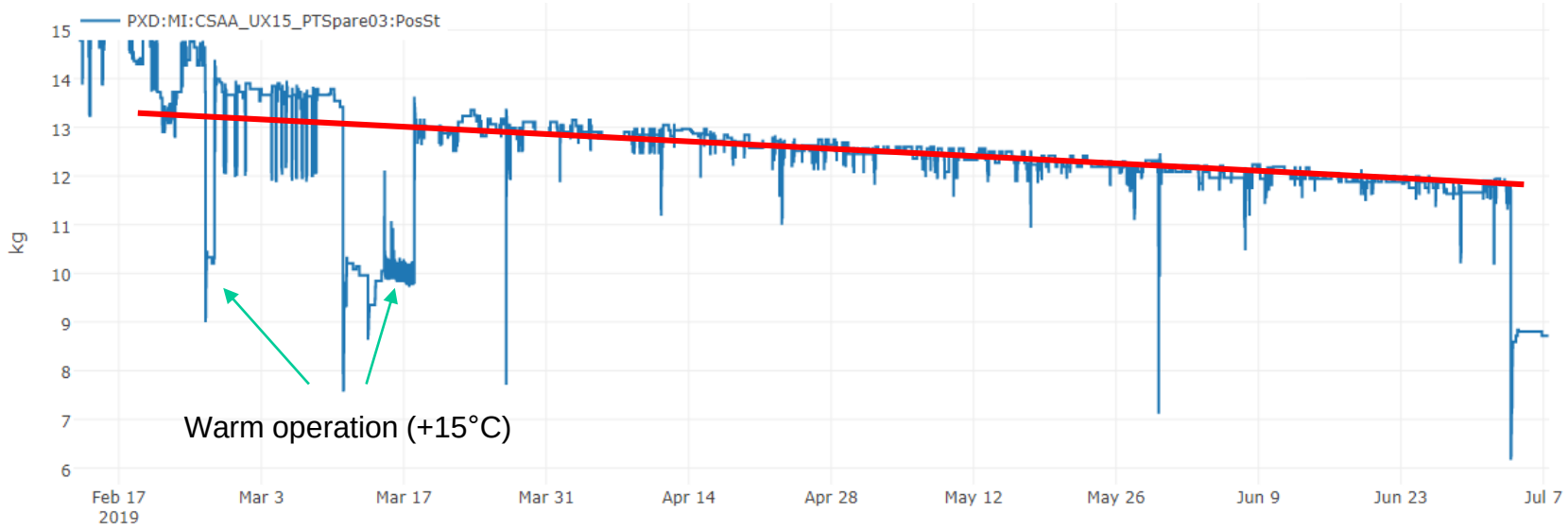
IBBelle

During Phase III IBBelle ran without interruptiones (except ‚warm operation') for 157 days. CO_2 loss was very low, ~10 g/day.

Some oscillations of the chiller after startup could be fixed by adjusting PID parameters.



Maintenance

July 22-25: Maintenance:

replace faulty heaters by more robust ones

- **heater exchange (at CO_2 accumulator)**
- two faulty heaters were exchanged against ones with an improved design:
- - shorter length so that heater is still completely immersed at low CO_2 levels
- - 90 deg connections to avoid harming of isolation conditions by condensation
- → heaters are working very well

- **Laptop upgrade**
- (access to PLC and dock box heaters)
- from Windows 7 to Windows 10 to be compliant with KEK rules

