Mitigation of a quadrupole failure at Linac 2

• Linac 2 has been in service since 1978.

• The quadrupoles inside the drift tubes are pulse with >300A ~700V every pulse. ~500 M pulses to date.

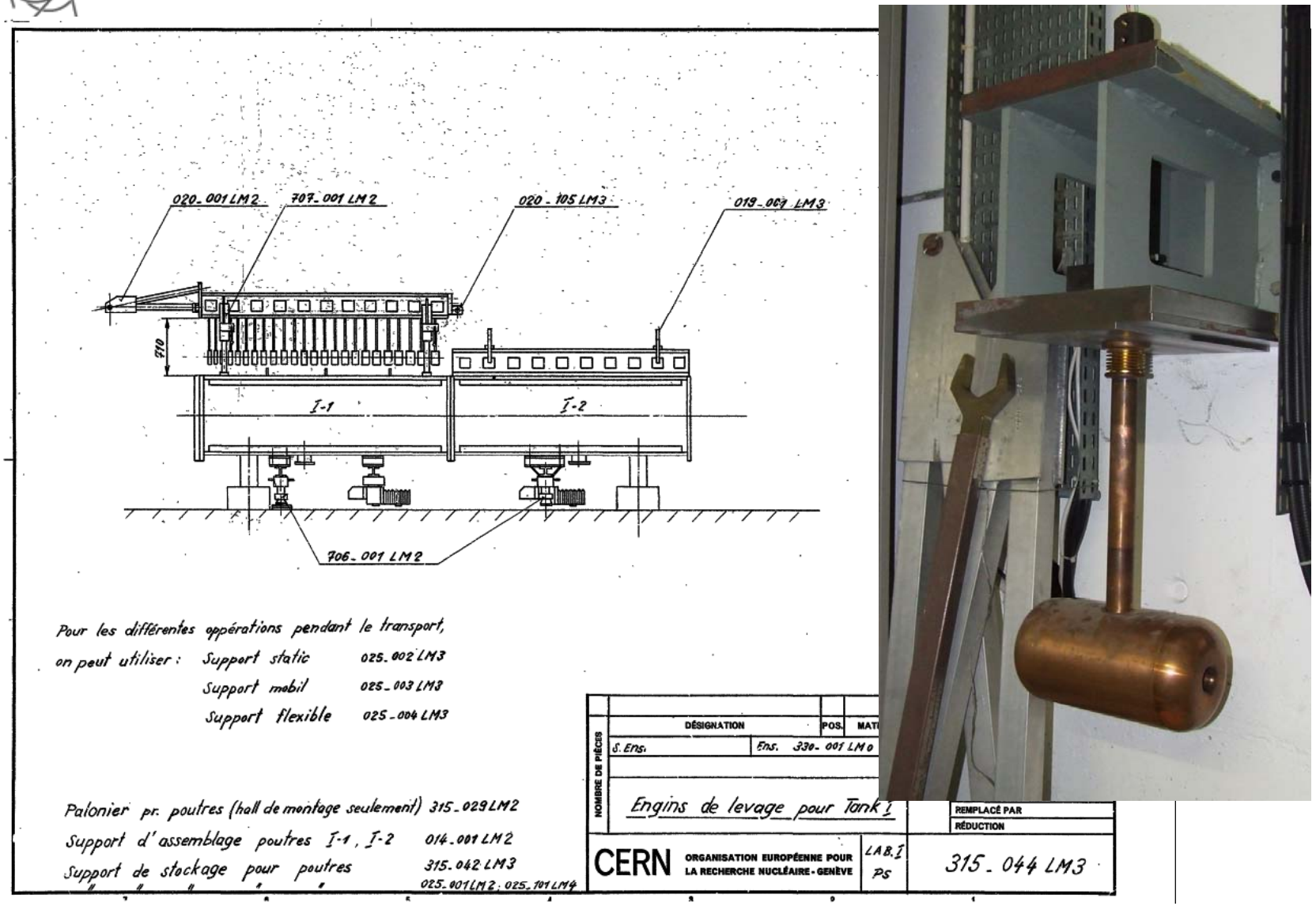
• No maintenance of these ~130 quadrupole circuits (inside the drift tubes) has ever been made.

• DESY used to make tests on the quadrupole circuit insulation. After a while the insulation began to weaken. It was assumed the tests had caused this. CERN's Linac2 quadrupole insulation integrity has never been tested.

• 1 drift tube has a vacuum leak. It is differentially pumped. It is assumed all vacuum leaks can be solved in this way.

