Instructions

1. Step by step description of Geomagic Control

The initial and final planned models must be imported together (Figure 1A). The tool “hide” is selected for the final model (Figure 1B), and the five points are marked per tooth on the initial model (click on the tab **Features → Point → Parameters)**. Mark the point and name it. For each tooth, the point marking order for proper reading by the application should be as follows: lingual gingival, mesial, distal, occlusal and vestibular gingival (**do not change this order**). For superior models, start from tooth 17, and once the five points are marked, initiate unit 16 and so on until unit 27. For inferior, start from tooth 37.

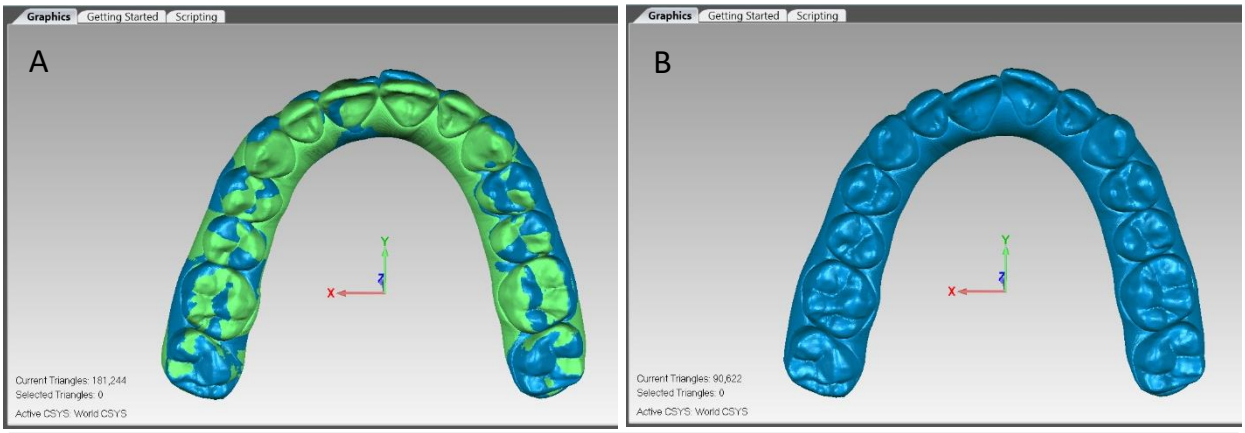


Figure 1- Models imported into Geomagic: **A-** in blue the initial model and in green the final planned model; **B-** visualization of the initial model only

1.1 Points transference from the initial model to the final model

Once all the points are marked, the final model must be selected to become visible. Set the initial model as “Reference” and the Final as “Test,” and request the software to individually perform the “best fit” alignment of each tooth from the initial with the respective tooth from the final planned model, so that the points can be copied from the first to the latter (**Features → Copy Features**). Better explaining, the “best

fit" alignment of unit 17 is performed, and only after this procedure its points are copied to the final model. The same must be performed for each unit.

1.2 Establishing the Reference Plane

After the copy of all points, the software must be requested to perform the "best fit" alignment of all teeth at the same time (except the second molars) as described in the article. Then, the tool "hide" is selected to the final model, and the Reference Plane is defined on the initial one through the best adjustment between the lingual gingival points of all teeth, with the exception of the second molars (**Features → Plane → Best Fit. Figure 2)**.

