MAUVE: LHCb UT & Velo CO_2 cooling system operation

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Summary of relevant document x MAUVE plants

EDMS repository

General docs

- WP for MAUVE plants construction https://edms.cern.ch/document/1575817
- Mauve P&ID plan & document https://edms.cern.ch/document/1556956
- Mauve Functional Analysis https://edms.cern.ch/document/1562732
- Drawings https://edms.cern.ch/document/1703238/1

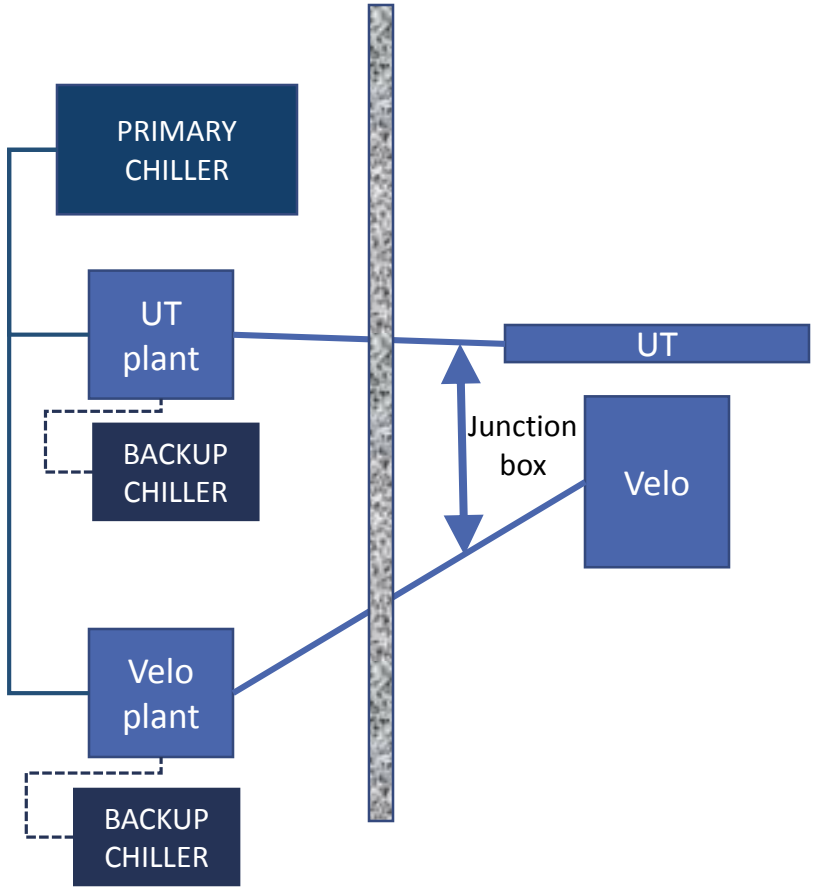
Components

- Accumulator https://edms.cern.ch/document/1836202/1
- Cold box https://edms.cern.ch/document/1867798/1
- Backup chiller https://edms.cern.ch/document/1810421/1
- Main chiller WP https://edms.cern.ch/document/1870688/1.1

Indico references

- Production Readiness Review Nov 1st, 2017 https://indico.cern.ch/event/675723/
- CO_2 cooling EDR Dec 5th, 2015 https://indico.cern.ch/event/450162/

Overview of the MAUVE system



Multiple cooling Apparatus for UT and Velo Experiments

A. 2 CO_2 cooling plants, one for Velo, one for UT

B. Each plant capable to cool both detectors together (detector power about 7 kW @ -35 C): i.e. if one plant fails, the second one can feed both detectors (Agreement on operating T needed when "swapping")