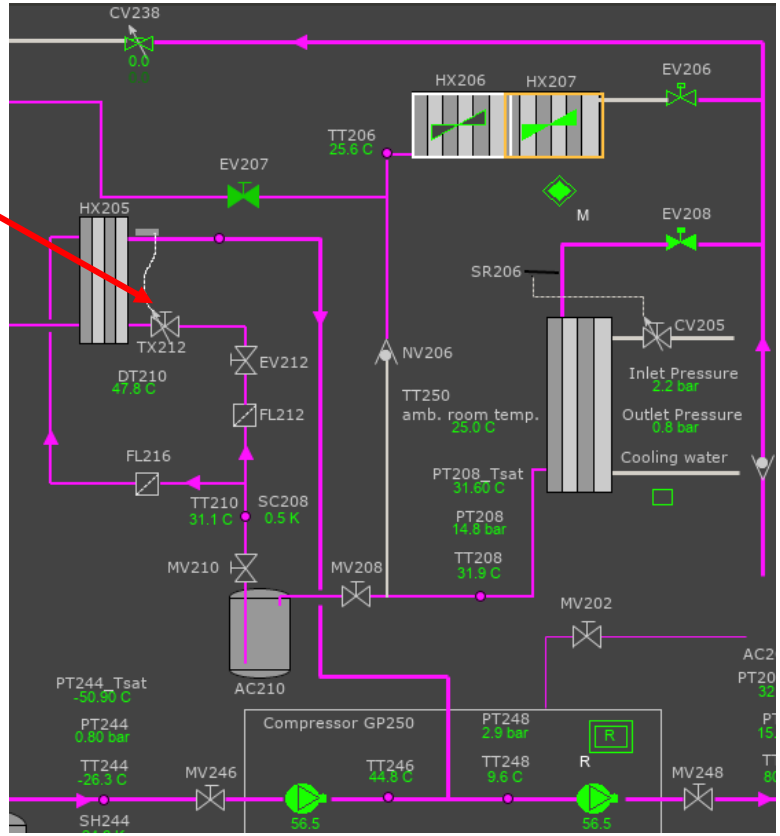
software updates

install heat pipe for improved subcooling of R404a - did not work

heat pipe did not work in the orientation needed (contrary to suppliers claim)
Install a system based on Peltier cooling in the next shutdown

Subcooling

- R404a needs to be subcooled (below condensation/evaporation temperature) to avoid flash gas in TX valve, harmful for valve



- no subcooler

- ambient room temperature high (> 26°C during summer)

  → subcooling is very low in average 0,3 K

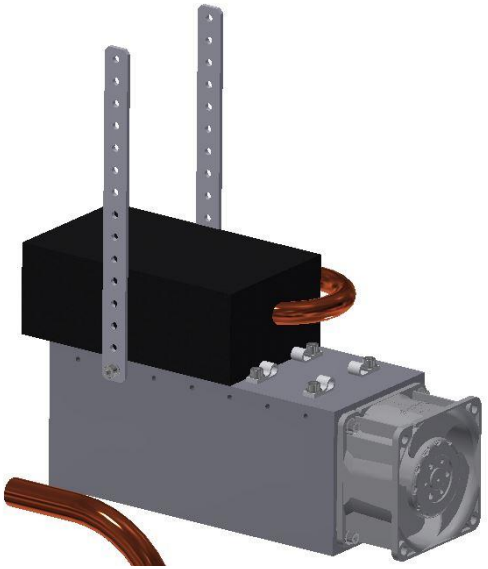
- horizontal receiver (vertical mounted would be better)

Subcooling

(Temporary) fixes:

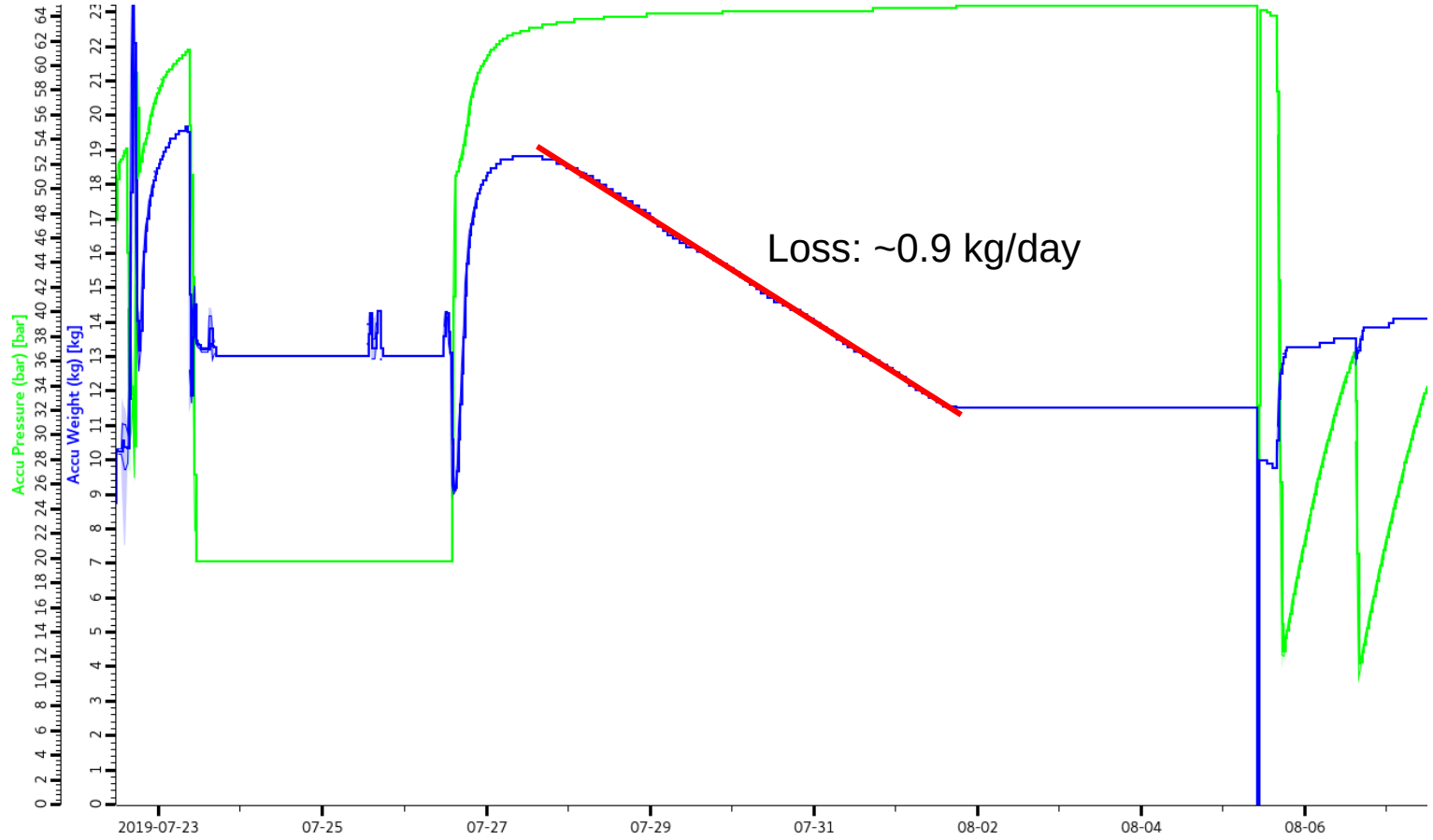
- operate fan from air cooled condenser to increase heat discharge from liquid line by forced convection
- Increase condensation temperature from 26°C to 32°C (reduces chiller efficiency)
- Get cooler air from main hall to fan inlet
- Active subcooling

