Crab cavities
Cryogenics progress for the SPS

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6th HiLumi Annual Meeting – Paris – 15 November 2016

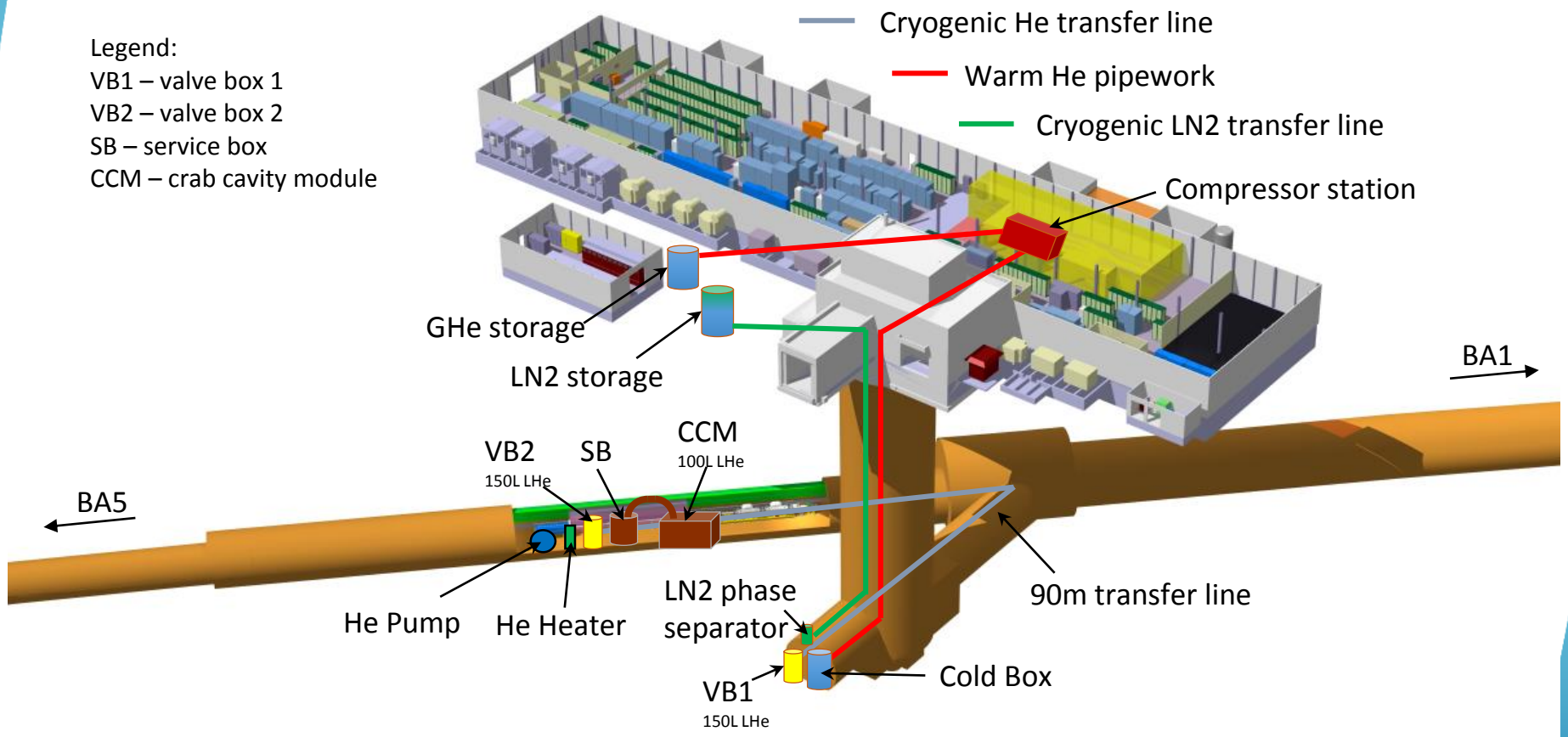
Outline

- Introduction – general layout
- Progress status for main cryo sub-systems
- CC module cryogenics
- Safety aspects (Nitrogen-Helium)
- SM18 cryogenics – status
- Conclusion and final remarks

BA6 general cryogenic layout

The SPS cryogenic infrastructure will be composed of Helium circuit and Nitrogen circuit

Legend:
VB1 – valve box 1
VB2 – valve box 2
SB – service box
CCM – crab cavity module



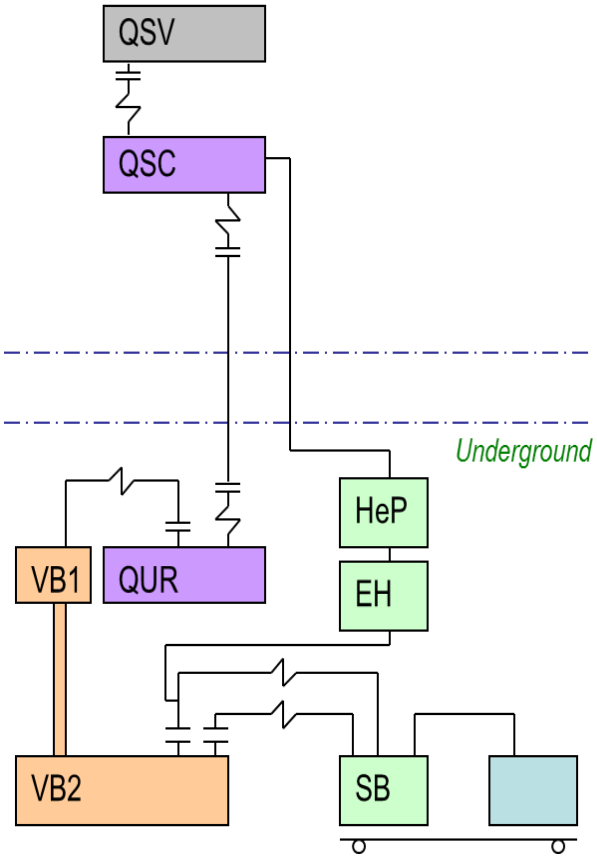
Helium main systems – status

The procurement of cryogenic infrastructure for BA6 was divided in three main subsystems:

