Moving Table Development for NA-64 Experiment

SAPHIR Annual Research Meeting 2023
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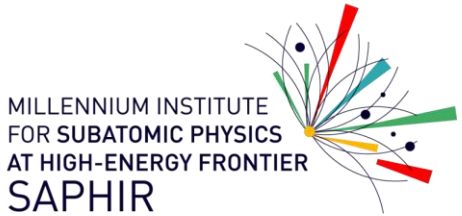

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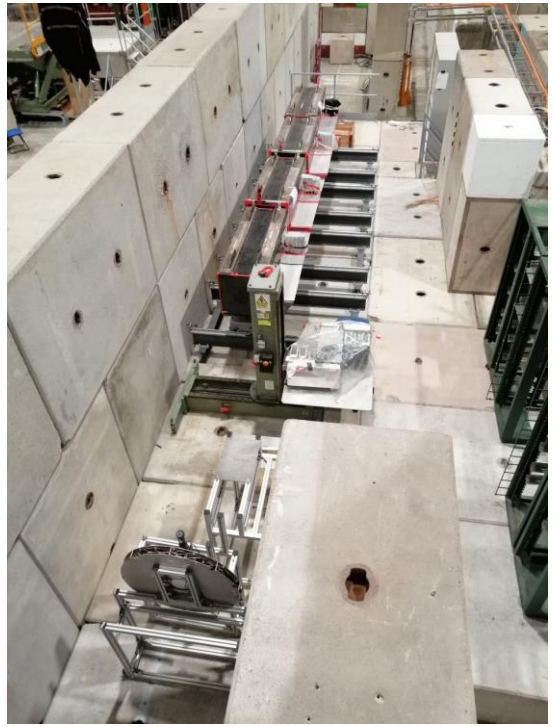
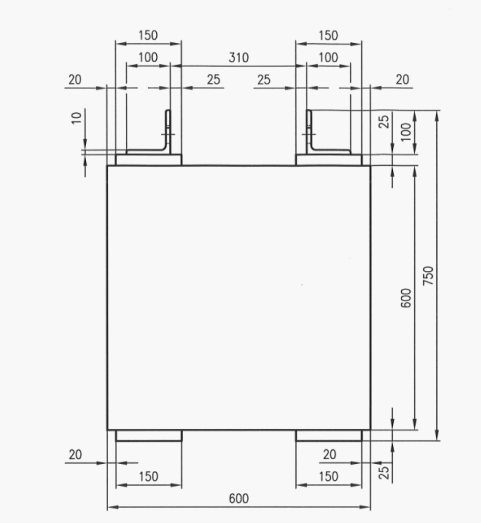
Introduction

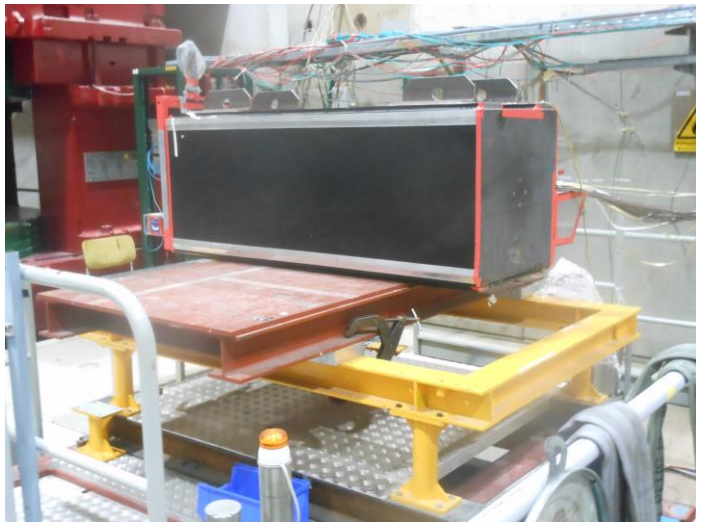
- NA64 Requirements. The challenge (Solution, restrictions).
- The team. (UTFSM, Eng, Colaborators & Experience and capabilities– 80 vs 20. Support).



Design requirements

- Location of the beam
- Full Beam sweep over the HCAL.
- 8 ton maximum capacity.
- 1 mm resolution in vertical axis.
- 1 mm resolution in horizontal axis.
- Remote control.

