ATLAS Helium Cryogenics

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Outline

► Introduction

► External & proximity cryogenics installed for ATLAS

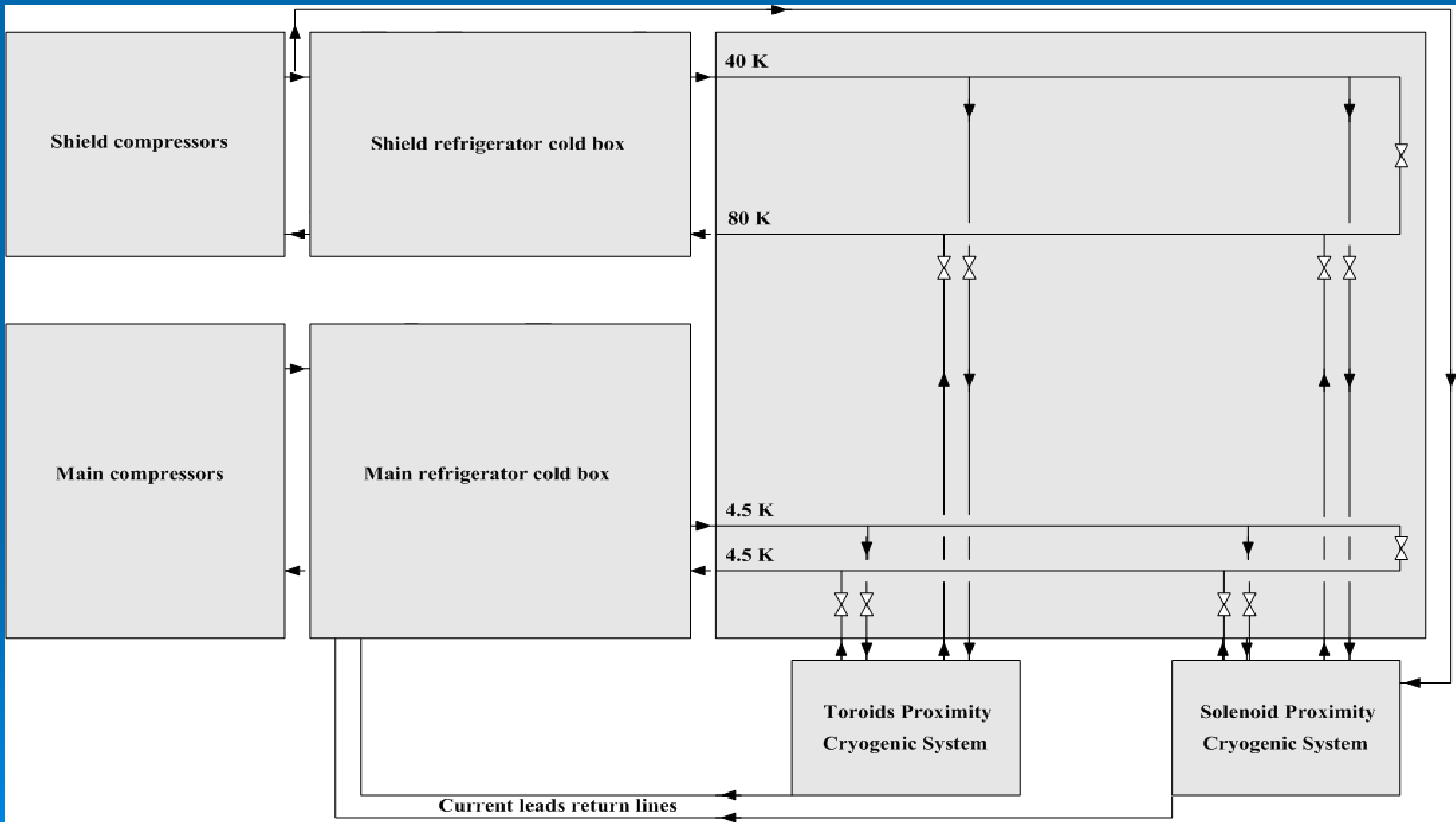
► Next steps for the helium cryogenics

Introduction (1)

- **The cryogenic system for a superconducting magnet can be divided into:**
  - Internal cryo = cooling system of coils, thermal shields, feedthrough;
  - Proximity cryo = all auxiliary equipment necessary for magnet operation (e.g. current leads, liquid He pumps, distribution valves, buffer dewar, etc.);
  - External cryo = helium refrigerators / liquefiers producing helium from 300K to 4.5 K.