1. Production plant (QSC+QUR) – IT4188
   status: offers received, preselection done, contract signature in one month (letter of intent in preparation)
   requested delivery for YETS 2017/18 (tight but realistic)

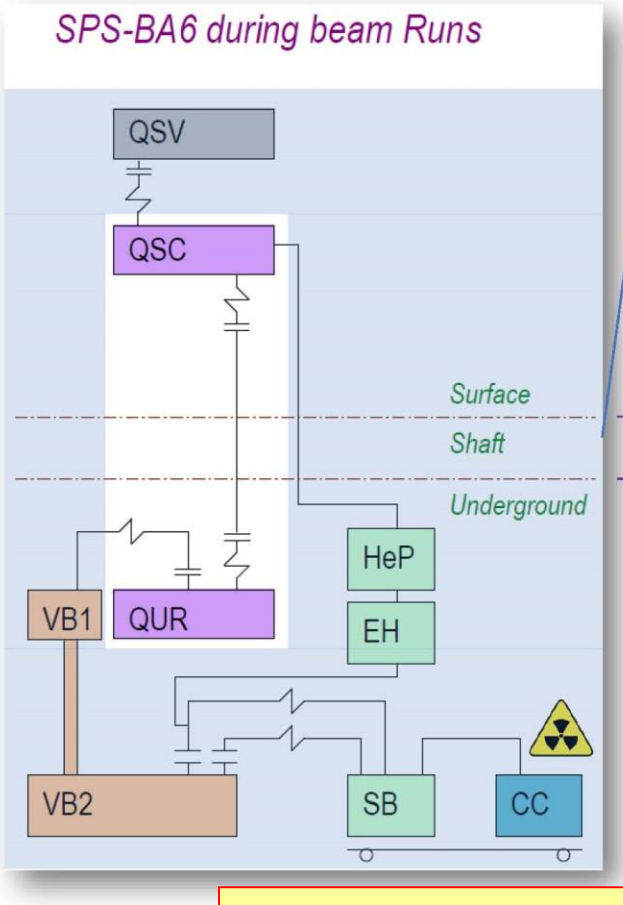
2. Distribution system (VB1+transfer line+VB2) – IT4189
   status: contact signed, visit to contractor on 4.11.2016, design and production underway
   transfer line delivery expected in Feb.2017, VB1 and VB2 end of 2017 (realistic)

3. Proximity equipment (SB and flex transfer lines – DO-30000, HeP, EH)
   status: SB+flex lines – offers received, supplier selected, contract to be signed in coming weeks, delivery in summer 2017 (realistic)
   HeP – to be installed in Mars 2017
   EH – to be ordered



