Detector **automated installation and maintainability**

**Description**
New HEP detectors must be designed to be easily maintained and possibly **robot friendly** to maximize detector accessibility and **decrease personnel exposures to hazards**. Layout and interface to automated systems/robots for maintenance and early intervention should be foreseen at the detector design level.

**Milestones** (starting in 2020) → **Deliverables**

1. Identification of industrial solutions and cutting edge technologies of automated and robotic system compatible with the needs of future remote detector handling and maintenance → **Report on robotic solution**

2. Definition of detectors interfaces and requirement to automated systems/robots. → **Design of detector/robot I/F**

3,4. Development of test articles for interface and automated systems/robots. → **Tests article for solution develop**
   Construction of EP Robot Laboratory for solution testing → **EP Rob Laboratory**

5. Experimental validation on test articles of the proposed automated systems/robots solutions. → **Report**

**Cooperation with**
CERN-EN-SSE, CERN-HSE, TAMPERE UNIV, ETH, NASA, ESA,...
Remote Manipulator System - RMS

- High radiation level in hh will requires design optimisation to allow remote installation, maintenance, repair and handling.

Towards the end of the FCC-hh operation, the dose rate levels 1 mSv/h in the entire tracker cavity values do not decrease significantly for 1 month or 1 year of cooling time. This radiation comes mainly from the highly activated forward calorimeters, so an opening scenario must foresee an automated displacement of this object into a shielded garage or bunker in order to limit the dose for personnel.

- Remote Manipulator System RMS, Automated Guided Vehicles AGV, will be investigated, detector I/F design developed.
Work in-situ will have tight limitations for future hh detectors. Simplify and minimize the services connections is a priority.

Investigate Mechanism for dis/engaging electrical and fluid line connectors in hazardous or remote locations.

ATLAS Pixel has 1 connector per module at PP0
AMS_02 has 1 connector for the entire Experiment.

Umbilical Mechanism Assembly (UMA)
The UMA is the way the power is supplied from the ISS to AMS-02.
New detector must be designed to be easily maintained such to decrease personnel exposures to hazards

Designing Detectors that can be maintained by robots using appropriate and easily accessible interfaces

Tele-manipulation system, Virtual and augmented reality, Learning by demonstration

**TIM**: Built at CERN, used for inspection, radiation mapping of LHC

**Telemax**: environment inspection, teleoperation.
Un/screwing LHC TDE inspection SPS TIDVC

Robots at CERN (EN-SMM-MRO)
Remote Manipulator System - RMS

ITS is designed to be handled and installed by humans.

Design modification to handle extract Detectors Half Barrel by robots/automated system?

Services Umbilical Mechanism Assembly - SUMA

ITS patch panel dis-connection requires de-mating 144 connectors electrical and 24 fluid lines connectors.

New Services architecture an connectivity to reduce complexity and automatize the disconnection?

Data wireless, modularity reduction

On Detector Robot Systems - ODRS

Different constraints like minimum gaps, difficult accessibility, long distances compromise the possibility of inspection and intervention.

Design interfaces for robot access?

Solution for extremely packed area?
Radiation levels in hadron collider and radiation-cooling times will severely constrain operational and maintenance scenarios.

Implications and requirements on near and far future detectors design should be defined.

R&D program shall start from the identification of possible available suitable robotic systems, compatible with the needs of future detectors, and proceed with the definition of space and interfaces to host such systems, already in the very first phase of the detector design.