current and co-extracted electrons where emulated with a resistance in series with the spark-gap.

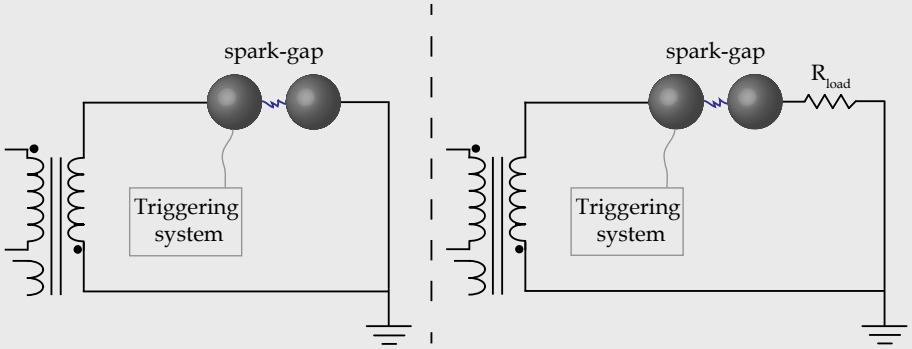




Tests with triggerable spark-gap





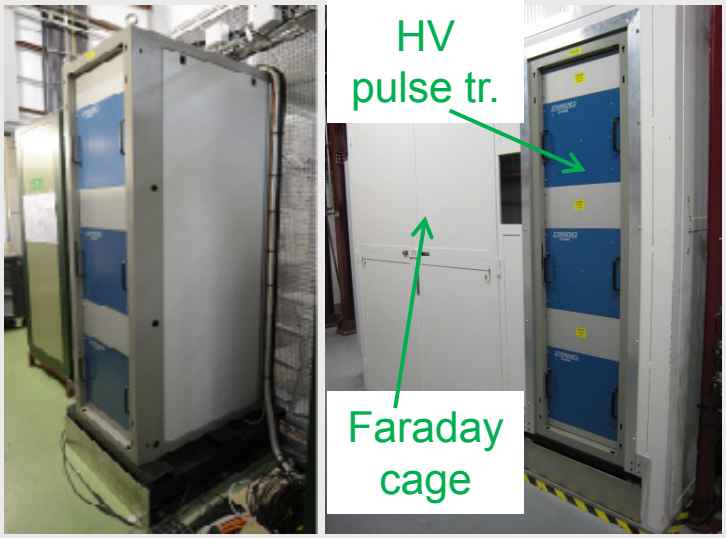


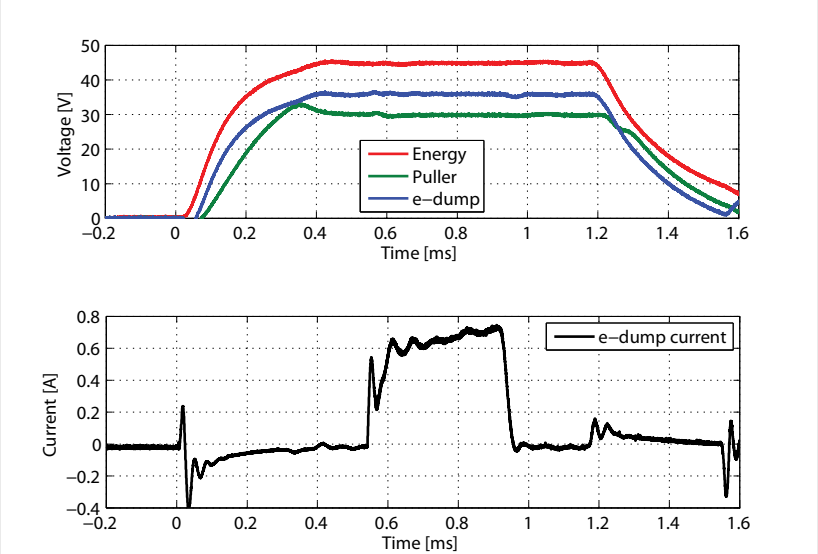
Achievements & Status

Achievements

- Commissioning in 3MeV test-stand in July 2012, 12 months after finalised specification!
- Commissioning in Linac4 Bld in September 2013.
- System meets specifications.
- Performances limited by “old” analogue electronic.

