A POSSIBLE SOLUTION FOR THE WALL MECHANICAL STRUCTURE

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Following the discussions during the workshop in December at CERN, we have elaborated a possible solution for the wall-support structure that fulfills the requirements stated at the workshop.

The driving ideas are:

- No material in front and behind the bricks.
- To concentrate the extra-target material at the brick corners.
- To allow “on line” brick removal.
- To hung the structure from the top in order to minimize the supporting material and fulfill the earthquake safety rules.
- To match the required precision in bricks positioning.

Very schematically (see fig 1), the structure consists of square bars (typically 5x5 mm^2 stainless steel square bars, see A in fig. 1) suspended from above. The bars are hanged to a top structure, which supports the weight, and fastened to a bottom structure, which keeps in place the bars. The two lateral sides are free for the brick access and removal. The bars have a pitch nearly equal to the brick dimension, and are welded to horizontal trays (see B in fig. 1) where bricks can slide individually. The horizontal trays are hollow and made of 0.5-mm stainless steel sheets, preformed with the pressing techniques. The trays have folded edges (see C in fig. 1) which help both in rigidity and brick sliding. The total amount of material around the brick is about 0.6% of the brick weight.

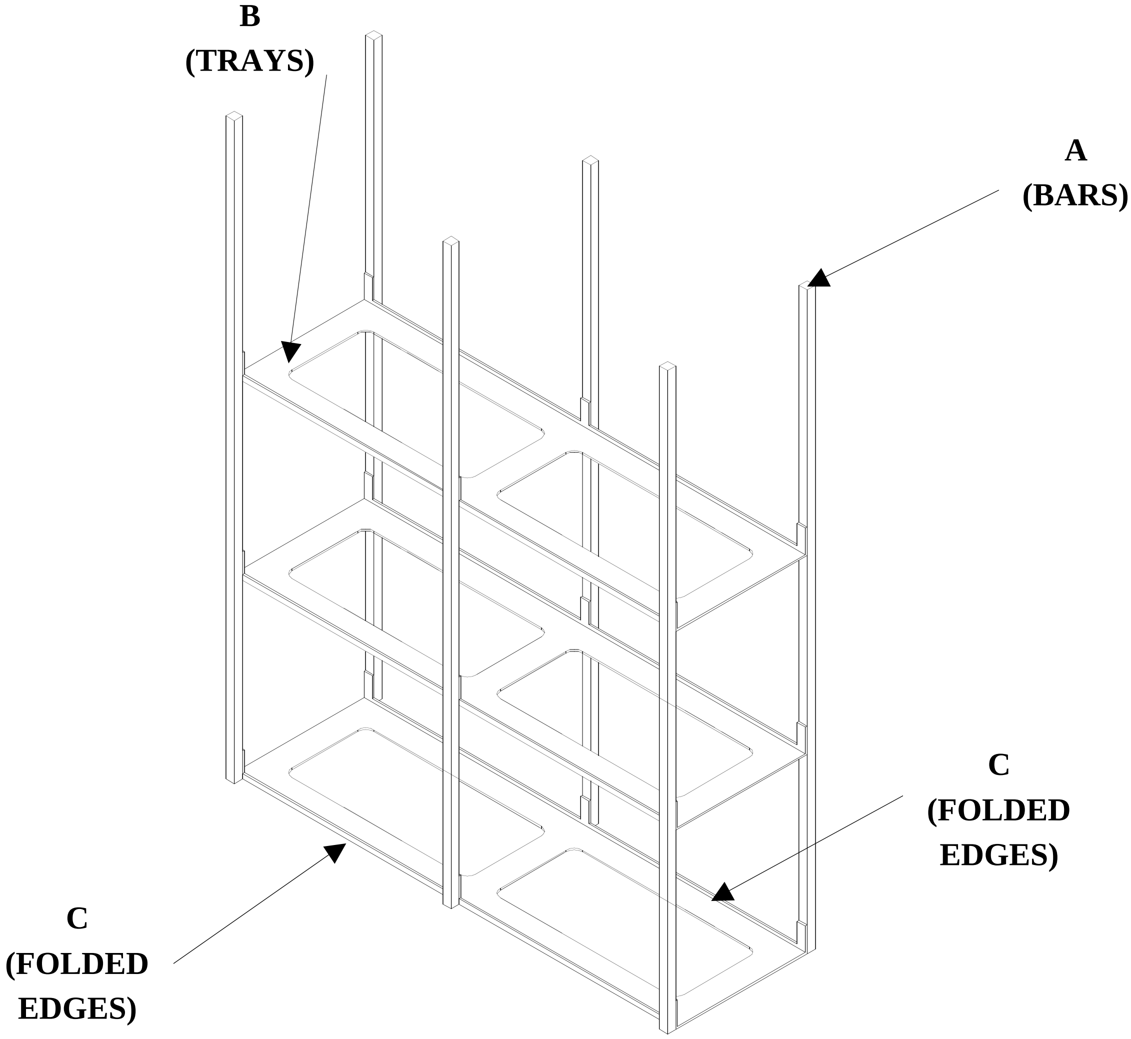
The main advantages of this structure are the following:

- The structure is light (0.6% of the brick weight), so the number of undesired neutrino interactions in the non-active material is reduced. Moreover these interactions can be clearly identified as undesired, if the tracking resolution is adequate, since are concentrated at the junction of two brick gaps.
- The well-localized supporting material makes easier the track following between adjacent bricks (both in longitudinal and transversal directions).
- The extraction from both sides minimizes the number of bricks to be moved (only half row is involved).
- The side extraction simplifies the robot design, making it cheaper, faster and self-guided by the tray edges.
- No movement of the structure during extraction is needed.

The distances between adjacent bricks can be as follows:

- twice the bar thickness (5 mm) + the tracker thickness, in the longitudinal direction;
- 0 mm in the transverse horizontal direction;
- The tray thickness + tolerances for brick insertion, in the transverse vertical dimension.

FIG. 1



A few items need to be additionally studied:

1. The main hanging system design in order to fulfill the earthquake safety rules;
2. The optimization of the tray design;
3. The possible use of the structure for the tracker support.

TAB 1

BRICK SUPPORTING STRUCTURE
MATERIALS AND STRESSES IN VERTICAL RODS

Weight = 250 Kg Tension = 50 Kg
Force tensioning each rod = 300 Kg

Force = Weight + Tension Mechanical Stress: $\sigma = F/A$ (A, surface area)

Rod section: 4x4	Rod section: 5x5	Rod section: 6x6
A = 16 mm^2 σ = 18.8 Kg/ mm^2	A = 25 mm^2 σ = 12.0 Kg/ mm^2	A = 36 mm^2 σ = 8.3 Kg/ mm^2

Stainless Steel

Rod section: 4x4	Rod section: 5x5	Rod section: 6x6
AISI 304 σy = 18 Kg/mm^2 $\sigma y/\sigma$ = 0.96 $\Delta l/l = 9.4x10^{-4}$ (6 mm over 6 m)	AISI 304 σy = 18 Kg/mm^2 $\sigma y/\sigma$ = 1.5 $\Delta l/l = 6x10^{-4}$ (4 mm over 6 m)	AISI 304 σy = 18 Kg/mm^2 $\sigma y/\sigma$ = 2.16 $\Delta l/l = 4.2x10^{-4}$ (3 mm over 6 m)
AISI 410 σy = 41 Kg/mm^2 $\sigma y/\sigma$ = 2.18 $\Delta l/l =9.4x10^{-4}$ (6 mm over 6 m)	AISI 410 σy = 41 Kg/mm^2 $\sigma y/\sigma$ = 3.42 $\Delta l/l = 6x10^{-4}$ (4 mm over 6 m)	AISI 410 σy = 41 Kg/mm^2 $\sigma y/\sigma$ = 4.94 $\Delta l/l = 4.2x10^{-4}$ (3 mm over 6 m)
AISI 420 σy = 57 Kg/mm^2 $\sigma y/\sigma$ = 3.03 $\Delta l/l =9.4x10^{-4}$ (6 mm over 6 m)	AISI 420 σy = 57 Kg/mm^2 $\sigma y/\sigma$ = 4.75 $\Delta l/l = 6x10^{-4}$ (4 mm over 6 m)	AISI 420 σy = 57 Kg/mm^2 $\sigma y/\sigma$ = 6.87 $\Delta l/l = 4.2x10^{-4}$ (3 mm over 6 m)

