How to ensure reliable Linac4 operation for 25 years

M. Vretenar, with input from the Linac4 Workpackage Holders

IEFC Workshop 2010

Foreword

In the present "favourite scenario" Linac4 will become the proton injector for CERN from spring 2015 :

- This presentation will not deal with what is required to keep Linac2 running until 2015 (in principle, only standard maintenance interventions).
- In the same way, this presentation will not deal with what is required to keep the ions running (Linac3).
- Instead, this presentation will examine the experience gained with running and maintaining Linac2, present how this experience has been incorporated into the design of Linac4, and introduce what we can foresee will have to be done on Linac4 to run safely for its first 20 years.

Linac4 compared to the others

The situation of Linac4 compared to the others, using Simon's metaphor…

Where are the other machines

Where is Linac4

Linac2: main consolidations in 32 years

After Linac2 commissioning in 1978:

- 1993: Replacement of ion source and 750kV column with new source and RFQ2 (motivated by need to increase the current for the LHC, but allowed to consolidate the low energy part).
- 1993: New control system.
- 1994-96: Upgrade of quadrupole and steerer power supplies.
- 1996-2000: Upgrade of RF interlocks and controls.

Conclusions:

- Control system has a lifetime of 10-20 years…
- Electronics has a lifetime of 15-25 years (probably less nowadays…).
- Big hardware has a long lifetime, but many problems start to appear after ~30 years…

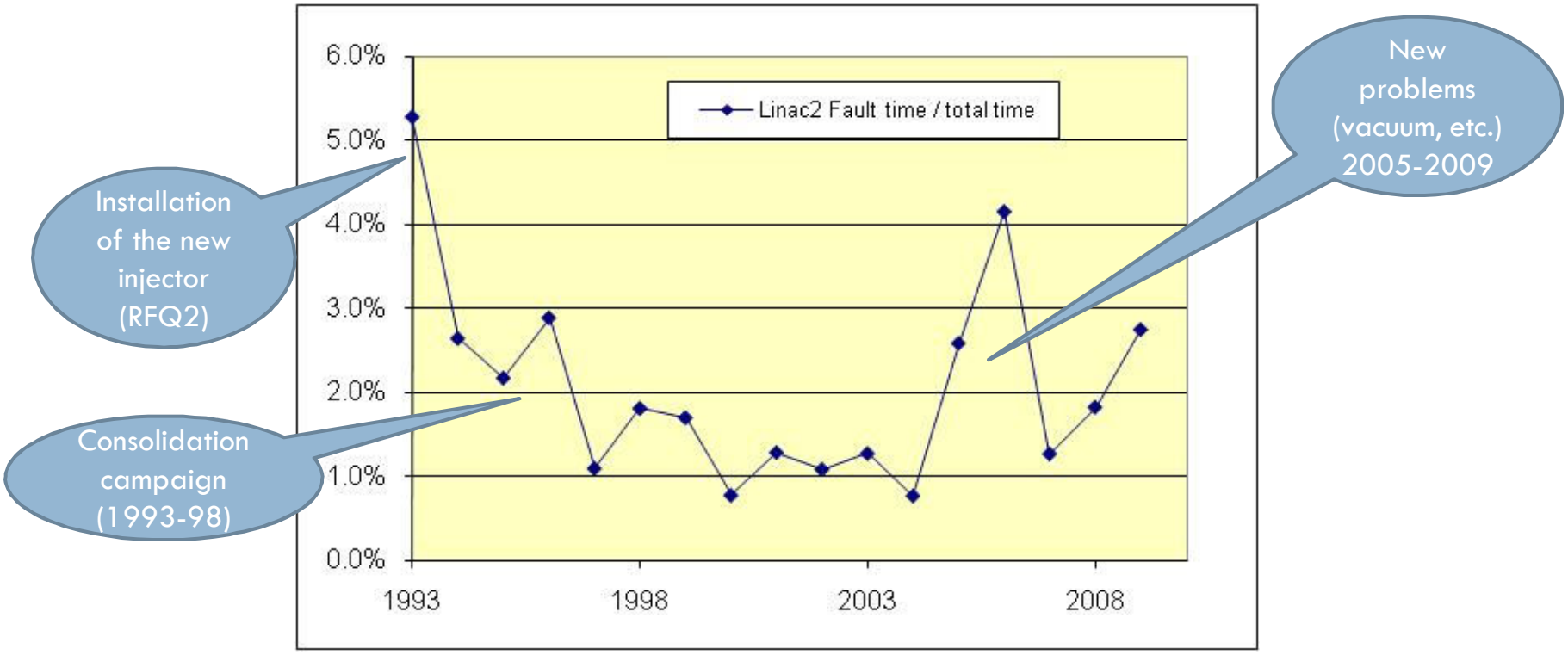
Linac2 remaining concerns

Main remaining problems with Linac2 (and concerns for future operation):

- Vacuum problems in the tanks, due to the particular construction technique (and to the limits of 40 years ago technology, most of the leaks are there from the very beginning!), increasing with time because of thermal cycles and internal arcing. The only solution would be a reconstruction of the tanks.
- Availability of the RF tubes : the TH triodes used in Linac2 are due to go out of production. The only solution would be a complete reconstruction of the RF system.

