

Universal Adjustment Platform (UAP)

Standardization of 6 degrees of freedom adjustment systems design and integration

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Special Interest Group Meeting: Precision Motion Systems & Control
15th – 16th November 2022



Position adjustment issues

Crowded neighbourhood of aligned components

- Difficult access to regulation mechanisms/screws – (circus skills needed for some of components regulation)
- Fragile equipment around workspace – slow and careful manipulation

Ergonomics of adjustment

- Mechanisms not always intuitive
 - Simple mechanisms →
 - Big backlash →
 - Multiple measurement and adjustment iterations needed →
- Long adjustment time

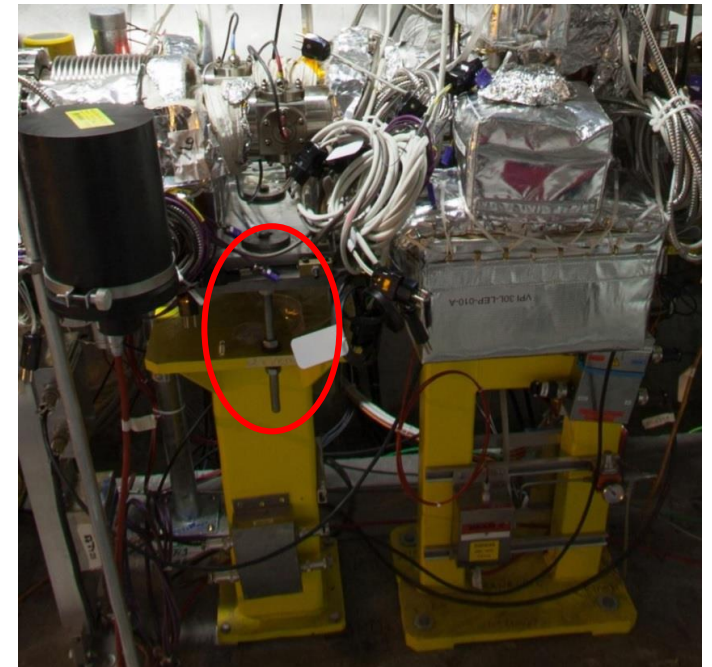
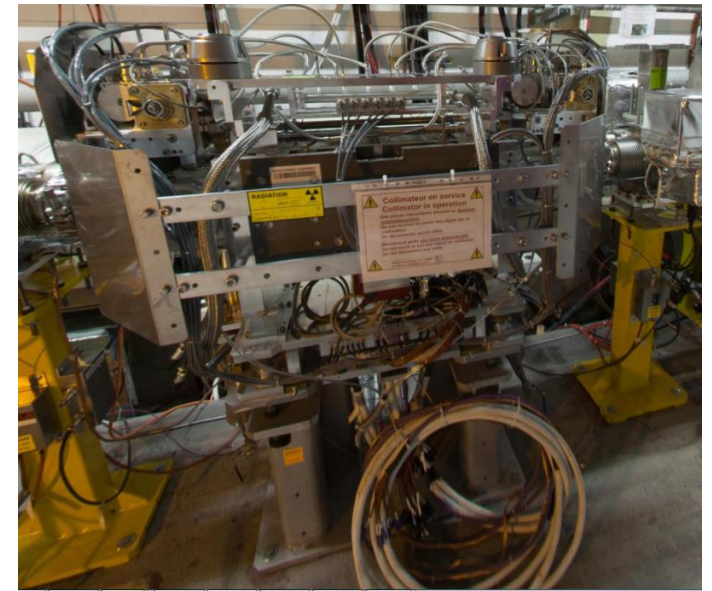


Safety of personnel

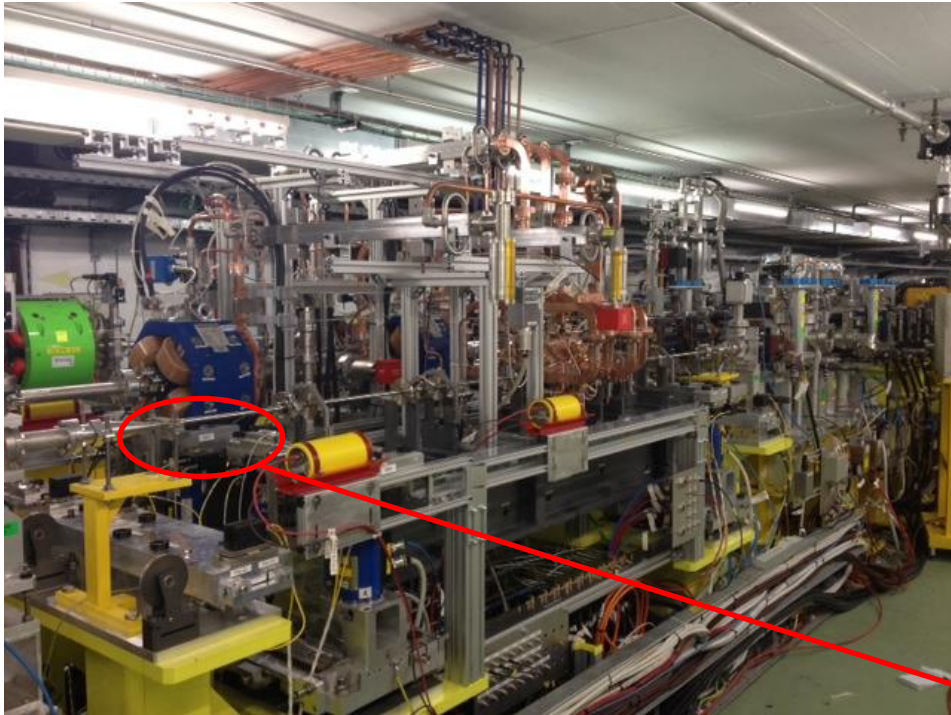
- Radiation (intervention time)
- Risks caused by electrical, water networks installations

	distance from IP (cm)	LSS5 (one side only) residual dose rate (uSv/h)				10 minutes dose (uSv)			
		1 week	1 month	4 month	1 year	1 week	1 month	4 month	1 year
D1	7442	800	410	140	55	133	68	23	9
	8450	350	150	50	20	58	25	8	3
TAXN	12626	900	450	150	55	150	75	25	9
	13047	400	220	90	30	67	37	15	5
D2	13779	650	350	130	65	108	58	22	11
	15224	15	10	5	5	3	2	1	1
Q4	17230	55	25	10	5	9	4	2	1
	18262	10	5	5	5	2	1	1	1
Q5	20115	125	65	25	10	21	11	4	2
	21027	20	10	5	5	3	2	1	1
Q6	22472	50	30	10	5	8	5	2	1
	23265	10	5	5	5	2	1	1	1
TCL4	13511	2500	1550	700	250	417	258	117	42
TCL5	19705	800	500	215	70	133	83	36	12
TCL6	22062	510	310	140	50	85	52	23	8
						1199	682	280	106
						2 hours (uSv)			
aisle	-	50	25	10	5	100	50	20	10
						Collective Dose (uSv)			
						1299	732	300	116

