

ADDITIVE MANUFACTURING IN THE CHARACTERIZATION OF HIGH-ENERGY TOMOGRAPHIC SYSTEMS

Dr. Stefano Benuzzi NDT Department Manager Special Process Level 3 (PT – RT Film – RT Non Film)







CENTER OF COMPETENCE IN MATERIALS TESTING

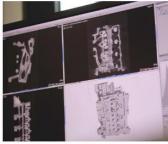






















CAMPOGALLIANO, (MO)



87 PERSONNEL



MORE THEN 5000 S.M. OF TESTING AREA





\$

COMPANY PROFILE



INDUSTRIES

Aerospace & Defence Automotive & Racing Medical Devices Oil & Gas Packaging Other industrials



PROCESS EXPERTISE

Additive Manufacturing Composite Materials Welding



Destructive testing
Non Destructive testing
Reliability
Certification
Inspection
Training
Failure analysis
Computed tomography



TECHNICAL

STAFF

IWE - International Welding Engineers
IWT - International Welding Technologists

ISO 9001:2015 EN 9100: 2018

ISO/IEC 17025:2018 - ACCREDIA ISO/IEC 17024:2012 - ACCREDIA

ISO/IEC 17065:2012 - ACCREDIA

NADCAP AC 7101 for Materials Testing

NADCAP AC 7114 for Non Destructive Testing Leonardo Aircraft | Leonardo Helicopters

ITANDTB CAE for NDT Qualification

ASTER Rete Alta Tecnologia Emilia Romagna





Material Engineers | Mechanical Engineers

Chemists | Physicists | Metallurgists

IWI - International Welding Inspectors

Composites Experts

Paints and Coating Experts

NDT 3rd Level | NDT 2nd Level



TEC EUROLAB CT HARDWARE

2013

NSI X5000 CT SYSTEM

Scan volume: D = 500 mm, H = 1200 mm

Max payload: 90 kg Max resolution: 5 μm

SOURCE: X-Ray WorX 240				
SOURCE. A-Ray Work 240				
X-Ray Tube Typology	Open, microfocus			
Maximum Voltage	240 kV			
Maximum Power	350 W			
Focal Spot Size	5 μm			
FLAT PANEL DETECTOR: Varian 2520 DX				

TEAT TAREE BETEGIOR: Varian 2020 B		
Pixel pitch	127 µm	
Sensible Surface 250x200 mm		
Maximum Acquisition Speed	12.5 fps - 30 binning	
Greyscale resolution	16 bit	
Caladillatan	Casium	



NSI X7500 CT SYSTEM

Scan volume: D = 1500 mm, H = 3000 mm

Max payload: 250 kg Max resolution: 70 μm

SOURCE: Varian HPX 450-11			
X-Ray Tube Typology	Closed, minifocus		
Maximum Voltage	450 kV		
Maximum Power	1500 W		
Focal Spot Size	0.4 mm		

FLAT PANEL: PE XRD 1621 AN14 ES

200 μm	
400x400 mm	
15 fps - 30 binning	
16 bit	
DRZ + (Gadox)	

LDA: Detection Technology 0.4iHE2-922

3,		
Pixel pitch	400 µm	
Length	92 cm	
Integration time	30-1550 fps	







PERSONNEL EVOLUTION

NORTH STAR IMAGING

2013

2019



CT personnel qualified 2rd & 3rd level EN 9712

Personnel qualified training 2rd & 3rd level EN 4179

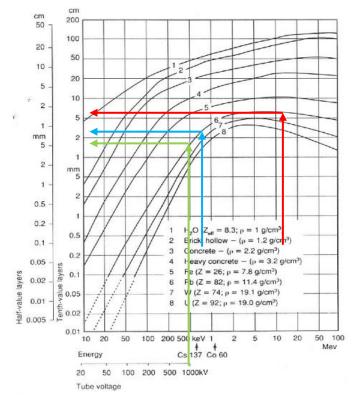


TEC EUROLAB CT HARDWARE



2019: D7 6 MEV LINAC





Manipulator:	6-Axes granite-based	
Variable FDD:	1500 – 4000 mm	
Scanning envelope:	D = 1000 mm, H = 2000 mm	
Max payload:	200 kg	
Max dose rate:	2.5 Gy/min @ 3 MeV, 9.0 Gy/min @ 6 MeV	
High resolution Line Detector Array:	length 600 mm, pixel pitch 200 μm	
3K Flat Panel Detector 4343 HE:	active area 417 x 417 mm, pixel pitch 139 μm	

