Investigation and Considerations about Option #2 (install SuperFGD in ND280 w/o HA-TPC's: Install SFGD in ND280 – uninstall it – install Bottom TPC – install SFGD in ND280 again)

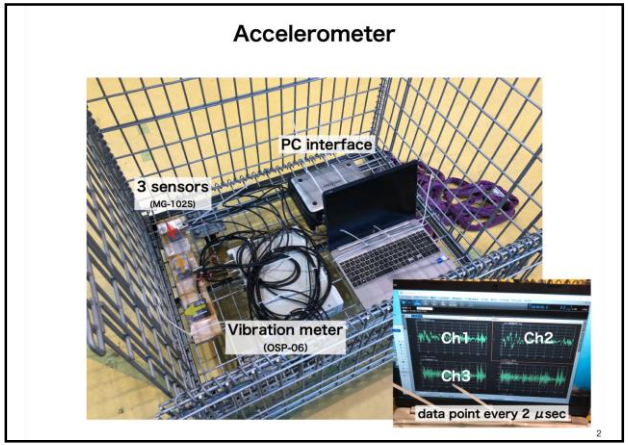
Option #2: considerations from WG1

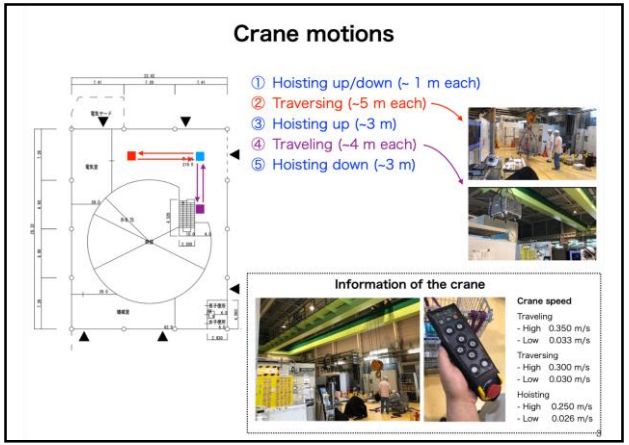
Comments from Franck

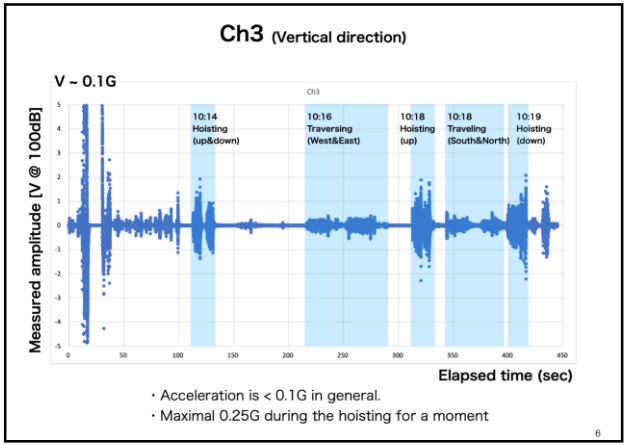
- To be considered the cabling/uncabling work
  - not a big issue for SFGD (C.Mauger - Electronics WG)
  - more complicated for ToF detector because it’s more fragile and has a lot of cables to be plugged (F.Cadoux)
- It may be considered to install SFGD w/ partial ToF installation, i.e. that does not need to be removed later for Bottom-TPC installation
- Be careful to avoid shocks - Typical risk during detector installation

Summary: Risk assessment of the crane acceleration in the lifting

・Acceleration measurement of the crane at the NM building were performed to evaluate the risk in the lifting detector.







・Comparable with the general standard value of 0.1G in every direction.

・Lower acceleration than the seismic standard of 0.65G is confirmed.
→ Relatively small risk w.r.t. the requirement for an earthquake.