- **Cryogenic tasks:**
  - Magnets cool-down;
  - Magnets steady-state operation at 4.5 K (with current ramping up/down);
  - Thermal recovery after a fast dump.

Introduction (2)



Introduction (3)

- **Why 2 helium fridges and not only 1 (like for CMS) ?**
  - Main Refrigerator (Air Liquide) was existing at SM18 and could be re-used for ATLAS;
  - But insufficient to cope with the big thermal-shield loads between 40 K and 80 K and with magnets cool-down time;

  => we bought a new fridge solely dedicated to cope with the cool-down (with the help of LN_2) and with thermal shields.
- **Advantages of this splitted solution:**
  - Important cost reduction (we bought only 1 refrigerator);
  - The new one has been specified to have a simpler process than the existing one => higher reliability;
  - During winter shut-down, the new Shield Refrigerator can have a maintenance time twice shorter than the Main Refrigerator and keep ATLAS shields temperatures < 80 K.

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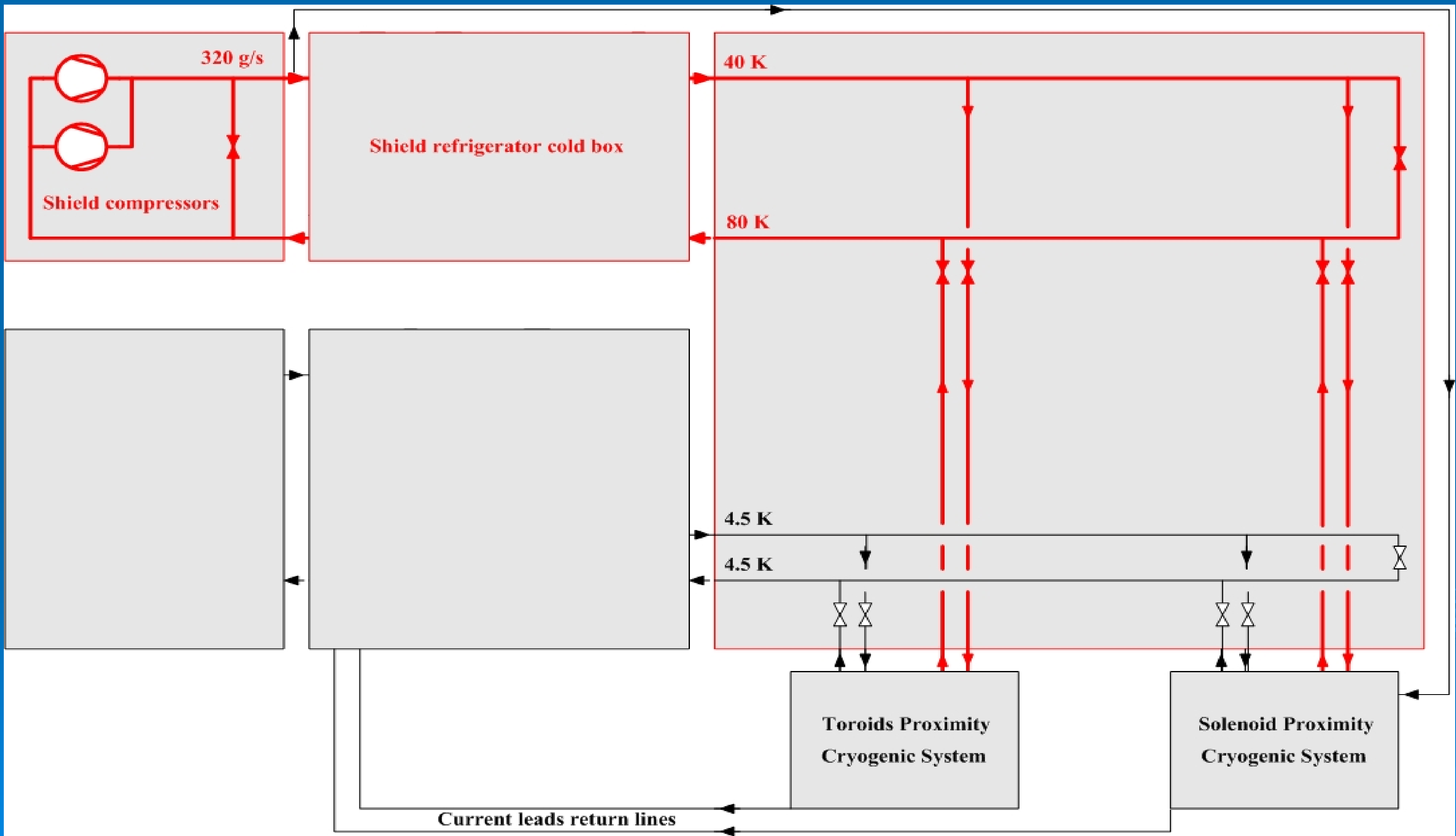
External & Proximity Cryo (1)