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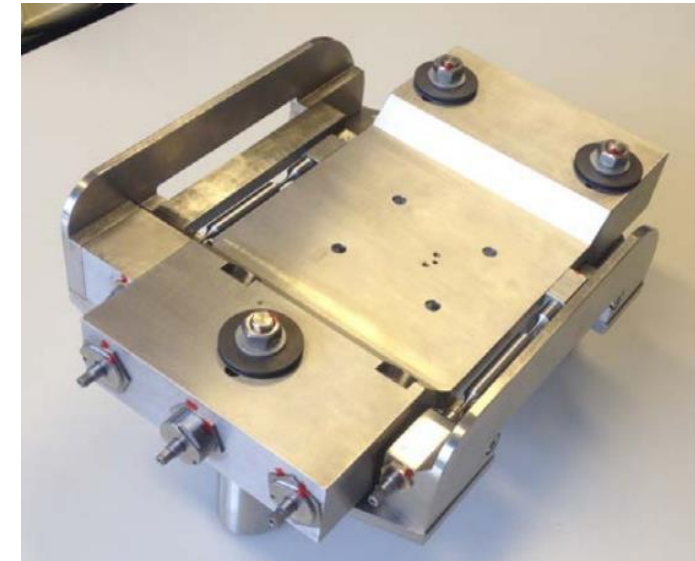
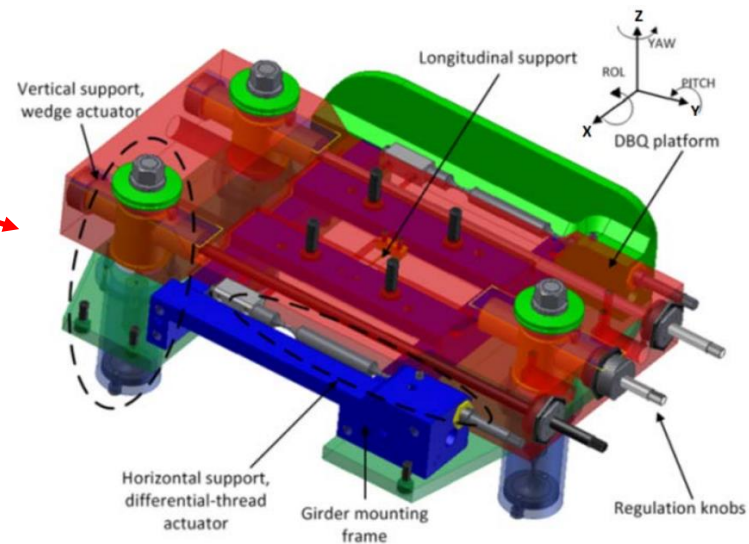


A bit of history - DBQ Platform for CLIC Project



Requirements

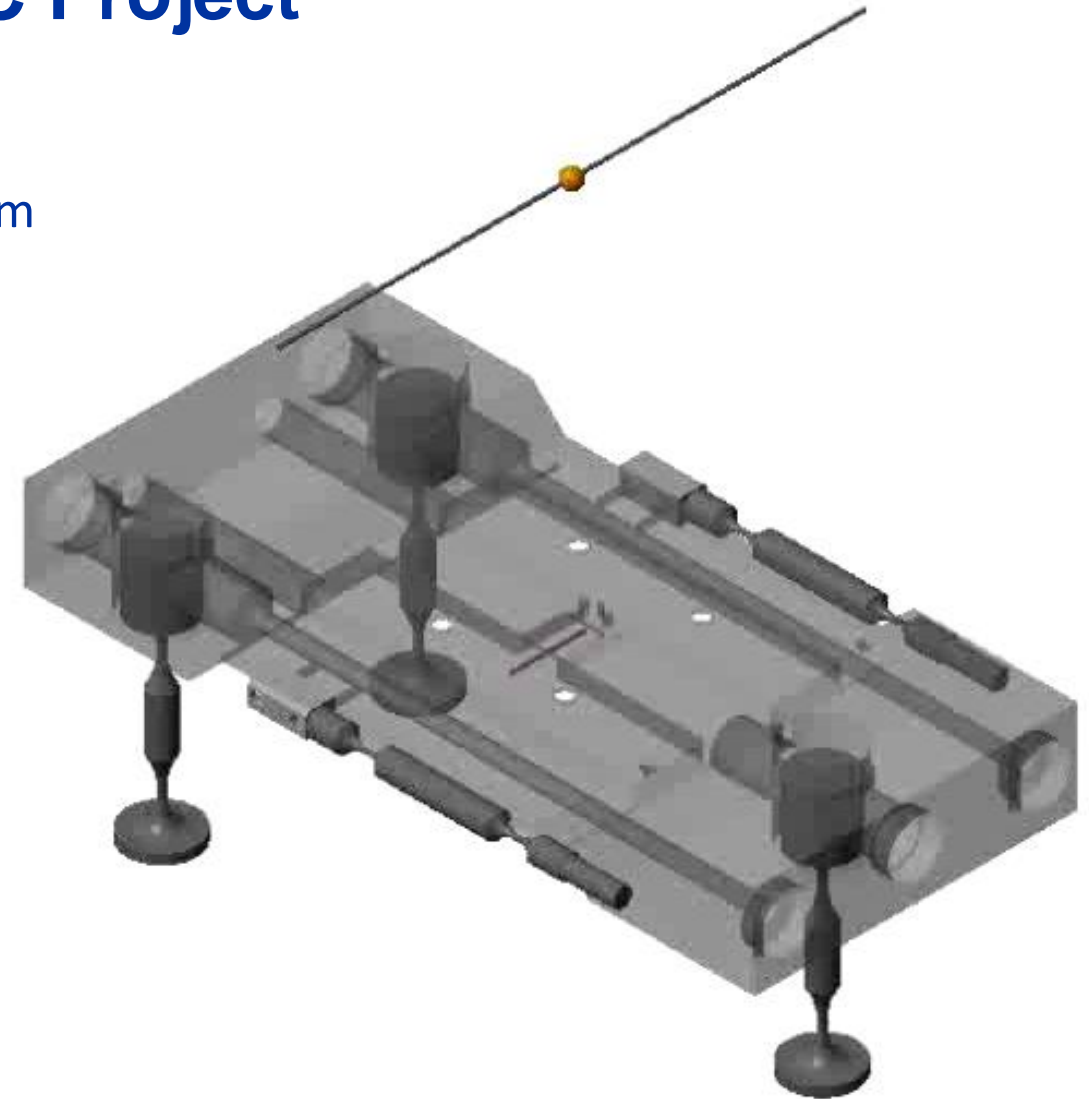
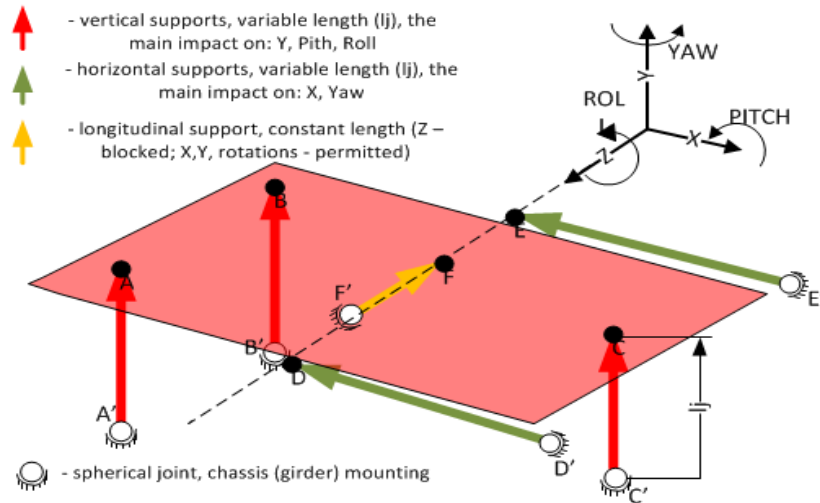
- Adjustment knobs from one (access) side
- 5 DOF adjustment possibility (Y & Z translations and 3 rotations)
- Load 170 kg
- Stroke: ± 1 mm in Y and Z (X blocked) ± 4 mrad in all rotations
- Resolution $< 5 \mu\text{m}$



