Technical update on the UAP design and ongoing technical developments on the FRAS

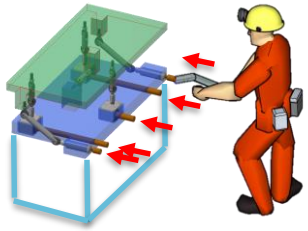
Mateusz Sosin on behalf of WP15.4

WP5.2 Technical Meeting 2021-10-18

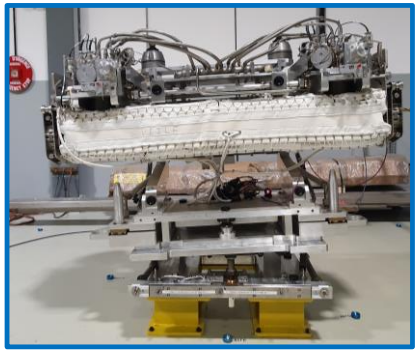
Outline

- Update on the switches integration (possible solutions being investigated)
- Update on sensors quantities to be implemented
- Update on the arguments for the UAP levelling and discussions on what to do for the two prototyes

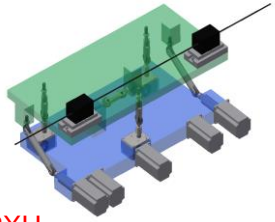
UAP - Limit switches integration



Universal adjustment platform – manual operation concept



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



TCLPX, TCTPXH,
TCTPXV, TCLMB support case

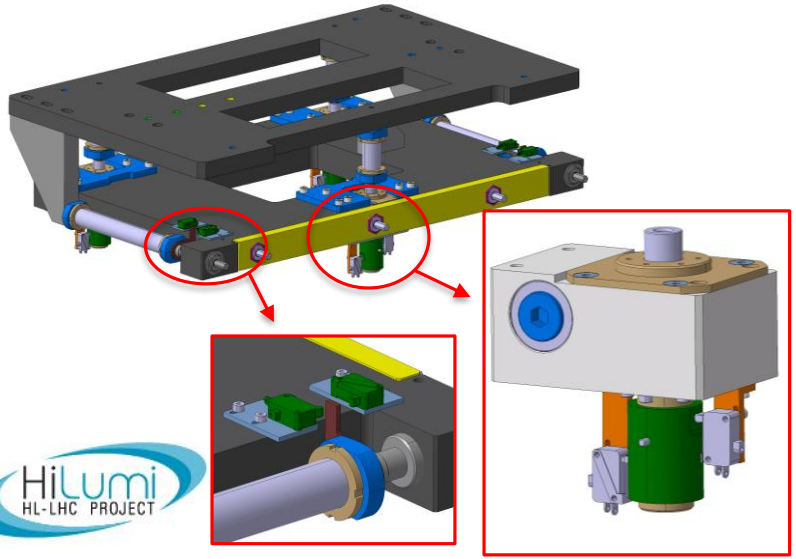
- For now manual UAP configuratuion tested
  - Internal review on UAP for Collimators and Masks (https://indico.cern.ch/event/1015011/) 2021-03-11
- Design of motorized UAP version (including imit switches integration) – starting Nov 21'

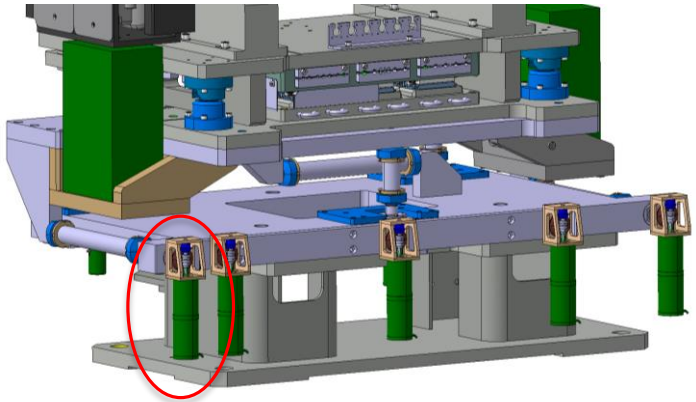
FRAS control system – limit switches required on each motorized axis

- Used to detect the presence of actuator reaching its limit position
  - Full Remote Alignment System software - Functional Specification LHC-_-ES-0047 (EDMS 2589302)
  - Final limit switches configuration under discussion in frames of FRAS risk assesment (EDMS 2592013)
- One of main feature, to provide safety of operators and machinery

UAP - Limit switches integration

- Limit switches are funtional part of FRAS systems → design under responsibility of WP15.2
- Two options considerd for limit switches integration
  - UAP Bottom plate, jigs (preliminarily studied) – this option will require help of WP5.2 to integrate required limit switches interfaces on the platform Bottom Plate (as equipment owner)
  - Limit switches integrated within motorized adapters (design and integration by WP15.4)
- Final decision depends on FRAS limit switches configuration, under discussion by CEM-GEM-ICS. Main issue is integration volume vs. available space





