

WP14.5

Mechanical & Thermal tools for Innovative Calorimeters



Task 1

Precision mechanics for calorimeter structures

Task 2

Infrastructure to evaluate thermal properties of calorimeter structures

Summaries of the achievements in sub-task 14.5-2

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AIDA 2020

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WP14.5 - Task 2

Compact and highly efficient Cooling Systems

2.1 Cooling system to test thermal modelling of large CF (carbon fiber) structures (*ECAL - LPSC*)

2.2 Cooling system for low power calorimeter readout electronics (*AHCAL - DESY*)

The development of a cooling system for low power calorimeter readout electronics is based on design close to those of the ILD innovative calorimeters @ ILC

Deliverables 14.8 (June 2018) / **Large leak-less System, thermal model**

- Construction of a real size water cooling circuit for both calorimeters
 - **Demonstrators and results**

HCAL: (Stainless Steel absorber stack structures +...)

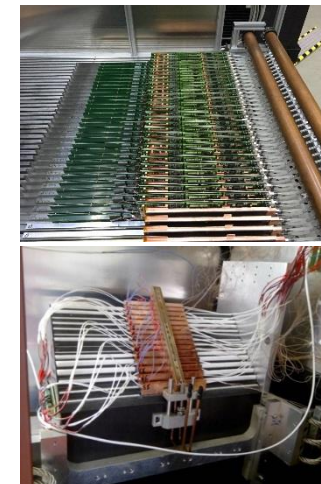
Cooling system for the full EUDET stack

(40 active layers of 2*2 HBUs)

Thermal coupling & system parameters

ECAL: (CFRP+W structures + Silicon detectors)

full size leak-less cooling-loop on 3 levels (13m-10m- 9m)



Task 2-1 ECAL: towards ILD - cooling developments (LPSC)

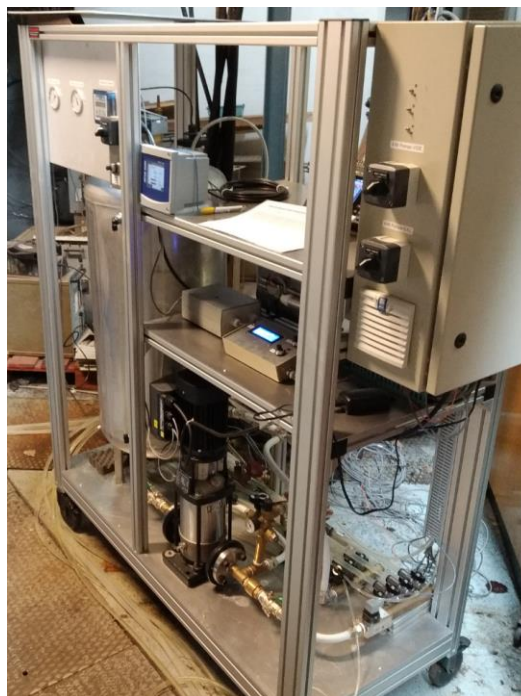
➤ **Location of the cooling station** (summer 2019) (possibility to install it on the moving platform)

- Demonstration and performance of the full size leak-less cooling loop on 3 levels