A bit of history - DBQ Platform for CLIC Project

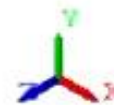
Kinematics

- Isostatic support configuration – modified Stewart platform

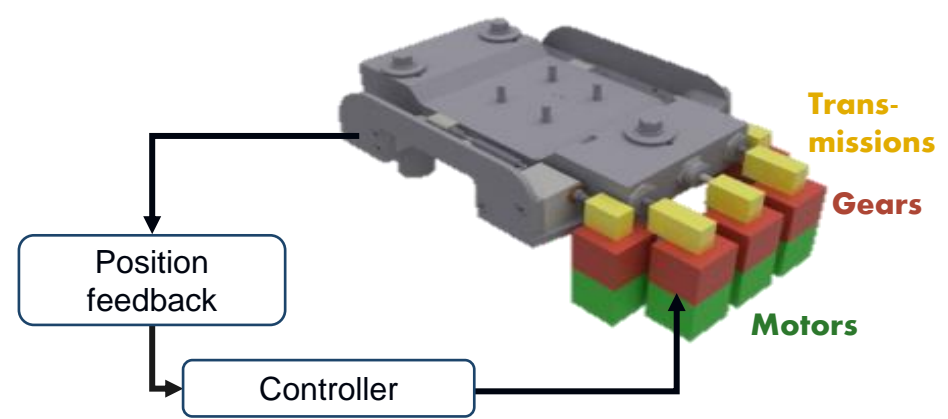


Ergonomics of use and reduction of adjustment time

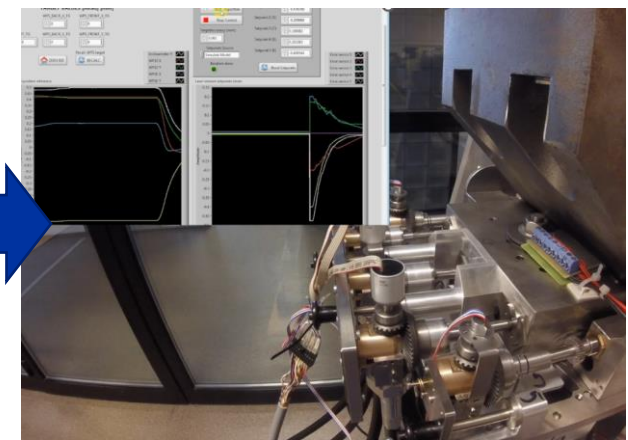
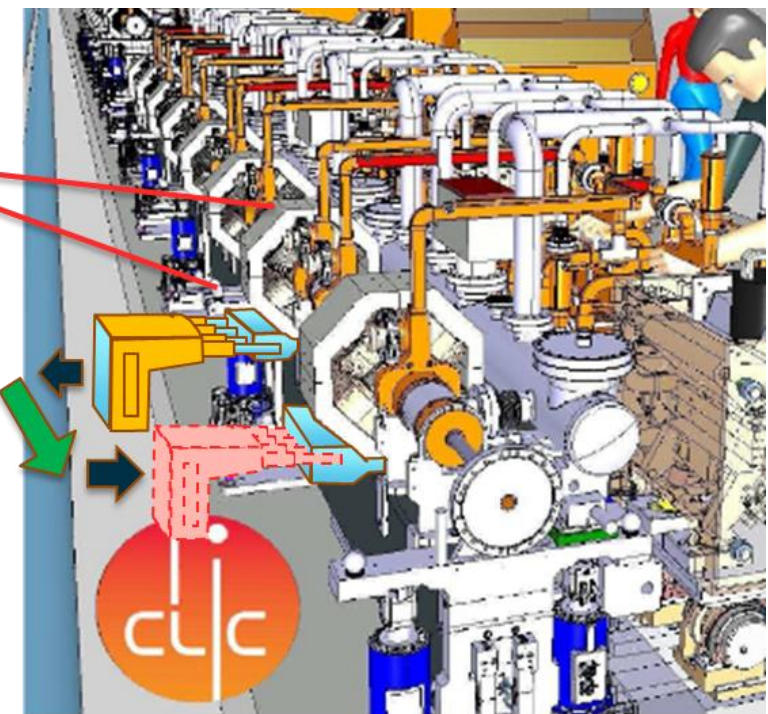
- Adjustment knobs located on one side of platform (access)
- Intuitive platform adjustment



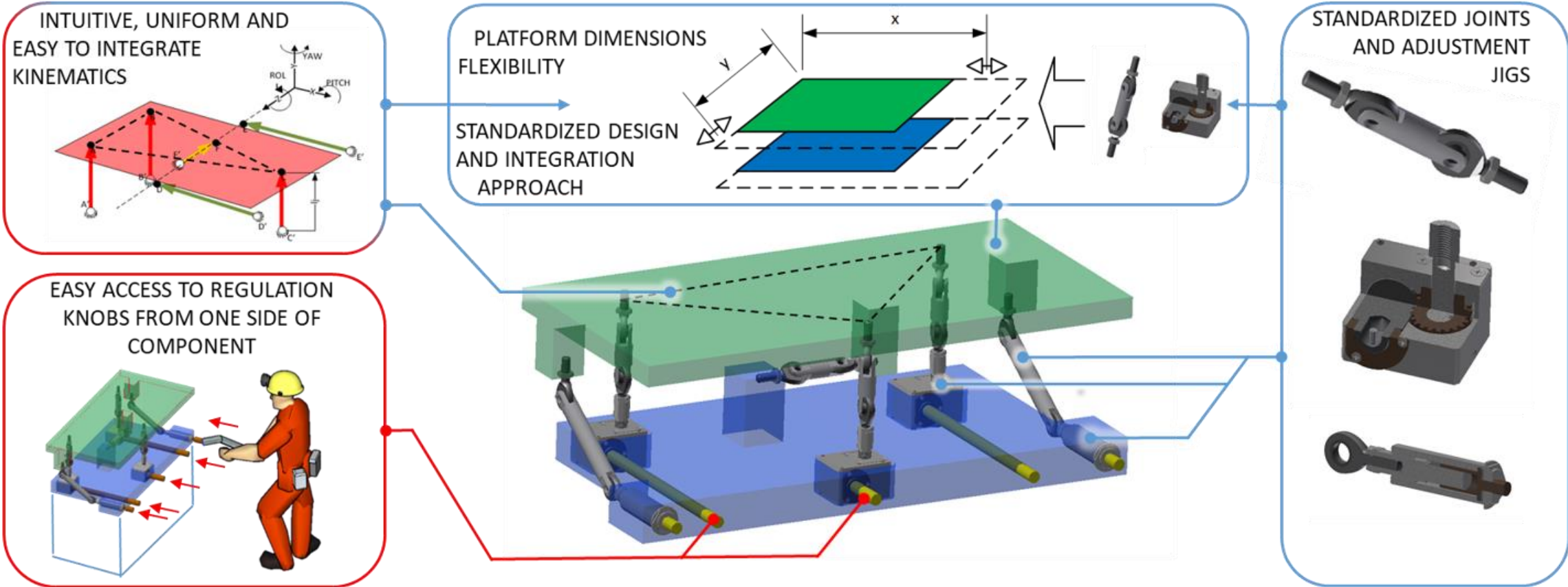
A bit of history - DBQ Platform for CLIC Project motorized or plug-in module version