Update on sendor quantities to be implemented on collimators TCLM masks

- *Reliability improvement in the position determination of HL-LHC components, V. Rude, A. Herty*, Working Group on Alignment, 2021-09-29 (https://edms.cern.ch/file/2617042/1/2021-09-29_WGA_VR.pptx)
  - Summary of the studies, undertaken to identify the means to improve alignment accuracy and redundancy of the FRAS

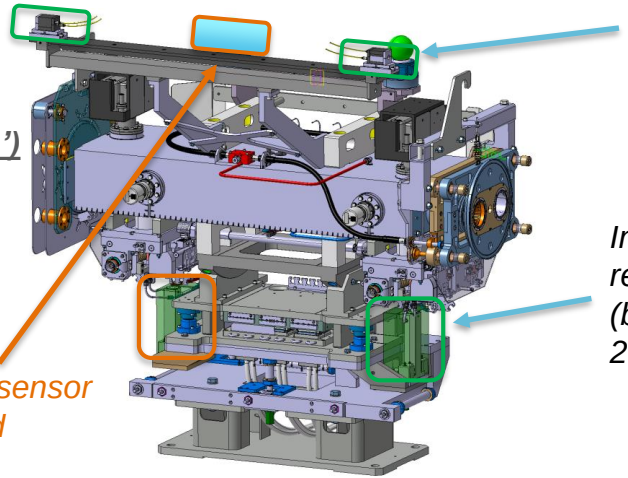
- **Recommendations of the reviewers – Review HL-LHC Alignment and Internal Metrology (WP15.4) 26-28 August 2019**
  - Recommendation n°6 : "*Extra care should be taken to validate the systems before, during and even after installation, built in as many tests and redundancies as reasonable*"

From Baseline (2019):

- 2 WPS + 1 inclinometer

Simulation 4 – redundancy upgrade (WGA 29-Sep 21')

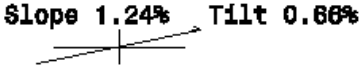
- Add 1 WPS → 3 WPS
- Add 1 inclinometer → 2 Inclinometers



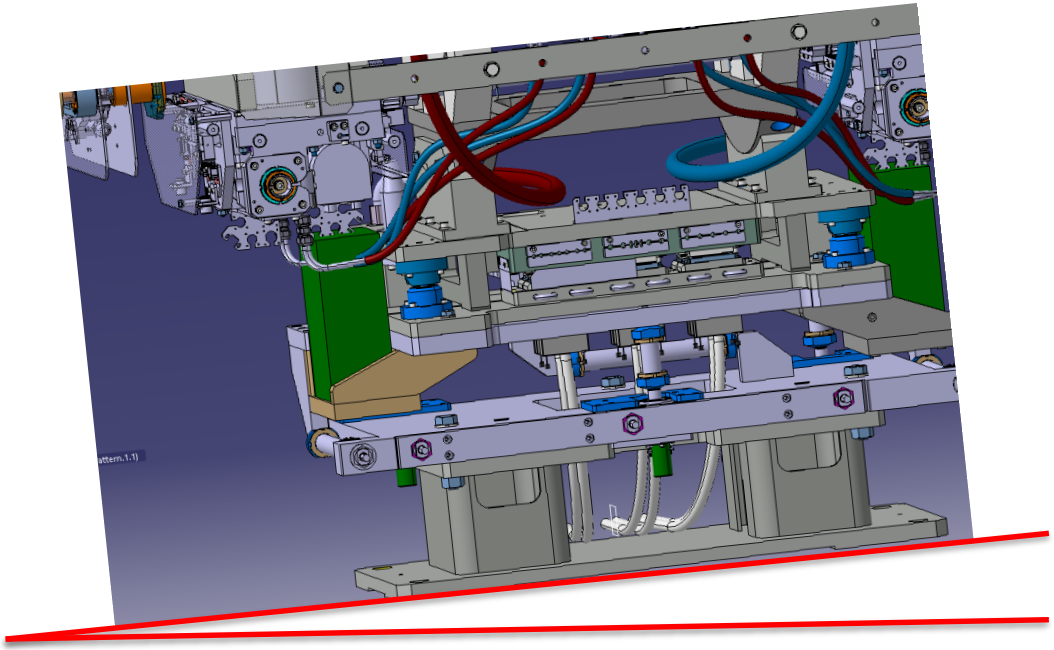
UAP levelling vs. Inclined floor

LHC tunnell floor is inclined

- P5 

- P1 

- Slope and (SU:roll) tilt **are invisible in integration models**
- Equipment owner have to consider floor inclination in design and installation procedure to avoid tilt/slope-derivative offsets



Tanα = 1.24/100 → α=~0.71deg

Inclined floor - supporting systems integration guideliness

Supporting and alignment structures need to be verticalized

- Anticipation of component centre-of-mass shifts
- Anticipation of MAD points marking offsets → Anticipation of longitudinal/lateral shifts of components
- Anticipation of adjustment tables range lost
- Keep adjustement kinematics standardized and compatilbe with SU procedures

