Ambient temperature considerations

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But honestly, mostly A. Vamvakas

Input from CV colleagues

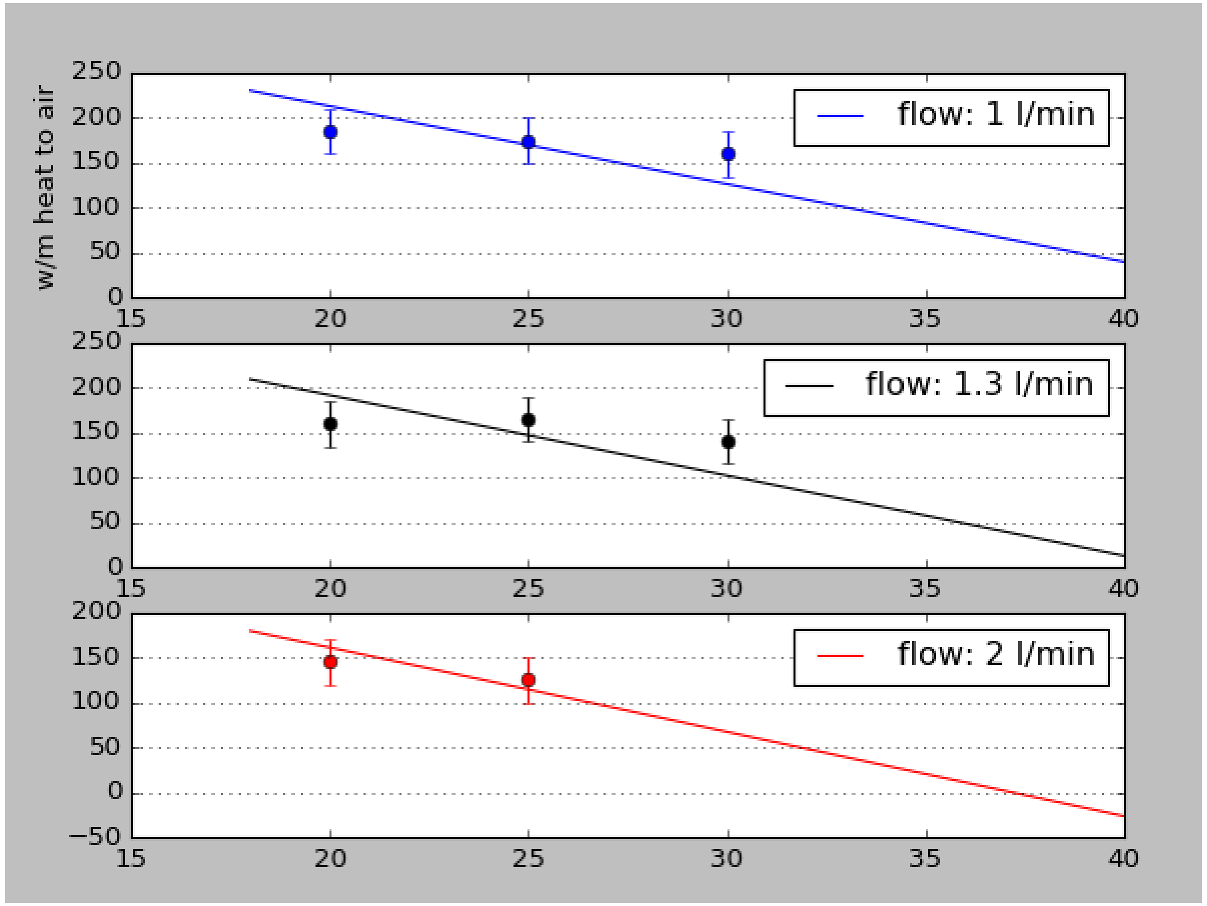
- Cooling tower produces 25C. Separate circuit for the tunnel, 27 fair assumption.
- Total DT not important for the efficiency of the overall cooling. Only affects pipes, heat exchangers and pumps.
- Ambient of 28C for commercial buildings (regulations). Operational temperature can be higher.
- If local ACU is installed, it should take care of **all** the heat.
- Tunnel walls only for dampening-error absorption (50W/m, EDMS 1562980). CFD guy looks into it further.
- ACU might need chilled water (~14C).
- Condensation not an issue at 27C.