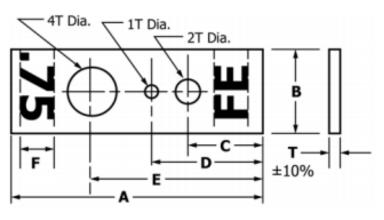






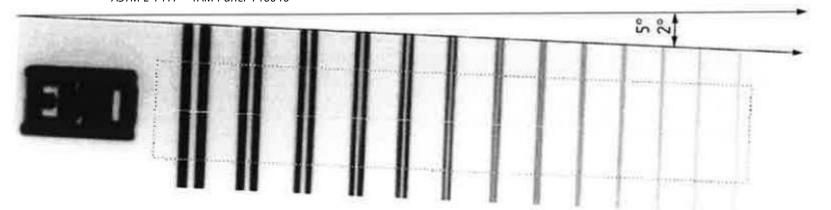
NON DESTRUCTIVE TESTING...





ASTM E 1742 - Hole Type IQI





Duplex Wire – Non Film Radiography

English Version

Aerospace series - Qualification and approval of personnel for non-destructive testing

Série aérospatiale - Qualification et agréssent du personnel pour les essois que destructifs Luft- und Bannführt - Qualifizierung und Zulassung des Personals für zerstärungsfreie Prüfungen

This European Standard was approved by CEN on 22 July 2016.

CEN rembers are beard to camply with the CEN/CENLLEC internal Regulations which stigulate the conditions for giving that heropean Searchied the states of a national standard without any polaration. Up an-date that and tablographic intervenes encourage path national standards may be obtained an application to the CEN-CENELEC Management, Centre or to any CEN members.

This European Standard exists in three official ventions (English, Princit, German). A version in any other language made by translation under the responsibility of a CEN element into its own language and notified to the CEN CENELEC Management Centre has the same estate as the efficial ventions.

GEM revelbers are the national standards besten of Austria, Belgister, Redgaria, Crossia, Cypera, Carch Bepublic, Peteraris, Emmis, Feland Former-Yagotion Republic of Marcedonia, France, Germany, Greece, Hengary, Kerlend, Feland, Taly, Larvia, Ethiosiana, Lacombaurg, Malta, Netherlands, Nervauy, Foland, Portugal, Rortunia, Serbia, Shyudda, Shrueria, Spain, Sweden, Switzerland, Turker and Uteria Ricadems.