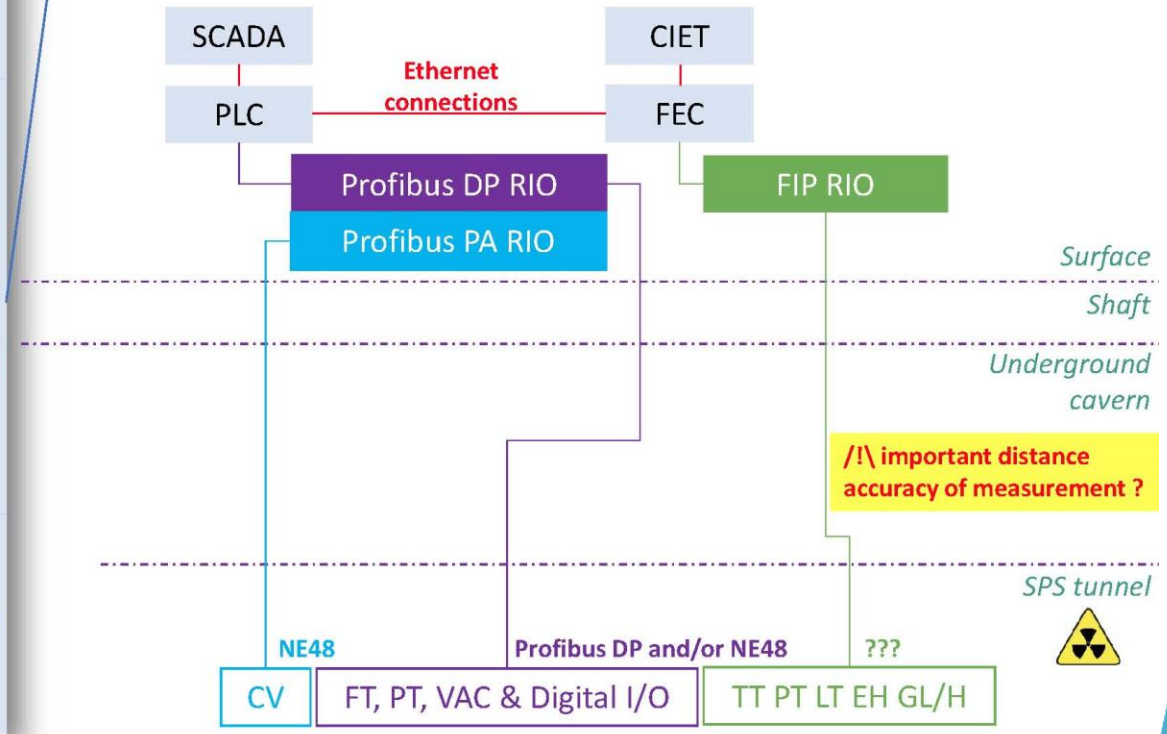
Baseline for controls architecture

Draft 29-04-2016



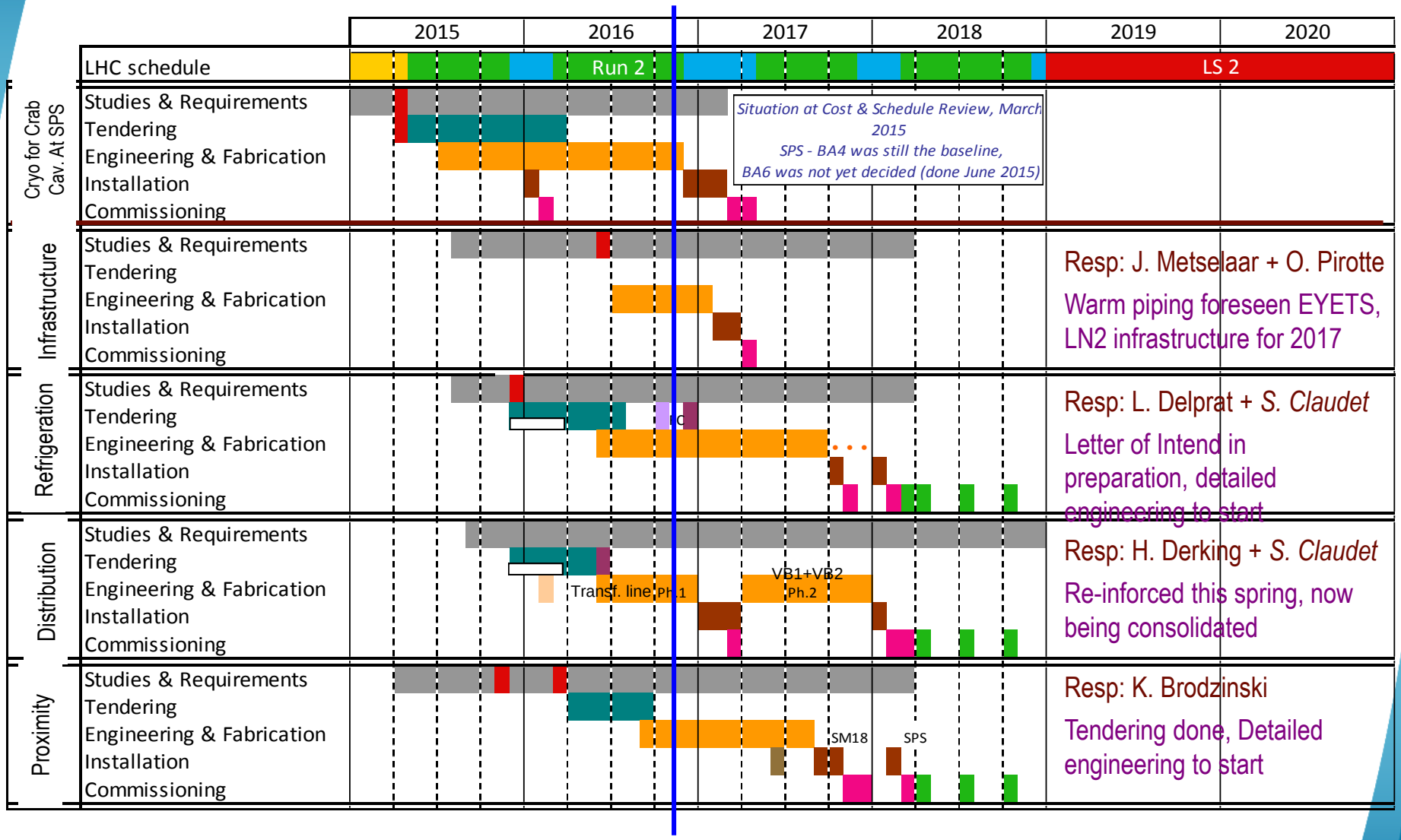
Control system made on the house according to CERN standards and in the basis of the LHC tunnel control architecture

Control architecture – solution 3



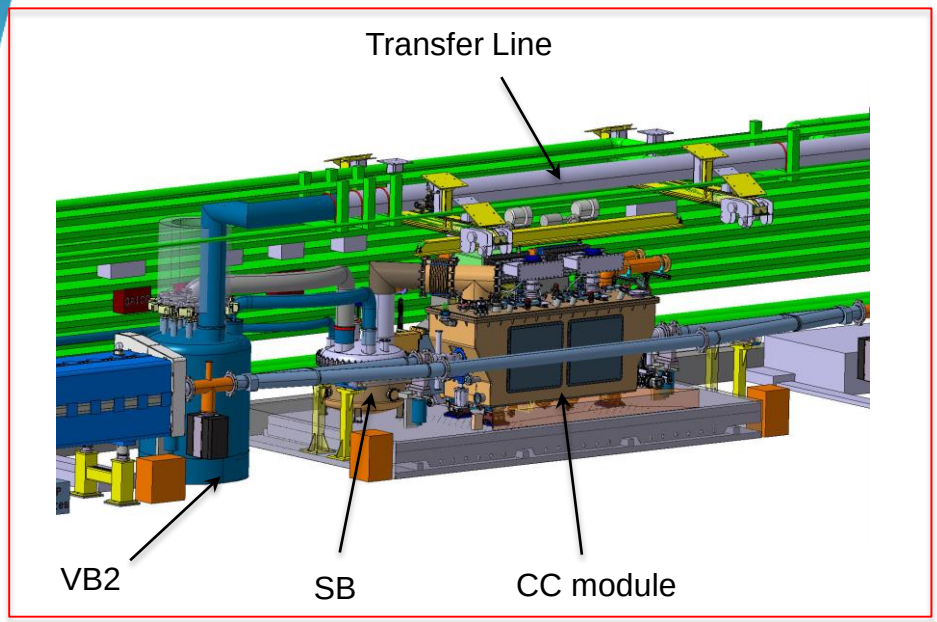
Definition important as well for cost control and schedule
(to allow installation of infrastructure already during EYETS early 2017)

