



# **5DOF / 6DOF adjustment platform**

## **Universal Adjustment Platform (UAP)**

M. Sosin, T. Blaszczyk, J. Jaros

Review of HL-LHC Alignment and Internal Metrology (WP15.4)  
CERN, 26-28 August 2019

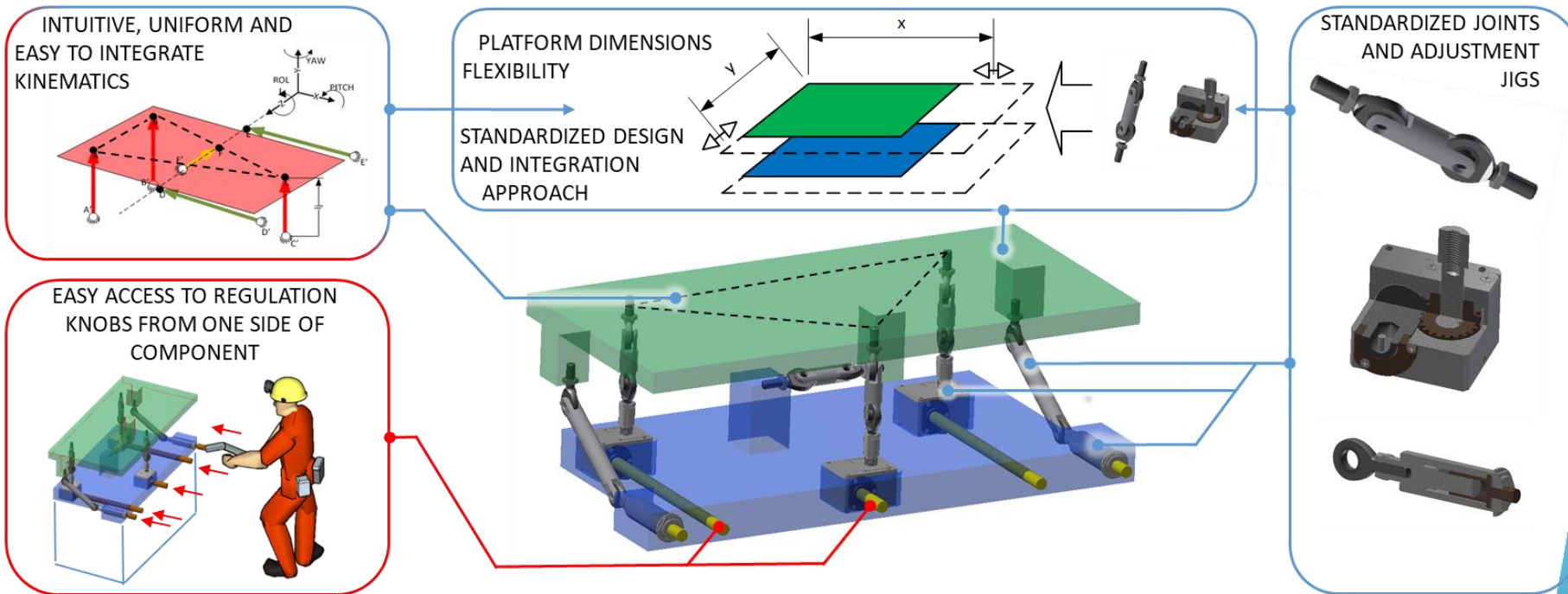
# Outline

- Universal Alignment Platform (UAP)
- Small UAP tests and conclusions
- Big UAP design
- UAP Project and documentation introduction
- UAP development schedule
- Conclusions

# Universal Adjustment Platform

Definition of set of design rules and development of standardized and modular components to:

- increase safety of surveyors
- unify small (<2T) accelerator components adjustment systems

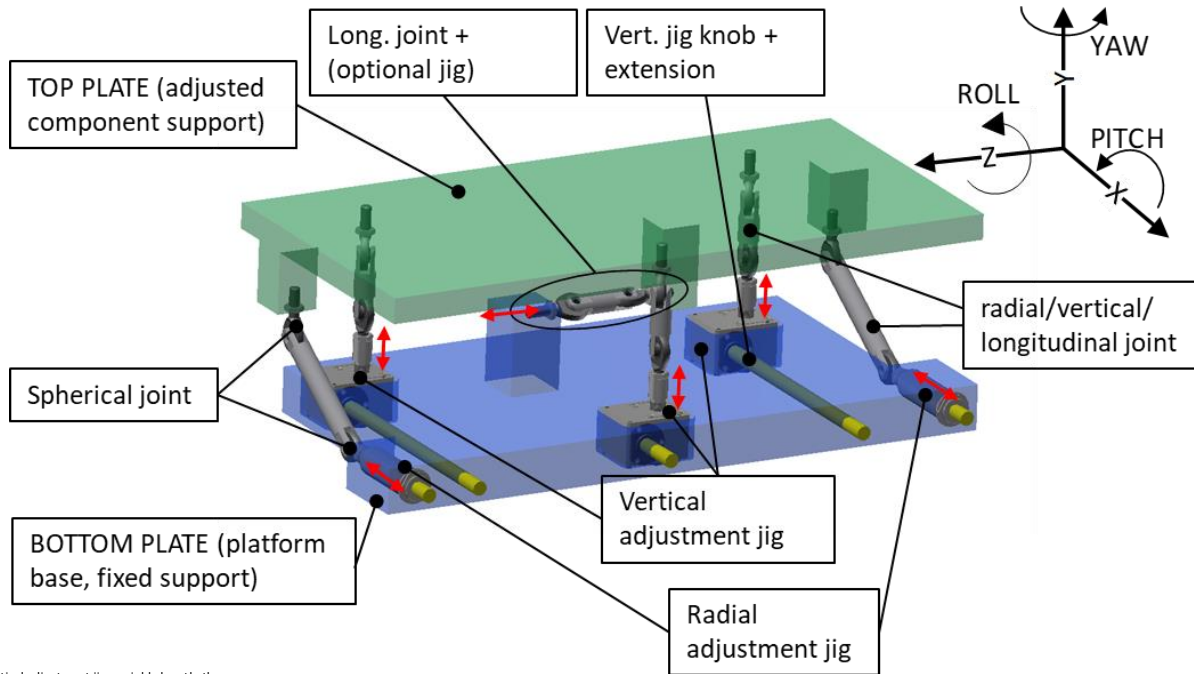


**PERSONNEL SAFETY**

(LIMITED INTERVENTION TIME IN RADIOACTIVE ZONES)

