

2022



Geometry Modelling in HEP

ALEXANDER
SHARMAZANASHVILI

The Book Presentation

SHARMAZANASHVILI Alexander

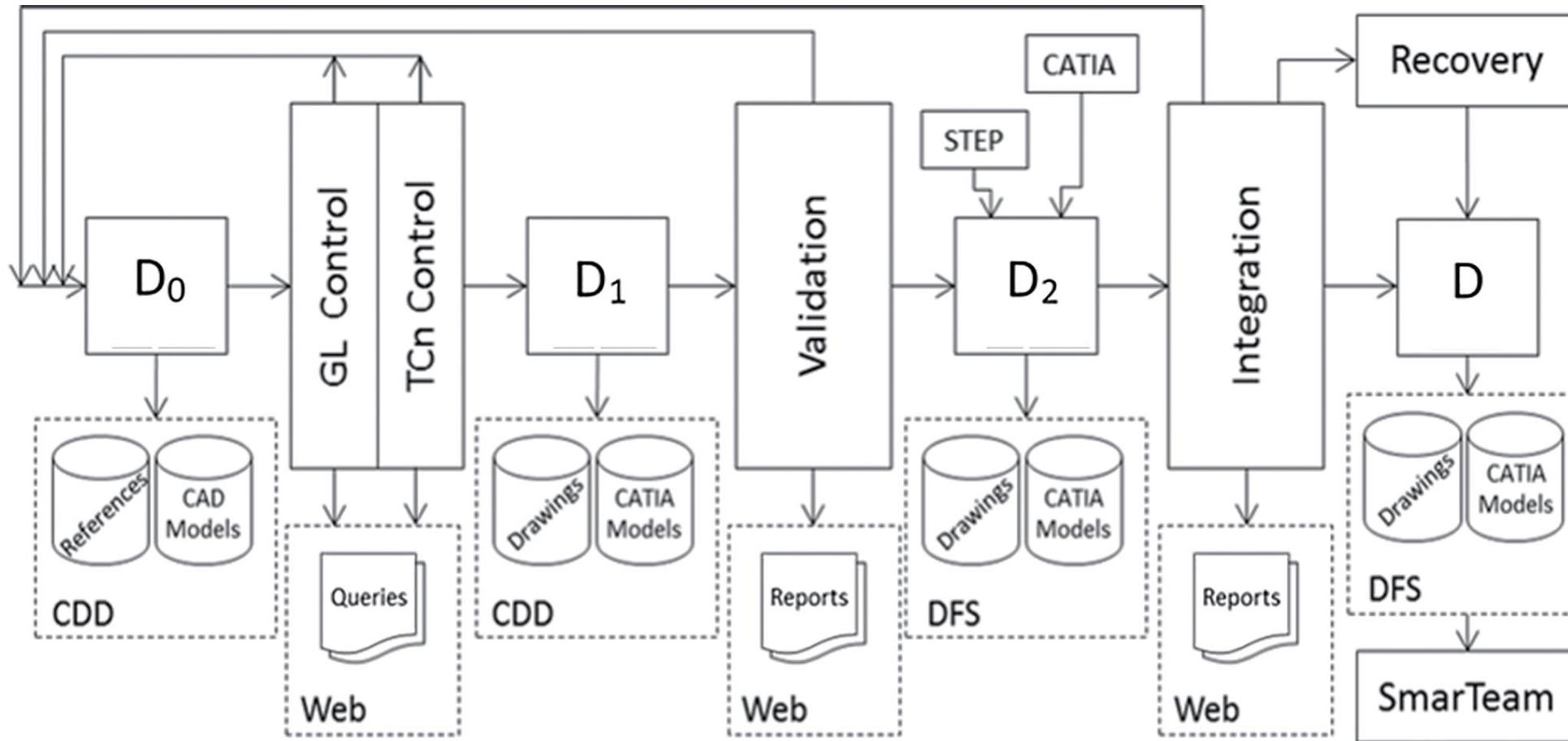
Georgian Technical University



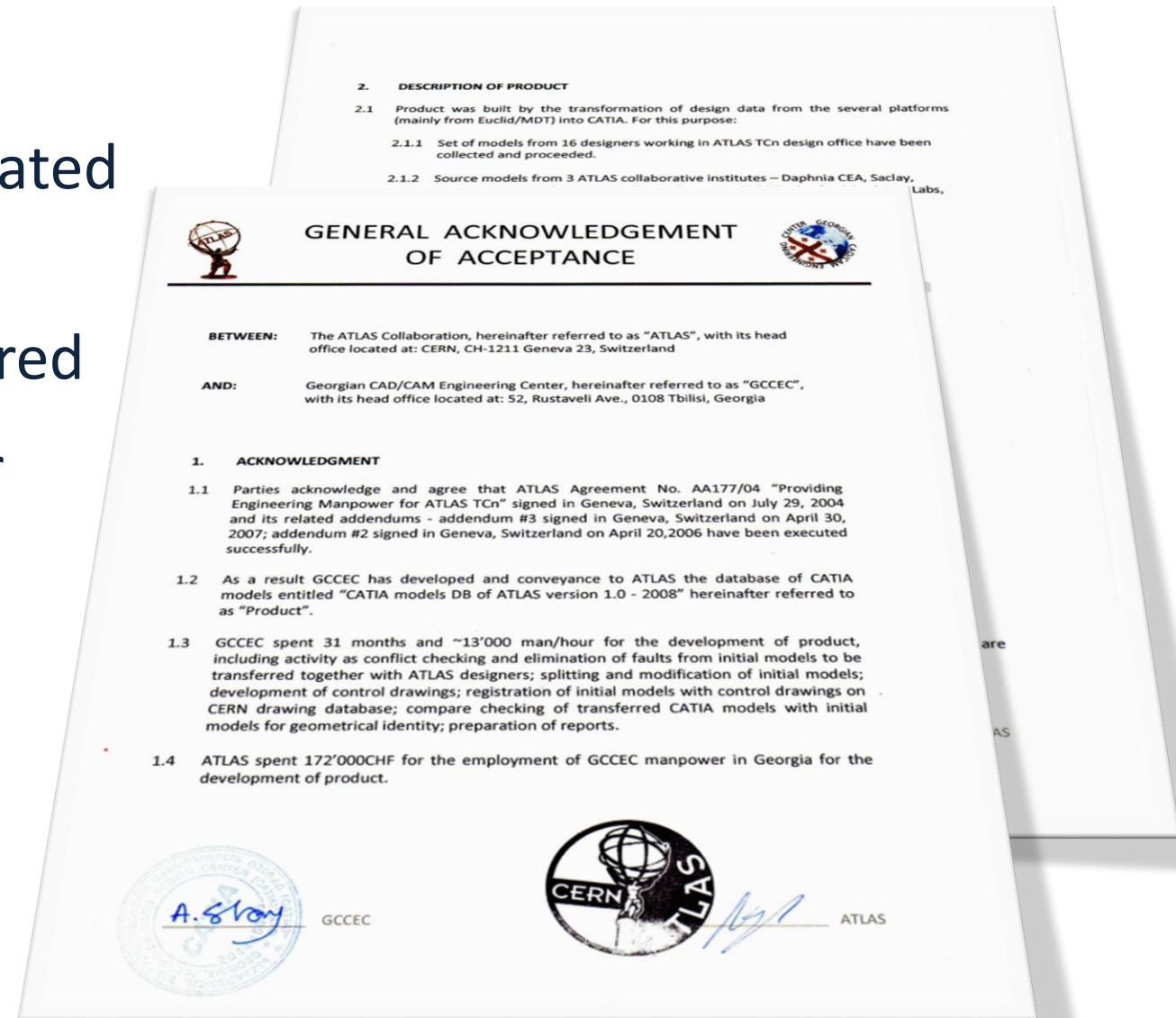




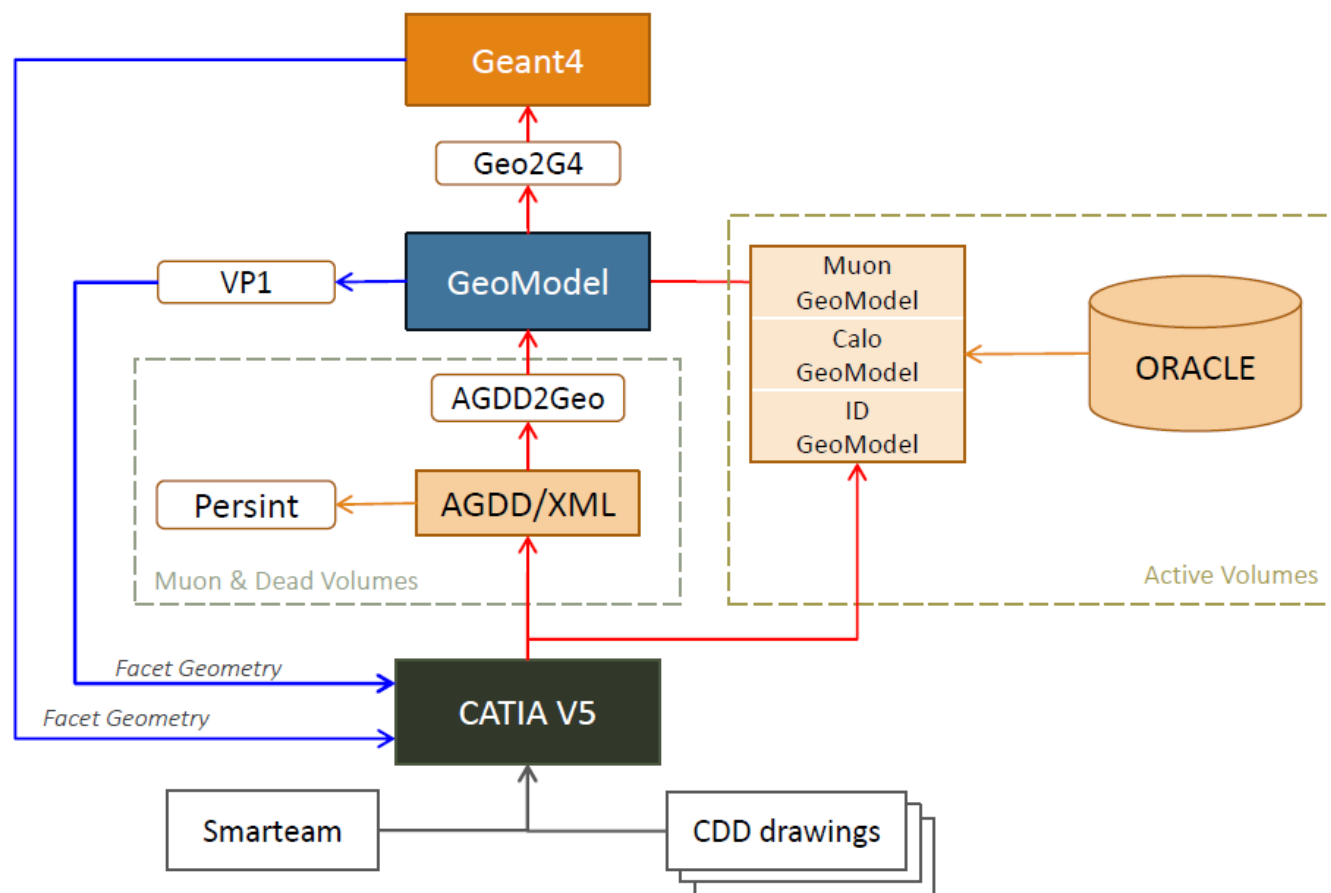
Geometry Migration from Euclid to CATIA



- 3'705 large assemblies were migrated in CATIA
- 713 technical reports were prepared