C. 1 common primary chiller to condense CO2, common to other LHCb systems, direct evaporation (EN/CV/DC responsibility)

D. 1 backup chiller for each UT & Velo plant @ -20 C (CO_2 Temperature) and 3 kW (LUCASZ chiller)

E. 2PACL circuit with constant pressure drop regulation

F. Local junction box for swap between plants U & V: no balancing of levels required

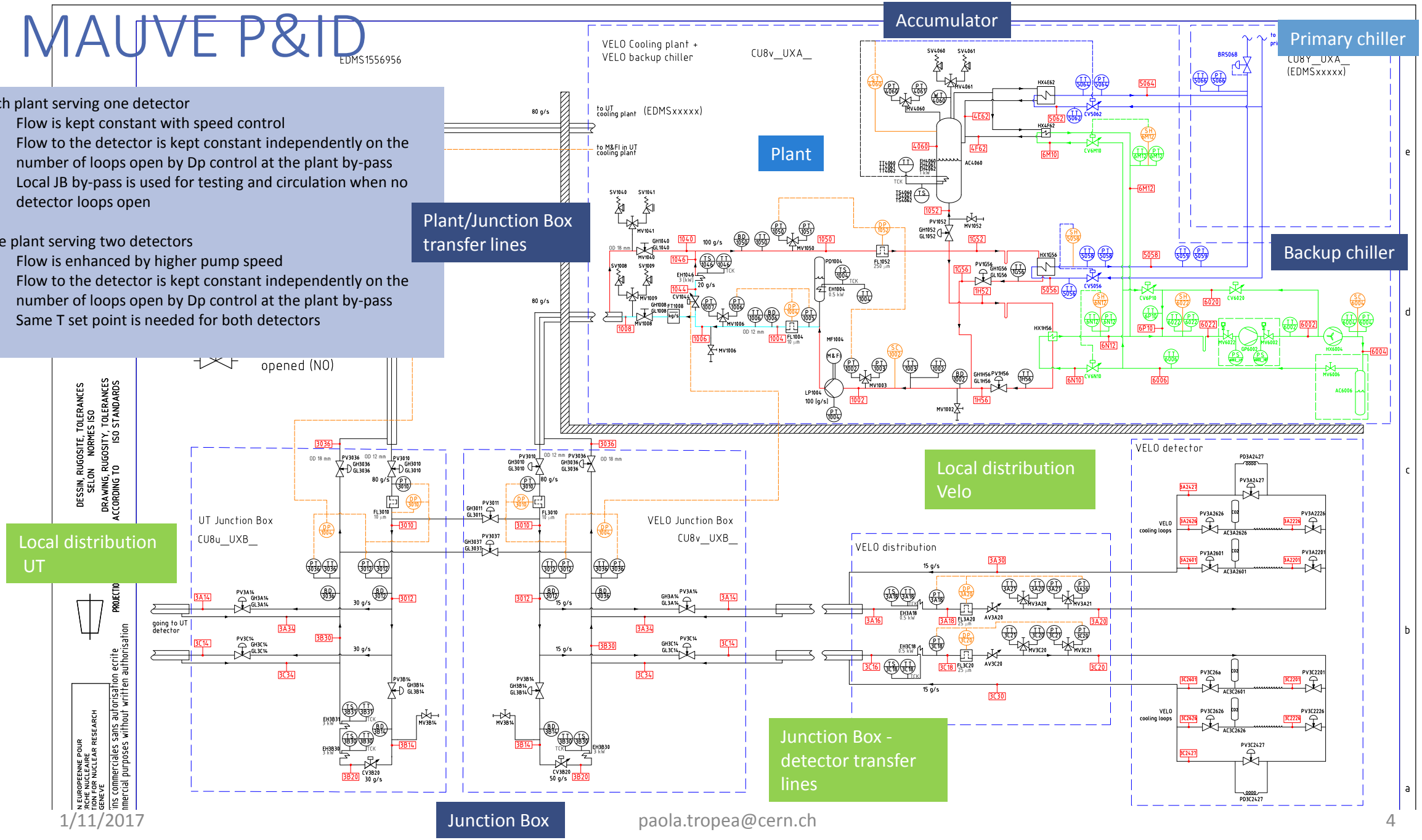
G. Distribution system at detector inlet for balancing right/left

MAUVE P&ID

EDMS1556956

Each plant serving one detector
- Flow is kept constant with speed control
- Flow to the detector is kept constant independently on the number of loops open by Dp control at the plant by-pass
- Local JB by-pass is used for testing and circulation when no detector loops open

One plant serving two detectors
- Flow is enhanced by higher pump speed
- Flow to the detector is kept constant independently on the number of loops open by Dp control at the plant by-pass
- Same T set point is needed for both detectors



MAUVE system operation

- The CO_2 plant is started with a **T set point = T detector** (data from DIP thanks to new protocol being developed)
- The **requested T set point** is gently reached after circulation is established (few C/min)
- **Interlocks** to the detector in case of CO_2 system failure are sent trough DSS
- Signal from the primary being off would trigger start of the **backup chiller**: need reaction to power off from detector side & precise **T set point to be maintained (-20 C?)**
- Flow rate to each detector loop is set by the calibrated orifices/capillaries: manual valves to balance A and C side of detector are foreseen at the detector entrance

