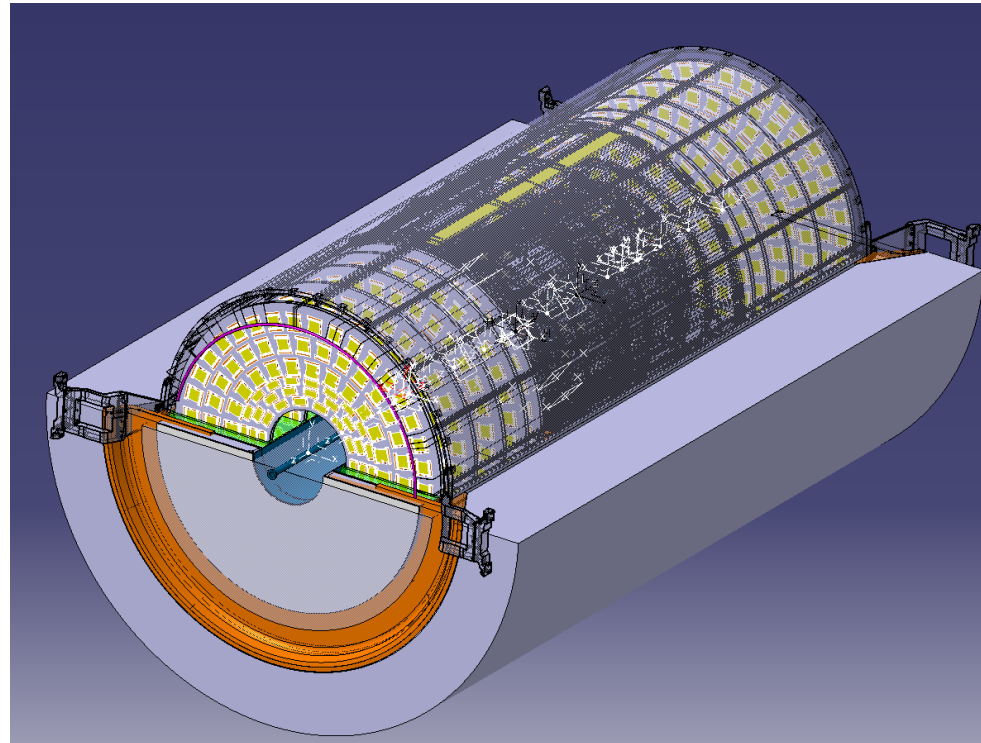


# CERN CATIA USERS FORUM

22 Sep 2016

## Integration Model Management - Interchangeability between detailed and simplified models

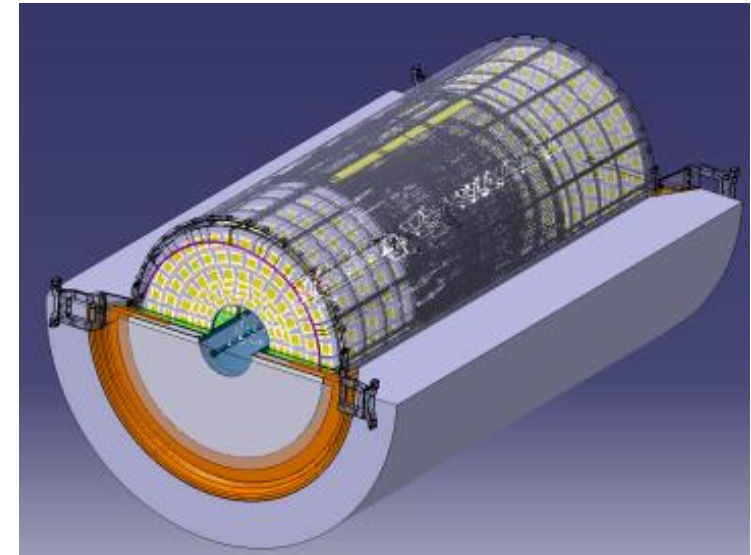
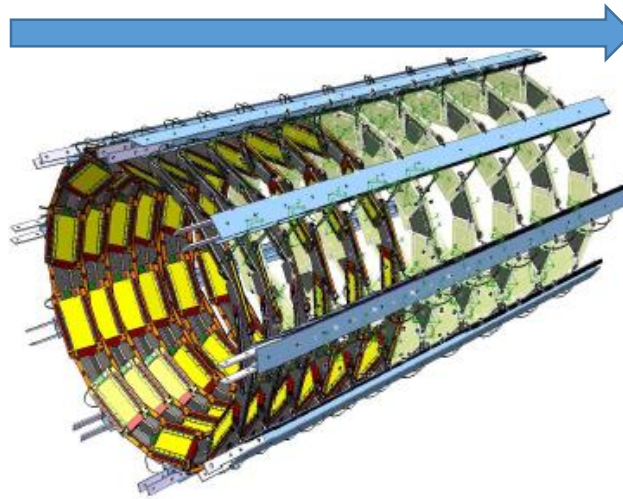
Philippe Lenoir, EP-DT-EO



# EP/DT-Engineering Office section is in charge of the Engineering and design support to CERN experiments

The specific tasks in the project “ Phase 2 Upgrade of the CMS Tracker “ are:

- Integration management
- Design of sub assemblies



=> EP/DT-EO **develops and applies** together with institutes of the CMS tracker collaboration methodologies for:

- 3D model exchanges between the institutes
- Use of detailed and simplified 3D models

## PEOPLE INVOLVED IN THIS METHODOLOGY DEVELOPMENT:

- Philippe Lenoir                    CERN EP DT EO
- Alexandros Koliatos            CERN EP DT CO
- Kamil Norbert Cichy            CERN EP DT CO
- Nick Lumb                        IPNL LYON

## Under the supervision of:

- Antti Onnela as project engineer for CMS Tracker upgrade
- Christophe Bault as supervisor in the EP DT engineering office

# Recommendations of Catia Support observed in this methodology:

## SMARTTEAM:

- A correct use of the motion of **ITEM**
- Mandatory **safety assurance of the SMARTTEAM database in the context of exchanges with external database**

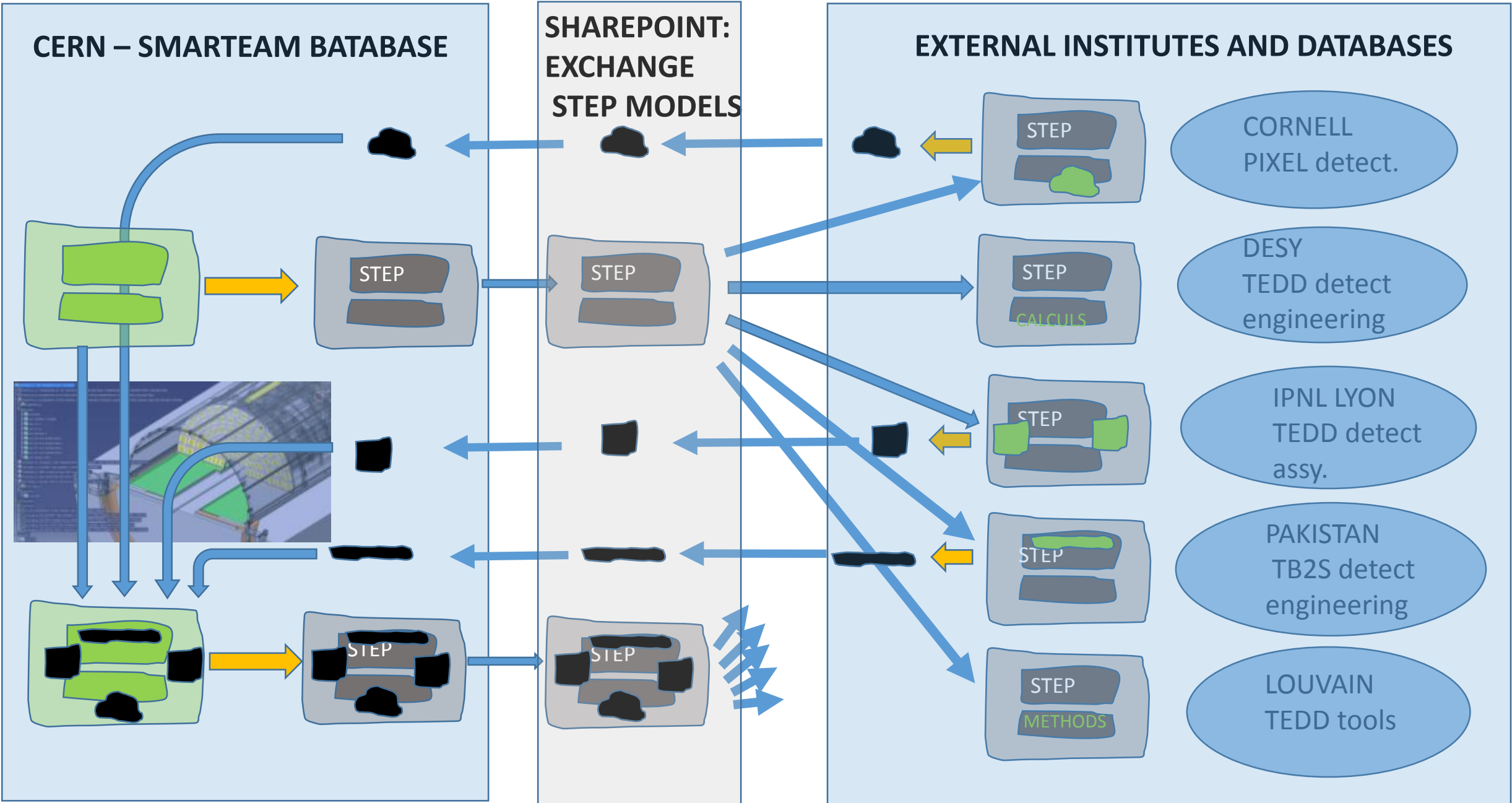
## CATIA:

- use of the **PUBLICATIONS** in PARTS / PRODUCTS to ensure reliable working of “REPLACE COMPONENT” function in the assemblies
- Integration models built by means of **COORDINATE SYSTEMS**
- **ADEQUATE SIMPLIFIED MODELS FOR INTEGRATION PURPOSE.**

# PRINCIPLES:

## 1 – DESCRIPTION OF DATA EXCHANGE

### BETWEEN CERN AND EXTERNAL INSTITUTES

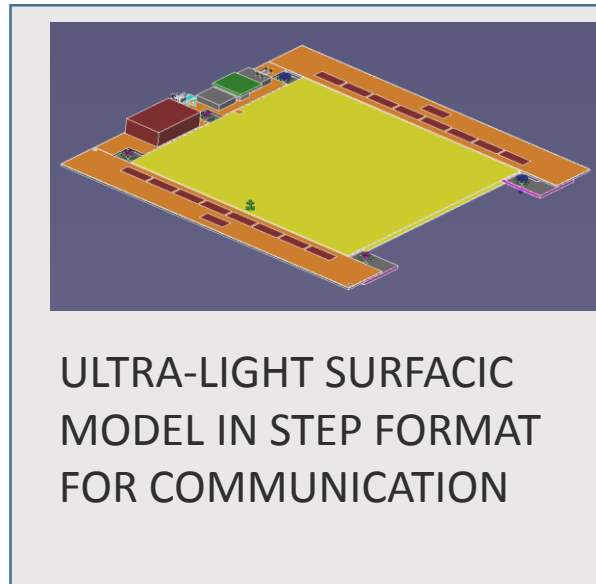
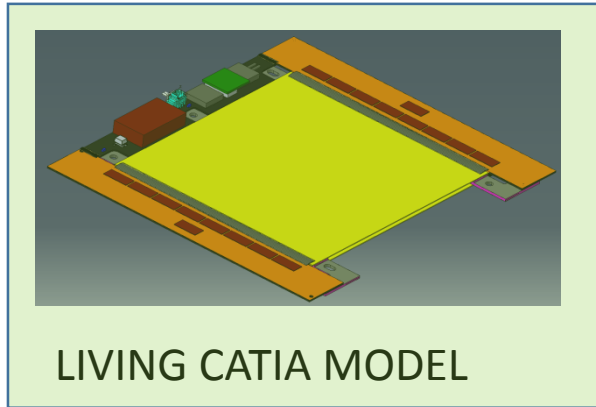


PRINCIPLES:

2 – AN EXAMPLE OF DATA EXCHANGE:

USE OF SIMPLIFIED STEP MODELS

# CERN CREATES AND ADDS IN THE ITEM “DETECTOR MODULE ” AN ULTRA-LIGHT PART MODEL FOR DATA EXCHANGE USE



CATIA V5

Data Chart

	Class	State	Document Number	Revision	Definition
1			ST0740789_01	a.00	2S 1.8mm 04.02.16
2			ST0740789_02	a.00	2S 1.8mm (ALLCATPart of ST0740789_01) 12.02.16
3			ST0740789_03	a.00	2S 1.8 mm Simplified Main Surfaces 250216

STEP FILE COPIED TO SHAREPOINT, WHERE ACCESSIBLE BY OTHER INSTITUTES

THIS MODEL CAN BE ASSIMILATED UNDER 1 SINGLE REFERENCE IN ALL EXTERNAL DATABASE OF THE COLLABORATION

= SURFACIC LIGHT MODEL SUITABLE ONLY TO EXPLORE THE INTEGRATION OF THE MODULE USED IN BIG QUANTITIES IN SEVERAL DETECTORS

Library Tools

Documents Library

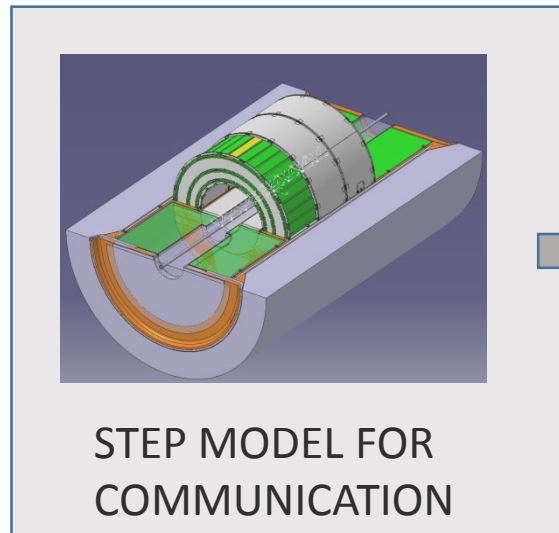
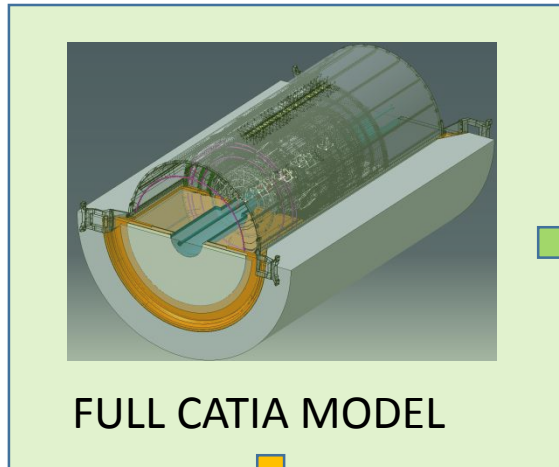
Mechanics > Shared Documents > ... 3D\_models > All Documents

STEP

Libraries	Type	Name	Modified	File Size	Modified By
Documents		SCREENSHOT OF STEP MODEL ST0579969_06 CMS TRACKER PHASE 2 UPDATE COPY OF _03 AT 12.07.2016	18/08/2016 01:44 PM	256 KB	Philippe Lenoir
Site Pages		ST0579969_06 CMS TRACKER PHASE 2 UPGRADE STEP COPY OF _03 AT 12.07.2016	18/08/2016 12:00 PM	141702 KB	Philippe Lenoir



# CERN CREATES AND ADDS IN THE ITEM “CMS TRACKER” an AllCat Part MODEL FOR DATA EXCHANGE USE



CATIA V5

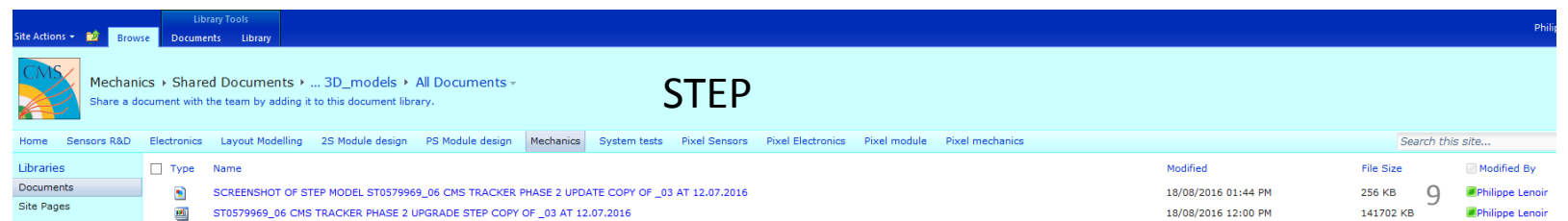
Data Chart

	Class	State	Document Number	Revision	Definition
1			ST0579969_01	a.00	CMS TRACKER OUTER BARREL UPGRADE
2			ST0579969_02	a.00	CMS TRACKER OUTER BARREL UPGRADE
3			ST0579969_03	a.00	CMS TRACKER PHASE 2 UPGRADE
4			ST0579969_04	a.00	
5			ST0579969_05	a.00	CMS TRACKER PHASE 2 UPGRADE
6			ST0579969_06	a.00	CMS TRACKER PHASE 2 UPGRADE
7			ST0579969_07	a.00	CMS TRACKER PHASE 2 UPGRADE