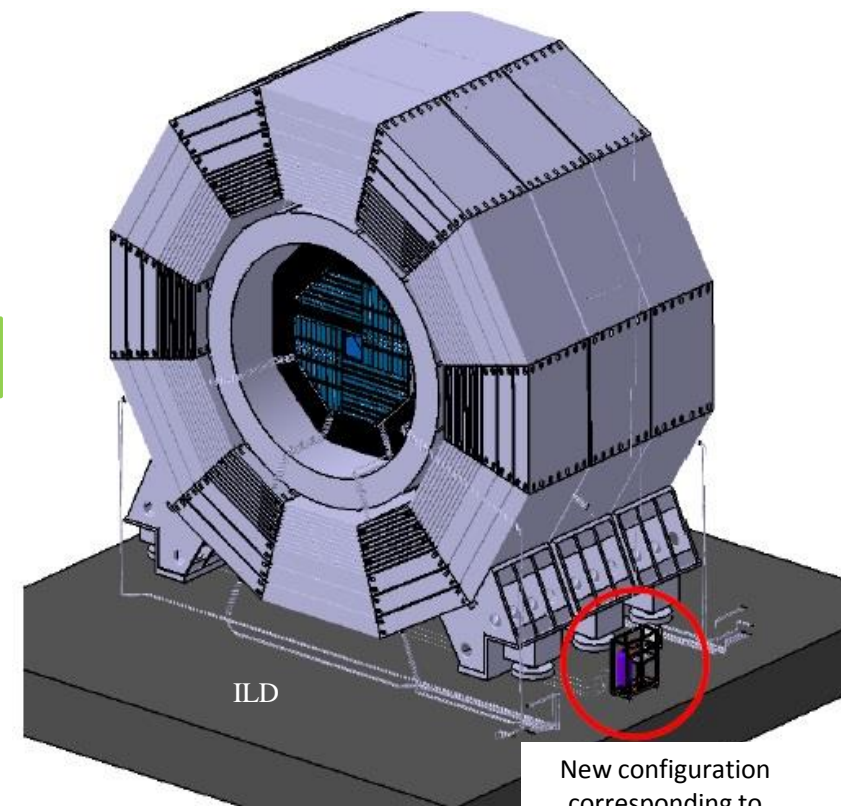
⇒ **Leakless-Cooling station can operate on the ILD platform**

Julien Giraud

Channel	Name	Unit	Range	Location	Flow	Experimental	Simulation	Simulation	Simulation
LEAK LESS COOLING						Real test	Loop 1	Loop 2	Loop 3
1	Q1	l/min	3 - 60	Outlet pump	12	13.42			
2	Q2	l/min	0.08 - 20	loop 1	4	4	4		
3	Q3	l/min	0.08 - 20	loop 2	4	4	4		
4	Q4	l/min	0.08 - 20	loop 3	4	4			4
5	Pr	m Bars	-1000 / 3000	Tank pressure		-750	-500	-600	-600
6	Pd	m Bars	-1000 / 3000	Starting pressure		1079	765	1515	1515
7	Pr	m Bars	-1000 / 3000	Return Pressure		-613			
Basse	8	P1b	m Bars	Pression ligne 1 basse		44	-120		
	9	P1m	m Bars	Pression ligne 1 milieu		-610	-790		
	10	P1h	m Bars	Pression ligne 1 haute		-337	-320		
Milieu	11	P2b	m Bars	Pression ligne 2 basse		-55		-180	
	12	P2m	m Bars	Pression ligne 2 milieu		-466		-570	
	13	P2h	m Bars	Pression ligne 2 haute		-459		-600	
Haute	14	P3b	m Bars	Pression ligne 3 basse		-262			-380
	15	P3m	m Bars	Pression ligne 3 milieu		-690			-720
	16	P3h	m Bars	Pression ligne 3 haute		-575			-600



Cooling station



New configuration corresponding to cooling station **on** the ILD platform.

Real dimensions detector / zone of tests

Maximum elevation between ground and ECAL top is 13m

Task 2-1 ECAL: towards ILD - cooling developments (LPSC)

➤ **Test of a Polarographic probe** (for dissolved oxygen) *(summer 2019)*

- To determine the rapidity of leak detection
(first results : not convincing evidence of operation)
=> *Goal: insert directly in cooling return-lines*
- Effort at LPSC definitively limited by available engineering person power

Julien Giraud



Integration Polarographic probe : OK



Control Interface: OK

➤ **No continuation**
(LPSC not involved in AIDA++)

Task 2-2 AHCAL: Cooling system for low power calorimeter readout electronics

AHCAL: (Stainless Steel absorber stack structures +...)