► Shield Refrigerator (Linde):

- Functionalities:
  - Cool-down from 300 K -> 100 K of all magnets (660 tons); 60 kW power required for 1 month => boosted by use of LN_2;
  - Then, maintain thermal shields between 40 K and 80 K; 20 kW power required without LN_2 (i.e. only with turbines).
- Components:
  - 2 identical screw compressors: mass flow = 2 x 160 = 320 g/s;
  - In normal shield cooling, 2nd compressor in stand-by for redundancy;
  - Cold box with 2 turbines in series + LN_2 precooler.

External & Proximity Cryo (2)

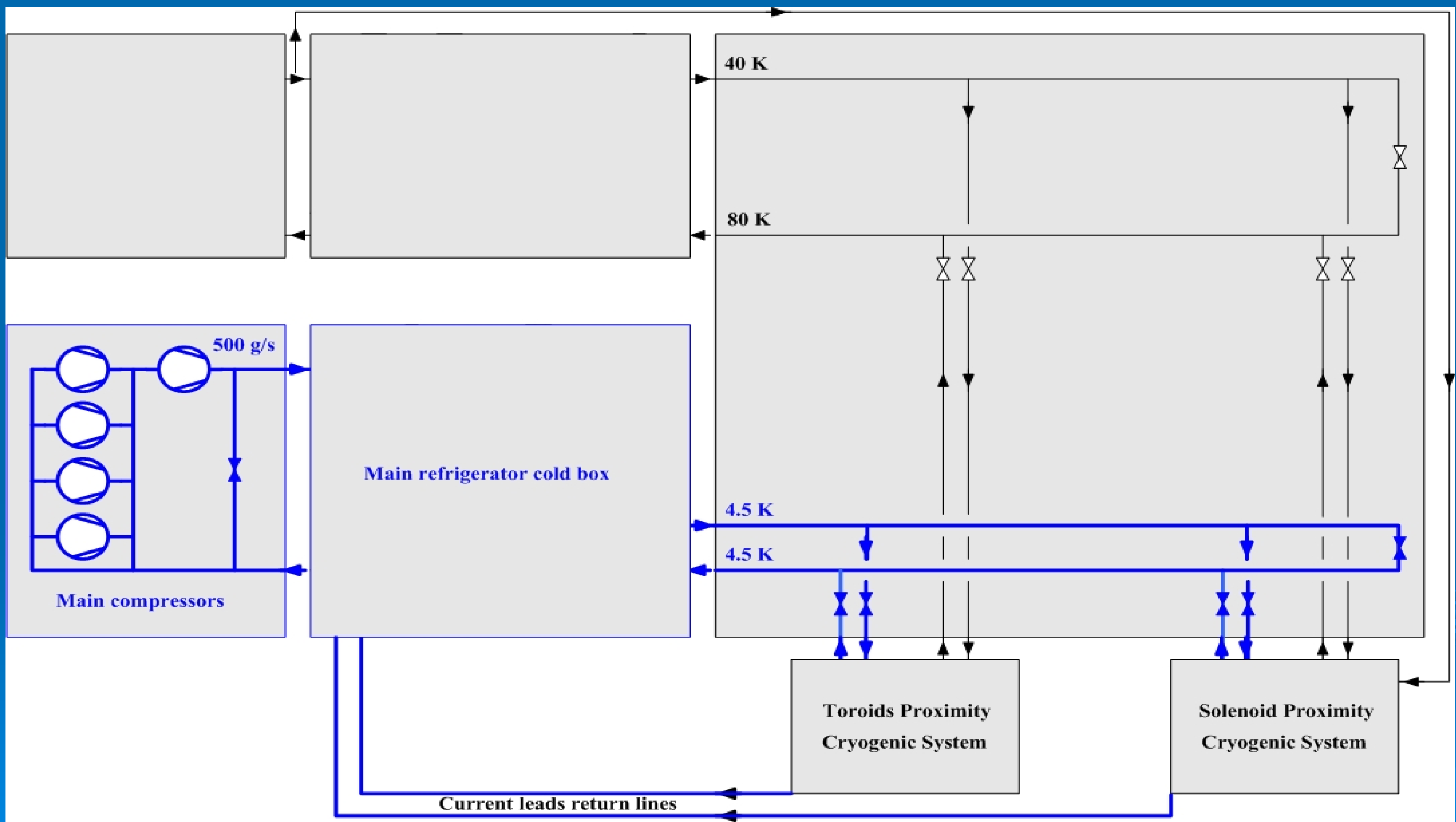



Linde

External & Proximity Cryo (3)

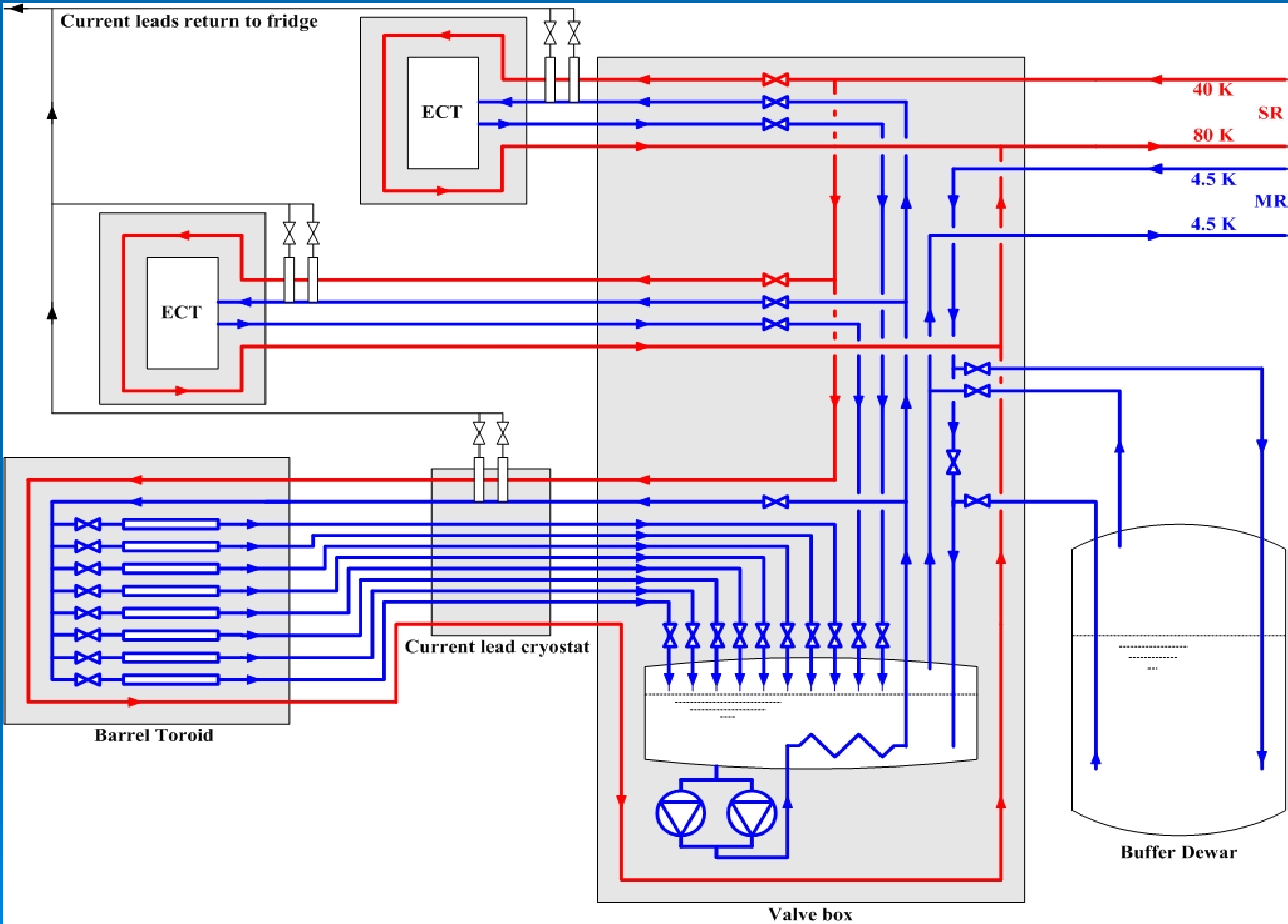
- **Main Refrigerator (Air Liquide):**
  - **Functionalities:**
    - Cool-down from 100 K -> 4.5 K of all magnets (660 tons);
    - Then, maintain the cold masses at 4.5 K and supply 11.2 g/s of liquid Helium for the current leads cooling; Equivalent power of 6 kW @ 4.5 K.
  - **Components:**
    - 5 screw compressors: 4 boosters + 1 high-stage for a total mass flow = 500 g/s;
    - Cold box with 3 turbines: 2 in series + 1 supercritical.