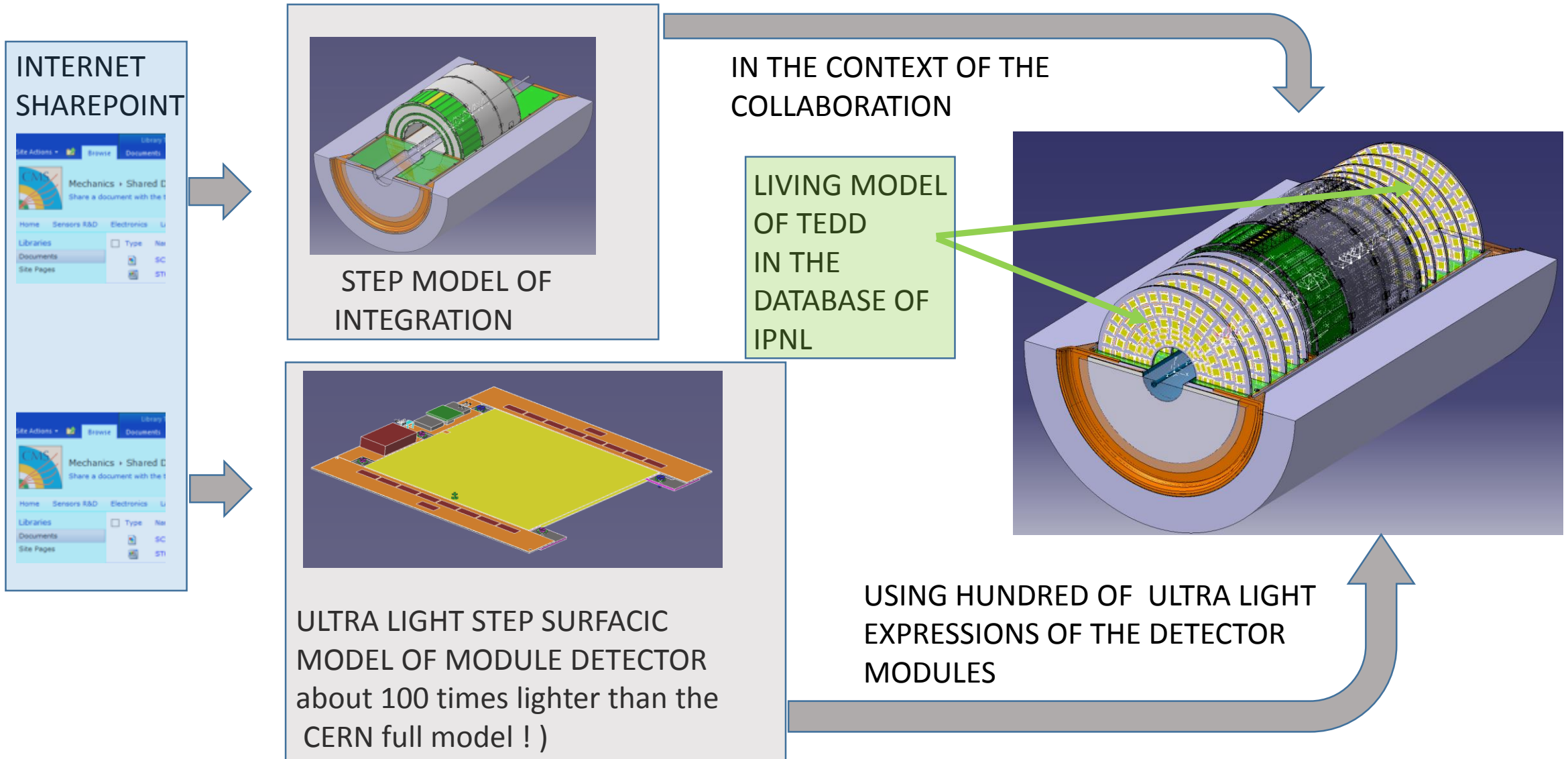
STEP FILE COPIED TO SHAREPOINT, WHERE ACCESSIBLE BY OTHER INSTITUTES

TRANSMISSION OF THE STEP MODEL ALLOWS:

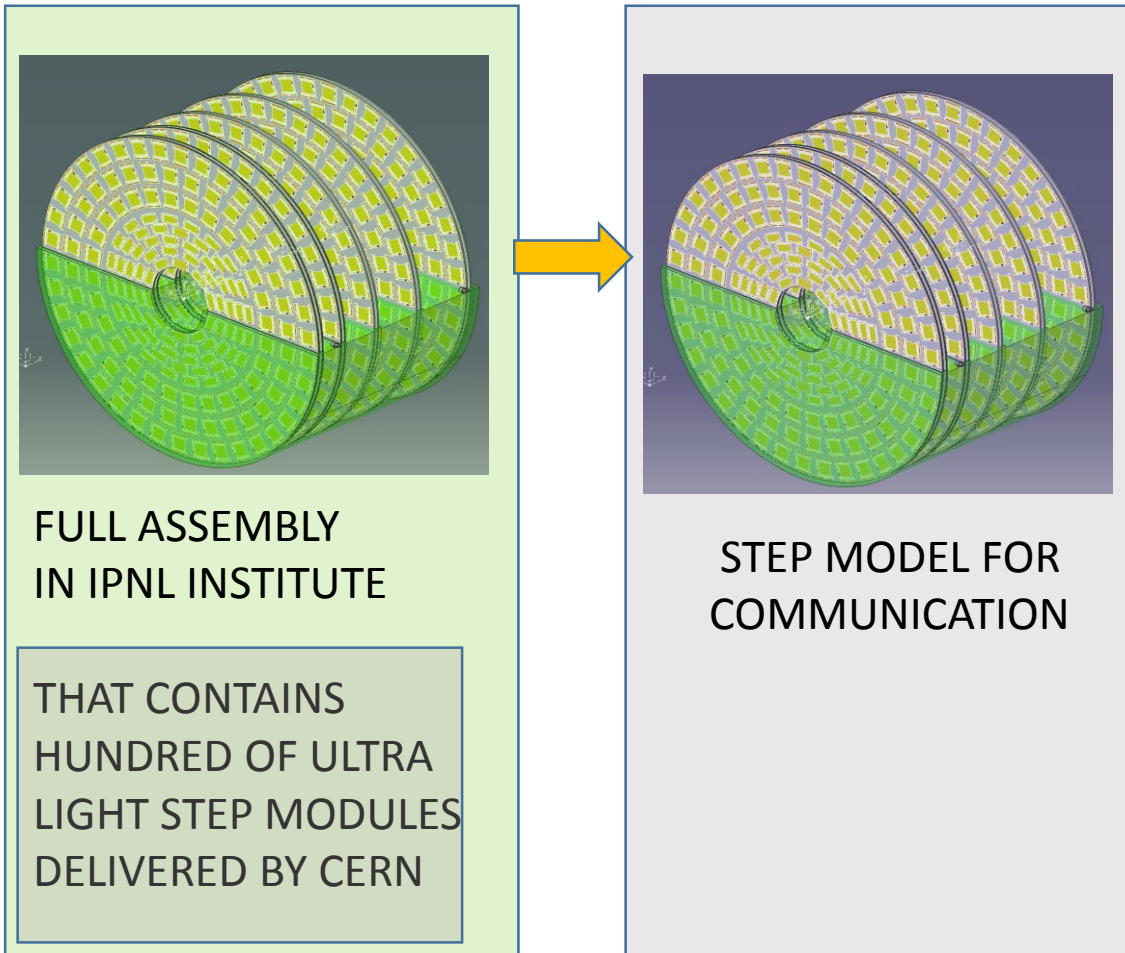
- ONE SINGLE REFERENCE TO SEND FOR AN ASSEMBLY
- BUT STILL ALL INTERNAL MODEL STRUCTURE INCLUDED



# IPNL INSTITUTE OF LYON ASSIMILATE THE 2 STEP MODELS IN IT'S DATABASE AND DEVELOP THE TEDD DETECTOR IN THE RIGHT CONTEXT



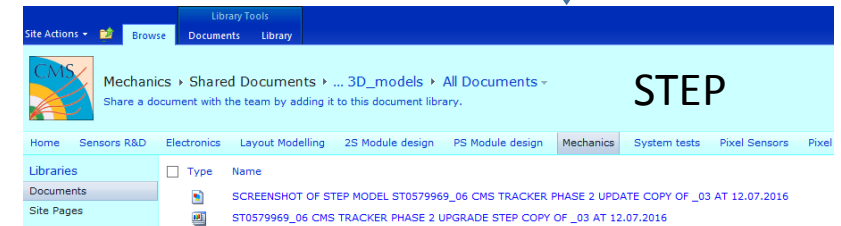
# IPNL INSTITUTE OF LYON DELIVER A STEP COPY OF IT'S TEDD DETECTOR IN SHAREPOINT



TRADUCTED IN STEP FORMAT, SENT IN INTERNET SHAREPOINT,

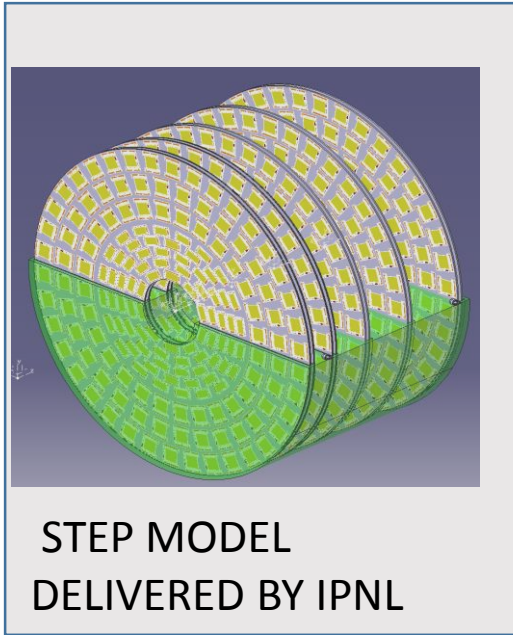
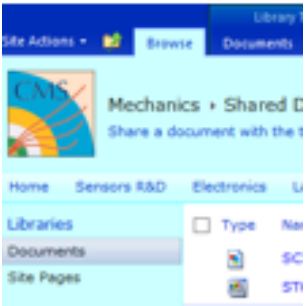
**THIS MODEL CAN BE ASSIMILATED UNDER 1 SINGLE REFERENCE IN ALL DATABASE OF THE COLLABORATION**