Global SPS cryo planning – status

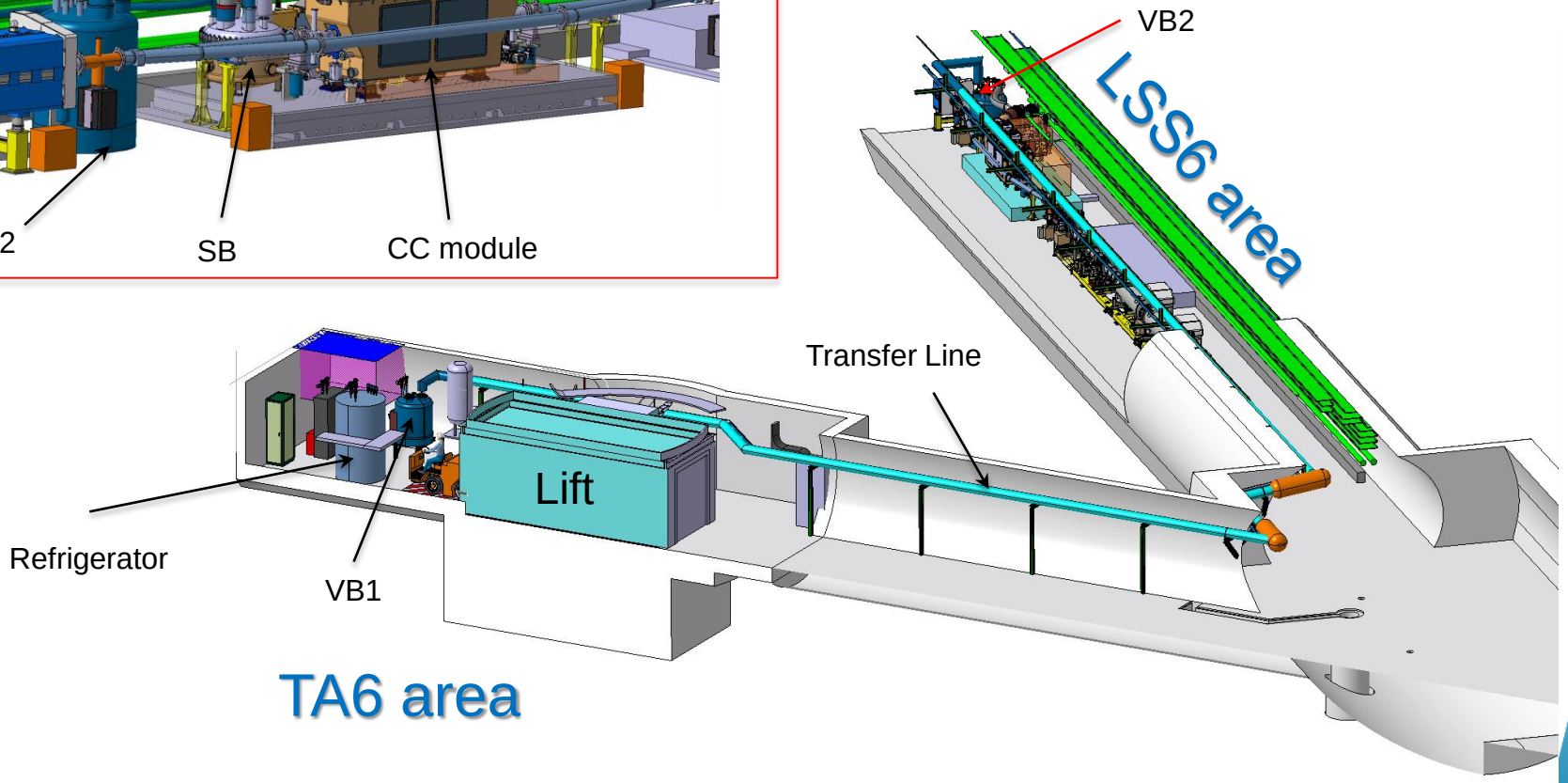


Looking closer underground

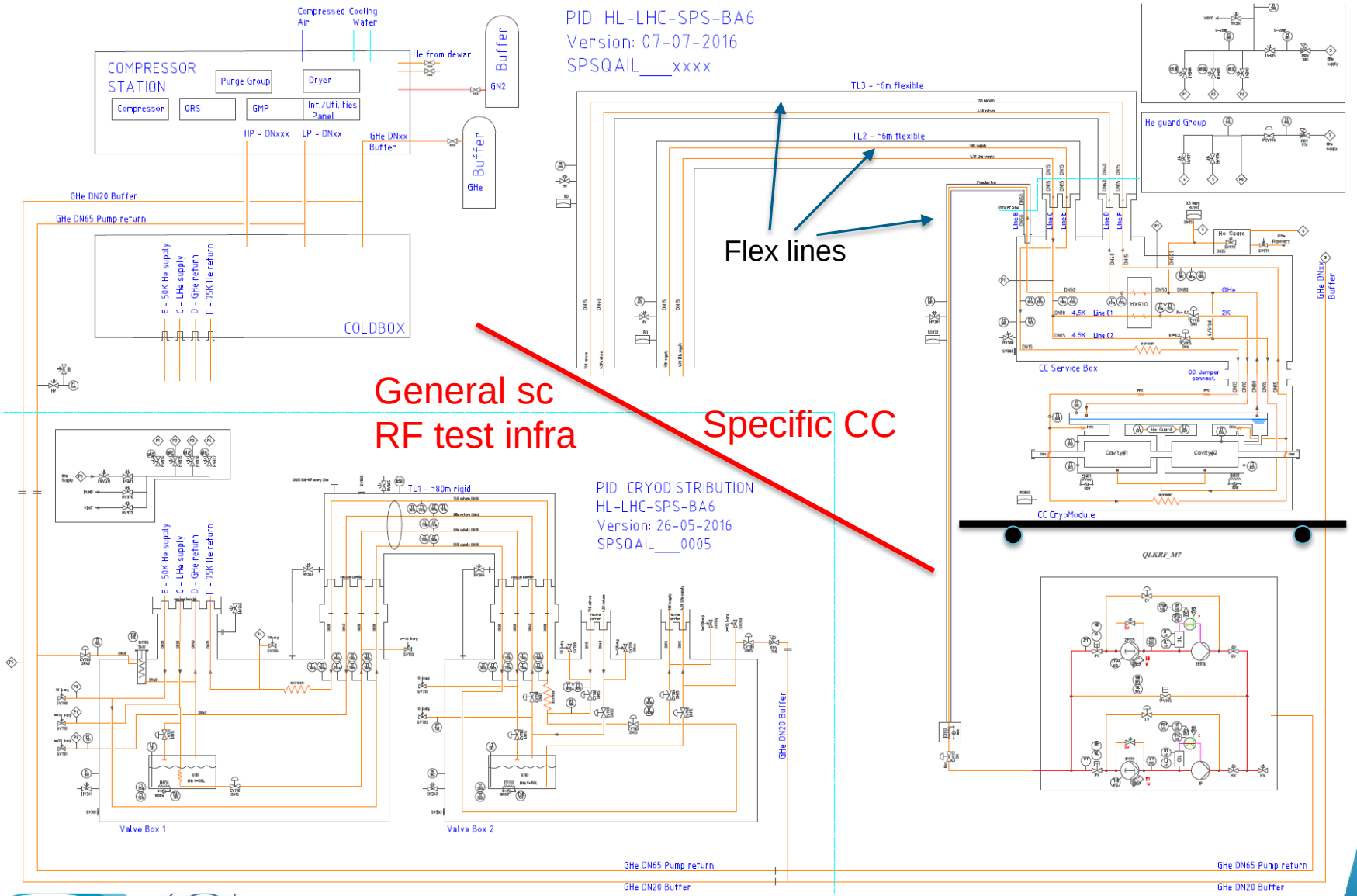
LSS6 area - zoom