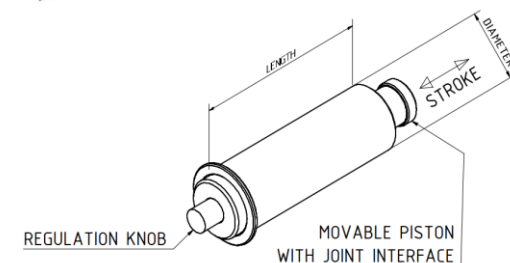
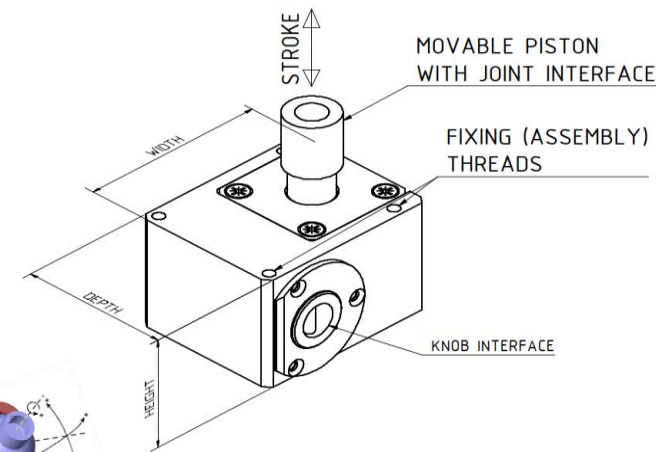
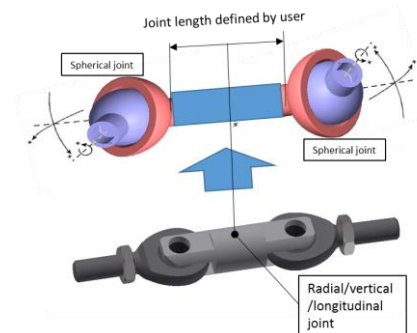
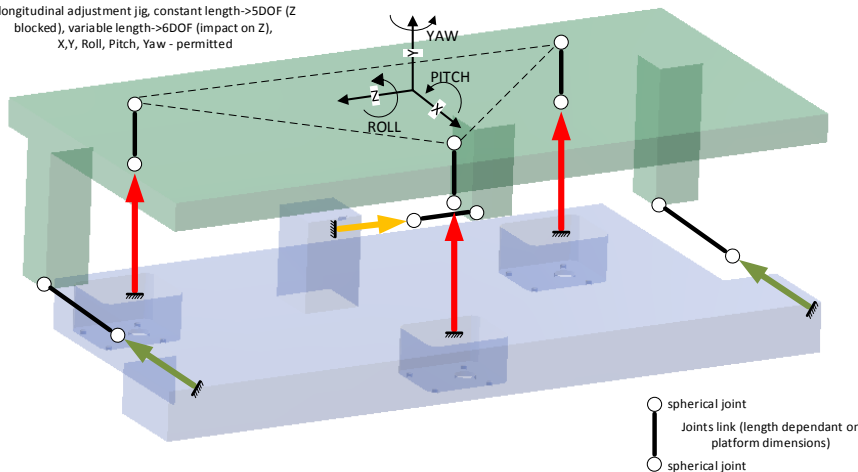
**STANDARDIZATION AND COST OPTIMIZATION**

# Universal Adjustment Platform



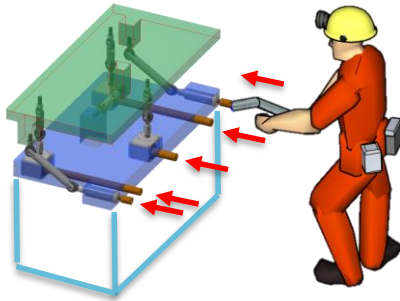
## Standardized equipment

- Vertical adjustment jig
- Radial adjustment jig
- Joints



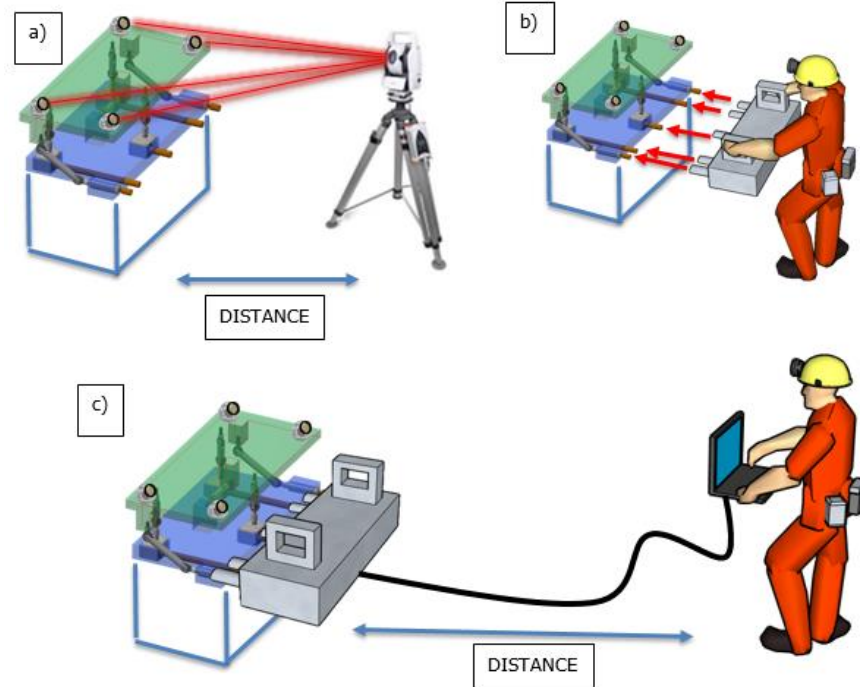
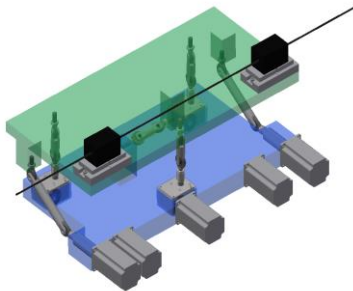
# Universal Adjustment Platform

- Allows for various operation use cases



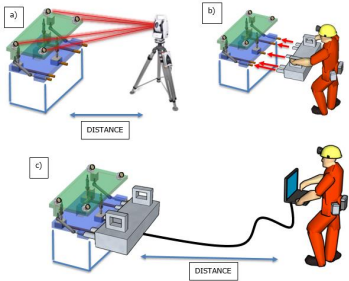
Universal adjustment platform – manual operation concept

Universal adjustment solution - permanent motors version concept. Platform equipped with WPS sensors



Universal adjustment solution – concept of use plug-in motors:  
a) Platform measurement from distance using a laser tracker;  
b) Installation of plug-in motors in less than one minute;  
c) Remote adjustment from distance.