J.C. Quesnel, https://edms.cern.ch/document/886573/1

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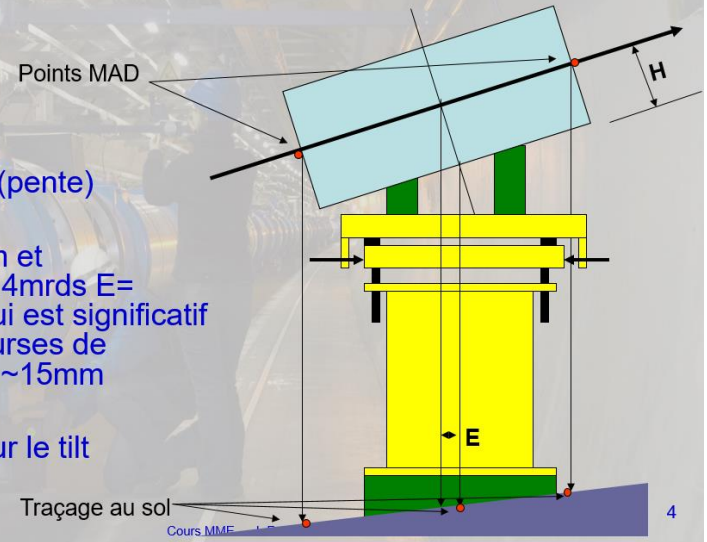
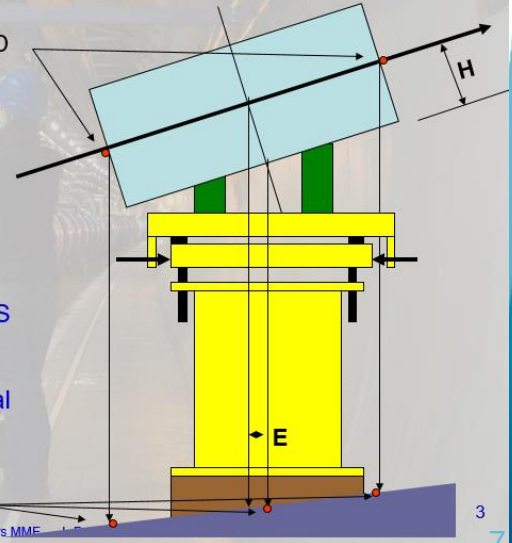
Exemple classique à appliquer dans les pentes



- E = H*tang(pente)
- Si H=0.50m et pente=0.014mrds E= 7mm, ce qui est significatif sur des courses de réglage de ~15mm
- Valable pour le tilt

Exemple classique à appliquer dans les pentes

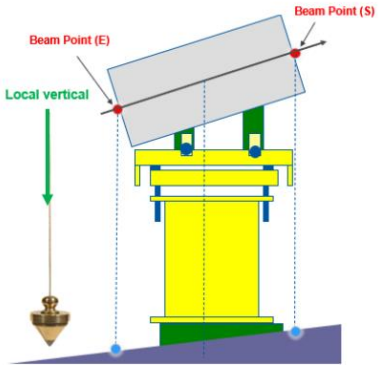


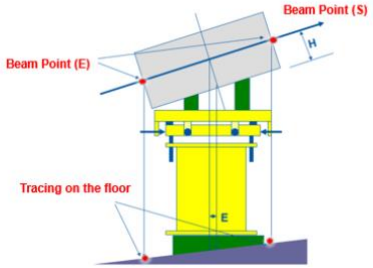
- Cale (marron) pour rattrapage de pente du sol
- Cale (vert) pour rattrapage de pente de l'élément
- Pied jaune vertical
- Réglage de hauteur et tilt SOUS le plateau de translation
- Plateau de translation horizontal

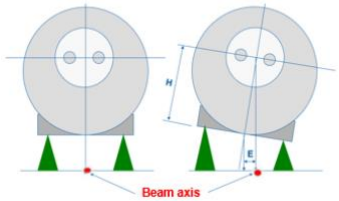
Inclined floor - supporting systems integration guideliness

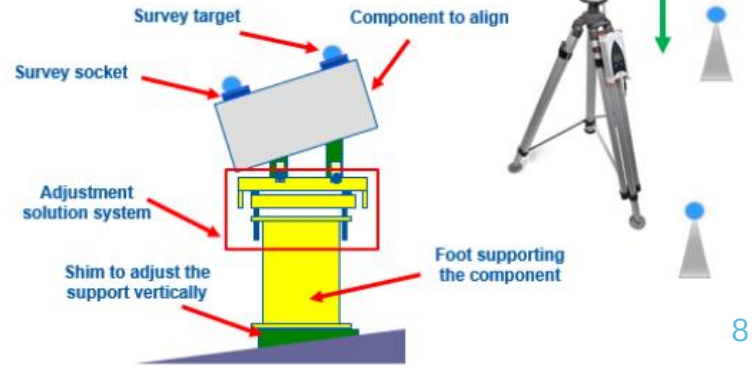
Why it is so important for SURVEY?