Down to VB2: Foreseen for any sc RF
On movable table: specific for Crabs



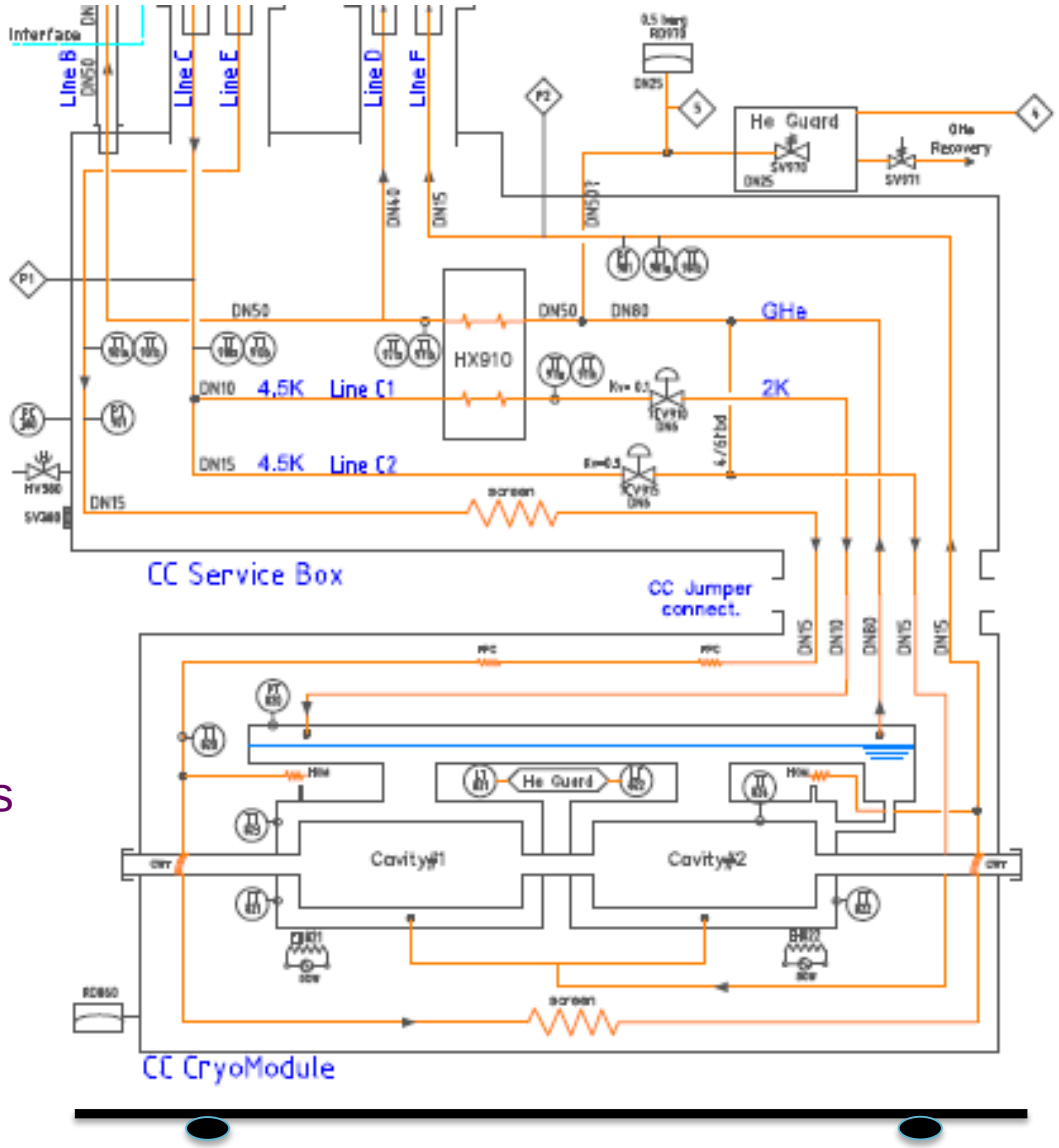
Cryogenic circuits and safety protection



