SSD documentation

SSD Ladder

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1 SSD Ladder design

Each SSD ladder is composed of the following elements (Figure 1):

- 16 modules aligned along the ladder axis (the beam axis),
- two pairs of ADC board and C2D2 board located at each end of the ladder and dedicate to the digitization and the control of the signals coming from respectively the N side and the P side of the modules,
- a low mass carbon fiber beam supporting the modules and the electronic boards,
- additional mechanical pieces to attach the ladder to the clamshell and to connect the ladder to the air cooling tubes.

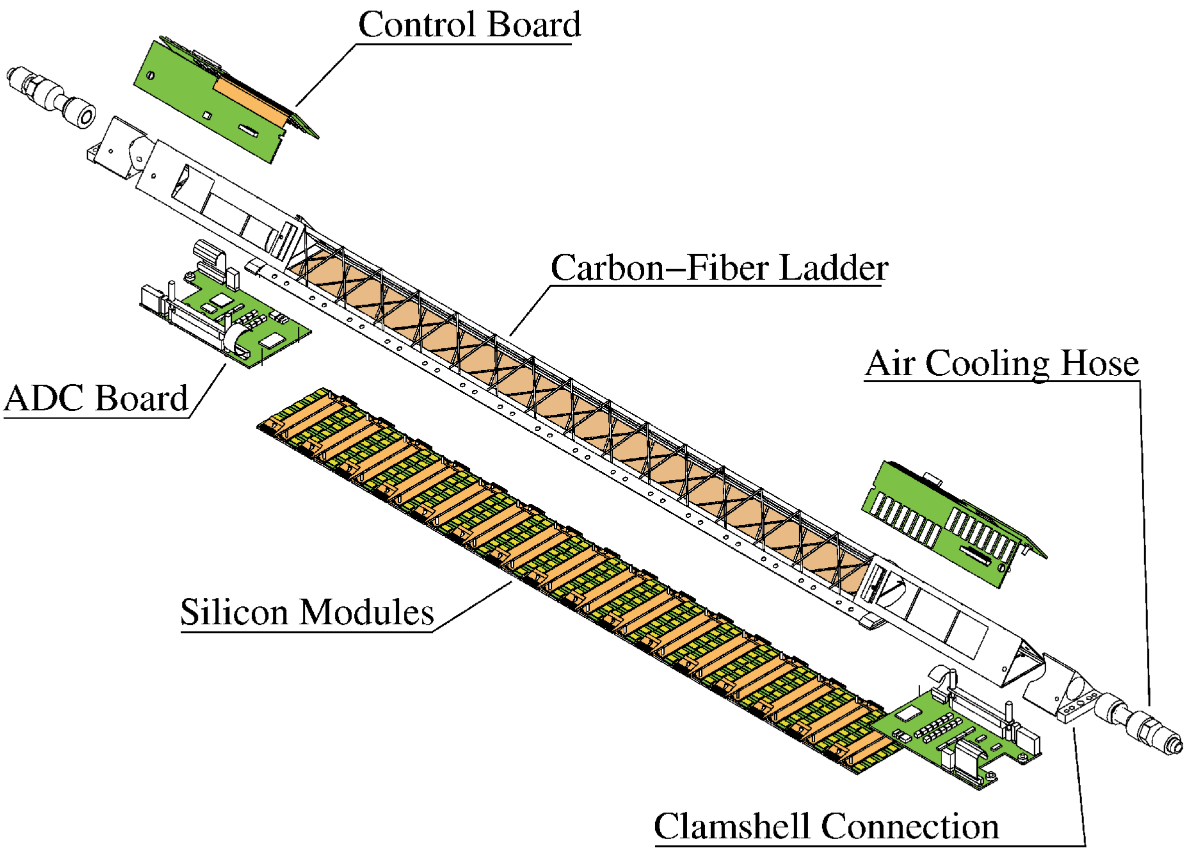

Figure 1 : Exploded view of an equipped ladder

2 The carbon fibber beam

The mechanical structure of the ladder (Figure 2,) is build into two parts. The upper and longest part as a triangular shape and holds the board at its extremities. The central part of the beam is build by welding a carbon fiber around the triangle corners and provides most of the ladder rigidity. Internal stiffeners are inserted at the ends this part in order to give additional strength. A second part (the bottom part) still made of carbon fibber is used as an interface piece to hold the module and integrates a kapton film to close the air path near the module. Figure 4 and Figure 5 show details of the ladder beam.

