DRD 8 WP1 status and plans

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DRD8 kick-off meeting
CERN, 31 January 2025

Two projects

1. The Vertex Region of Future Particle Physics Experiments

- Development of the next generation mechanics for advanced vertex layouts, including
  - Curved and tilted silicon sensors
  - Low radii vertex and retractable detectors
  - Ultra-light, high-vacuum leak tight beam pipes and vessels
  - Low mass hardware alignment systems for future vertex detectors
  - Machine Detector Interface and impact on Detector

2. Robots in the HEP Experimental Caverns

- Development of robotic systems for future high energy physics experiments for inspection monitoring and first intervention for particle detectors even during the operation of beams
  - Legged ground robotic platform in experimental cavern
  - Aerial robotic platform in experimental cavern
  - Mini-robots swarm and mobile mesh network

WP 1.1

Curved Sensors

Develop new wafer-scale curved silicon pixel chips to surround the beampipe and their carbon foam mechanical support. This concept has the potential to reduce the material budget and to bring the first detection layer closer to the interaction point.

Expertise at CERN within the context of the ALICE ITS3, and Strasbourg

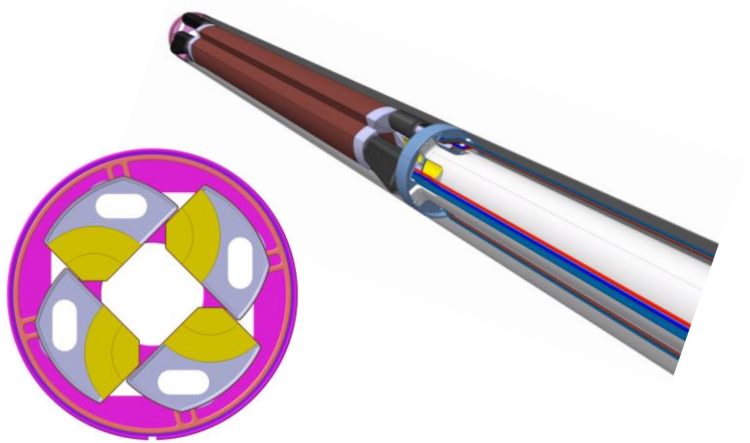
Composite structures expertise (among others) in Bristol, Geneva, Liverpool and Oxford

Air-cooling integration is needed
Non-planar wire-bonding is required

Potential experiments: ALICE, FCC-ee, CEPC, EIC vertex detectors

WP 1.1

Retractable Detectors



Development of a retractable Vertex Detector, inside the beampipe, positioning the first sensor layer as close as possible to the interaction point. Apertures, impedance and vacuum stability are key beam parametres and the Vertex detector petals has a direct impact on them.

Expertise at CERN within the context of the ALICE3
Nikhef with UHV

Accelerator experts feedbacks mandatory

Conductive cooling needed

Potential experiments: ALICE3, FCC-ee vertex detectors

WP 1.1

Thin Beam Pipe

Decrease material budget. Next CERN beryllium beampipe of a 16 mm inner radius and 0.5 mm wall thickness. Under study for FCC-ee one a 20 mm diameter and a double layer of 0.35 mm thick beryllium walls for cooling purposes. Retractable Vertex detector as well RICH detectors could also require ultrathin vacuum tight wall cases. To achieve wall impermeability R&D will focus on material like beryllium alloy, AlBeMet, and carbon composite.