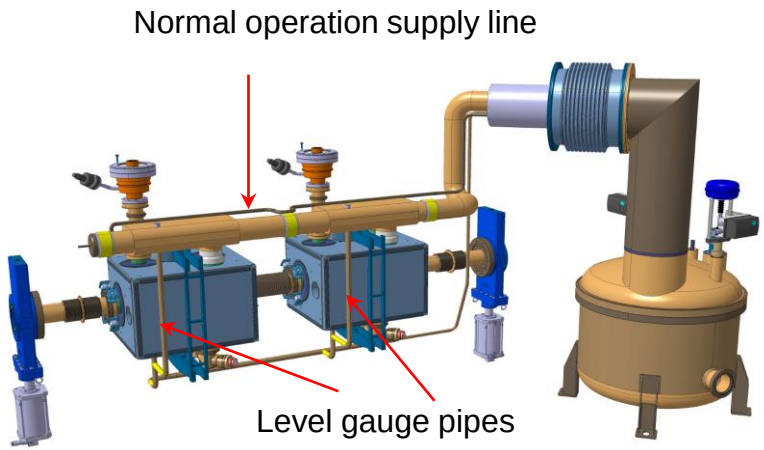
Cryogenic circuits and safety protection

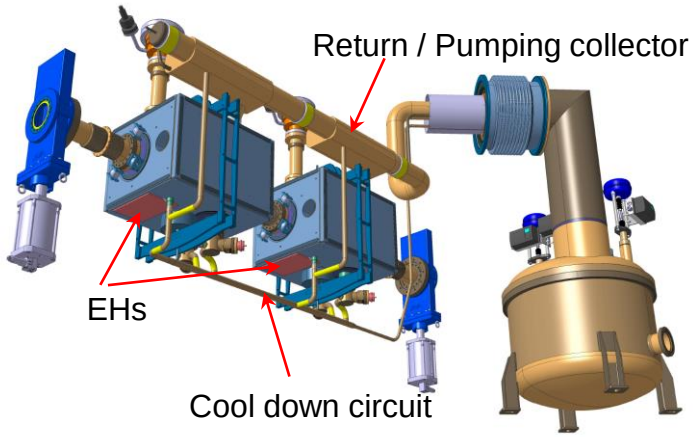
Being ordered, to be tested with 1st CC cryomodule at SM18 in 2017

Functional analysis and specific instrumentation under Cryogenics scope of supply



Looking closer – CC module cryogenics





Heat load – cool down and 2 K normal operation circuits

BNL: static HL of 12.7 W and dynamic HL of 16.8 W -> total= 29.5 W

D: static HL: 12.2 W RFD dynamic HL: 15.5 W -> total= 27.7 W

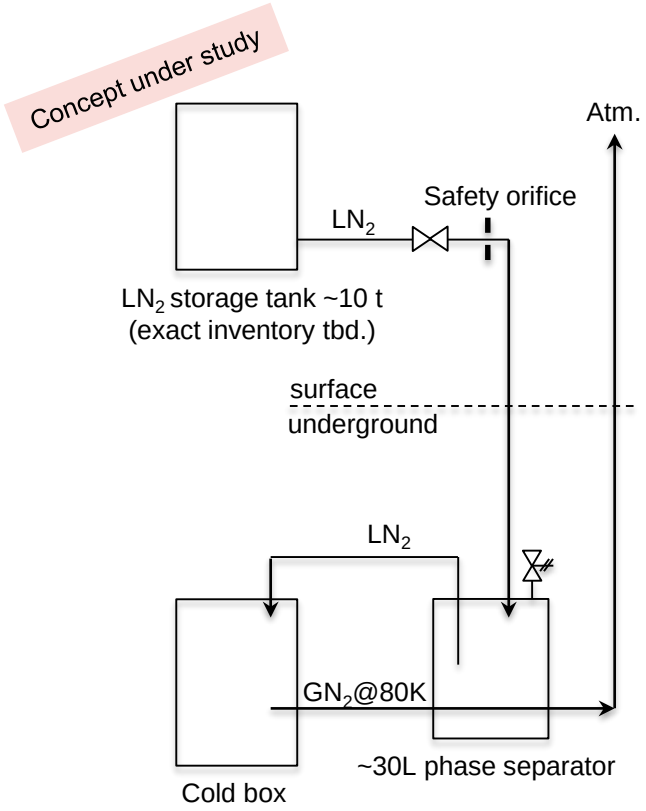
Heat Loads from Federico Carra – update Sep.2016

Instrumentation:

Summary meeting for cryogenic instrumentation was held on 7th November 2017 (with TE/CI Juan Casas) -> all instrumentation will be ordered and delivered for installation on the components of the cryomodule by May 2017.