ALL THE INTERNAL VOLUMIC STRUCTURE STILL EXISTS FOR MEASUREMENTS



# CERN INTEGRATE IN CATIA/SMARTTEAM THE STEP MODEL OF THE TEDD

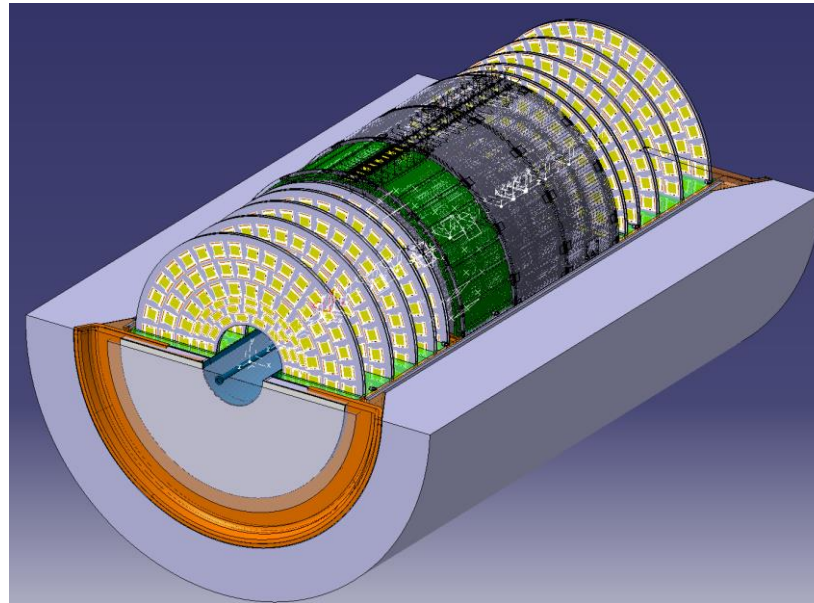
RECEIVED AT CERN VIA SHAREPOINT  
UNDER STEP FORMAT



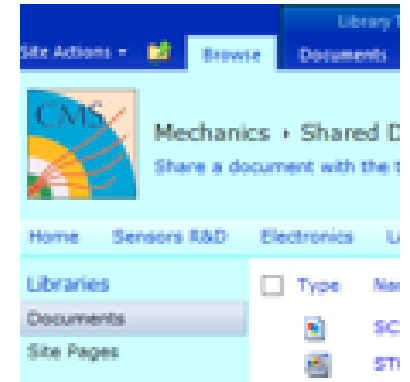
STORED IN SMARTTEAM AT CERN AS A CATIA Part

	Class	State ▾	Document Number	Revision	Definition
1			ST0684314_01	a.00	TEDD

ADDED IN THE INTEGRATION MODEL OF CERN .....



READY FOR THE NEXT .step EXPORT IN SHAREPOINT

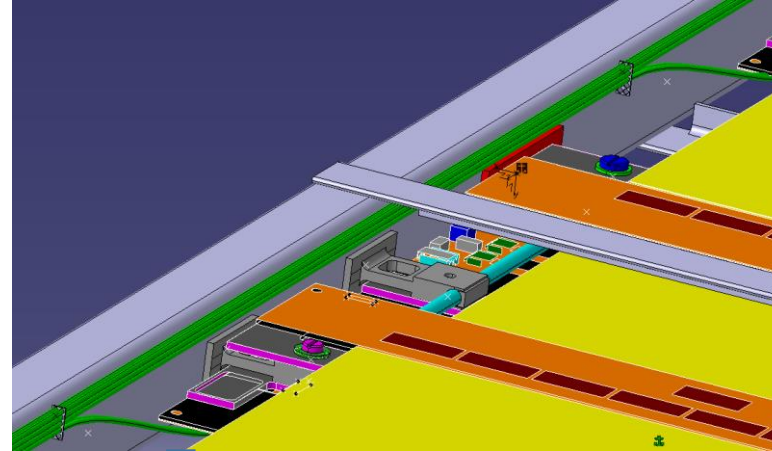
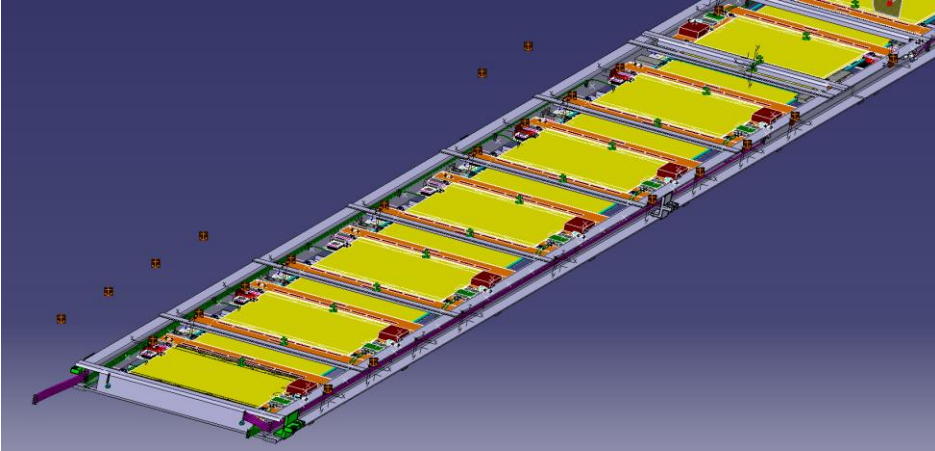


## PRINCIPLES:

3 – Use of simplified models in the LIVING database of CERN

# EXAMPLE

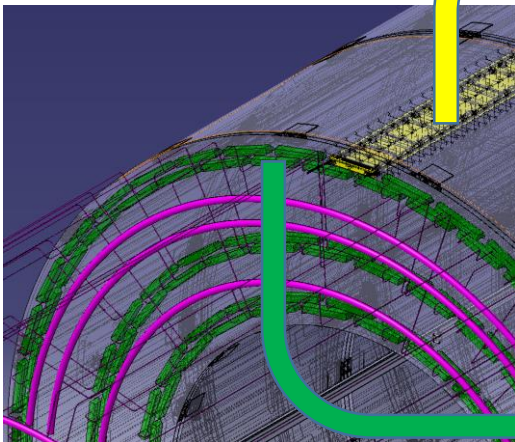
A SUB-PART OF A DETECTOR CONTAINING A LOT OF PIECES ....



WILL APPEAR 186 times in the detector

=> WE NEED TO CREATE SIMPLIFIED EXPRESSION OF IT UNDER THE SAME ITEM

=> A HUGE MODEL IN SIZE



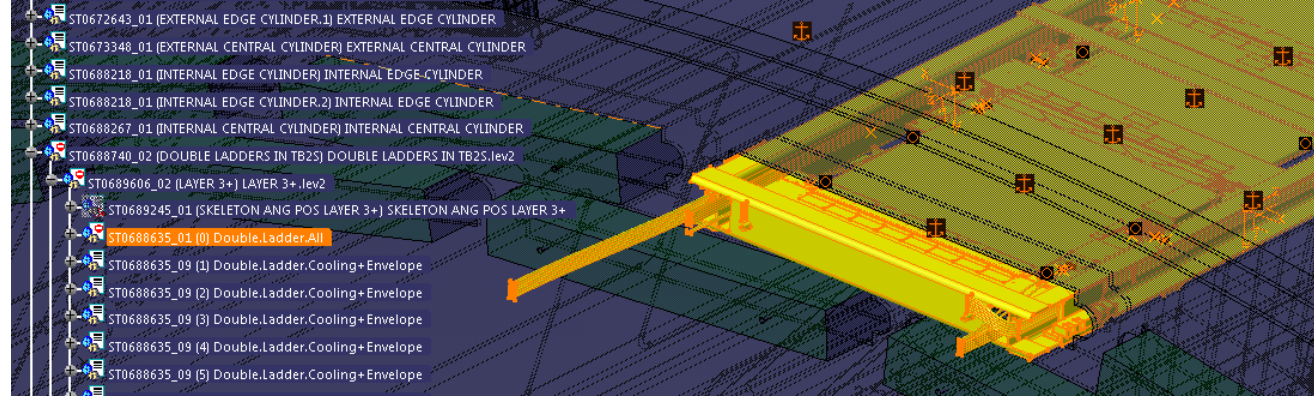
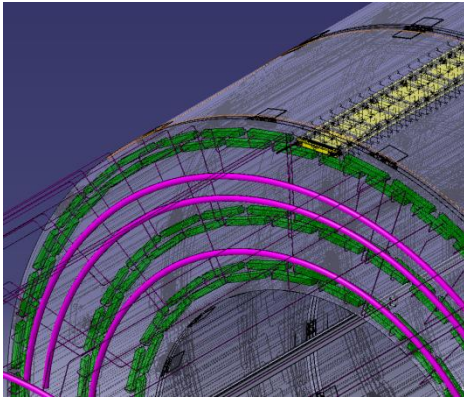
CATIA V5

Data Chart

	Class	State	Document Number	Revision	Definition
1			ST0688635_01	a.00	Double.Ladder.All

9			ST0688635_09	a.00	Double.Ladder.Cooling+Envelope
---	--	--	--------------	------	--------------------------------

# IN THE ASSEMBLY WE CAN USE DETAILED, SIMPLIFIED OR A MIX OF TWO !



For this we use the CATIA function : **REPLACE COMPONENT**

## REQUIREMENTS TO ACHIEVE THIS WITH A CORRECT WAY:

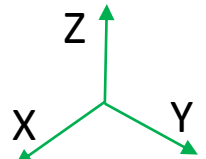
- The different models expressions share the **SAME** coordinates definition
- The same for the connexions needed for integration ( like screw positions, cable connexions, etc... )