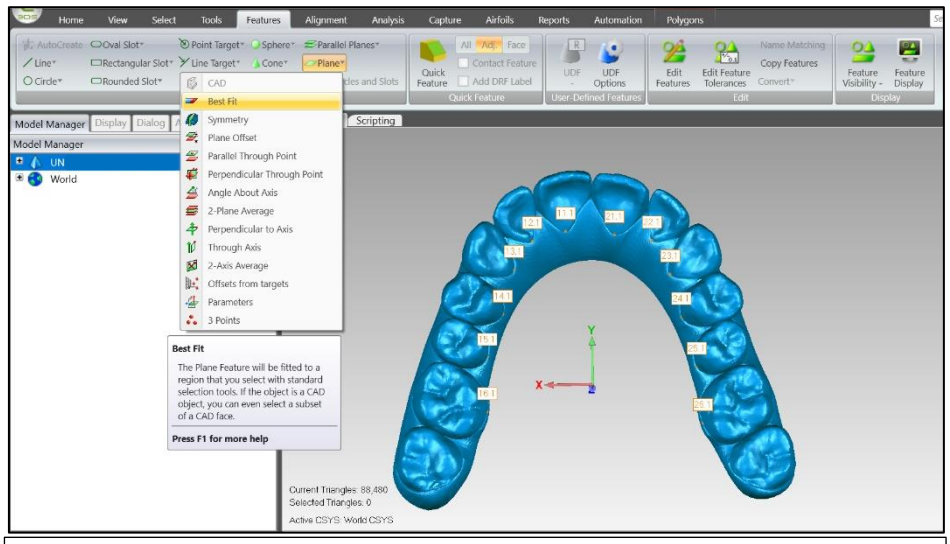


Figure 2- Establishing the Reference Plane

Another Reference Plane, a median one, must be created perpendicular to Plane 1 and to Plane XZ (**Features → Plane → Perpendicular Trough Point.** Figure 3). Planes 1 and 2 must be copied to the final model.

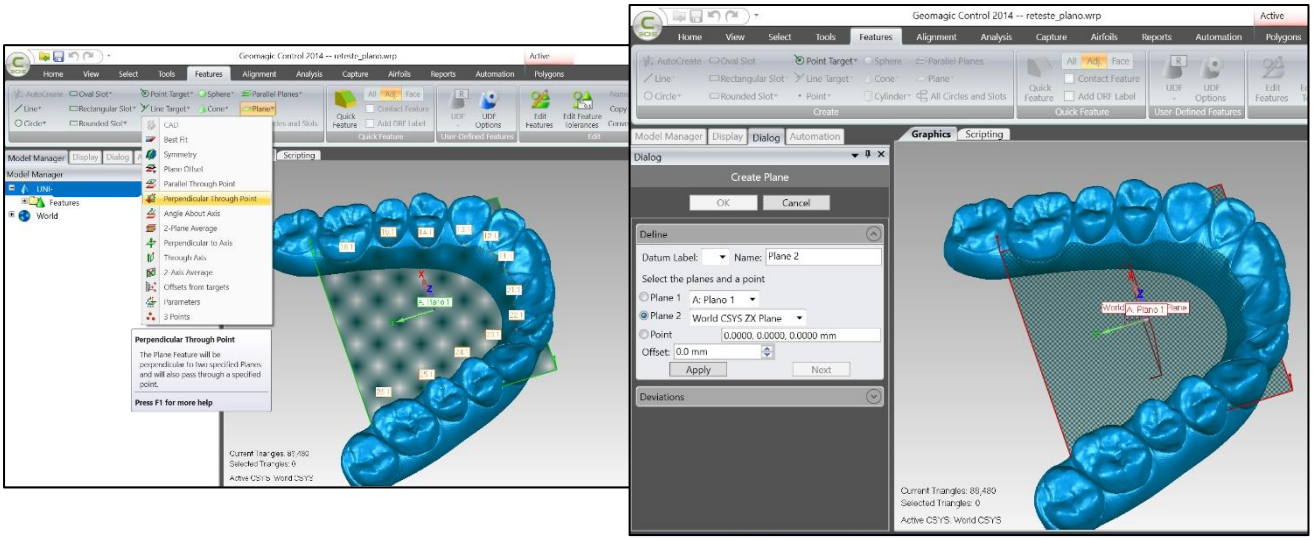


Figure 3- Establishing the Reference Plane

1.3 Reorientation of XYZ

The XYZ must be transferred to the Reference Plane: **Alignment → Align to World** → Create pair: XY & Plane 1/ YZ & Plane 2 (Figure 4; Figure 5). The reorientation must be performed for both models.