Interesting amb temp

	interesting because	problems	calculations
20	Makes calibration easier, as same temp (although operational temp of components will be higher)	Heat to air explodes (>1000W/m)	ACU flow@14: 0.1kg/s /m (~200% of total flow)
20-27	This range is nor particularly interesting		
27-28	Makes on/off transients easy Automatically maintained with machine off Relatively low heat to air Manageable for people	Heat to air still significant Need ACU with 14C water	ACU flow@14: 0.006kg/s /m (~10% of total flow)
28-33	Heat to air gets lower Possible for local ACU with 27C water	Hot for people still need local ACU	For 30C: ACU flow@27: 0.05kg/s /m (~10% of total flow) ACU flow@14: 0.0005kg/s /m (~0.1% of total flow)
33	Equilibrium temperature, no heat to air No ACU	Too hot for people and equipment Need separate temp for maintenance Calibration/alignment gets tricky	

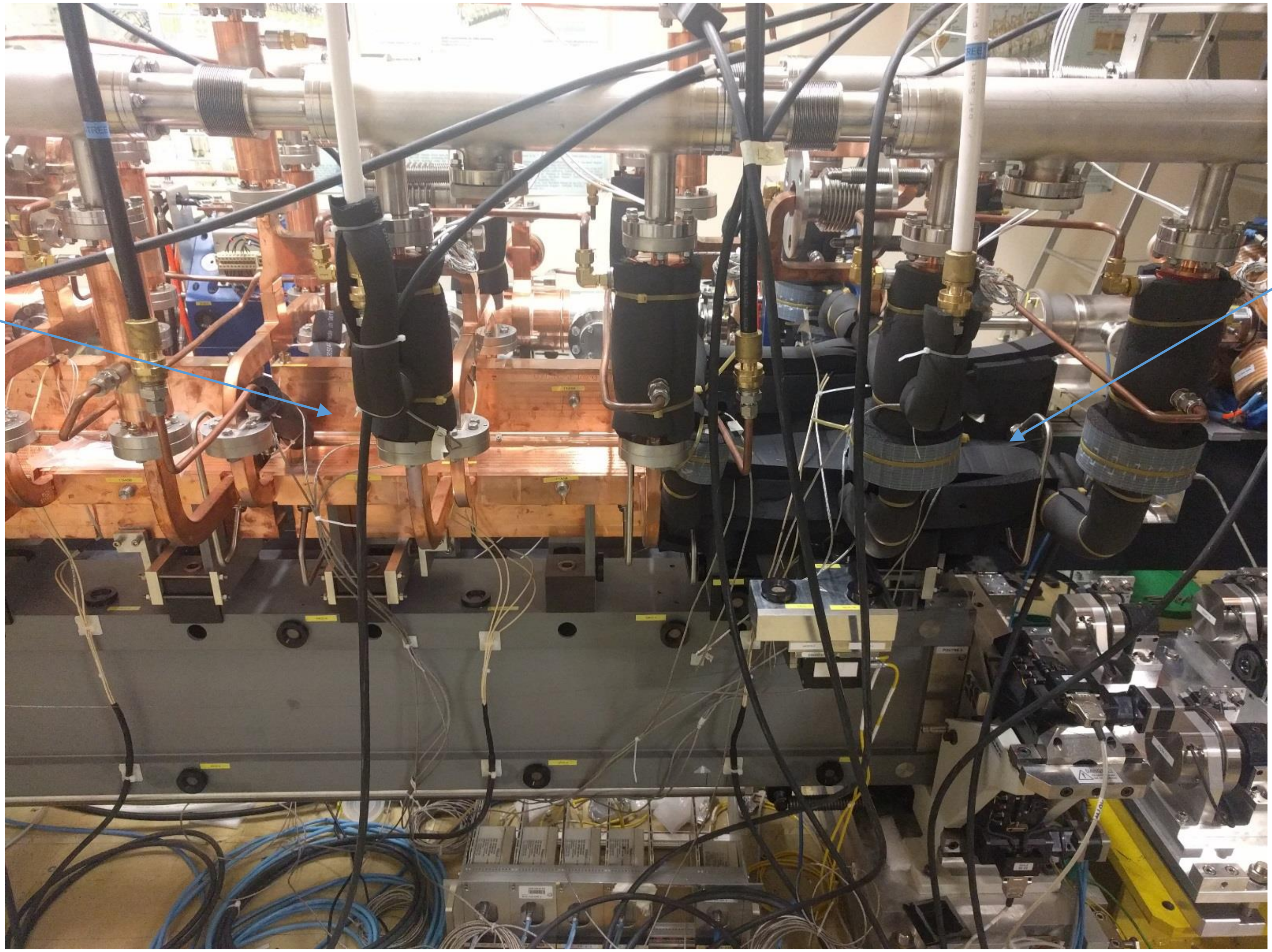
Heat to air tests vs model

- More data points are required (ongoing)
- Modelling only SAS
- Model is long tube working as heat exchanger -> can be elegantly solved analytically but in real components cooling channels are curled up



