



GOBIERNO  
DE ESPAÑA

MINISTERIO  
DE CIENCIA  
E INNOVACIÓN

**Ciemat**

Centro de Investigaciones  
Energéticas, Medioambientales  
y Tecnológicas



CIEMAT  
física de partículas

# DArT Project General Meeting

21/04/2022

**Particle Astrophysics Engineering Group**

Carlos Díaz Ginzo

Miguel Polo Rodríguez

Miguel Lobo Puga

## Summary

Who we are

Starting point: requirements and initial ideas

Study of ArDM

Development and improvement of the initial design

Implications of the additional load due to the lead shielding

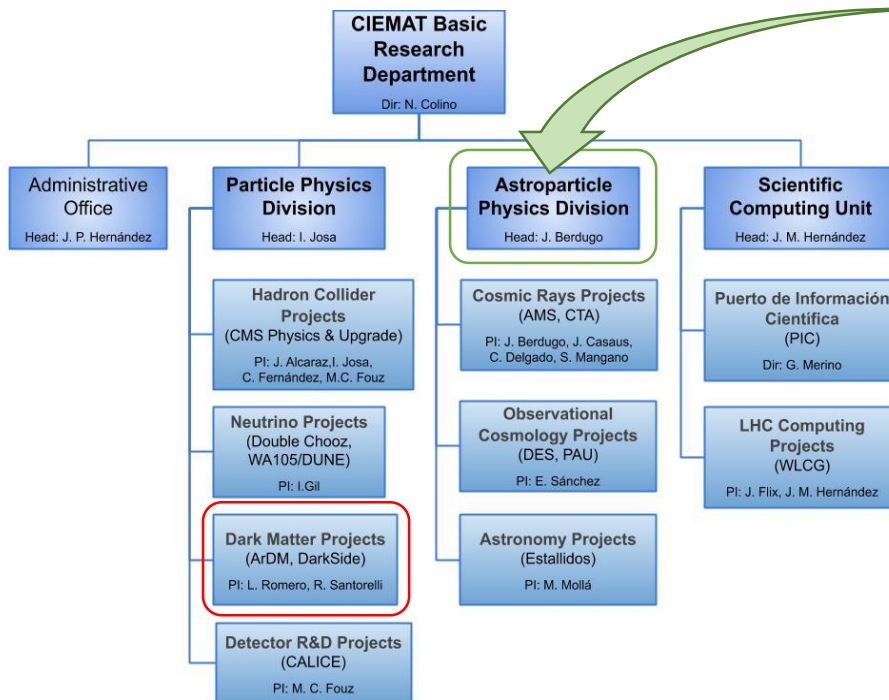
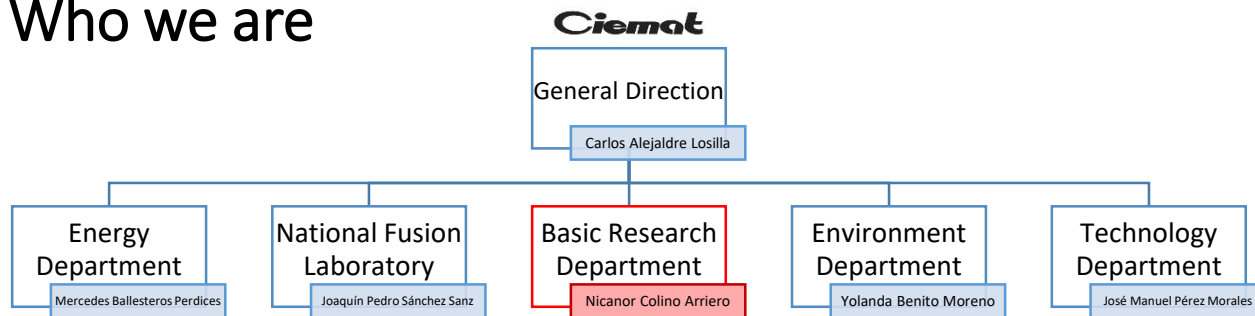
Design validation