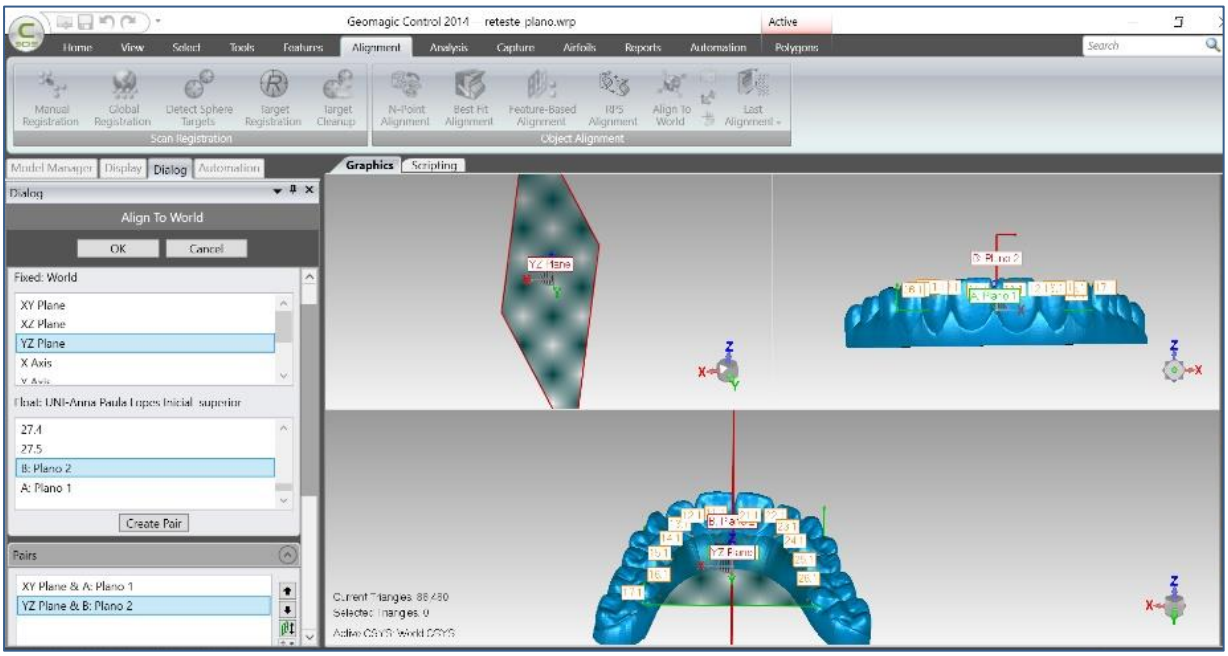


Figure 4- Reorientation of XYZ

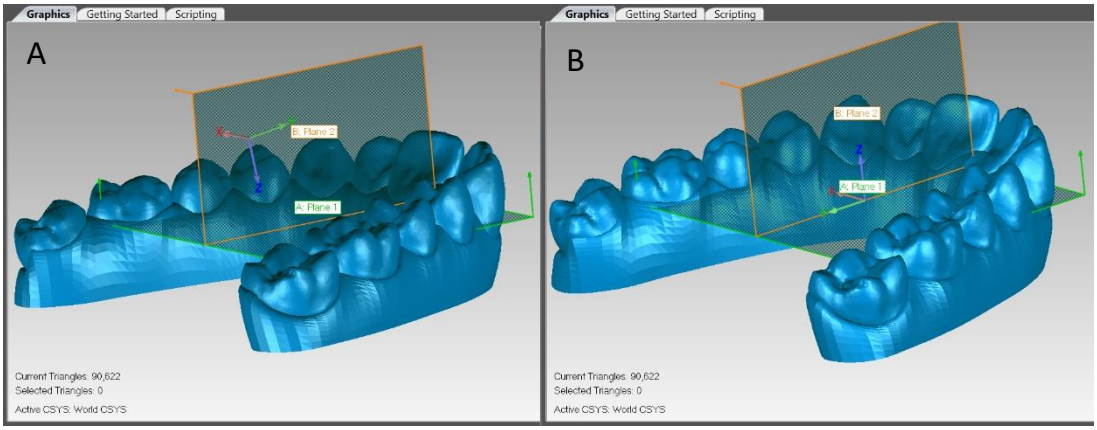


Figure 5- **A**- Note the position of the XYZ before re-orientation. **B**- Note that after the re-orientation, the XY coincide with Plane 1, and YZ with Plane 2.