- The first draft of the ATLAS DB for Smarteam was produced

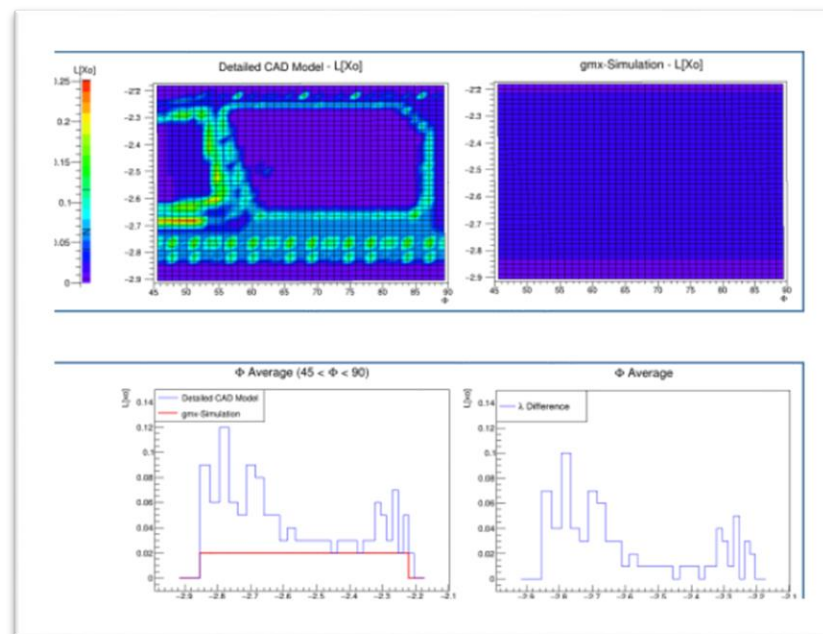
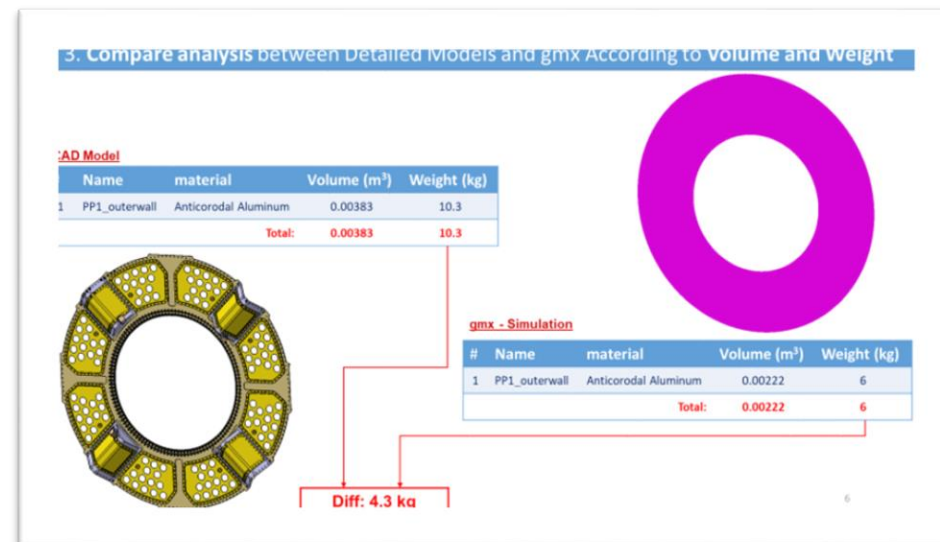


- ATLAS Simulation infrastructure with CATIA

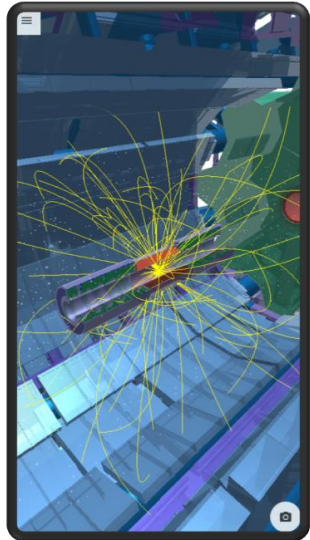


15 Compare Geometry Analysis projects were executed for:

- Muon Spectrometer
- Magnet Systems
- Tile Calorimeter
- Support structures
- Services