# Plug-in motorized version - principle



# Universal Adjustment Platform

## Two sizes of UAP assumed:

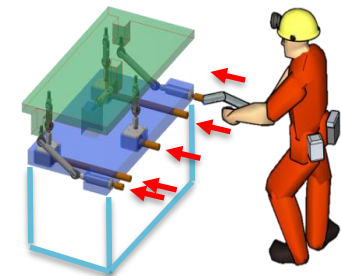
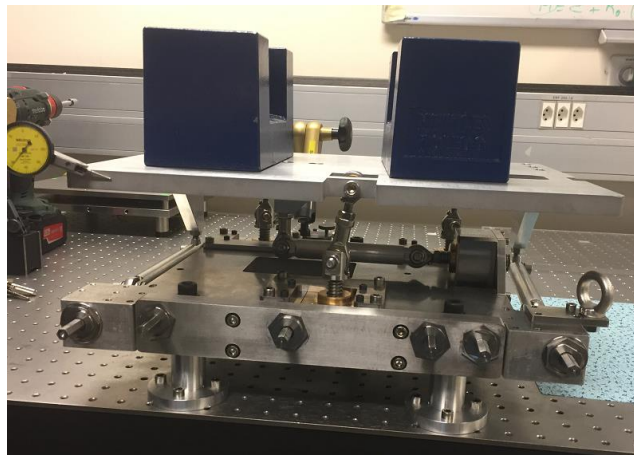
- **SMALL UAP** – for smaller components with max. weight of 300 kg
- **BIG UAP** - for bigger components, max. weight < 2 t
- SMALL and BIG UAP design methodology is the same
- Each platform will need different family of joints/adjustment jigs

# UAP R&D tests summary

- Preliminary radiation tests of prototype jigs – 8.2018 – 6.2010
- Small UAP functional prototype preliminary tests 10.2018 – 1.2019 (PHASE1):
  - Verification of jigs and different joints types parameters
  - Measurements of platform directional stiffness and backlash
  - Behaviour of platform under different load
  - Check of the adjustment torques
  - Adjustment stability
  - Ergonomics tests
  - Impact of vacuum longitudinal force
- Small UAP tests after PHASE1 upgrade - April 2019 (PHASE2):
  - Same set of tests as for PHASE1



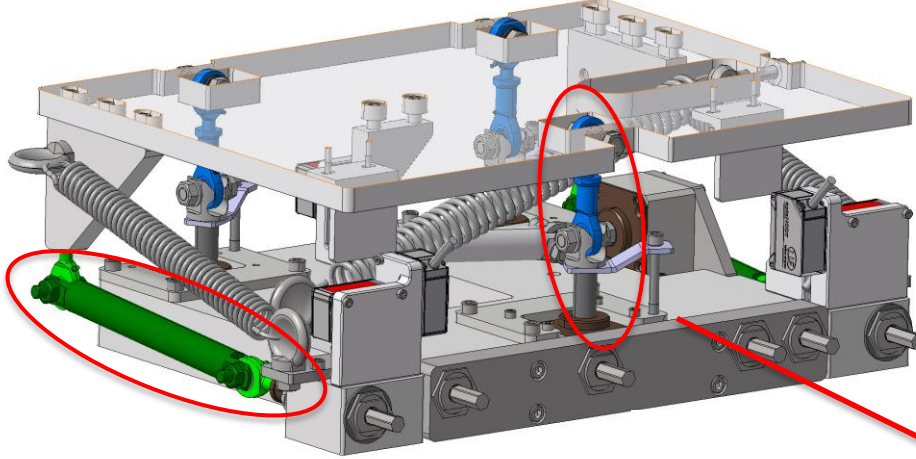
## SMALL, Manual UAP



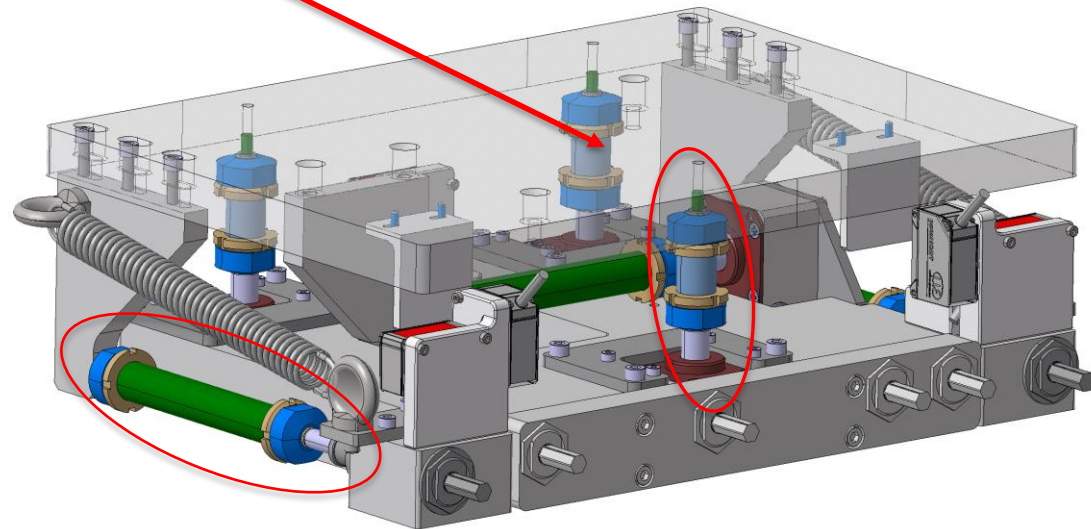


# UAP prototype changes after PHASE 1

- Upgrade of joints design
- Upgrade of TOP plate thickness/stiffness (previous one deformed with - vacuum test - lateral forces)
- Upgrade of joints assembly plates