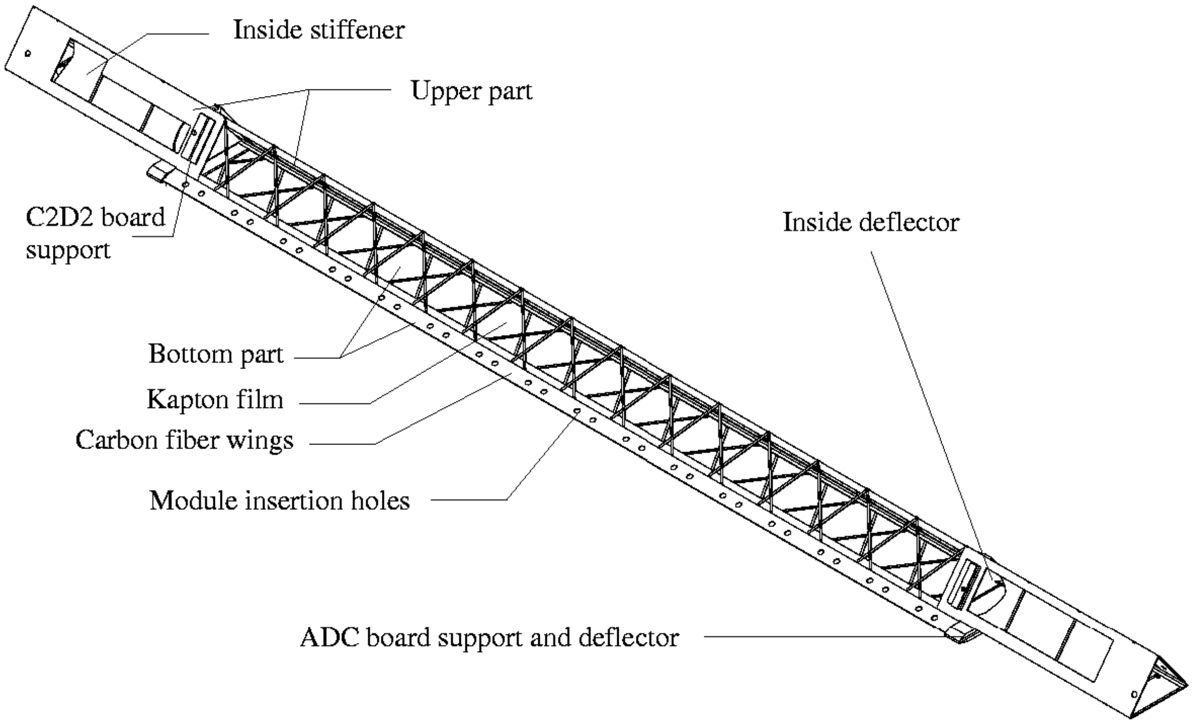

Figure 2 : Components of the ladder support structure

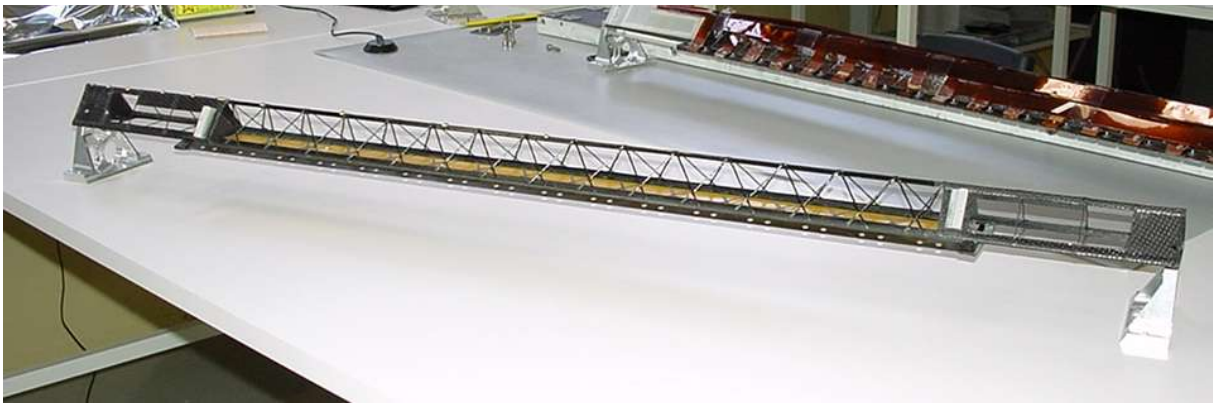

Figure 3 : a carbon fiber mechanical structure of a ladder

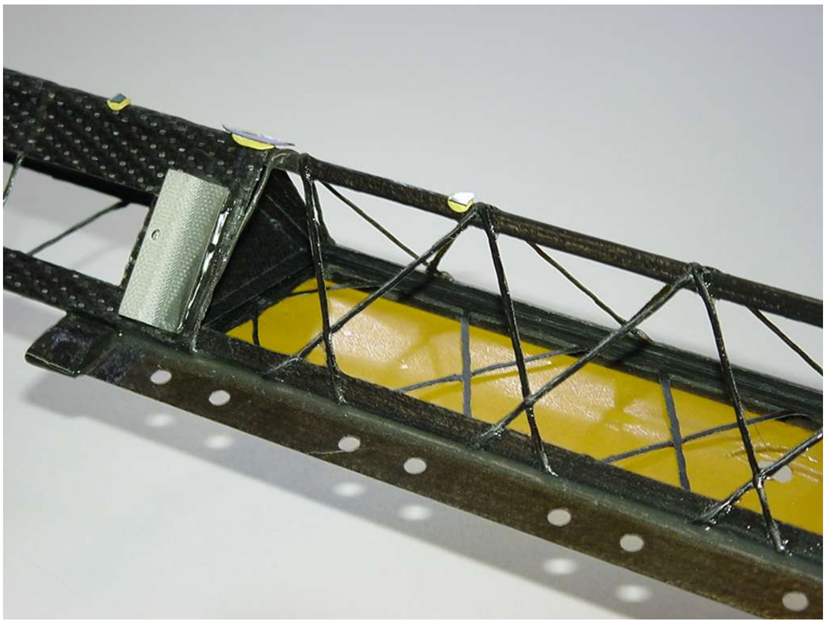

Figure 4 : Detailed view of the ladder mechanical structure

The weight of the bare carbon structure is around 90 g while the load coming from the modules and the electronic boards is around 350 g (9 g per module). The sagging of the ladder under a central load of 