Linac2 availability

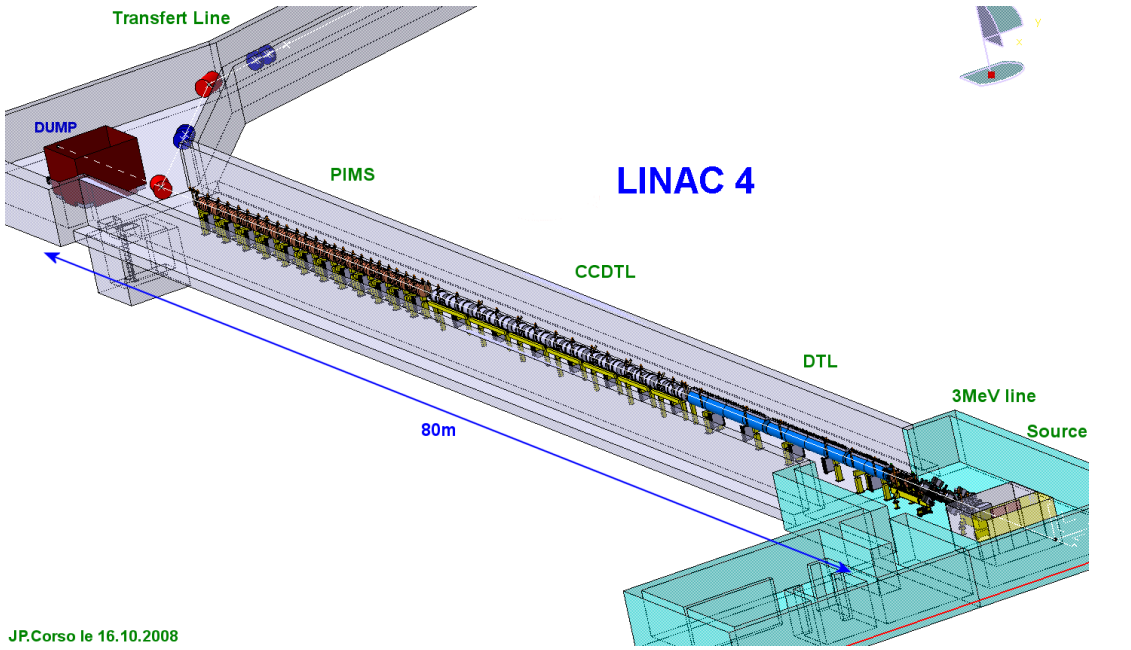
- Linac2 still shows a very good availability for the last 16 years (it is the injector for all of CERN!) but there is a clear degradation in recent years.



Linac4 "sustainability"

Learning from the Linac2 experience, Linac4 is designed to run for 30 years, with:

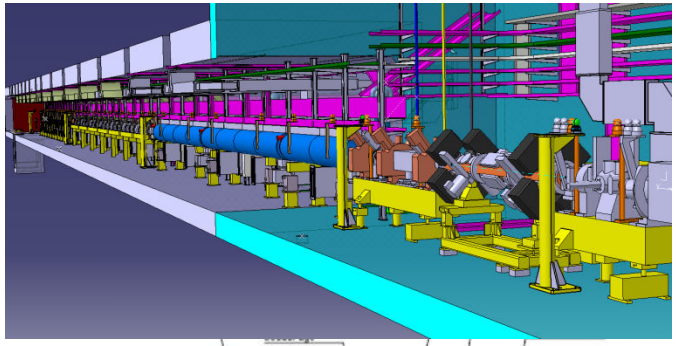
1. An initial consolidation after commissioning (aimed at improving reliability after the first experience in running the machine).
2. Standard regular maintenance during machine lifetime.
3. Usual upgrades of the electronics every 10-20 years (control system, interlocks, etc.)

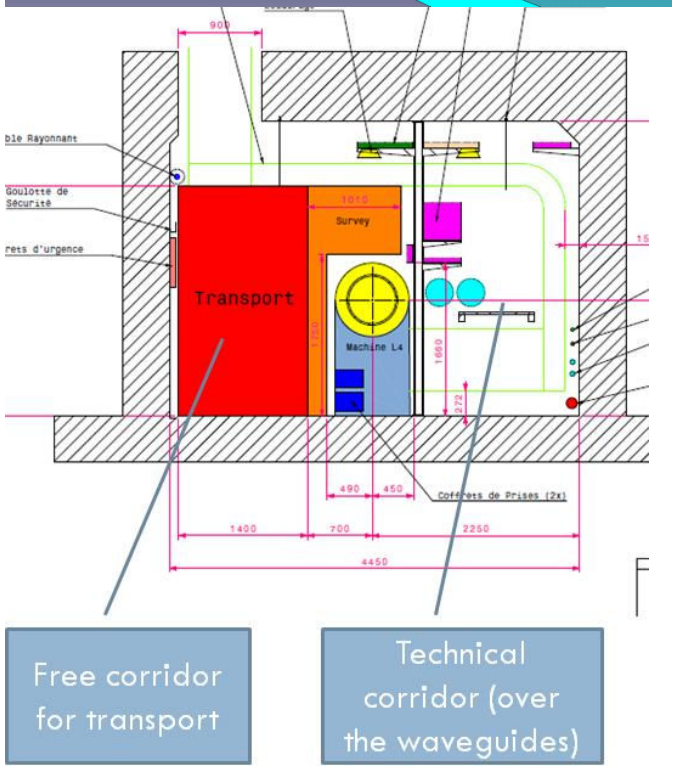


Linac4 “maintainability”