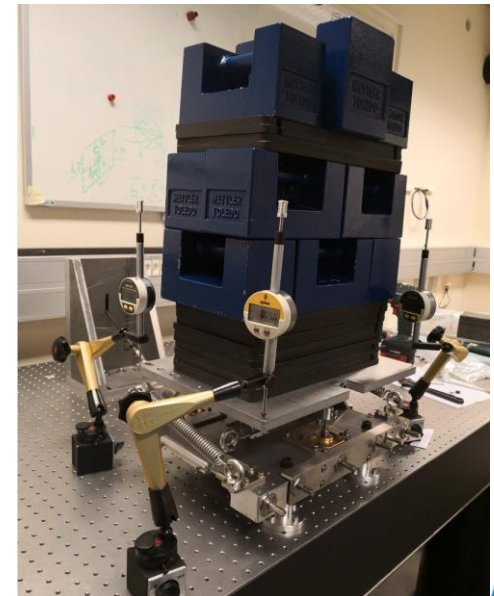
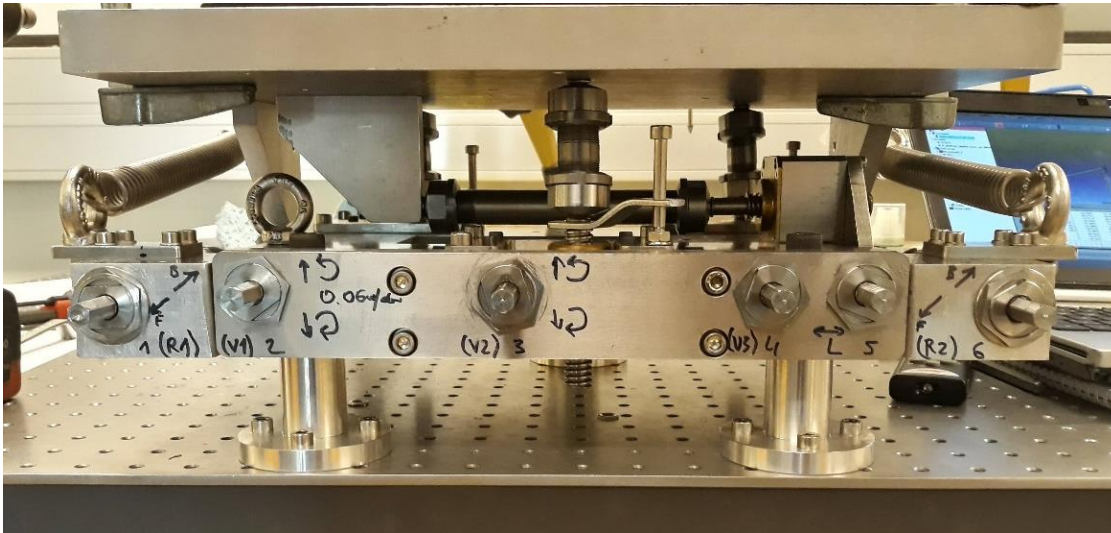


- Vertical jigs backlash adjusted using shimming rings
- PHASE 2 test 15 – 30 April 2019



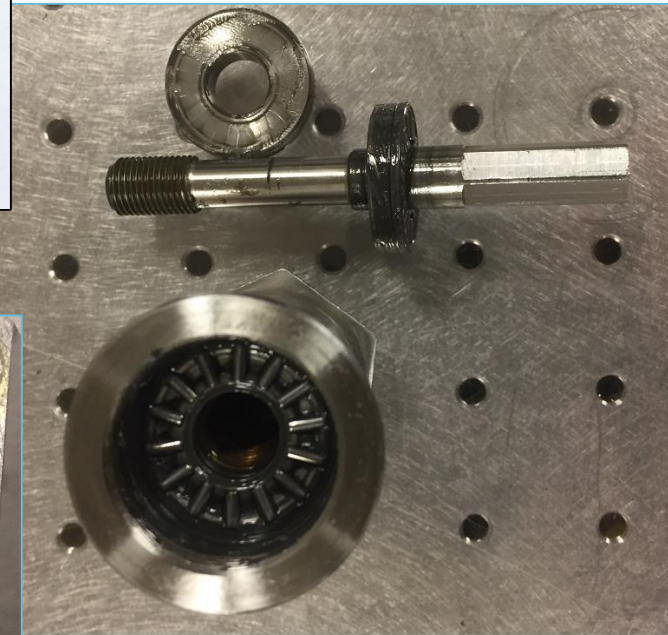
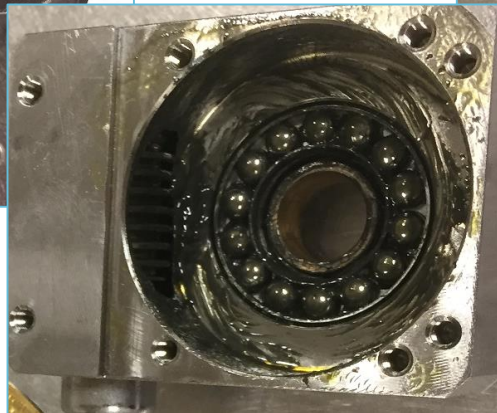
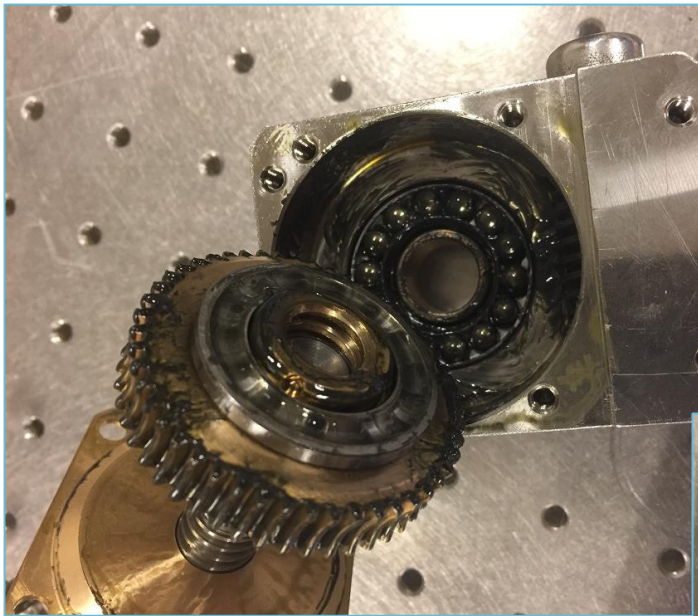
# UAP tests - conclusions