200 g has been measured to be of the order of 200 μm . Under realistic load and realistic conditions the sagging of the ladder has been estimated to be below 50 μm.

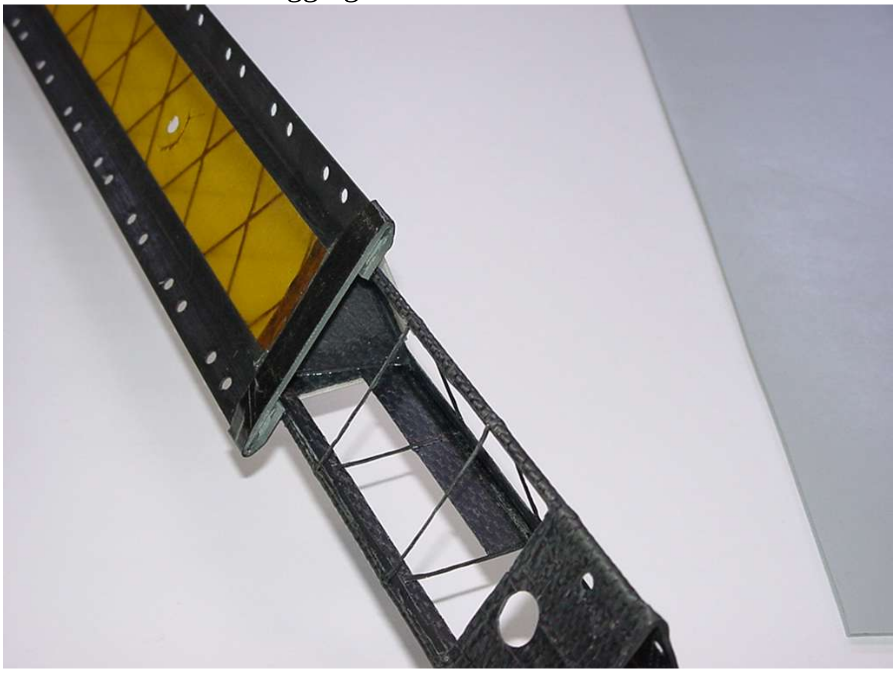

Figure 5 : Detailed view of the end ladder beam showing the bottom part (the kapton film is in yellow) and one end of the upper part

A fully equipped ladder has been assembled which will be installed in STAR. The following pictures show complete views (,) and partial views (, , ,) of the ladder.