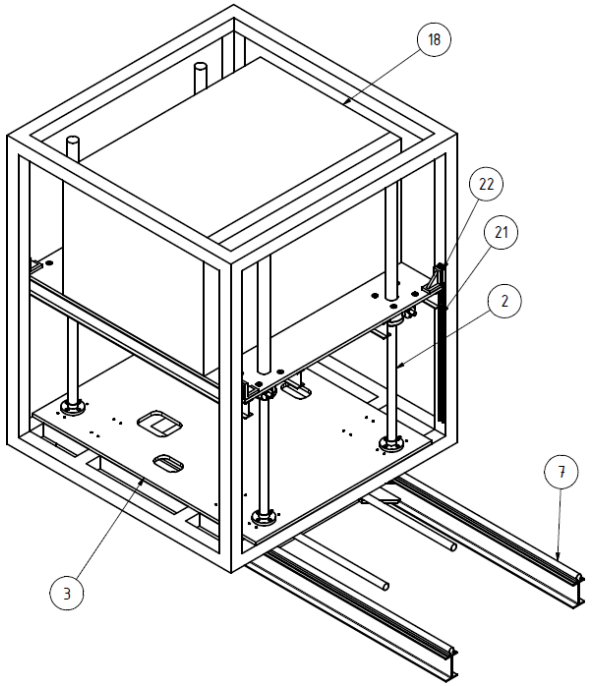


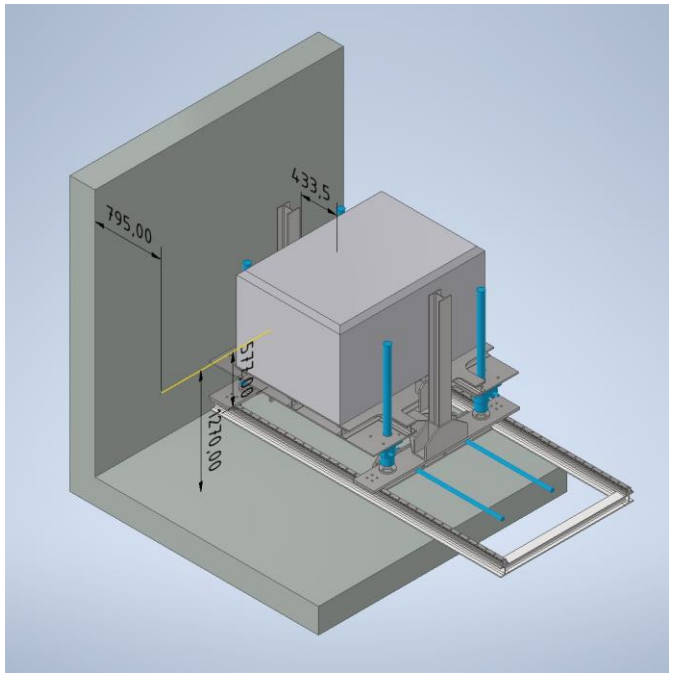


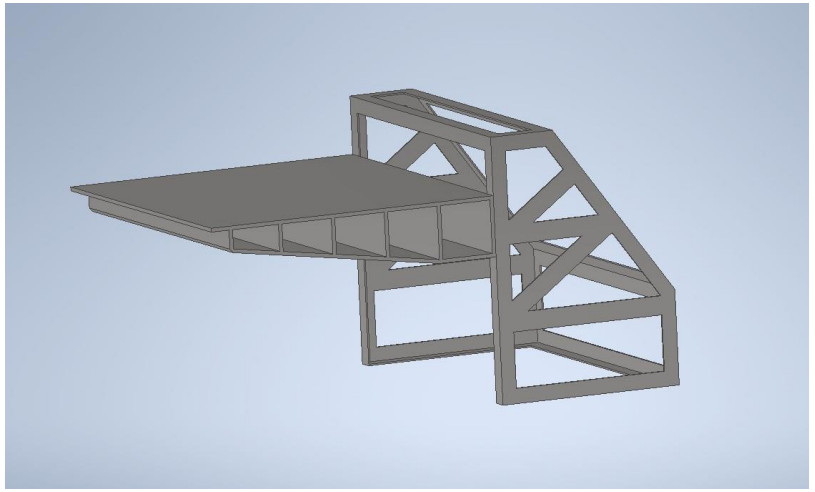
- HCAL sensitive area: 600x600 mm.
- Beam to wall distance: 1270 mm vertical, 800 mm horizontal.

