

# DRD8: Cooling

On behalf of the DRD8 collaborators



The University of Manchester



Centro Nacional de Microelectrónica



CSIC



Norwegian University of  
Science and Technology

IMPLEMENTING DRD8:

AN R&D COLLABORATION ON Mechanics & Cooling of Future Vertex and Tracking Systems

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## DRD8.3: New coolants

<b>Project Name</b>	Project/Task: New cooling fluids and systems (WG 8.3)
<b>Project Description</b>	Cold detector cooling using Krypton as a new refrigerant
<b>Innovative/strategic vision</b>	Exploration of a new cooling domain using a natural refrigerant in a novel cycle
<b>Performance Target</b>	Cooling detector structures with high dissipation in the temperature domain between -90 °C and -50 °C
<b>Contributors</b>	CERN, NTNU-Trondheim, Companies <ul style="list-style-type: none"> <li>• Norway – NTNU - Trondheim - Armin.Hafner@ntnu.no</li> <li>• Switzerland- CERN – Bart.Verlaat@cern.ch</li> </ul>

[Latest update \(LHCb VELO U2 Workshop\)](#)

DRD8.3: Warm and Supercritical CO<sub>2</sub>

\*to be included

Project	Warm and supercritical CO <sub>2</sub>
Description	Operation of CO <sub>2</sub> at warm temperature (reduced pressure) and at supercritical single-phase (sCO <sub>2</sub> )
Innovative/Strategic vision	provide precision measurements of thermal-fluidic properties of sCO <sub>2</sub> in the range of temperatures of interest for possible ultra-light future detectors operating in environments with low radiation levels
Performance target	Theoretical and experimental study of thermal and fluidic behaviour of sCO <sub>2</sub> flowing in small pipes/microchannels, heat exchangers design and operation optimization, Reliable performance prediction, study the passage from sub- to super-critical
Contributors	CERN

## DRD8.3: Microchannels

<b>Project Name</b>	Project/Task: Microchannels cooling substrates
<b>Contact people</b>	Oscar Augusto de Aguiar Francisco (oscar.augusto@manchester.ac.uk) Miguel Ullán (miguel.ullan@csic.es) Julien Cogan (cogan@cppm.in2p3.fr)
<b>Project Description</b>	Development of the next generation of microchannels cooling structures envisaging cost-reduction, better electronics integration, different materials and/or manufacturing techniques.
<b>Innovative/strategic vision</b>	Better integration of electronics (sensor and/or frontend electronics) and/or cost reduction
<b>Performance Target</b>	Explore the cooling parameter space of low material budget (down to $\leq 0.2 \%X_0$ ) and low power dissipation ( $\sim 10\text{-}100 \text{ mW/cm}^2$ ) and high power dissipation ( $\sim 2\text{W/cm}^2$ ). The progress will be tracked via public reports through presentations, public notes and/or papers.

## Silicon microchannels

- CMOS compatible process (CNM)
- Thermocompression (“Hyperbar”, CPPM)

## Ceramics

- LTCC/HTCC (UoM)

## 3D printing

- Metal (UoM)

## DRD8.3: Cooling Facilities

### Available systems

Location	System	Capacity	Description
153	Primary System A	70kW @ -53°C	A primary CO2 refrigeration system with oil lubrication
153	Lucasz	2kW @ -30°C	User friendly oil free CO2 I-2PACL station
153	Traci	400W @ -25°C	User friendly mobile oil free CO2 I-2PACL station
153	CORA	2kW @ -25°C	Early prototype cooling machine, possible upgrade to cold temperatures
2175/ 3584	DEMO inheritance	65kW @ -45°C	Former DEMO cooling system used for phase-2 detector construction
186	CMS TIF	14 kW @ -35°C	CMS tracker development for phase 1 and 2
180	ATLAS Baby-DEMO	6kW @ -40°C	ATLAS cold RnD system for phase 2 upgrade

## DRD8.3: Plans

- Common meetings
  - Share ideas which can be useful to the community
  - Every 2 months
    - Critical developments take time
    - First one by the end of February
- Krypton and CO<sub>2</sub>
  - Krypton System at CERN by (next week)
  - Explore supercritical and 2-phase area (coming months)
  - System ready to be tested with samples (summer?)
  - New PhD starting in April
  - DORIN: Oil free compressor before the end of the year
  - New partner interested to develop a freezer (this year)
    - Commercial demonstrator