Final design

Current status and next steps



# Who we are



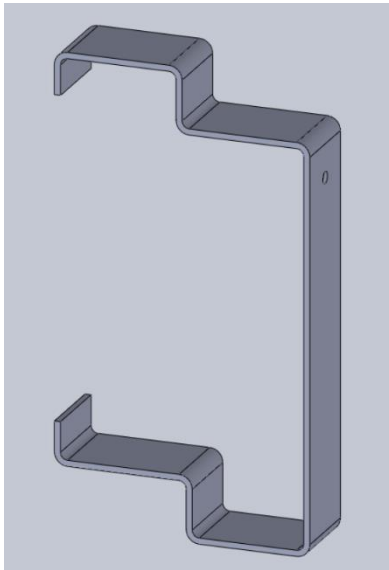
IB-ASTRO-ING Group  
Engineering group of the Astroparticle Physics Division

## Starting point: requirements and initial ideas

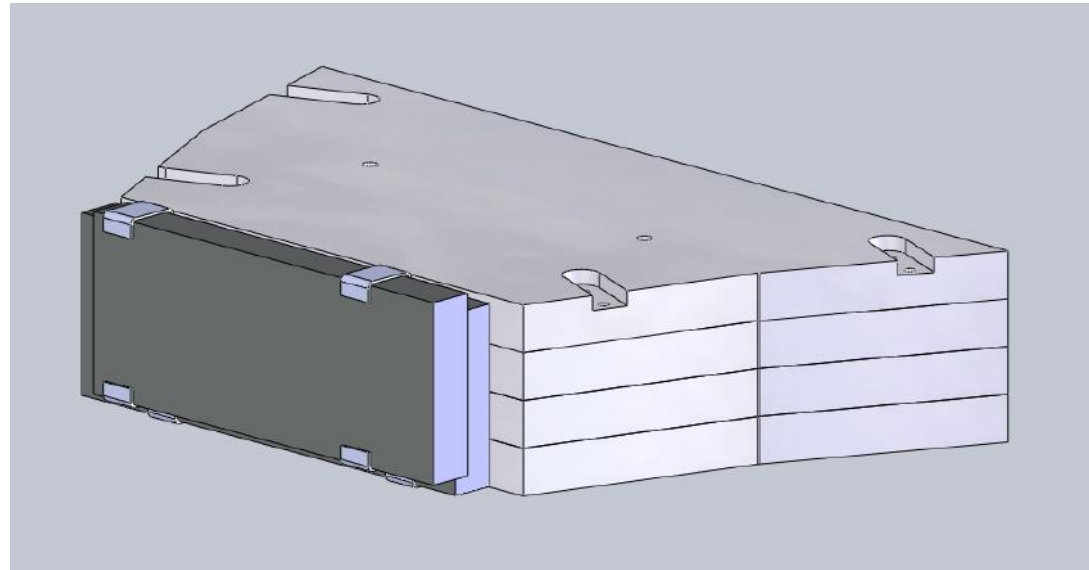
A gamma shield belt in ArDM is to be implemented for DArT, with the following requirements:

1. Material: Pb or Iron
2. Thickness: 10 cm
3. Height: 2 m

Original idea by CIEMAT DArT Group

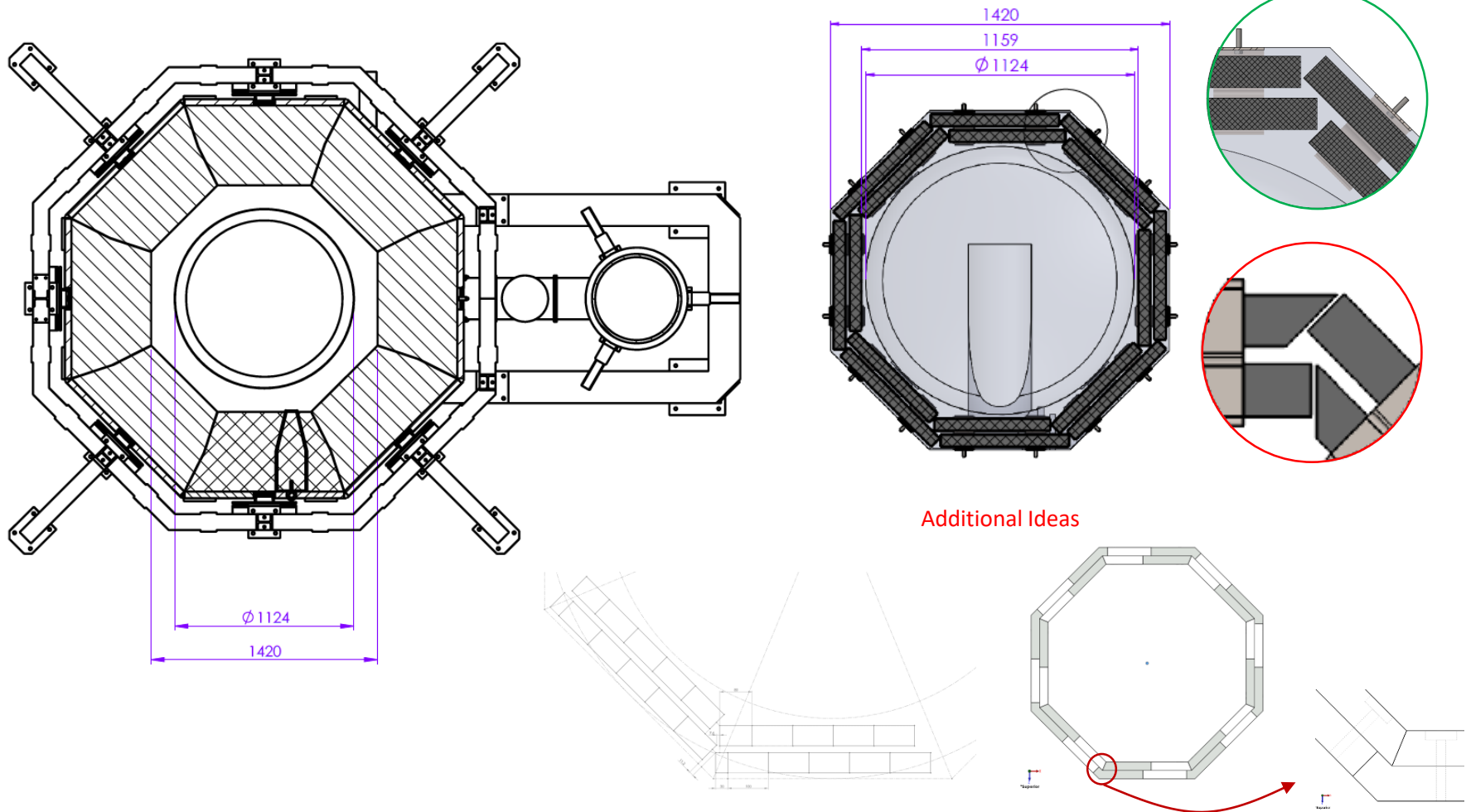


Initial idea of the clamp



Preliminary view of a module of the shielding

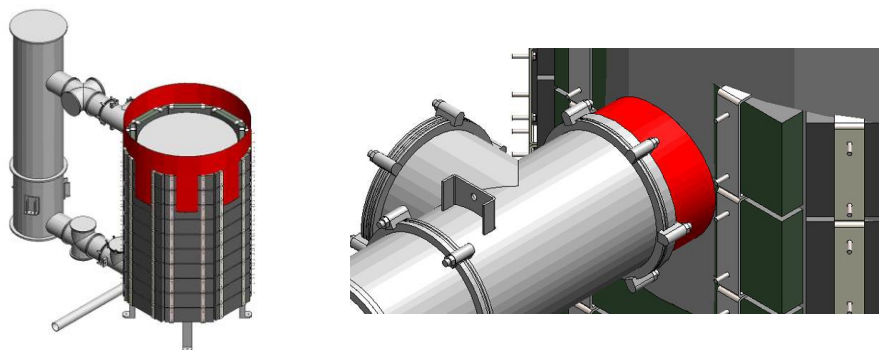
# Study of ArDM: available space and overlapping



## Study of ArDM: detection and solution of big interferences

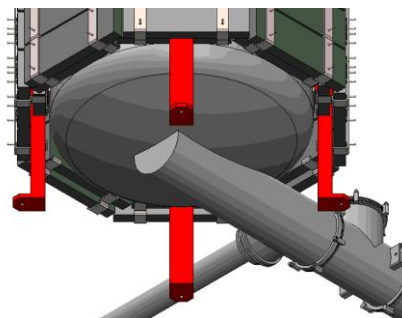
**Problem:** Interferences with the upper part of ArDM and the piping