Figure 6 : Top view of the equipped ladder

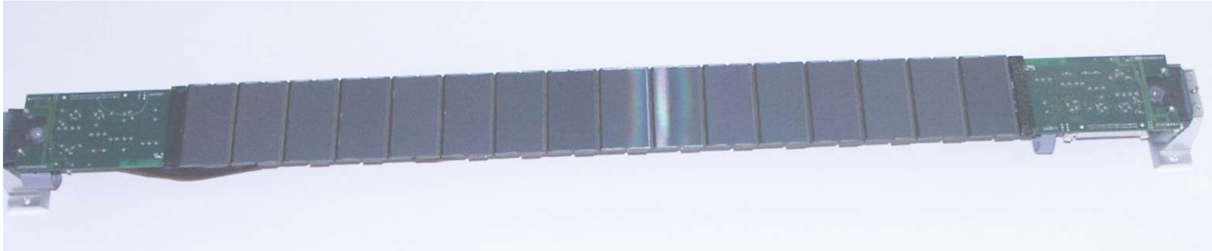

Figure 7 : Bottom view of the equipped ladder

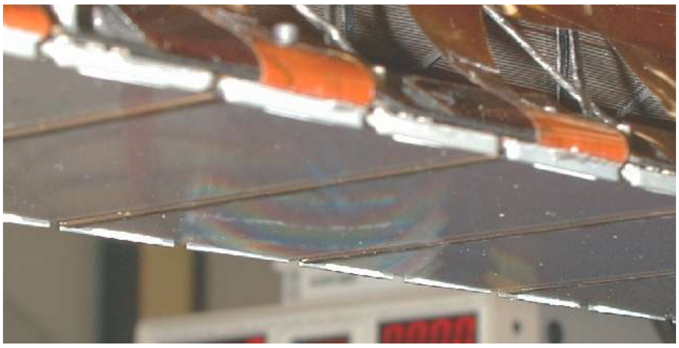

Figure 8 : Detailed bottom view of the ladder showing some silicon wafers

Figure 9 : Detailed top view of the ladder showing the aluminum buses connected to the hybrids and running along the ladder

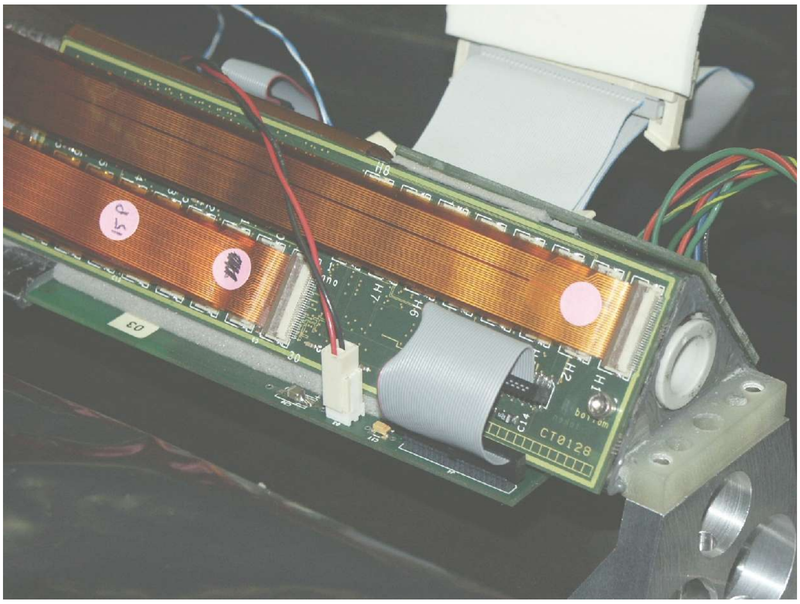

Figure 10 : Detailed end view of the ladder. The C2D2 board is on the top with the buses connected while the ADC board is partly visible at the bottom. The mechanical interface (dirty white) is shown on the right with the air hose connector inserted.