- Measurements performed using loacal vertical direction (all instruments measurements prior to levelling)
  - All marking is done w.r.t. gravity direction
  - All adjustments shall compatible with instruments coordinate systems → adjustment tables kinematics shall be ‚levelled'
  - SURVEY teams (usually contractors) follow-up standardized procedures of alignment → no rotations/translations recalculation while alignment of various components









Inclined floor - supporting systems integration guideliness

General needs for design of supporting structures and alignment tables can be found in:

- Rules applied since many years in CERN → JP Quesnel training from 2008 https://edms.cern.ch/document/975680/3)
- *Alignement des composants des accélérateurs : Généralités et besoins mécaniques* https://indico.cern.ch/event/998389/ (https://edms.cern.ch/document/2450861/1 - tilted floor issue is described in part3.pptx)

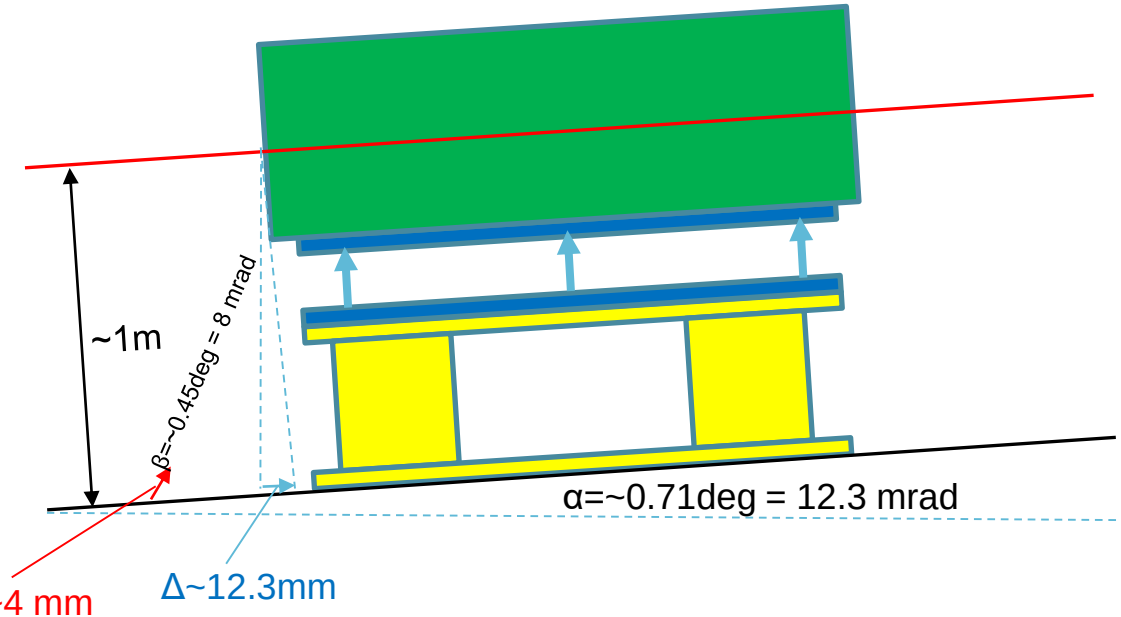
Non-conformity cases detected for components:

- Examples: TANB, TDIS, TI2/TI8 collimators, multiple collimators reached maximum longitudinal adjustment stroke , all caused by errors in integration of the MAD points marking offsets

Currently BE-GM working on **CERN Standard:** *Guidelines and requirements for an alignment of a new component on a beam line at CERN, by J.-F. Fuchs*, which introduces requirement of supports verticalization

- To standardize the components alignment supports installed in a way compatible with Survey measurement/alignment way of work (vertical/horizontal measurements, coordinate systems);
- To avoid offset related errors (impacting further alignment actions) while installation of components
- Objective is to keep standardized way of adjustment supports design for all accelerator components

Collimator, TCLM case – parallel installation – current integration for HL-LHC (and LHC collimators case)



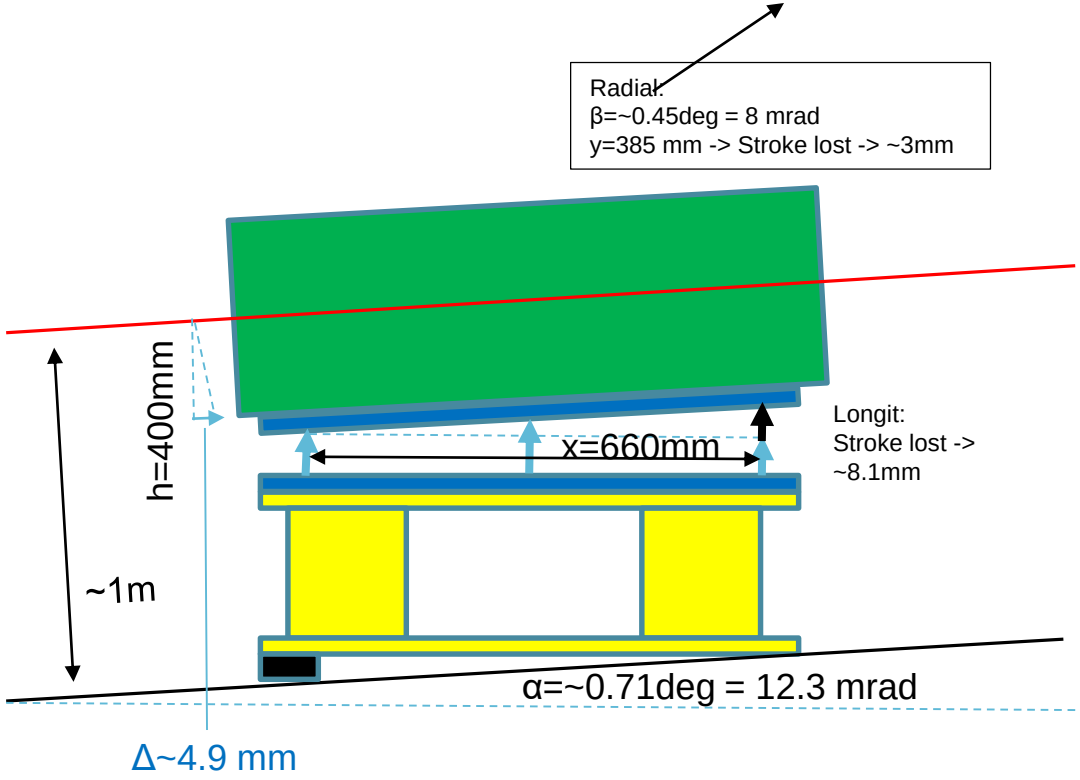
Alignment issues –
straight design of all support:

- Slope ~1.25%
- Needed longitudinal/lateral shift offsets when installing supporting tables (error prone during installation)
- Kinematics introduces additional complexity – difficult for manual adjustment (need on-site translation/rotation corrections by SU contractor teams)
- Adjustable (levelling) FRAS inclinometer support required

Pros:

- No UAP stroke lost
- Simplest design

Single shimming – only supporting table verticalized (example of adjustment platforms stroke lost)



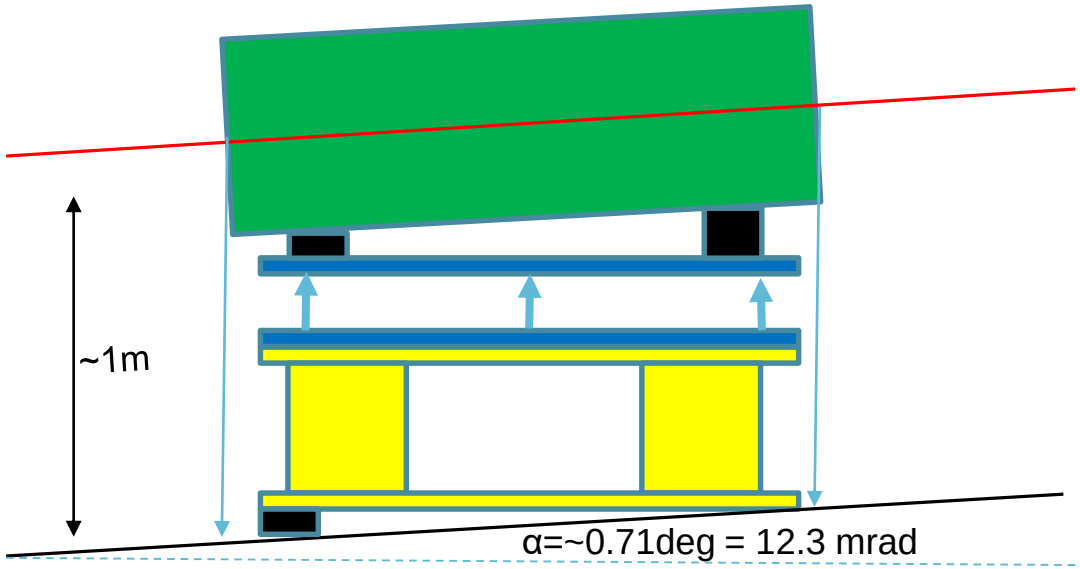
Alignment issues – straight design of all support:

- Slope ~ 1.25%
- ~4.9 mm longitudinal shift caused by UAP vs. beam height distance tilted
- Kinematics introduces additional complexity
- Adjustable (levelling) FRAS inclinometer support required

Pros:

- Supporting table easy to level, using shims and standard level tools

Supporting table and adj. platform levelled



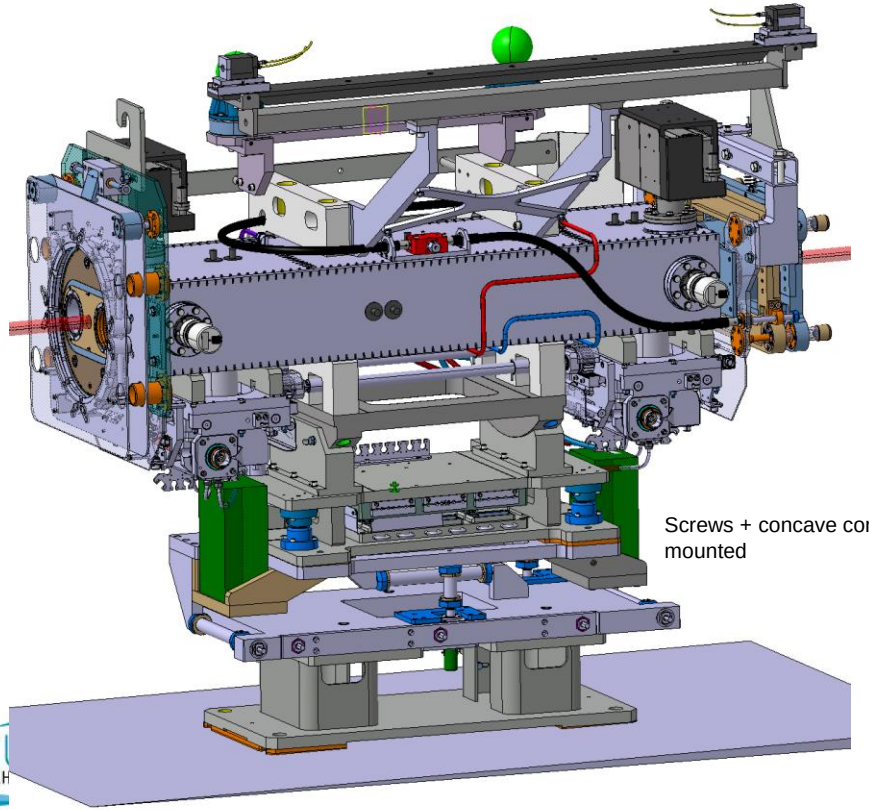
Alignment issues –
straight design of all support:

- Slope ~1.25%
- Smallest longitudinal shift caused by UAP vs. beam height distance tilted
- Additional shims required

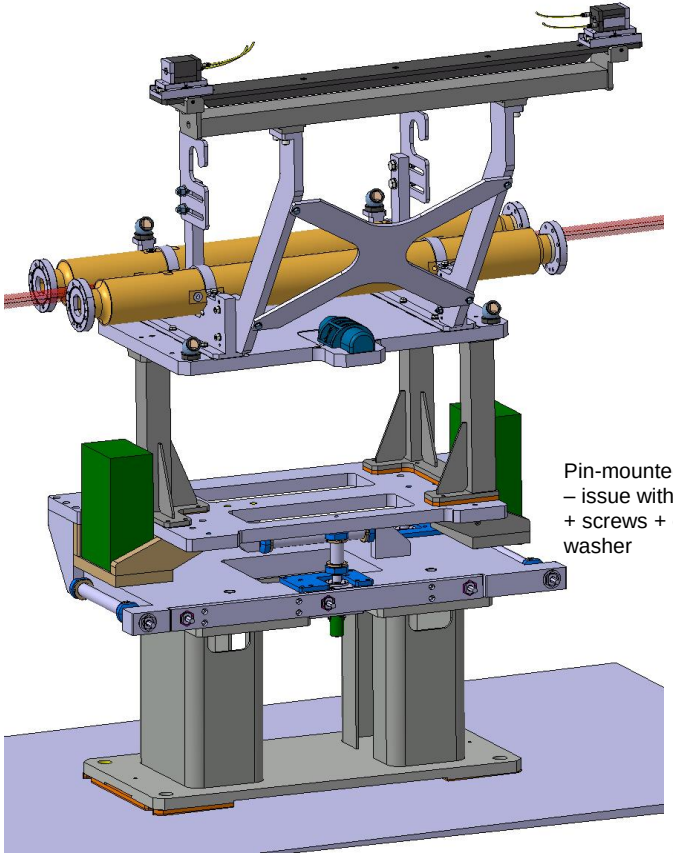
Pros:

- No UAP stroke lost
- No need for inclinometers angled supports
- Minimized risk of assembly offset errors
- Intuitive kinematics for SU teams during manual alignment

Solution option - shims integration?



Screws + concave convex washer mounted



Pin-mounted
– issue with pins fitting
+ screws + concave conve
washer

Other alternatives – grouting?

Jack levelling

Product category

STANDARD GROUTING MORTAR

Our standard grout products – often also called swelling mortar – are ideally suited and indispensable for the casting of precision machines of all kinds, steel and concrete components or crane runway rails. Thanks to their outstanding durability and high early and final strengths, our standard grout products are ideally suited even for the casting of components that are exposed to extreme environmental conditions such as freeze-thawing attack with and without de-icing salt.