**Solution:** Reduce the height of the shielding from 2 m to ~1.5 m



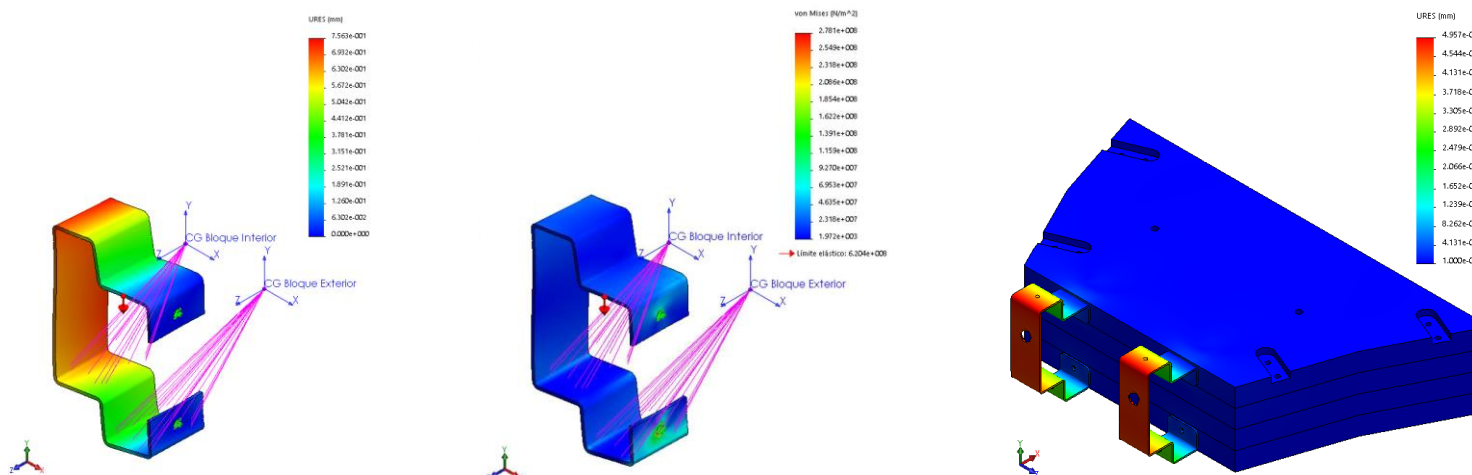
**Problem:** Interferences with the detector feet and neck

**Solution:** Special lead blocks for the first and the last ring of the shielding

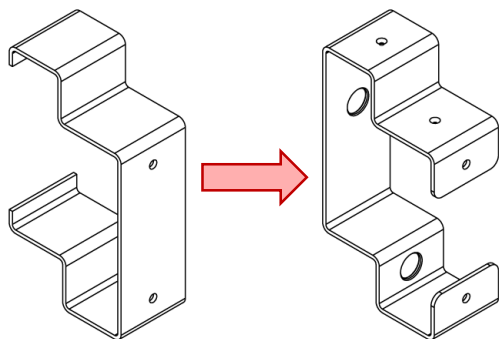


# Development and improvement of the initial design

Exhaustive study of the clamps: parametric design to minimize weight while ensuring safety

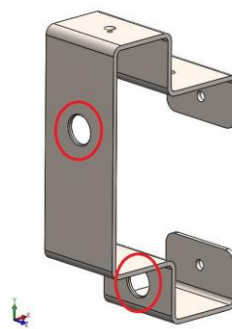


Improvements thought for easier and safer assembly



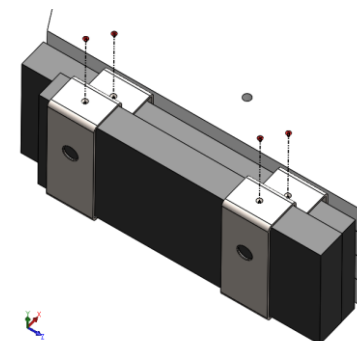
Continuous side of the sheet metal on the outer side