Aluminum Alloy

Rod section: 4x4	Rod section: 5x5	Rod section: 6x6
Anticorodal 100 σy = 27 Kg/mm^2 σy/σ = 1.44 $\Delta l/l = 2.7x10^{-3}$ (16 mm over 6 m)	Anticorodal 100 σy = 27 Kg/mm^2 σy/σ = 2.25 $\Delta l/l = 1.7x10^{-3}$ (10 mm over 6 m)	Anticorodal 100 σy = 27 Kg/mm^2 σy/σ = 3.25 $\Delta l/l = 1.2x10^{-3}$ (7 mm over 6 m)
Avional 14 σy = 41 Kg/mm^2 σy/σ = 2.18 $\Delta l/l = 2.7x10^{-3}$ (16 mm over 6 m)	Avional 14 σy = 41 Kg/mm^2 σy/σ = 3.42 $\Delta l/l = 1.7x10^{-3}$ (10 mm over 6 m)	Avional 14 σy = 41 Kg/mm^2 σy/σ = 4.94 $\Delta l/l = 1.2x10^{-3}$ (7 mm over 6 m)

TAB 2

BRICK SUPPORTING STRUCTURE
MATERIALS LIST WITH YELDING STRESSES

Stainless Steel

Density: 7900 Kg/m^3

Material	σy
AISI 304	17.5 Kg/mm^2
AISI 316	19.5 Kg/mm^2
AISI 410	41.0 Kg/mm^2
AISI 420	47.5 - 57.0 Kg/mm^2
AISI 431	56.5 Kg/mm^2

Aluminum Alloy

Density: 2800 Kg/m^3

Material	σy
ANTICORODAL 63	17 - 23 Kg/mm^2
ANTICORODAL 61	24 - 31 Kg/mm^2
ANTICORODAL 100	27 - 34 Kg/mm^2
AVIONAL 22	23 -30 Kg/mm^2
AVIONAL 14	41 - 45 Kg/mm^2
AVIONAL 24	32 - 40 Kg/mm^2
ERGAL 55	49 - 60 Kg/mm^2
ERGAL 65	51 - 60 Kg/mm^2

TAB 3

BRICK SUPPORTING STRUCTURE
MASS AND COST

Total material volume

Rod section: 4x4	Rod section: 5x5	Rod section: 6x6
Rods: 1.16 m^3 Sheets (0.5 mm): 1.15 m^3 Total: 2.31 m^3	Rods: 1.81 m^3 Sheets (0.5 mm): 1.15 m^3 Total: 2.96 m^3	Rods: 2.61 m^3 Sheets (0.5 mm): 1.15 m^3 Total: 3.76 m^3

Stainless Steel

Density: 7900 Kg/m^3
Cost : 8-12 CHF/Kg

Rod section: 4x4	Rod section: 5x5	Rod section: 6x6
Total mass (5 supermod.): 18.2 T Mass/wall: 152 Kg Mass/brick: 53 g (0.6 %)	Total mass (5 supermod.): 23.4 T Mass/wall: 195 Kg Mass/brick: 68 g (0.8 %)	Total mass (5 supermod.): 29.7 T Mass/wall: 248 Kg Mass/brick: 86 g (1.0 %)
Total material cost: 146.000-218.000 CHF	Total material cost: 187.000-281.000 CHF	Total material cost: 238.000-356.000 CHF

Aluminum Alloy

Density: 2800 Kg/m^3
Cost : 18-24 CHF/Kg

Rod section: 4x4	Rod section: 5x5	Rod section: 6x6
Total mass (5 supermod.): 6.5 T Mass/wall: 54 Kg Mass/brick: 19 g (0.2 %)	Total mass (5 supermod.): 8.3 T Mass/wall: 69 Kg Mass/brick: 24 g (0.3 %)	Total mass (5 supermod.): 10.5 T Mass/wall: 88 Kg Mass/brick: 30 g (0.4 %)
Total material cost: 117.000-156.000 CHF	Total material cost: 149.000-199.000 CHF	Total material cost: 189.000-252.000 CHF