1.4 Exporting coordinates of each point

On the Model Manager, select all points (one model at a time), use right-click and choose export. Select .igs file format (Figure 6).

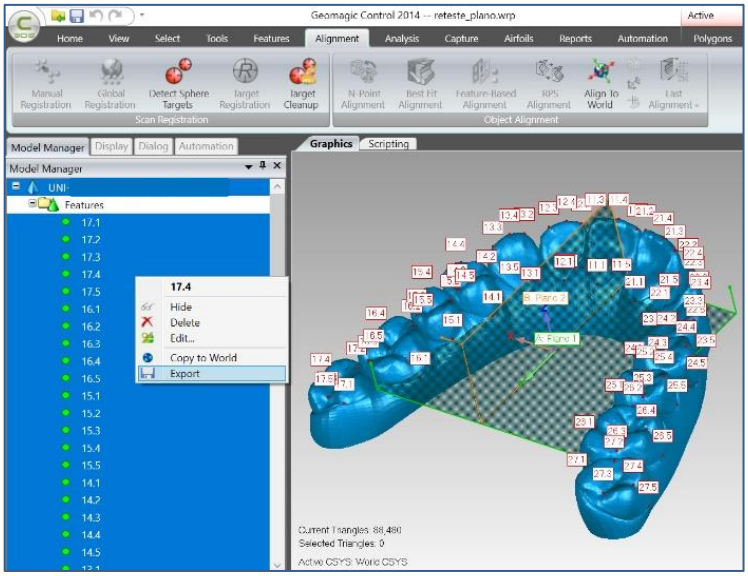


Figure 6- Exporting coordinates

2.Step by step description of Applications

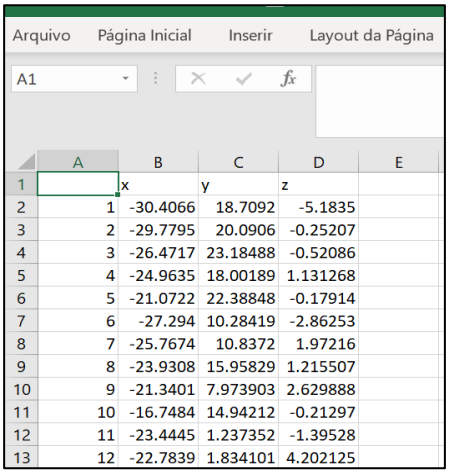
2.1 Go to the first application:

http://165.227.146.152/IGES%20Coordinates%20extractor/

Click on **Choose File**, select the .igs file exported by Geomagic and submit the file. The purpose of this application is to organize the coordinates exported.