External & Proximity Cryo (4)



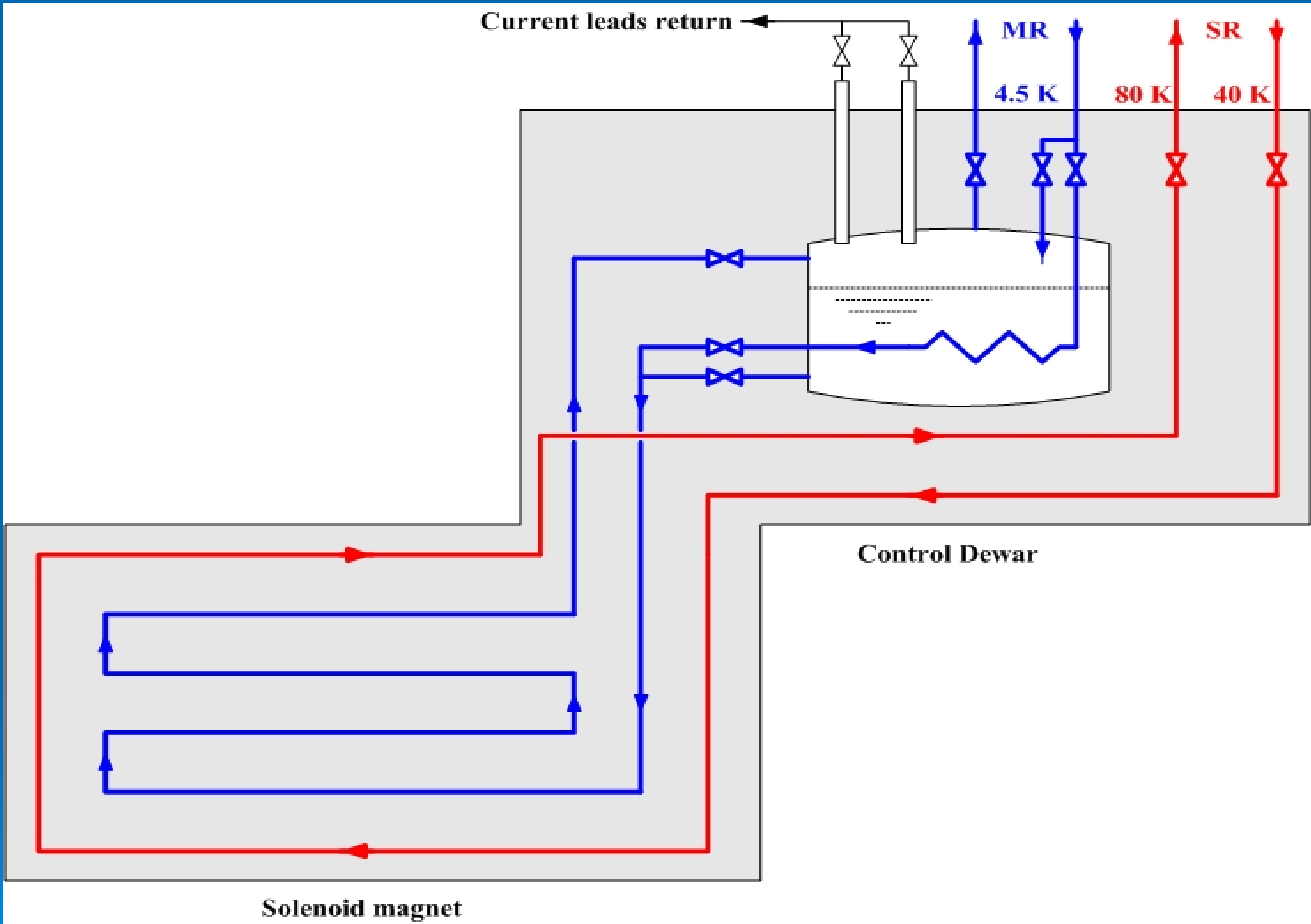
External & Proximity Cryo (5)

- 2 types of cooling principle for the toroids and for the solenoid => 2 independant Proximity Cryogenics
  - 1 centrifugal pump providing 1.2 kg/s (≈ 10 L/s) of helium forced-flow to keep the toroids at 4.5 K;
  - Supercritical helium flow provided directly by the fridge at 2.6 bar for the solenoid having a simple cylindrical shape. (cooling in thermosiphon mode is also possible).
- Proximity cryogenics for the toroids (RAL collabor.)
  - Consists of: distribution valve box with its phase-separator, a current lead cryostat, a pump cryostat (with 2 pumps) and a 11'000 L buffer Dewar;
  - Each pump provides a mass flow of 1.2 kg/s with a pressure head of 400 mbar.