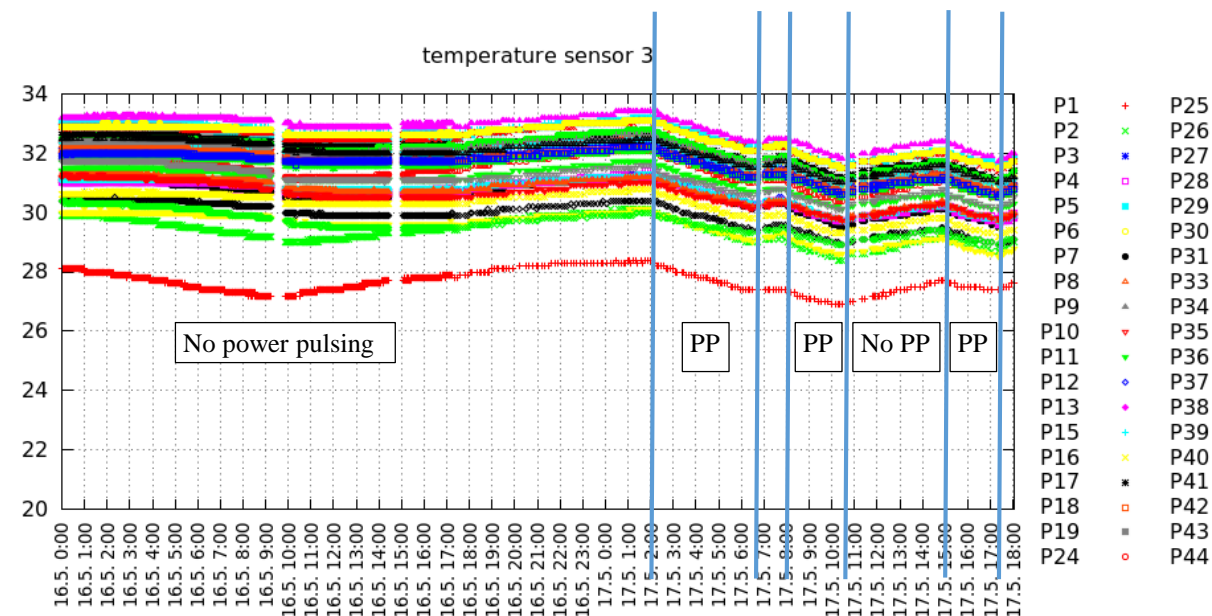
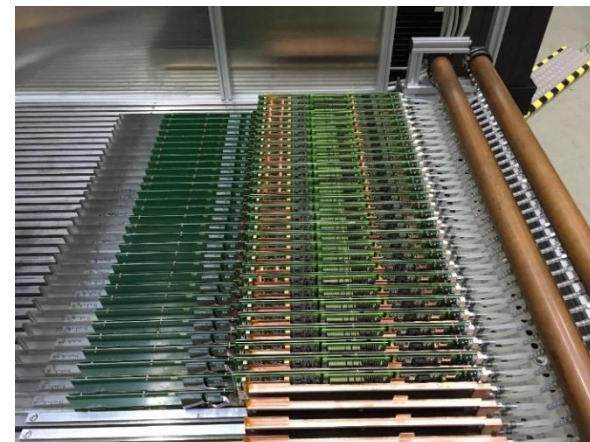
➤ EUDET stack equipped with 38 active layers of 2*2 HBUs

- allows test of system aspects (e.g. distribution of cooling water between layers)
- several testbeams at CERN SPS with prototype in 2018, so reliable cooling essential
 - stay with the previous over-pressure system
 - system parameters like pipe diameters are already designed for leak-less system, so experience gained with this prototype will be valuable lesson for leak-less system

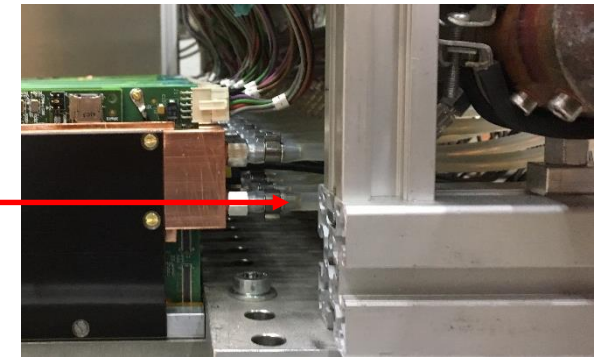
➤ Reliable operation during all periods with and without power pulsing