Conceptual design

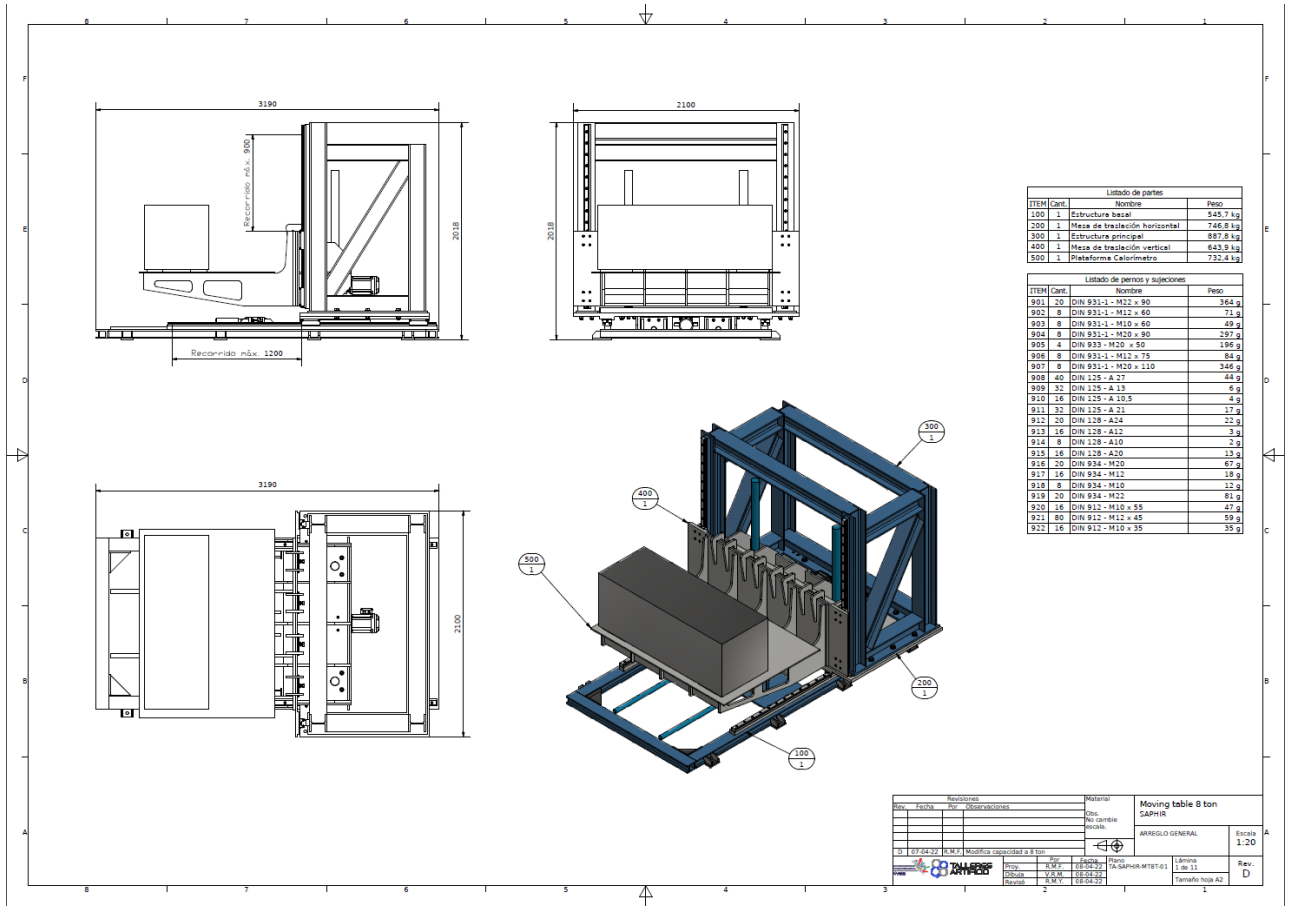
- Iterative process

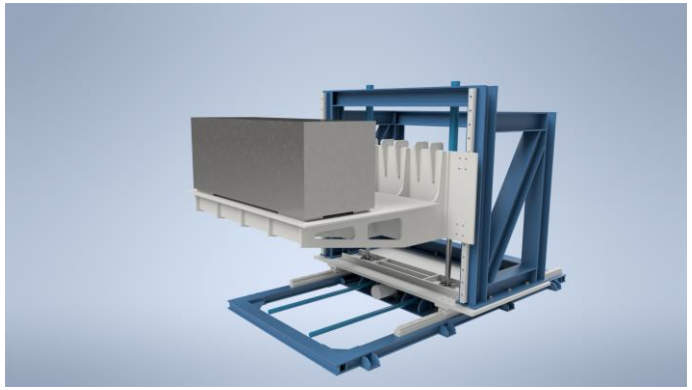


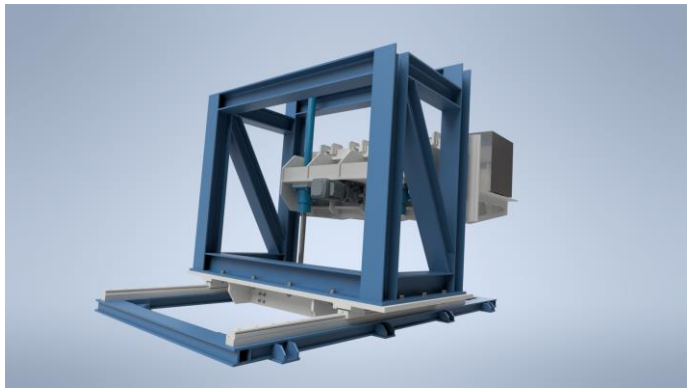


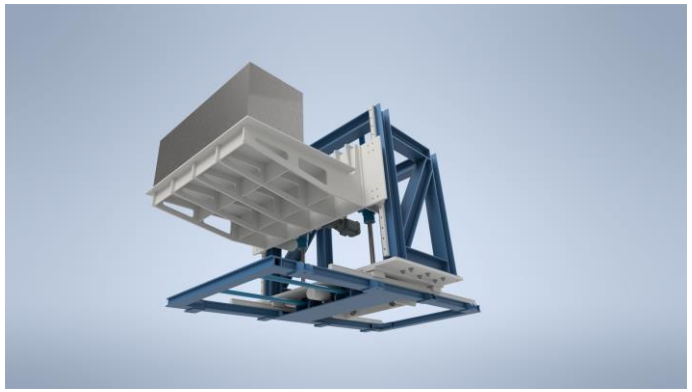


Conceptual design



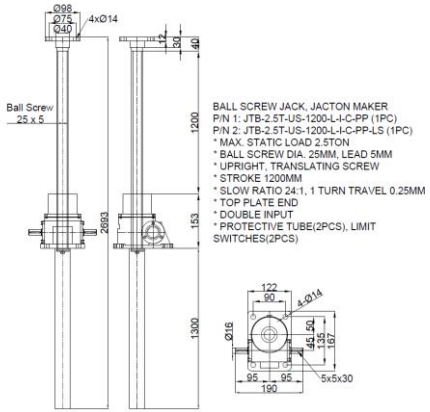


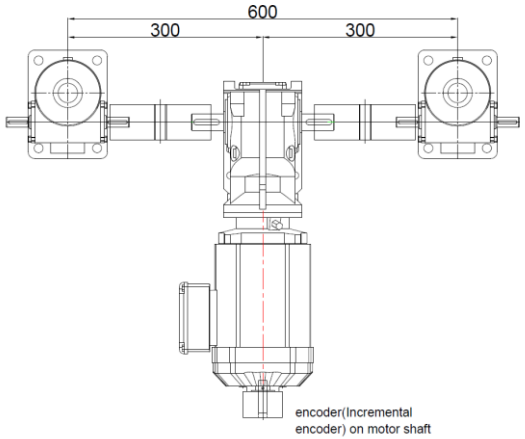


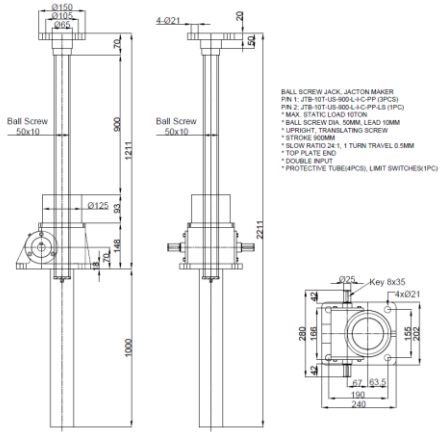


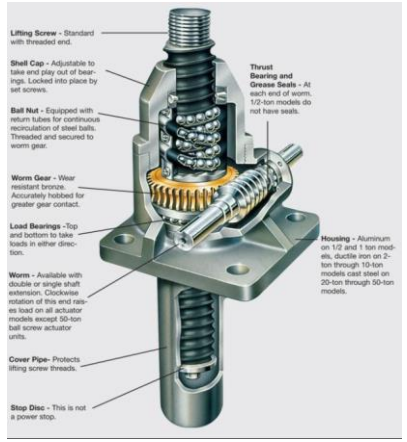
Main components selection and validation

- Ball screw jacks
  - High accuracy, high efficiency, low backlash, long service life, and uniform lifting speed.
- 2 Ball screw jack of 2,5 ton for horizontal displacement.