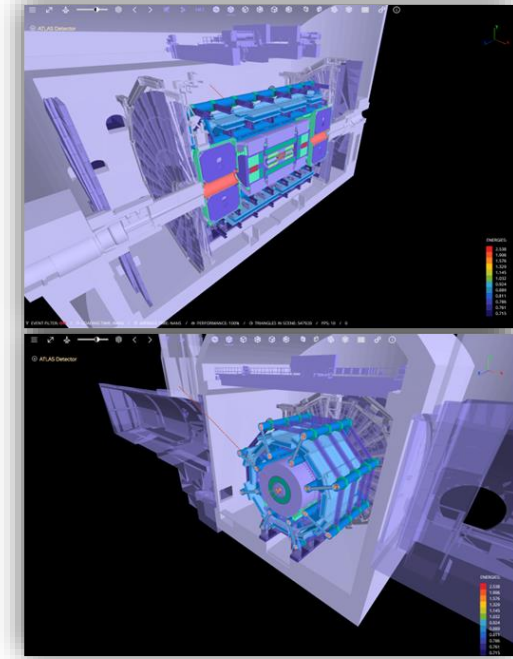
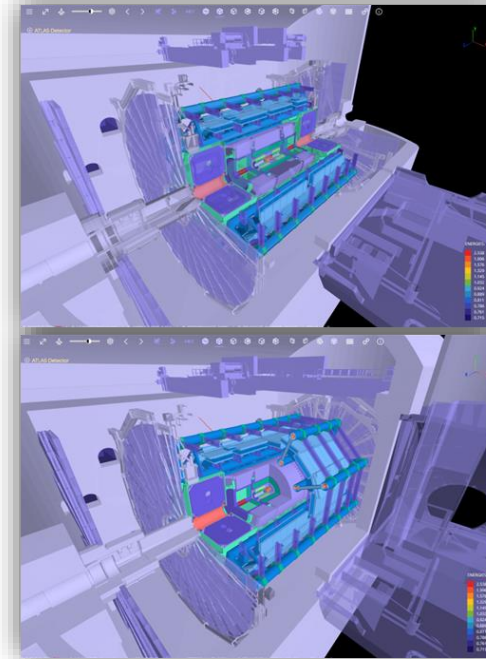
Development of geometry 3D scenes of the cognitive visualisation applications



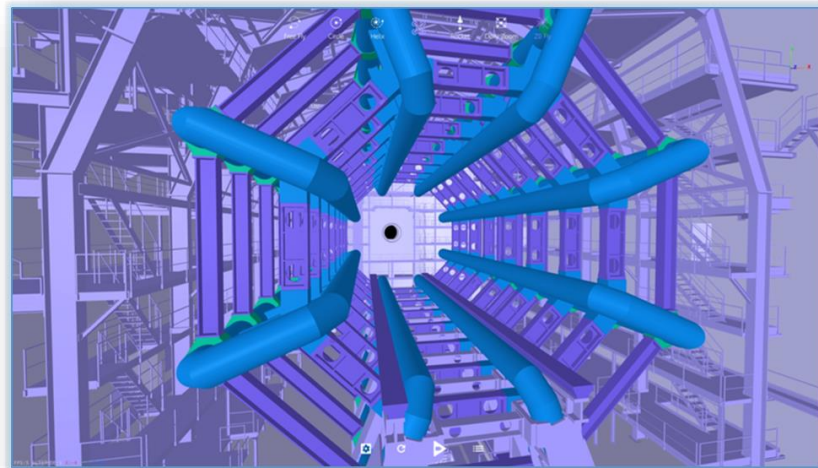
TileCAL Display



ARB



Detector Viewer



VR

ART

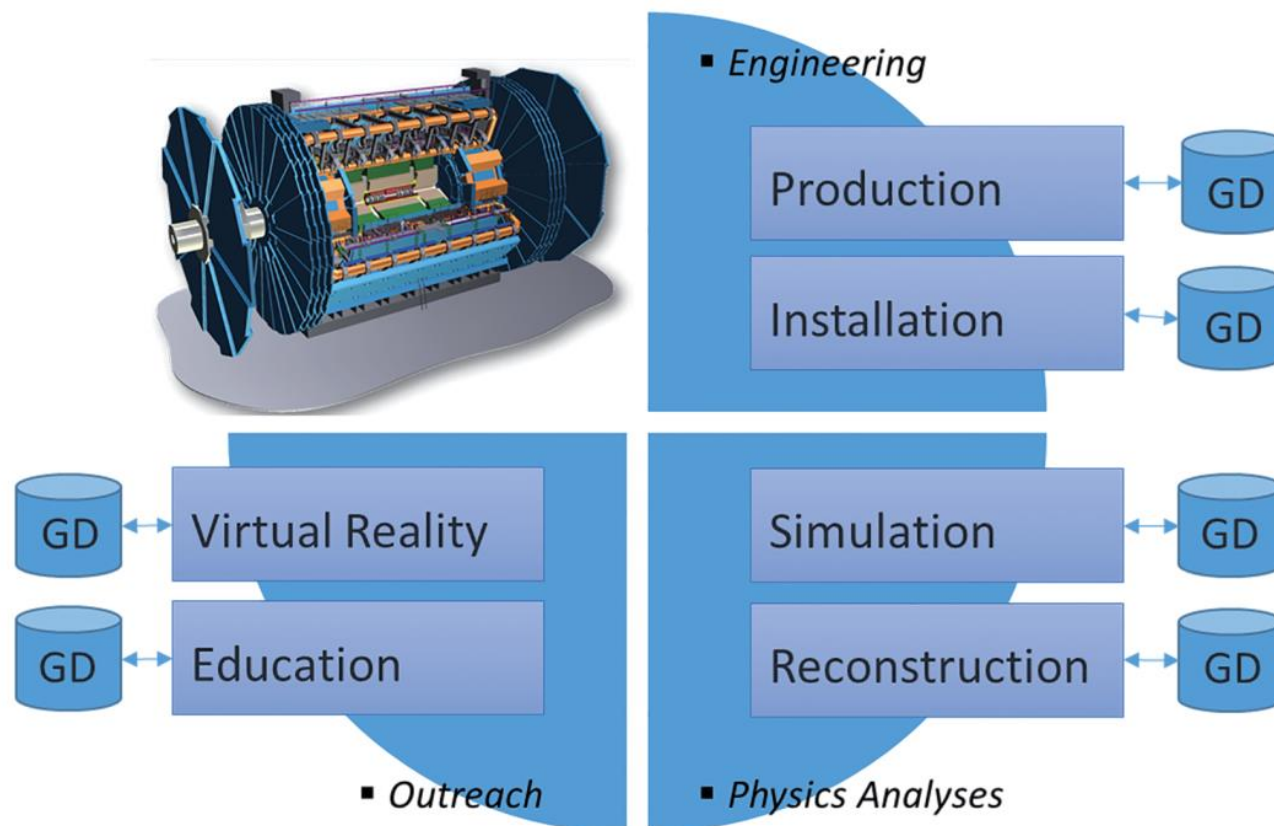


- 13 Agreements and 25 Work Packages were executed
- 43 GTU students were involved
- 3 PhD and 9 MSc dissertations were defended
- Participated in 146 ATLAS workshops – about 7-8 participation per year