Nitrogen system

The nitrogen circuit is necessary to be used as a boost for the cold box capacity and is foreseen to be operated only when necessary. Stand-by of the cavities with liquid will not require using the LN2 circuit. However, the boost will be used during cool down, filling and in situation of high dynamic heat load.



Main operation and safety data:

LN_2 consumption: 25 g/s -> ~110 l/h

Dedicated safety orifice will be installed on the supply line limiting the flow to 250 l/h (0.25 m^3/h@cold -> 0.25*700= 175 Nm^3/h)

Ventilation flow injected via BA6 is ~ 45 000 m^3/h

TA6 cavern volume is 224 m^3

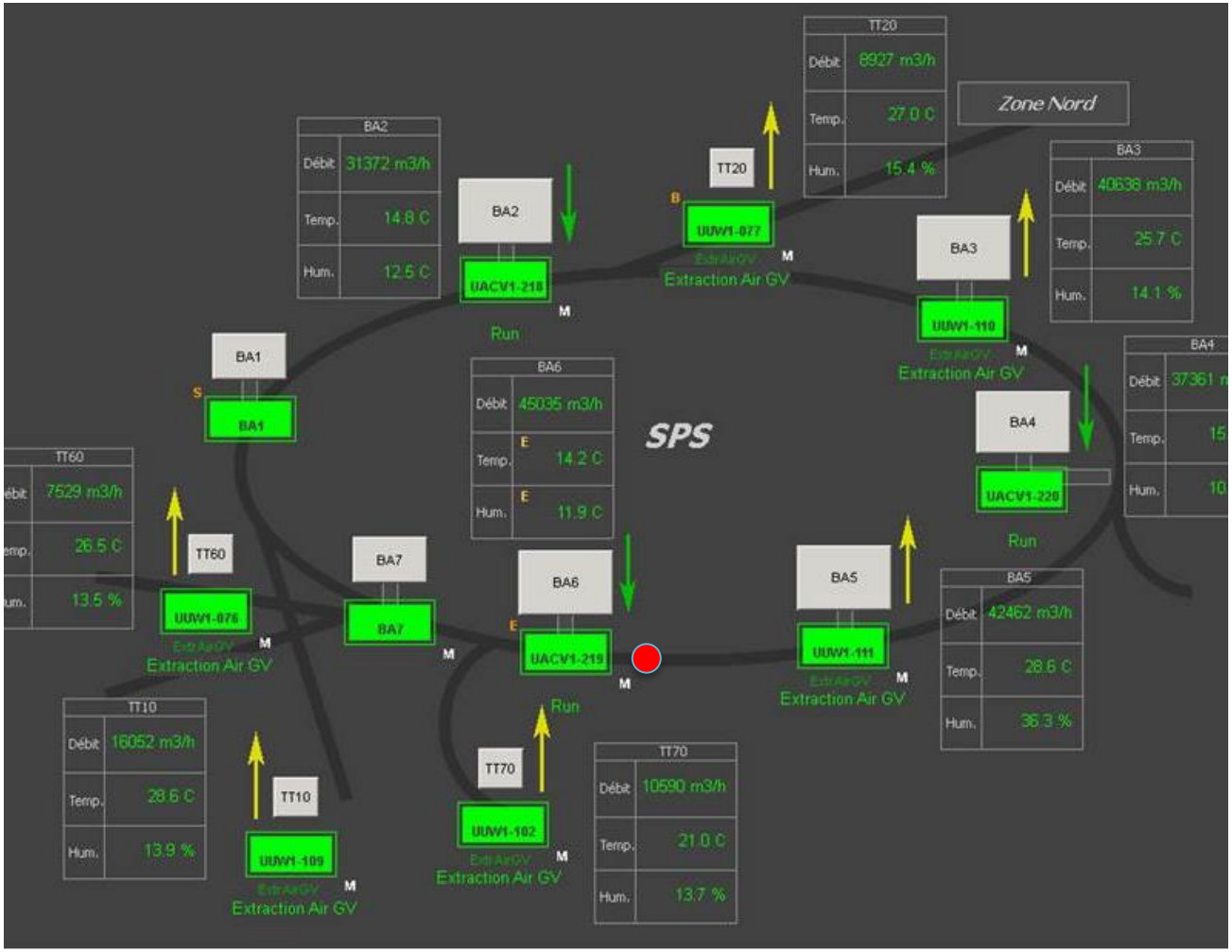
Exercise:

Assumptions considered:
- Closed volume of 224 m^3
- Instantaneous release of 30 L of LN_2

Result: Release and expansion of 30 L of LN_2 would decrease the oxygen concentration to 19 %.