- 2 Ball scew jack of 10 ton for vertical displacement.
- Selection by capacity of screw jack and linear velocity.



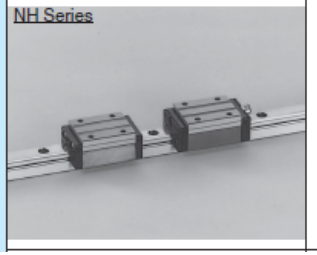
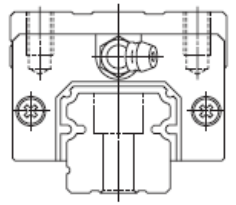
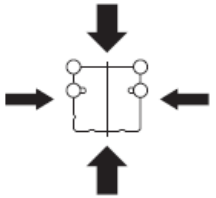


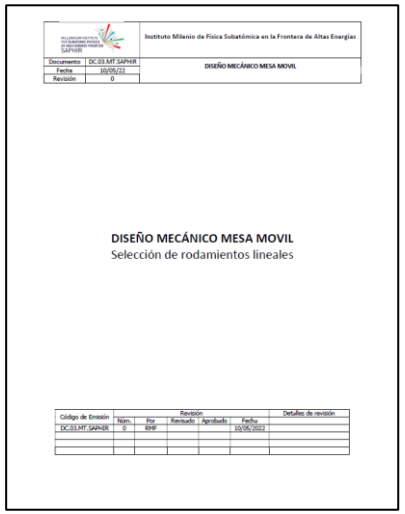




Main components selection and validation

- Linear rolling bearings
  - High precision and quality, high reability and durability, high load capacity, withstand forces and moments in all directions, grease lubrication.

Product	Appearance	Shape	Rolling element	Load carrying characteristics
	NH Series 		Ball	High vertical load carrying capacity 


Instituto Milenio de Física Subatómica en la Frontera de Altas Energías

DISEÑO MECÁNICO MESA MOVIL

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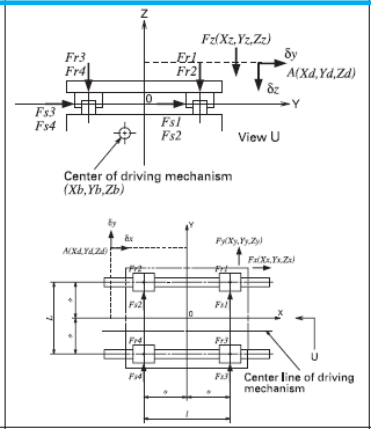
Selección de rodamientos lineales

El centro de masa de una sumatoria de masas en una dimensión puede ser determinada mediante la siguiente expresión:

$$X_t = \frac{\sum_{i=1}^{k} m_i \cdot x_i}{\sum_{i=1}^{k} m_i} \text{ [mm]}$$

Dónde:

- m_i: Masa individual de cada componente.
- x_i: Centro de masa de cada componente.
- X_t: Centro de masa de la sumatoria de componentes.

