Dual Phase TPC group

WP2 : CRP Mechanical structure and automation

Responsibles : D. Duchesneau , N.Geffroy

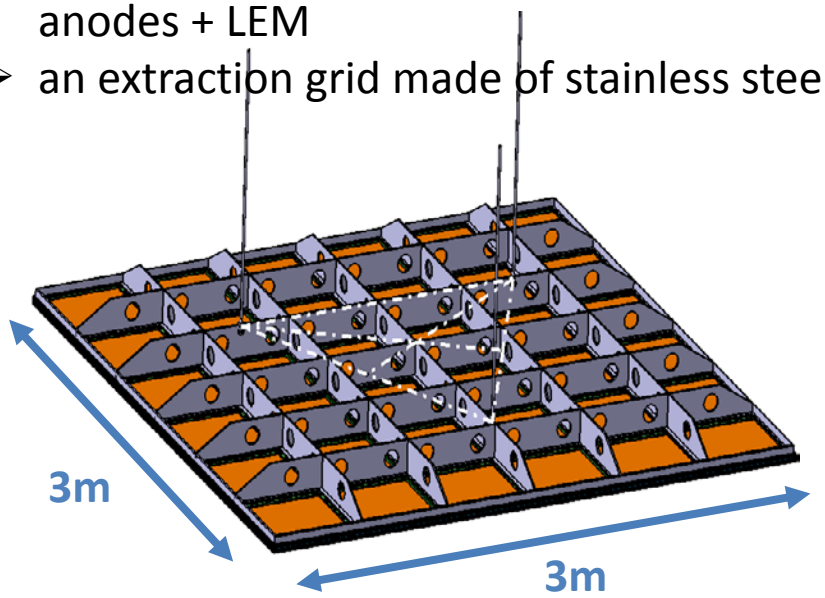
Subjects covered by the WP2 :

- Mechanical design of 3x3m² modules including extraction grid
- Thermal tests and validation
- Module production, assembly and metrology
- Transportation issues (box and manipulation)
- Mounting sequence in cryostat including module lifting and electrical connections
- Motorised suspension system and module positioning system from warm to cold conditions

Mechanical design of 3x3m² modules including extraction grid

The modules are composed of:

- a frame, ensuring rigidity and stability in cold conditions according to tolerances described hereafter.
- a G10 structure playing the role of interface between the frame and anodes + LEM
- an extraction grid made of stainless steel wires

