

KLOE magnet test: Cryogenic System

G. O. Delle Monache

DUNE Italia Collaboration Meeting

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Istituto Nazionale di Fisica Nucleare



KLOE magnet test: Cryogenic System

Objectives:

1. To cool down and energize the coil up to some hundreds Amps in order to verify that “all systems are go!” after the roll out from the DAPHNE hall before the shipment. Repeat the test before re inserting the coil in the yoke at installation site
2. Optional - commissioning of subsystems that possibly underneath an upgrade or service before the shipment (PS; CS + DAQ; probes etc.)

Test options:

- a. Re-connect the magnet to the KLOE dedicated LINDE cryogenic plant.
- b. Magnet directly filled with cryogenic liquids

a) Magnet CD using the LINDE cryogenic plant.

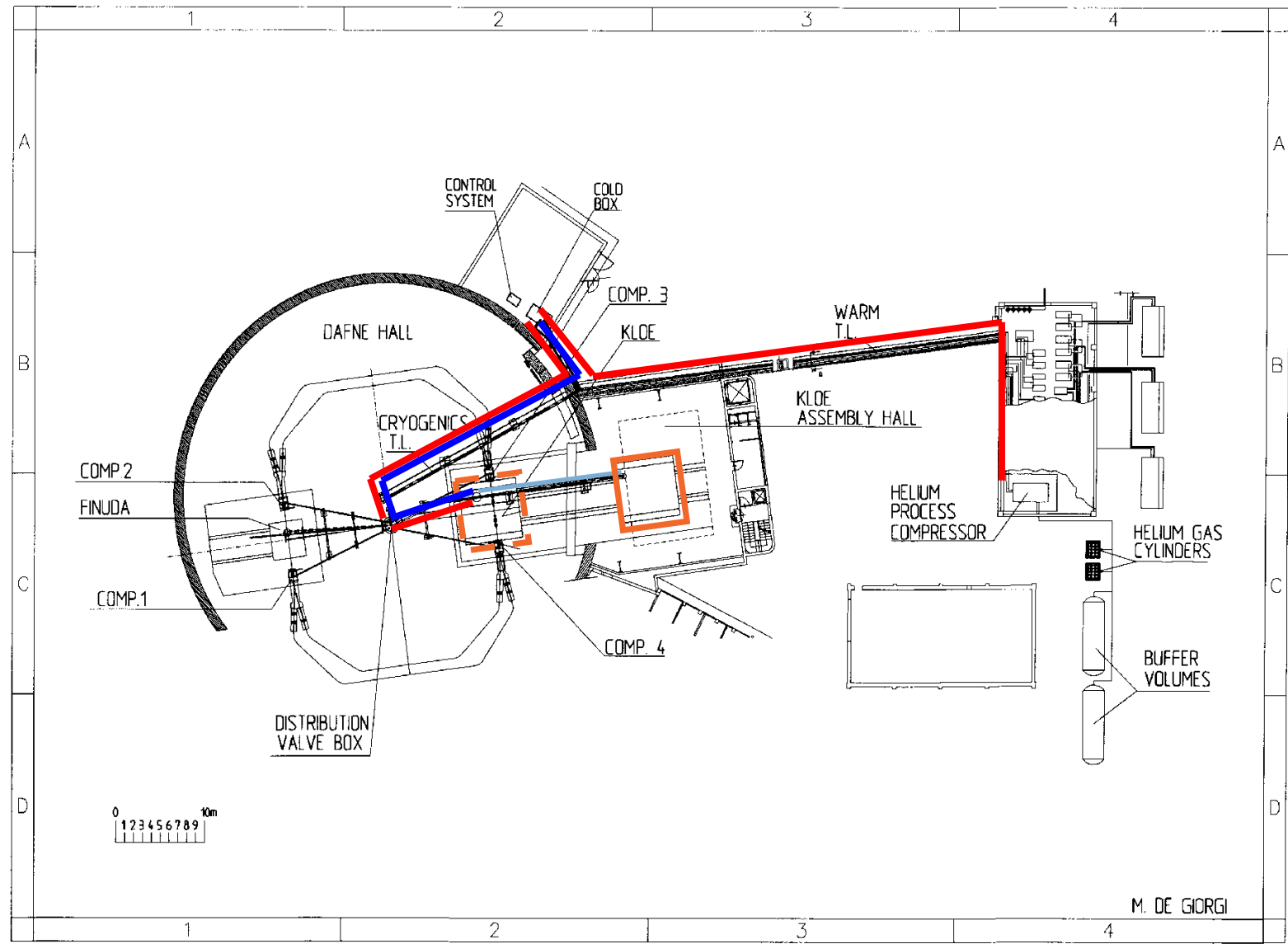
Pros

- Well known process, performed several times by LNF personnel from 1998 to 2018

Cons

- Requires nontrivial re-installation/re-manufacturing of KLOE TL + bridge extension
- Requires full re-installation of the fluidic subsystems
- Requires cryo plant to be put back in service after 5 years just for a few weeks' operation
- Most of the listed HW and services not useful to repeat the test in the US