- 2 weeks + 1 week AHCAL stand-alone + 2 weeks combined with CMS HGCAL prototype

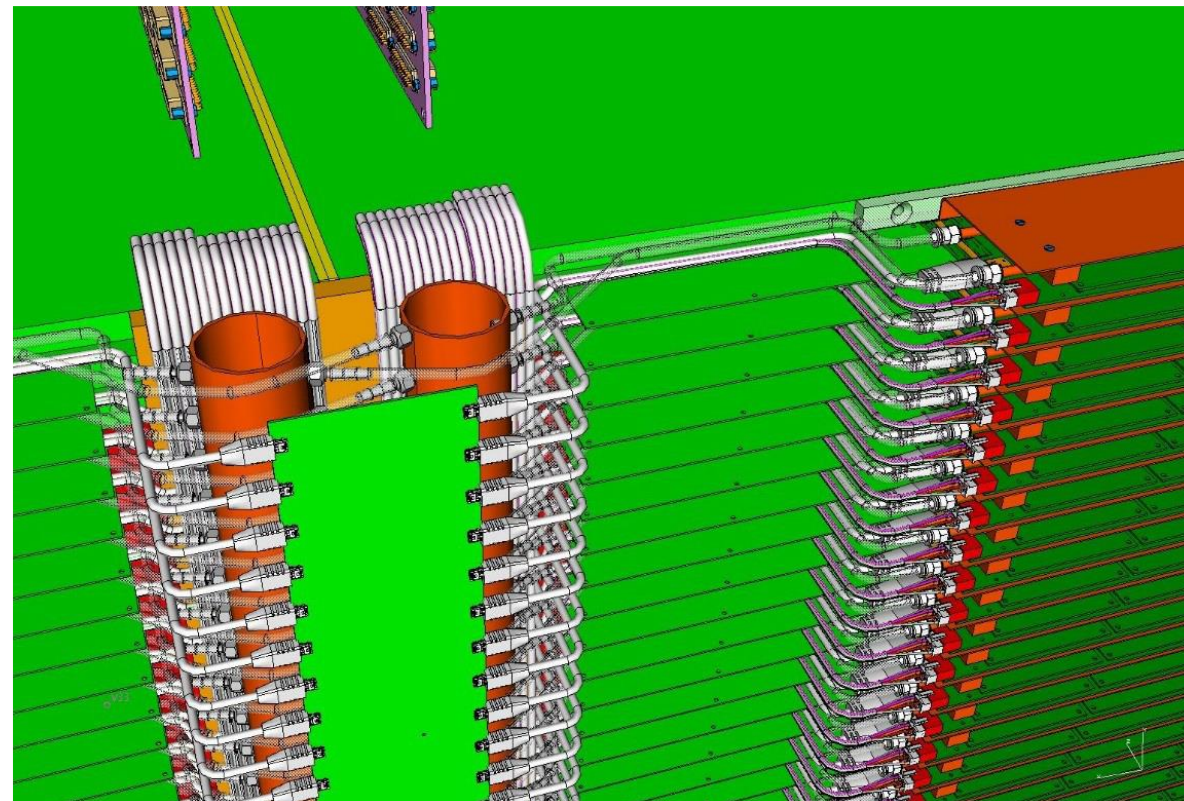
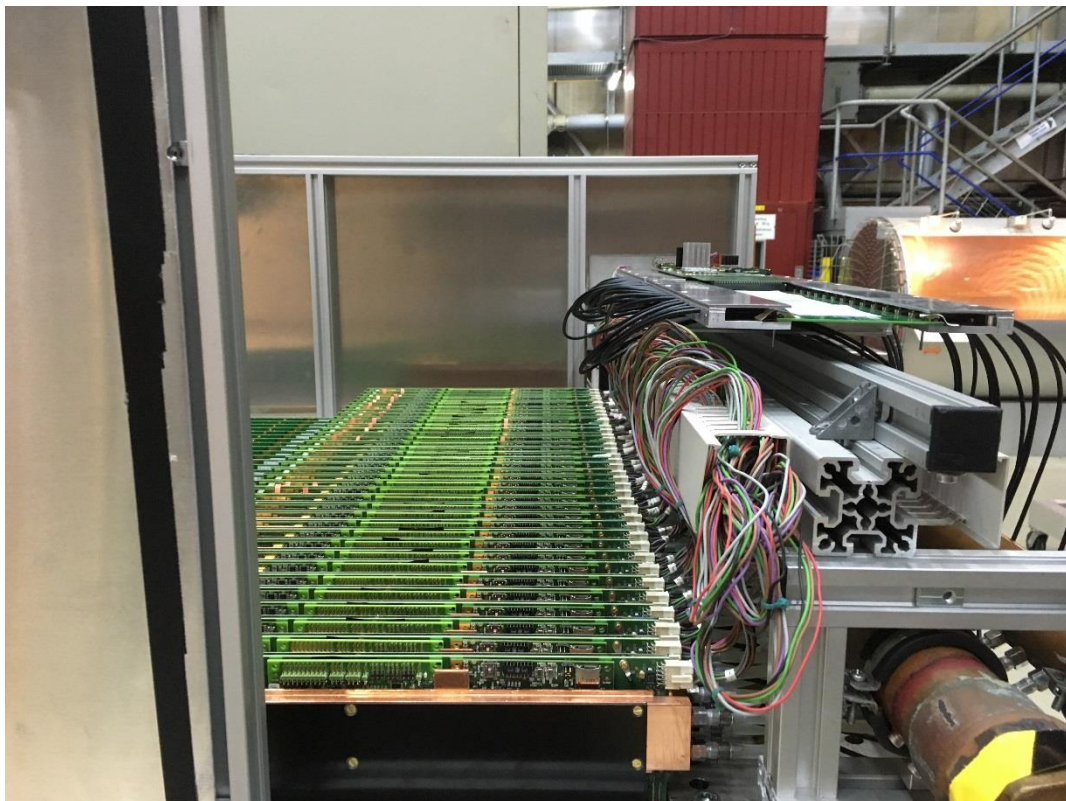
➤ documented in D14.8 report