Pattern	Arrangement of slides	Load to slide and deformation at Point A
4	 Center of driving mechanism (Xb,Yb,Zb) View U Center line of driving mechanism	$Fr_1=\frac{\sum_{k=1}^{n}Fz_k}{4}+\frac{M1}{2L}+\frac{M2}{2l}$, $Fr_2=\frac{\sum_{k=1}^{n}Fz_k}{4}+\frac{M1}{2L}-\frac{M2}{2l}$ $Fr_3=\frac{\sum_{k=1}^{n}Fz_k}{4}-\frac{M1}{2L}+\frac{M2}{2l}$, $Fr_4=\frac{\sum_{k=1}^{n}Fz_k}{4}-\frac{M1}{2L}-\frac{M2}{2l}$ $Fs_1=Fs_3=\frac{\sum_{j=1}^{n}Fy_j}{4}+\frac{M3}{2l}$, $Fs_2=Fs_4=\frac{\sum_{j=1}^{n}Fy_j}{4}-\frac{M3}{2l}$ $M1=\sum_{j=1}^{n}(Fy_j\cdot Zy_j)+\sum_{k=1}^{n}(Fz_k\cdot Yz_k)$ $M2=\sum_{i=1}^{n}\{Fx_i(Zx_i-Zb)\}+\sum_{k=1}^{n}(Fz_k\cdot Xz_k)$ $M3=-\sum_{i=1}^{n}\{Fx_i(Yx_i-Yb)\}+\sum_{j=1}^{n}(Fy_j\cdot Xy_j)$ $\delta x=Y_d\cdot\frac{Fs_1-Fs_3}{l\cdot Ks}+Z_d\cdot\frac{Fr_1-Fr_2}{l\cdot Kr}$ $\delta y=\frac{\sum_{j=1}^{n}Fy_j}{4\cdot Ks}+X_d\cdot\frac{Fs_1-Fs_2}{l\cdot Ks}+Z_d\cdot\frac{Fr_1-Fr_3}{L\cdot Kr}$ $\delta z=\frac{\sum_{k=1}^{n}Fz_k}{4\cdot Kr}+X_d\cdot\frac{Fr_1-Fr_2}{l\cdot Kr}+Y_d\cdot\frac{Fr_1-Fr_3}{L\cdot Kr}$

Main components and their validation

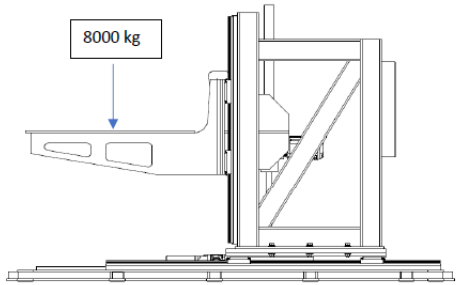


Figura 2: Vista lateral Mesa móvil con definición de ubicación de carga.