21/04/2022



Holes for easy tightening of screws

DARt General Meeting

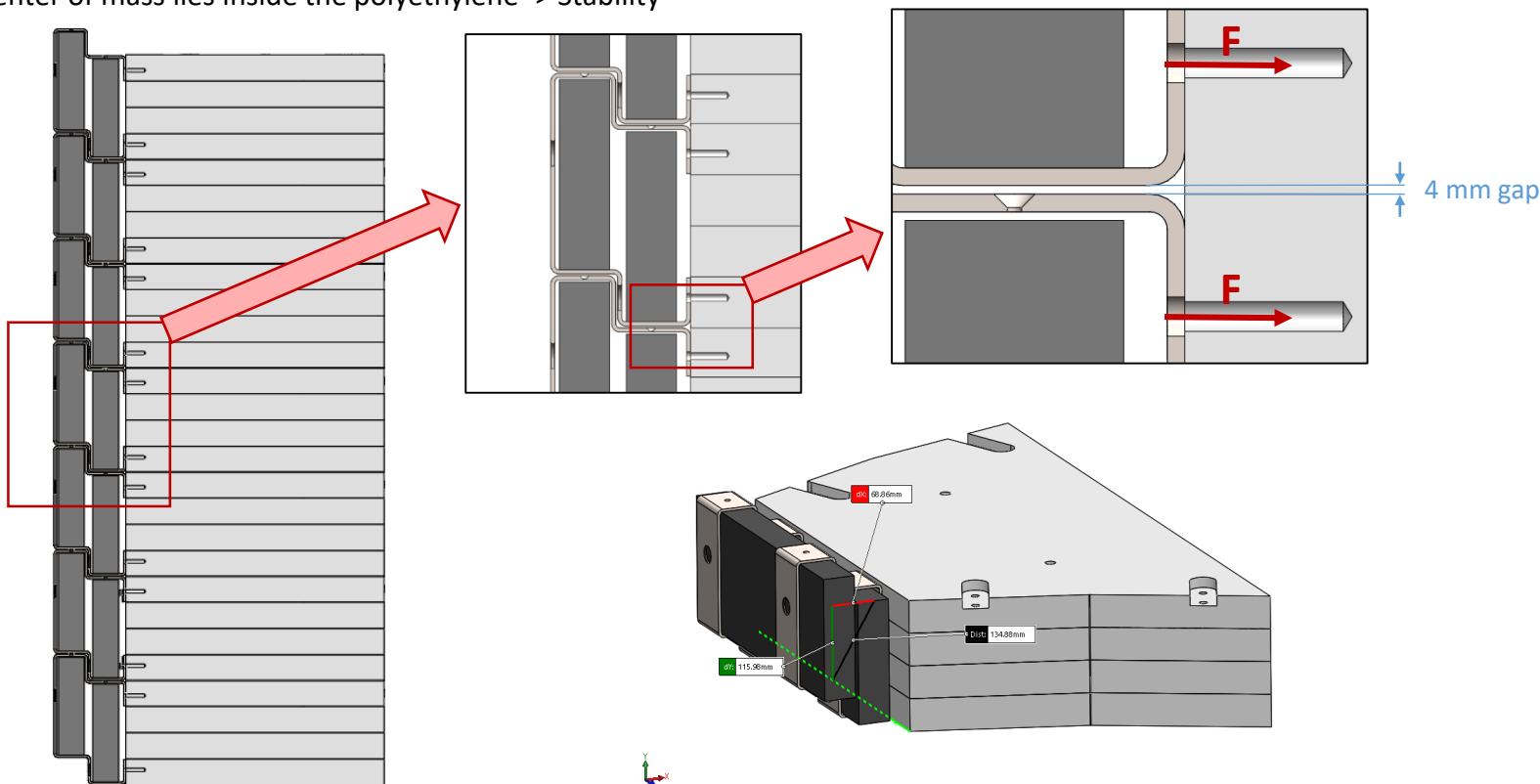


Movement restriction of lead blocks using screws

# Development and improvement of the initial design

## Advantages of a self-contained design

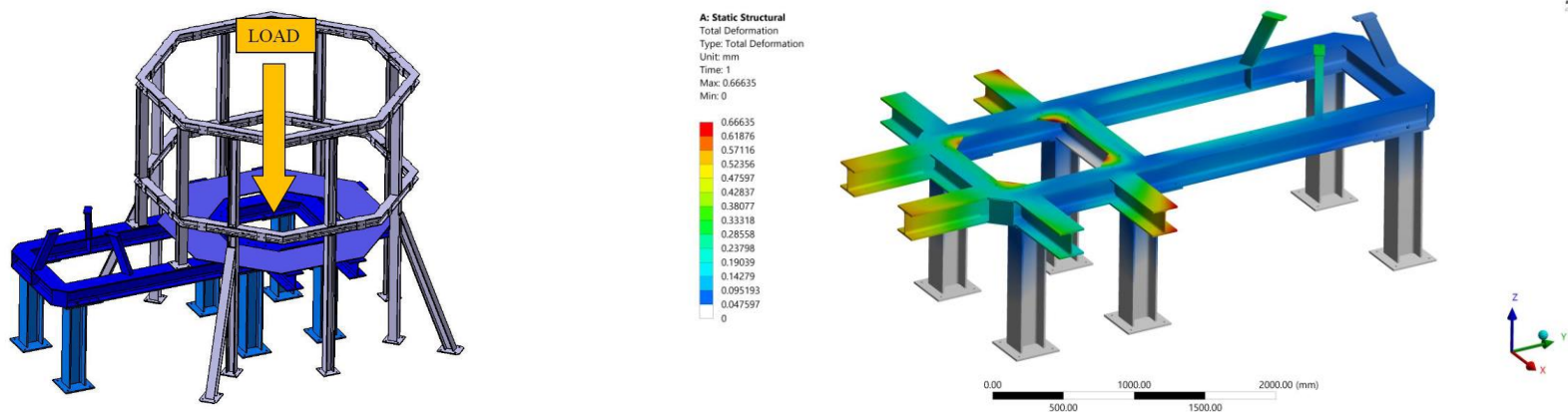
- Loads are transmitted through the polyethylene blocks
- The units do not interfere with each other
- Center of mass lies inside the polyethylene -> Stability





# Implications of the additional load due to the lead shielding

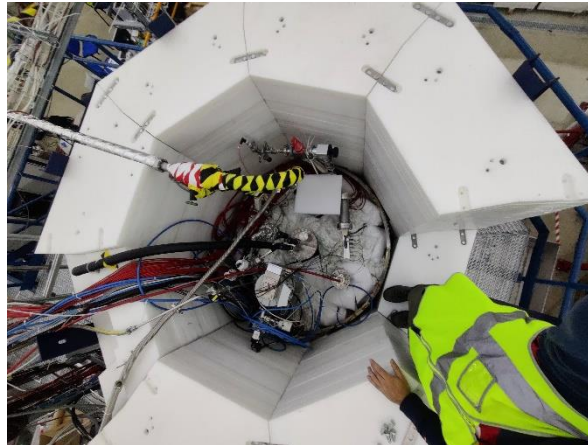
New lead shielding adds ~6500 Kg that need to be supported by the structure. This is guaranteed by simulations and a load test performed by ETH.



Credit to Adamo Gendotti (Ref. Load Calc ArDM\_05\_2021): results of the simulation (upper right) and image of the load test (bottom)

## Design validation: inspection of ArDM at LSC

We traveled to the LSC in April 2021. We carried out measurements of the polyethylene blocks and inspection of the available workspace + safety regulations (LSC).