3MeV/Bld 152 Linac4/Bld 400





Achievements & Status

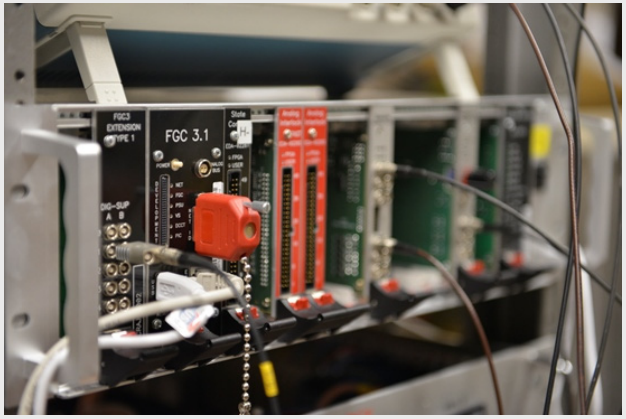
- Crash program challenges:
  - From specifications, DELIVER IN 12 MONTHS!
  - Design and deliver a topologically new power converter
  - First time interconnection made of HV pulse transformers!
  - Special mechanical integration for fast interventions

Achievements & Status

- Status
  - 3 x operational full systems (power electronics & transformers)
  - 1 operating system in L4 and 1 in Bld 152 with “old” analogue electronics
  - Personnel safety, material protection, remote control and basic diagnostics are guaranteed with “old” electronics
  - BIS communication via CIBU not yet available
  - New digital FGC3 electronics under test (first HV pulse regulation in digital control achieved)

Future work

- Status: Budget
  - 640kCHF has been estimated in 2011
  - 717kCHF have been spent: over cost due to change in Einzel lens spec. (from 35kV to 50kV). Estimation accuracy without Einzel spec. modification better than 10%
  - Remaining expenditures ~~~80kCHF
- Control electronics upgrade
  - New control elect. chassis under test – A TE-EPC project.
  - Optimization of digital control loops until December 2013.

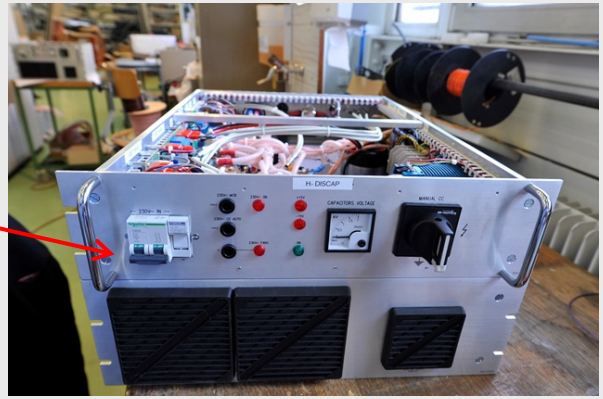


  - Upgrade in 3MeV (~03.2014?) & in L4 during DTLs install.

Magnetron Power converter

- Preliminary technical solutions
  - Prelim. specs: 500*V*, 25*A*, 1*ms* pulse, 10*Hz* rep. rate, 10*μs*-20*μs* rise time.
  - Possibility of re-use a modified version of the developed power chassis for the H^- HV puled power converters – no transformers.
  - Possibility of installing the power electronics and controls in the klystron gallery.

Existing power chassis (7U)
Called H-DisCap.



Magnetron Power converter

- Required resources (preliminary)
  - Personnel: Roughly 4 months FTE (Eng. + Technician), IF the re-use of H-Discap converters is viable
  - Budget: ROUGHLY 80kCHF for 1 operating unit + 1 spare
  - Timing: Roughly 8 months if FTEs available

If technically viable, one spare H-DisCap (3 x existing today) can be used for first evaluations.

Summary

- HV system operational
- Very high reliability, up to now…
- Delay in upgrading control electronics (mid 2014)
- Total budget exceeded (~20%) mainly because of specs changes (Einzel lens)
- Magnetron power converter could be based on existing design

HV System details:

D. Aguglia, “Design of a system of high voltage pulsed power converters for CERN's Linac4 H− ion source*”, in IEEE Proc. 19th Pulsed Power Conference*, San Francisco, 2013, pp. 1 – 6.