In the design of Linac4, we have taken care to:

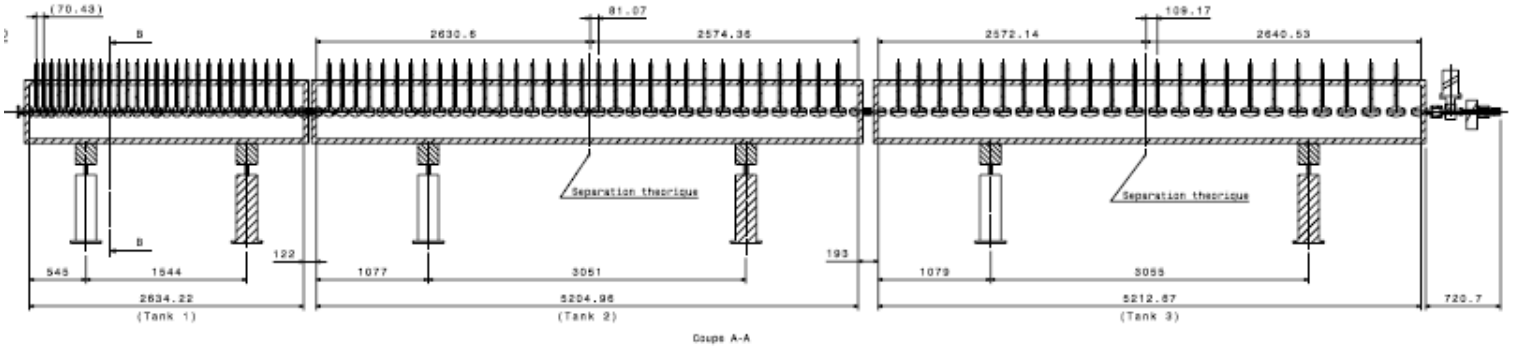
1. Facilitate maintenance: 50% of quadrupoles accessible from the outside (they are inside drift tubes in Linac2), standardised RF components for all the machine (RF couplers, tuners), modular design for all equipment, access to the machine from both sides, etc.
2. Define a general spare policy: the project will provide the same amount of spares that we have in the present installation (for elements similar to Linac2 and for PSB injection), or a “reasonable” amount of spares for new items (to be reconsidered after the initial running experience.
3. Specifically avoid the weak points of Linac2.





Experience from Linac2 to Linac4

- Linac4 is made of accelerating tanks of smaller diameter (352 vs. 202 MHz), made of smaller components with less mechanical efforts from temperature. Copper plating is used instead of copper cladding, avoid the weak point of the cladding welds.
- DTL drift tubes are mounted with a vacuum joint, without precise adjustment: can be removed and repaired in case of problems, for some of them even without taking the tank out of the beam line.



- The RF power is generated by klystrons: we are negotiating the contract for the klystrons, which will likely be split between two suppliers, to ensure competition and long-term availability of the RF sources (the project is ready to take the extra cost!).

Linac4 initial consolidation

After the initial commissioning phase and a reliability test (run for 1 month/24 hours with beam on the dump) we will have a clearer view of what is needed in terms of initial consolidation and where we have to increase the number of spares.

At the moment, we see the following items:

1. Spare chopper driver (~200kCHF)
2. Replace 2 solenoid power supplies (recuperated) with new ones (~300kCHF).
3. Consolidate the power supplies of the LTB line (after BHZ20, max. 430kCHF).
4. Check of the alignment every year for the first 3 year.

Some items will be paid by the project (if required by operation for the PSB) or might be paid by the project with the remaining budget (if any…), other could go to a consolidation budget.

Additional items

In 1991 it was decided to have a complete spare RFQ for Linac2, because of the troubled history of the RFQ2.

For Linac4, in spite of our spare policy, we did not go so far yet (no spare RFQ foreseen).

Next year (2011) we should decide if we want for Linac4 a spare RFQ, but also a complete low-energy set-up (source, beam transport, RFQ) to be permanently installed in the South Hall Test Stand. Construction of 2nd RFQ can immediately follow after 1st one.

Advantages:

- Available set of working spares for the most critical part of our accelerator complex.
- Test bench for improvement.
- Infrastructure already available in the South Hall.

Cost: approximately 1.5 MCHF

Conclusions

- The design of Linac4 is based on the Linac2 experience, aiming at long term sustainability and maintainability of the machine.
- However, we foresee a preliminary consolidation campaign after commissioning, which will be partly covered by the remaining project budget.
- Additional items aimed at reducing risks/down time in the future, as a spare low-energy injector, should be considered and discussed.