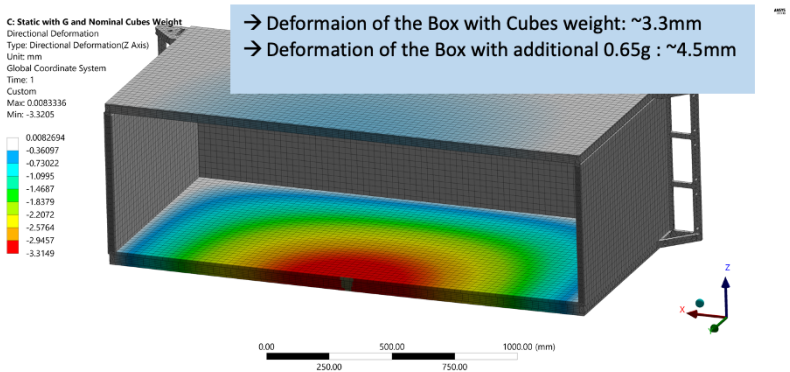
・Other risk mitigations under discussion
  ・A guide to the basket during the detector installation
  ・Transportation between buildings (NA → NM)

Considerations from Mechanics WG

A.Gendotti

BOX FEA RESULTS

- Deformations at the Box caused by using crane are negligible.
- Vibrations induced from the crane are for sure not worse than vibrations caused by an earthquake



→ Deformaion of the Box with Cubes weight: ~3.3mm
→ Deformation of the Box with additional 0.65g : ~4.5mm

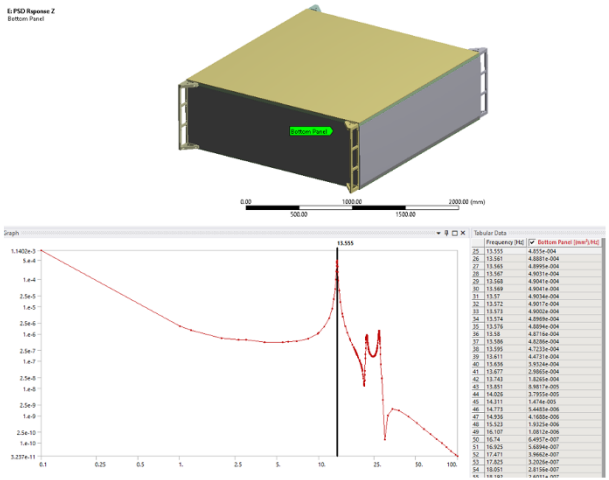


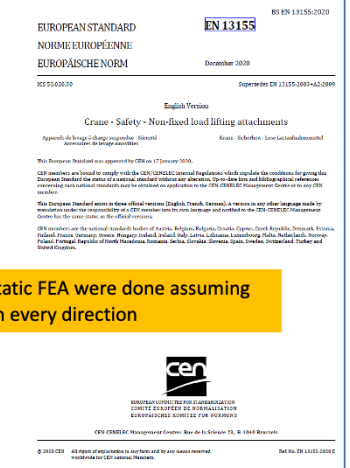
Figure 6-59 Scenario 1 – Vibration in Z direction – Results at the Bottom Panel

A peak is found at 13,555 [Hz] with a PSD of $4.855e^{-4}$ [(mm^2)/Hz]

Indicatively vibrational amplitude derived of the Bottom Panel → A=0.081 mm

Max Crane Acceleration considered for Lifting Device Design:

Additional 0.1g in every direction


BS EN 13155:2020

EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN 13155

December 2020

ICS 53.020.20

Supersedes EN 13155:2003+A2:2009

English Version

Crane - Safety - Non-fixed load lifting attachments

Appareils de levage à charge suspendue - Sécurité - Accessoires de levage amovibles