Insulation

SAS 3
(naked)



SAS 4
15mm ‘armaflex’
insulation

*RF loads are always insulated
for more realistic results

Insulation

According to Armacell:

Heat transfer coefficient of armaflex is 5 < h < 9W/m2*K

For comparison:

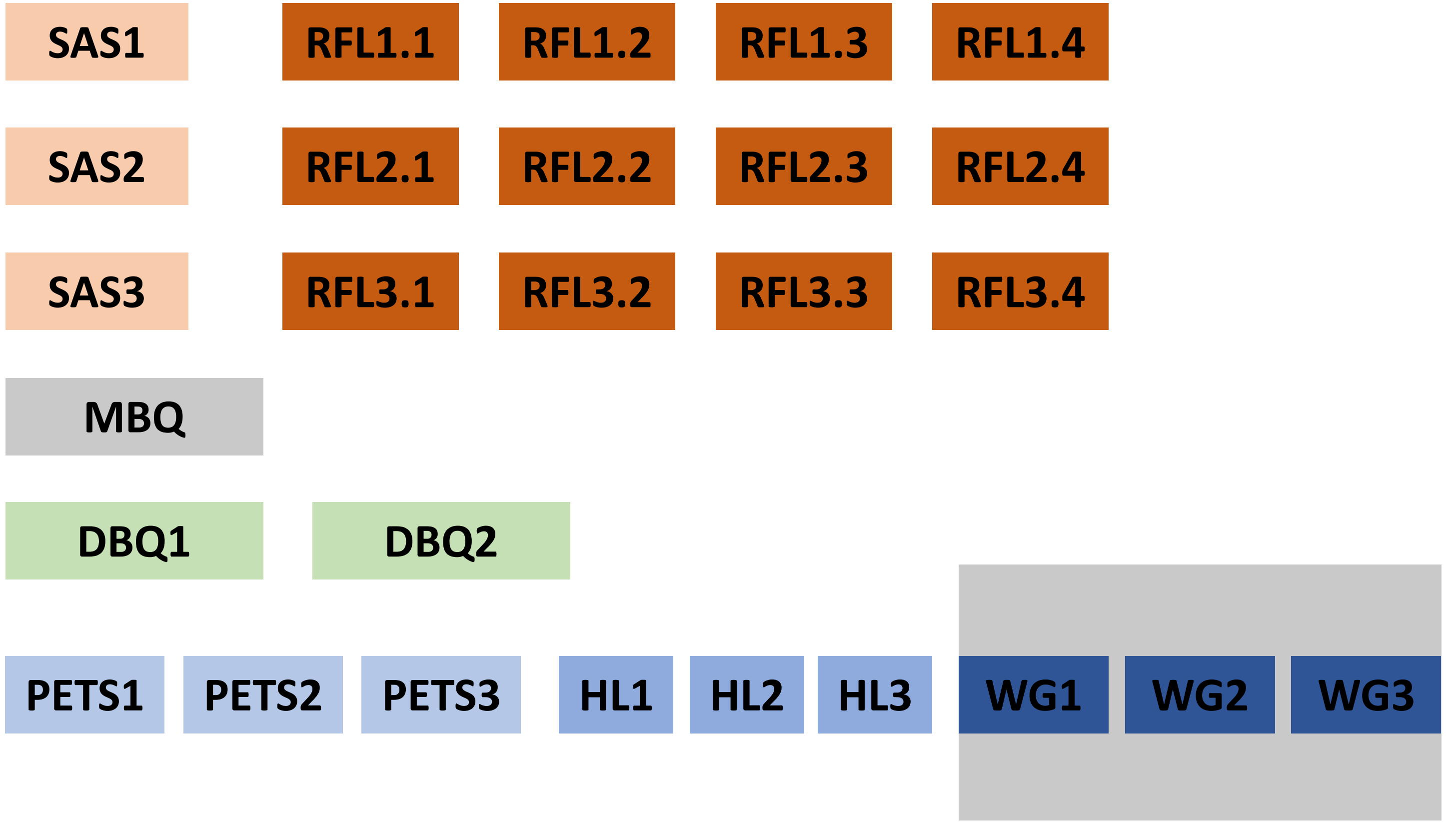
In our simple thermomechanical simulations we assume an average h of 15W/m2*K