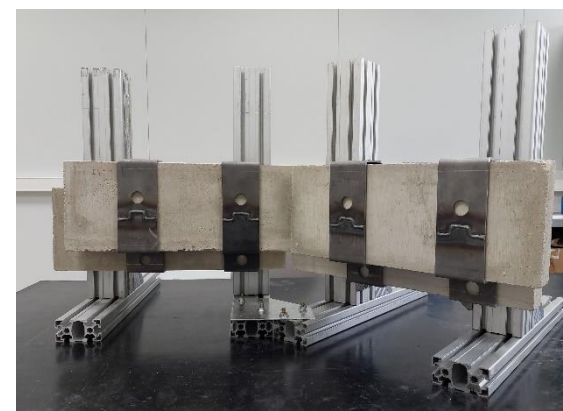


## Design validation: prototypes

### 1. Prototype with concrete blocks to validate stacked modules and the corners

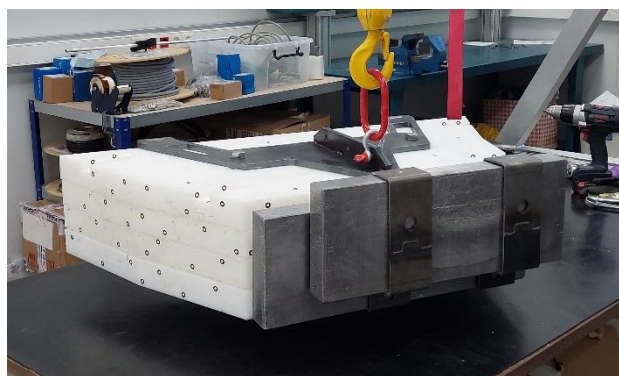


Different stacked configurations



Concrete prototype to simulate a corner

### 2. Prototype with lead blocks to validate tolerances, integration and tooling





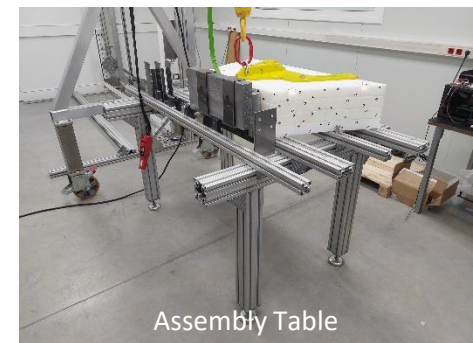
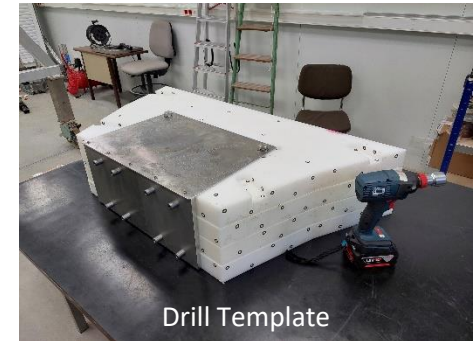
# Design validation: tooling and tests

## Tooling

- Lifting Tool
- Drill template
- Assembly table

## Tests

- Tensile tests to evaluate the quality of screwed polyethylene joints
- Load test on the lifting tool
- Assembly of a module of the shielding