Kräne - Sicherheit - Lose Lastaufnahmemittel

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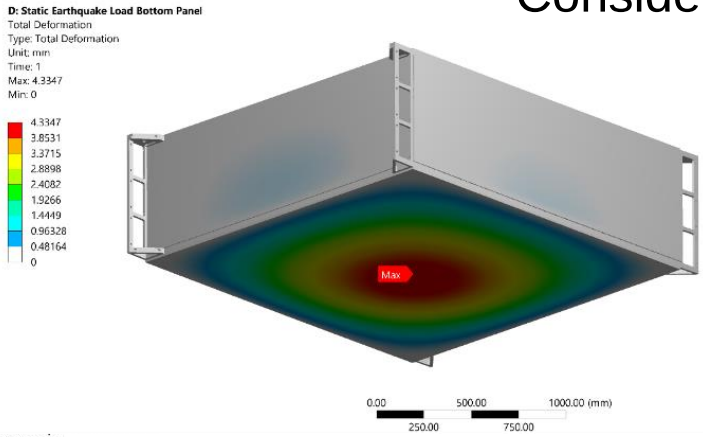
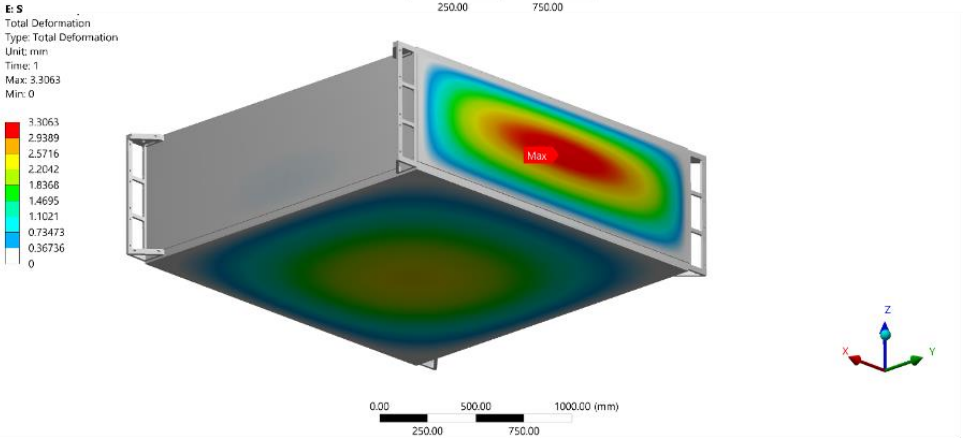
Ref. No. EN 13155:2020 E

→ Semi-Static FEA were done assuming 0.65g in every direction

Considerations from Mechanics WG

A.Gendotti





Static FEA analysis (worst-case scenario): all cubes move together along the same direction. Very unlikely

1 G along Z (gravity)

- Max deformation ~2.6mm bottom panel, smooth

1.65G along Z (gravity + earthquake)