- Platform adjustment accuracy below  $\pm 20 \mu\text{m}$  for 2 iteration approach
- Stability of platform after random lateral load:  $\pm 30 \mu\text{m}$
- Ergonomics OK ( $\sim 15$  minutes adjustment time)
- Lateral stiffness of platform  $1.3 \mu\text{m/kg}$
- Platform behaviour assessed as satisfactory



# Small UAP jigs radiation tests

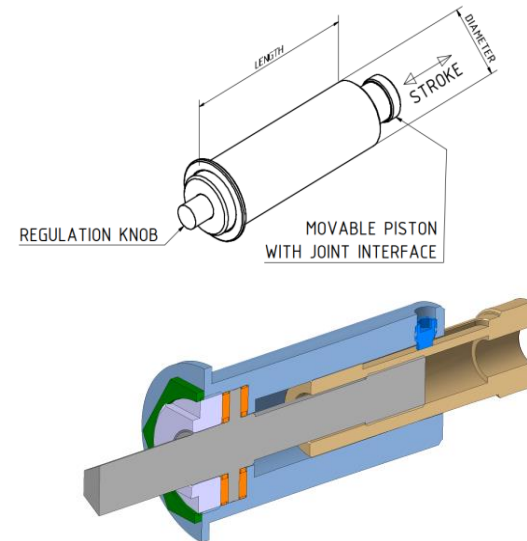
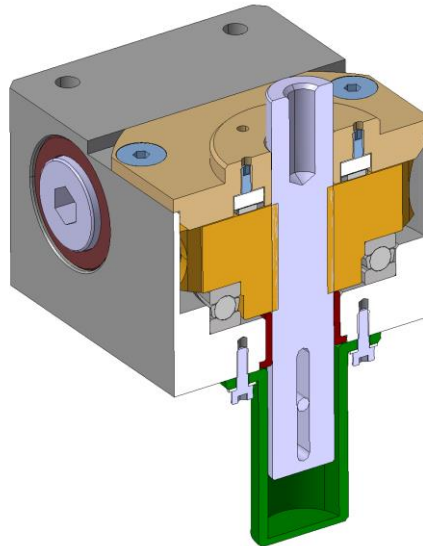
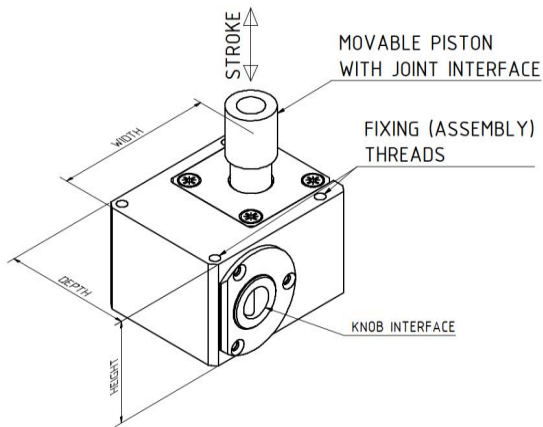
- Preliminary 3MGy radiation tests in Fraunhofer Institute 8-10.2018
- No operational issues observed, no grease problems
- Preliminary 10MGy tests finished August 2019 – samples under tests





# BIG UAP design

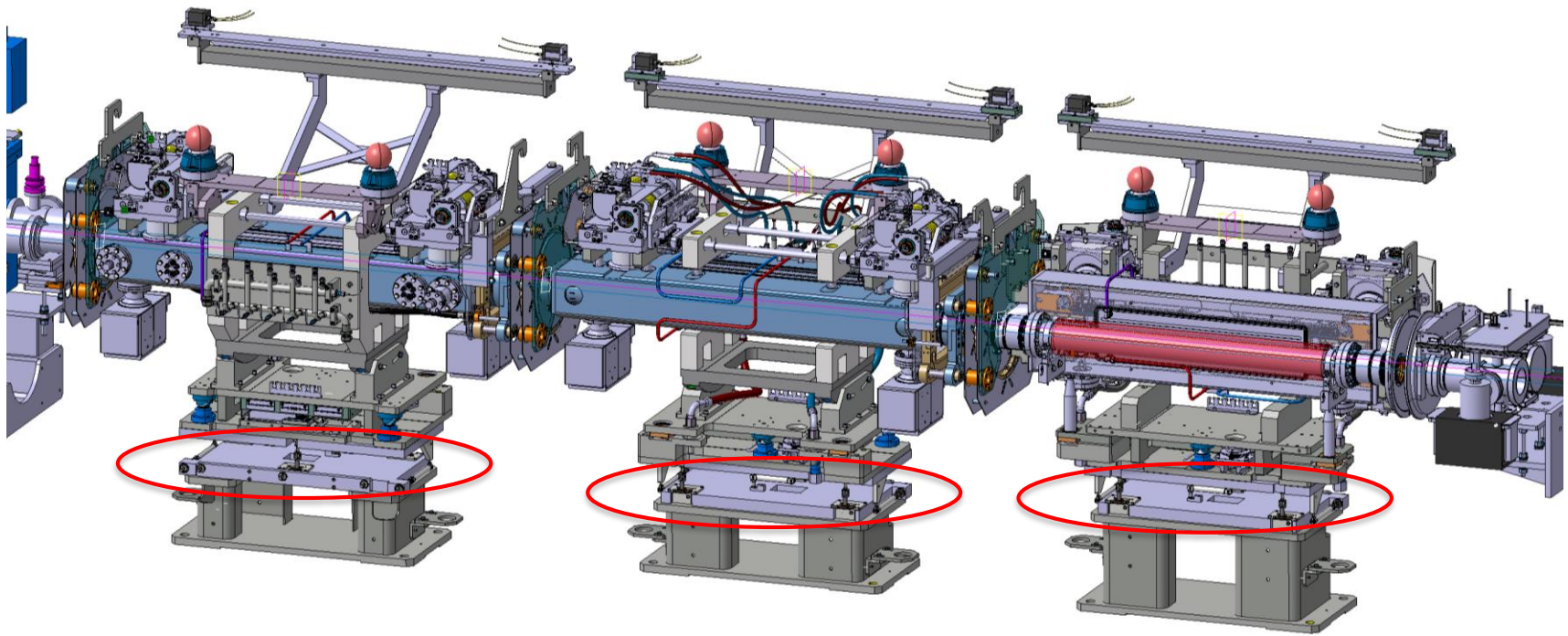
- Big UAP design started in June 2019
- Jigs and joints designed at first (<https://edms.cern.ch/document/2113940/1>)
  - Nominal load of vertical jig > 15 kN;
  - Nominal stroke of vertical jig piston:  $\pm 10$  mm (maximum  $\pm 15$  mm);
  - Nominal load of radial jig movable piston > 2 kN;
  - Nominal stroke of movable piston:  $\pm 10$  mm (maximum  $\pm 15$  mm);
- **3D models and manufacturing plans finalized mid of August 2019, parts under procurement**
- Tests of jigs in October 2019