Tcomp is somewhere between 32 and 36°C
-> hence at high ambient difference of insulation is not that striking

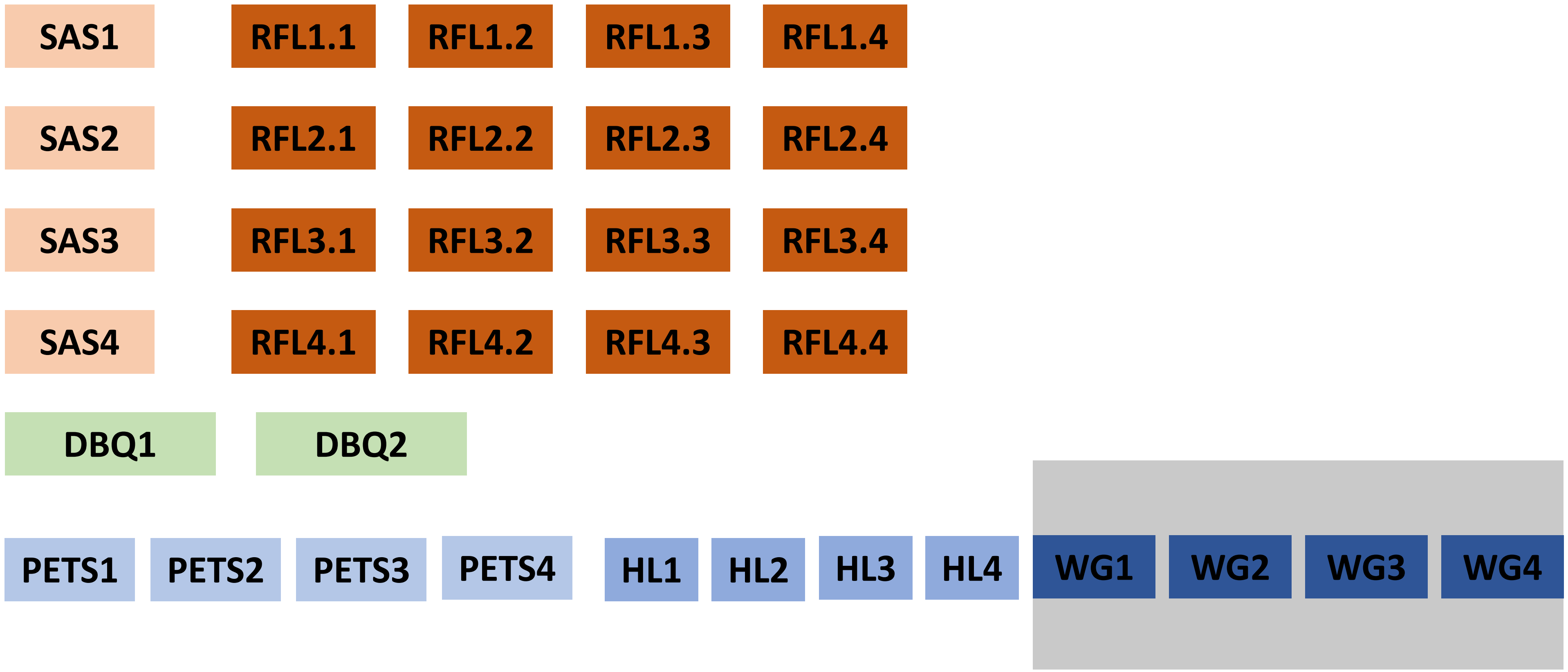
ambient	flow (l/m)	Hair naked (W)	Hair insulated (W)	difference	
30	1	170	130	40	-24%
30	1.3	150	130	20	-13%
25	1	175	115	60	-34%
25	1.3	165	120	45	-27%
25	1.9	125	90	35	-28%
20	1	185	110	75	-41%
20	1.3	160	95	65	-41%
20	2	145	70	75	-52%

