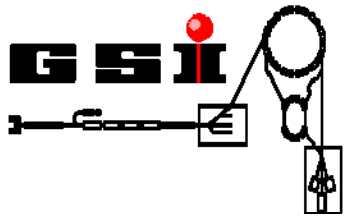
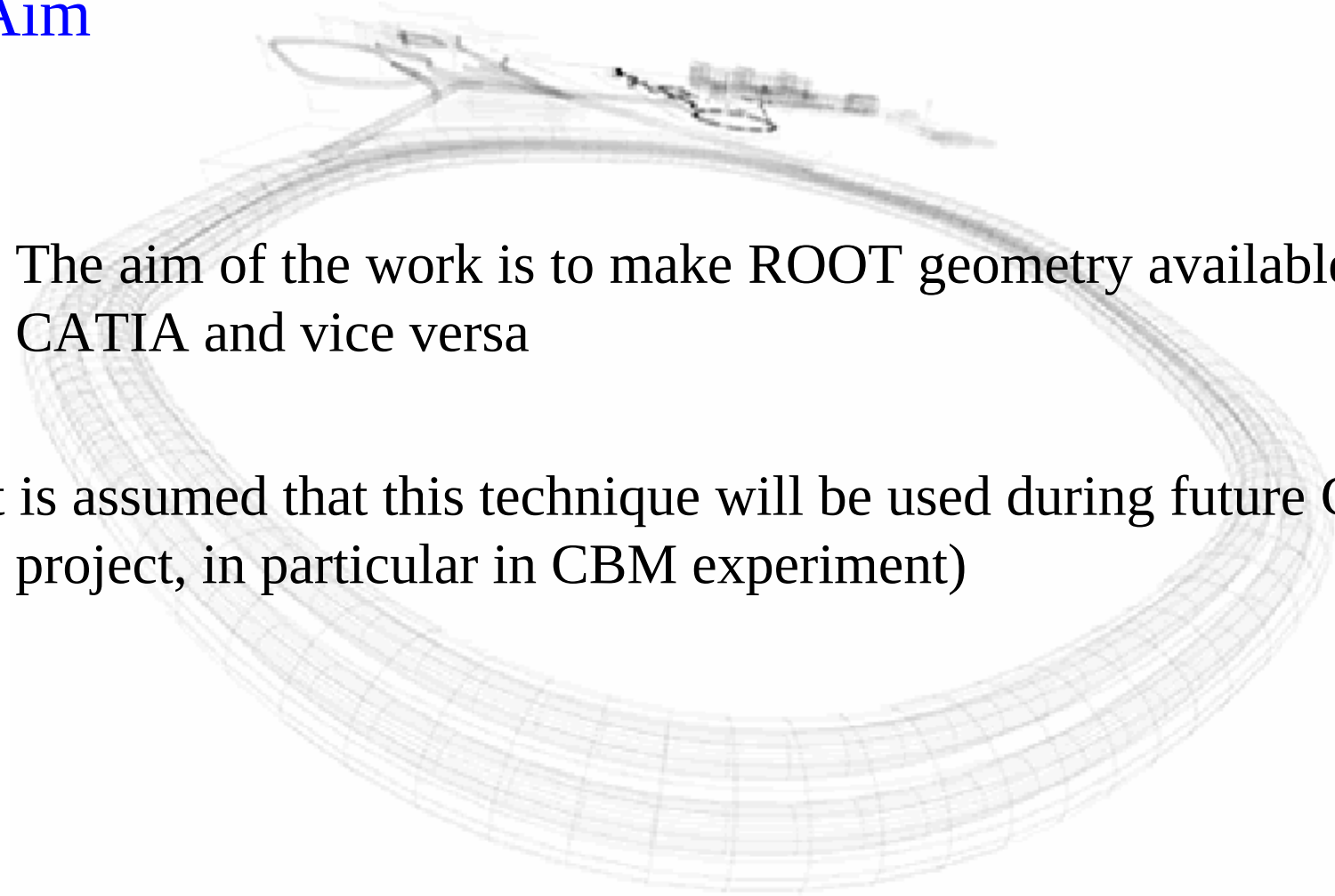


Interplay between ROOT and CATIA

P. Biryukov

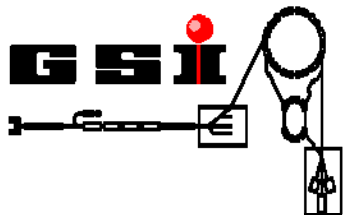
(p.biryukov@gsi.de)

Aim



- The aim of the work is to make ROOT geometry available in CATIA and vice versa

(It is assumed that this technique will be used during future GSI project, in particular in CBM experiment)



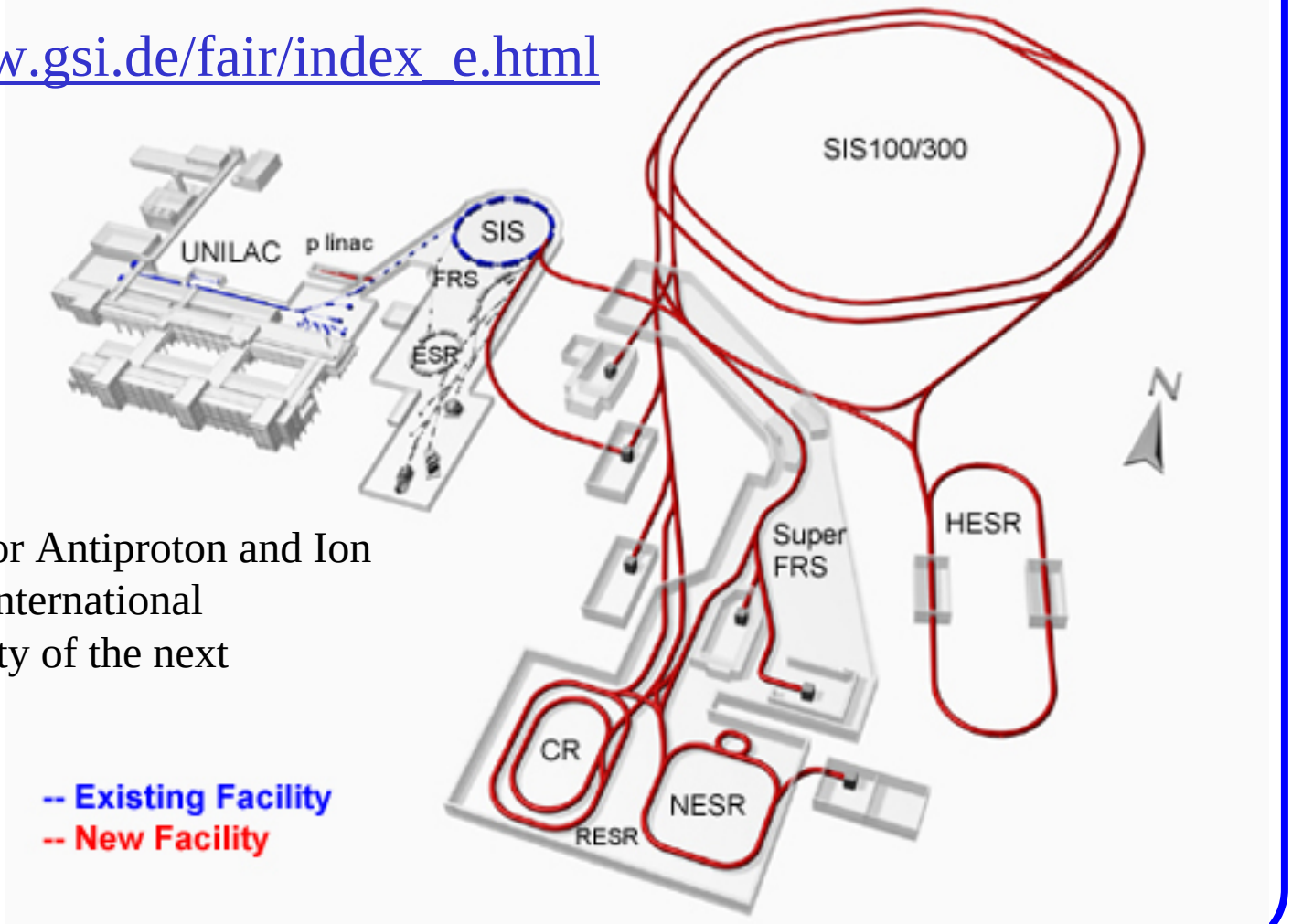
Future GSI project

The proposed project FAIR (Facility for Antiproton and Ion Research) is an international accelerator facility of the next generation. It builds on the experience and technological developments already made at the existing GSI facility, and incorporates new technological concepts. At its heart is a double ring facility with five times the circumference of the current SIS. A system of cooler-storage rings for effective beam cooling at high energies and various experimental halls will be connected to the facility.

Future GSI project

Future GSI project

http://www.gsi.de/fair/index_e.html



FAIR (Facility for Antiproton and Ion Research) is an international accelerator facility of the next generation.

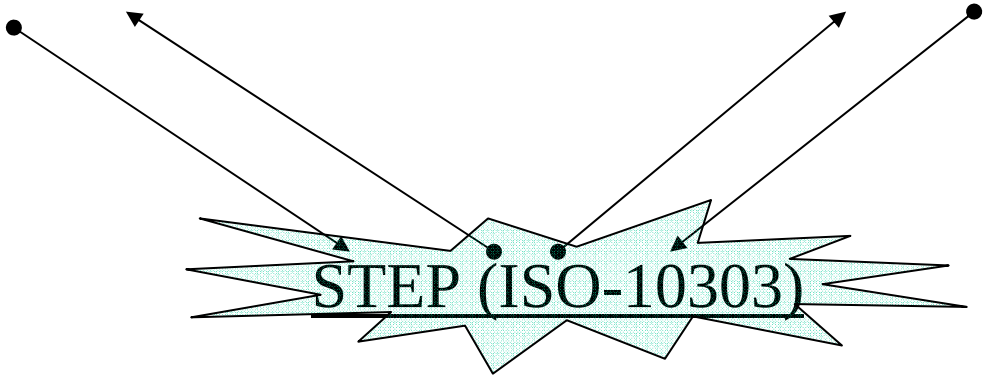
Software

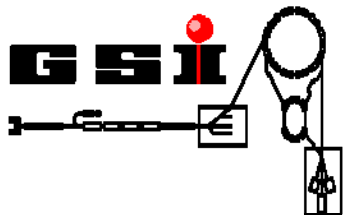
Simulation

- ROOT-VMC
- GEANT4 (in future)

CAD

- CATIA (v 5.14)
- AutoCAD (might be)





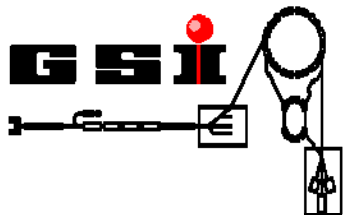
CATIA

CATIA is the CAD/CAM/CAE commercial software suite developed by Dassault Systemes and marketed world-wide by IBM. It is commonly referred to as a 3D PLM software. All stages of product development are supported, from conceptualization, through design (CAD) and manufacturing (CAM) until analysis (CAE). It provides an open development architecture through interfaces which can be used to customize or develop applications. The API's are supported in Fortran and C for V4 and Visual Basic and C++ for V5. These API's are called as CAA2 (or CAA V5). The CAA2 are COM based interfaces. These interfaces provide a seamless integration for products developed on the CATIA suite of software.

Catia V4 is principally a surface based boundary representation package. Catia V5 is a parametric solid/surface feature based package.

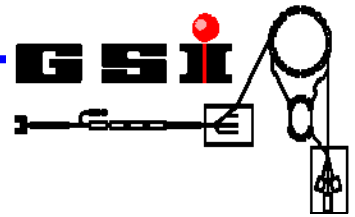
CATIA is widely used throughout the engineering industry, especially in the automotive and aerospace sectors, where Catia V4, Catia V5 and NX (Unigraphics) are the three dominant systems.

Dassault Systemes http://www.3ds.com



STEP

STEP is the ISO **st**andard for the **e**xchange of **p**roduct data (ISO-10303) It is an evolving standard which covers the whole Product Life Cycle in terms of data sharing, storage and exchange. STEP is replacing other CAE exchange standards like IGES, DXF, SET and VDAFS, as well as allow for complete descriptions in electronic form of all data related to Manufacturable Products.