■ Participation in the ATLAS Workshops

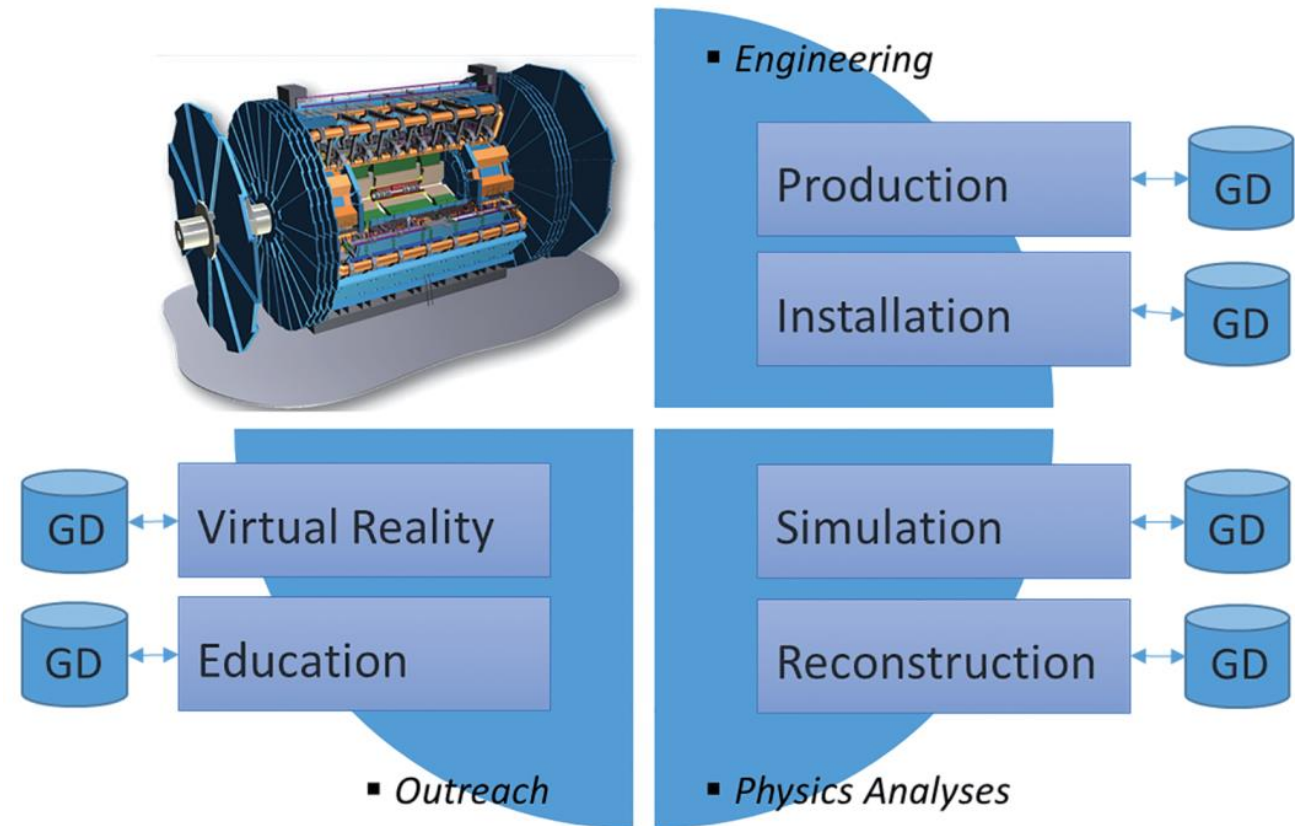
- 2011-07-18 SW CTB
- 2012-01-30 Simulation - Coils
- 2014-12-16 Muon Week - ECT
- 2015-05-12 TIZIANO
- 2015-05-13 CHRISTOPH
- 2015-06-02 Muon Week
- 2015-06-02 Muon Week - ECT - plus
- 2015-06-12 CMS
- 2015-07-01 SC Week - CTB_R12
- 2015-10-12 Muon Week Munich
- 2015-12-10 NSW Meeting
- 2016-01-29 CTB Weekly
- 2016-02-04 Outreach
- 2016-03-03 SC Week - SIMULATION
- 2016-04-19 Paolo Point4 Integration
- 2016-06-09 Paolo Point4 Status
- 2016-06-14 CTB R12.08
- 2016-06-14 Simulation
- 2016-07-01 ATLAS Tracer
- 2016-10-18 ATLAS Tracer
- 2017-01-25 SDSC Workshop - ATLAS Tracer
- 2017-02-14 Outreach Weekly
- 2017-02-22 Outreach Weekly
- 2017-02-27 Simulation
- 2017-03-15 CTB R12.09
- 2017-03-28 HSF Workshop
- 2017-04-10 Outreach Tracer
- 2017-05-12 UNIGE
- 2017-06-14 OpenData Tracer
- 2017-06-29 Muon Week - NSW
- 2017-07-02 Simulation HF Trucks
- 2017-07-04 Simulation - Truck-NSW
- 2017-07-18 Management
- 2017-11-07 Muon Week
- 2018-02-05 Software RD Meeting - Geometry
- 2018-02-13 Simulation - Tower
- 2018-02-20 Outreach - Tracer
- 2018-02-26 Software RD Meeting - Tracer
- 2018-03-15 Management - Geometry
- 2018-04-18 Outreach Weekly - Tracer
- 2018-05-08 Simulation Meeting
- 2018-07-04 Management
- 2018-08-07 Simulation Meeting - Flexible Chain
- 2018-09-26 Outreach Weekly - Scaled Models
- 2018-10-04 IPPOG
- 2018-11-05 Art@CMS
- 2019-01-15 Simulation Meeting - Flexible Chain
- 2019-02-12 Outreach Tracer
- 2019-02-13 Simulation
- 2019-02-28 SQ Meeting
- 2019-03-14 Muon Meeting - Concept
- 2019-03-28 Muon Meeting - FLX-Chain-S9
- 2019-04-25 Management - About NEC
- 2019-04-30 Meeting Ed-Andi
- 2019-05-13 Round-Table - Tracer
- 2019-06-07 Muon Meeting - Feets
- 2019-06-14 TileCal Tracer-TC
- 2019-07-04 Muon Week - Feets +
- 2019-10-04 Tile Week - Tracer-TC
- 2019-11-21 ASCIG
- 2019-11-21 Muon Weekly - NSW-2019
- 2020-01-23 Event Display Workshop - Tracer
- 2020-01-30 Muon Weekly - NSW2019-II
- 2020-02-06 ASCIG - Coverity
- 2020-02-11 SCweek-Simulation -NSW
- 2020-02-11 TileCALweek DB
- 2020-02-12 SCweek-ASCIG
- 2020-02-14 TileCALweek Tracer-TC
- 2020-02-18 DetectorDescription Monthly-NSW
- 2020-02-26 ATLAS Week Outreach-ART
- 2020-04-28 Simulation-AGDD Geometry
- 2020-04-30 ASCIG Weekly
- 2020-05-12 Simulation - NSW
- 2020-05-29 Ivica-Paris-AR Book
- 2020-06-15 ASCIG-Cppcheck-Luka
- 2020-06-16 Nico-Stefano-NSW
- 2020-06-16 TileCAL Week-DB
- 2020-06-19 TileCAL Computing-Tracer
- 2020-06-24 ATLAS Week Outreach-Tracer Framework
- 2020-07-01 Management-Tracer
- 2020-08-13 Muon Week - Platforms
- 2020-10-22 Muon Week - Muon Passive Materials
- 2020-12-02 TileCAL-DB
- 2020-12-03 IPPOG AR-Visualization
- 2020-12-04 FCC About NEC
- 2020-12-04 Simulation - Cavern
- 2021-02-10 ATLAS Week Outreach-Tracer
- 2021-02-18 Event Display Workshop - Tracer
- 2021-02-19 ITK
- 2021-03-02 Simulation - RD plus Services S7
- 2021-03-19 Outreach - VR
- 2021-03-26 TileCAL LA-Pump
- 2021-04-28 TileCAL DB
- 2021-05-20 vCHEP - Tracer
- 2021-05-26 DD4 Meeting
- 2021-06-14 ASCIG Coverity
- 2021-06-15 TileUpgrade DB
- 2021-06-18 TileCAL-SIM
- 2021-06-18 Tracer-TileCAL
- 2021-06-22 SIM-Book
- 2021-06-30 ATLAS Week - TracerEVD
- 2021-11-17 IPPOG
- 2022-01-31 GTU - About the METAVERSE
- 2022-02-08 ITK StartUP
- 2022-02-10 Outreach StartUP
- 2022-03-08 ITK Plenary - About
- 2022-05-10 Simulation CATIA-Radiation
- 2022-05-16 LHCP
- 2022-06-01 Outreach - Tracer-VR
- 2022-06-17 TileCAL - Tracer
- 2022-07-11 IPPOG-EVD
- 2022-10-29 IPPOG-EVD-II
- 2022-11-29 PMBC-2022 Workshop
- 2022-12-21 ICS Faculty Workshop
- 2023-02-15 ATLAS Week - TracerARB
- 2023-03-29 Outreach ARB
- 2022-Participants-GTU.jpg