CEN-CENELEC Munagement Centre: Avenue Marnis 17, B-1000 Brussels

EN 4179 – Qualification and approval of personnel for non destructive testing





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...VS CT

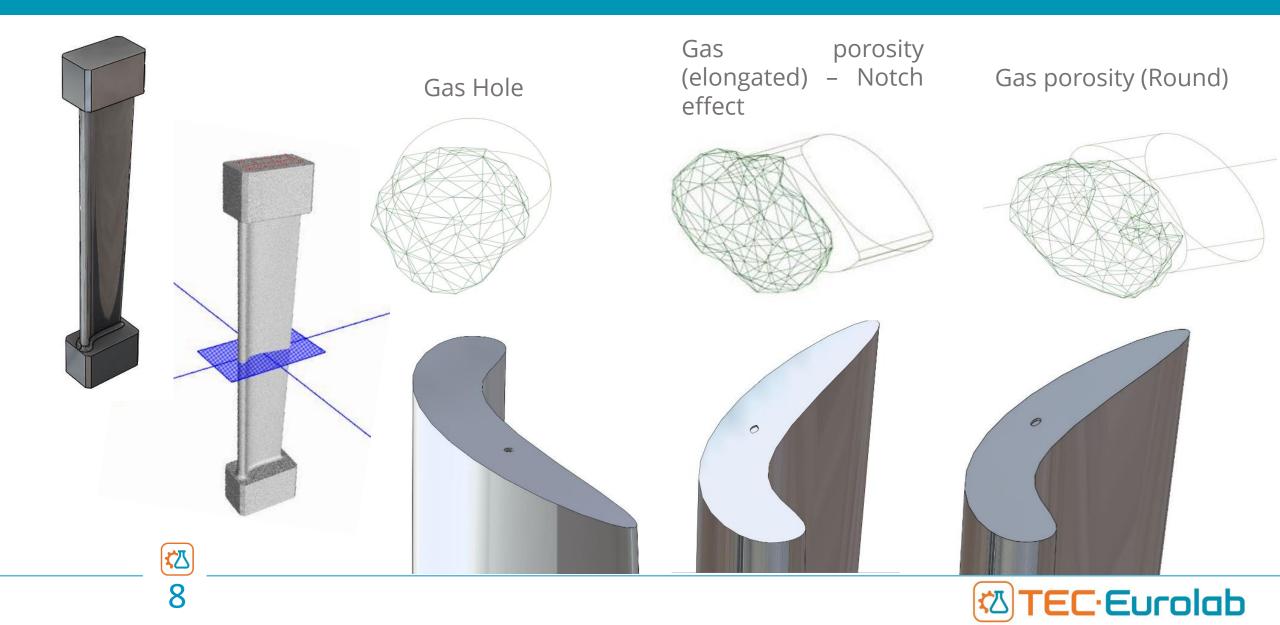
- **ASTM E 1695:** standard test method for Measurements of Computed Tomography (CT) system performance
- **ASTM E 1441:** Guide for Computed Tomography (CT) Imaging
- ASTM E 1570: Practice for Computed Tomography (CT) examination
- **ASTM E 1316:** Terminology for Non Destructive Examination
- Customer specifications
- Absence of a clear regulatory framework and method framing as well as other Non-Destructive Controls
- There is a lack of unique requirements for the definition of the quality of the tomographic image, ensuring that proper control is carried out for the purpose of dimensional or defective detections
- Additive Manufacturing is the fabrication process which, with the manufacturing of samples containing artificial defects, can help characterizing a tomographic system and checking for their stability





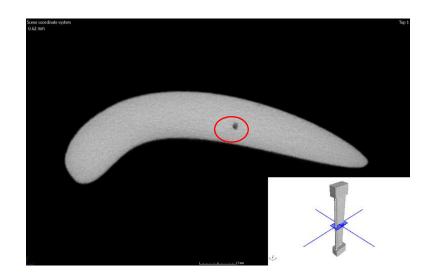
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RQI PART 1