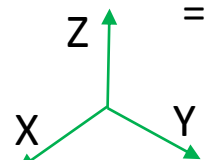
# BRIEF TECHNICAL DESCRIPTION

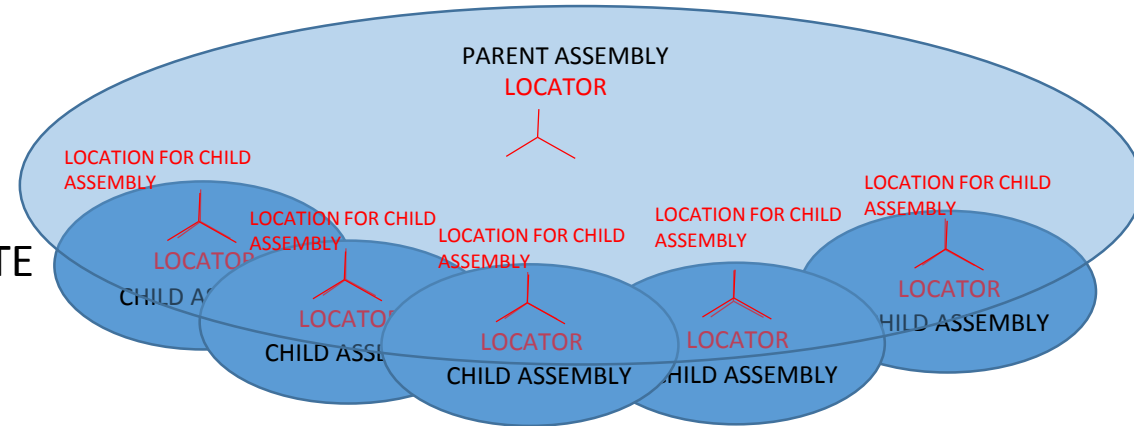
1 – HOW TO DO THIS IN PRACTICE ?



# 1 - "LOCATOR-LOCATION" STRUCTURE FOR EACH ASSEMBLY

LOCATOR  = chosen ORIGIN of the ASSEMBLY ( PARENT ASSEMBLY )

LOCATIONS  = DESIRED PLACES WHERE TO LOCATE CHILD OBJECTS IN THE ASSEMBLY

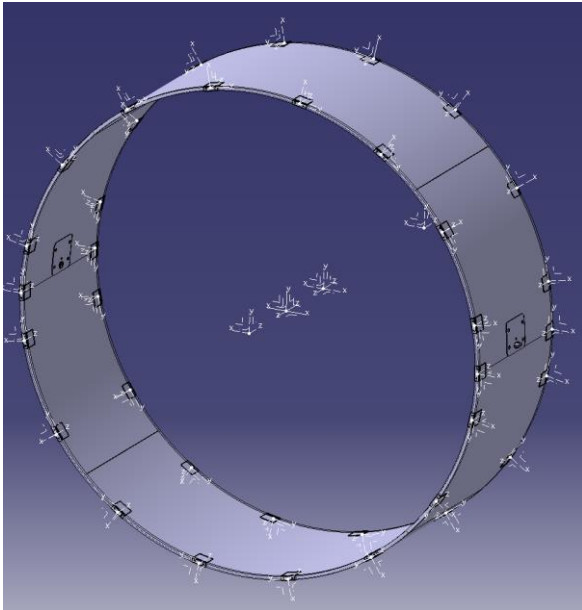


EACH CHILD ASSEMBLY CAN ALSO BE A PARENT ASSEMBLY FOR FURTHER ASSEMBLIES.

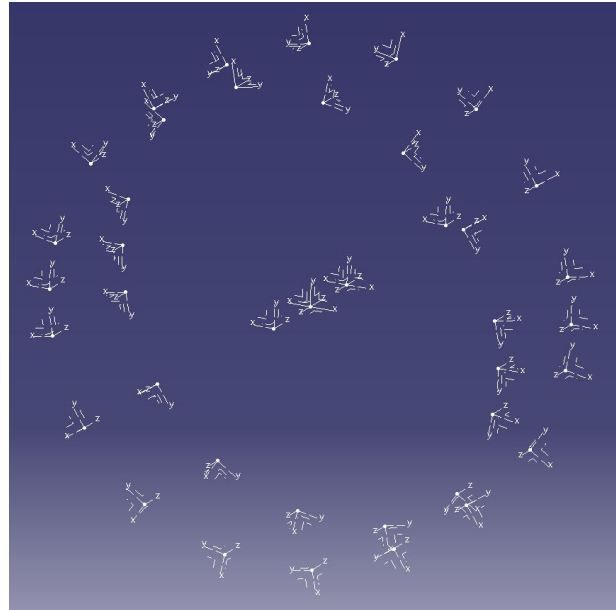
THE STRUCTURE TAKES PLACE IN SPACE BY COINCIDENCE CONSTRAINTS BETWEEN THE LOCATOR AND THE LOCATIONS AT ANY LEVEL OF THE ASSEMBLY

BUT TO KEEP THE RIGHT GEOMETRY OF THE STRUCTURE AFTER 'REPLACE COMPONENT' AT ANY LEVEL OF THE STRUCTURE: **THE STRUCTURE 'LOCATOR-LOCATION' HAS TO BE BUILT WITH A SPECIAL CARE:**

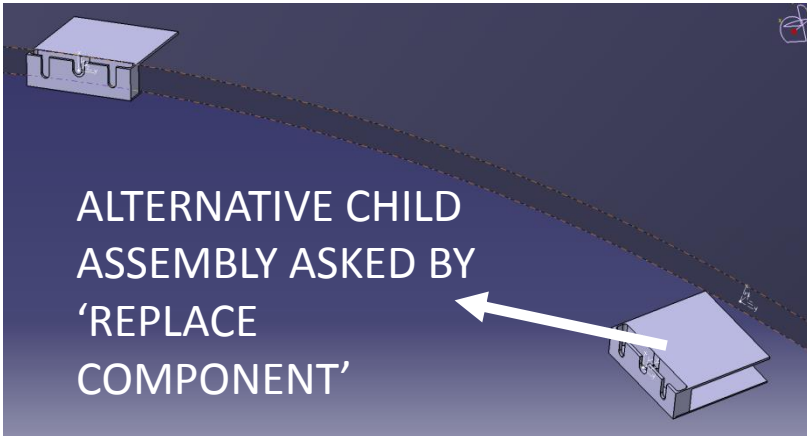
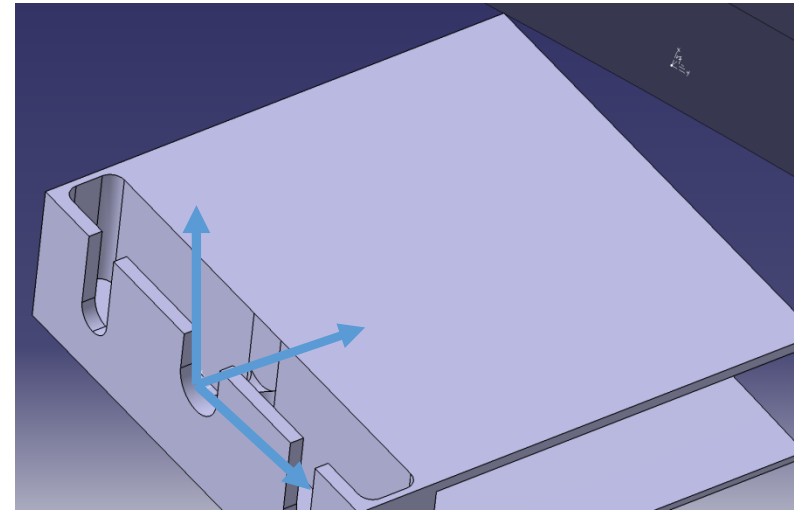
### GIVEN ASSEMBLY



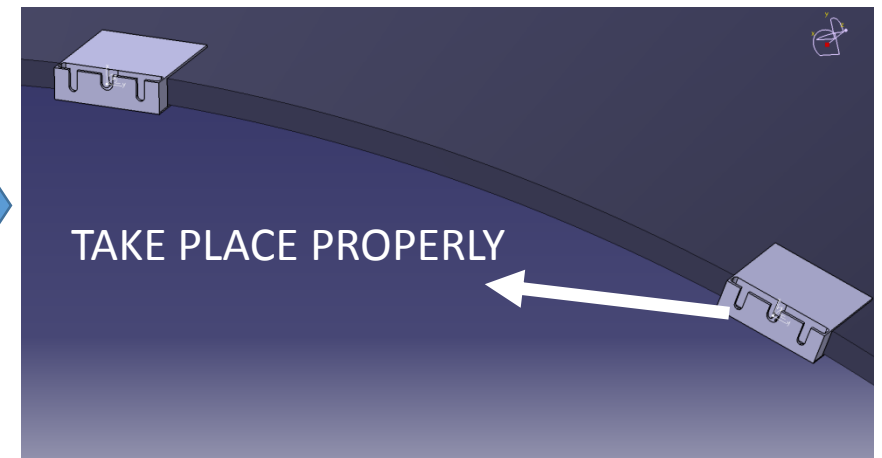
### LOCATIONS OF FATHER ASSEMBLY



### CHILD ASSEMBLY (OR PIECE) TYPE 1



CLICK



# HOW TO DO THIS IN CATIA ?

## ASSEMBLY

**PART SKELETON  
(NOT IN BOM)**

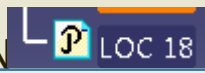
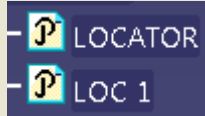
PART SKELETON

LOCATOR

LOCATION1

...