Cool downa Option a



b) Magnet CD using cryo liquids

Pros

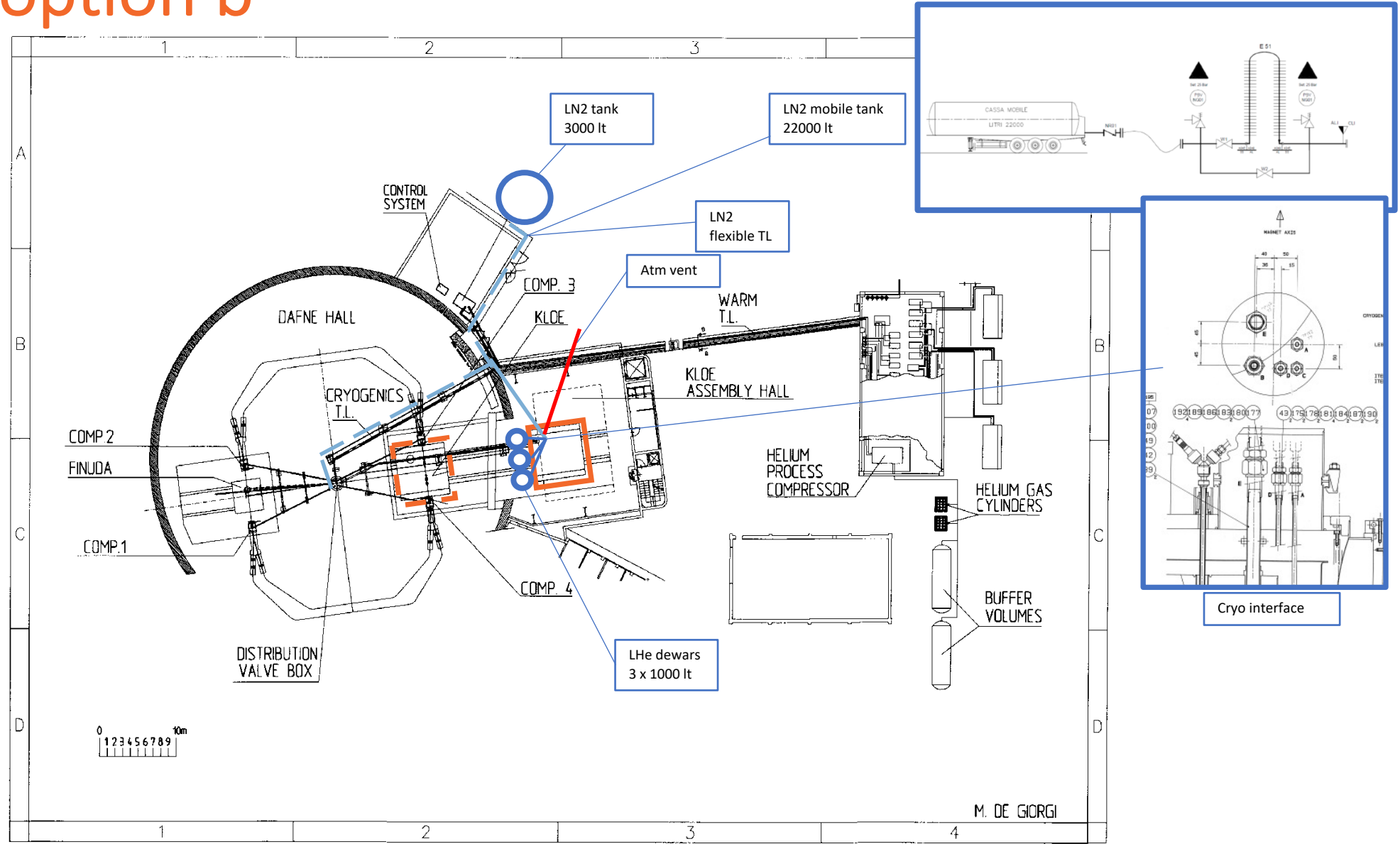
- Requires very limited re-installation of the original fluidic subsystems
- LN2 flexible TL already in place (with 3000 lt LN2 tank for preliminary test)
- LHe dewars available in house (3x1000 lt)
- Requires the manufacturing of noncomplex cryogenic interfaces
- The HW is self consistent to repeat the test “keys in hand” before magnet re-integration in the yoke in the US