Expertise at CERN, Frascati and IHEP

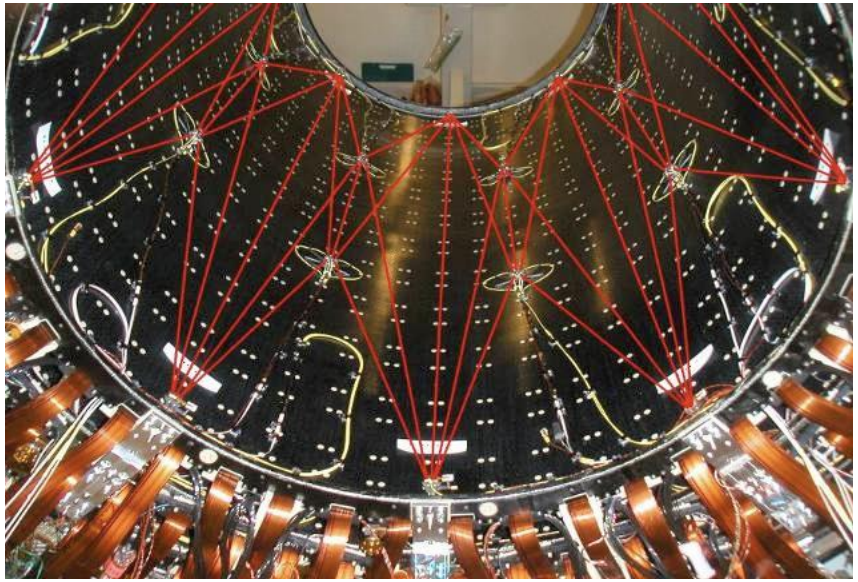
Accelerator experts feedbacks mandatory

Cooling integration

Potential experiments: ALICE, FCC-ee, CEPC, EIC

WP 1.1

Low mass hardware alignment systems for future vertex detectors



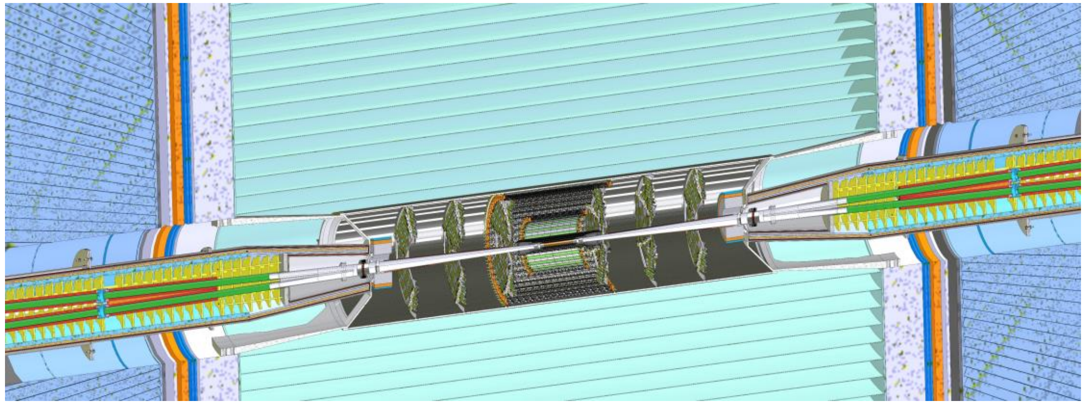
Achieving the ultimate performance of a tracking detector ultimately often depends on the quality of its alignment. Especially weak degrees of freedom, often linked to the direction through the sensor thickness, can be limiting factors. Develop a solution to provide information that is complementary to that available through track-based alignment algorithms and that is low mass and radiation-hard.

Expertise at CERN, Freiburg, GSI, IHEP

Potential experiments: ALICE, FCC-ee, CEPC, EIC

WP 1.1

Accelerator and Vertex Detectors Integration



Complex optics very close to the IR are needed to focalize the beam and achieve the high luminosity of the FCC-ee. The assembly of the detector must cope with tight requirements and allow the operations and maintenance.

Expertise widespread

Accelerator experts feedbacks mandatory – Frascati, CERN, IHEP

Potential experiments: ALICE, FCC-ee, CEPC, EIC

WP 1.1 – deliverables and milestones

Label	Topic	Month	Description
M1.1.1	Curved and tilted sensors	12	Demonstrate curved and tilted sensors bringing the first hit point closer to the interaction point.
D1.1.1	Ultra thin beam pipe	24	Deliver an ultra-thin vacuum beam pipe (carbon, beryllium, Albemet) for primary and secondary vacuum compatible with vacuum operational requirements.
M1.1.2	Retractable detectors	36	Develop a design for a retractable vertex detector with minimum material budget that could withstand the primary and secondary vacuum.
D1.1.2	Mock-up & integration	36	Delivery of a mock-up of the interaction region with integration of vertex detector and services.

Need to discuss who is contributing – intermediate check points?

Need to be revisited by the Institutes contact persons

WP 1.1 – Resources

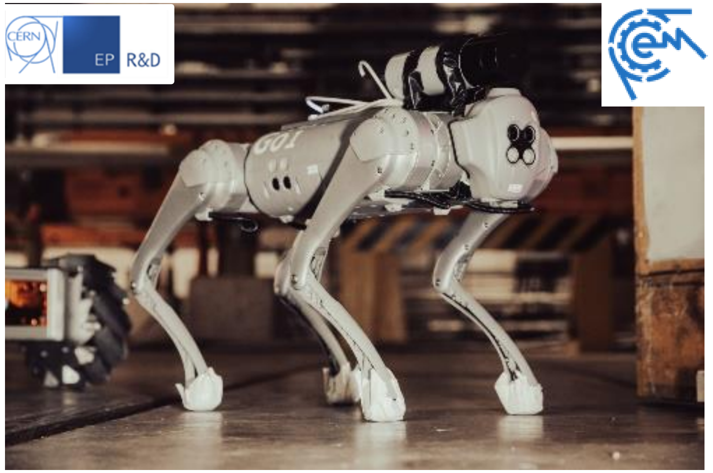
Table 1: Summary of available and required resources for WP1 Project 1.