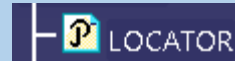
LOCATION N



CHILD ASSEMBLY OR  
PIECE

OCCURRENCE 1 OF CHILD ASSEMBLY ( OR PIECE)

LOCATOR



.....

CHILD ASSEMBLY OR  
PIECE

OCCURRENCE N OF CHILD ASSEMBLY ( OR PIECE)

LOCATOR



**CONSTRAINTS**

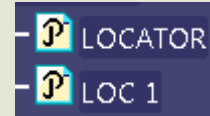
FIX PART SKELETON

COINCIDENCE (  OF SKELETON ;  OF OCCURRENCE 1 )

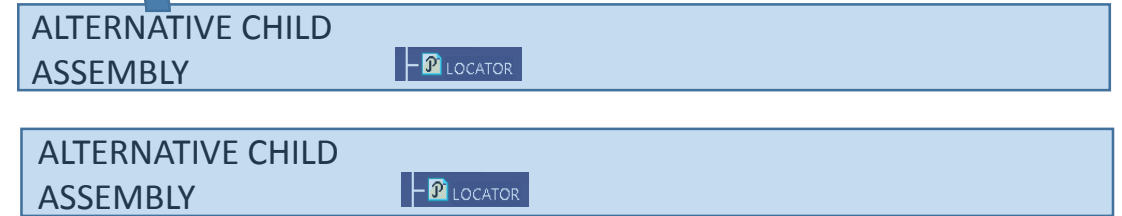
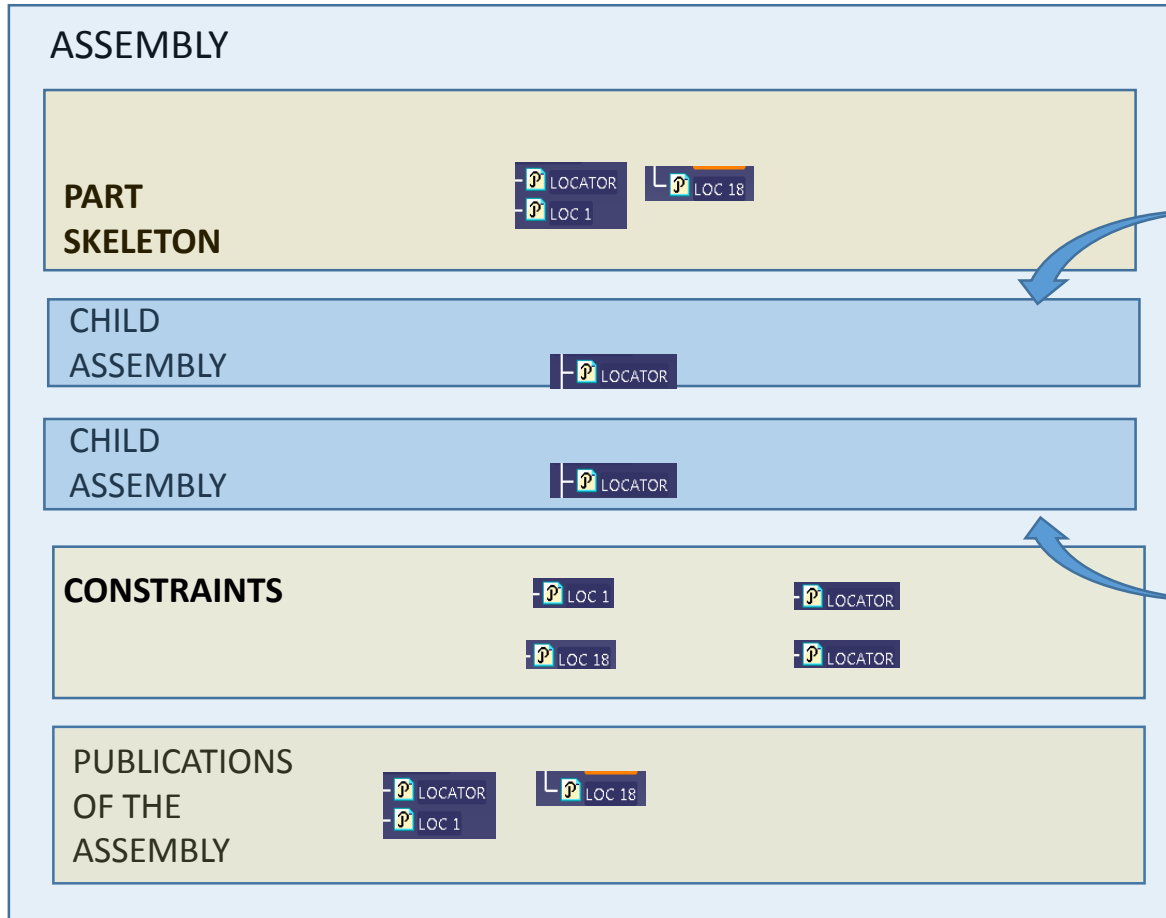
.....

COINCIDENCE (  OF SKELETON ;  OF OCCURRENCE 18 )

PUBLICATIONS OF THE  
ASSEMBLY



# WHY SUCH STRUCTURE ?

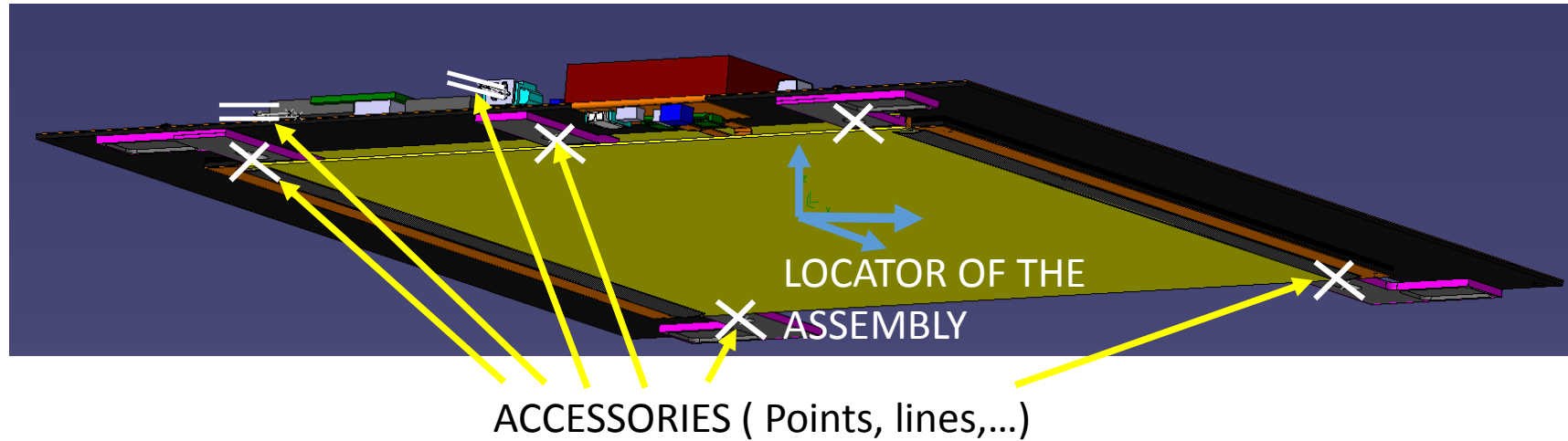


IN CATIA, THIS METHOD IS A WAY THAT ALLOWS A REPLACE COMPONENT WITH **THE GUARANTEE OF A CORRECT AUTOMATIC 3D PLACEMENT.**

## BRIEF TECHNICAL DESCRIPTION

- 2 – The creation of ULTRA-LIGHT EXPRESSIONS OF ITEMS WITH INTERFACES that have to be widely integrated