Problem

Different representation of geometry in ROOT and CATIA:

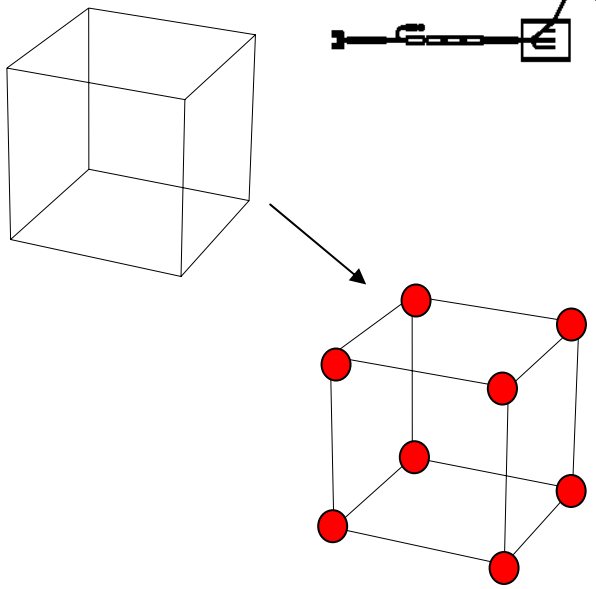
CATIA

- no hierarchy
- solids composed of surfaces, edges, vertexes

ROOT

- hierarchy
- solids as primitives

Solution

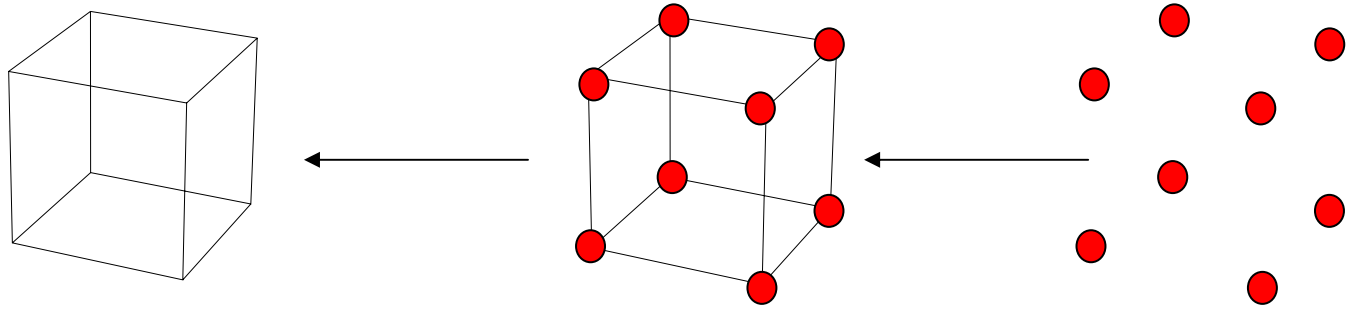


Composed/monolithic solids:

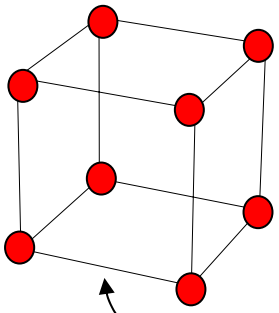
- Key points

Different styles of hierarchy:

- additional information about ROOT's hierarchy is needed

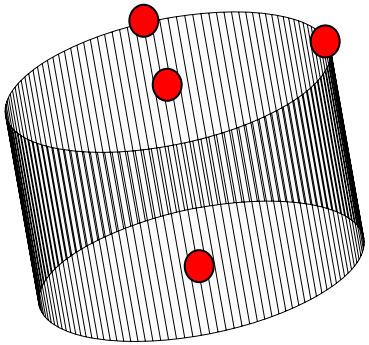


Solution: key points

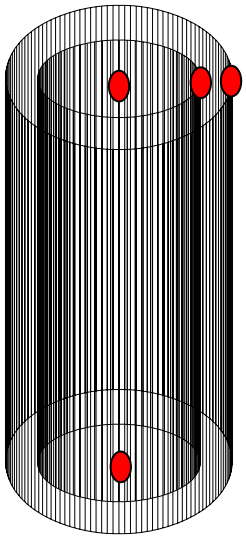


TGeoEltu

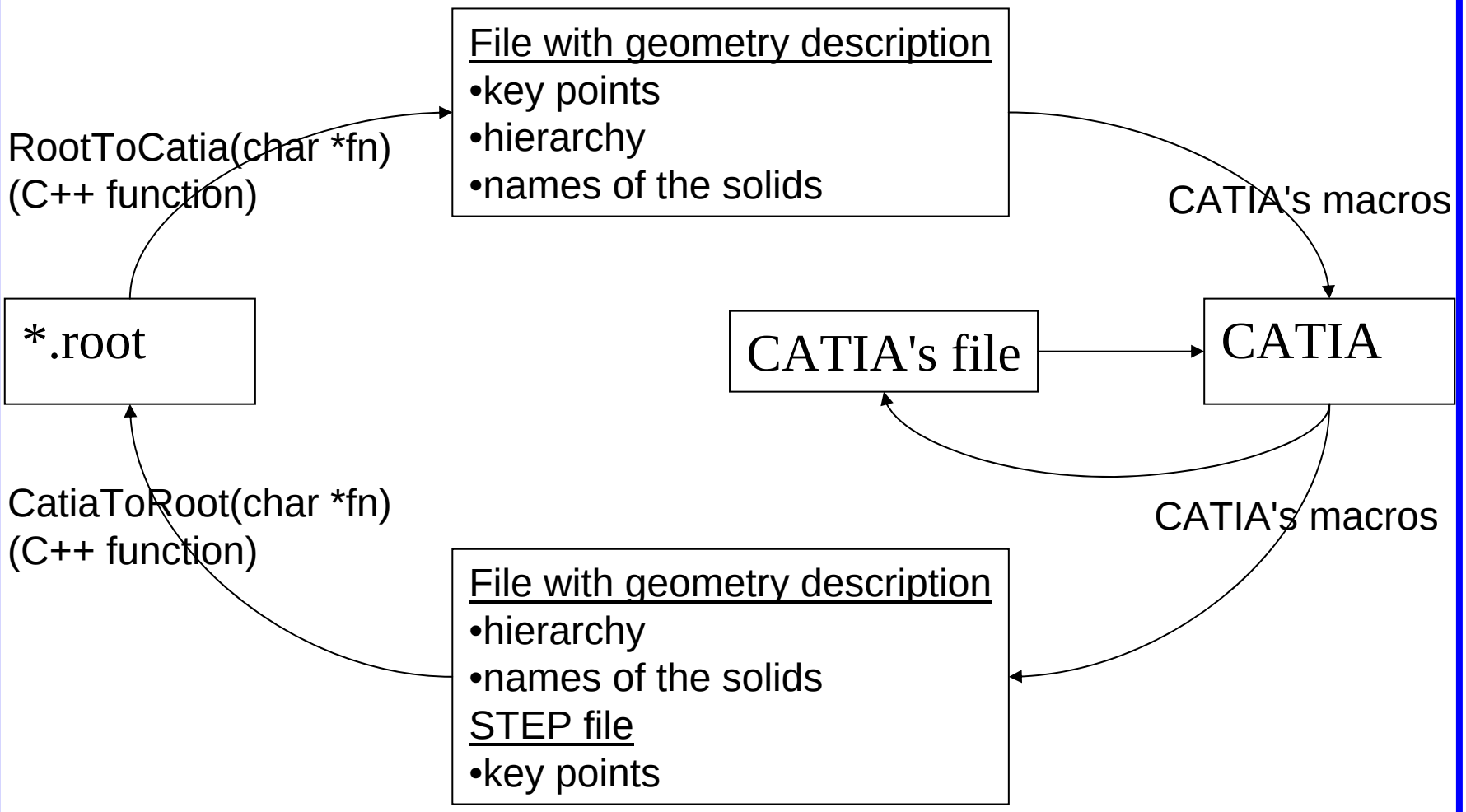
TGeoBox
TGeoPara
TGeoTrd1
TGeoTrd2
TGeoTrap
TGeoGtra
TGeoArb8



TGeoTube



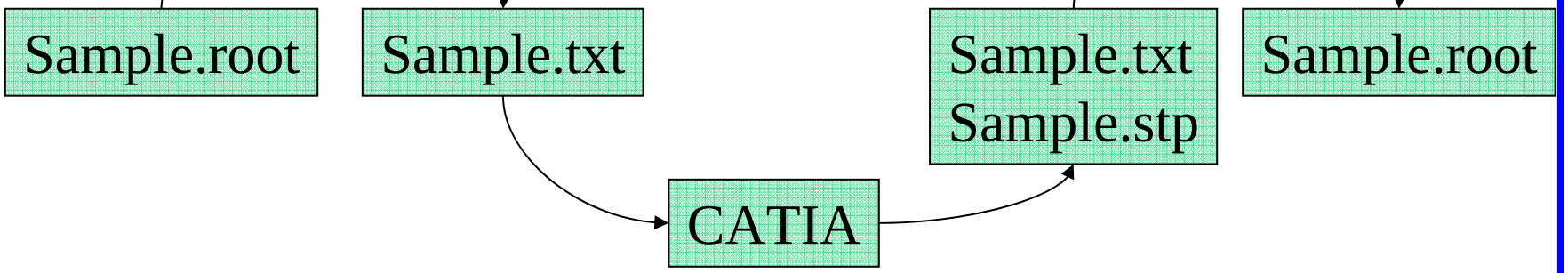
Data transfer



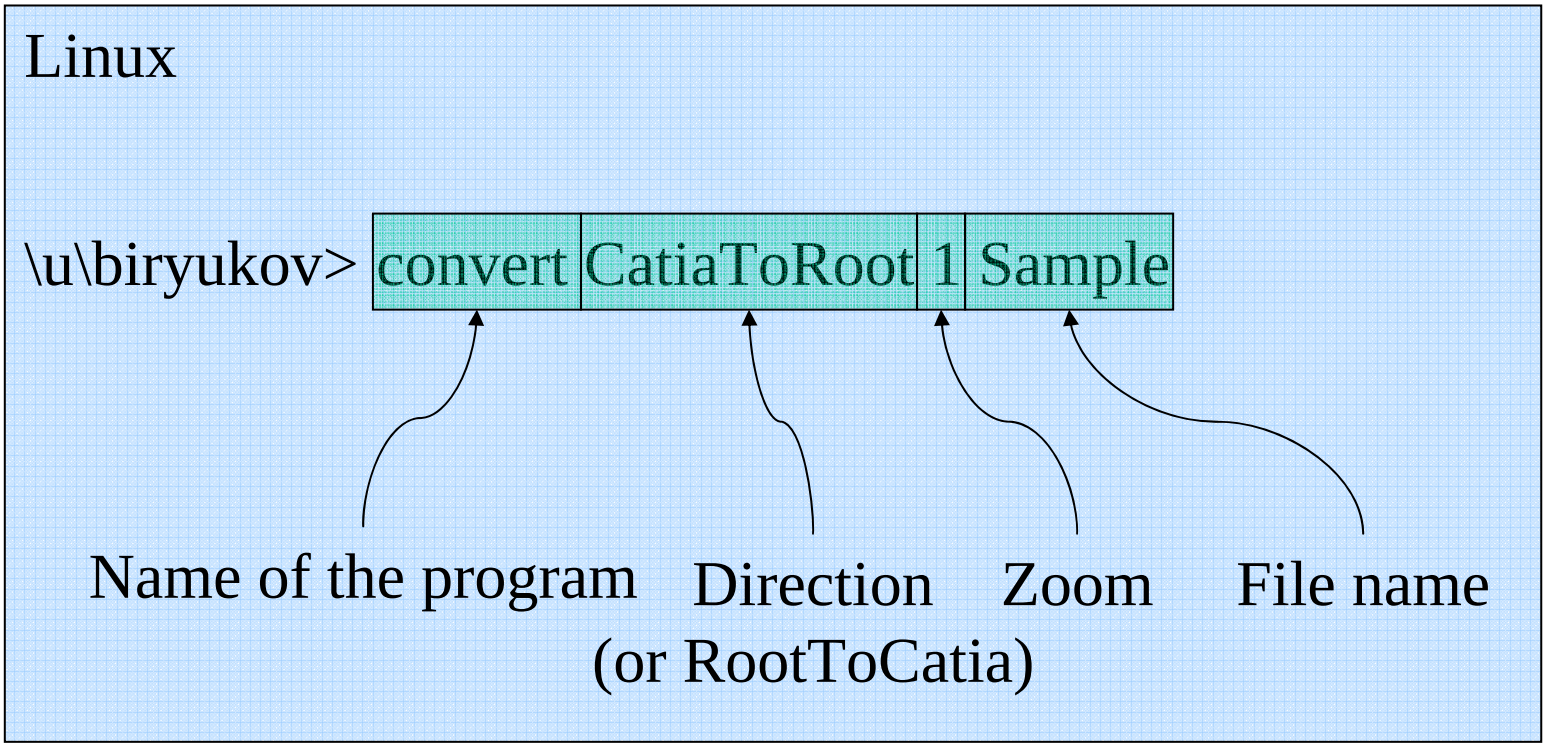
Example: RootToCatia/CatiaToRoot

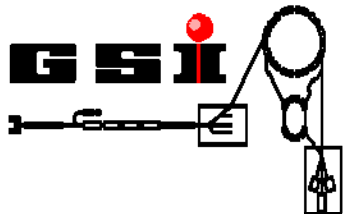
```
void main()
{
        ...
        RootToCatia("Sample");
        ...
}
```

```
void main()
{
        ...
        CatiaToRoot("Sample");
        ...
}
```