## DRD8.3: Plans

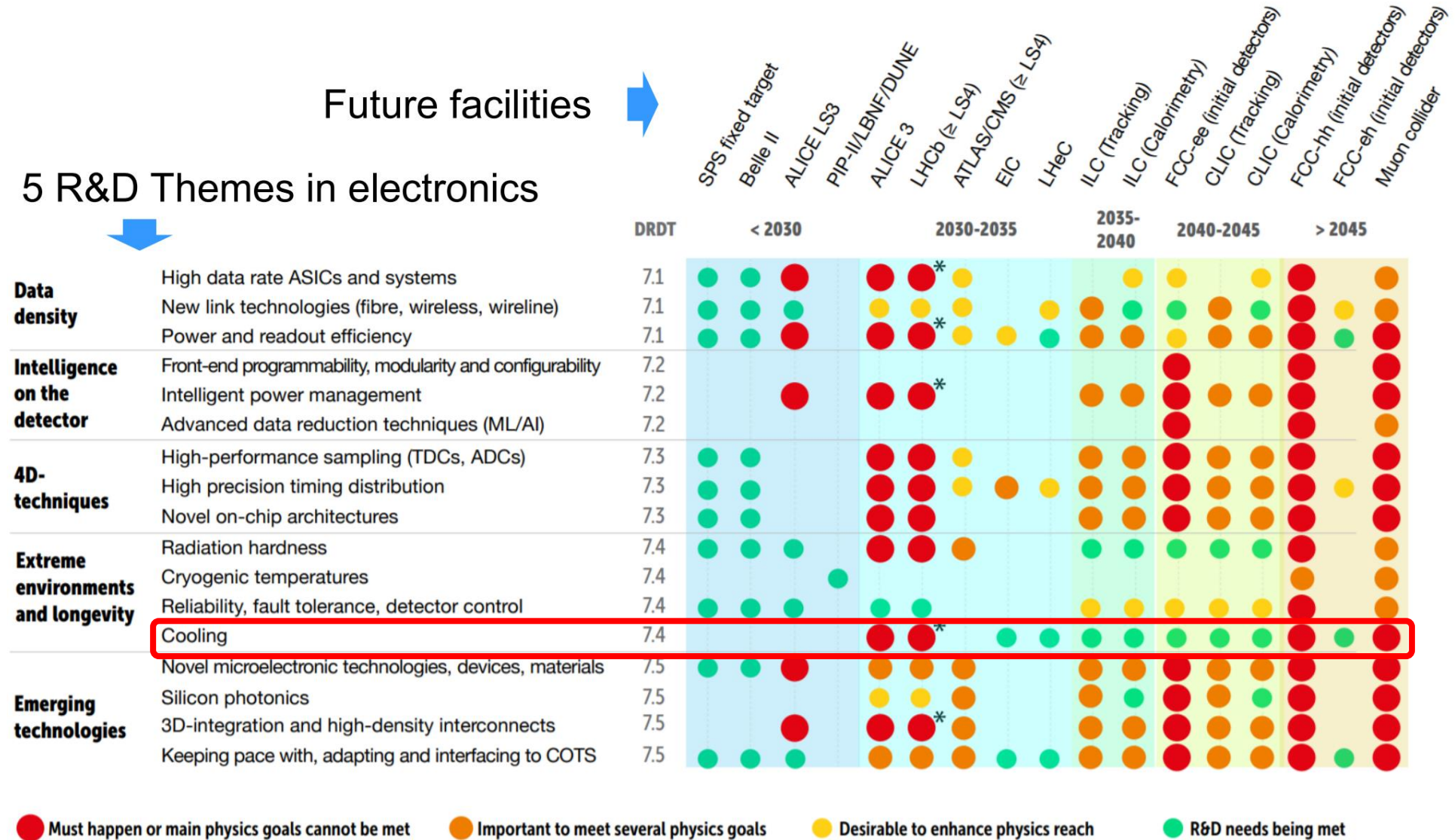
- Ceramics:
  - Initial cooling tests with CO<sub>2</sub>
  - Potential to share test with the Krypton set-up well (summer?)
  - New production being organized @ CERN
- 3D metal printing:
  - New samples: 1mm<sup>2</sup> cross section visually good and not blocked
  - Samples submitted to welding/brazing tests
  - Samples with 250um wall thickness will be high pressure tested
- Silicon microchannels:
  - CPPM:
    - Impact of selective metallization on high pressure tests (TBC)
    - More information [here](#)
  - CNM:
    - Activities ramping after hiring a new engineer

# Backup slides



# Future facilities

## 5 R&D Themes in electronics



\* LHCb Velo