



3D METROLOGY
CONFERENCE

3DMC 2022
Aachen

November 15 - November 17

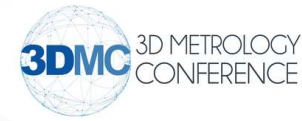


The importance of Virtual Fitting and Uncertainty estimation in Nuclear Fusion field



GEATOP - Who we are

We are a Metrology company based in North-Italy close to Turin



We are Hexagon Technical partner



Authorised Hexagon technical partner

We work on Nuclear Fusion field since from 10 years

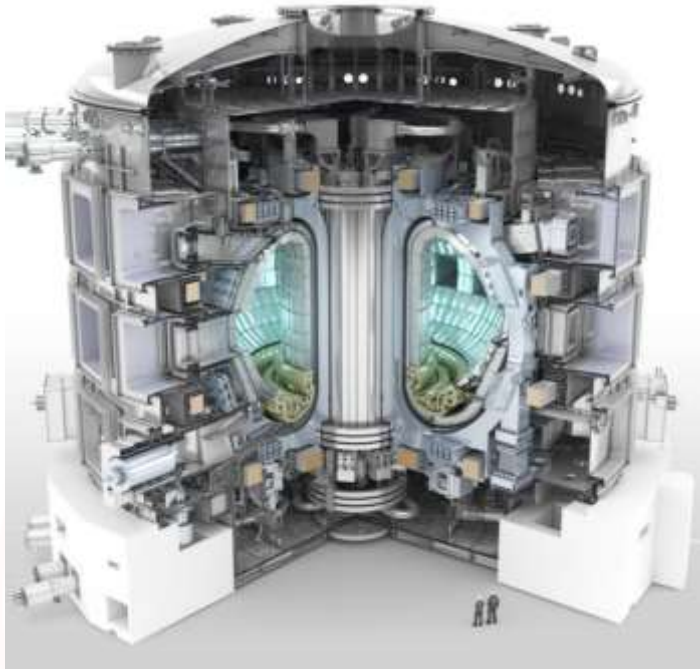


KEYWORDS



- **FIDUCIALS:** fixed points of known coordinates X, Y, Z in reference system
- **LASER TRACKER (LT):** 3D measurement system useful to make Large Volume Metrology with a typical MPE of $15\mu\text{m} + 6\mu\text{m} \cdot \text{meter}$
- **SPATIAL ANALYZER (SA):** metrology software of New River Kinematics (part of Hexagon) used to make measurements, simulation, uncertainty computation, etc..
- **VIRTUAL FITTING (VF):** simulation of two (or more) parts fitting based on real measurements set of data and CAD model (nominal or reversed).
- **ITER PROJECTS:** one of the most ambitious energy projects in the world today.
- **NUCLEAR FUSION:** Fusion is the energy source of the Sun and stars.
- **TOKAMAK:** The tokamak is an experimental machine designed to harness the energy of fusion.