- Heterogeneous System

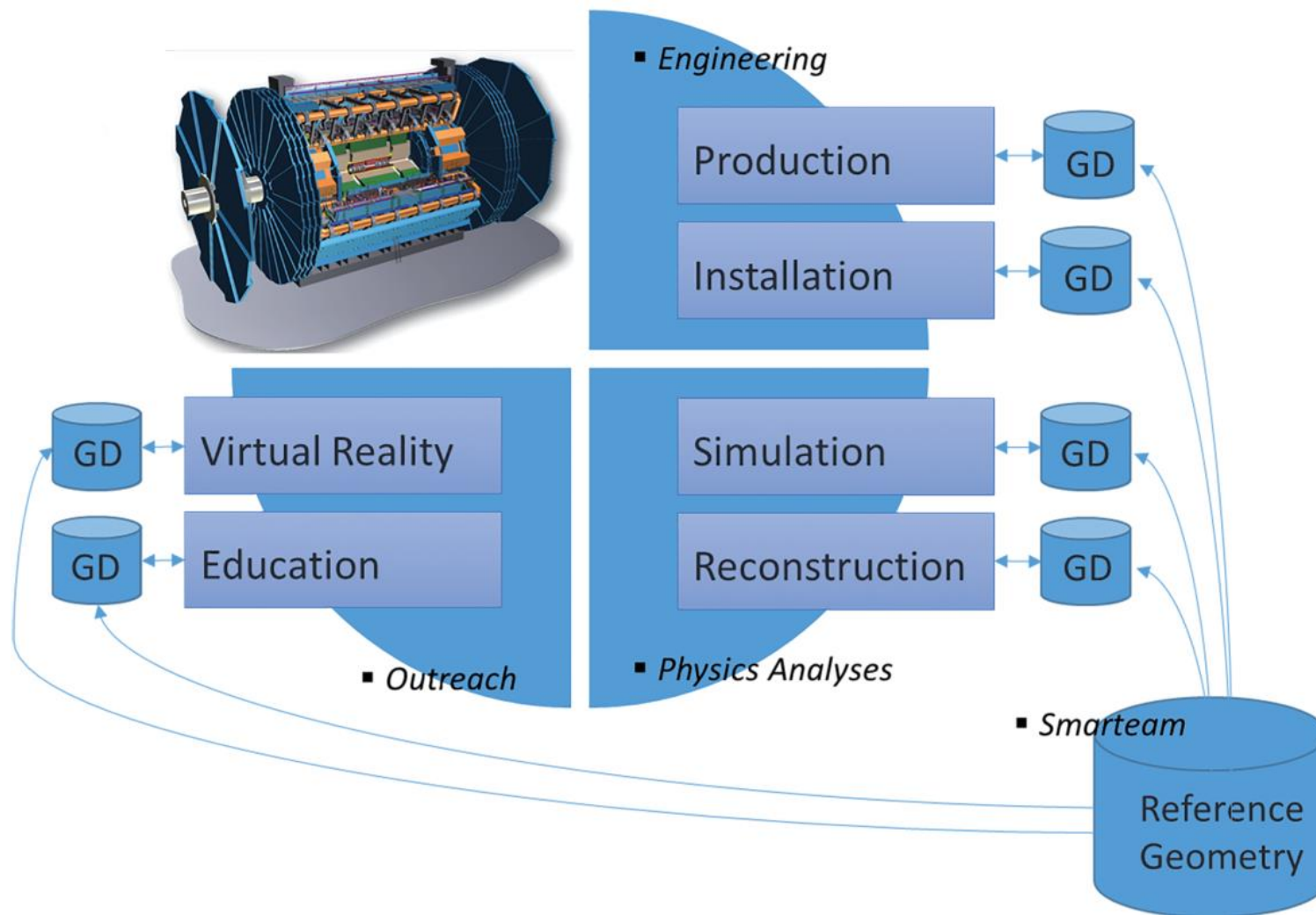


Negative trends:

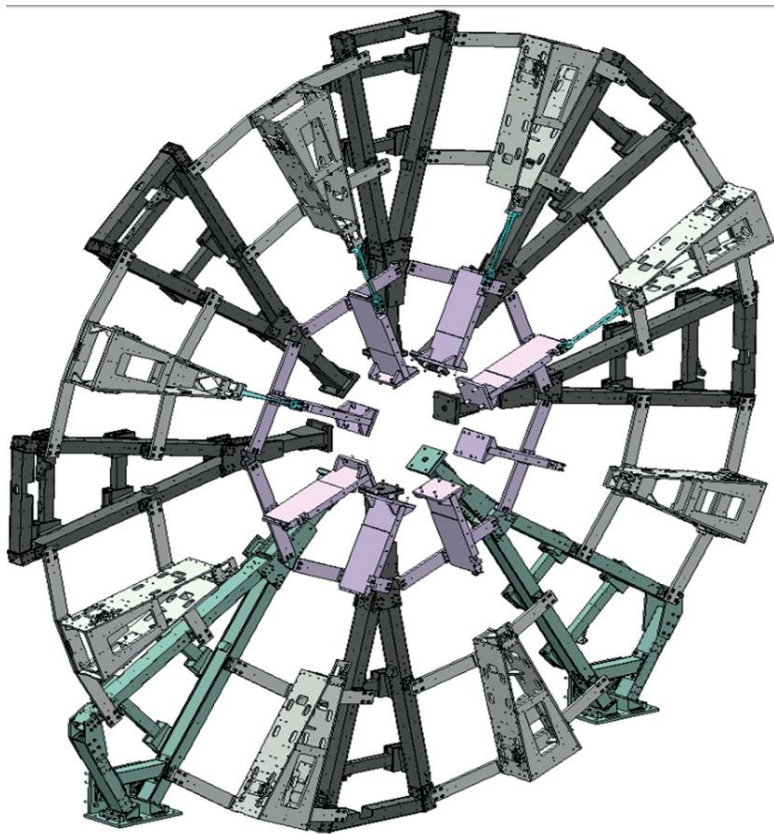
1. Complexity of development
2. Difficultness of upgrade
3. Inaccurateness which affects the precision of the physics analyses
4. A necessity in the highly qualified developer's teams



- Homogeneous System

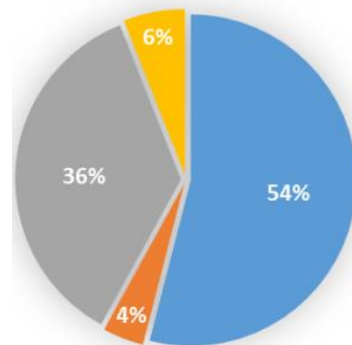


■ EIL/EIS Structure of the Small Wheel



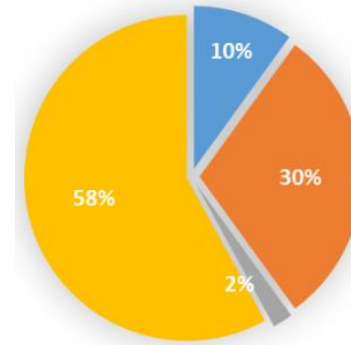
Mechanical Structures		Assemblies		Parts		Primitives
		Number	Sym	Number	Sym	
Spacer	EIL	144	94%	692	98%	119'824
	EIS	177	94%	688	99%	116'628
Spokes	EIL	42	90%	456	97%	35'428
	EIS	18	83%	664	97%	98'912
Hub		14	50%	250	93%	36'156
<i>Total:</i>		395	82%	2750	96%	406'948