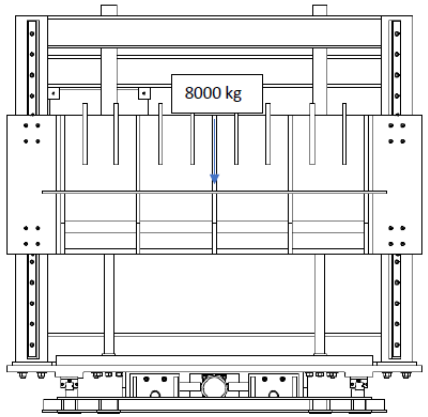
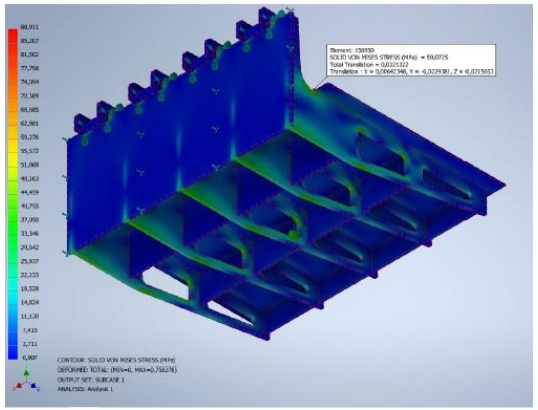
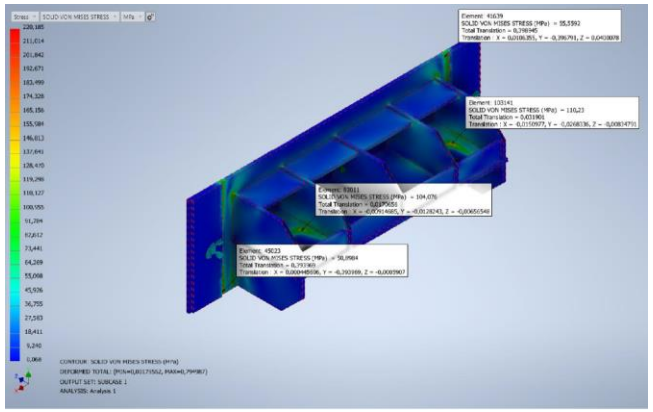
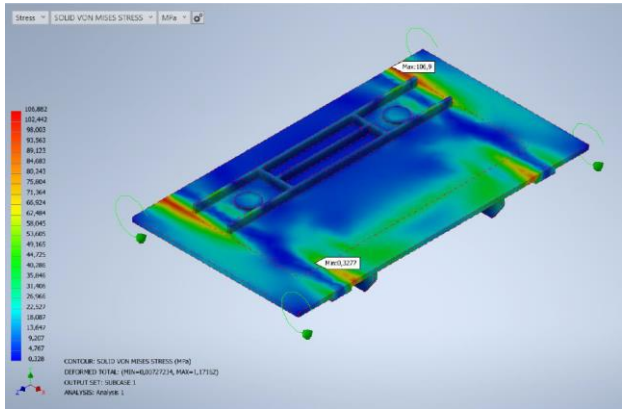
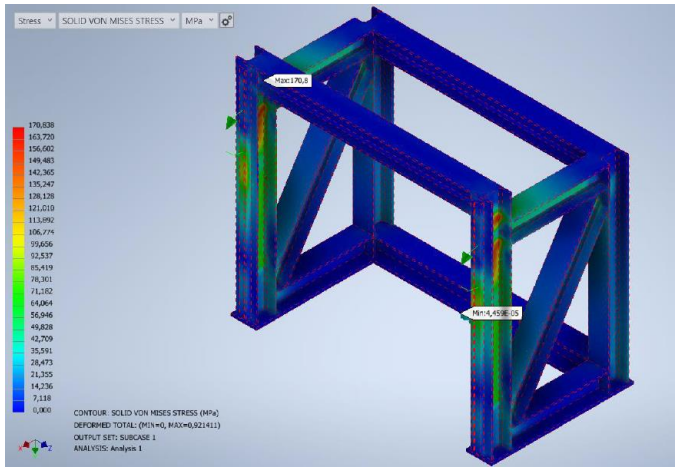


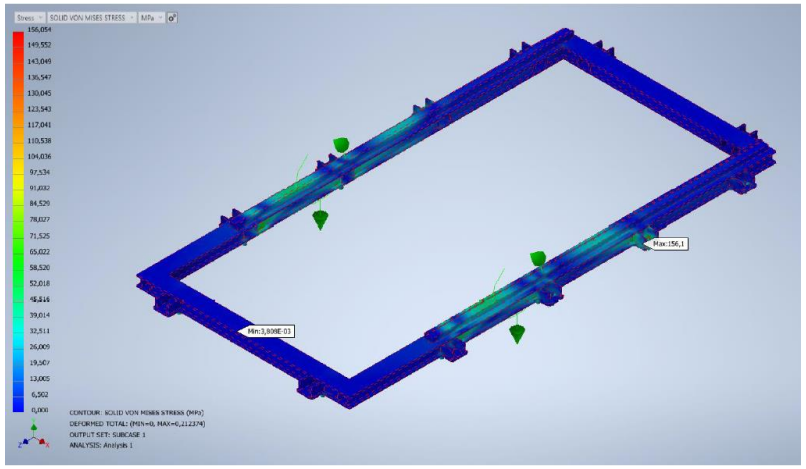
Figura 3: Vista frontal Mesa móvil con definición de ubicación de carga.