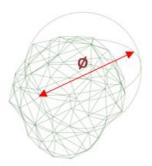


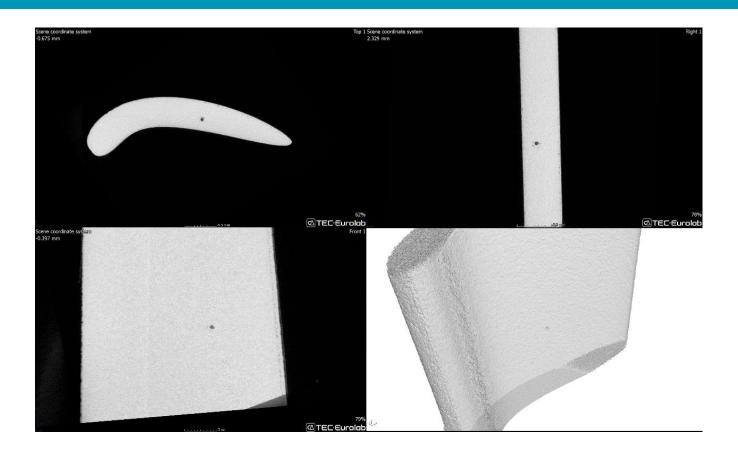
RQI PART 2



Gas Hole

• Ø 0,8mm





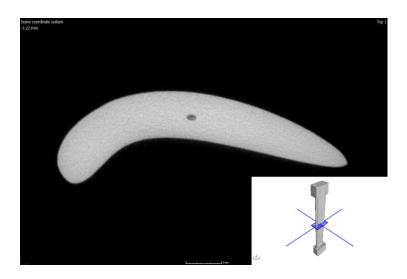
- Maintaining the rounded geometry of the defect
- Partial collapse of printed geometry





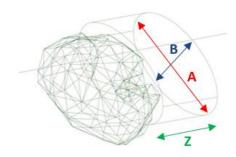


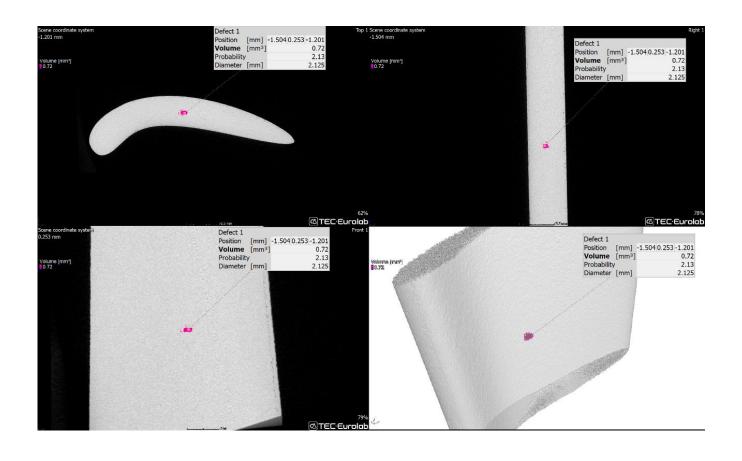
RQI PART 3



POROSITA' ALLUNGATA (rounded)