- Max deformation ~4.3mm bottom panel, smooth

Near the box holes the deformation is almost 0

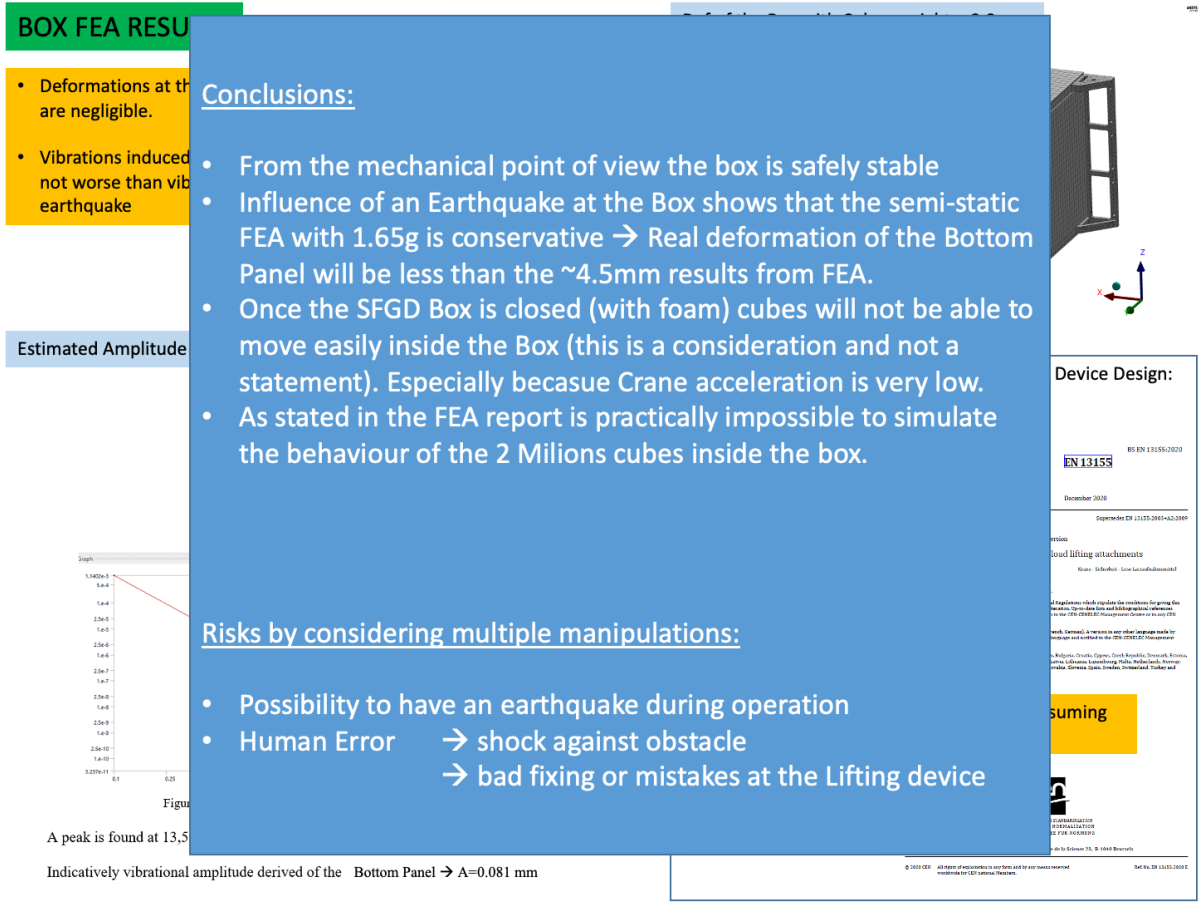
Still 1G along Z (gravity) and 0.65G along Y

- No change on bottom panel deformation.
- Max ~3mm side panel deformation but smooth
- Near the box holes the deformation is almost 0

Important consideration: the FEA static shows the worst-case scenario to be considered as a safety margin that the target (5mm max deformation) is achieved

Considerations from Mechanics WG

A.Gendotti



Conclusions:

- From the mechanical point of view the box is safely stable
- Influence of an Earthquake at the Box shows that the semi-static FEA with 1.65g is conservative → Real deformation of the Bottom Panel will be less than the ~4.5mm results from FEA.
- Once the SFGD Box is closed (with foam) cubes will not be able to move easily inside the Box (this is a consideration and not a statement). Especially becasue Crane acceleration is very low.
- As stated in the FEA report is practically impossible to simulate the behaviour of the 2 Milions cubes inside the box.

Risks by considering multiple manipulations:

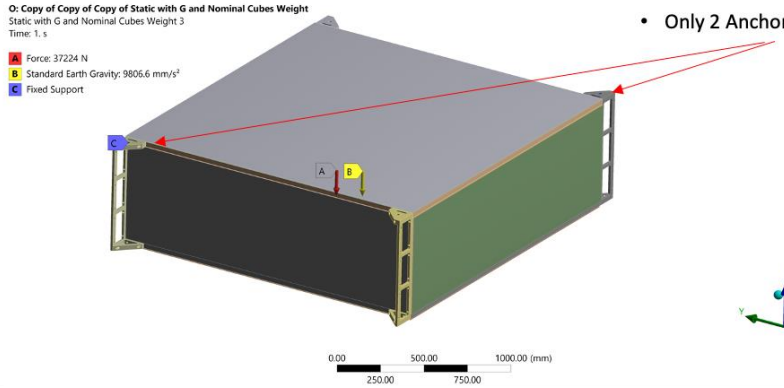
- Possibility to have an earthquake during operation
- Human Error → shock against obstacle
  → bad fixing or mistakes at the Lifting device