  by heat pipe (simple, but did not work)
  peltier cooler (ordered, to be installed)



Maintenance

After maintenance IBBelle was refilled, tested and left off (warm!)



Leak Search

Started leak search, with the help of the KEK cyrogenics group

lock different sections and observe pressure loss
active search with CO_2 sniffers

Results quite confusing, some leak candidates (but many false positives)
some could be fixed by tightening connectors (CO_2 pump by Nikkiso)

one leak confirmed: Feed through of R404a line of B unit to cooling coil in accumulator (which is not used)

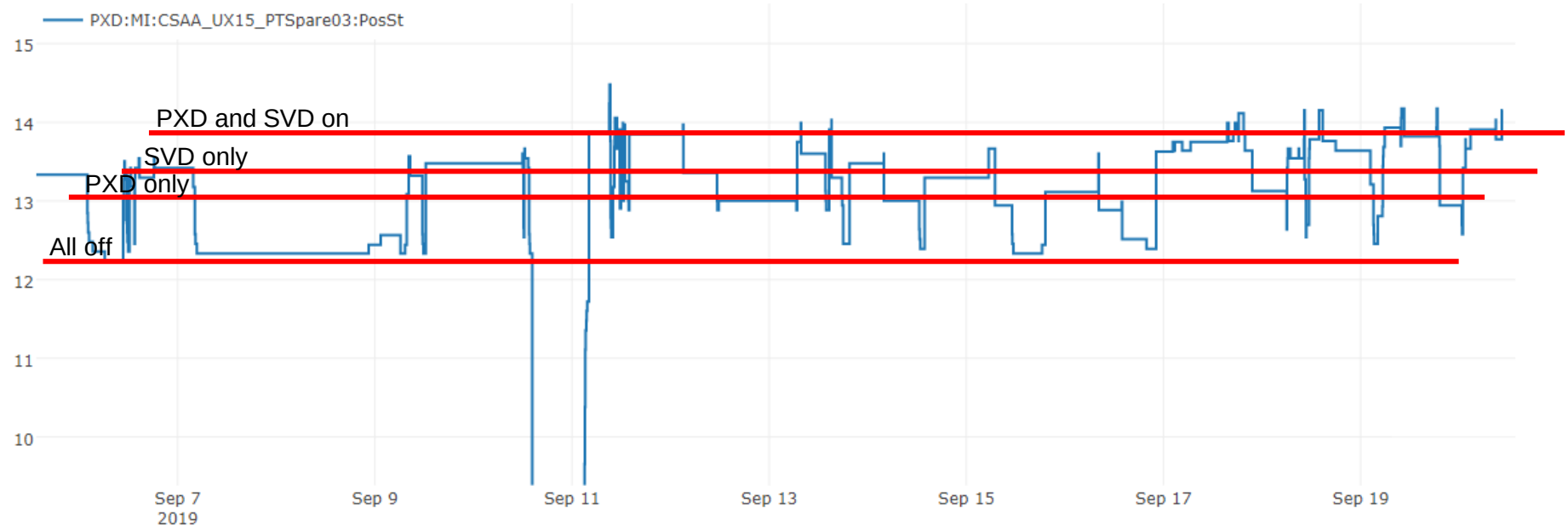
Unfortunately this joint is difficult to fix.