Complexity of Geometry



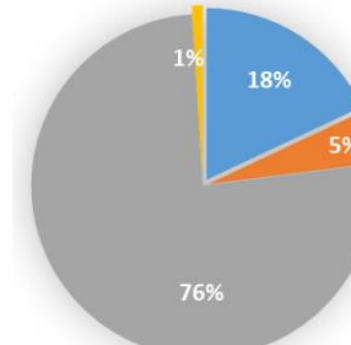
■ Barrel ■ EC TGC ■ EC MDT ■ NSW

Complexity of Parts



■ Barrel ■ EC TGC ■ EC MDT ■ NSW

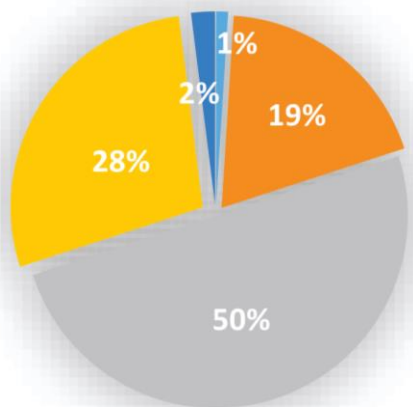
Complexity of Assemblies



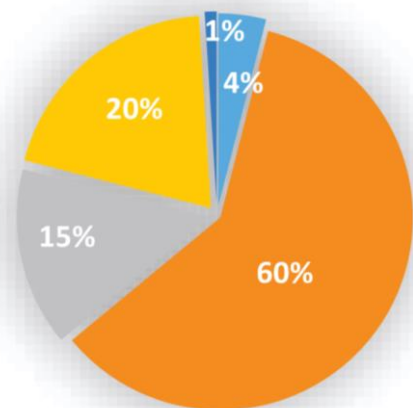
■ Barrel ■ EC TGC ■ EC MDT ■ NSW

- Overall characteristics of Geometry of the ATLAS detector

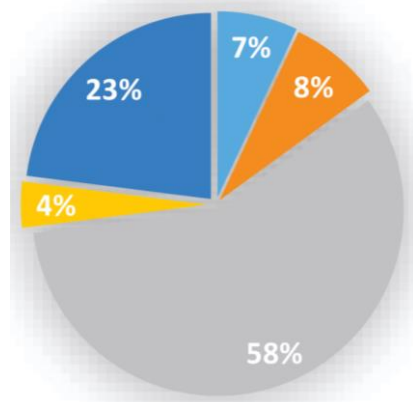
Complexity of Geometry



Complexity of Assemblies

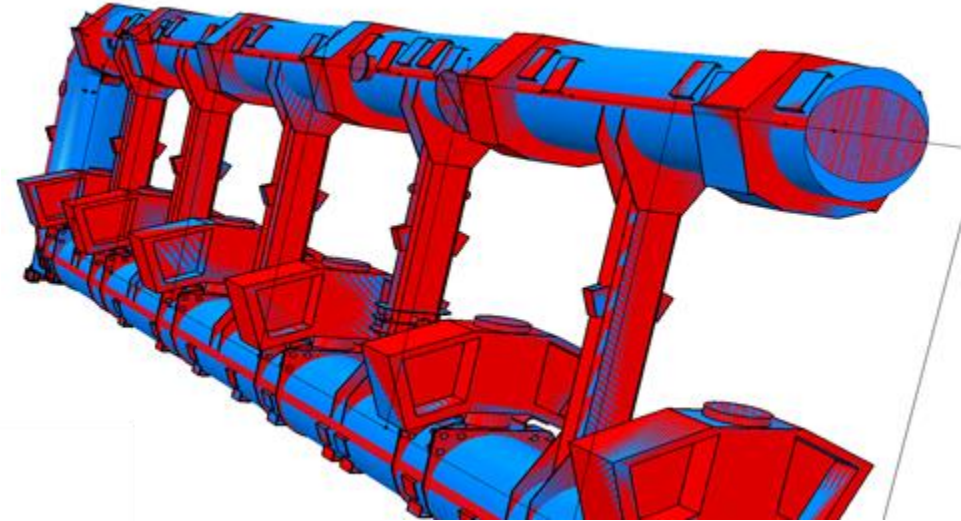
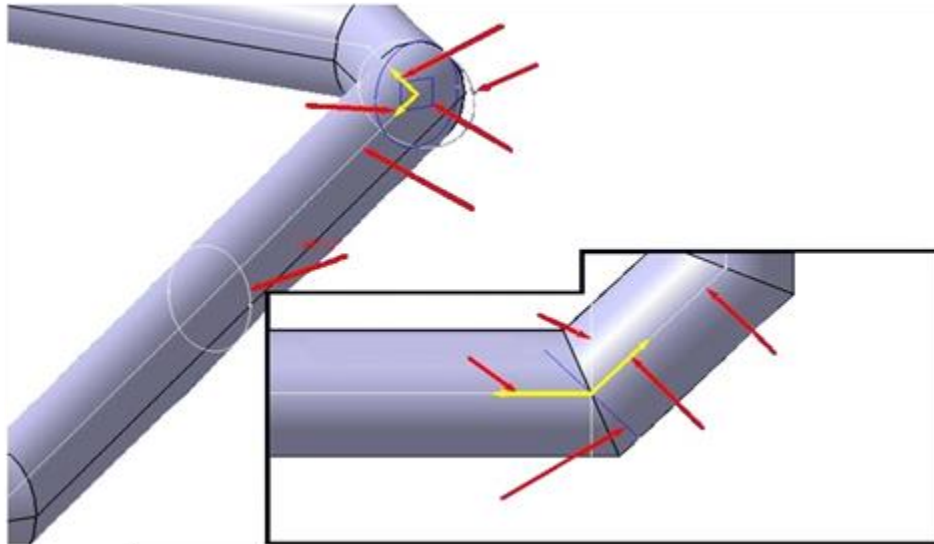


Complexity of Parts

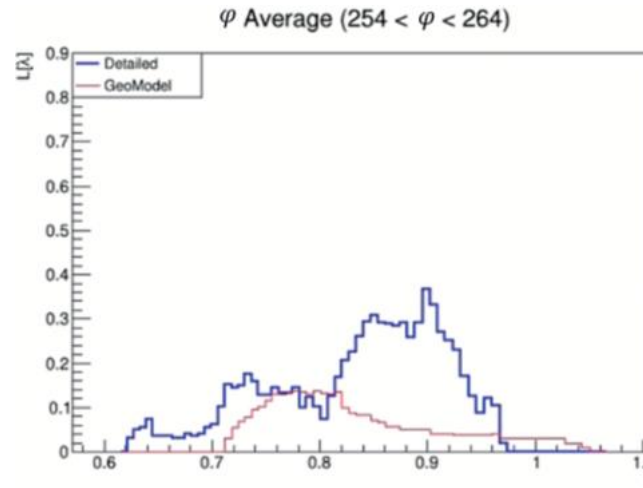
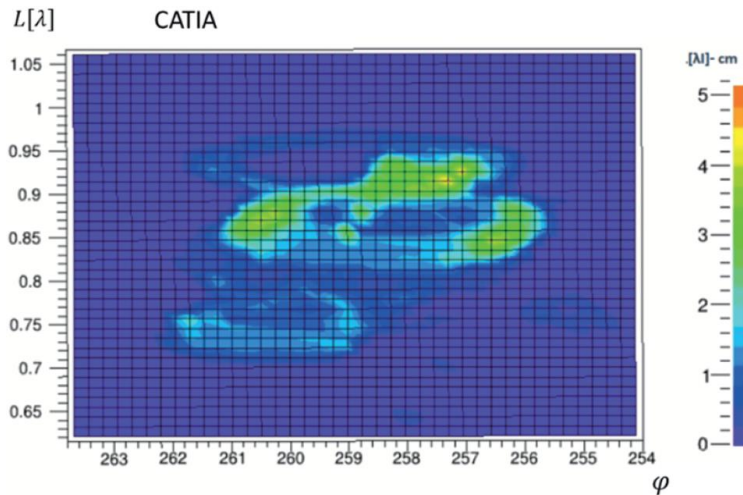


ATLAS Detector	Assemblies	Parts	Primitives
Magnet System	347	16'345	398'924
Inner Detector	413	337'484	9'024'069
Calorimeters	568	119'111	23'490'492
Muon Spectrometer	3'266	915'756	13'380'286
Mechanical Structures	935	9'466	740'028
<i>Total:</i>	5'529	1'398'162	47'033'799

- Geometry Migration
- Geometry Validation
- Geometry Integration



- GEANT/GeoModel/XML Programming
- Modelling Accuracy
- Comparative Analysis of Geometries