The idea:



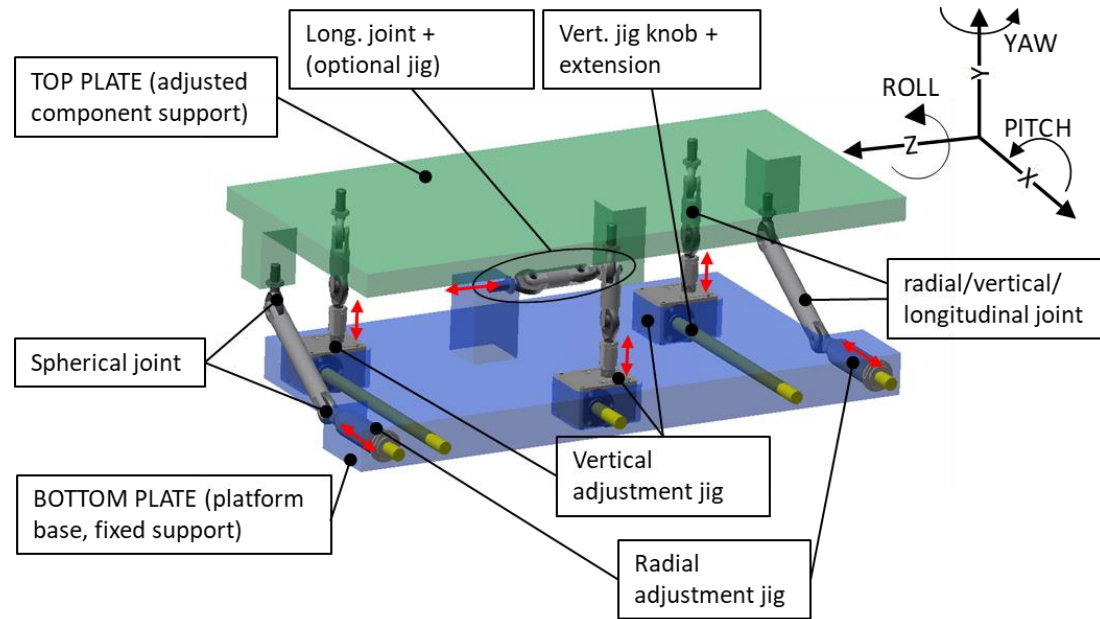
Universal Adjustment Platform (UAP)



PERSONNEL SAFETY
(LIMITED INTERVENTION TIME IN RADIOACTIVE ZONES)