Proper repair needs orbital welding (to be done by a company)

Some easier fixes dicussed, but the problem is that the cooling coil cannot be removed

Consulting Swagelock (Oct 23).

Cold again



Running cold (-20°C) from September 5 (except short +5°C operation at Sep. 11):

⇒ No indication of a leak
⇒ Leak probably only open at high pressure. -20°C: 20bar, ambient: 65bar !

⇒ Expert from Swagelok will inspect and consult October 23, repair earliest in New Year Shutdown

Conclusions

IBBelle worked absolutely reliable during Phase III run

Maintenance in July to fix problematic heaters and update software

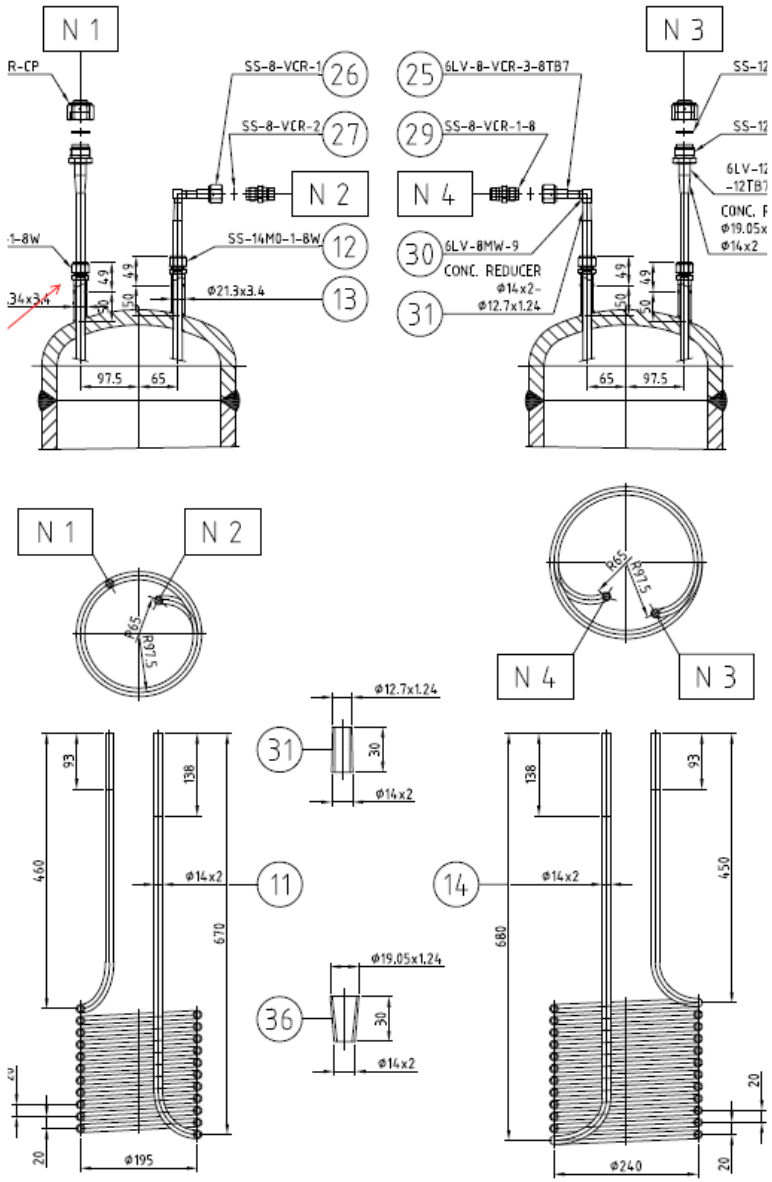
- Active subcooling of R404a before TX valve still needs to be implemented
- Problem caused by high ambient temperature (>26°C)

CO_2 leak(s) appears at high pressure (warm up when unit is off)

No problem at the moment if IBBelle runs cold (but may get worse!)

⇒ Difficult to fix, best way discussed with experts
⇒ Repair during next shutdown (New Year?)
=> Avoid frequent changes of operation mode (warm, off)

Accu


N 1
R-CP
SS-8-VCR-1
26
SS-8-VCR-2
27
N 2
SS-14M0-1-8W
12
Φ21.3x3.4
13
97.5
65
N 3
25
6LV-8-VCR-3-8TB7
29
SS-8-VCR-1-8
N 4
30
6LV-8MW-9
CONC. REDUCER
Φ14x2-
Φ12.7x1.24
31
65
97.5
N 1
N 2
N 4
N 3
Φ12.7x1.24
31
30
Φ14x2
93
138
460
Φ14x2
11
670
Φ19.05x1.24
36
30
Φ14x2
Φ195
20
14
Φ14x2
680
450
Φ240
20