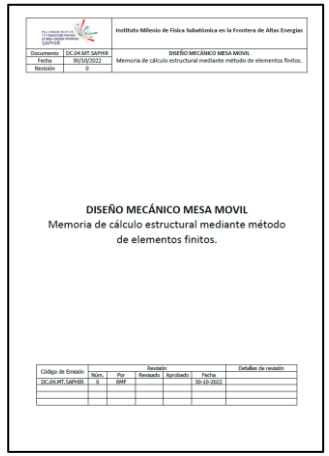












Manufacturing Process

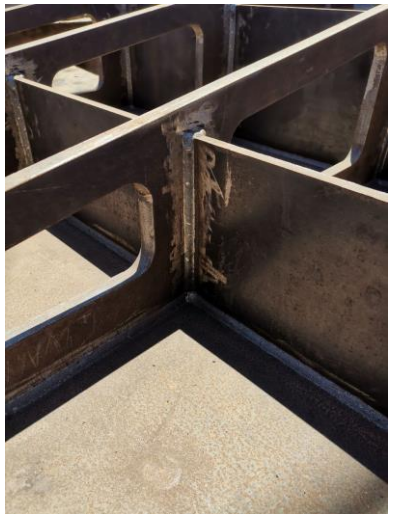
TALLERES ARTIFICIO I+D

- Material: ASTM A572 Gr 50 (Yield strenght 38% more than ASTM A36).
- Thickness= 12,20,30,40,50 mm
- HEB 180 Beam.

1. Dimensioning:
   - CNC Laser cut (12 mm).
   - CNC Plasma cut (20 mm).
   - Oxygen cut (30,40 and 50 mm).
2. Joining and welding.
   - MIG 70s6
3. Machining.
   - Milling and boring machine.

Manufacturing Process

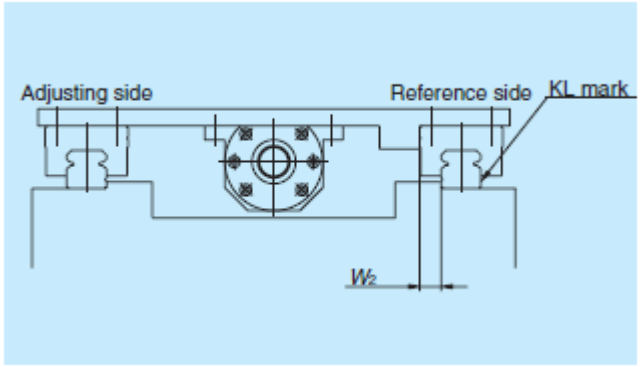
- Machining Process
  - Flatness (0,2 mm).
  - Acuracity in important dimensions (± 0,1 mm).
  - Surface quality (Ra 3.2).

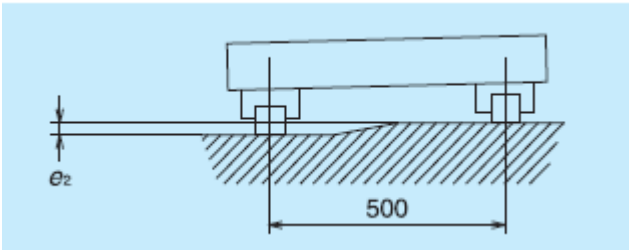


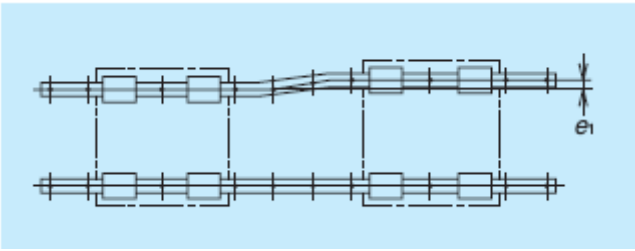
Assembly and testing procedures

- Assembly
  - Smooth assembly for all componentes
  - Assembly procedure is highly influenced by bearing instalation.
  - Lubrication of rolling elements.
  - Appliying proper torque to bolted joints.

- Testing
  - Smooth displament of both axis.
  - Test the control system at no load.
  - Test under load and measure deformations.







Capabilities and perspectives of mechanical design at SAPHIR

- The Challenge. Oportunities & Acknowledgements
- Industrial size for science and engineering from Chile to the World.
- The relevant union UNIV-GOB-IND for science, people and economy.
- Starting point opportunity to continue learning and development of science and engineering form Chile to the world.