- Cooling system for 40-layer testbeam prototype
 - Successfully operated in several beam tests
 - Next steps:
 - At the moment cooling plates are thermally decoupled from absorber to understand cooling of interface boards
 - Replace by thermally conductive material and understand influence of absorber
- Thermal test with full layer
 - Horizontal steel structure for 3 full layers exists
 - assembled electronics for first large layer (3*6 HBUs)
 - Final mechanics (~2 m long cassettes) not yet available
- Adaptations for leakless system
 - Flexible cooling pipes need to be replaced by rigid ones
 - Each cooling plate needs a valve to regulate the flow
 - Tests with different configurations (horizontal / vertical)
- Effort at DESY strongly limited by available engineering person power and development objectives should be concentrated on electronics within AIDAinnova

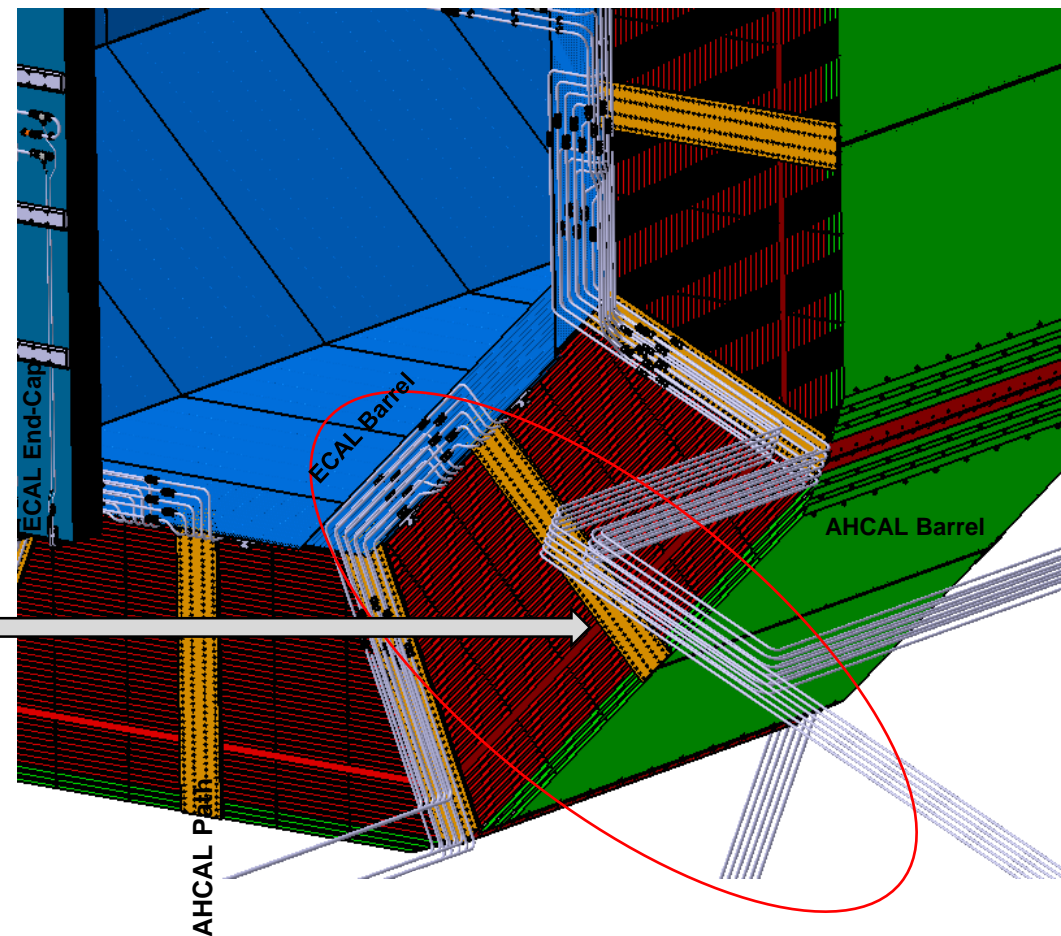
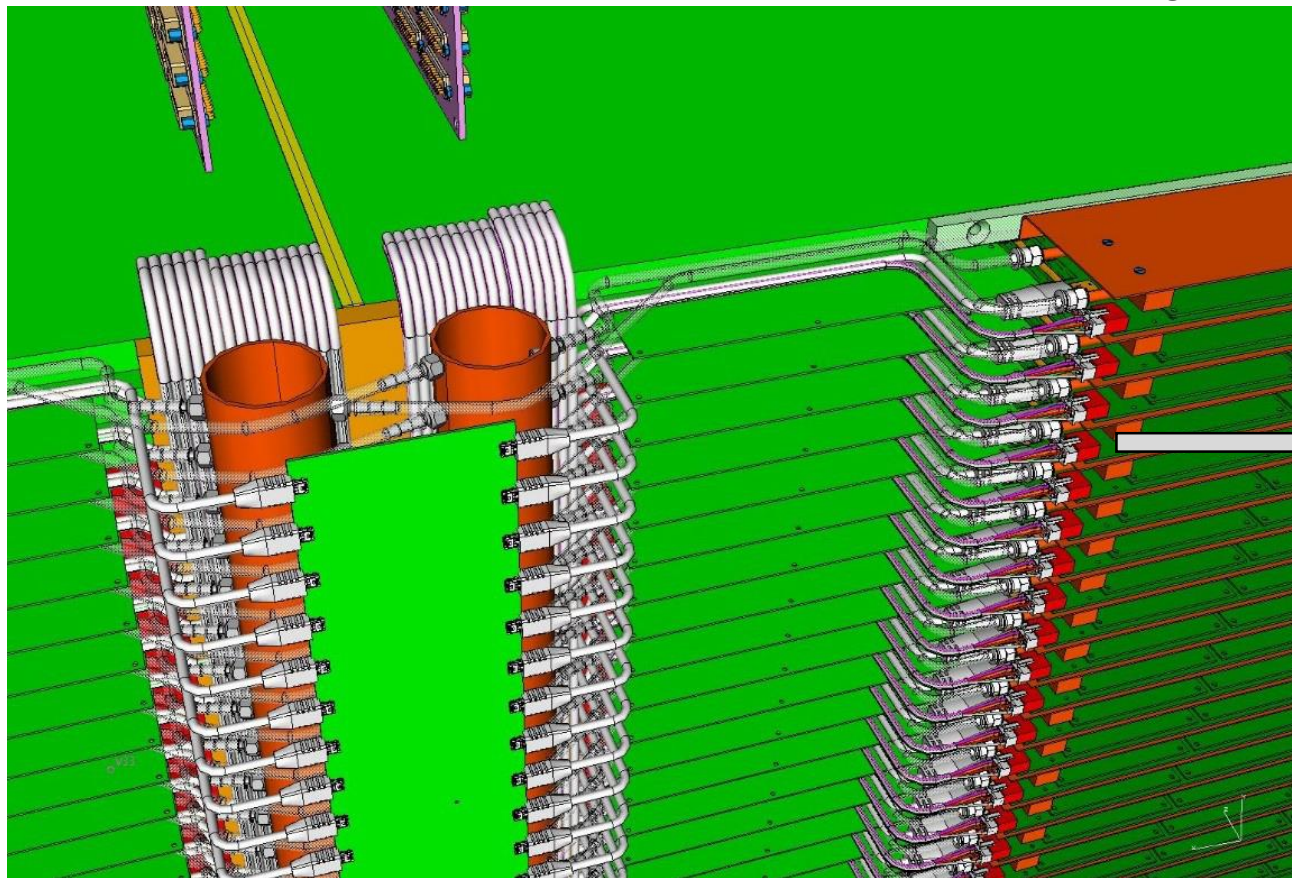