Example: RootToCatia/CatiaToRoot

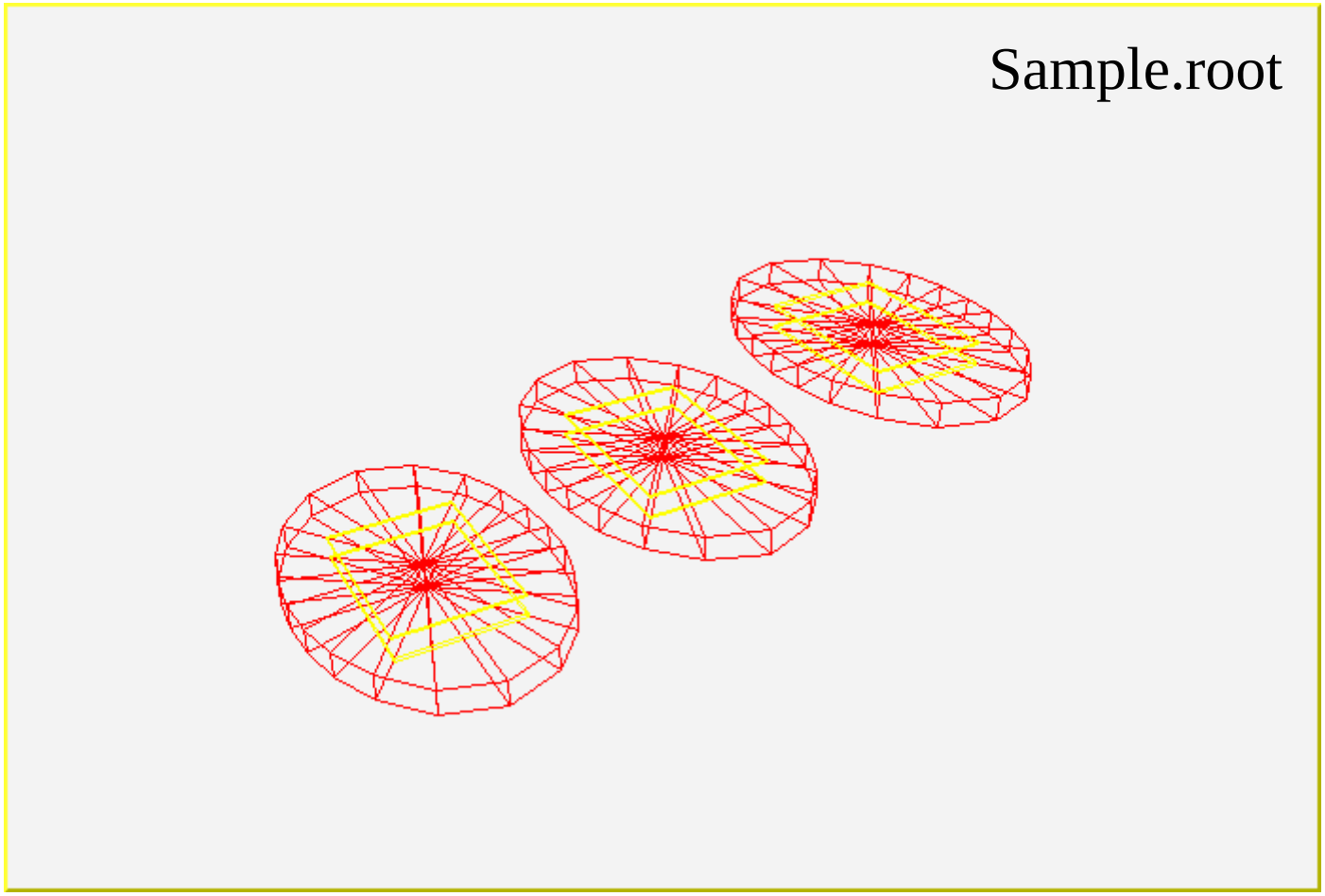




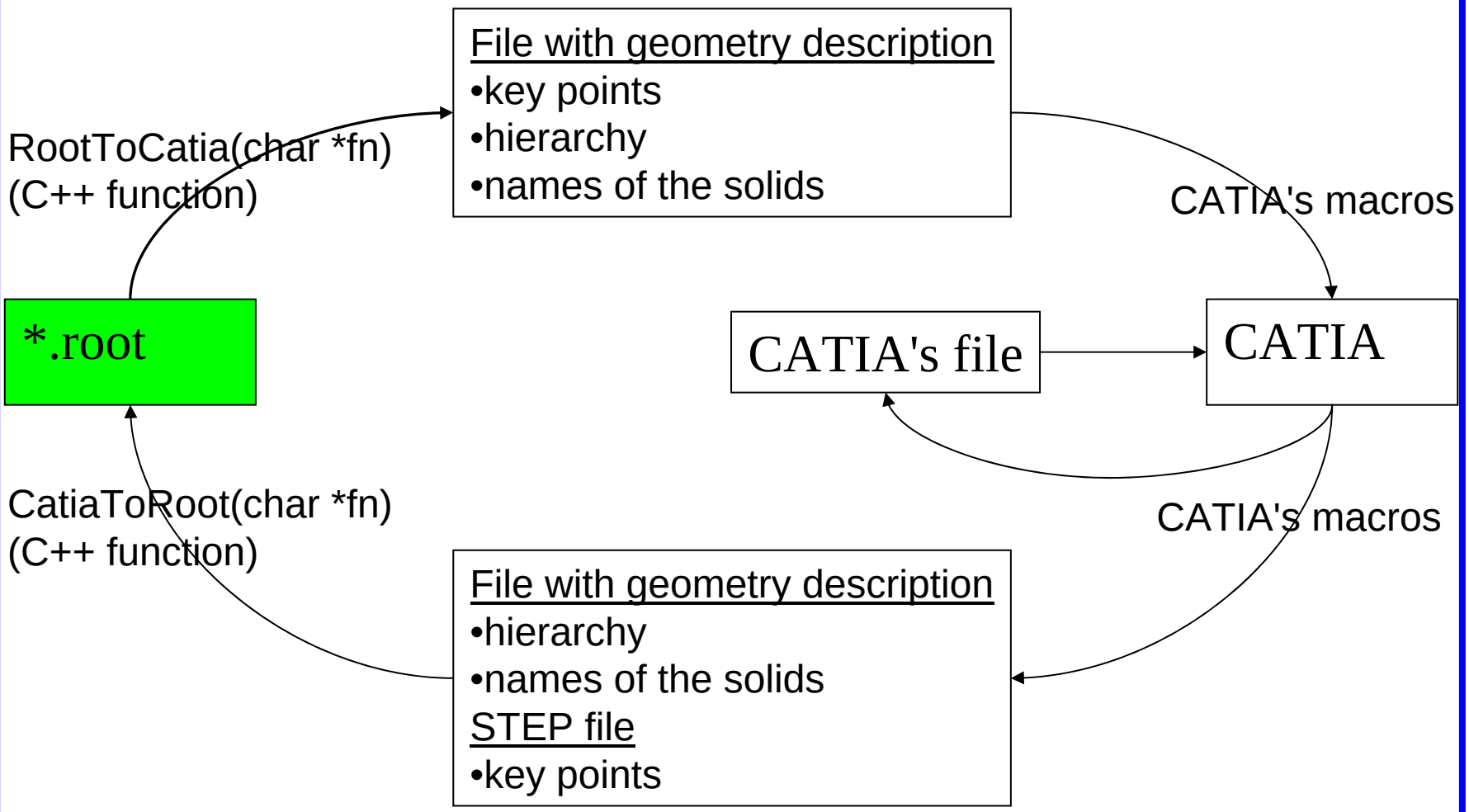
Example: Sample.C

```
void Sample ()
{
        gSystem->Load("libGeom"))
        geom=new TGeoManager("simple1", "Simple geometry");

        TGeoMaterial *matVacuum = new TGeoMaterial("Vacuum", 0,0,0);
        TGeoMedium *Vacuum = new TGeoMedium("Vacuum",1, matVacuum);

        TGeoMedium *medium=Vacuum;

        TGeoVolume *top = geom->MakeBox("TOP", medium, 1000., 150., 100.);
        top->SetLineColor(kWhite);
        geom->SetTopVolume(top);

        TGeoVolume *vA = geom->MakeEltu("vA", medium, 100., 150., 10.);
        vA->SetLineColor(kRed);

        TGeoVolume *vB = geom->MakeBox("vB", medium, 50., 70., 1.);
        vB->SetLineColor(kYellow);

        vA->AddNode(vB,1, new TGeoCombiTrans(0,0,-9,new TGeoRotation("",0,0,0)));
        vA->AddNode(vB,2, new TGeoCombiTrans(0,0,9,new TGeoRotation("",0,0,0)));

        top->AddNode(vA,1, new TGeoCombiTrans(-200,0,-50,new TGeoRotation("",0,0,0)));
        top->AddNode(vA,2, new TGeoCombiTrans(0,0,0,new TGeoRotation("",0,0,0)));
        top->AddNode(vA,3, new TGeoCombiTrans(200,0,50,new TGeoRotation("",0,0,0)));


        geom->CloseGeometry();
        geom->Export("Sample.root");
}
```

Geometry in ROOT

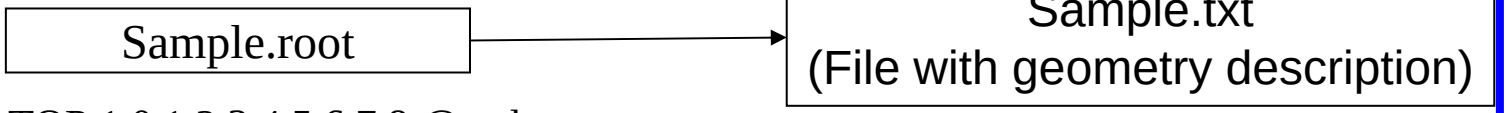


Data transfer



Example: ROOT->CATIA

RootToCatia(char *fn)




```
0 TGeoBBox TOP 1 0 1 2 3 4 5 6 7 8 @end
1 catiaPoint (1)Point -1000.000000 -150.000000 -100.000000 @end
2 catiaPoint (2)Point -1000.000000 150.000000 -100.000000 @end
3 catiaPoint (3)Point 1000.000000 150.000000 -100.000000 @end
4 catiaPoint (4)Point 1000.000000 -150.000000 -100.000000 @end
5 catiaPoint (5)Point -1000.000000 -150.000000 100.000000 @end
6 catiaPoint (6)Point -1000.000000 150.000000 100.000000 @end
7 catiaPoint (7)Point 1000.000000 150.000000 100.000000 @end
8 catiaPoint (8)Point 1000.000000 -150.000000 100.000000 @end
9 TGeoEltu vA 2 0 10 11 12 13 @end
10 catiaPoint (0)BottomCentre -200.000000 0.000000 -60.000000 @end
11 catiaPoint (0)A -100.000000 0.000000 -60.000000 @end
12 catiaPoint (1)B -200.000000 150.000000 -60.000000 @end
13 catiaPoint (2)TopCentre -200.000000 0.000000 -40.000000 @end
```

File format: ROOT->CATIA

for solids:

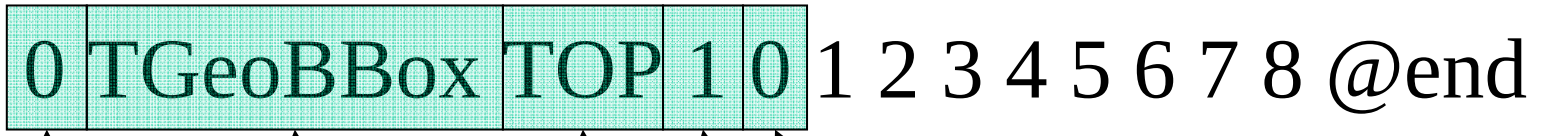
NUMBER - number of a record in the file
TYPE - TGeoTube/TGeoTrd1/...
NAME - name of the logical volume
UID - volume serial number in the list of volumes
NUM_PARENT - number of a parent volume
NUM_POINT1 - number of a record that contain information about point

for the "key points":

NUMBER TYPE NAME X Y Z @end

TYPE - always catiaPoint
NAME - name of the point
X Y Z - coordinates of the point

File format: ROOT->CATIA



NUMBER of a record in the file

TYPE TGeoTube TGeoTrd1 ..