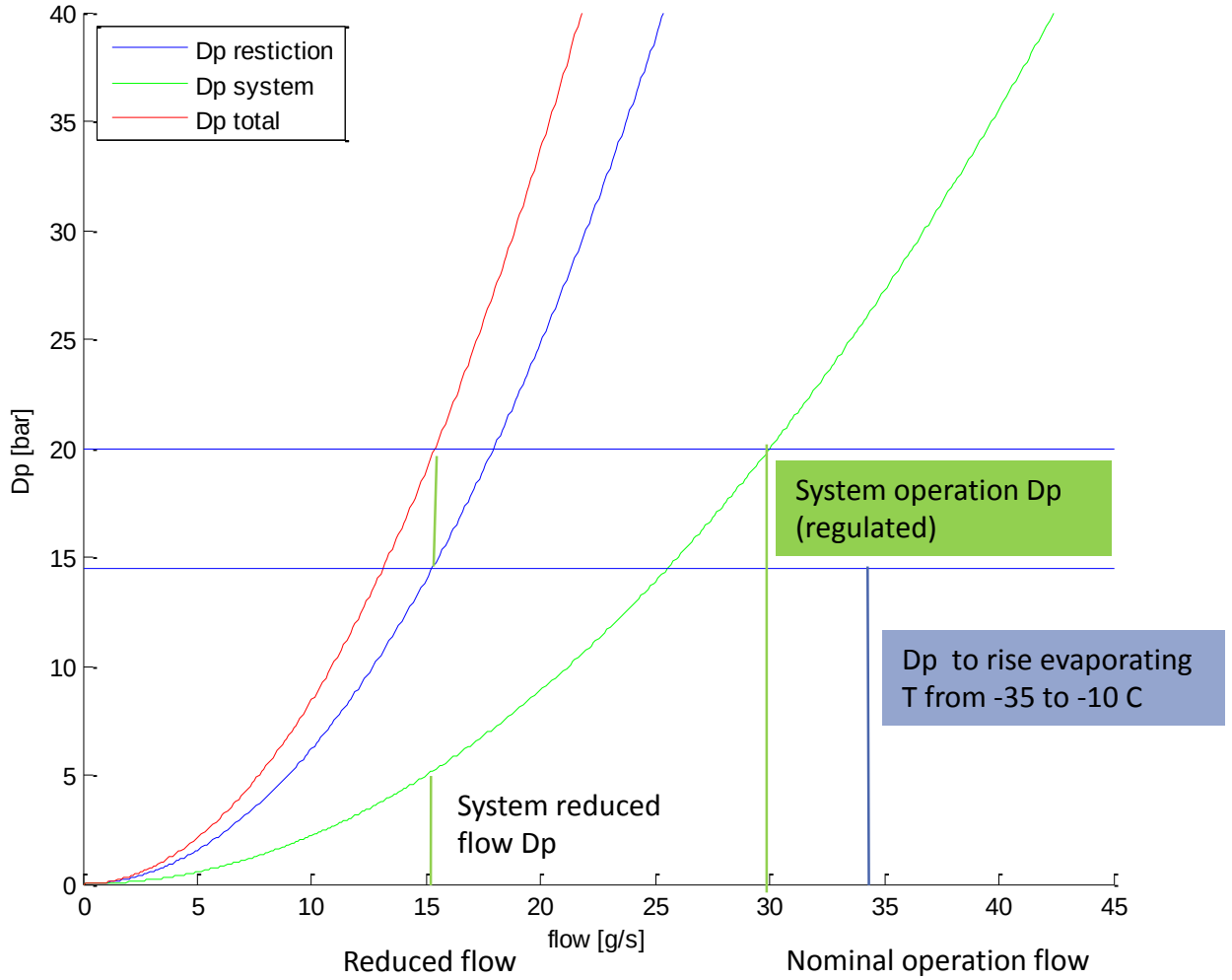
See P&ID doc for details https://edms.cern.ch/document/1556956/1

Protection against low T operation

Study case:

- Taccumulator = -35
- Set point for T evap in UT = -10
- Dp needed = 14.5 bar

- Nominal ½ UT flow = 30 g/s
- Nominal Dp across regulation valves + detector = 20 bar