ITER in numbers



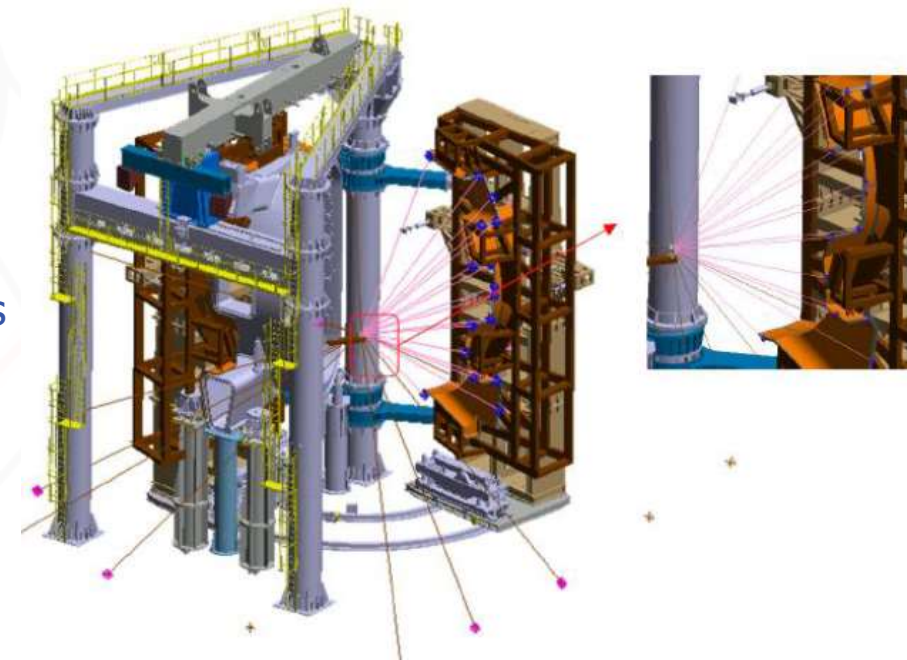
Height: 24 meters

Width: 30 meters

Plasma Radius: 6.2 meters

Total Weight of the Tokamak: 23000 tons

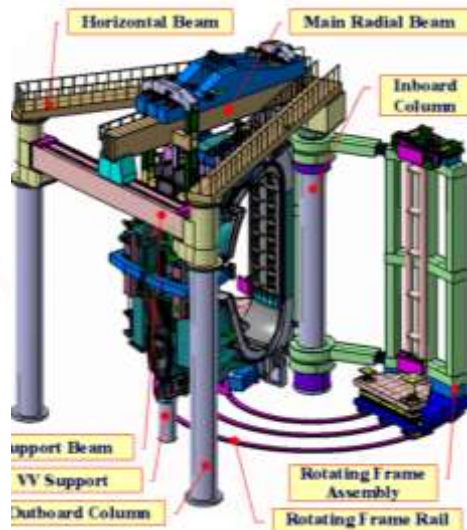
Total Weight of the Vacuum Vessel: 8000 tons



Big numbers, but tight tolerances ($\pm 0.25\text{mm}$ in final positioning!)

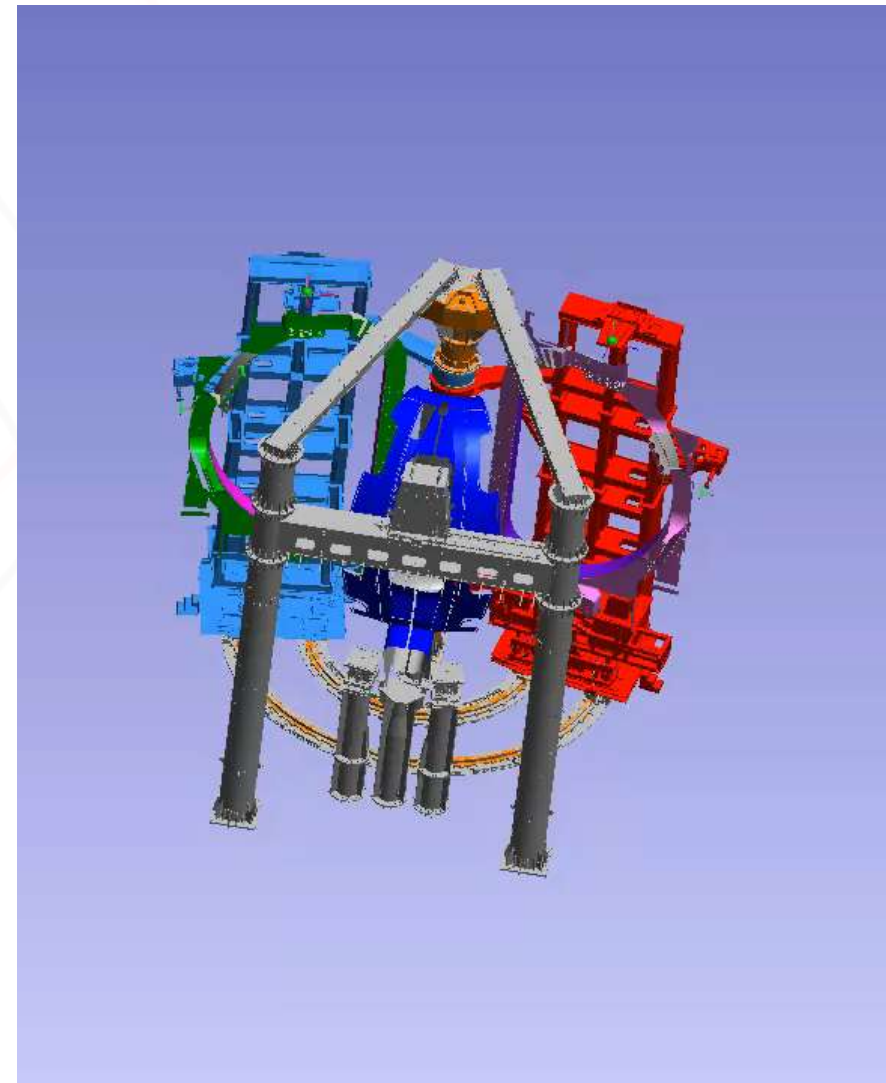
VIRTUAL FITTING (VF)

- **Back office** activity- no impact on the field
- **Risk Assessment** of assembly thanks to **Spatial Analyzer** software
- **Time saving** - no negative impact on time schedule
- **Cost saving**