NAME of the logical volume

UID volume's serial number in the list of volumes

NUM_PARENT number of a parent volume

File format: ROOT->CATIA

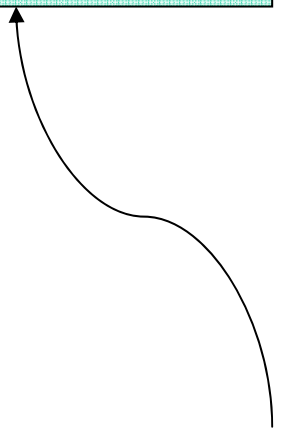
0 TGeoBBox TOP 1 0 1 2 3 4 5 6 7 8 @end

NUM_PARENT
number of a
parent volume

1 TGeoBBox myBox 0 0 1 2 3 4 5 6 7 8 @end

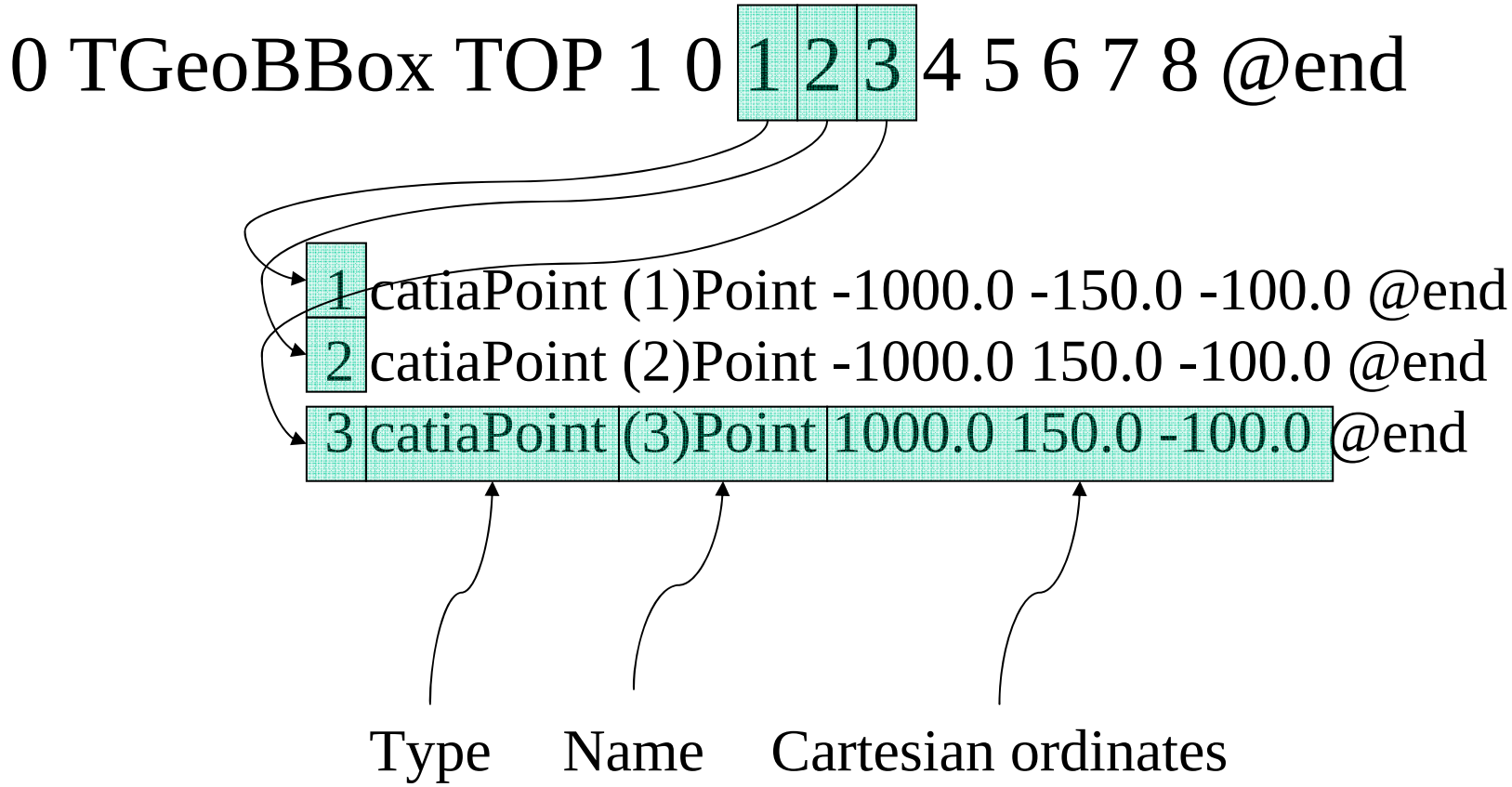
File format: ROOT->CATIA

0 TGeoBBox TOP 1 0 1 2 3 4 5 6 7 8 @end



NUM_POINT1
number of a record that contain information about point

File format: ROOT->CATIA

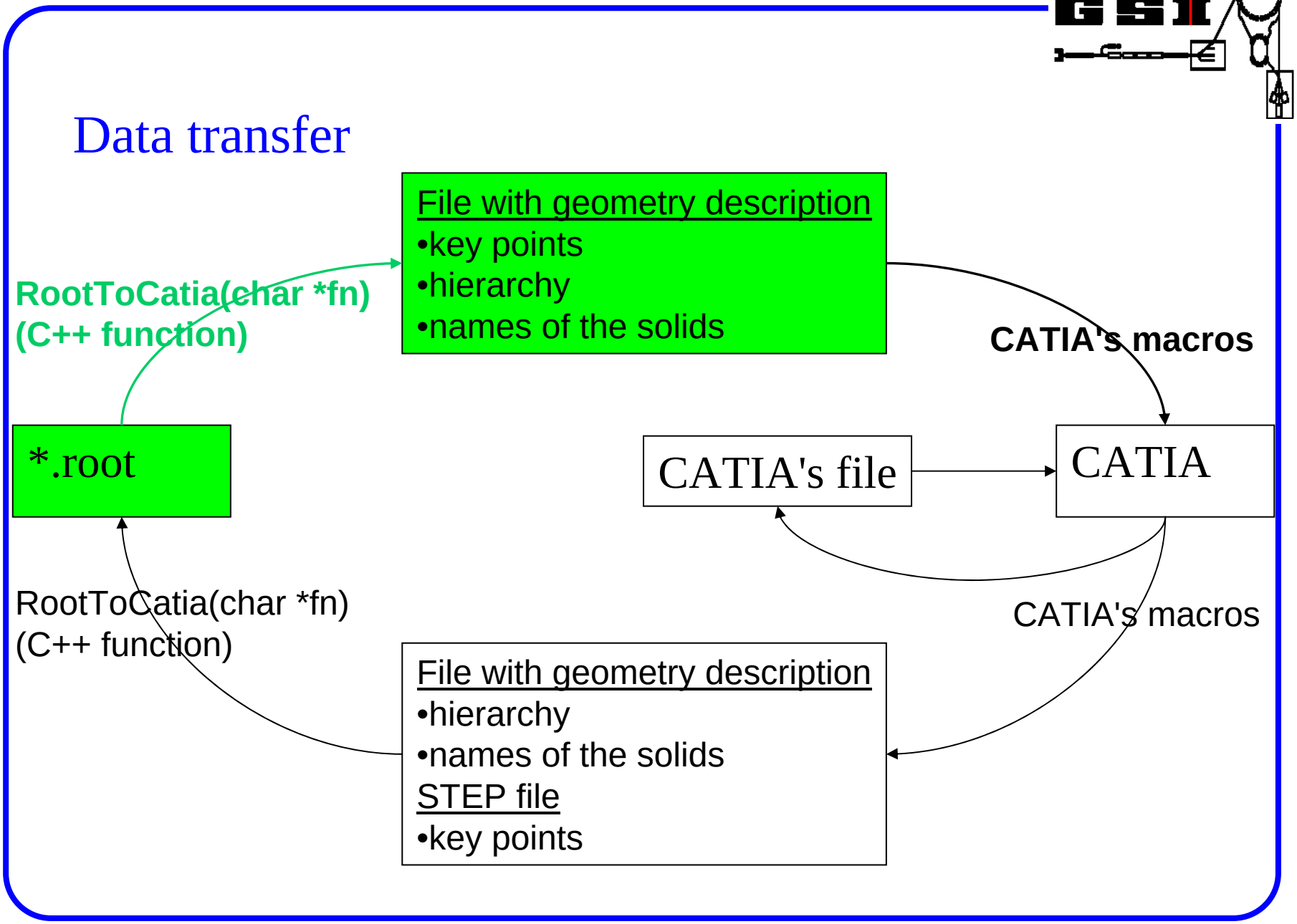


File format: ROOT->CATIA

0 TGeoBBox TOP 1 0 1 2 3 4 5 6 7 8 @end

@end
end of the
record

Data transfer

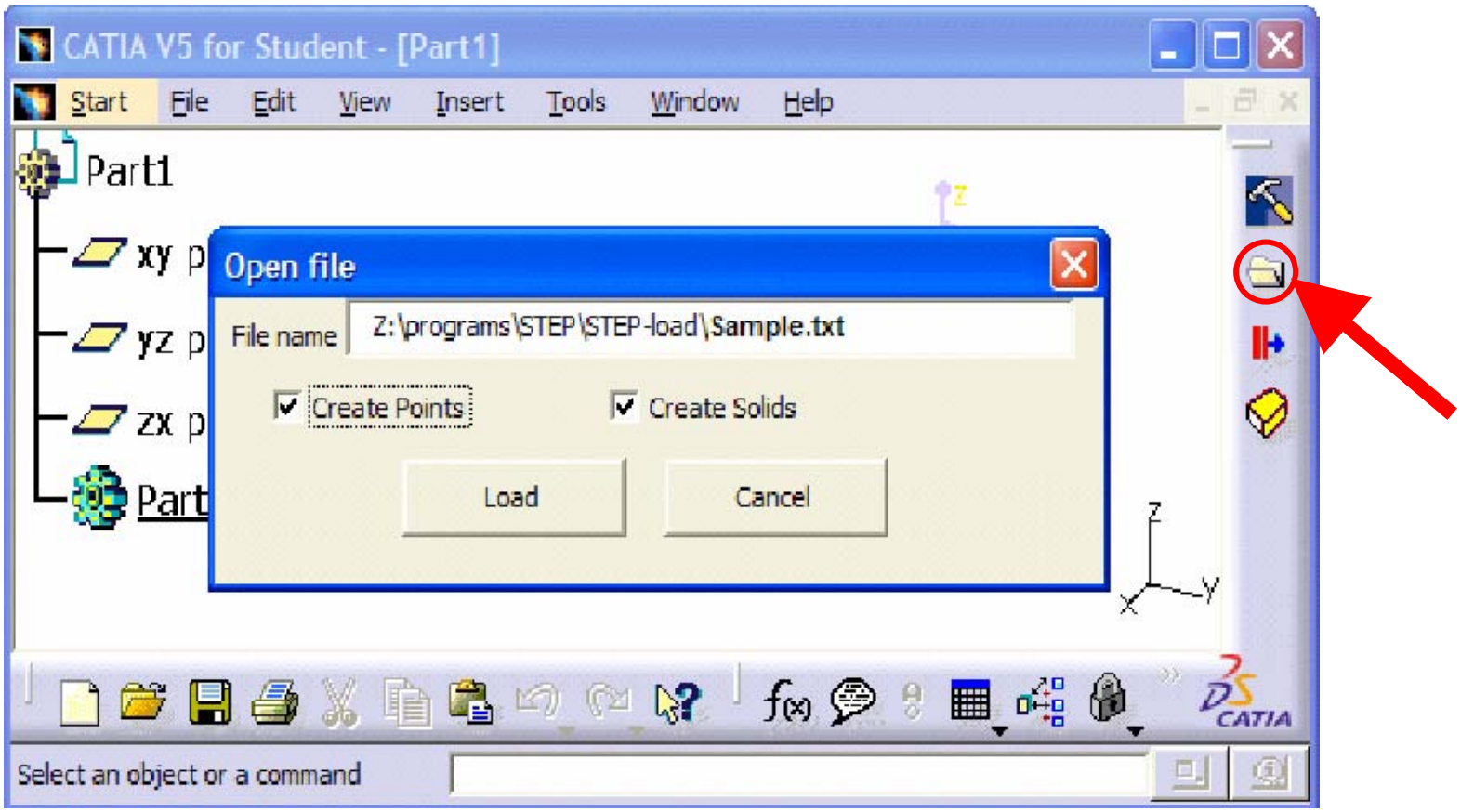


Example

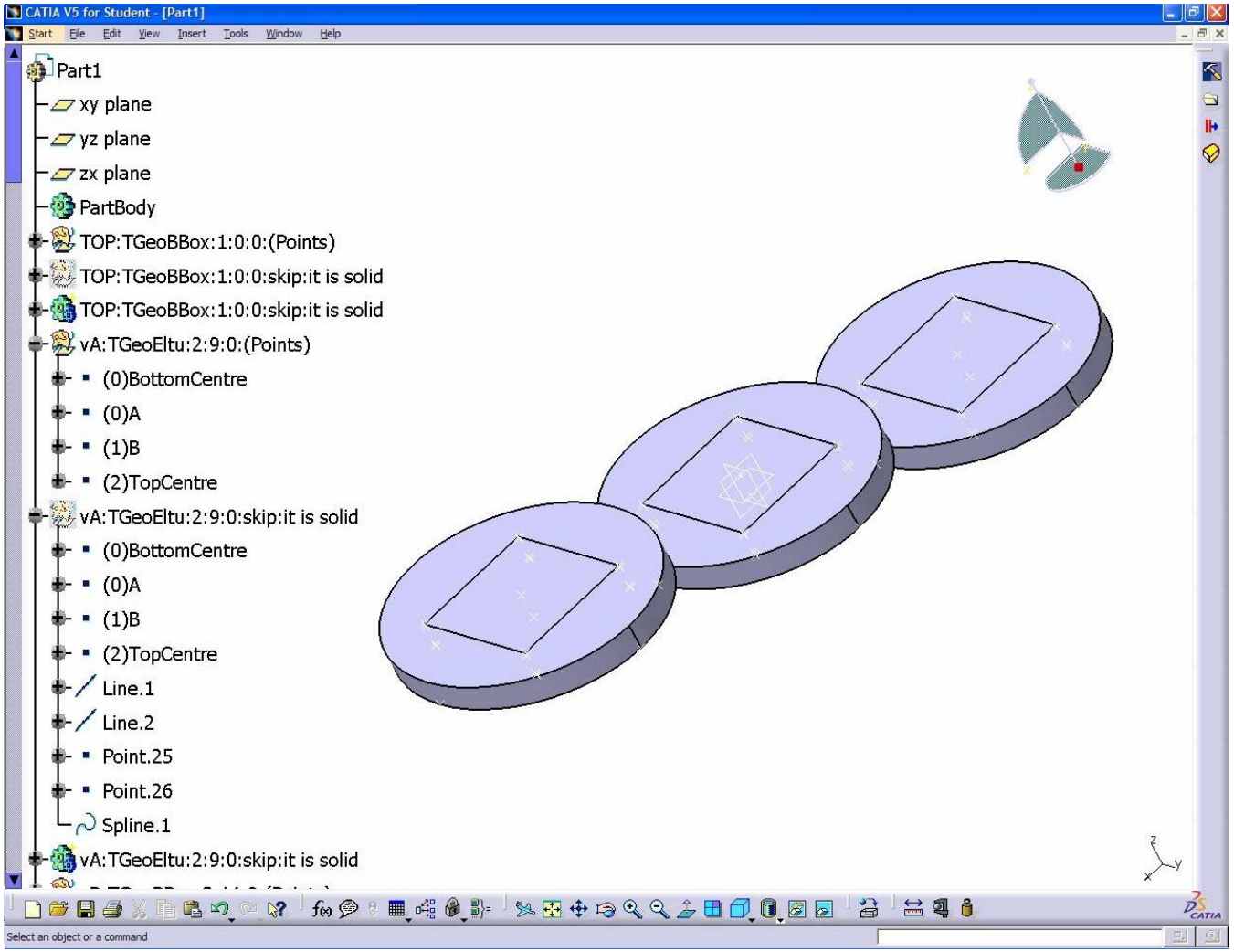
Sample.txt
(File with geometry description)