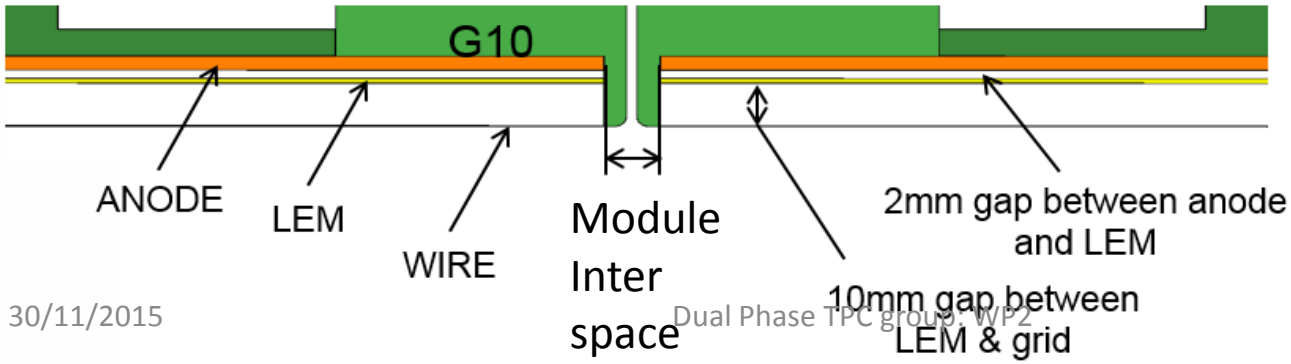


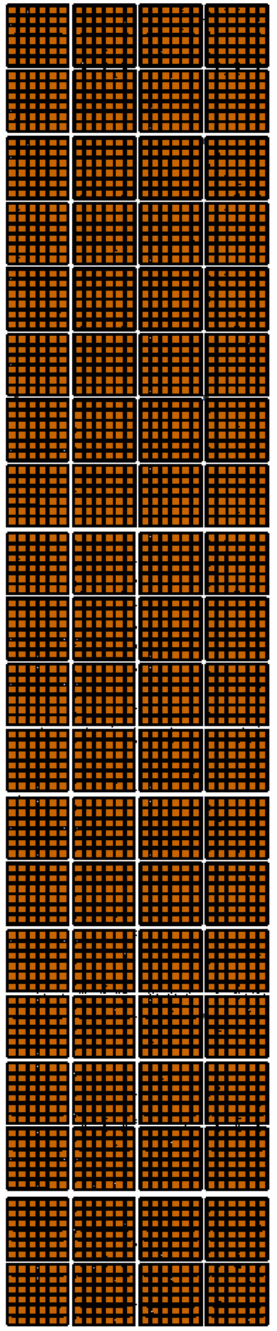
DUNE setup
60 m x 12 m

- *Eighty 3x3 modules*
- *Individual extraction grids 3x3*

Each 3x3m² module will be hanged to a drive system thanks to 3 cables

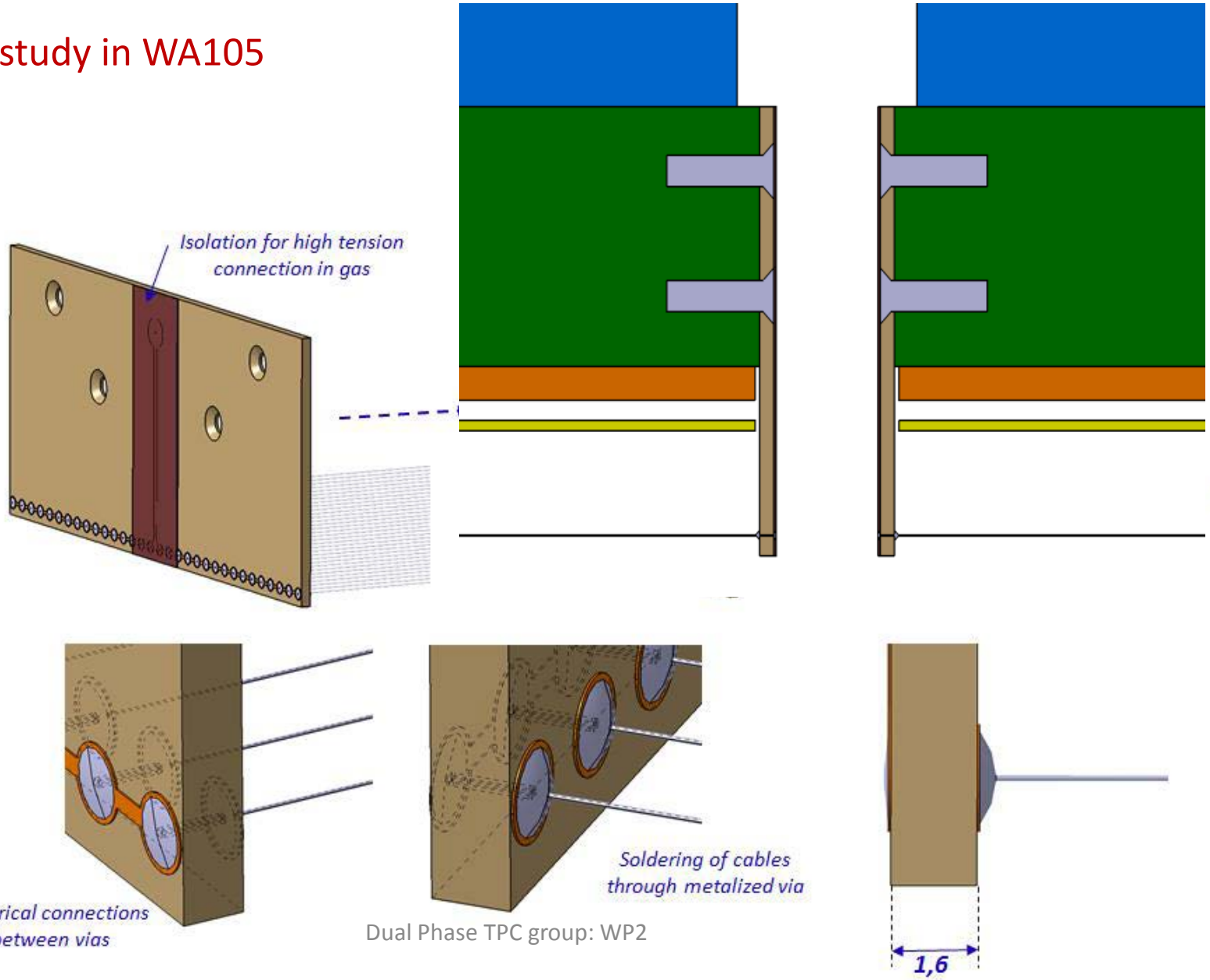
Side view: near 2 modules





- Mechanical aspect of the extraction grid wire support and electrical connections

Under study in WA105



The aim of this WP

to converge on a mechanical design of the eighty 3x3m² modules required for DUNE following the actual design work done for WA105.

The module design specifications are:

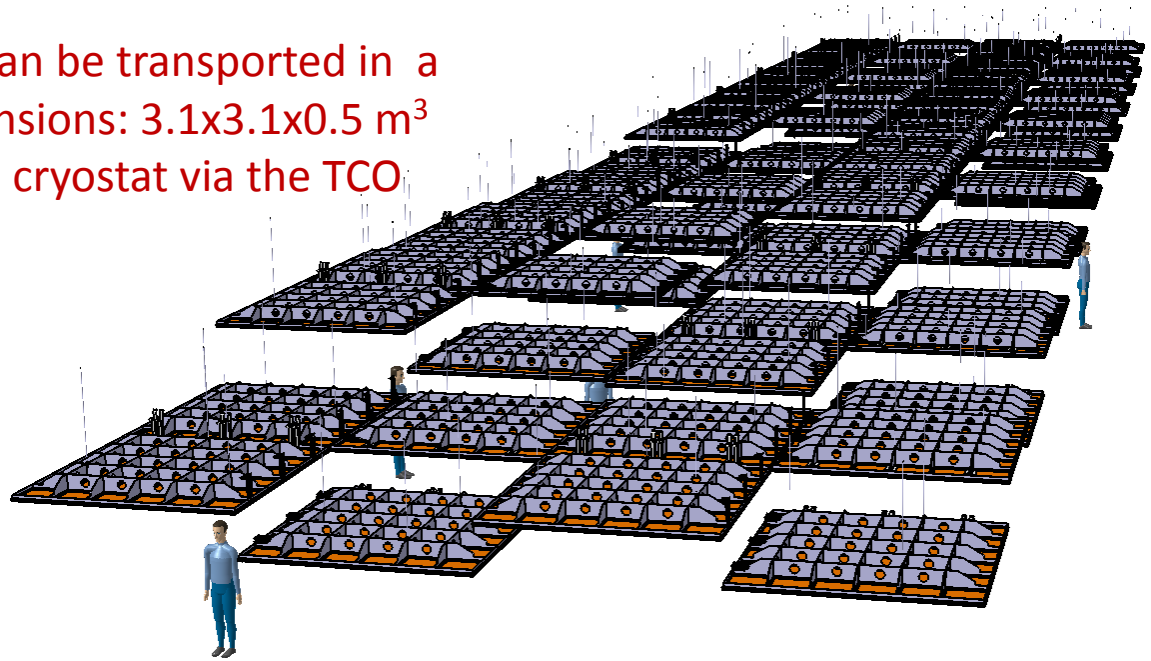
1. in cold conditions, the CRPs must be between two fictive parallel planes separated by 1mm (+/- 0.5mm requirement with respect to the neutral plane)
2. the resulting mean CRP plane must be parallel and accurately positioned with respect to the Liquid Argon surface (nominal position of the CRP LEM is 5 mm above the liquid level).
3. the extraction grid wires, having 0.1 mm diameter, should have a maximal sagging of 0.1mm.
4. the inter-space between consecutive modules has to be minimised and is under discussion
5. all electrical connections (on feedthrough chimneys) have to be taken into account in the mounting procedure
6. the stroke for CRP height position is 40 mm (equivalent to +/-20mm)