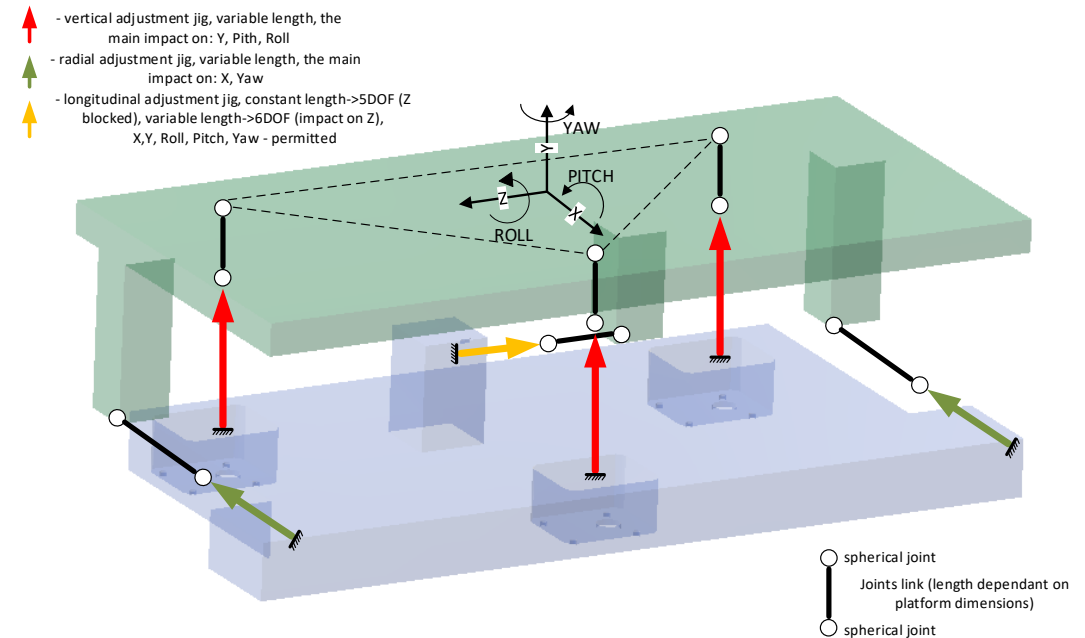
STANDARDIZATION AND COST OPTIMIZATION

Universal Adjustment Platform

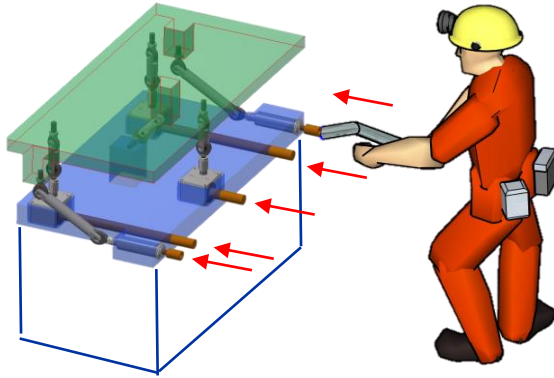


Standardized equipment

- Vertical adjustment jig
- Radial adjustment jig
- Joints

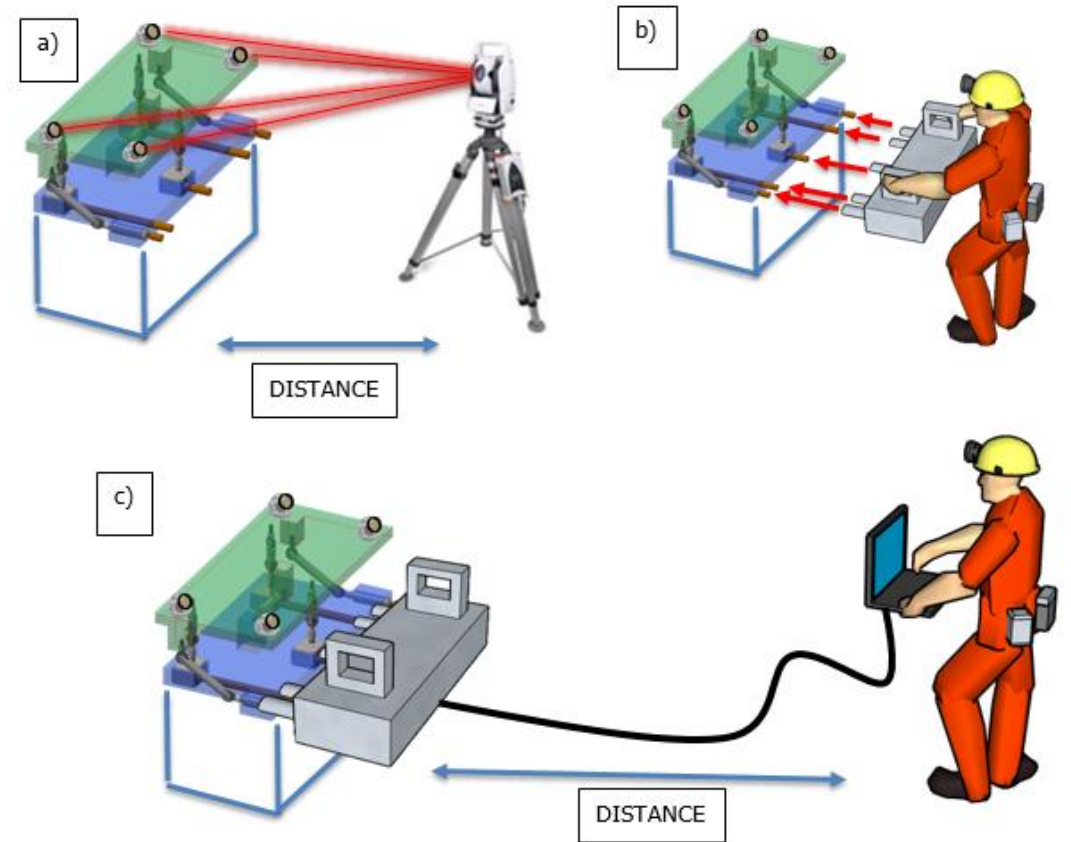
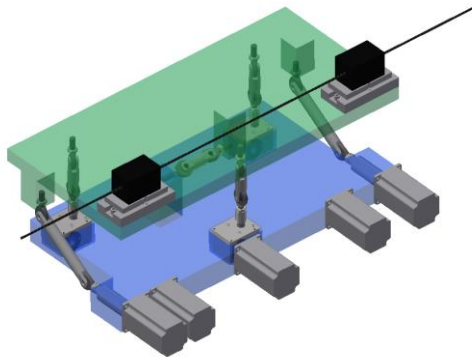


UAP – operation scenarios



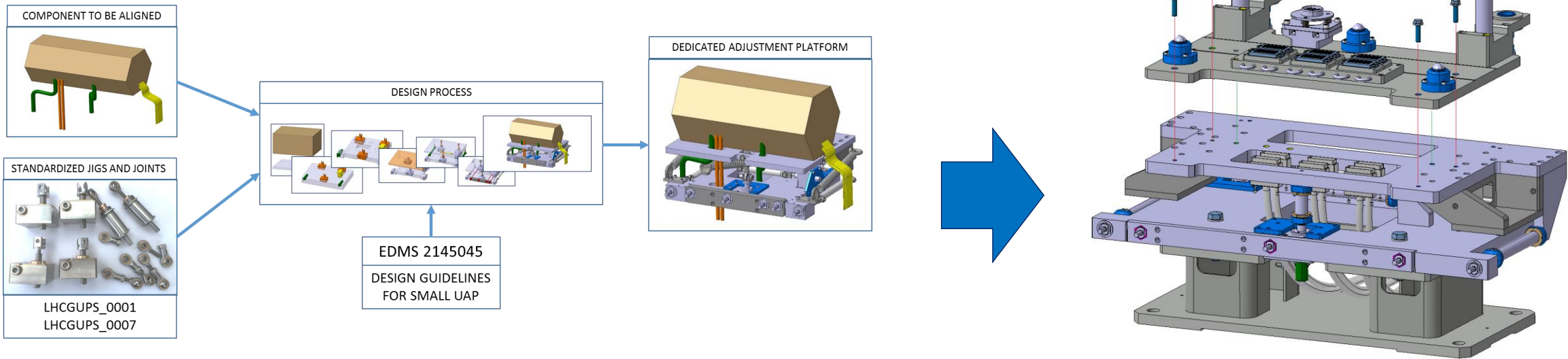
Universal adjustment platform – manual operation concept

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



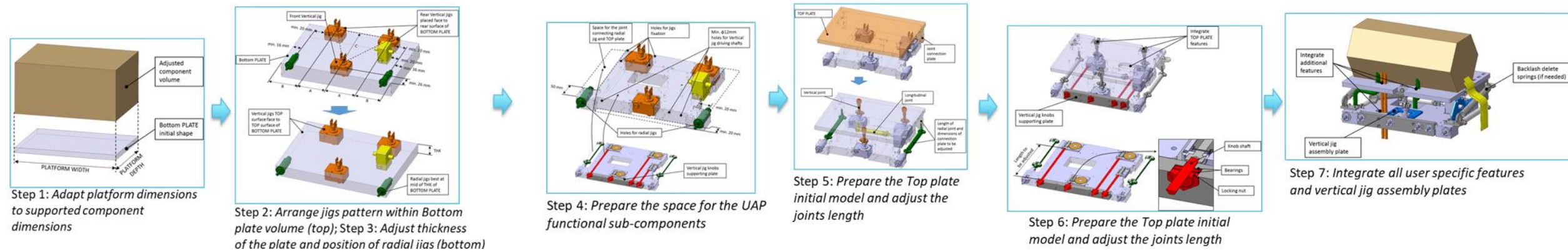
Universal adjustment solution – concept of use plug-in motors:
a) Platform measurement from distance using a laser tracker;
b) Installation of plug-in motors in less than one minute;
c) Remote adjustment from distance.