CATIA

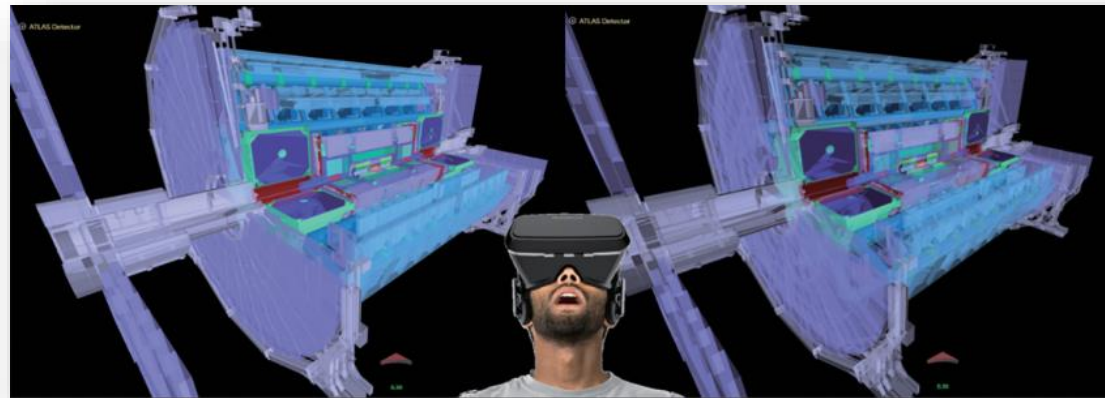
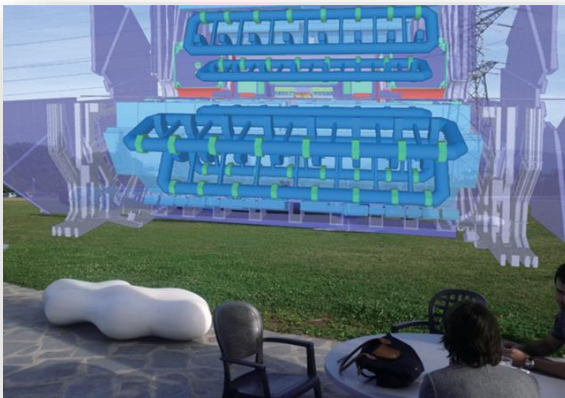
#	Name	Material	Volume (m ³)	Weight (kg)
1	Barrel link	Stainless Steel	0.0013	10
2	Vatterfly valve	Aluminum/Plastic/Stainless Steel	0.00667	21.3
3	gauge	Stainless Steel	0.0000634	0.5
4	Pirani gauge	Stainless Steel	0.0000764	0.6
5.1	Baffle	Stainless Steel / Copper	0.000946	7.2
5.2	Diffusion Pump	Aluminum/Stainless Steel Oil	0.003823	16.6
6	HV angle valve	Stainless Steel	0.000144	1.13
7	Pipe	Stainless Steel	0.000192	1.5
8	Bolts	Stainless Steel	0.000312	2.45
			Total:	61.8

GeoModel

#	name	material	Volume (m3)	Mass (kg)
1	Base Envelope	LArServices8	0.067	23.5
2	Base Plate	Aluminum	0.0027	7.3
3	Bridge Envelope	LArServices8	0.0228	8
			Total:	38.8

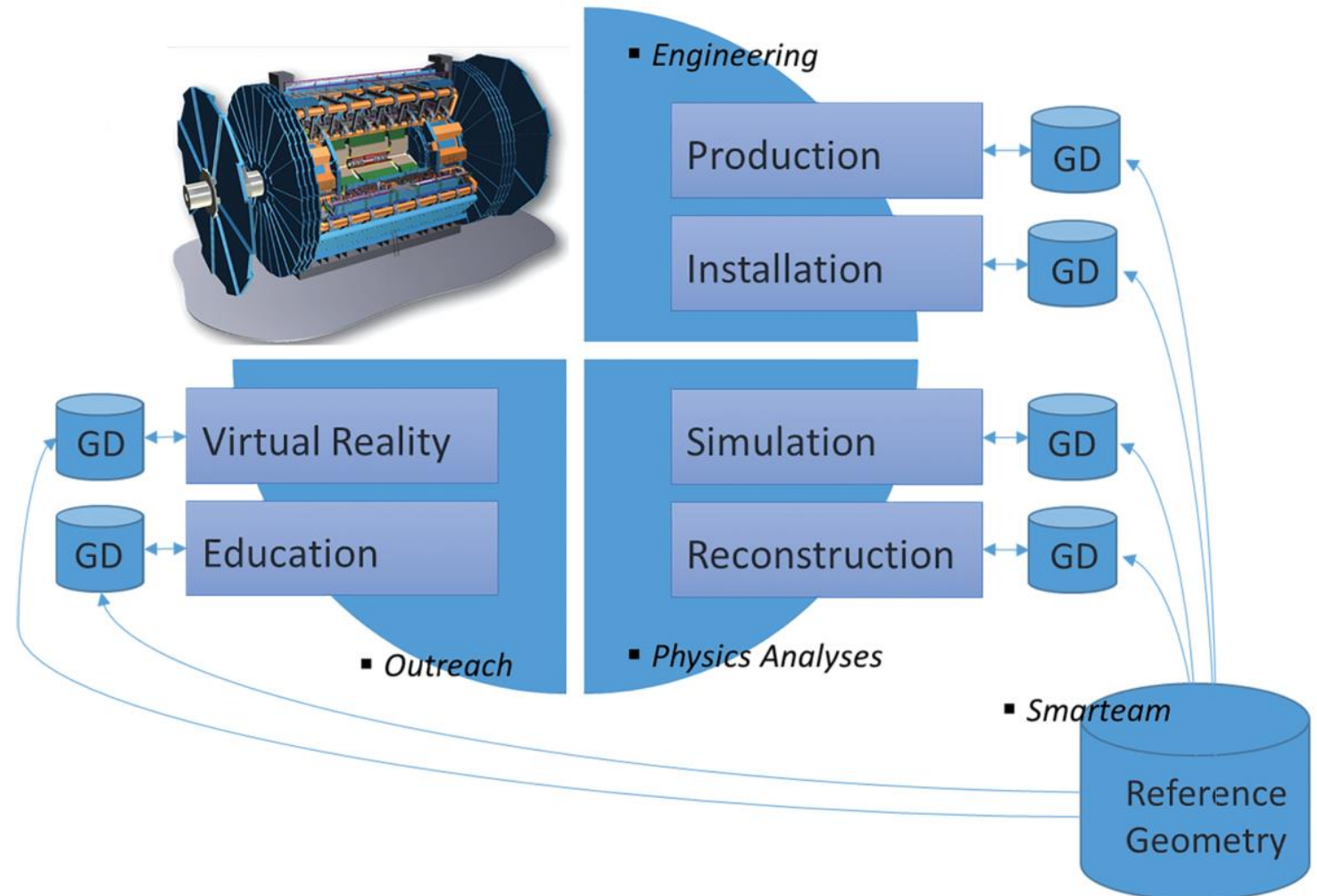
Diff: -23 kg

- The Augmented Reality Applications
- Gaming Engines in the Visualisation Applications
- Internal Methods for Geometry Creation
- Importing Methods of Geometries
- Geometry Cuts in Browsers
- Architecture of the Browser-Based Visualisation Applications