Scalability for DUNE : proposed solution

- *Eighty 3x3 modules*
- *Individual extraction grids 3x3*

- *Each module can be manufactured separately in different areas*
  (++ for collaborative work and restrictive schedule)
- *Several 3x3 modules can be installed simultaneously, reducing installation time*
  - *(see next slides)*

Each module can be transported in a box with dimensions: 3.1x3.1x0.5 m^3
=> enter in the cryostat via the TCO



Issues and actions:

Spec. 1 issues:

To achieve the desired planarity of the CRPs many contributions must be taken into account:

- shape precision of individual parts
- assembly tolerances of the structure
- gravity acting on modules suspended by 3 points (creating possible flexural effects on structures)
- thermal loads acting on the structure (creating possible flexural effects on structures)

Actions:

- Thermo-mechanical simulations and cold tests are foreseen (material properties in cold, behaviour of assembled structures)
- Production of sample to identify manufacturing and assembling procedures
- Thermal loss simulation from cryostat people to know well the module thermal loading

Spec. 2 issues:

The 3 hanging wires, associated with motors, will be used to adjust possible tilts between CRP and LAr surface and distance between them.

Actions:

- Control algorithm must be developed and tested using LAr-to-LEM capacitance inputs

Spec. 3 issues:

The 0.1mm sagging requirement must be achieved thanks to wire pretension applied in warm conditions.
No other action in cold conditions is possible.
Electrostatic effects on wire (due to electrical field) sagging to be clarified.

Actions:

- Check that the wire tension in cold is still sufficient for 0.1mm sagging.
- Thermal expansion coefficients between stainless steel wires and structure on which extraction grid is fixed must be considered
- The use of combs every 1m is envisaged to decrease the level of wire pretension needed.

Spec. 4 issues:

Due to thermal contraction of CRP between warm and cold conditions, a resulting inter-space between modules will be created.
Scenarios to position the modules at proper locations depend strongly on this inter-space value.
Having 80 modules, we should optimize the mounting sequences.

Actions:

- Evaluate the maximal inter-space value requirement allowed by physics studies.
- Compare the different scenario for the mounting procedure.

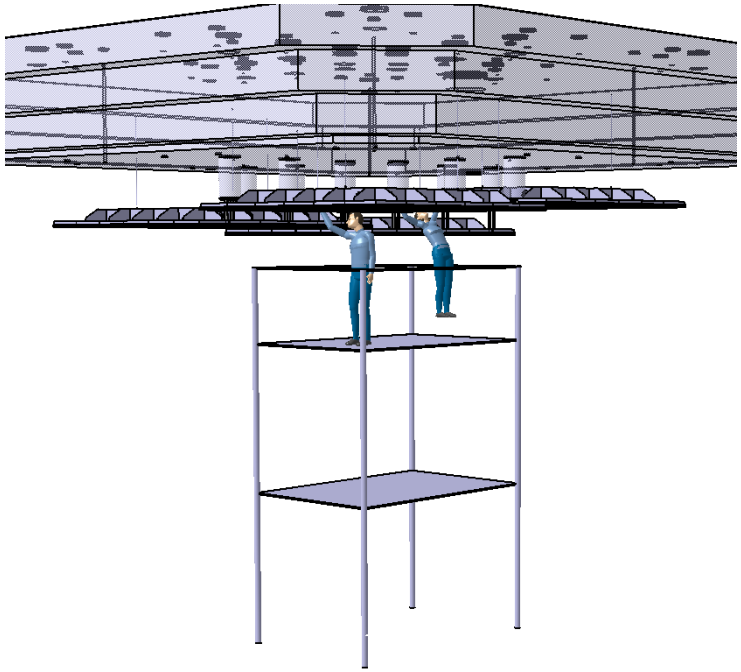
Spec. 5 issues:

Mounting procedure has to be investigated in details to be sure that all feedthrough chimneys are reachable for manual connection.