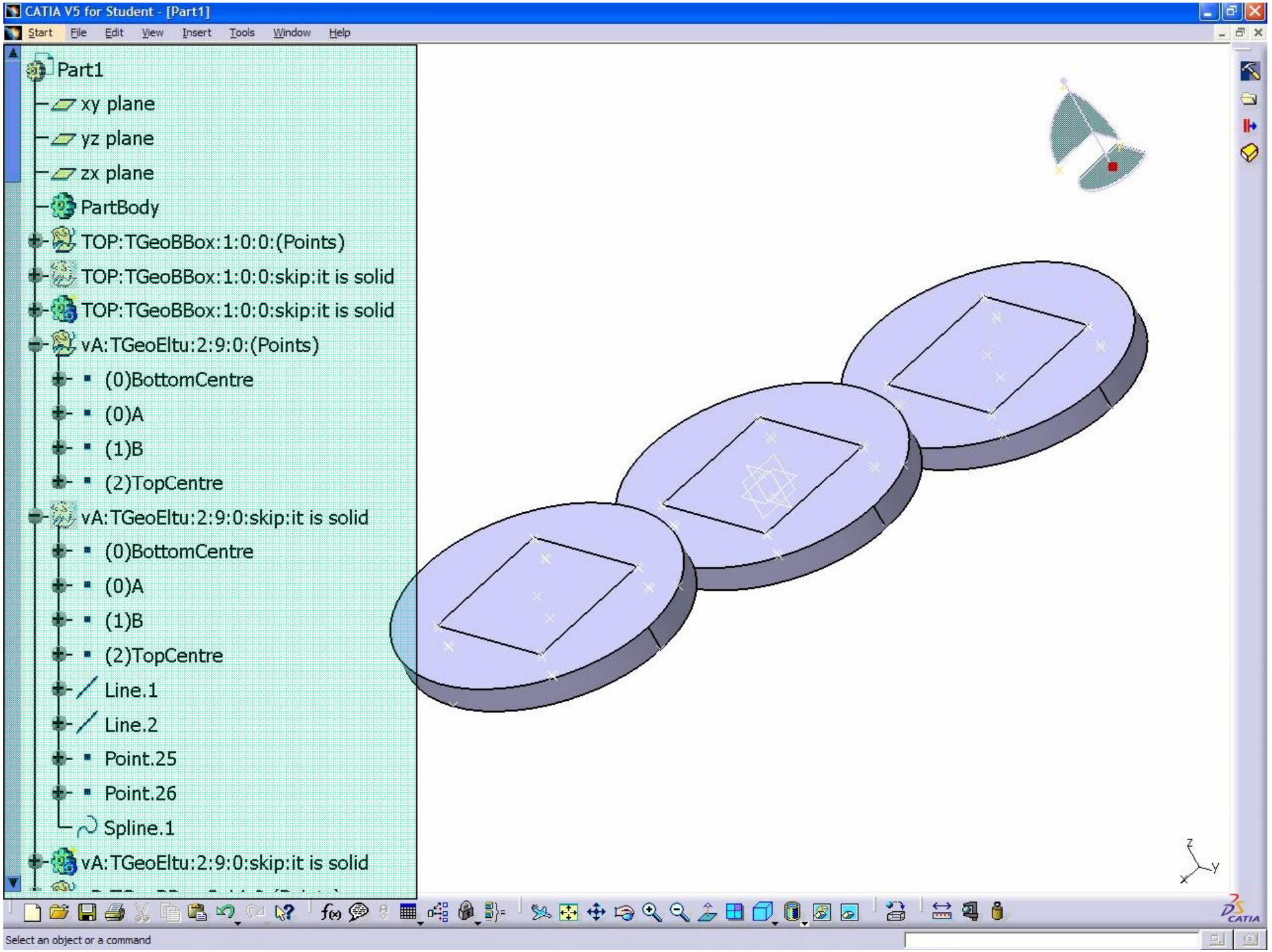
CATIA's macros

CATIA

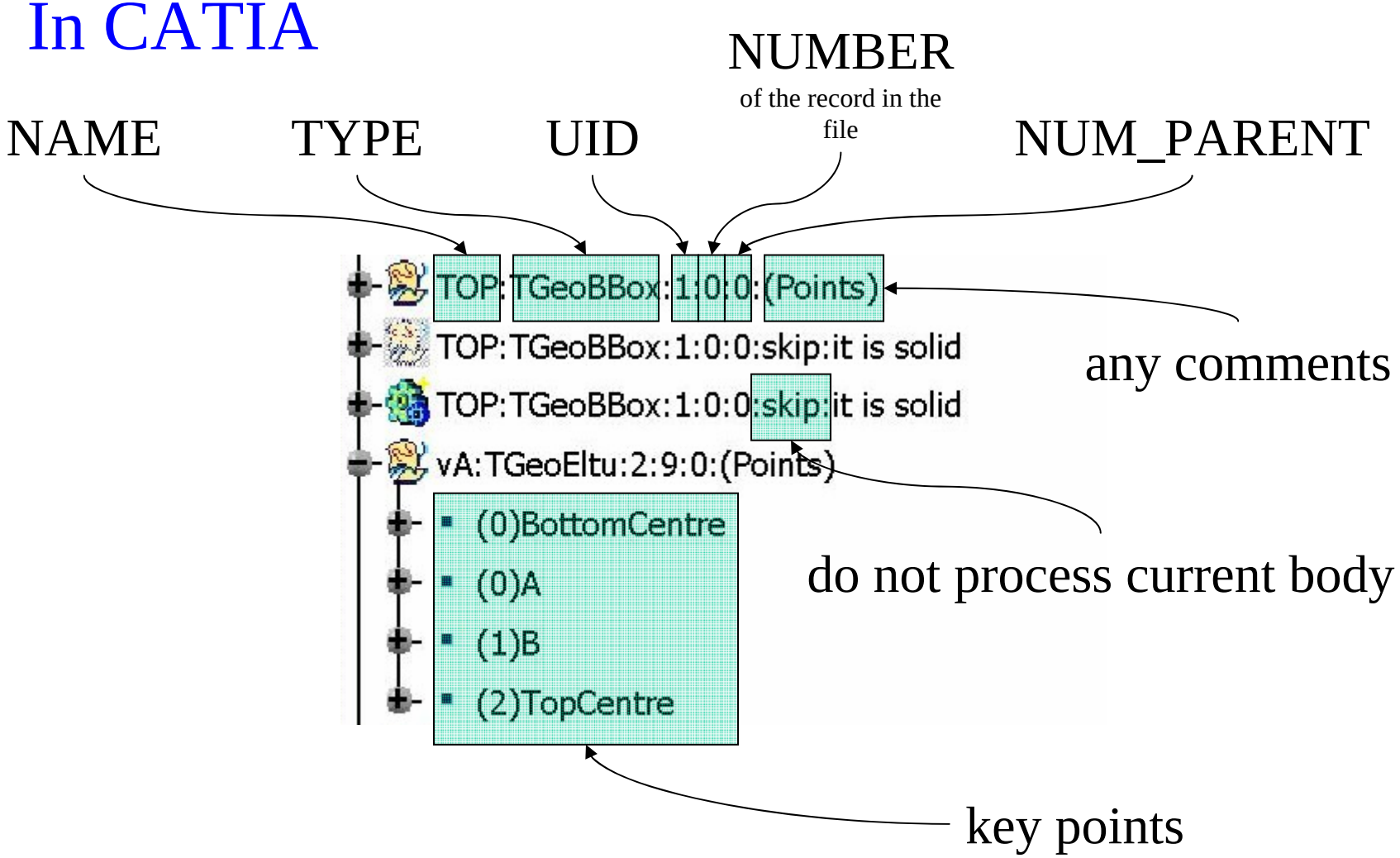


Example: In CATIA

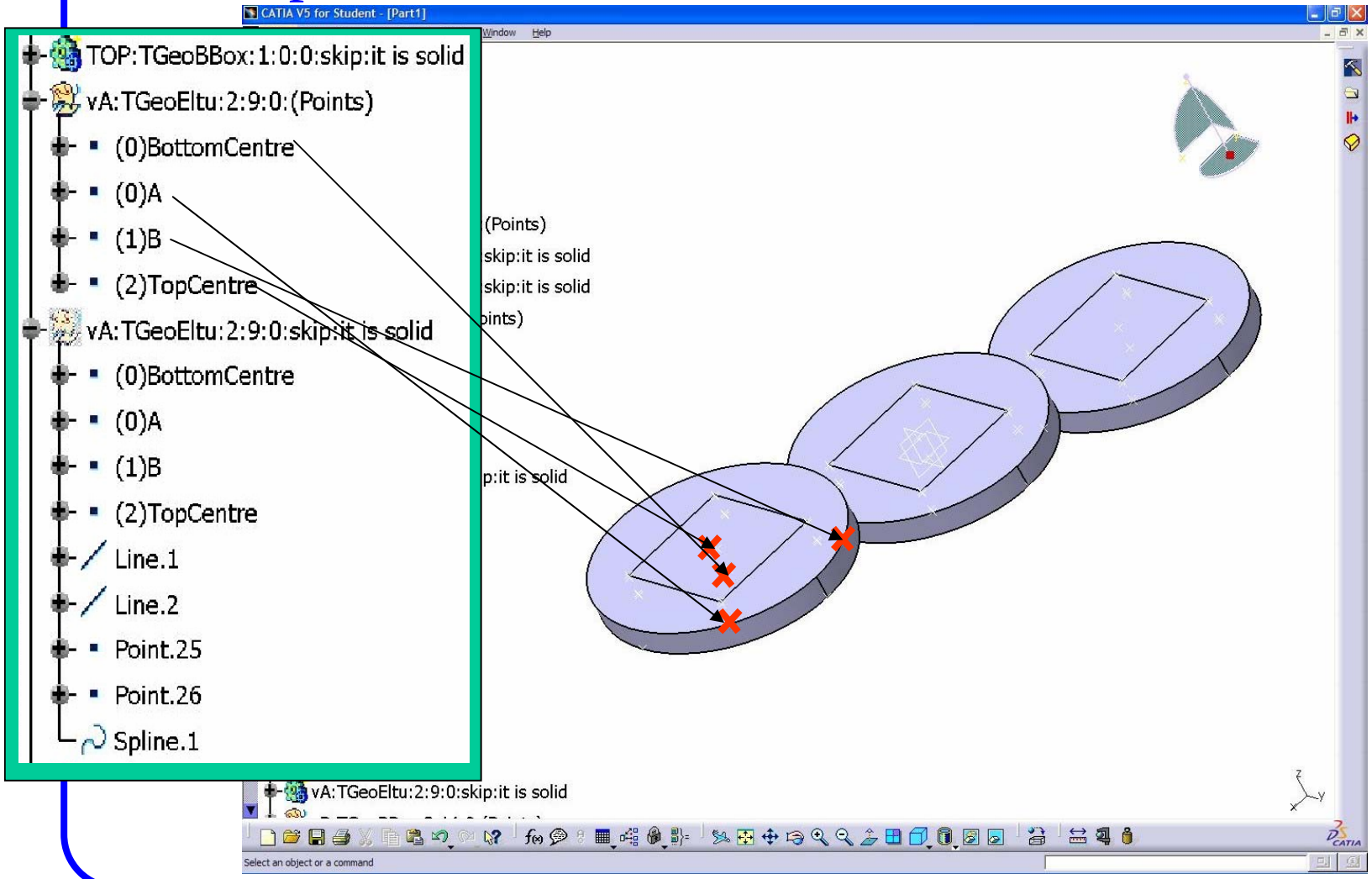



CATIA V5 for Student - [Part1]
Start
File
Edit
View
Insert
Tools
Window
Help
Part1
xy plane
yz plane
zx plane
PartBody
TOP:TGeoBBox:1:0:0:(Points)
TOP:TGeoBBox:1:0:0:skip:it is solid
TOP:TGeoBBox:1:0:0:skip:it is solid
vA:TGeoEltu:2:9:0:(Points)
(0)BottomCentre
(0)A
(1)B
(2)TopCentre
vA:TGeoEltu:2:9:0:skip:it is solid
(0)BottomCentre
(0)A
(1)B
(2)TopCentre
Line.1
Line.2
Point.25
Point.26
Spline.1
vA:TGeoEltu:2:9:0:skip:it is solid
Select an object or a command

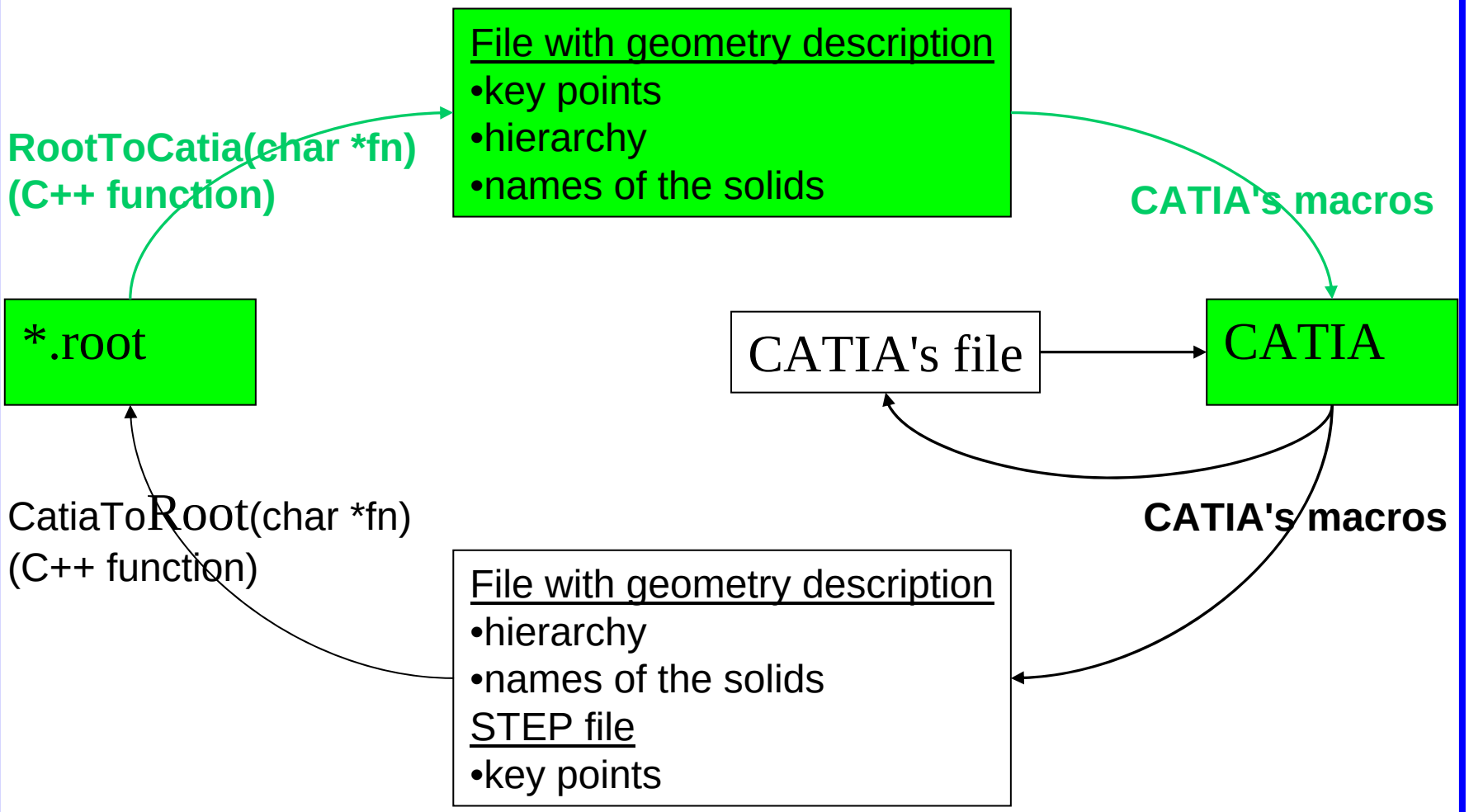
In CATIA


NUMBER
of the record in the file
NAME
TYPE
UID
NUM_PARENT
TOP:TGeoBBox:1:0:0:(Points)
TOP:TGeoBBox:1:0:0:skip:it is solid
TOP:TGeoBBox:1:0:0:skip:it is solid
vA:TGeoEltu:2:9:0:(Points)
(0)BottomCentre
(0)A
(1)B
(2)TopCentre
any comments
do not process current body
key points