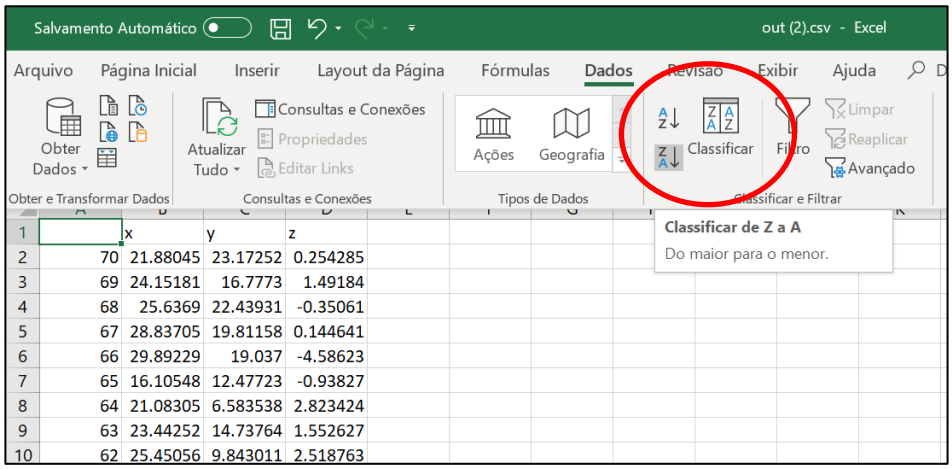
Figure 7- First application

The application will output a file in .csv format with the coordinates of the seventy points as shown in Figure 8 (excel will open the .csv file adequately if the settings are adjusted as (,) for decimal separators and as (.) for thousand separators). See Figures 9 and 10 for the description of the following steps.



	A	B	C	D	E
1		x	y	z	
2	1	-30.4066	18.7092	-5.1835	
3	2	-29.7795	20.0906	-0.25207	
4	3	-26.4717	23.18488	-0.52086	
5	4	-24.9635	18.00189	1.131268	
6	5	-21.0722	22.38848	-0.17914	
7	6	-27.294	10.28419	-2.86253	
8	7	-25.7674	10.8372	1.97216	
9	8	-23.9308	15.95829	1.215507	
10	9	-21.3401	7.973903	2.629888	
11	10	-16.7484	14.94212	-0.21297	
12	11	-23.4445	1.237352	-1.39528	
13	12	-22.7839	1.834101	4.202125	

Figure 8- Although the numbering indicates the points are organized from the first to the seventieth, the application exports the inverse order. Choose Data, Sort and select Descending Order.



		x	y	z
1		x	y	z
2	70	21.88045	23.17252	0.254285
3	69	24.15181	16.7773	1.49184
4	68	25.6369	22.43931	-0.35061
5	67	28.83705	19.81158	0.144641
6	66	29.89229	19.037	-4.58623
7	65	16.10548	12.47723	-0.93827
8	64	21.08305	6.583538	2.823424
9	63	23.44252	14.73764	1.552627
10	62	25.45056	9.843011	2.518763

Figure 9- Once this step is completed, the points will be organized from the first to the last. The coordinates of each point can be compared with the values available in the program, so there is no risk that a mistake in the order of some point could lead to an error in obtaining the measurements. To facilitate this comparison, we usually put the name given to each point in the left column (17.1, 17.2, 17.3; see figure 10). Save the file.

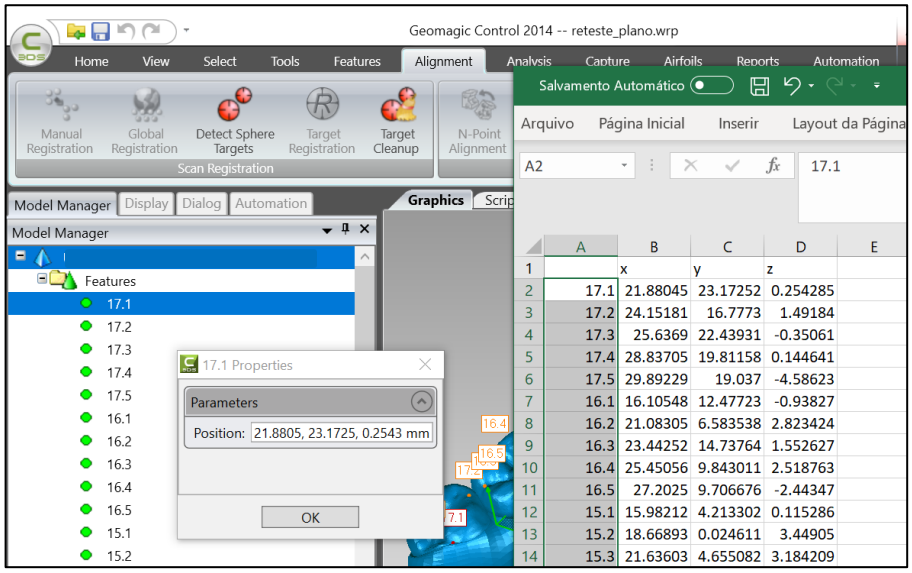


Figure 10- Coordinate check.