UAP as a design framework – Design Guidelines



Use of standardized components („LEGO” blocks approach) and design guidelines

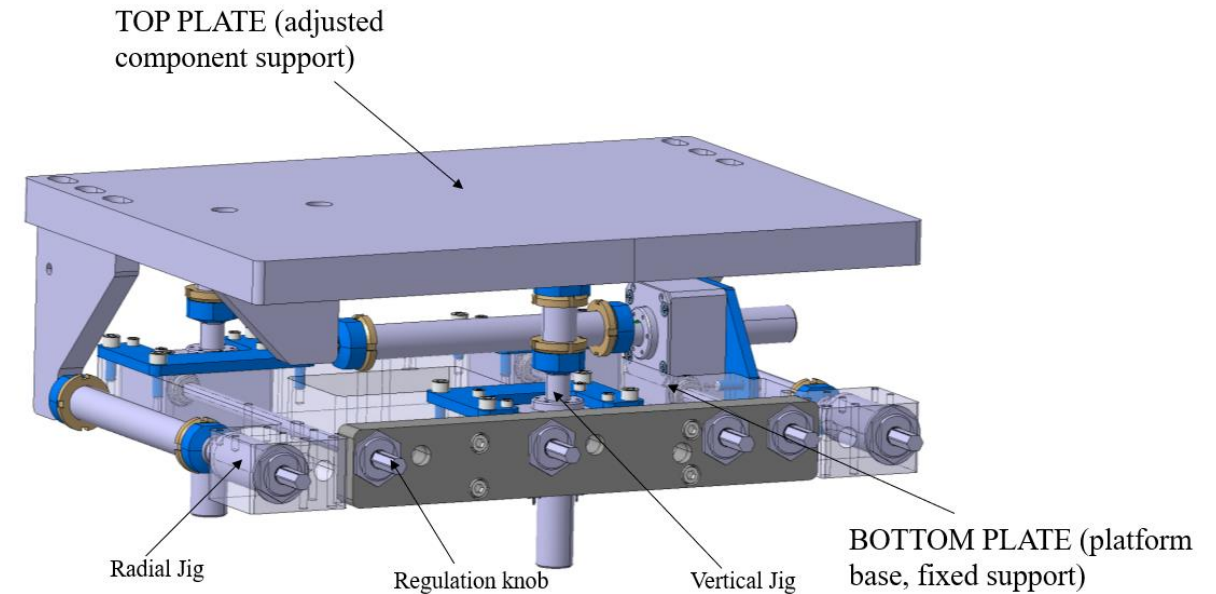
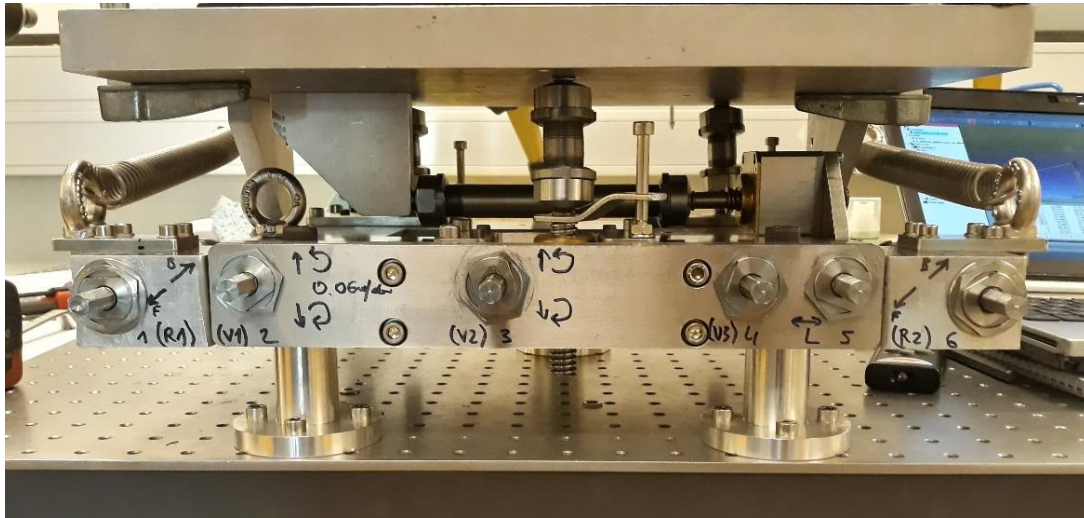
- We can design dedicated platform for various dimensions of components
- The „Guidelines” kinematics scheme shall be kept



UAP study and prototype tests: Small UAP

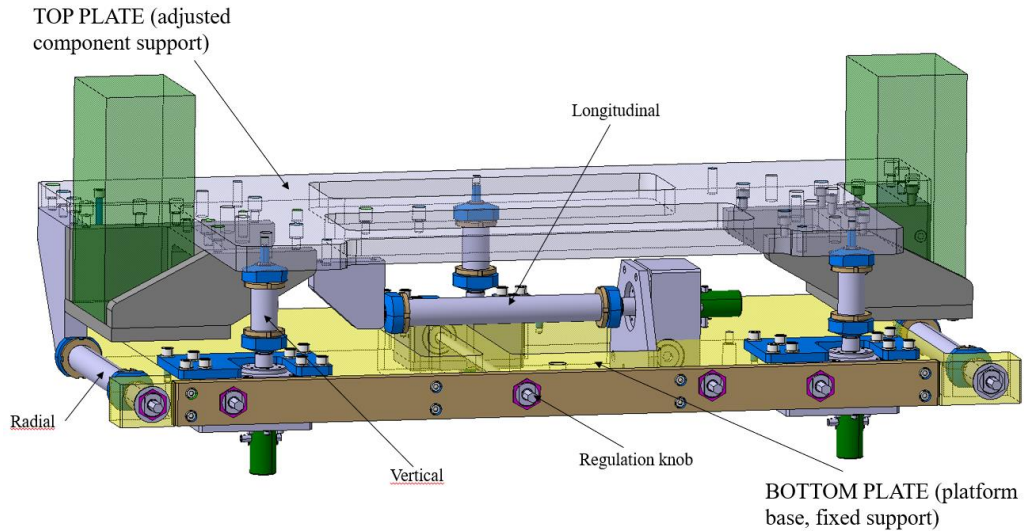
Two sizes of UAP chosen

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



- Nominal stroke of the jigs: ± 10 mm (max. ± 15 mm),
- Platform adjustment accuracy < ± 20 μ m (2 iterations)
- Stability of platform after random lateral load: ± 30 μ m
- Ergonomics ~15 minutes for manual adjustment time (including measurements and calculations)