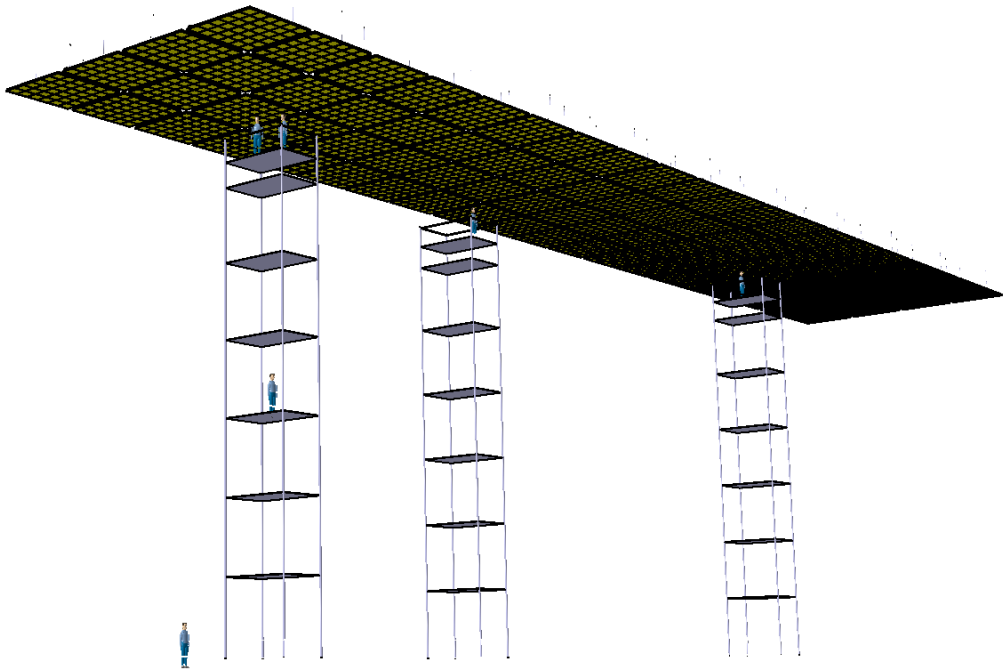
Actions:

- scenarios must be modelled by CAD and validated

Scaffoldings for WA105 and DUNE



WA105

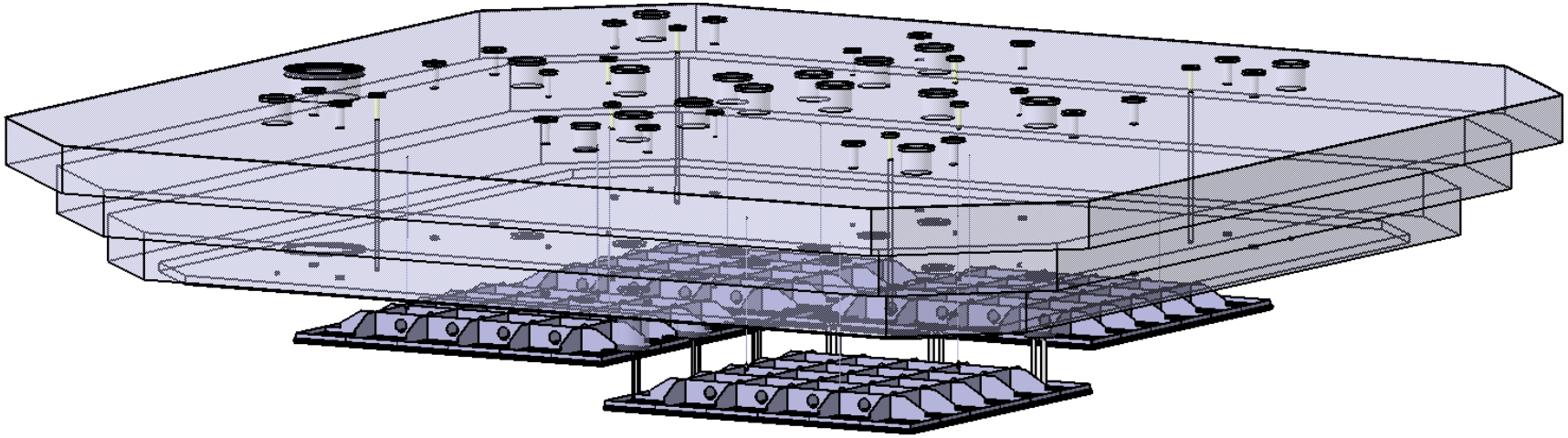


DUNE

- *Whatever chosen solution, scaffolding system have to be foreseen for both projects :*
  - *Ground of the cryostat has to be **flat and solid** enough to support scaffoldings*
  - ***Safety means** are required to work at 6 meter height or more*

Details on solution based on WA105:

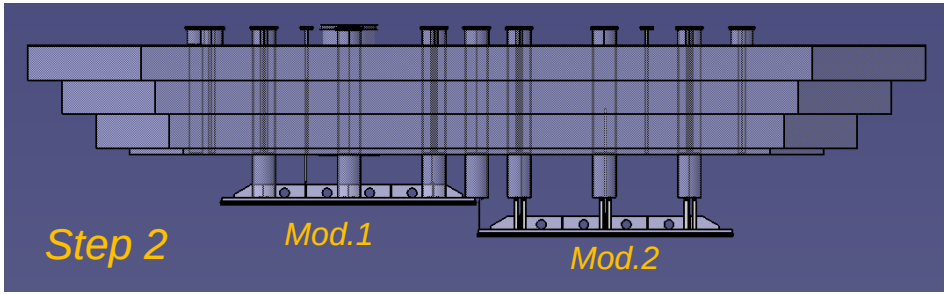
Assembly



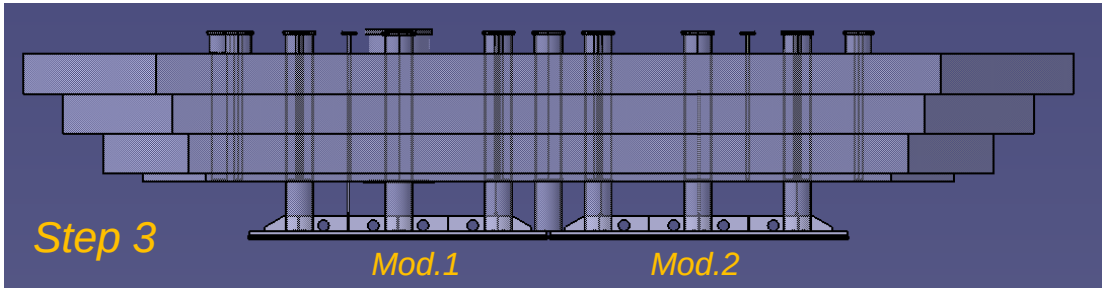
Assembly : Scenario

*Modules are **raised at lower** position, **connected** and then **raised to upper** position*