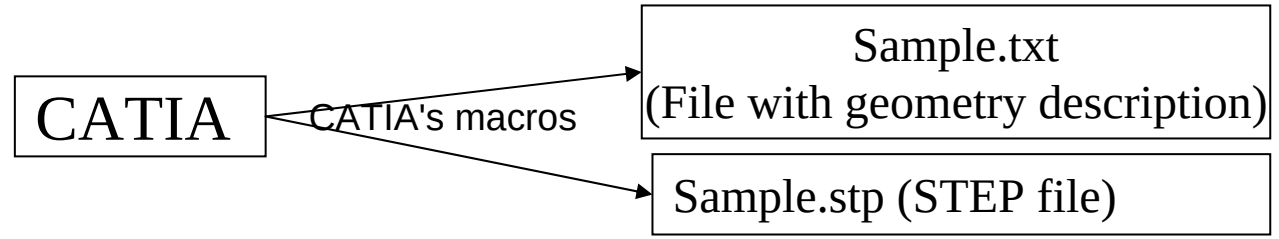
Example: In CATIA

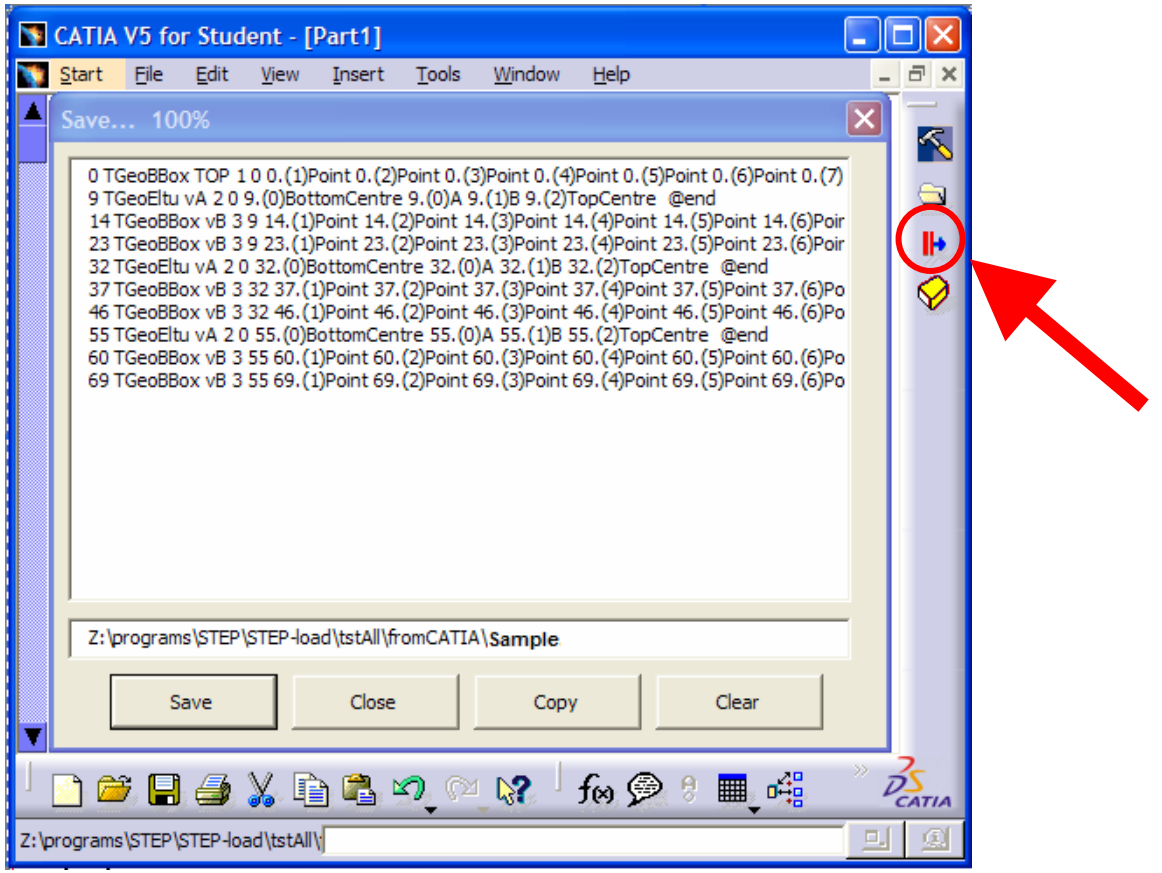


Data transfer



Example:


CATIA
CATIA's macros
Sample.txt
(File with geometry description)
Sample.stp (STEP file)


CATIA V5 for Student - [Part1]
Start File Edit View Insert Tools Window Help
Save... 100%
0 TGeoBBox TOP 1 0 0.(1)Point 0.(2)Point 0.(3)Point 0.(4)Point 0.(5)Point 0.(6)Point 0.(7)
9 TGeoEltu vA 2 0 9.(0)BottomCentre 9.(0)A 9.(1)B 9.(2)TopCentre @end
14 TGeoBBox vB 3 9 14.(1)Point 14.(2)Point 14.(3)Point 14.(4)Point 14.(5)Point 14.(6)Poir
23 TGeoBBox vB 3 9 23.(1)Point 23.(2)Point 23.(3)Point 23.(4)Point 23.(5)Point 23.(6)Poir
32 TGeoEltu vA 2 0 32.(0)BottomCentre 32.(0)A 32.(1)B 32.(2)TopCentre @end
37 TGeoBBox vB 3 32 37.(1)Point 37.(2)Point 37.(3)Point 37.(4)Point 37.(5)Point 37.(6)Po
46 TGeoBBox vB 3 32 46.(1)Point 46.(2)Point 46.(3)Point 46.(4)Point 46.(5)Point 46.(6)Po
55 TGeoEltu vA 2 0 55.(0)BottomCentre 55.(0)A 55.(1)B 55.(2)TopCentre @end
60 TGeoBBox vB 3 55 60.(1)Point 60.(2)Point 60.(3)Point 60.(4)Point 60.(5)Point 60.(6)Po
69 TGeoBBox vB 3 55 69.(1)Point 69.(2)Point 69.(3)Point 69.(4)Point 69.(5)Point 69.(6)Po
Z:\programs\STEP\STEP-load\tstAll\fromCATIA\Sample
Save
Close
Copy
Clear
Z:\programs\STEP\STEP-load\tstAll\

Example: CATIA->ROOT

Text file (geometry description) – Sample.txt

...

14 TGeoBBox vB 3 9 14.(1)Point 14.(2)Point 14.(3)Point 14.(4)Point 14.(5)Point 14.(6)Point 14.(7)Point 14.(8)Point @end

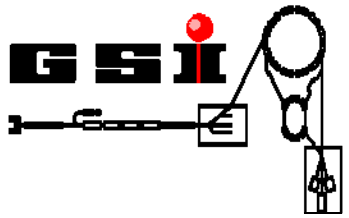
...

STEP file - Sample.stp

...

#142=CARTESIAN_POINT('14.(3)Point',(-150.,70.,-60.)) ;
#143=CARTESIAN_POINT('14.(4)Point',(-150.,-70.,-60.)) ;
#144=CARTESIAN_POINT('14.(5)Point',(-250.,-70.,-58.)) ;
#145=CARTESIAN_POINT('14.(6)Point',(-250.,70.,-58.)) ;
#146=CARTESIAN_POINT('14.(7)Point',(-150.,70.,-58.)) ;
#147=CARTESIAN_POINT('14.(8)Point',(-150.,-70.,-58.)) ;
#148=CARTESIAN_POINT('23.(1)Point',(-250.,-70.,-42.)) ;
#149=CARTESIAN_POINT('23.(2)Point',(-250.,70.,-42.)) ;

...



Example: Geometry Description (hidden)
Sample.stp

0 TGeoBBox TOP 1 0 0.(1)Point 0.(2)Point 0.(3)Point 0.(4)Point 0.(5)Point 0.(6)Point 0.(7)Point 0.(8)Point @end

9 TGeoEltu vA 2 0 9.(0)BottomCentre 9.(0)A 9.(1)B 9.(2)TopCentre @end

14 TGeoBBox vB 3 9 14.(1)Point 14.(2)Point 14.(3)Point 14.(4)Point 14.(5)Point 14.(6)Point 14.(7)Point 14.(8)Point @end

23 TGeoBBox vB 3 9 23.(1)Point 23.(2)Point 23.(3)Point 23.(4)Point 23.(5)Point 23.(6)Point 23.(7)Point 23.(8)Point @end

32 TGeoEltu vA 2 0 32.(0)BottomCentre 32.(0)A 32.(1)B 32.(2)TopCentre @end

37 TGeoBBox vB 3 32 37.(1)Point 37.(2)Point 37.(3)Point 37.(4)Point 37.(5)Point 37.(6)Point 37.(7)Point 37.(8)Point @end

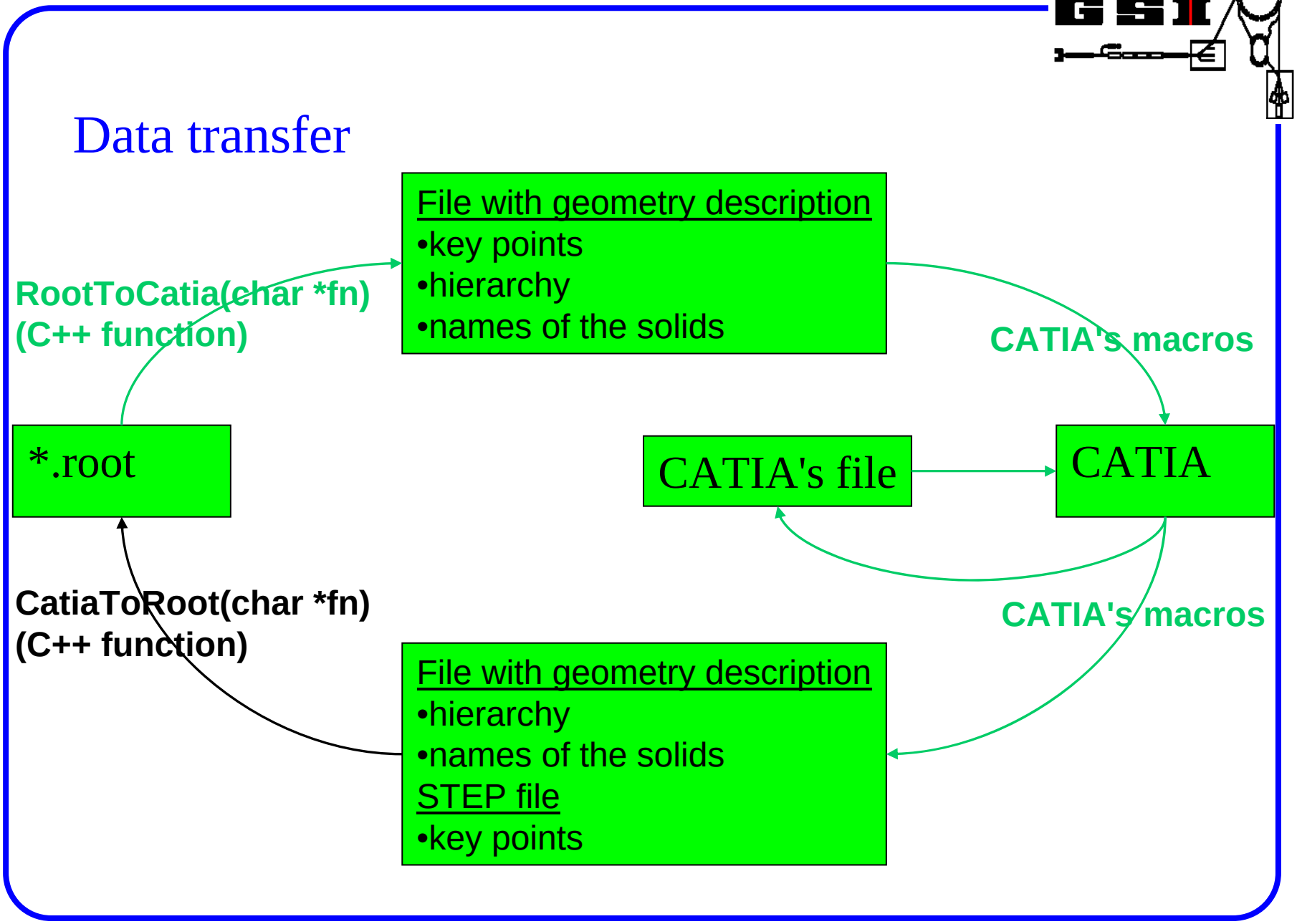
46 TGeoBBox vB 3 32 46.(1)Point 46.(2)Point 46.(3)Point 46.(4)Point 46.(5)Point 46.(6)Point 46.(7)Point 46.(8)Point @end