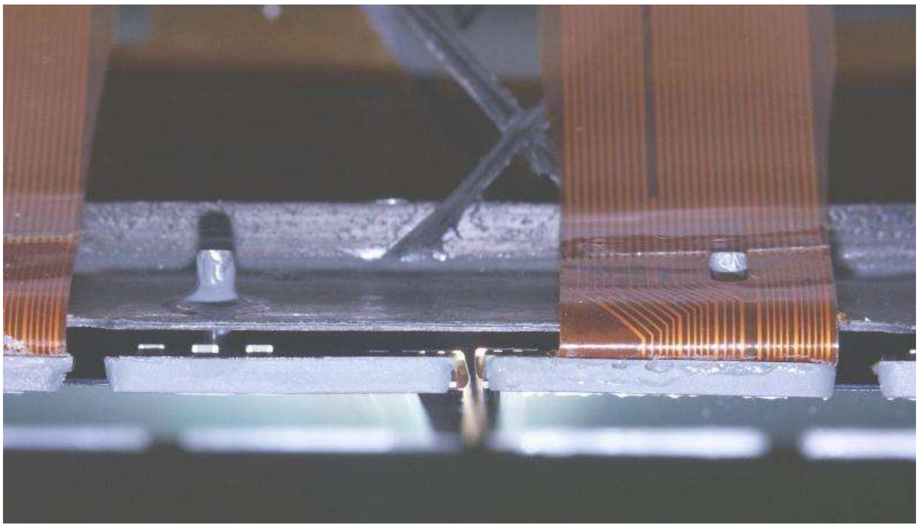

Figure 11 : Detailed front view of the ladder showing the ladder-module interface. The central bottom part shows the interface between two modules and the TAB tape going from the wafer to the A128 chips.

3 Detailed material budget

The SSD ladder can be split in the following components using the specified material :
Equipped

Module				*
Ladder	Upper part	Upper part		Carbon epoxy fiber
		Inside Deflector	Deflector	Carbon epoxy fiber
			Glue	Araldite 2013
		Inside stiffener	Stiffener	Carbon epoxy fiber
				Araldite 2013
		C2D2 board support		Glass epoxy fiber
	Base	Wings		Carbon epoxy fiber
		Central part		Kapton
		ADC board support		Carbon epoxy fiber/ Glass epoxy fiber
	Glue			Araldite 2013
Glue				Araldite 2013
Boards	ADC board			Glass epoxy fiber/ Copper/ Standard electronic components and connectors
	C2D2 board			Glass epoxy fiber / Copper / Kapton / Standard electronic components and connectors
	Bottom Insulation foam			PVC
Cables	Module to C2D2 cable			Kapton/Aluminum
	ADC to ADC cable			PVC/Copper
	ADC to C2D2 cables			PVC/Copper
Cooling	Connectors			Polyacetal
	Shielding			Mylar

* See the SSD Module Material Budget

4 Radiation length budget

The following table detailed the radiation length budget for a particle crossing the ladder in the active area at normal incidence. The normalized radiation length is calculated by weighting the intrinsic radiation length of a component by its surface to the wafer surface ratio.
The total radiation length is around 1,05% which is close to the target figure (1%). The TAB tape and the module aluminum pins produce very large intrinsic radiation lengths but localised to very small areas. The "connections" sector gives a significant contribution which is mainly due to the overlapping aluminum buses.