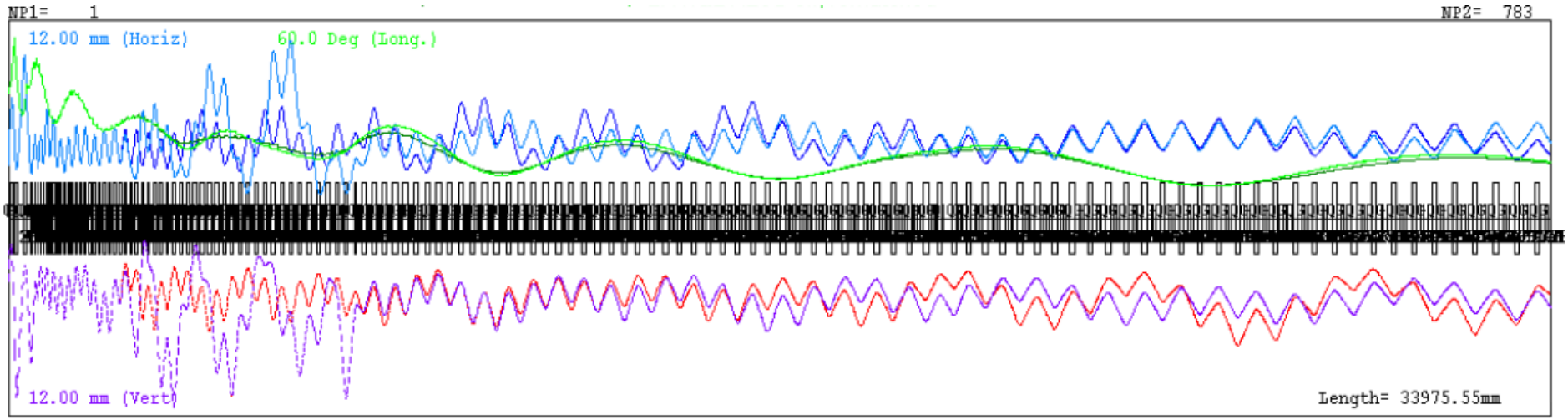
• The crane does not have enough space to lift out the girder to which the drift tubes are attached. (Already remedied.)

• If a quadrupole were to fail (inter turn short, ground fault), we did not know how long to repair.


020_001 LM2
707_001 LM2
020_105 LM3
019_007 LM3
710
I-1
I-2
706_001 LM2
Pour les différentes opérations pendant le transport,
on peut utiliser : Support static 025_002 LM3
Support mobil 025_003 LM3
Support flexible 025_004 LM3
Palonier pr. poutres (hall de montage seulement) 315_029 LM2
Support d'assemblage poutres I-1, I-2 014_001 LM2
Support de stockage pour poutres 315_042 LM3
" " " " " 025_001 LM2, 025_101 LM4
NOMBRE DE PIÈCES
DÉSIGNATION
POS.
S. Ens.
Ens. 330_001 LM0
Engins de levage pour Tank I
REMPLACÉ PAR
RÉDUCTION
CERN ORGANISATION EUROPÉENNE POUR LA RECHERCHE NUCLÉAIRE - GENÈVE
LAB. I
PS
315_044 LM3

- Operation without a quadrupole was simulated (A Lombardi and S Lanzone).
- One failed quadrupole was considered for each tank with a linear optics code. One case was followed up with multi-particle simulations (in tank 1, which should give rise to the highest emittance growth).
- With recabling, high transmission could be retained through the Linac, with the emittance increasing by a factor 2.5 .
- Under the assumption this can be rematched to the PSB, the PSB transmission would be ~50% (for LHC beams).
- Diagnosing the problem, simulating the solution, recabling, recommissioning, and setting up the PSB could take several days. (There is no transverse beam diagnostic in Linac2 in the DTL tanks.)

• Beam envelopes in the Linac2, LA1.QFN25 off, polarity changes and rematching.



• Unless such a fault occurs in the last months of Linac2 operation, or happens in an area where the emittance growth is not as dramatic after rematching, a repair will be necessary.

• Met with experts from AT/MEL, AT/VAC, AB/RF, TS/MME, TS/SU, SC/RP to consider the issue.

• Made a 37 point plan for repair.

• The repair will be an extended event. No figure given yet until the study is complete.

• In order to be able to meet this, studies and tooling has to be prepared in advance.

- Cranes are already installed, with sufficient space to lift out the DTs.

- Areas to be studied (still to be finalised):
  - Pre study plus study of lifting system (crane hook to girder), guiding cylinders, supports, un-sticking the seal.
  - Study of the alignment axis and targets.
  - Study of how to remove DT from the girder. Design of tooling.
  - Inventory of available spares (bellows, collars).
  - Study of repair (to open and close the drift tube).
  - Study of tooling for drift tube leak test.
  - Study of tooling to leak test the drift tube to girder seal.
  - Verification of seals (AT/VAC).
  - Study of preventative varnishing on liner (AT/VAC)
  - Check of spare magnets (AT/MEL)
  - Procure copper for repairs.

- The follow up of these actions requires time and money.
- Linac4 schedule has again shifted 1 year. Linac2 WILL BE the pre-injector for LHC for the next 5 years.
- Even with the preparation, the repair to Linac2 will be ~x weeks.
- Without this preparation phase, considerable additional time would be necessary to validate and produce tooling.

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