2.2 Go to the second application:

http://165.227.146.152/Teeth%20position%20on%20digital%20models/

Click on **Choose File**, select the .csv file that was saved after the modifications described, and submit it (Figure 11) .

Figure 11- Second application

The application will output a file in .csv format as shown in Figure 12:

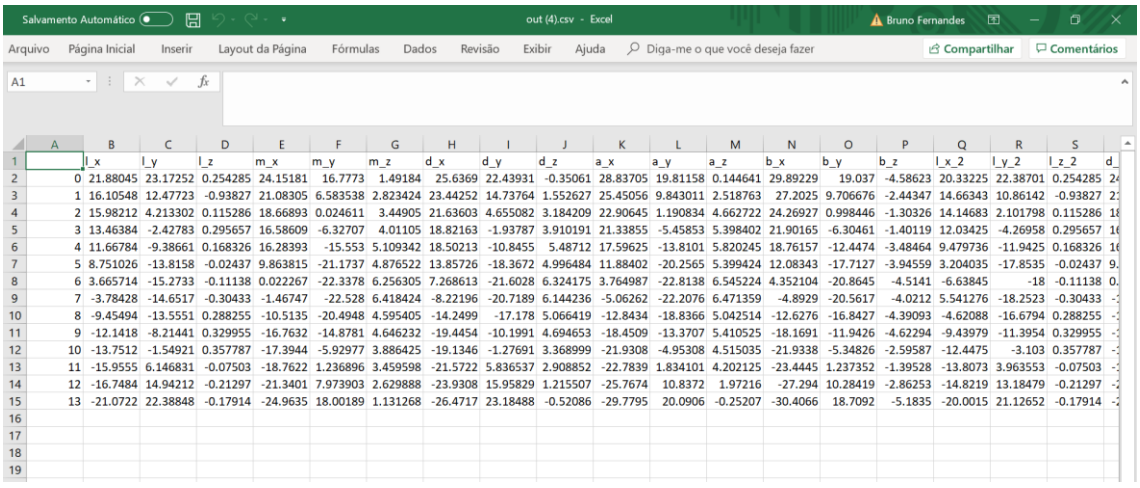
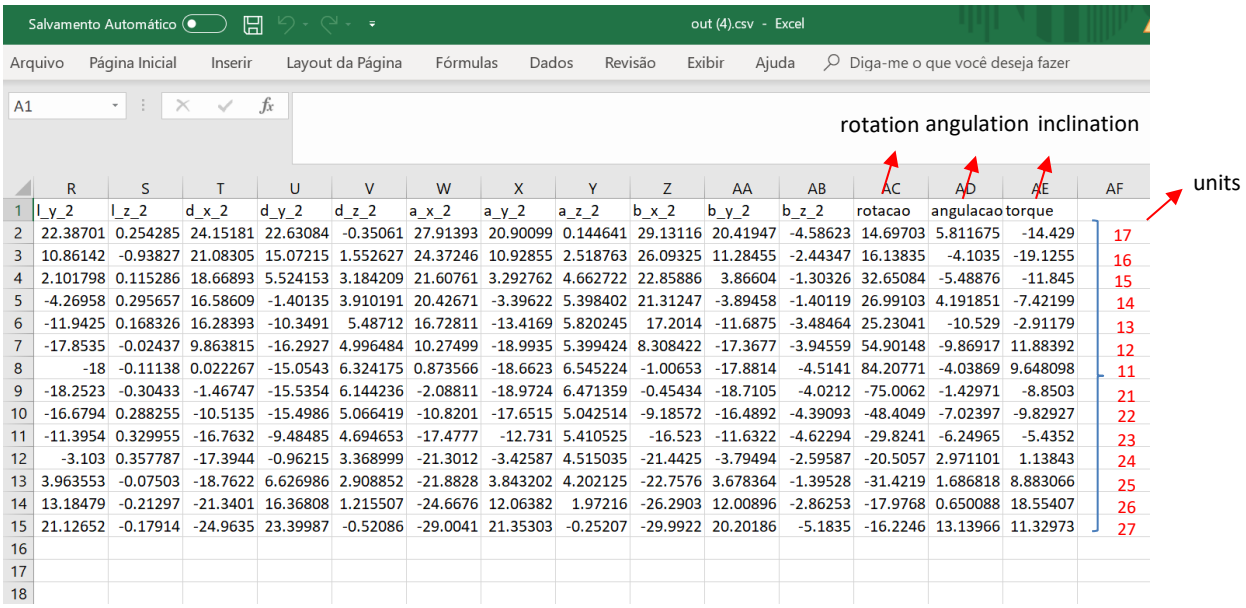