UAP study and prototype tests: Big UAP

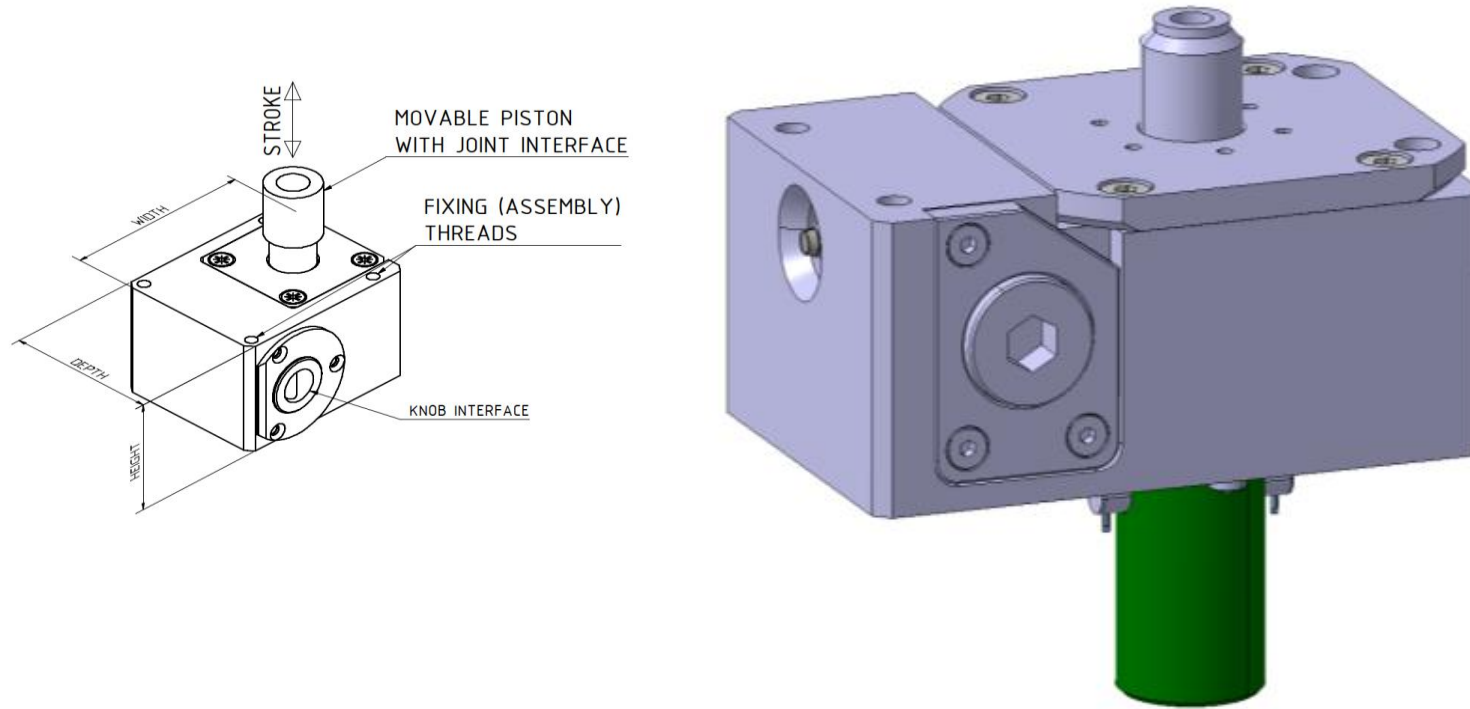


- Allowable load: 2000 kg
- Nominal stroke of the movable piston: ± 10 mm (maximum ± 15 mm),

- With typical misalignment – 1 iteration
- With misalignment bigger than ± 2 mm - 2 iterations
- 1 iteration = 9min
measurement + calculation + adjustment + measurement
- Adjustment time less than 3min



Standardized vertical jigs

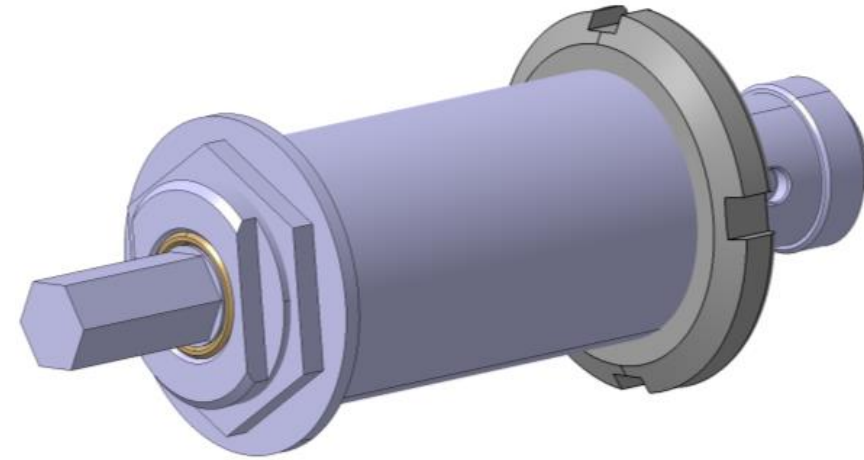
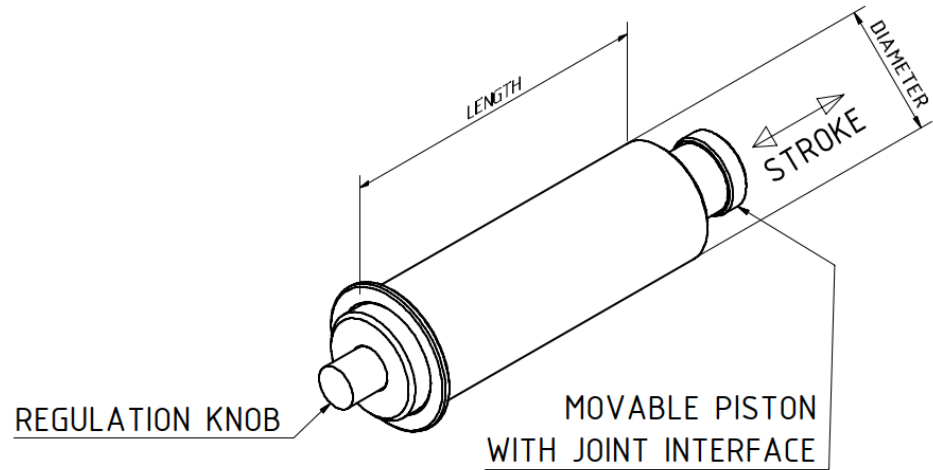


Parameters:

- Axial piston backlash $< 5 \mu\text{m}$,
- Radial piston backlash $< 20 \mu\text{m}$,
- Nominal load of the jig: Big UAP $> 15 \text{ kN}$; Small UAP $> 2.5 \text{ kN}$
- Compact dimensions; Easiness of integration



Standardized radial jigs

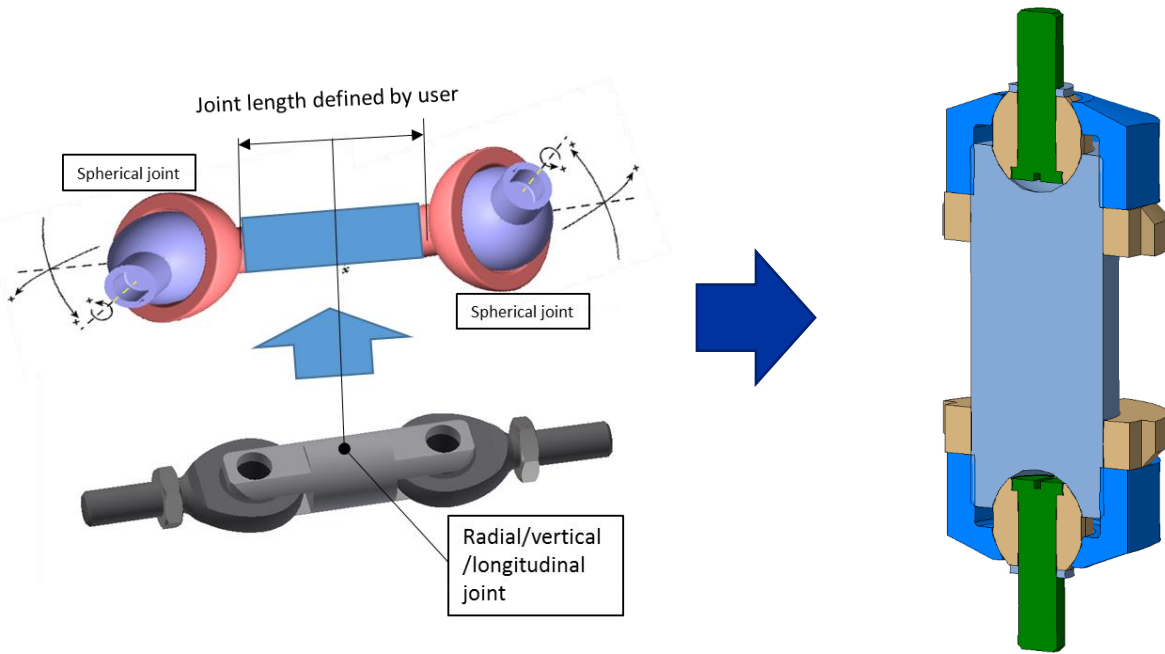


Parameters:

- Axial piston backlash $< 5 \mu\text{m}$,
- Radial piston backlash $< 20 \mu\text{m}$,
- Nominal load of the jig: Big UAP $> 2 \text{ kN}$; Small UAP $> 1 \text{ kN}$
- Compact dimensions; Easiness of integration