VF on ITER Assembly

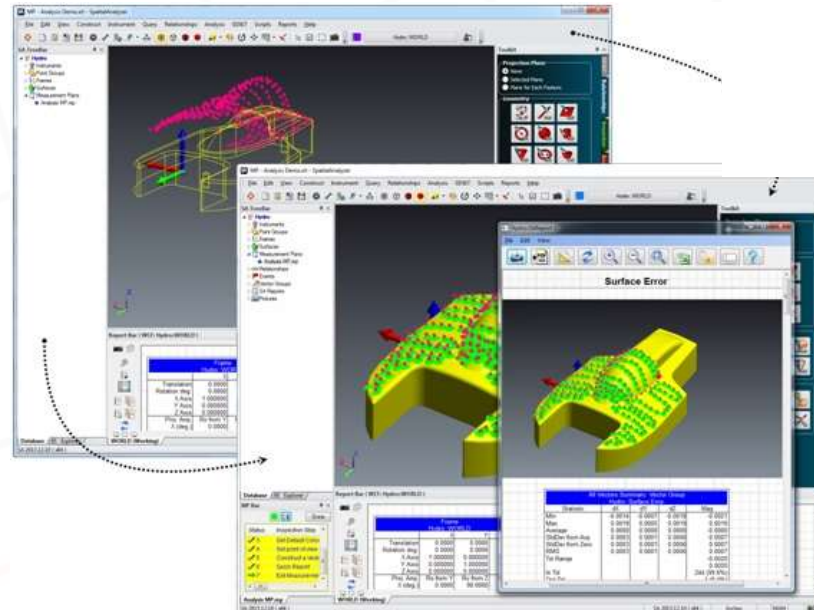
- **Trajectory definition to avoid clashes**
- **Final gap prediction**
- **Final fiducial position prediction**



SCRIPTING

Highly recommended to speed up VF
It could be done directly on SA

Arg	Type	Description	Method	Value
1	Integer	Point Name Index	Enter Value	0
2	String	Point Name List	Enter Value	0
3	String	Point Name	Enter Value	0
4	String	Point Name	Enter Value	0
5	String	Point Name	Enter Value	0
6	String	Point Name	Enter Value	0
7	String	Point Name	Enter Value	0
8	String	Point Name	Enter Value	0
9	String	Point Name	Enter Value	0



Step List

Step Title: Get i-th Point Name From Point Name Ref List (Iterator)

Comment:

Arg	Type	Description	Method	Value
0	Point Name Ref List	Point Name List	Reference	
1	Integer	Point Name Index	Enter Value	0
2	Step ID	Step to Jump at End of List	Enter Value	3
3	String	Collection	Result Only	Result Only
4	String	Group	Result Only	Result Only
5	String	Target	Result Only	Result Only
6	Point Name	Resulting Point Name	Result Only	Result Only

Reference Selection

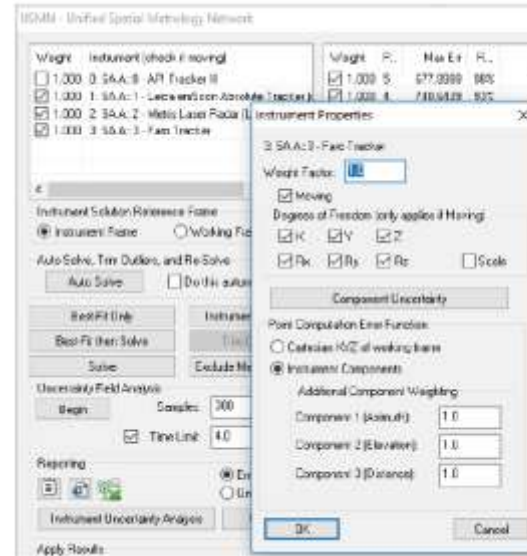
Step Title	Arg0	Arg1	Arg2	Arg3	Arg4	Arg5	Arg6
0 Make a Point Name Ref List - Runtime	[String] (User Provided)	[Point Name Ref List] (Resultant Point Name List)					
1 Get i-th Point Name From Point Name Ref List (Iterator)	[Point Name Ref List] (Point Name List)	[Integer] (Point Name Index)	[Step ID] (Step to Jump at End of List)	[String] (Collection)	[String] (Group)	[String] (Target)	[Point Name] (Resulting Point Name)

Thanks to scripting we save time and we minimize the risks of human error in VF!