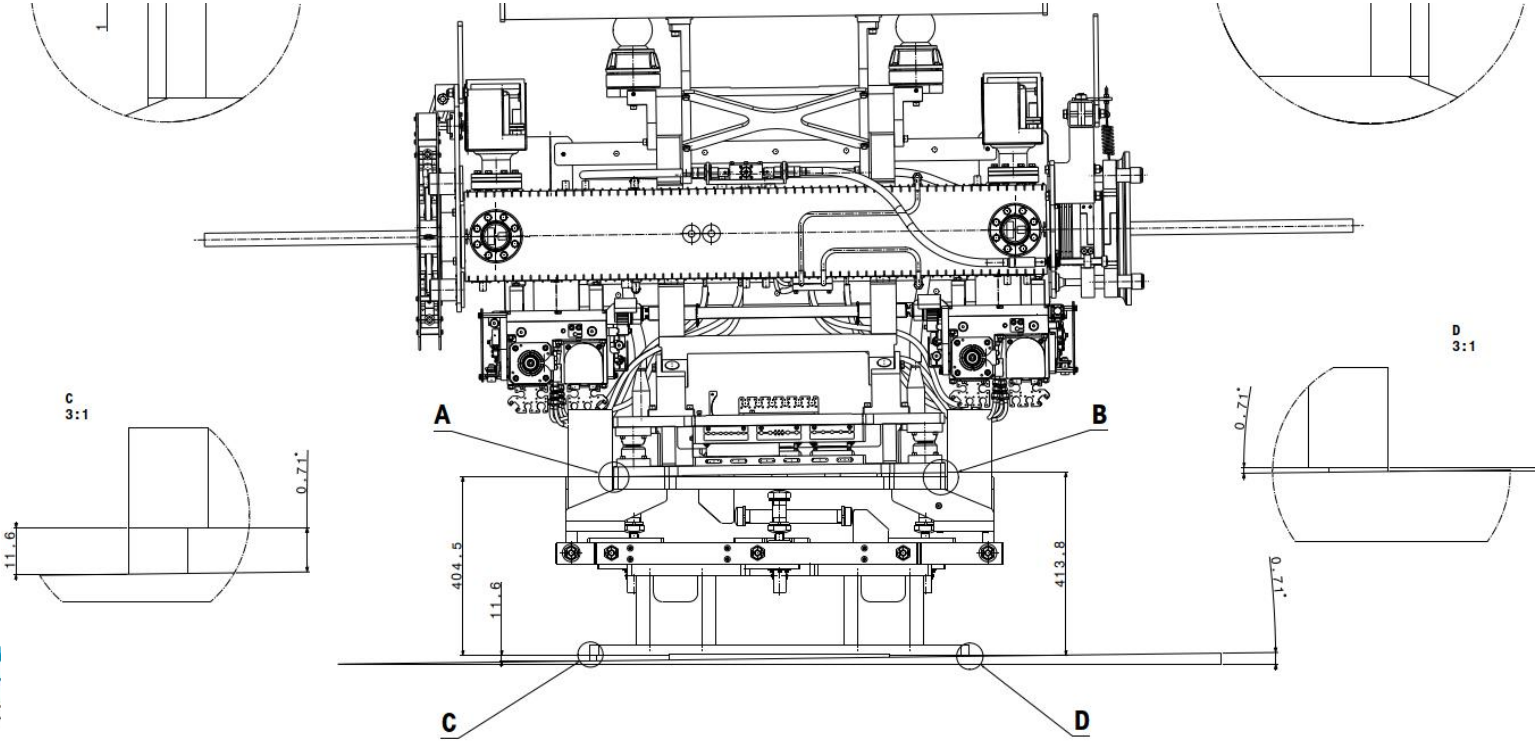
With our grouting concrete V80C45 and V160C45 even constructive repair measures according to DAfStb guideline protection and repair of concrete components are possible.

Our product selection in the category standard grouting mortar:

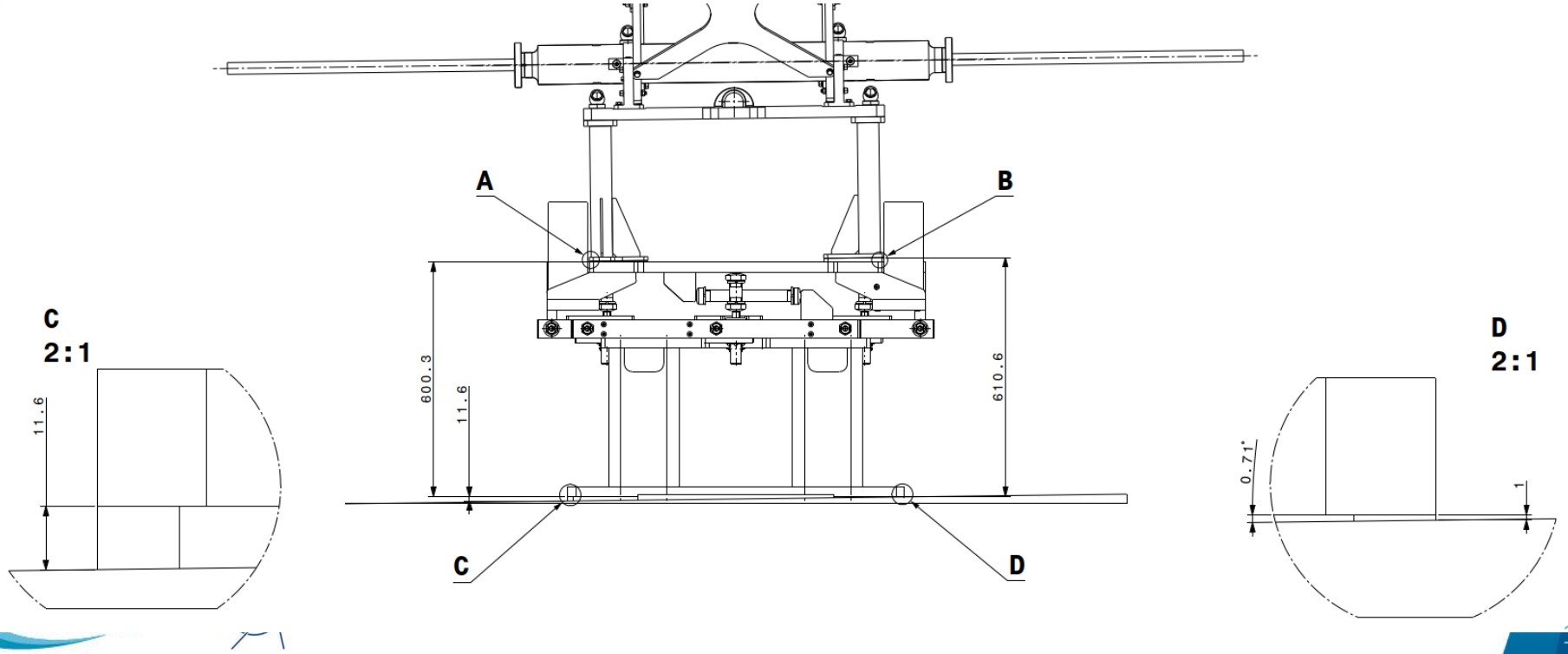
V1/10 PAGEL-grout	V1/50 PAGEL-grout	V1/160 PAGEL-grout
V80C45 grouting concrete	V160C45 grouting concrete	V14/10 baseplate mortar
V14/40 baseplate mortar	V14/80 baseplate mortar	