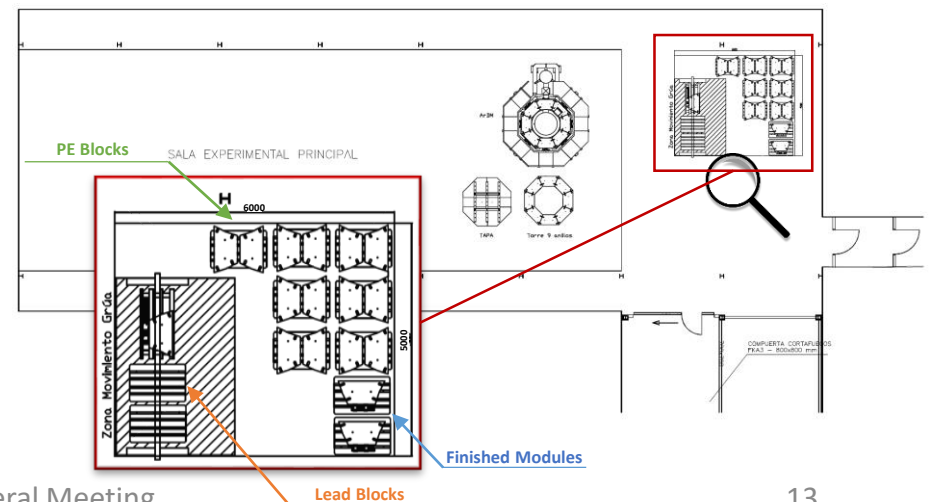
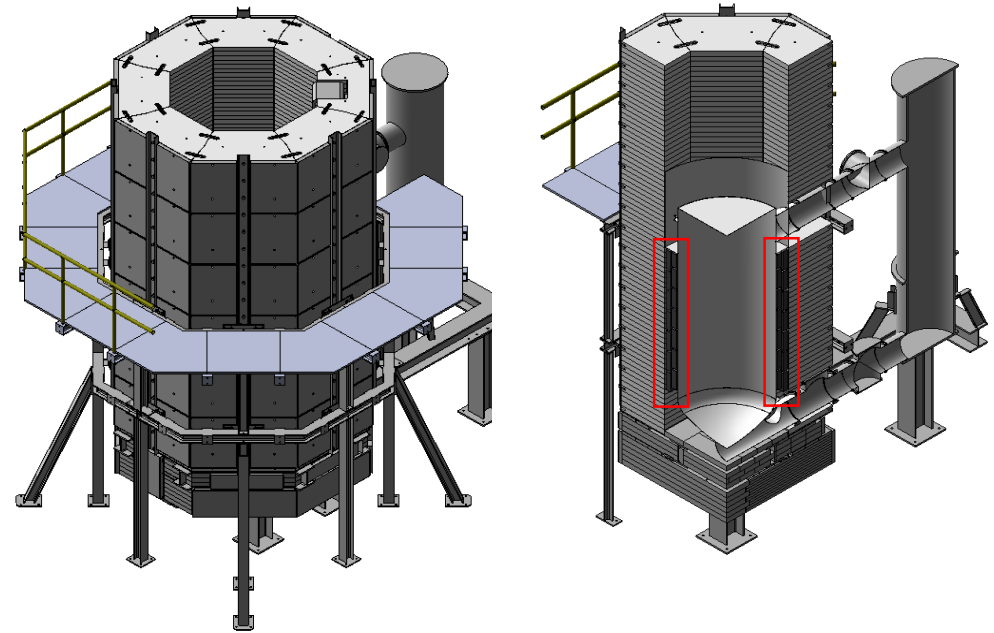
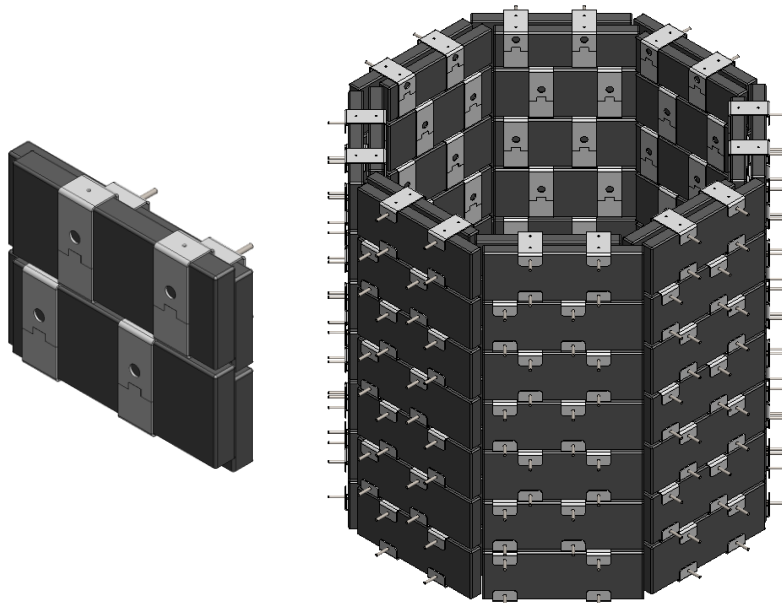


1.5 x Nominal Load



## Final design: summary

- 56 modules of polyethylene + lead (7 rings)
- Additional ~6500 Kg
- Steel clamps designed and manufactured
- Recast lead blocks
- Assembly and integration process fully detailed
- Design agreed with CIEMAT DArT Group and LSC



## Final design: documentation

- Preliminary design: parametric design of the clamp and results of FEM simulations
- Additional proposals: smaller lead blocks, more sophisticated geometries...
- Final drawings for the manufacture of clamps and lead blocks
- Drawings for the manufacture of tooling
- Complete bills of materials
- Reports of the tests and prototypes shown to the collaboration
- Detailed sequence for the assembly of a module
- General procedure for the dismantling of the existing shielding and the installation of the new one

# Current status and next steps

## Our Status (IB-ASTRO-ING)

- All steel clamps and tools are manufactured and tested
- Necessary equipment have been bought and is ready to be used
- Team available and in contact with CIEMAT DArT Group

## Next steps

- Manufacture of lead blocks and reception at LSC (on-going)
- Required space for the assembly process
- Dismantling of the polyethylene shielding and orderly storage according to the proposed sequence (estimated time 1-2 weeks)
- Assembly of all the modules and integration into ArDM (estimated time 1 week)
- Electronic set-up, tests...

THANK YOU FOR YOUR ATTENTION