T. Mikkola, I.A. Romero

# BIG UAP design

- First prototype of BIG UAP to be designed as support for collimator
- Design started August 2019 (under responsibility of EN/MME)
- Prototype unit order will start end of September 2019



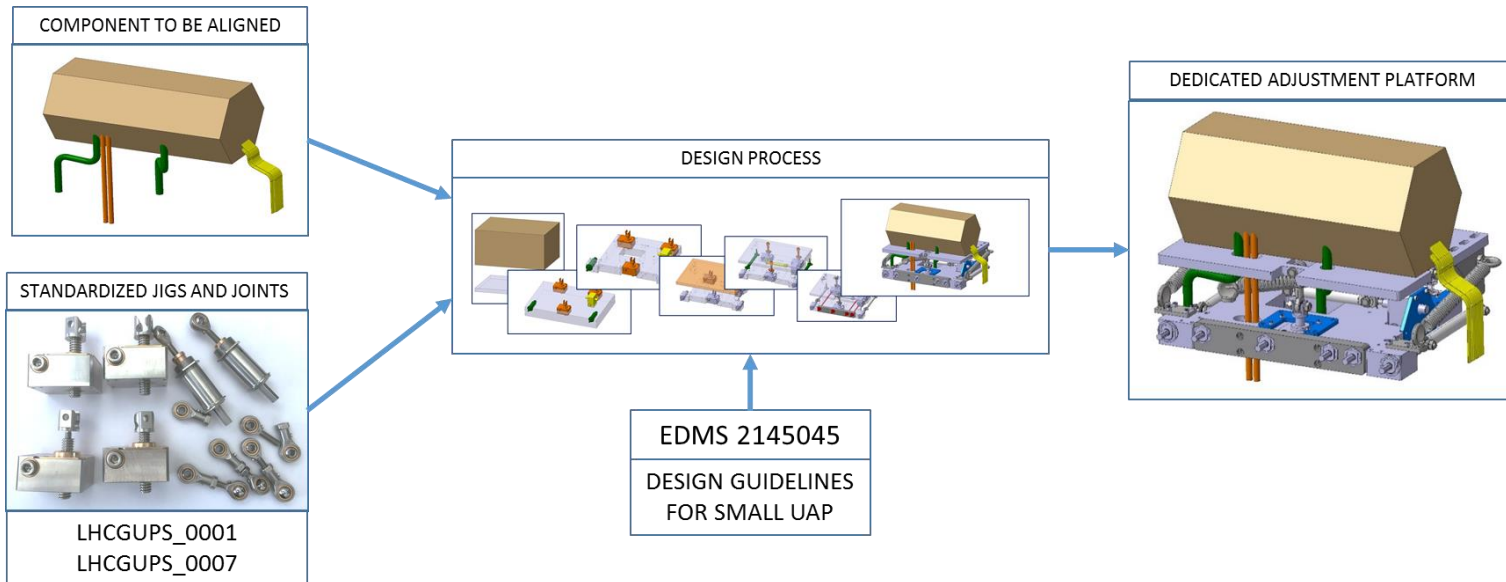
Curtesy of L. Gentini



# UAP Project

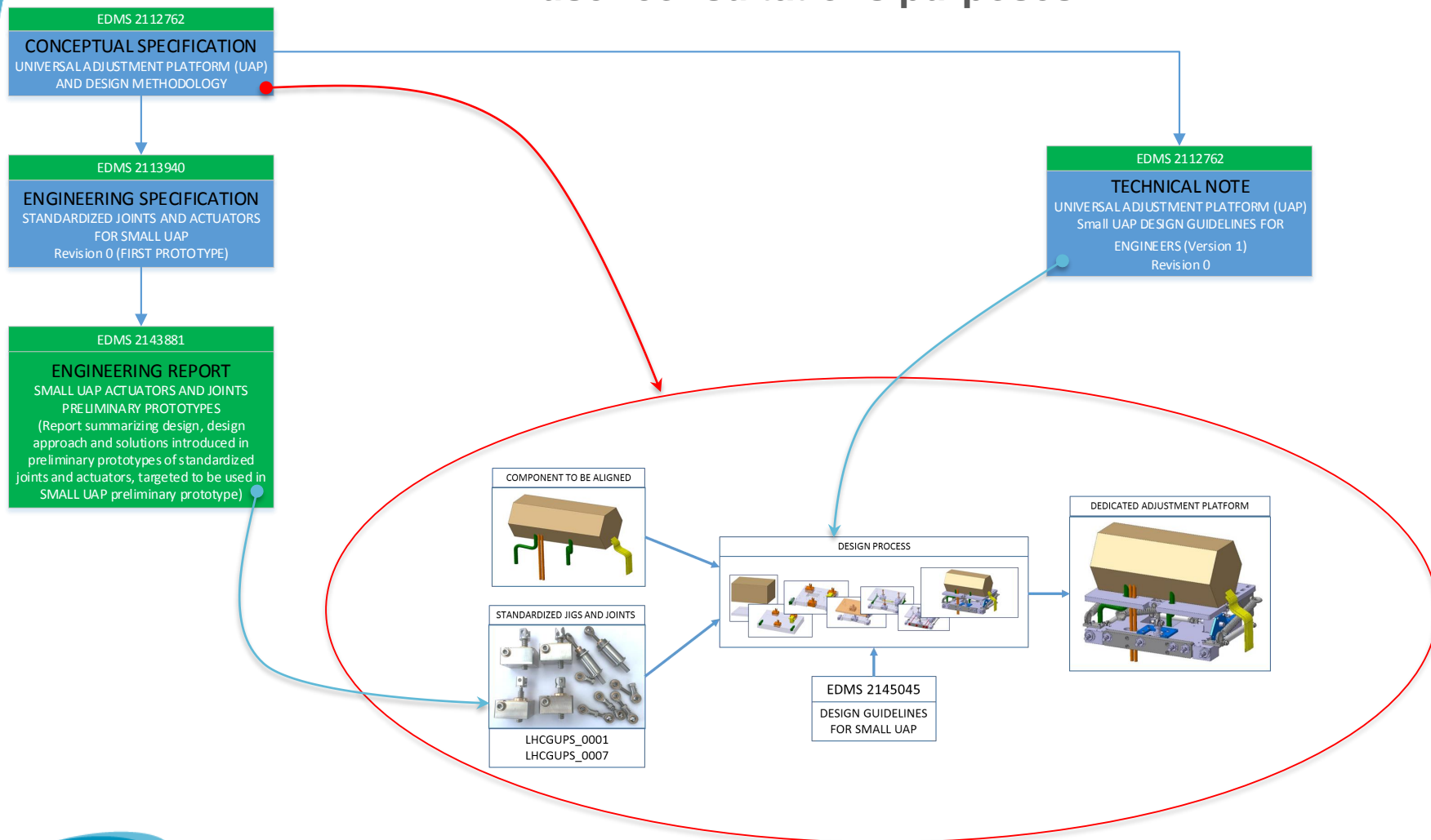
## Objectives:

- Propose standardized methods and technical solutions to unify of small (<2t) accelerator components adjustment systems integration
- To involve all potential UAP users to elaborate „in loop” the final versions of standardized adjustment components and design procedures



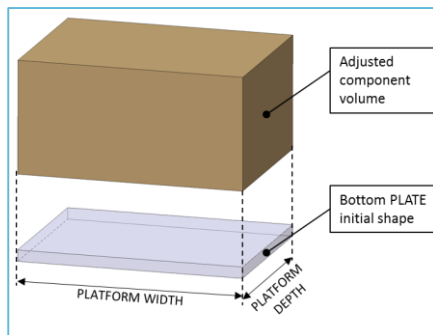
# UAP Project - baseline documentation

Drafts of UAP specifications, engineering notes created for future user consultations purposes

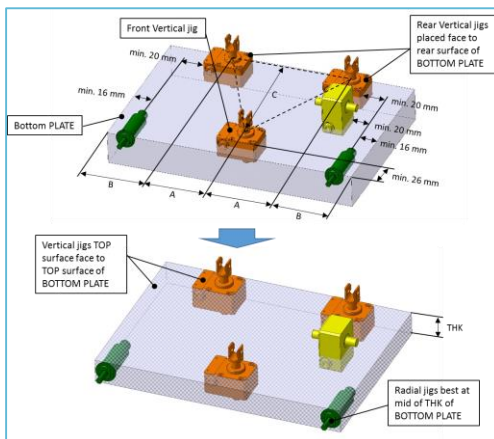


# UAP Project - baseline documentation

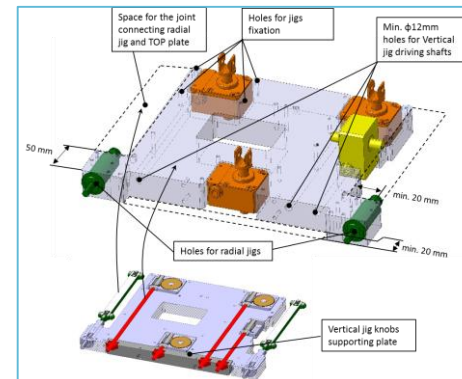
i.e. UAP DESIGN GUIDELINES (EDMS 2112762) – manual for the engineers how to design the UAP adopted for user equipment



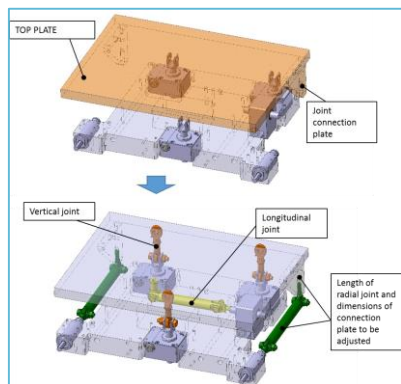
Step 1: Adapt platform dimensions to supported component dimensions



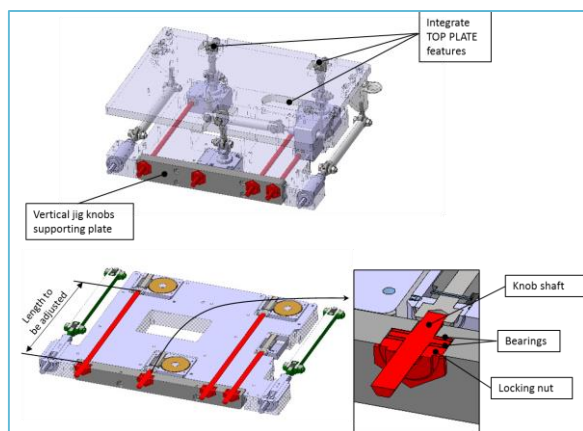
Step 2: Arrange jigs pattern within Bottom plate volume (top); Step 3: Adjust thickness of the plate and position of radial jigs (bottom)



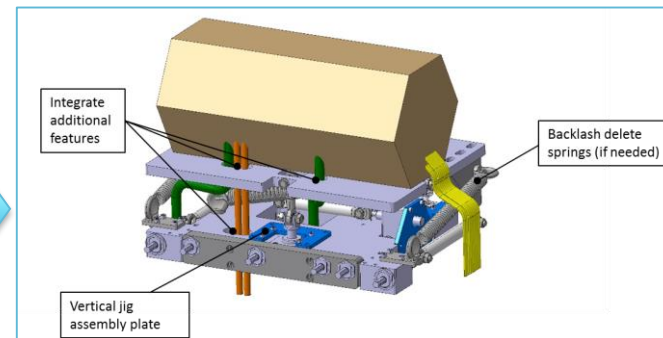
Step 4: Prepare the space for the UAP functional sub-components