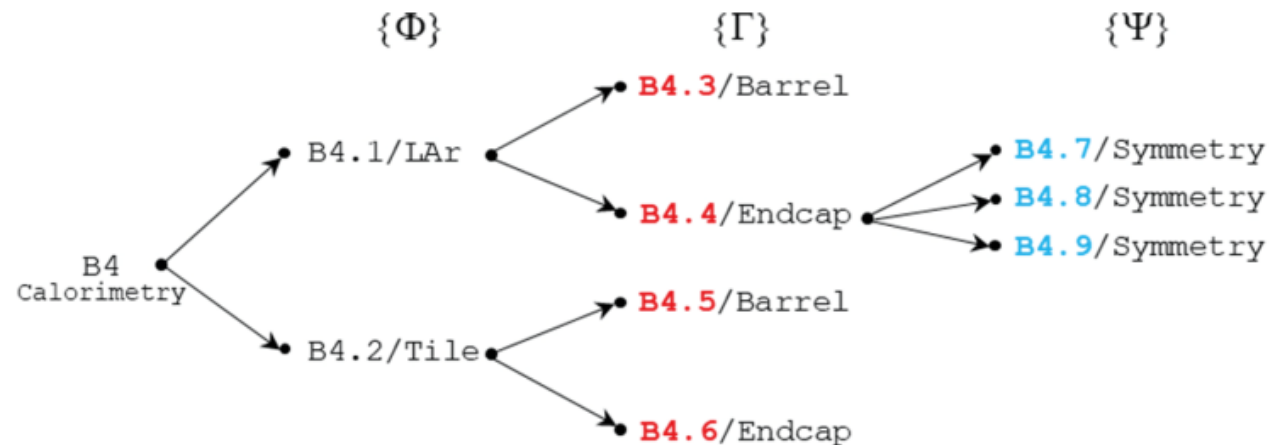


Main Requirements

- Completeness
- Detalization
- 3D dimensionality
- Editability
- Usability

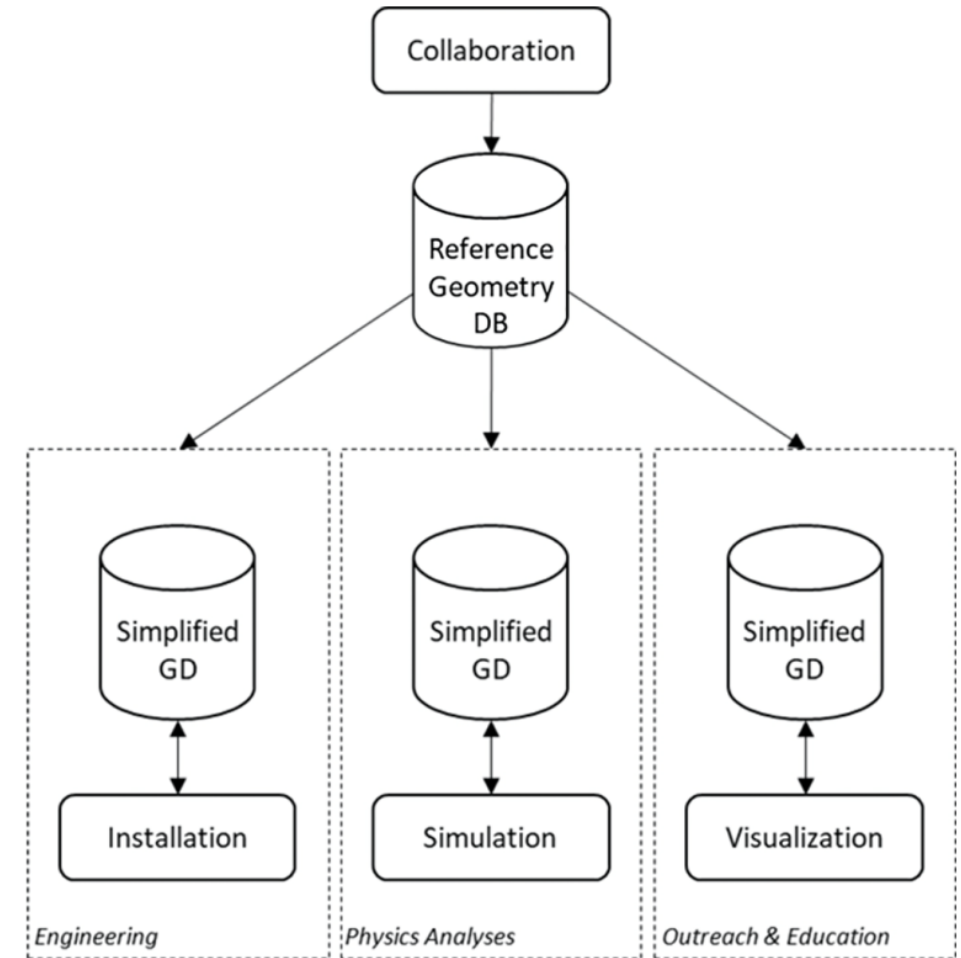
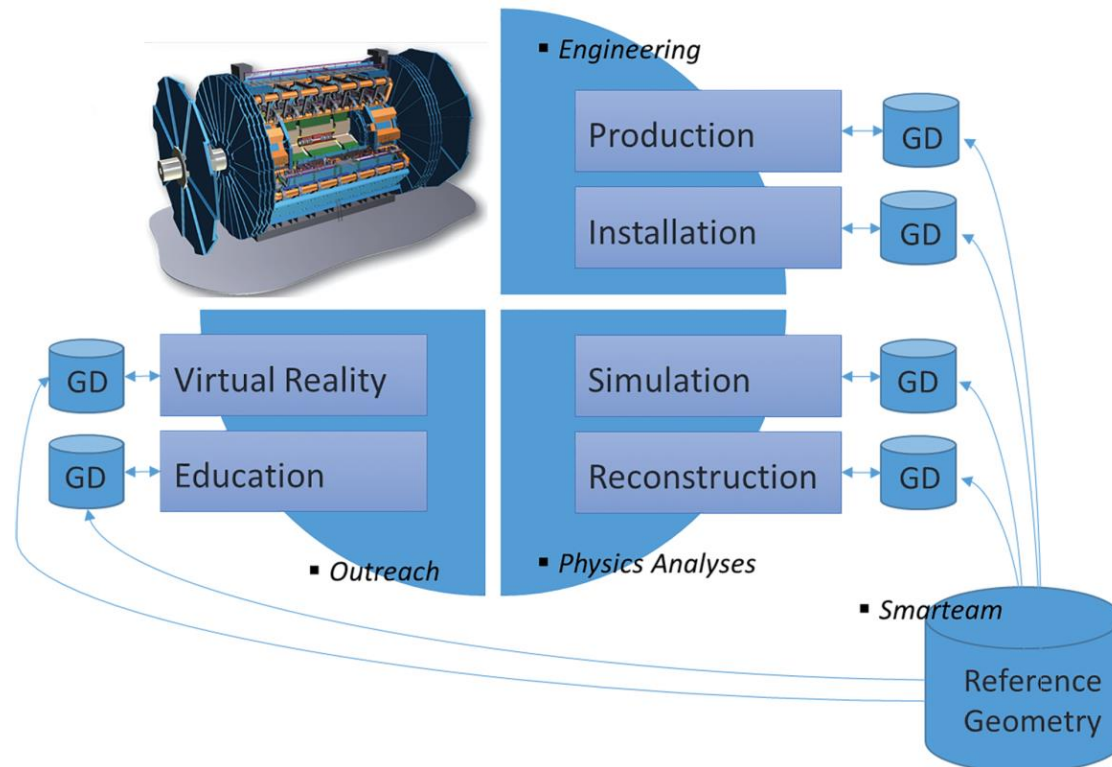


- Decomposition be the $\{\Phi\}$ Criteria: Functionality
- Decomposition be the $\{\Gamma\}$ Criteria: Distribution in Space
- Decomposition be the $\{\Psi\}$ Criteria: Symmetricity
- Final Classification
- Nine levels of the hierarchy and 142 elements for the ATLAS detector

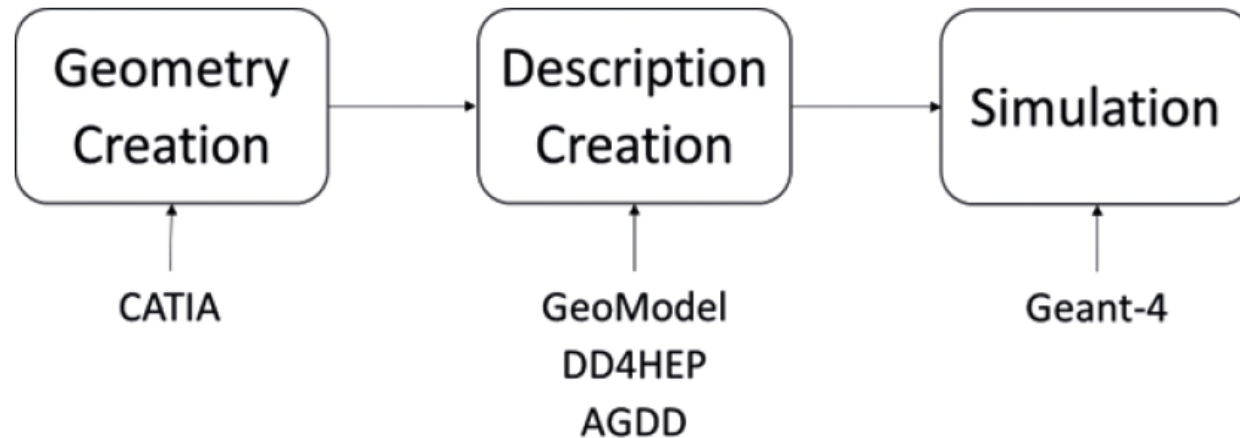


- Main Criteria:
 1. Presence of the Solids
 2. Completeness
 3. Editability
 4. Details
 5. Modularity
 6. Normalization
 7. Integration Conflicts
- Geometry Ranking
- Reproduction of the Geometry

- Simplification for the Engineering
- Simplification for the Simulation
- Simplification for the Visualisation



- Geometry Programming for the Best Simulation Performance
- CATIA Tools for the Radiation Calculations
- CATIA-to-GEANT Interface



Thanks!