# CREATION OF EXTRA-LIGHT EXPRESSIONS OF AN ITEM INCLUDING INTERFACES



THIS MODULE IS DESIGNED AT CERN

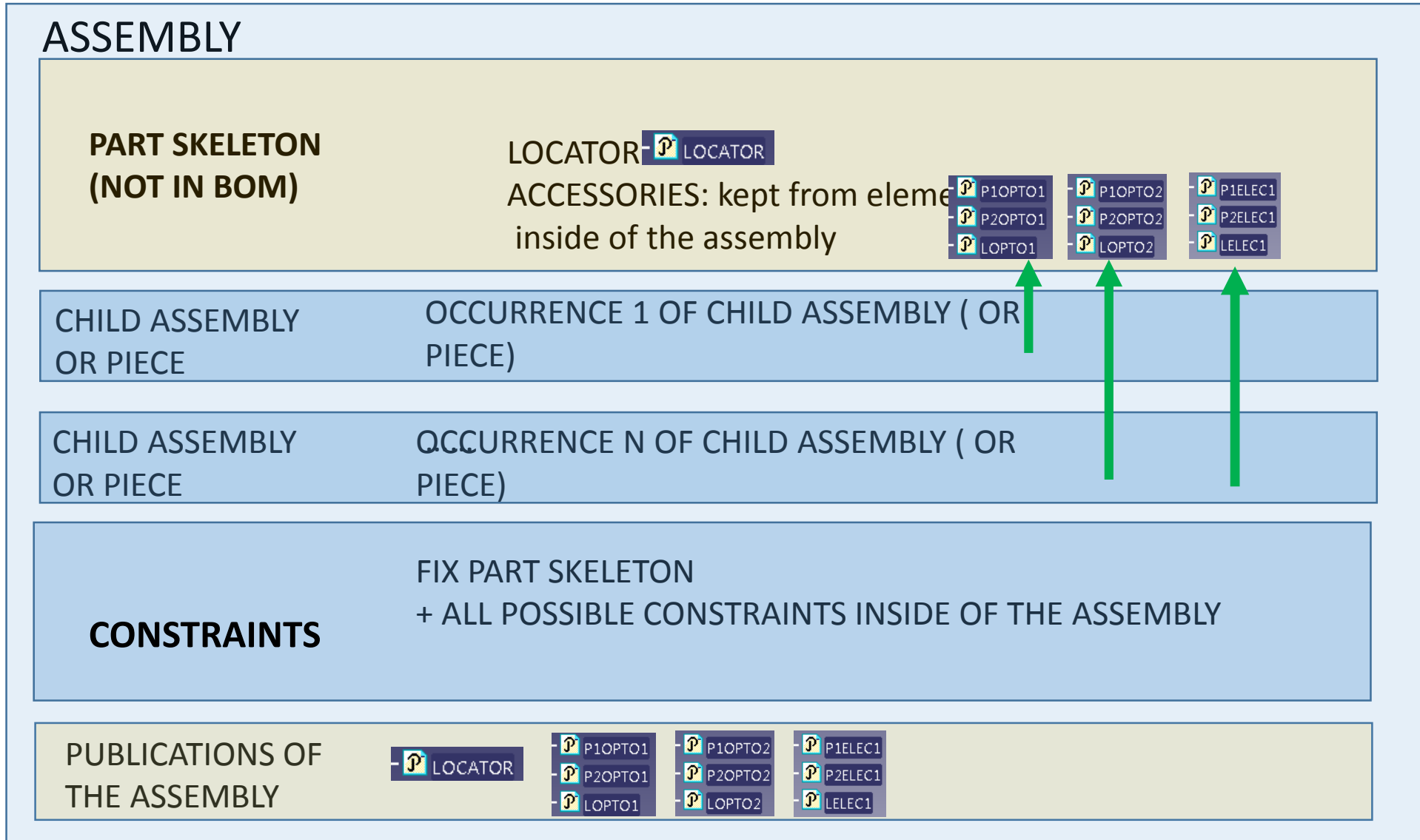
**THE COLLABORATION INSTITUTES NEED FOR THEIR INTEGRATION DESIGN WORK  
ULTRA-LIGHT COPIES OF THIS MODEL.**

IN THE ULTRA-LIGHT MODEL, WE NEED ONLY:

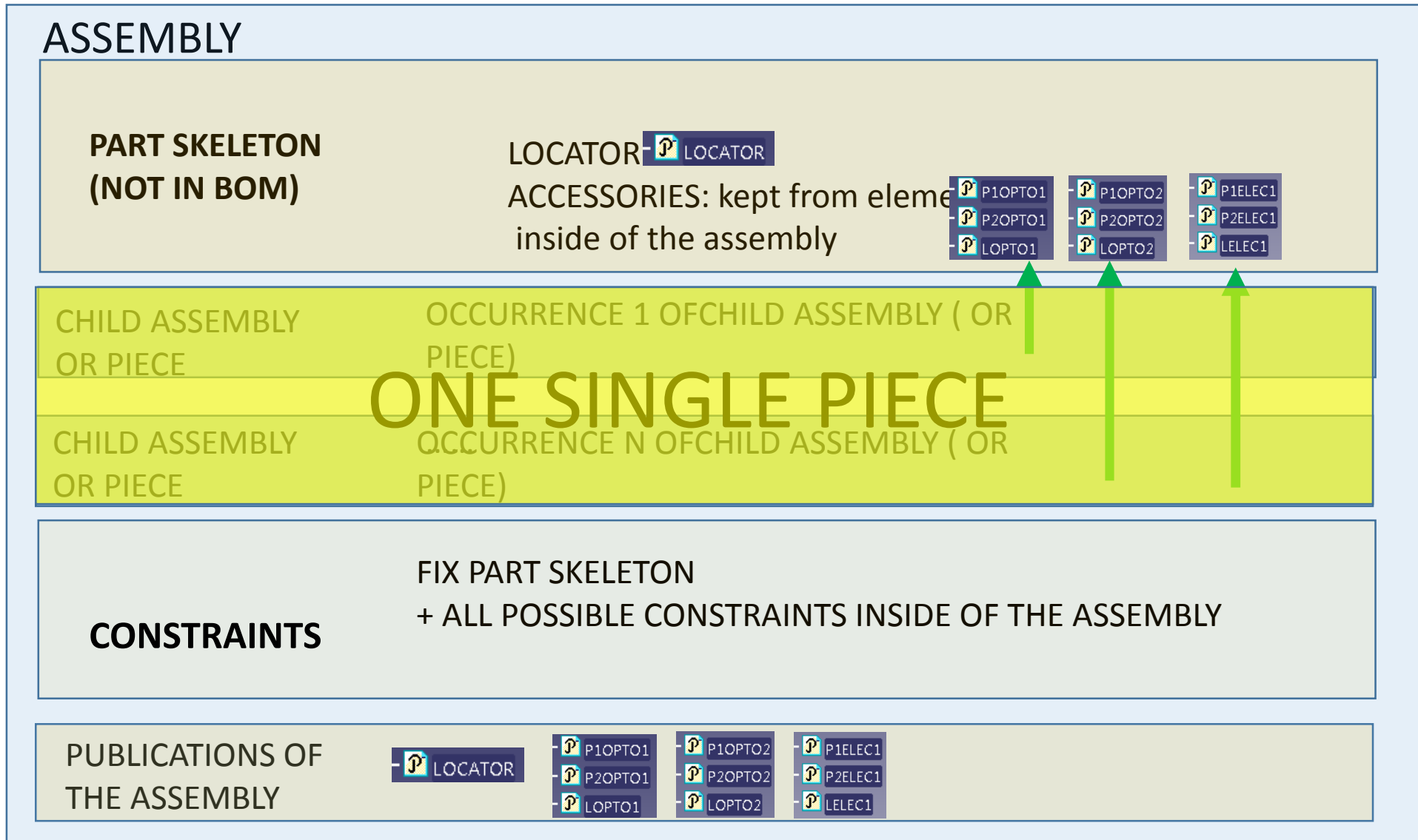
- THE LOCATOR OF THE MODULE
- THE ACCESSORIES FOR MECHANICAL AND ELECTRICAL EXTERNAL CONNEXIONS
- EXTERNAL CONTOURS OF THE MODULE

## PREPARING SUCH ULTRA-LIGHT MODEL:

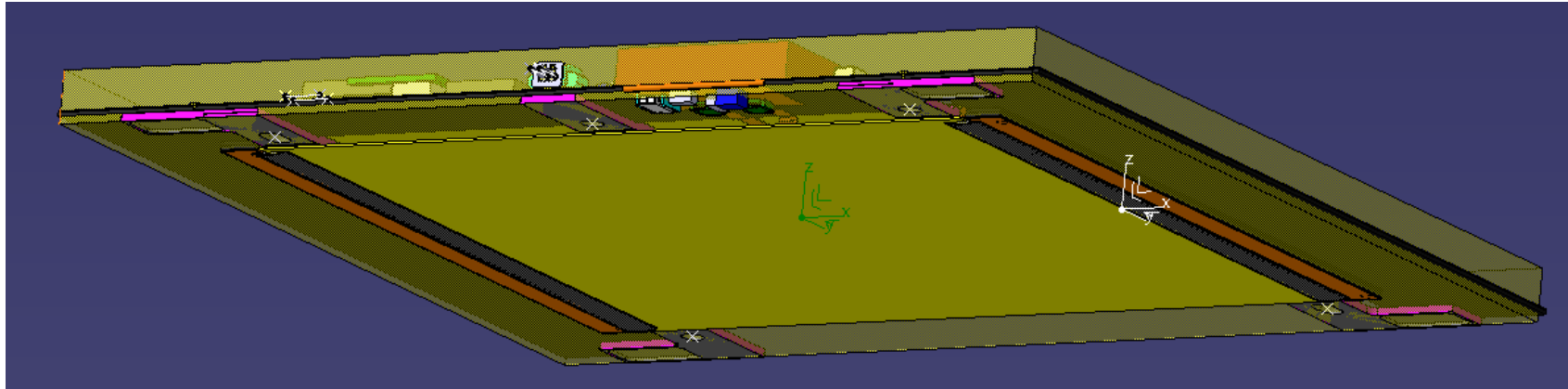
- ADD A PART SKELETON, DEFINE A LOCATOR FOR THE ASSEMBLY
- COPY THE REQUIRED ENTITIES FROM THE CHILD OBJECTS TO DEFINE THE ACCESSORIES TO THE SKELETON