Step 5: Prepare the Top plate initial model and adjust the joints length



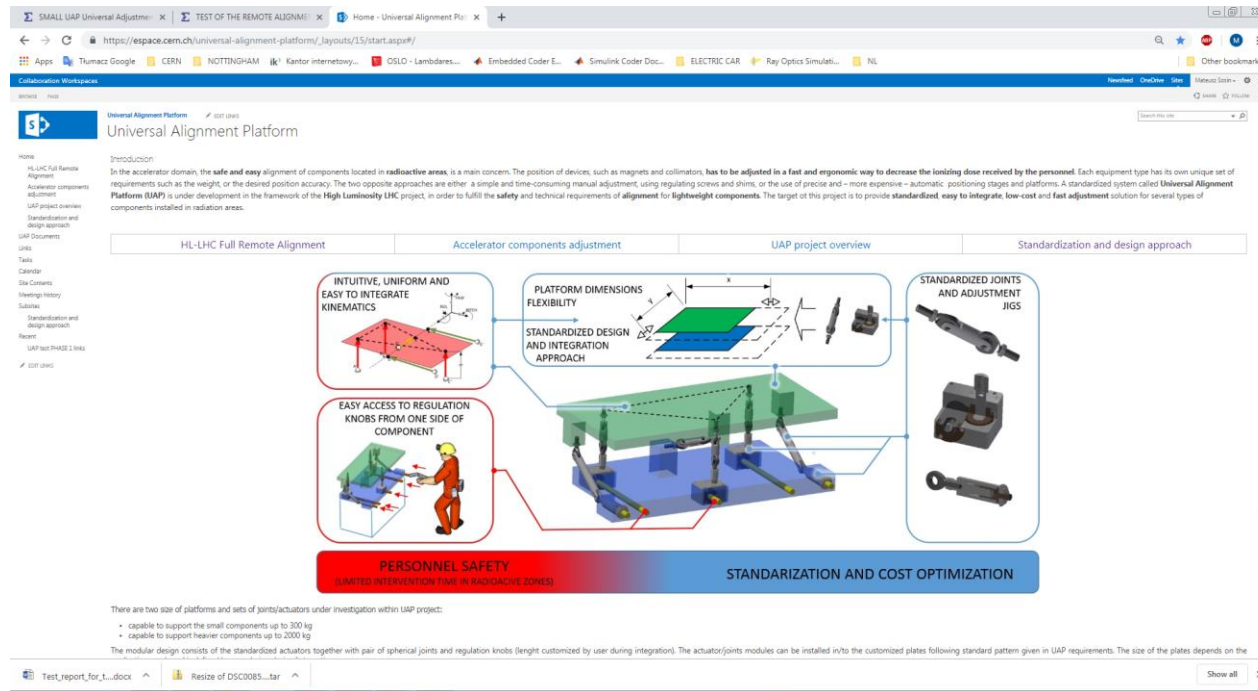
Step 6: Prepare the Top plate initial model and adjust the joints length



Step 7: Integrate all user specific features and vertical jig assembly plates

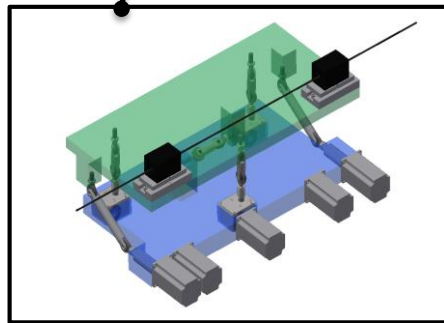
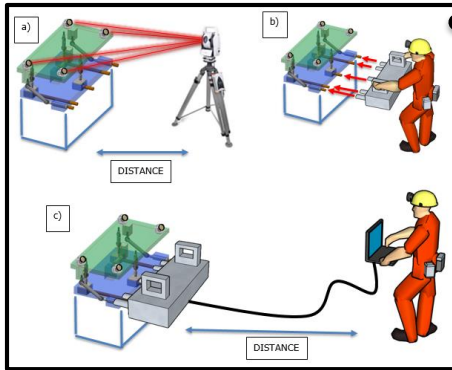
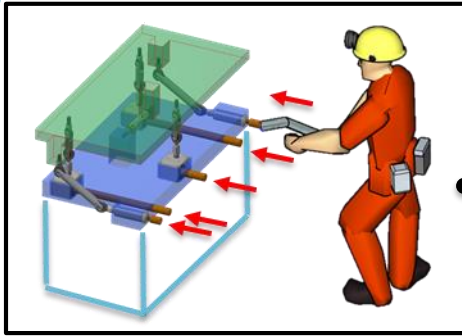
# UAP Collaboration workspace

<https://espace.cern.ch/universal-alignment-platform/>



- Collaboration workspace created to group important information about the project:
  - Current status of R&D and tests
  - Links to important documents and tests

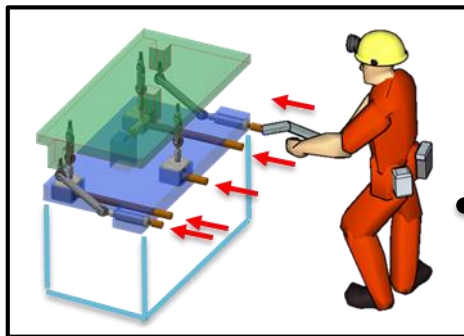
# Small UAP development schedule



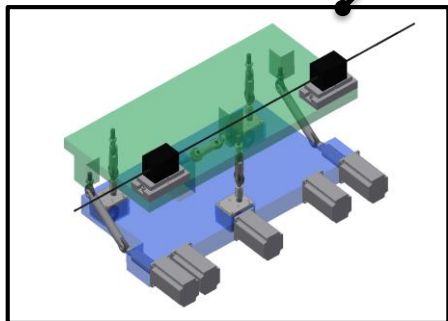
Project milestones	2018			2019				2020			
	II	III	IV	I	II	III	IV	I	II	III	IV
Standardized Jigs / Joints design and tests											
SMALL UAP design and tests											
Modification of SMALL UAP design to final version and tests											
Plug-in motor solution design and tests											
Motorized adapter design											
Standardized components serial production preparation (supplier survey, know-how exchange, serial production preparation...)											
<b>PARALLEL TESTS</b>											
Irradiation tests of components											



# Big UAP development schedule



Project milestones	2019			2020				2021			
	II	III	IV	I	II	III	IV	I	II	III	IV
Standardized Jigs / Joints design and tests											
BIG UAP design and tests											
Modification of BIG UAP design to final version and tests											
Final tests and validations											
Motorized adapter design and tests											
Standardized components serial production preparation (supplier survey, know-how exchange, serial production preparation...)											
<b>PARALLEL TESTS</b>											
Irradiation tests of components											



- Final tests and validations under the responsibility of EN/MME according to the schedule provided by EN/MME

# Conclusions

- Small UAP prototype tests demonstrated the expected performance of the platform
- Plug-in motors operation option design and tests are under preparation (first tests planned autumn 2019)
- Design of the Big UAP started in July 2019. First tests of components expected end of September 2019
- Small and Big UAP fully motorized version design end tests will start at the beginning 2020



***Thank you for your attention***