Figure 12- Output of the second application

Roll the bar sideways to read the values of rotation, angulation and inclination. If the steps were followed as described, the values correspond to the order in which teeth were marked (Figure 13):



	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF
1	l_y_2	l_z_2	d_x_2	d_y_2	d_z_2	a_x_2	a_y_2	a_z_2	b_x_2	b_y_2	b_z_2	rotacao	angulacao	torque	
2	22.38701	0.254285	24.15181	22.63084	-0.35061	27.91393	20.90099	0.144641	29.13116	20.41947	-4.58623	14.69703	5.811675	-14.429	17
3	10.86142	-0.93827	21.08305	15.07215	1.552627	24.37246	10.92855	2.518763	26.09325	11.28455	-2.44347	16.13835	-4.1035	-19.1255	16
4	2.101798	0.115286	18.66893	5.524153	3.184209	21.60761	3.292762	4.662722	22.85886	3.86604	-1.30326	32.65084	-5.48876	-11.845	15
5	-4.26958	0.295657	16.58609	-1.40135	3.910191	20.42671	-3.39622	5.398402	21.31247	-3.89458	-1.40119	26.99103	4.191851	-7.42199	14
6	-11.9425	0.168326	16.28393	-10.3491	5.48712	16.72811	-13.4169	5.820245	17.2014	-11.6875	-3.48464	25.23041	-10.529	-2.91179	13
7	-17.8535	-0.02437	9.863815	-16.2927	4.996484	10.27499	-18.9935	5.399424	8.308422	-17.3677	-3.94559	54.90148	-9.86917	11.88392	12
8	-18	-0.11138	0.022267	-15.0543	6.324175	0.873566	-18.6623	6.545224	-1.00653	-17.8814	-4.5141	84.20771	-4.03869	9.648098	11
9	-18.2523	-0.30433	-1.46747	-15.5354	6.144236	-2.08811	-18.9724	6.471359	-0.45434	-18.7105	-4.0212	-75.0062	-1.42971	-8.8503	21
10	-16.6794	0.288255	-10.5135	-15.4986	5.066419	-10.8201	-17.6515	5.042514	-9.18572	-16.4892	-4.39093	-48.4049	-7.02397	-9.82927	22
11	-11.3954	0.329955	-16.7632	-9.48485	4.694653	-17.4777	-12.731	5.410525	-16.523	-11.6322	-4.62294	-29.8241	-6.24965	-5.4352	23
12	-3.103	0.357787	-17.3944	-0.96215	3.368999	-21.3012	-3.42587	4.515035	-21.4425	-3.79494	-2.59587	-20.5057	2.971101	1.13843	24
13	3.963553	-0.07503	-18.7622	6.626986	2.908852	-21.8828	3.843202	4.202125	-22.7576	3.678364	-1.39528	-31.4219	1.686818	8.883066	25
14	13.18479	-0.21297	-21.3401	16.36808	1.215507	-24.6676	12.06382	1.97216	-26.2903	12.00896	-2.86253	-17.9768	0.650088	18.55407	26
15	21.12652	-0.17914	-24.9635	23.39987	-0.52086	-29.0041	21.35303	-0.25207	-29.9922	20.20186	-5.1835	-16.2246	13.13966	11.32973	27
16															
17															
18															

Figure 13- Values of rotation, angulation and inclination in the order in which the teeth were marked.