Spare slides

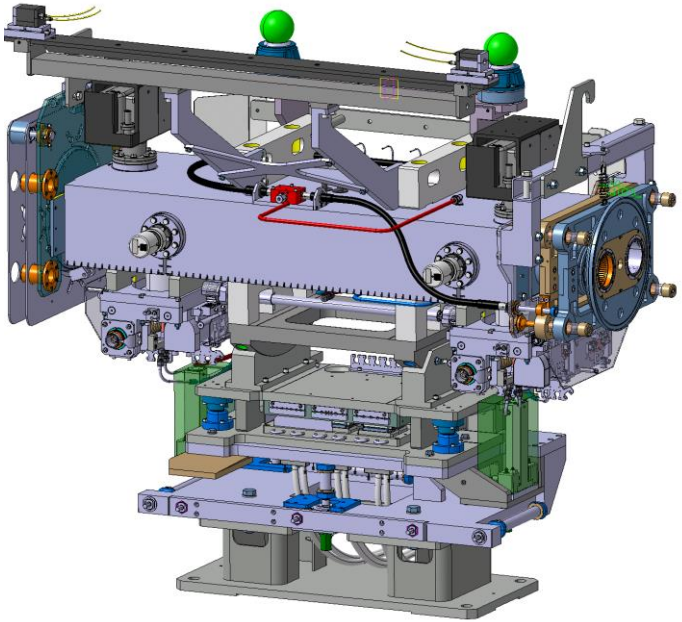
Collimator shims – example of integration

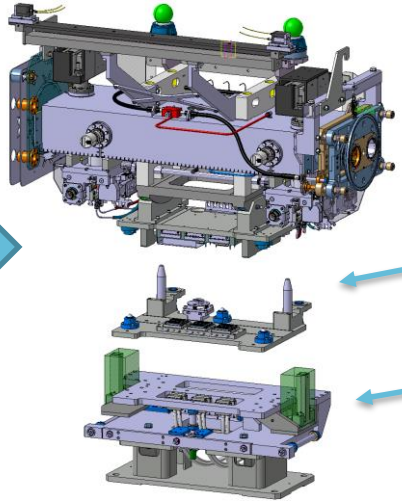


TCLMB shims – example of integration

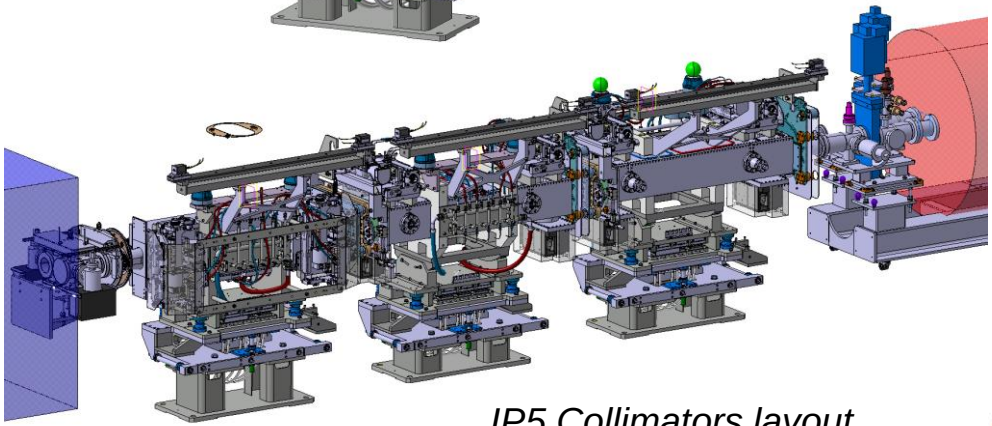


Universal Alignment Platform integration





Collimator installed on the Universal Alignment Platform (UAP)
ST1164052_01 (L. Gentini, E. Urrutia)



IP5 Collimators layout