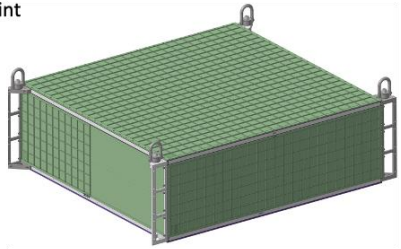
Considerations from Mechanics WG

A.Gendotti

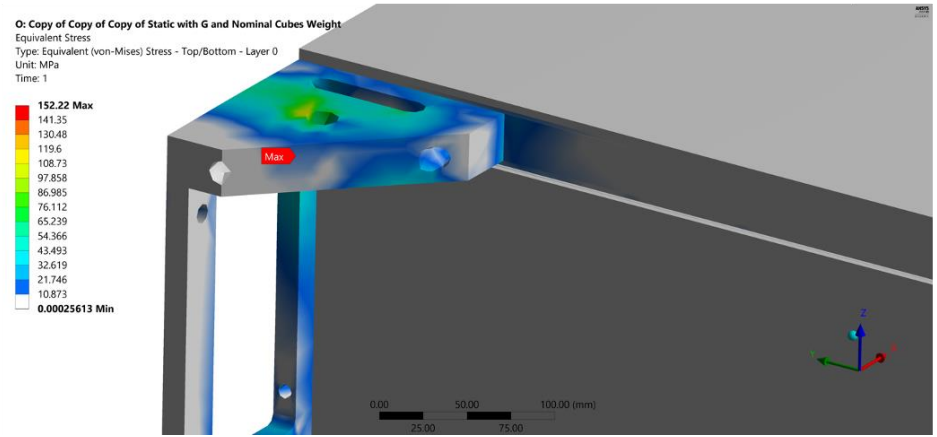
Stress at the Bracket during Lifting

- Force 37’224 N → Cubes weight + 0.65g
- Only 2 Anchoring Point





Max Stress at the Bracket: 152Mpa



MoS= 0.577

The static FEA were done by applying the acceleration also to the side panels of 0.65G. Irrelevant the impact of the slightly different boundary conditions between lifting and basket (e.g. 2 vs 8 anchoring points), also given the fact that the static FEA is the very worst-case scenario, very unlikely to happen

Conclusion

Last Verifications:

- Threads calculations at the aluminum Frame

  Threads have a relatively big safety marge in the ALU frame → SF=8 for M6 and SF=3 for M8

- Stress Calculation with finer mesh at the Alu Frames

  Stress calculated with finer mesh shows always a consistent low stress of 54 MPa

- Stress Calculation at Brackets during Lifting

  By calculating the stress during lifting using only 2 lifting point, the stress is always inside the Margin of Safety MoS = 0.577 (MoS includes all the safety Factors i.e Material safety factor and load safety factor). If MoS is > or = to zero, it can be considered as safe.

Considerations from Mechanics WG

- No major problems about mechanics and sagging
- Hard to say what happens about fibers inside the box as it can't be modeled. In general, people don't very worried about breaking fibers during the lifting
  - very low crane acceleration
  - conservative assumptions made about cubes in the FEA model (cubes are strong and when pressed it will be a rigid body)
  - However, it's not possible to make a precise model of cubes+fibers inside the box

Overall, the box design was done to be safe for earthquake with minimal deformation. However, it's not possible to model fiber+cube inside box, so there could be other boundary conditions (displacement of cubes from vibrations, variation of size and hole position of the cubes, etc.) that can't be taken into account precisely.

Run Plan JFY2022-2023 - (K.Sakashita-san @T2K bi-weekly 21/7/22)

Run plan based on discussions so far

- **March beam time is important because lets ND280 check new beam, so**

  A. if March beam time is given, we request

  - **1+α cycles in Jan. for beamline commissioning(w/o ND280),**
  - **1 cycle in Mar. w/ ND280**
  - **1 cycle in Jun. w/ ND280 partially upgrade, and**
  - **3 cycles after October w/ ND280 full upgraded**

  B. if March beamtime is not given, we request

  - **1+α cycles in Jan. for beamline commissioning(w/o ND280),**
  - **2 cycle in Apr.-Jun. w/ ND280 (possibly w/o upgrade), and**
  - **3 cycles after October w/ ND280 full upgraded**