Component	Intrin. Dimen. mm	Surface mm2	Thick. mm	Nbr	Material	X0 mm	% X0	% X0 norm.
Wafer	75 by 42	3150,00	0,300	1	Si	93,6	0,321	0,320
Total								***0,320***
Hybrid support								
Stiffener	75 by 20	1500,00	0,380	2	C-Epoxy	285	0,133	0,127
Stiffener steps	1.8 by 20	36,00	1,830	4	Epoxy	456	0,401	0,018
Total								***0,145***
Printed circuit								
Substrat	105 by 20	2100,00	0,050	2	Kapton	281	0,018	0,024
Coverlay	105 by 20	2100,00	0,050	2	Polyimide	281	0,018	0,024
strips	4064 by .12	487,70	0,018	2	Cu	14,3	0,126	0,039
Gold on strips	2032 by .12	243,85	0,001	2	Au	3,35	0,030	0,005
Via (bottom)	Ri=.12 Re=.36	0,09	0,036	912	Cu	14,3	0,252	0,007
Via (cylinder)	Ri=.12 Re=.156	0,01	0,050	912	Cu	14,3	0,350	0,001
Footprint A128	6 by 9	13,20	0,018	12	Cu	14,3	0,126	0,006
Footprint Costar			0,018	2	Cu	14,3	0,126	
connection pad		8,00	0,018	2	Cu	14,3	0,126	0,001
Total								***0,105***
Chips								
A128	6 by 8.5	51,00	0,300	12	Si	93,6	0,321	0,062
Costar	4.3 by 4	17,20	0,300	2	Si	93,6	0,321	0,004
Total								***0,066***
Passive components								
Capa 0805	2.0 by 1.3	2,60	1,300	14	Al2O3	75,5	1,722	0,020
Capa 0603	1.5 by 0.76	1,14	0,760	38	Al2O3	75,5	1,007	0,014
Capa 0402	1 by 0.5	0,50	0,500	14	Al2O3	75,5	0,662	0,001
Resistor 0603	1.5 by 0.76	1,14	0,450	6	Al2O3	75,5	0,596	0,001
Resistor 0402	1 by 0.5	0,50	0,280	20	Al2O3	75,5	0,371	0,001
Total								***0,038***

Connections								
TAB wafer (sub.)	2.0 by 12	24,00	0,070	12	Kapton	281	0,025	0,002
TAB wafer (strips)	2.0 by 128x0.03	7,68	0,017	12	Cu	14,3	0,119	0,003
TAB hybrid (sub.)	7.5 by 12	90,00	0,070	12	Kapton	281	0,025	0,009
TAB hybrid (strips)	7.5 by 128x0.03	28,80	0,017	12	Cu	14,3	0,119	0,013
TAB folding (sub.)	12 by 0.07	0,84	2,000	12	Kapton	281	0,712	0,002
TAB folding (strips)	128x0.03x.017	0,07	2,000	12	Cu	14,3	13,986	0,003
Total TAB								0,033
Length Bus (sub.)	43 by 15	645,00	0,050	17	Kapton	281	0,018	0,062
Length Bus (strips)	43 by 30x0.3	387,00	0,025	17	Al	88,9	0,028	0,059
Length Bus (cover.)	43 by 15	645,00	0,030	17	Polyimide	281	0,011	0,037
Turn Bus (sub.)	26 by 15	390,00	0,050	2	Kapton	281	0,018	0,004
Turn Bus (strips)	26by 30x0.3	234,00	0,025	2	Al	88,9	0,028	0,004
Turn Bus (cover.)	26 by 15	390,00	0,030	2	Polyimide	281	0,011	0,003
Total Bus								0,169
Connect. HIROSE	*3.55 by 30x0.2*	*21,30*	*0,640*	*2*	*Cu*	*14,3*	*4,476*	*0,061*
Total								***0,202***
Mechanical structure								
Pins (bottom)	Ri=2 Re=6	25,12	,250	4	Al	88,9	0,281	0,009
Pins (cylinder)	Ri=1.5 Re=2	1,37	7,000	4	Al	88,9	7,874	0,014
Ladder (fiber)	1 by 43	43,00	1,000	3	C-Epoxy	285	0,351	0,014
Ladder (bottom)	1 by 60x15/16	56,25	1,000	2	C-Epoxy	285	0,351	0,013
Ladder (sides)	1 by 75x15/16	70,31	1,414	2	C-Epoxy	285	0,496	0,022
Plates (film)	35 by 43	1505,00	,100	1	C-Epoxy	281	0,036	0,017
Plates (horiz.)	8 by 43	344,00	,400	2	C-Epoxy	285	0,140	0,031
Plates (inclined 15°)	12 (proj) by 43	516,00	,414	2	C-Epoxy	285	0,145	0,048
Total								***0,167***

Wafer	0,320
Hybrid support	0,145
Printed circuit	0,105
Chips	0,066
Passive components	0,038
Connections	0,202
Mechanical structure	0,167
Total	1,043