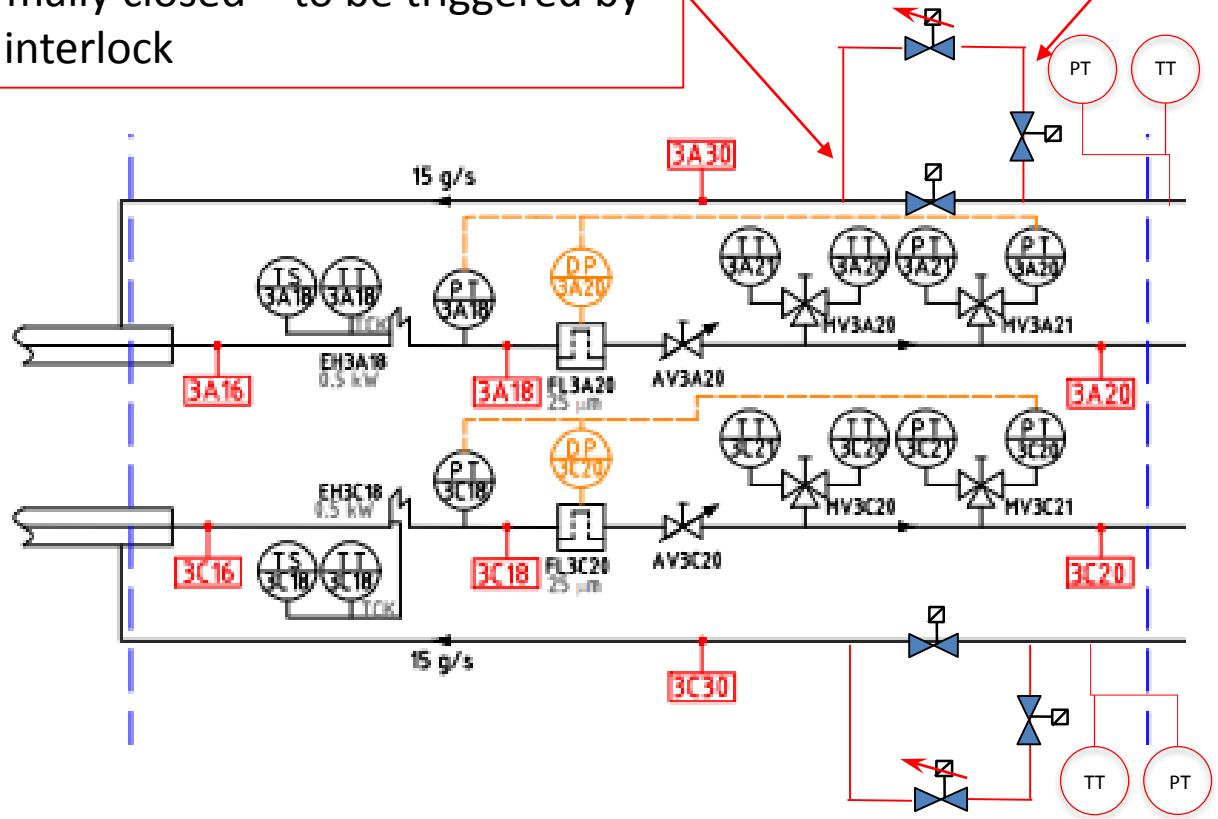
Protection against low T operation – possible implementation

Manual regulation valve
(to set new impedance)