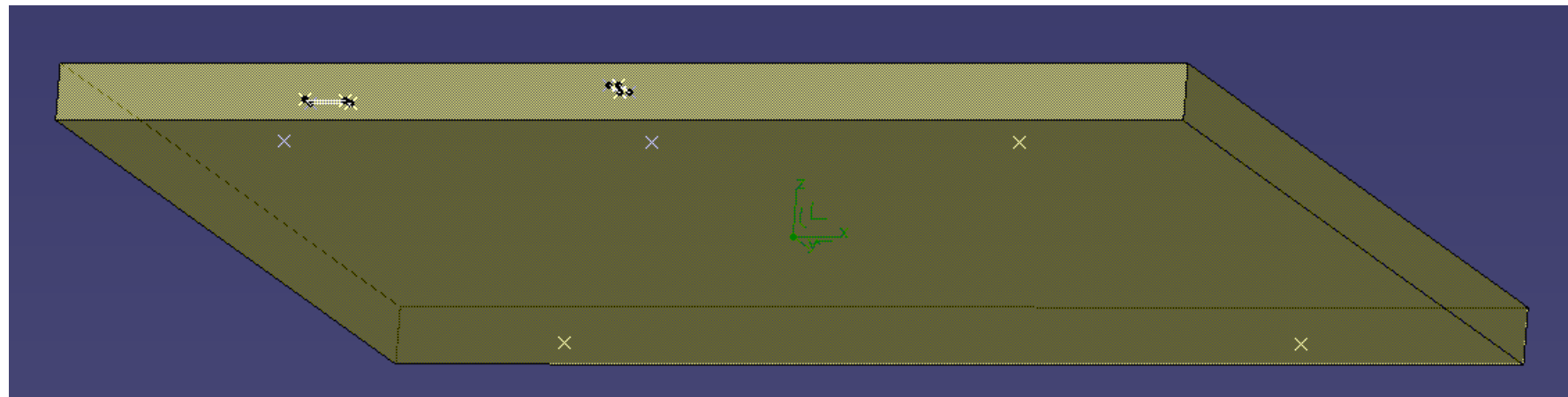
**ONCE THE ACCESSORIES HAVE BEEN COPIED TO THE PART SKELETON, THE CONTENT OF THE ASSEMBLY MAY BE REPLACED BY SIMPLIFIED CONTENT AS FOR EXAMPLE ONE SINGLE PIECE**







AND AFTER REMOVAL OF ALL ELEMENTS EXCEPT THE VOLUME OF SUBSTITUTION:



WE OBTAIN AN ULTRA-LIGHT ASSEMBLY WHICH CAN BE USED TO SUBSTITUTE THE ORIGINAL ONE BY 'REPLACE COMPONENT'. **THE CONNECTION POINTS AND LINES FOR ALL INTERFACES ARE STILL AVAILABLE.**

# WE CAN CREATE ULTRA-LIGHT MODELS WITH THE EXACT CONTOUR OF THE FULL MODEL : BY ALEXANDROS KOLIATOS

**Size of file: about 1/100 from the full detailed model**

## General principles:

- 1- An AllCat Part is generated from the detailed assembly
- 2 -The LOCATOR and ACCESSORIES are still existing in the AllCat Part and we publish them
- 3- All external surfaces are extracted from the AllCat Part
- 4- The volumes of the AllCat Part are deleted

⇒ Such ULTRA-LIGHT SURFACIC versions of the modules TRANSMITTED IN STEP FORMAT are now EXTENSIVELY USED in the CMS UPGRADE COLLABORATION :

TB2S detector at CERN

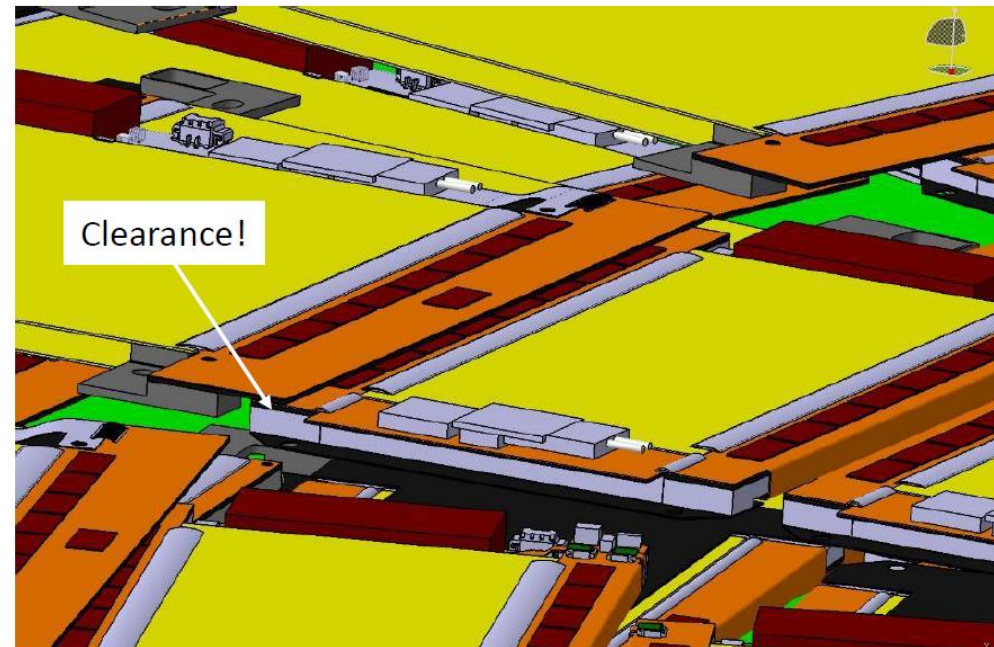
TBPS detector at CERN

TEDD detector at INPL (LYON), UCL(LOUVAIN)

# USE OF ULTRA-LIGHT MODELS IN IPNL – LYON FOR INTEGRATION STUDIES



## Aside: R8/R10 clearance



The fact that the PS and 2S modules are now staggered in Z gives clearance (0.6mm) between the PS frontend chips on R8 and the underside of the 2S hybrid on R10  
This clearance should be increased (to 1.0mm) by adjusting the height of the cooling inserts *or by raising the 2S hybrid with respect to the sensor*

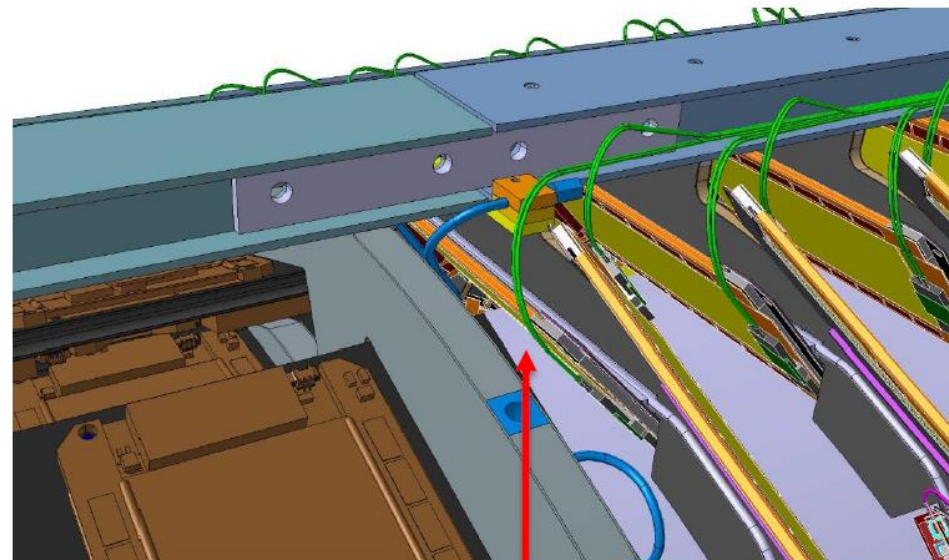
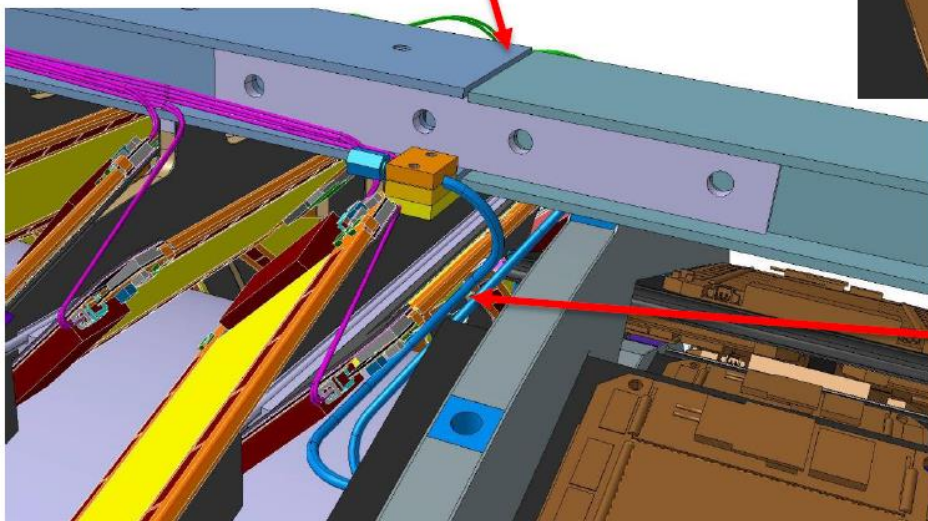
# USE OF ULTRA-LIGHT MODELS AT CERN FOR A HIGHLY COMPLEX 3D GEOMETRY



## TBPS Layer 1 – joining area



Minor mismatch between support profiles – already solved



Clearances between flat and tilted sections – OK!  
- Services routing and strain relieves to be studied

## CONCLUSION:

With the “LOCATOR-LOCATION” protocol:

- Any CATIA MODEL becomes a structure of ITEMS that can each be **EXPRESSED AT ANY DESIRED LEVEL OF DETAILS** under request.
- This property is valid also for STEP MODELS that can be EXCHANGED WITH OTHER INSTITUTES.

Thank you for your attention