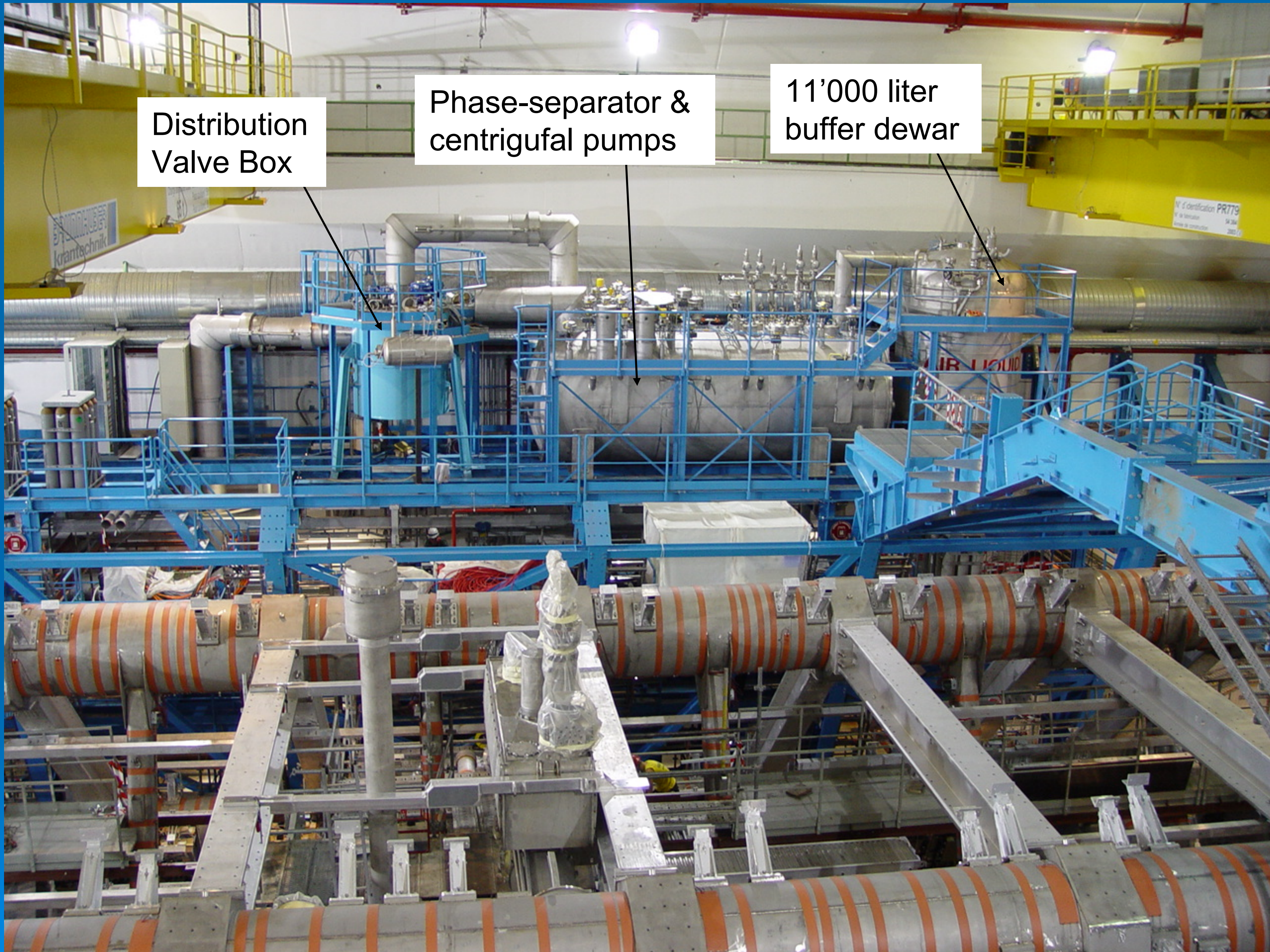

Current leads return to fridge
ECT
ECT
40 K
SR
80 K
4.5 K
MR
4.5 K
Current lead cryostat
Barrel Toroid
Buffer Dewar
Valve box

External & Proximity Cryo (6)

- **Proximity cryogenics for the solenoid (KEK)**
  - Consists of: control Dewar housing the 8 kA current leads and a valve unit with the instrumentation & control valves;
  - Control Dewar is placed in the cavern at the top of ATLAS detector (13 m from the central axis);
  - Complete system successfully tested in Point 1 in May 2006.



Current leads return
MR
SR
4.5 K
80 K
40 K
Control Dewar
Solenoid magnet


Distribution Valve Box
Phase-separator & centrigufal pumps
11’000 liter buffer dewar

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Next steps for the He cryogenics

- Cool-down of the Barrel Toroid and the Solenoid (July 2006);
- Replacement of some faulty electrical heaters inside SR cold box after BT test (autumn 2006);
- Possible upgrade of Air Liquide turbines after BT test;
- Test at 4.5K of End-Cap 'A' alone in Point 1 (December 2006) after surface-test at 80 K in West Area;
- Test at 4.5K of End-Cap 'C' alone in Point 1 (March 2007) after surface-test at 80 K in West Area;
- First cool-down of the complete ATLAS detector in Point 1 during May-June 2007.