Pneumatic shut-off valve
normally open – to be triggered by
UT interlock

Pneumatic shut-off valve
normally closed – to be triggered by
UT interlock

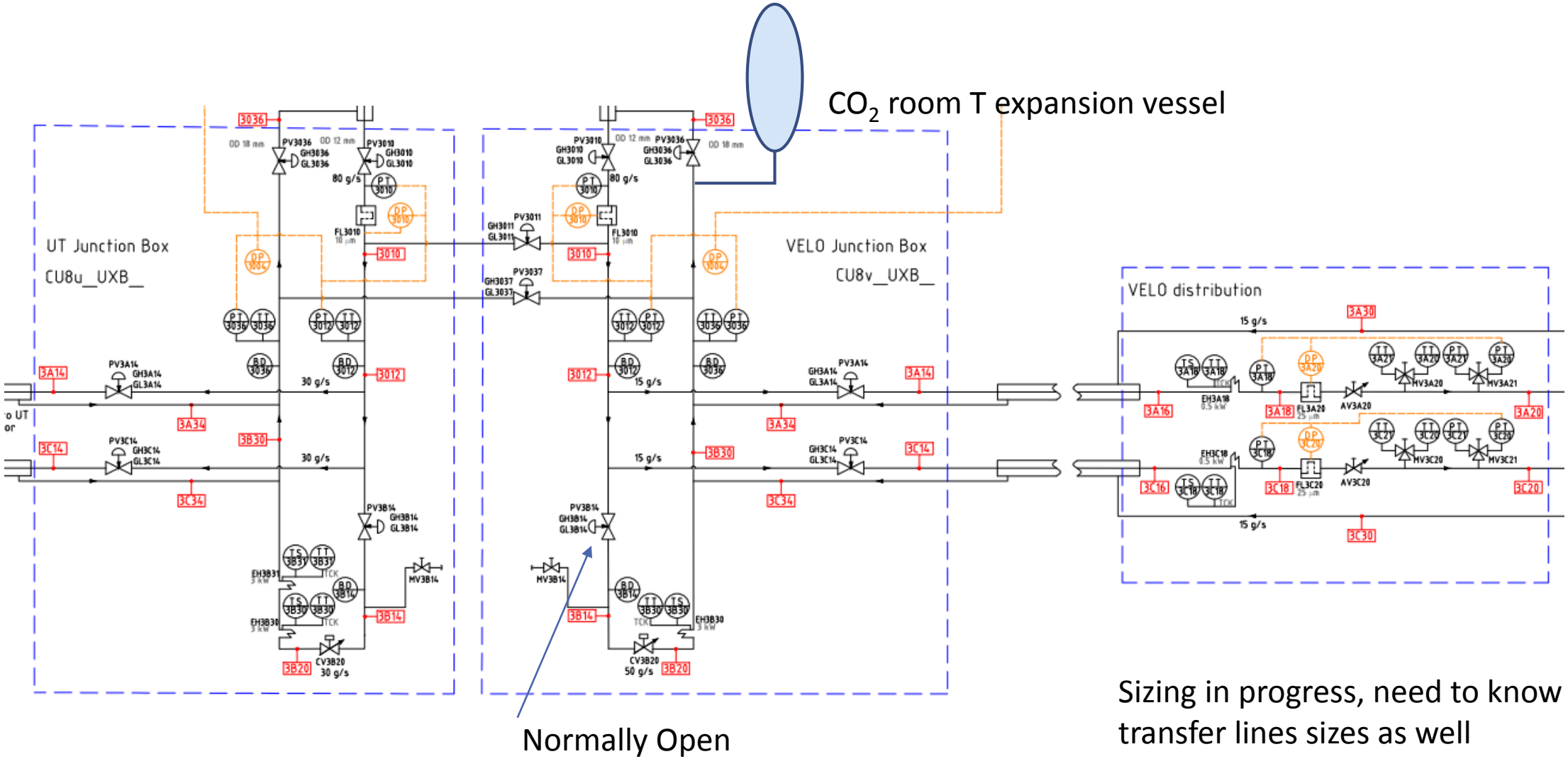
Local distribution at the detector entrance



Data collection
- Velo and UT DP
- DT set point (-10?)

Sizing of valves
Component list
DESIGN (who is doing it?)

Protection against trapped liquid



Planning for construction & commissioning

Junction Box

- ✓ Construction Jul/Aug
- ✓ Installation in TS2 (Sept 18, 2017)
- ✓ Verification of size for connections – LHCb integration team
- Removal & testing @ TIF – CL, student – Oct-Nov 17

Accumulator

- ✓ Design in Jul/Aug – TK, JD
- ✓ DO in Oct 17
- Purchase Nov 2017
- Delivery Apr 2018

Plant core

- ✓ Design i
- ✓ PR
- C
- Co ce bldg 153 in May/Oct 18
- Inst in LHCb

Local distribution

- Need fu collaboration
  n integration)

Co

018
153: Apr 2018
installation LS2

esign in Q2 2017
✓DO Q3 2017
- Delivery Nov 2017

To be updated – 1 month delay with purchases

2 MAUVE plants + 2 backup chillers to be connected to electrical cupboards for local testing with junction box in Bldg 153 in Spring/Summer 2018

Installation & underground commissioning planning

- The MAUVE plants will be kept in bldg 153 up to LS2 start, or up to 5 months before primary chiller available
- We take the primary chiller availability date as milestone for planning (M), unless other LHCb constraints appear
- We need a few months operation with primary for fine tuning before detector operation
- Local distribution valves come with detector?

	Months																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
LS2																		
JB installation	x																	
JB cabling & piping	x																	
Plant installation		x																
Accu installation		x																
Backup chiller installation (BC)		x																
Cabinets installation		x																
Cabling in alcove			x															
Piping in alcove x primary			x															
Piping in alcove x CO2			x	x														
CO2 commissioning on JB & BC					x	x												
Primary chiller available (PC)							x											
CO2 commissioning on JB & PC							x	x	x									
Piping JB/detector	?																	
UT installation	?																	
VELO installation	?																	
CO2 commissioning with detector	2 Months at least?																	

Summer 2019?

Summary (from PRR remaining & today chat)

CO_2 plants

- Operation mode to be endorsed & detector spec frozen
- Design almost completed, green light for production needed

Cooling system overall – Open points

- Integration of connection pipes & electrical trails in alcove
- Design and procurement JB to detector transfer lines
- Local distribution: how do we design and install? Shall we add safety protections for UT