Components on the surface are to be installed by Autumn 2017, underground components should be delivered to CERN by end of September 2017 and installed in YETS2017/18 (➔realistic)

SPS Ventilation – input for safety analysis

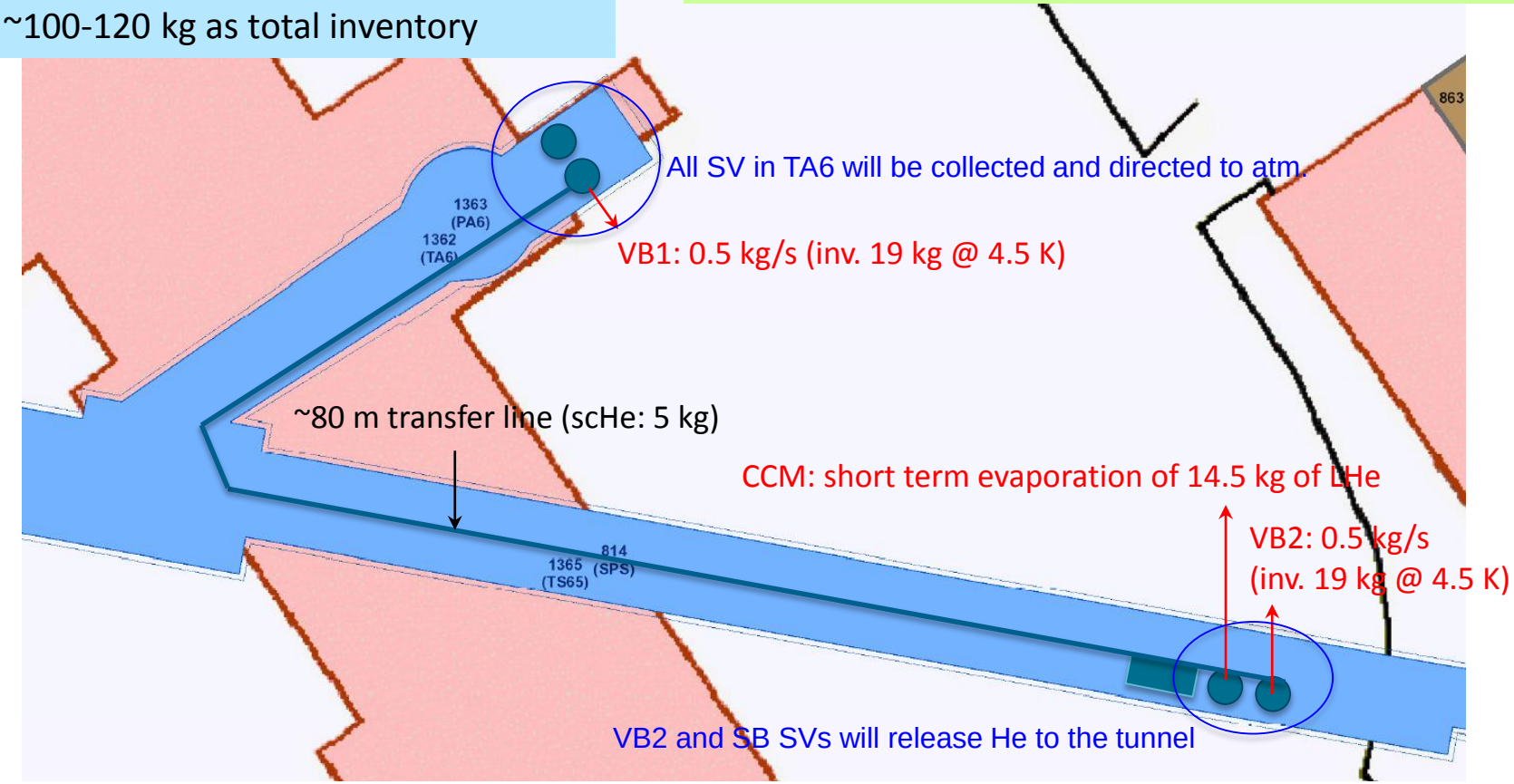


The air injection is in SPS via BA 2,4 and 6. LSS6 flow measured by CV is at average 21 600 m^3/h.

MCI helium case

Assumptions for He inventory:
- ~400 L (55 kg) of LHe underground
- ~100-120 kg as total inventory

MCI for VB1, VB2 or TL -> break of the insulation vacuum
MCI for CCM: break of the beam vacuum



Dedicated safety review for SPS done on 9.11.2016 – no showstopper for the design, related recommendations were given for adaptation.

SM18 test and infrastructure

- Cryogenic goals: Tests in SM18 will allow to check operational behavior of CC cryogenics for cool down, normal operation stability, warm up and helium tightness. Functional test of control system (cryogenic valves) and instrumentation will be checked. The heat load measurement will be done.

- Preparation status: M7 bunker cryogenic infrastructure requires to install dedicated valve box on the interface between SM18 cryogenic infrastructure and CC service box. Engineering specification of M7 valve box has been completed, related price enquiry process is underway.
  Delivery is foreseen in April 2017 -> tight schedule.

- Remark for planning: Late delivery of the valve box could have an impact on SM18 operation schedule since the valve box connection shall be done with double valve isolation from running process. This double valve protection do not exists today. Alternative solutions to connect the valve box after April17 are being studied.

Conclusions and final remarks

- Big progress on study and design of the cryogenic infrastructure was done in 2016. Procurement of 3 main sub-systems for SPS test is underway, planning is tight but realistic.
- Controls of entire cryogenic infrastructure studied and being refined, with cables requirements already provided for installation at this EYETS.
- CC module cryogenics definition is finalized, instrumentation list is completed and validated, order of the instrumentation will be done for delivery in May 2017.
- BA6 surface cryogenics as well as the nitrogen circuit must be studied, specified and ordered -> additional engineering manpower is needed (will come after restructuration of CRG from 1st December 2016).
- The safety review for SPS test done -> no showstopper in existing design was identified (some more detailed study must be done/completed -> details in related report). The ODH layout was proposed and will be applied for SPS.

Thank you for your attention !