b) Magnet CD using cryo liquids

Cons

- Process performed only once in Oxford by Oxford Instrument personnel before 1996
- Cryogenic liquids requirement estimated from LINDE T-S diagram
- To extend/repeat the test does increase the costs consistently

Cool down option b



Cool Down from 300 to 100 K - 2 weeks

Cryo liquids requirement

A preliminary estimate of the LN2 and LHe quantities needed for the CD is based on the parameters of the CDs of the magnet with the Linde system.

The magnet was cooled by mixing GHe 300 K - 77 K.

At the end of the phase (two weeks) the flow meter of the 77 K line was beyond scale limit, we can estimate a flow of 6 g/s at 6 bar.

Therefore, considering the average value of 3 g/s with a $\Delta h = 1200$ W (NIST), we obtain $\Delta H = 3600$ W equivalent to 18 g/s of LN2 LN2 \approx 22.000 kg \Rightarrow

26000 liters x 1.5-2.0

Cool Down from 100 to 4.4 K - 3 days

The magnet was cooled with a GHe 77 K \approx 2 bar line (screens), and a SC 5.4 K line at 3 bar (coil).

Hypotesis:

1. 50% of nominal power @ 77 K to the screen \equiv 450 W 2.25 g/s of LN2
(see T-S Linde diagram)

Total LN2 \approx 600 kg \Rightarrow 720 liters

2. 2/3 of nominal power @ 4.4 K to the coil \equiv 2 g/s LHe

Total LHe \approx 520 kg \Rightarrow 4000 liters

Magnet Cold a 4.4 K - N days

LN2 \approx 240 liters/day

(450 W)

LHe \approx 700 liters/day

(1 g/s)

Procurement and costs estimate

- Cryo interface connecting the LN2 and LHe lines to the magnet turret + exhaust He and N2 lines **(quoted)** 50 kEuro
- 30.000 liters of LN2 + 4/6 weeks of renting LN2 mobile tank + manufacturing of evaporator to control the LN2 T inlet to the magnet 80 kEuro
- Interface for the connection of the DAFNE compensator TL to the mobile tank + its redeployment 30 kEuro
- LHe 6000 l x 25 Euro/lt 150 kEuro

Order for the revamping of 3 dewars 1000 lt each already placed

Test start: milestone to be set between November 2023 – February 2024

Procurement



SOCIETÀ ITALIANA ACETILENE E DERIVATI
S.I.A.D. S.p.A.
24126 Bergamo, Italy - Via S. Bernardino, 92
Tel. +39 035 328111 - Fax +39 035 315486
www.siad.com - siad@siad.eu
Capitale Sociale - Share Capital € 25.000.000 i.v. - paid up
P.IVA, C.F., Reg. Impr. Bg - VAT and Fiscal Nr.: (IT) 00209070168
R.E.A. BG-15532 - Export: BG 000472

Bergamo, 3 novembre 2022

Oggetto: nuovo *shortage* Elio

Gentile cliente,

La informiamo che a causa di imprevedibili ed eccezionali eventi globali, i prossimi mesi saranno caratterizzati da un nuovo *shortage* di Elio, che interesserà trasversalmente tutti i mercati mondiali.

Anche i nostri fornitori ci stanno confermando le riferite criticità, anticipandoci, nel contempo, contrazioni e/o annullamenti delle forniture già calendarizzate.

Come di consueto ci siamo prontamente attivati per tentare di mitigarne gli effetti sulla nostra utenza che, tuttavia, stante l'entità del fenomeno, potremmo non essere in grado di soddisfare nei volumi o nella tempistica richiesta.

Nelle prossime settimane, la nostra rete di vendita potrà fornirvi maggiori dettagli circa i possibili effetti della circostanza di forza maggiore sui nostri approvvigionamenti. Nel frattempo, vogliate comunque tenere in debita considerazione la criticità nella programmazione delle Vostre attività.

Restando a disposizione per ogni necessità o chiarimento, porgiamo distinti saluti.

SIAD S.p.A.

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Questions?



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