- Detailed design of the AHCAL and ECAL services



- Detailed design of the AHCAL and ECAL services

Integration



WP 14.5-2 – Outlook on relevant publications

Overview on the publications since the beginning of AIDA2020:

Common running of calorimeter prototypes /

Krüger, K. (DESY)

AIDA-2020-D14.5.- Geneva : CERN, 2018 AIDA-2020, 14.5 **Fulltext:** [5.PDF](#);

Large leak-less system, thermal model /

Grondin, D. (CNRS-LPSC) ; Krüger, K. (DESY) ; Giraud, J. (CNRS-LPSC)

AIDA-2020-D14.8.- Geneva : CERN, 2018 AIDA-2020, 14.8 **Fulltext:** [8.PDF](#);

Design of cooling systems for tungsten / carbon fibre and for hadron calorimeter structures /

Grondin, D. (CNRS-LPSC) ; Krüger, K. (DESY) ; Giraud, J. (CNRS-LPSC)

AIDA-2020-MS31.- Geneva : CERN, 2016 AIDA-2020, 31 **Fulltext:** [PDF](#);

CALICE Si/W ECAL: Endcap structures and cooling system /

Grondin, D. (LPSC, Grenoble) ; Giraud, J. (LPSC, Grenoble) ; Hostachy, J.-Y. (LPSC, Grenoble)

The next major project of particle physics will be the International Linear Collider: a linear accelerator in which electrons and positrons will collide with energies of 500 to around 1000 billion electronvolts. [...] arXiv:1702.03770. - 2017. - 12 p. [Preprint](#) - [Full text](#)

No publication since the last Annual Meeting in Oxford

WP14.5 - Task 2

Compact and highly efficient Cooling Systems

Contributions and outlooks on the future including AIDA++ (AIDAinnova):

➤ AHCAL

- Cooling system worked well and cooled the detector interfaces reliably
 - Further analysis of the data to perform
 - hardware is back at DESY, so further tests possible, but very little person power
- Developments will be concentrated on electronics within AIDAinnova

- **ECAL** : the work on the cooling station will stop in 2020 - *no involvement in AIDAinnova, but for FCC-ee ?*
 - Except for Cooling network of a real size large End-Cap module (*full network on rear side of a module*)
 - If necessary: Test of the compatibility of the cooling system with the SL-Board developed at IJCLab