Standardized joints

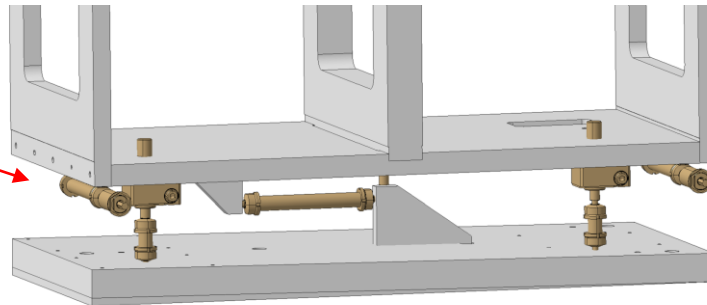
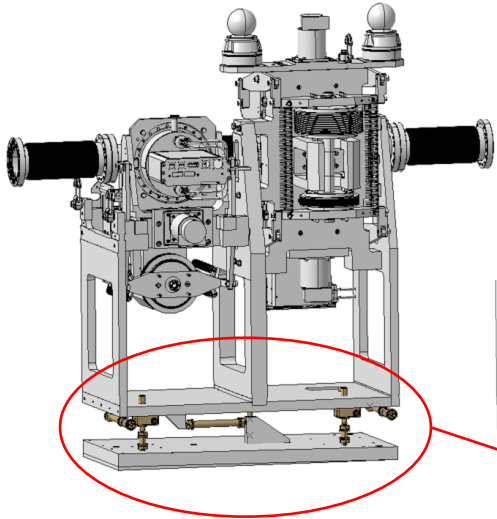
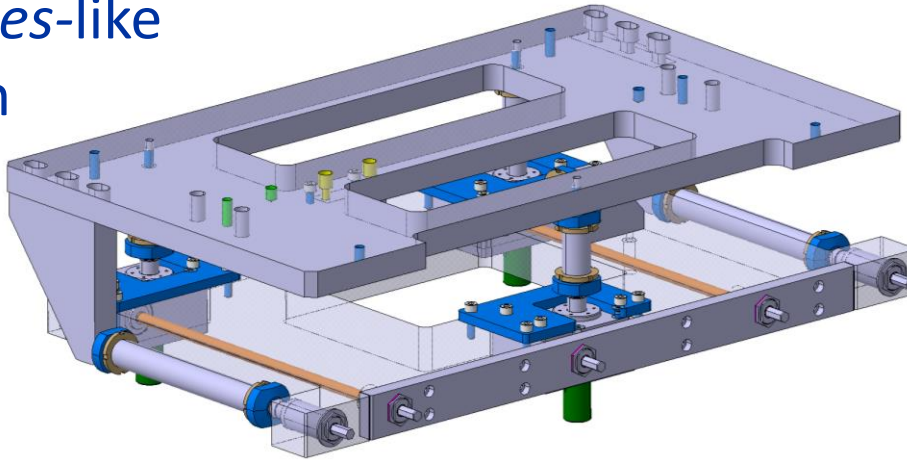


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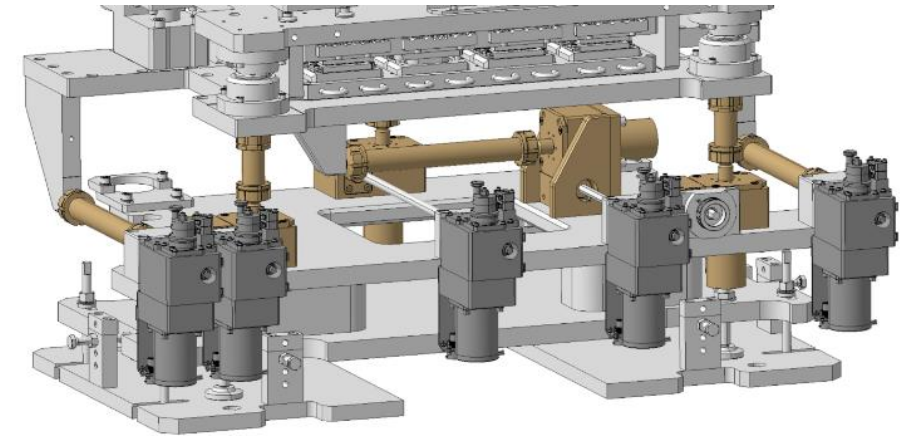
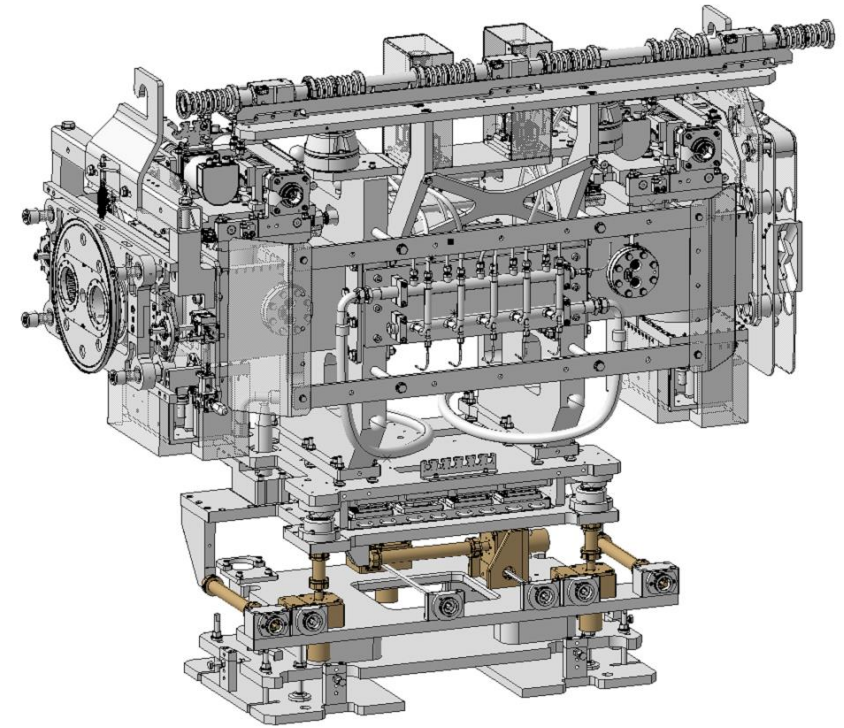
- Nominal longitudinal load of spherical joint link $> 12 \text{ kN}$,
- With „zero backlash joints”, the total backlash (in all directions) of TOP PLATE interface vs. jig piston interface $< 20 \text{ }\mu\text{m}$,

UAP implementation flexibility

*Design Guidelines-like
implementation*



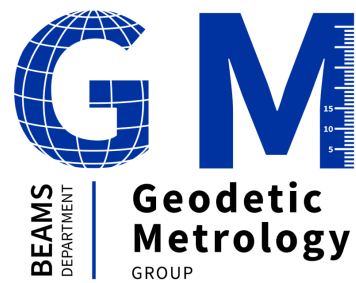
Precision Proton Spectrometer (inversed, 5 DOF)



Collimator support (non motorized / motorized)

Summary

- The Universal Adjustment Platform tests showed, that homogenization of adjustment solutions for accelerator components is feasible and can be applied with success to different types of components
- Tests performed on the prototypes of the Big and Small UAP demonstrated a very good performance of the platforms prepared according to the UAP *Design Guidelines*



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