IF we want to do something about ΔT of water

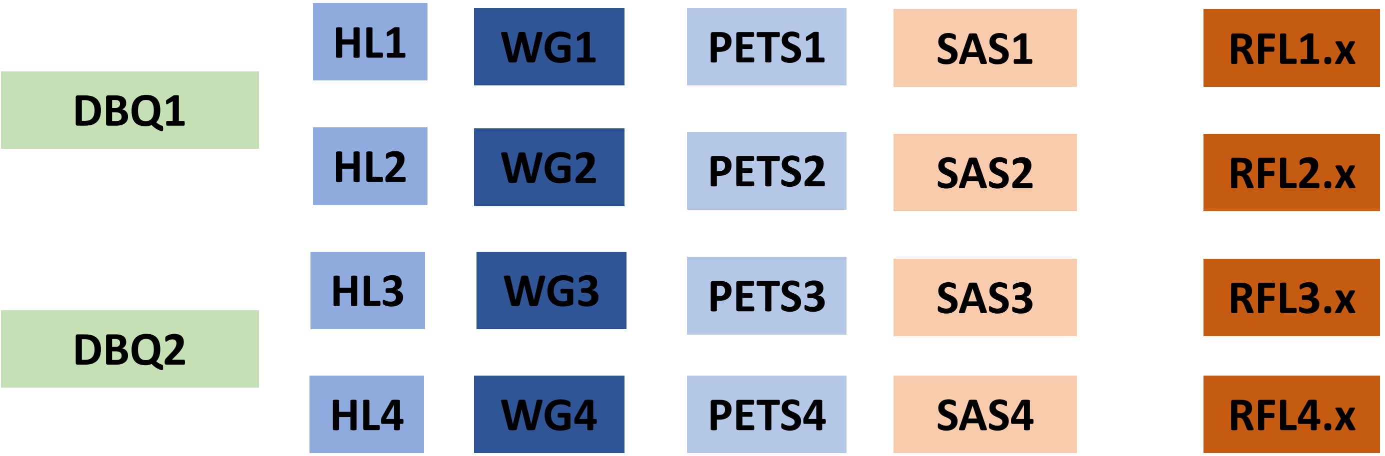
CDR T1


SAS1
RFL1.1
RFL1.2
RFL1.3
RFL1.4
SAS2
RFL2.1
RFL2.2
RFL2.3
RFL2.4
SAS3
RFL3.1
RFL3.2
RFL3.3
RFL3.4
MBQ
DBQ1
DBQ2
PETS1
PETS2
PETS3
HL1
HL2
HL3
WG1
WG2
WG3

CDR T0


SAS1
RFL1.1
RFL1.2
RFL1.3
RFL1.4
SAS2
RFL2.1
RFL2.2
RFL2.3
RFL2.4
SAS3
RFL3.1
RFL3.2
RFL3.3
RFL3.4
SAS4
RFL4.1
RFL4.2
RFL4.3
RFL4.4
DBQ1
DBQ2
PETS1
PETS2
PETS3
PETS4
HL1
HL2
HL3
HL4
WG1
WG2
WG3
WG4

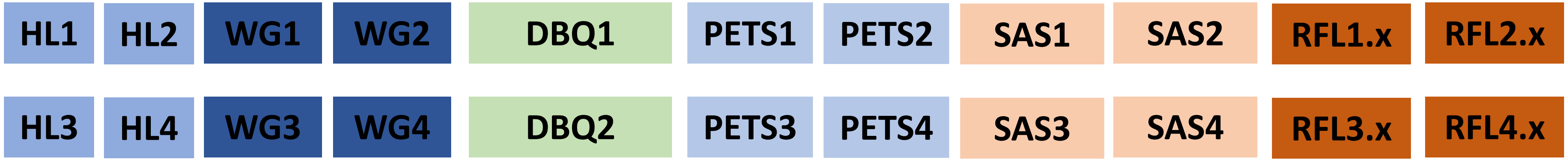
Aim higher ΔT



For same power loss we need to reduce the flow -> less parallel, more series

Rule of thumb: components with small Ploss need to be at low T in order to keep Pair low

Extreme high ΔT



Rule of thumb pushed to extreme, but T stability for SAS questionable and Pair very high