55 TGeoEltu vA 2 0 55.(0)BottomCentre 55.(0)A 55.(1)B 55.(2)TopCentre @end

60 TGeoBBox vB 3 55 60.(1)Point 60.(2)Point 60.(3)Point 60.(4)Point 60.(5)Point 60.(6)Point 60.(7)Point 60.(8)Point @end

69 TGeoBBox vB 3 55 69.(1)Point 69.(2)Point 69.(3)Point 69.(4)Point 69.(5)Point 69.(6)Point 69.(7)Point 69.(8)Point @end

Data transfer



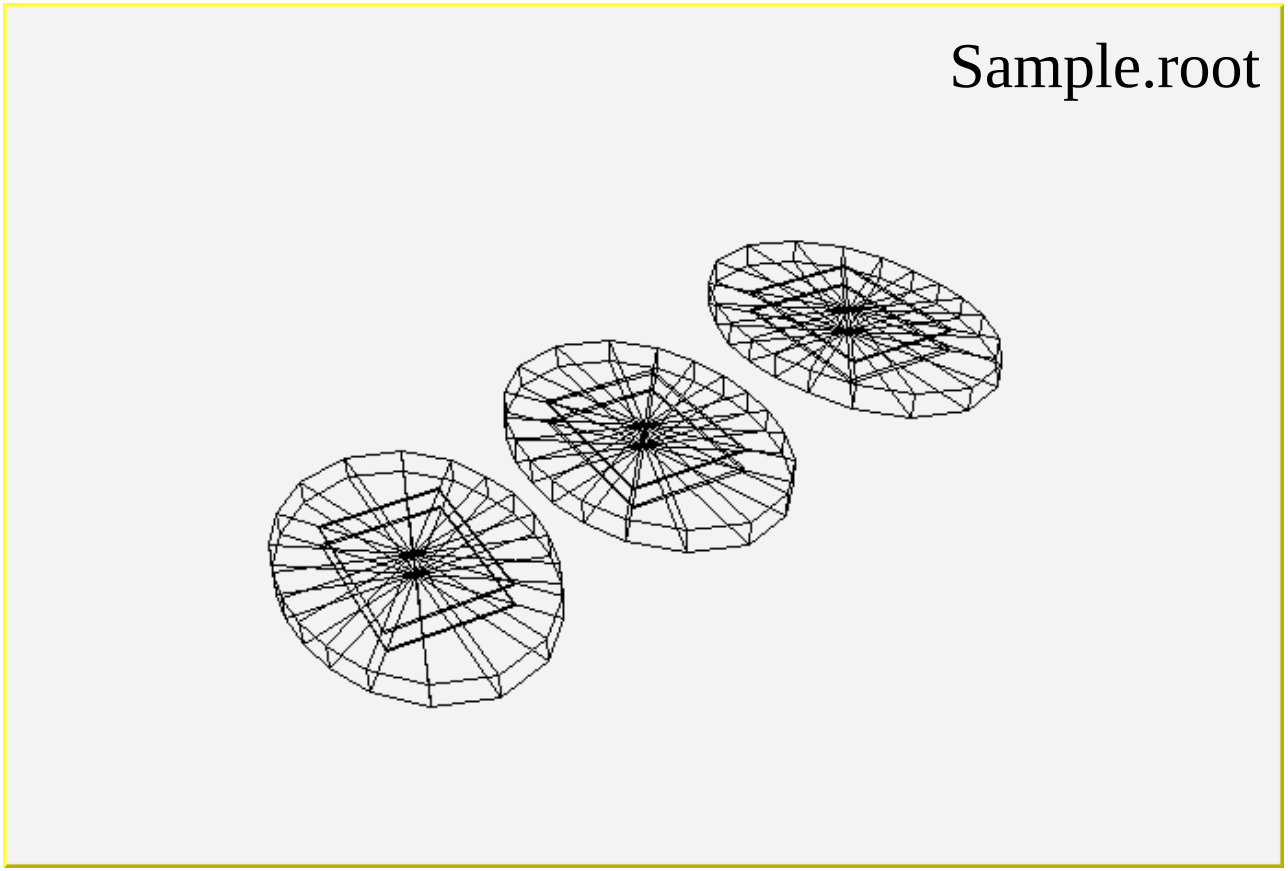
Example:

Sample.txt
(File with geometry description)

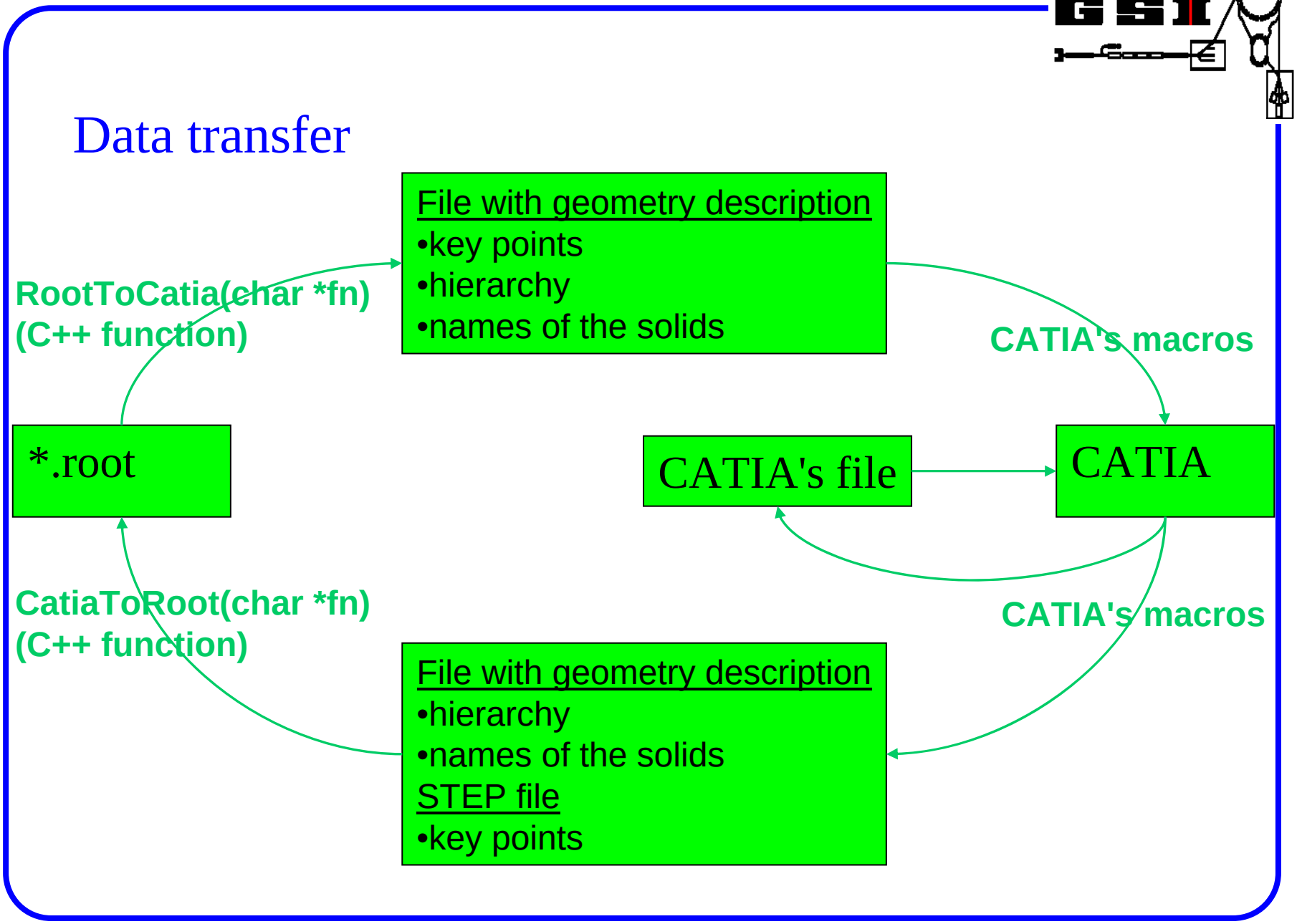
Sample.stp (STEP file)

CatiaToRoot(char *fn)