Institute	Effort [FTE/year]		Material budget [kCHF]	
	available	required	available	required
CERN	1.0	1.0	100	100
IHEP/CAS	0.5	1.0	50	100
GSI Darmstadt	0.2	0.4	0	10
INFN Pisa	0.5	1.0	50	90
INFN Perugia	0.5	0.5	0	30
INFN LNF Frascati	0.5	1.0	100	500
INFN Torino	0.5	1.0	0	25
Nikhef	0.5	1.0	20	50
IPHC Strasbourg	3.0	4.0	10	10
IFIC Valencia	0.5	1.0	300	300
University of Geneva	0.5	0.5	10	10
University of Liverpool	0.5	1.0	0	50
University of Oxford	0.5	1.0	0	100
University of Bristol	0	0.5	0	100
University of Freiburg	0.5	1.0	10	30
Total	**10.2**	**16.4**	**650**	**1555**

Needs **60% more FTE** and **140% more** material budget to accomplish the tasks

WP 1.2

Legged Ground Robotic Platform



Develop legged ground robotic platforms for the autonomous and on-demand inspection, patrolling all the walkable areas. These robots are characterized by a high payload, allowing them to be equipped with a wide variety of sensors, and an enhanced mobility, which makes them suitable to operate inside detector cavern.

Expertise at CERN, Rome, Arizona U.

Magnetic shielding of actuators

Simulation of virtual environment

WP 1.2

Robotic Airship

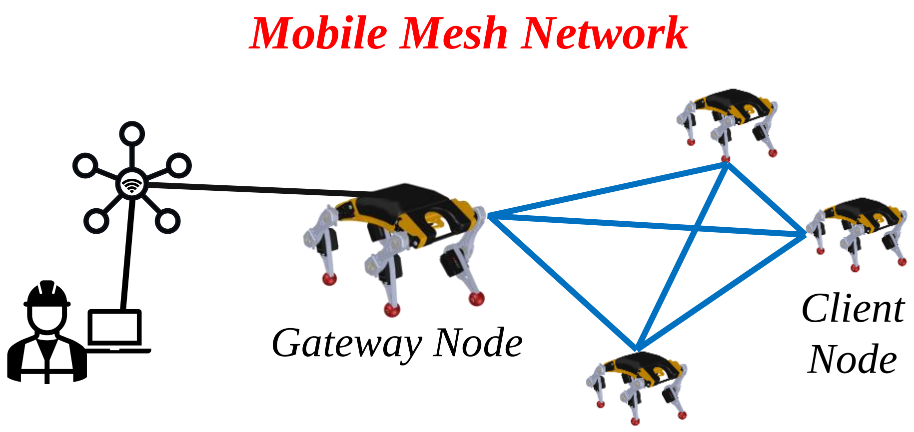
Develop Lighter than Air Unmanned Aerial Vehicles (LtA UAV), such as blimps, to provide a 3D environmental mapping of the background magnetic field and radiation dose of the whole cavern volume by employing a custom lightweight payload. Blimps are harmless solutions for the detector equipment in case of failure.

Expertise at CERN, Rome, Arizona U.

Magnetic shielding of actuators

Simulation of virtual environment

WP 1.2



Investigates the use of a swarm of mini robots to inspect tight and cluttered confined spaces, spotting leaks and anomalies among the intricate detector services. A mobile ad-hoc mesh network that guarantees an uninterrupted communication within the swarm has to be developed to ensure that information originating from the deepest robot inside the experiment can reach the external one.

Expertise at CERN, Rome, Arizona U.

Magnetic shielding of actuators

WP 1.2 – deliverables and milestones

Label	Topic	Month	Description
M1.2.1	Mobile mesh network in cavern	12	Demonstrate a robust ad-hoc mesh network ensuring an efficient data stream within a cavern confined space.
D1.2.1	Legged robots and robotic airships in magnetic field	24	Deliver robots able to counteract the background magnetic field disturbances.
D1.2.2	Legged robots and robotic airships in cavern	36	Deliver robots able to perform an autonomous inspection/monitoring of the detector cavern environment.
M1.2.2	Legged robots and robotic airships control system	36	Develop a robust control system including the magnetic disturbances.
M1.2.3	Mobile mesh network cavern inspection	36	Inspect a cavern with confined spaces with an uninterrupted data stream.

Need to discuss who is contributing – intermediate check points?

Need to be revisited by the Institutes contact persons

WP 1.2 – Resources

Table 2: Summary of existing and required resources for WP1 Project 2.

Institute	**Effort [FTE/year]**		**Material budget [kCHF]**	
	available	**required**	**available**	**required**
CERN	2.0	2.0	100	100
IHEP/CAS	0.0	1.0	0	100
Roma I (La Sapienza)	0.5	0.5	10	10
University of Arizona	0.5	0.5	10	10
Total	**3.0**	**4.0**	**120**	**220**

Needs 30% more FTE and 80% more material budget to accomplish the task

How to move forward?

- March/ April – Organize a first meeting to establish a strategy for success based on:
  - *Status of already running activities at different Institutes*
  - *Institute commitment in the different activities*
    - *Consider to setup working groups*
  - *Feedbacks on Institutes requests to the FA*
  - *Assessment on the need to increase the FTE and material budget to accomplish the tasks*
    - *May need to have in place the MoU?*
  - *Assessment, alternatively, which activities can be pursued and what is the descoping strategy (if needed)?*

- June - Finalize a credible plan with clear commitment of the different Institutes in each WP to be presented at Bristol Forum

- Follow up meetings every ~6 months.