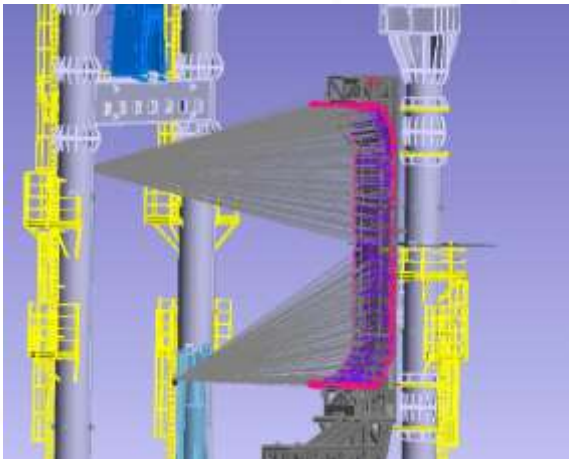
UNCERTAINTY

Fundamental to ensure **good final results!**

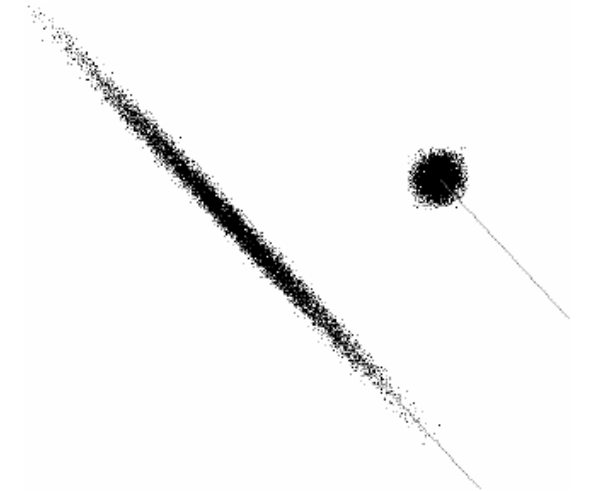
To be **estimated** in advance thanks to simulation



To be **calculated after survey** using real world parameters

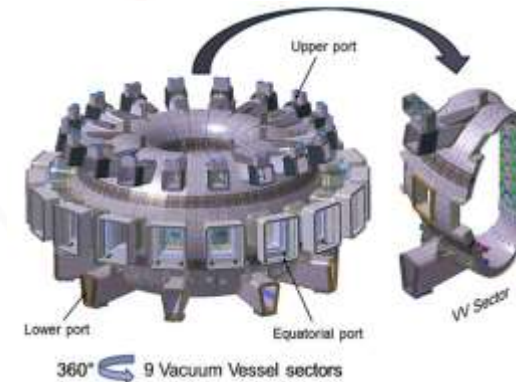


Thanks to uncertainty prediction, we could ensure to be in line with tight tolerances despite the big dimensions!



VF + UNCERTAINTY

The combination of the two, allow us to be **confident** in each manufacturing\assembly step



If metrology is used just in the final phase, its **contribution** to the project is **minimum**

Annex-5_MR-GTP-CWP0122-IWP4-21-00121_V001

TOP Surface:
Uncertainty Max: 0.002mm
Uncertainty Avg: 0.002mm
Flatness: 0.046mm

BOTTOM Surface:
Uncertainty Max: 0.002mm
Uncertainty Avg: 0.002mm
Flatness: 0.092mm

LEFT Surface:
Uncertainty Max: 0.003mm
Uncertainty Avg: 0.003mm
Flatness: 0.122mm

RIGHT Surface:
Uncertainty Max: 0.002mm
Uncertainty Avg: 0.002mm
Flatness: 0.137mm

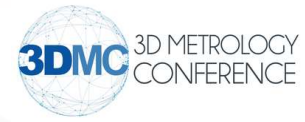
FRONTAL Surface:
Uncertainty Max: 0.002mm
Uncertainty Avg: 0.002mm
Flatness: 0.066mm

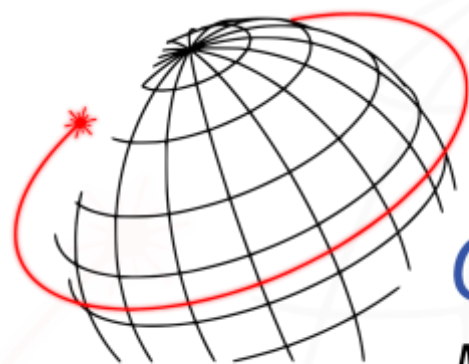
TFC13 INTERNAL GAP

SA 2022.2.0624.8 (1.0)4 | WORKING FRAME: G0&T Analysis: Frame - | Page 2 / 6
LOCKED (REVISED 08.10.20) | UNIT: Millimeter | LOCKED (REVISED 08.10.20)

Use metrology during all the process, since from the preparatory activity, is the best way to **minimize risks!**

Q&A





GEATOP
Metrology & Survey

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