Sample.root

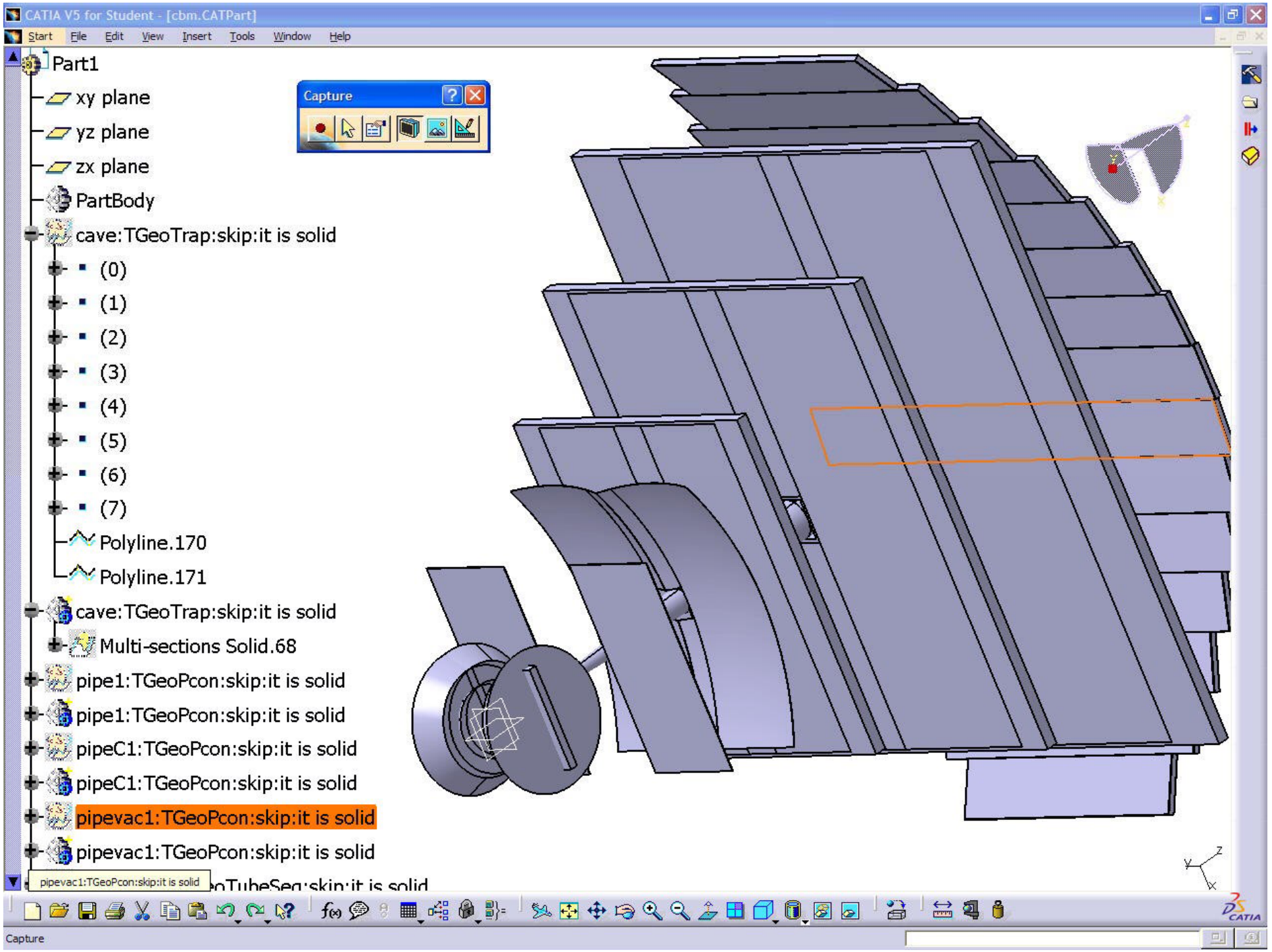


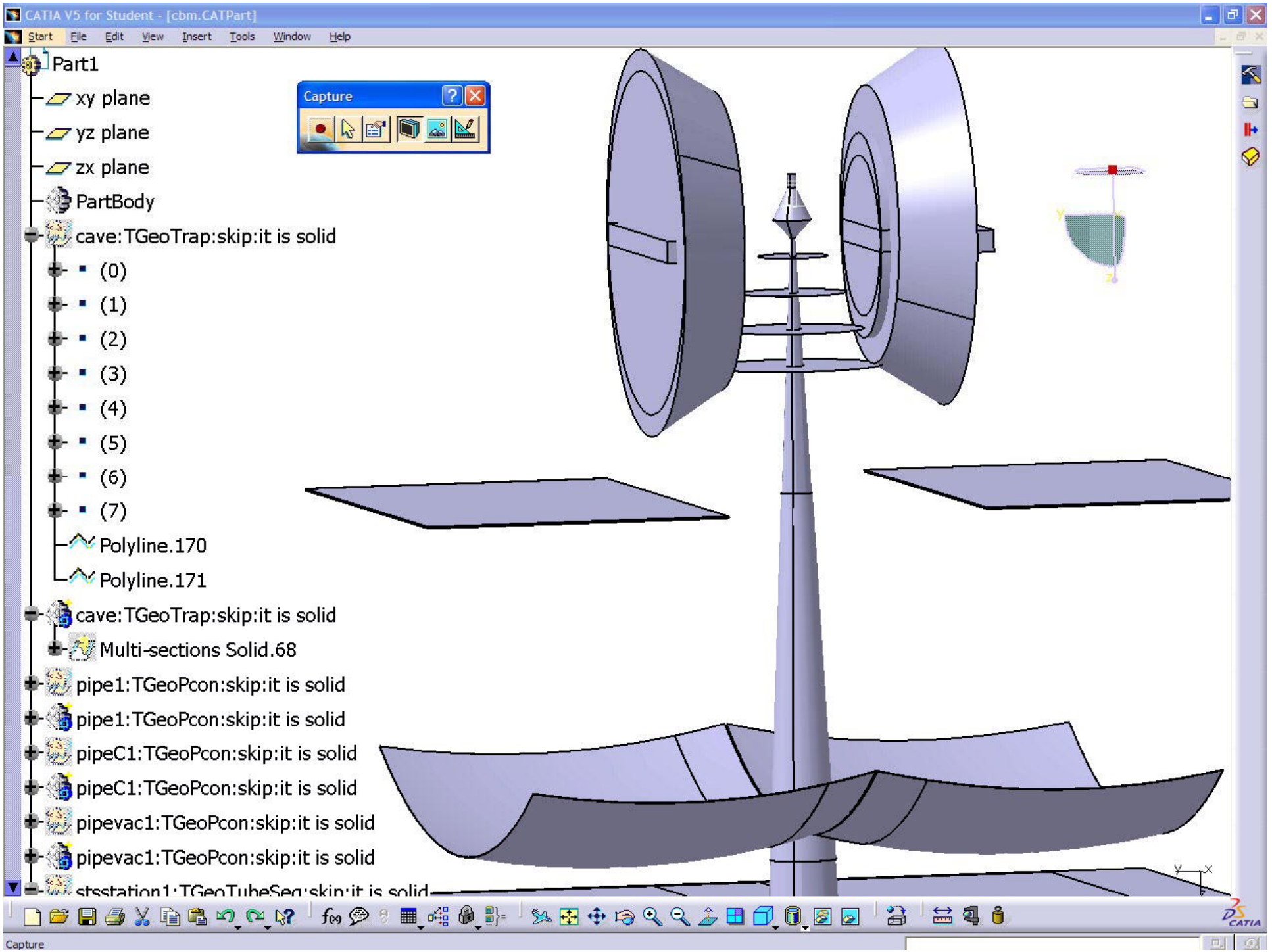
Data transfer

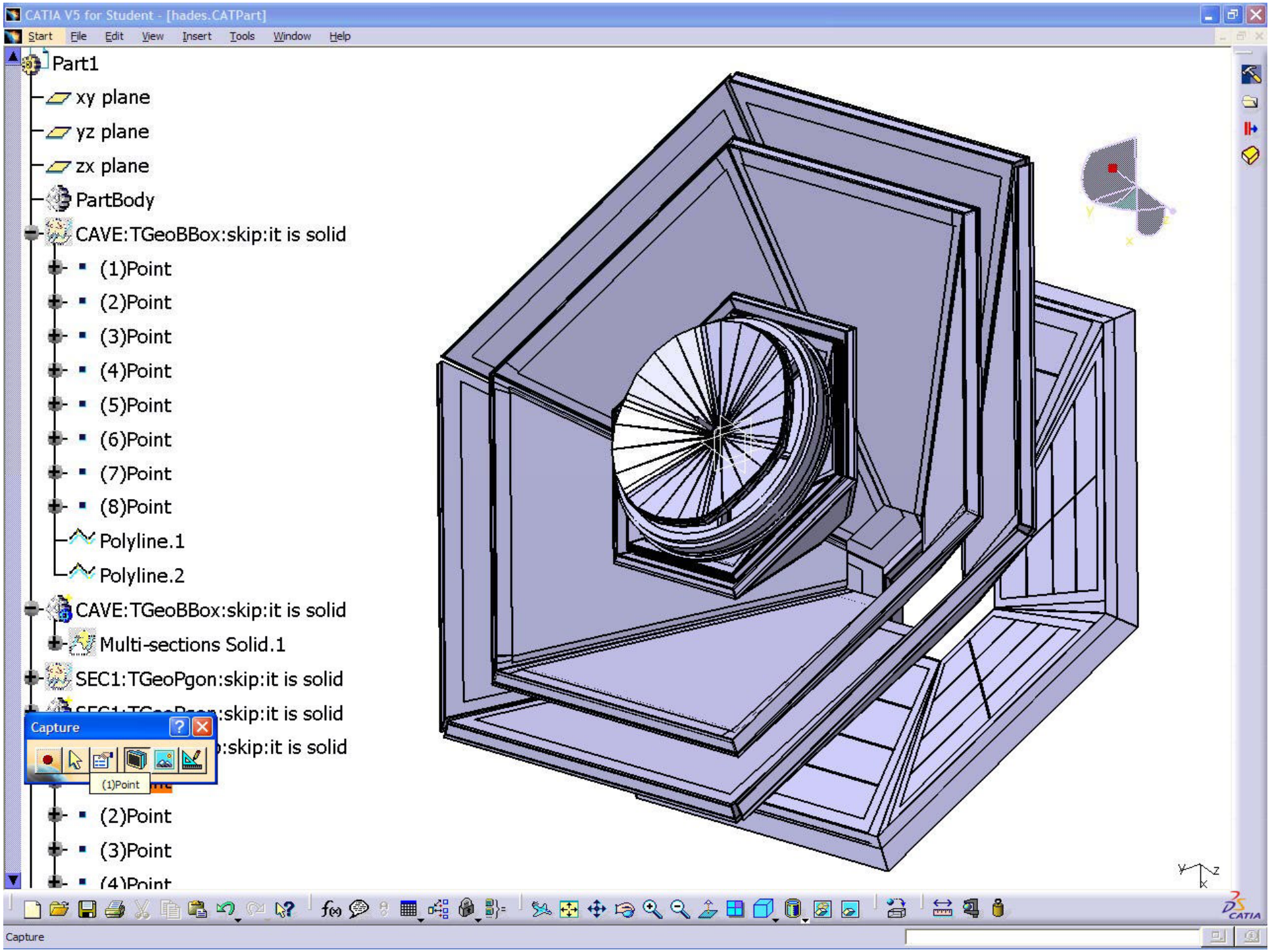


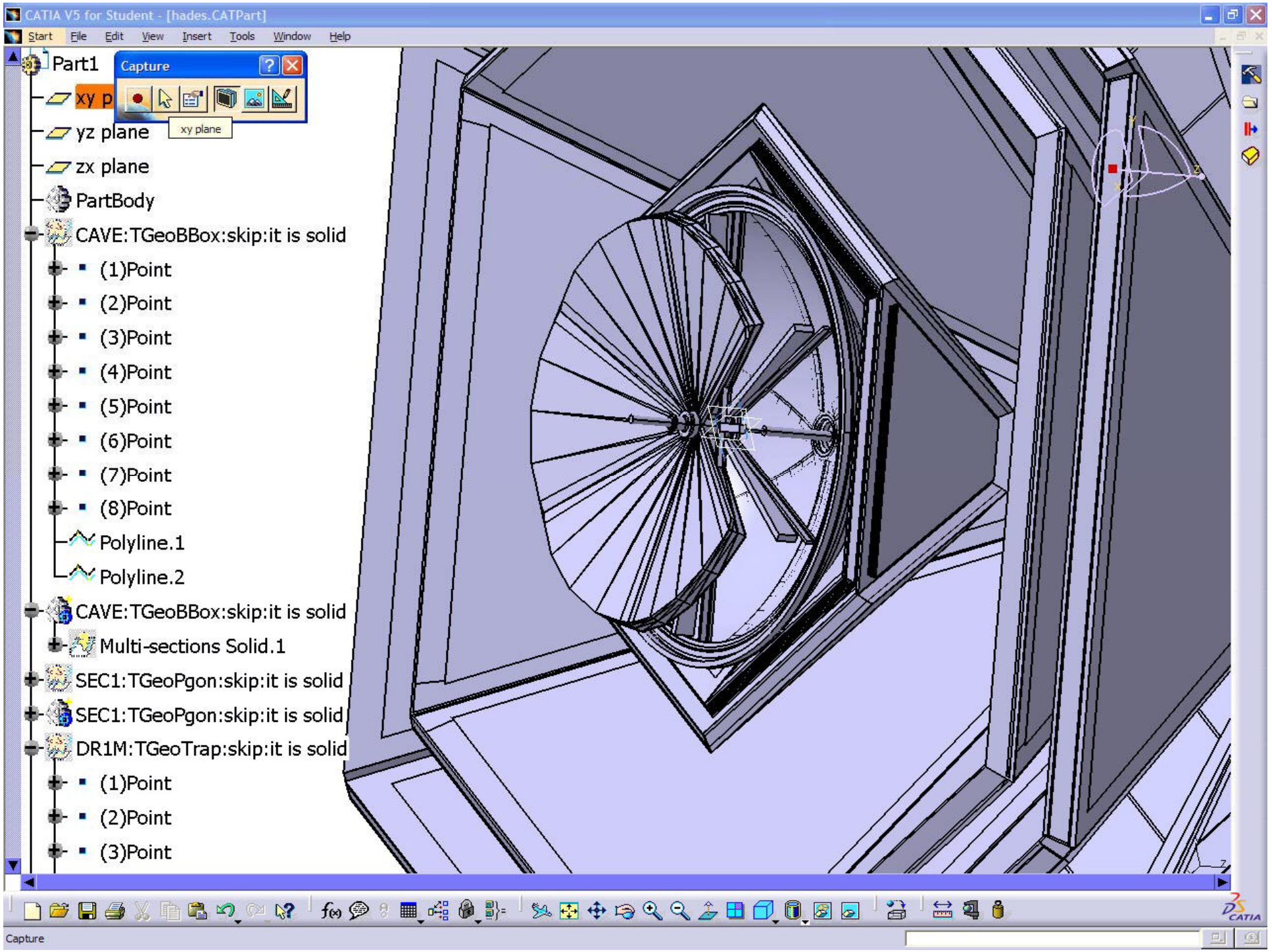
Progress

	.root->.txt	*.txt->CATIA	CATIA-> *.txt/*.stp	*.txt/*.stp->*.root)
TGeoBox				
TGeoPara				
TGeoTrd1				
TGeoTrd2				
TGeoTrap				
TGeoGtra				
TGeoArb8				
TGeoTube				
TGeoTubeSeg				
TGeoEltu				
TGeoCtub				
TGeoCone				
TGeoConeSeg				
TGeoTorus				
TGeoSphere				
TGeoPgon				
TGeoPcon				


CATIA V5 for Student - [cbm.CATPart]
Start
File
Edit
View
Insert
Tools
Window
Help
Capture
Part1
xy plane
yz plane
zx plane
PartBody
cave:TGeoTrap:skip:it is solid
(0)
(1)
(2)
(3)
(4)
(5)
(6)
(7)
Polyline.170
Polyline.171
cave:TGeoTrap:skip:it is solid
Multi-sections Solid.68
pipe1:TGeoPcon:skip:it is solid
pipe1:TGeoPcon:skip:it is solid
pipeC1:TGeoPcon:skip:it is solid
pipeC1:TGeoPcon:skip:it is solid
pipevac1:TGeoPcon:skip:it is solid
pipevac1:TGeoPcon:skip:it is solid
pipevac1:TGeoPcon:skip:it is solid
Capture


CATIA V5 for Student - [cbm.CATPart]
Start
File
Edit
View
Insert
Tools
Window
Help
Capture
Part1
xy plane
yz plane
zx plane
PartBody
cave:TGeoTrap:skip:it is solid
(0)
(1)
(2)
(3)
(4)
(5)
(6)
(7)
Polyline.170
Polyline.171
cave:TGeoTrap:skip:it is solid
Multi-sections Solid.68
pipe1:TGeoPcon:skip:it is solid
pipe1:TGeoPcon:skip:it is solid
pipeC1:TGeoPcon:skip:it is solid
pipeC1:TGeoPcon:skip:it is solid
pipevac1:TGeoPcon:skip:it is solid
pipevac1:TGeoPcon:skip:it is solid
Capture


CATIA V5 for Student - [hades.CATPart]
Start File Edit View Insert Tools Window Help
Part1
xy plane
yz plane
zx plane
PartBody
CAVE:TGeoBBox:skip:it is solid
(1)Point
(2)Point
(3)Point
(4)Point
(5)Point
(6)Point
(7)Point
(8)Point
Polyline.1
Polyline.2
CAVE:TGeoBBox:skip:it is solid
Multi-sections Solid.1
SEC1:TGeoPgon:skip:it is solid
Capture
(1)Point
(2)Point
(3)Point
(4)Point
Capture


CATIA V5 for Student - [hades.CATPart]
Start
File
Edit
View
Insert
Tools
Window
Help
Part1
Capture
xy plane
yz plane
zx plane
PartBody
CAVE:TGeoBBox:skip:it is solid
(1)Point
(2)Point
(3)Point
(4)Point
(5)Point
(6)Point
(7)Point
(8)Point
Polyline.1
Polyline.2
CAVE:TGeoBBox:skip:it is solid
Multi-sections Solid.1
SEC1:TGeoPgon:skip:it is solid
SEC1:TGeoPgon:skip:it is solid
DR1M:TGeoTrap:skip:it is solid
(1)Point
(2)Point
(3)Point
Capture

Future plans

- Finish all the solids
- Check everything

- Improve hierarchy support
- Improve geometry marking technique

- Feedback from users

The End