- *Module 1 is raised to upper position, then connected*



- *Module 2 is raised to lower position, then connected*

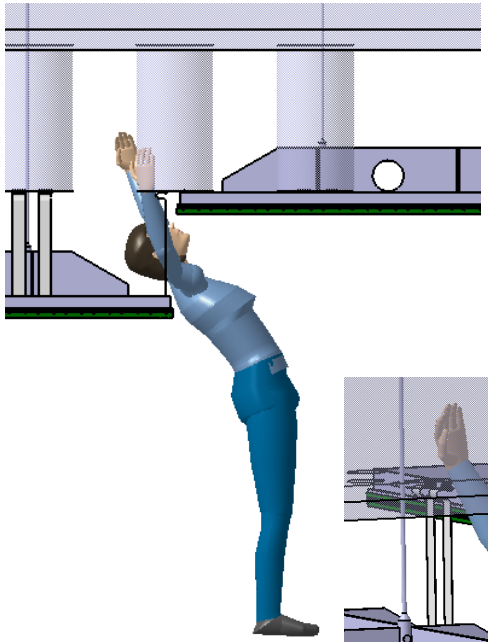


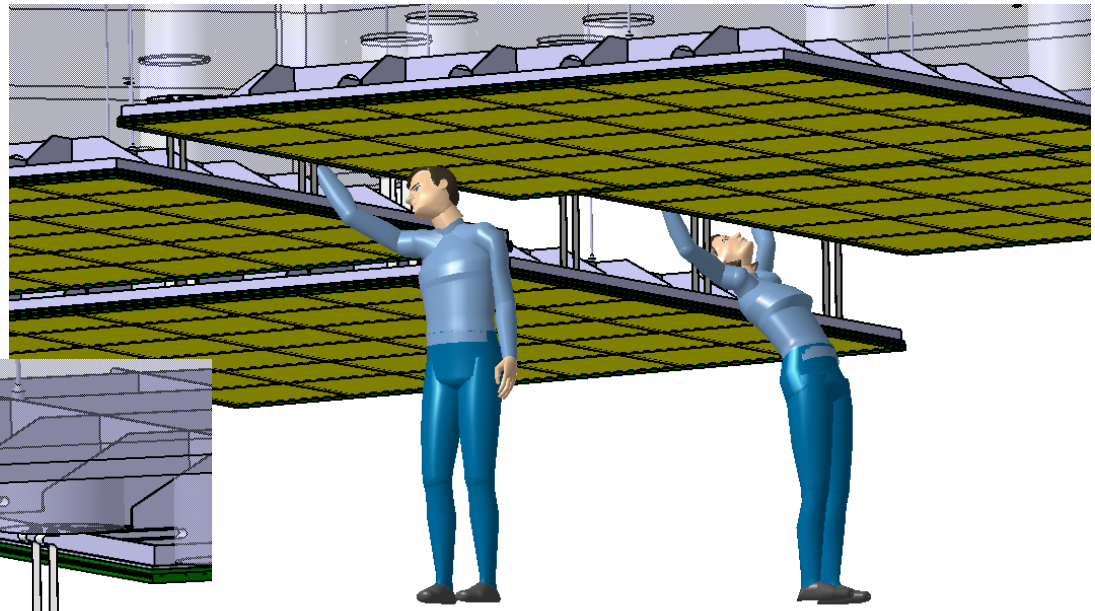
- *Module 2 is raised to upper position*
- *Module 3 is raised to lower position …*
- *Etc…*

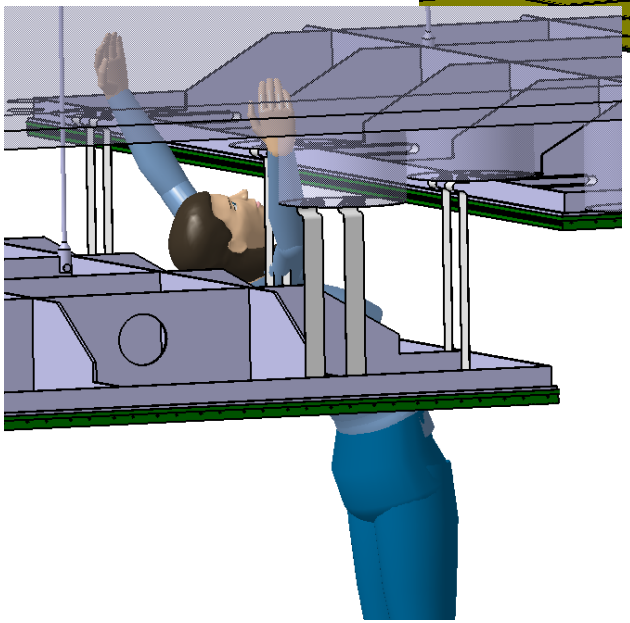
- *Additional suspension cable for modules lifting*
- *Manual (or electrical?) winches instead of SPFT drive*

Assembly : Min and max modules position

- *If full space is available (294mm), possibility of several workers in the same time*







Spec. 6 issues:

The motorization of 80x3 suspension cables

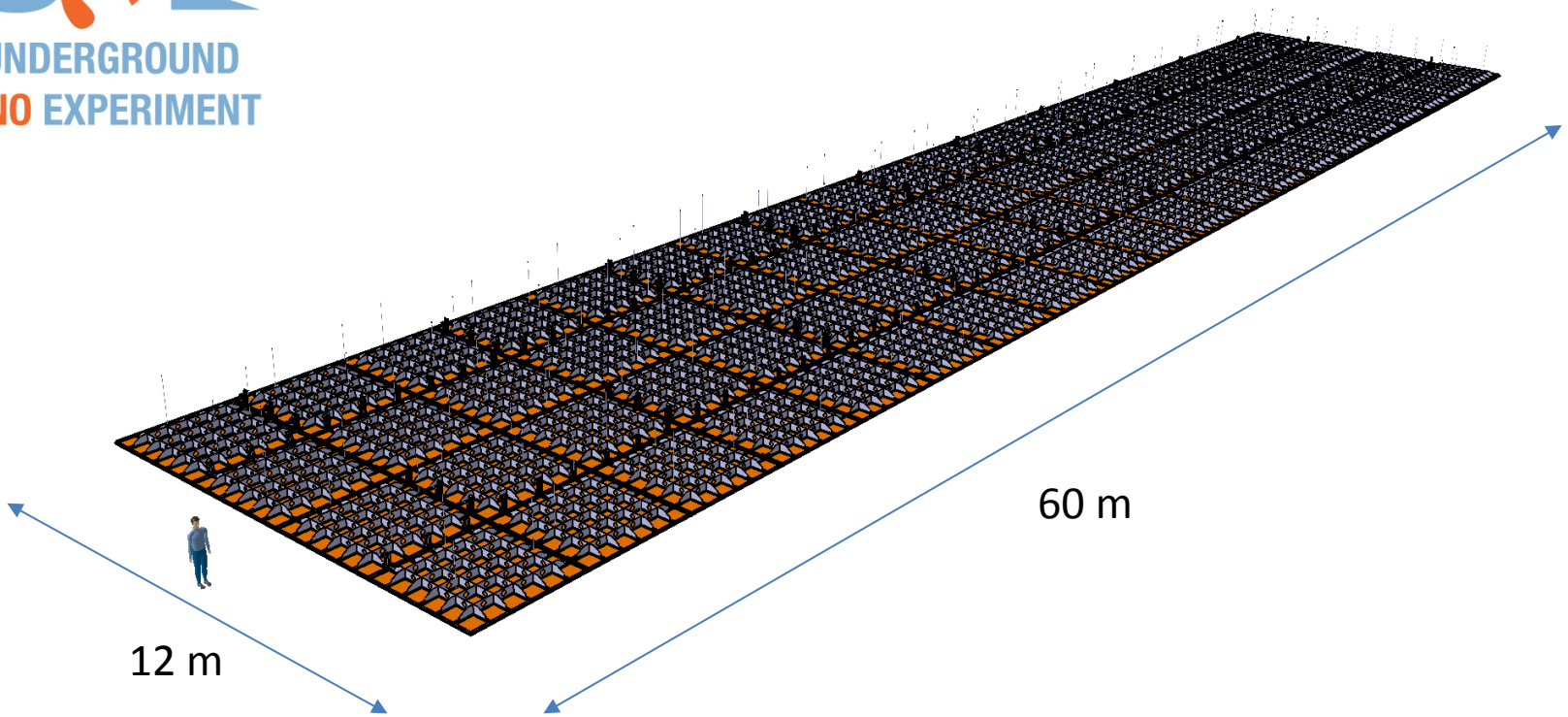
Actions:

- Check if tilts and first nominal height of modules with respect to LAr surface can be done without automation.
- Explore scenario where the automation used to follow the LAr surface distance for groups of 3x3m² modules can act with less motors (several suspension wires linked to 1 motor)

Interface with the other WPs

There is a clear need to have tight interface with the other WP of this WG.

DEEP UNDERGROUND NEUTRINO EXPERIMENT



Thank you!