- Z 0,5mm
- A 1,3mm
- **B** 1,0mm



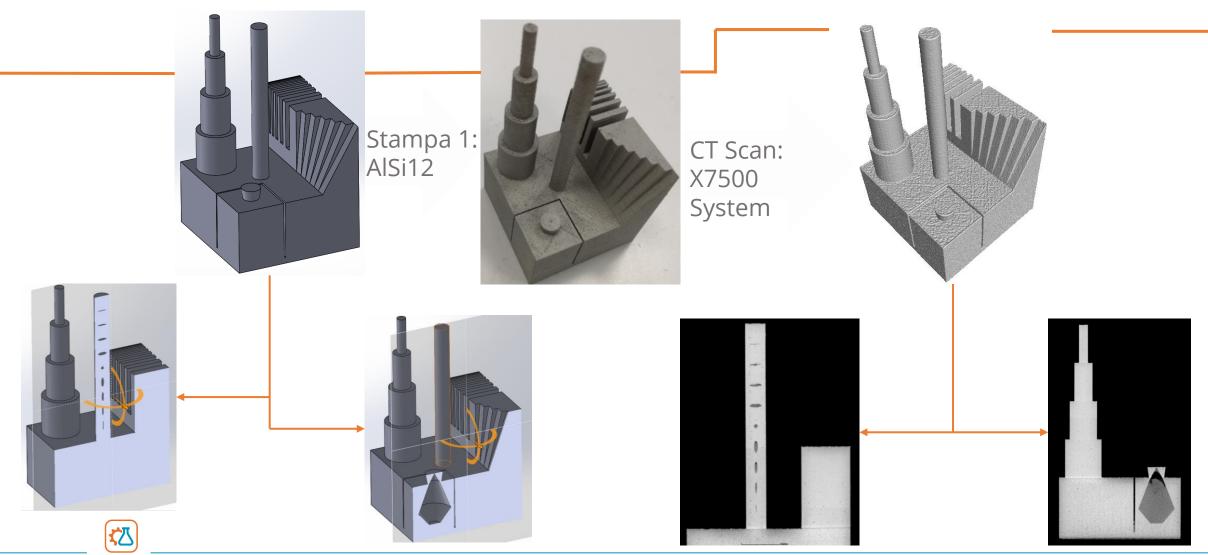








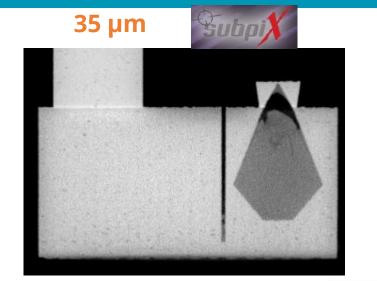
CASE STUDY 2: AL ALLOY RQI DESIGN

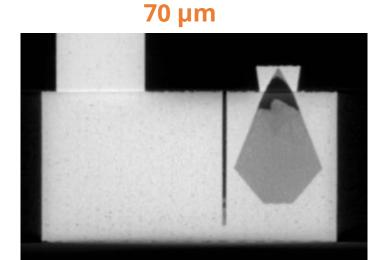


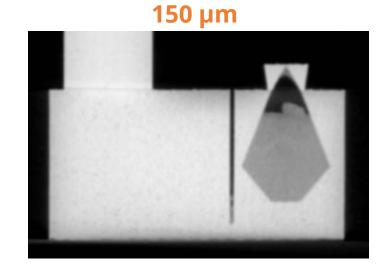
TEC·Eurolab



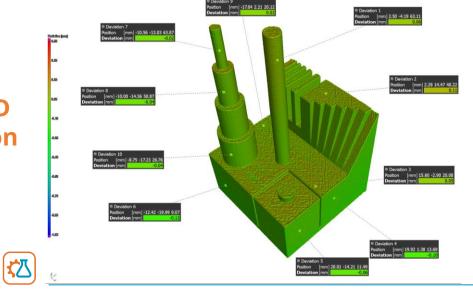
CASE STUDY 2: RQI INSPECTION WITH X7500



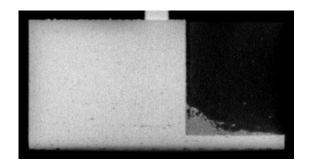




Analisi CAD Comparison



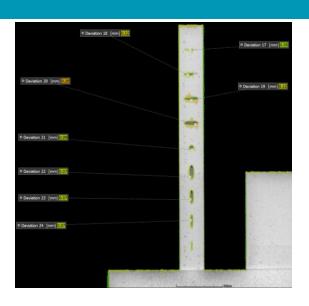
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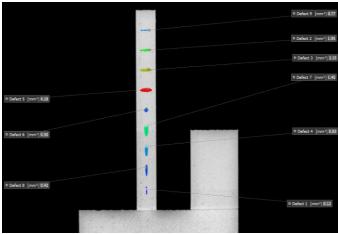


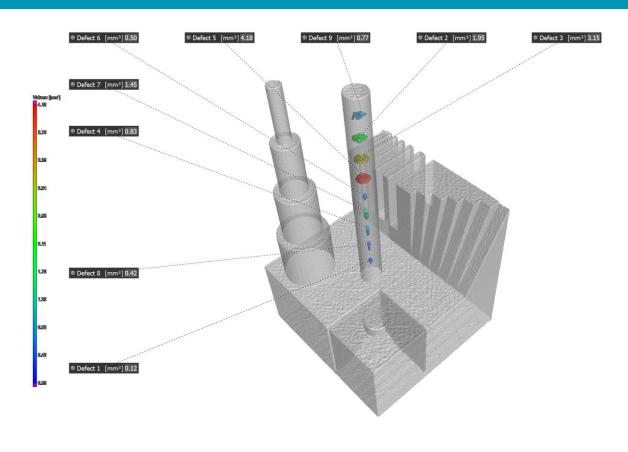


CASE STUDY 2: POROSITY EVALUATION







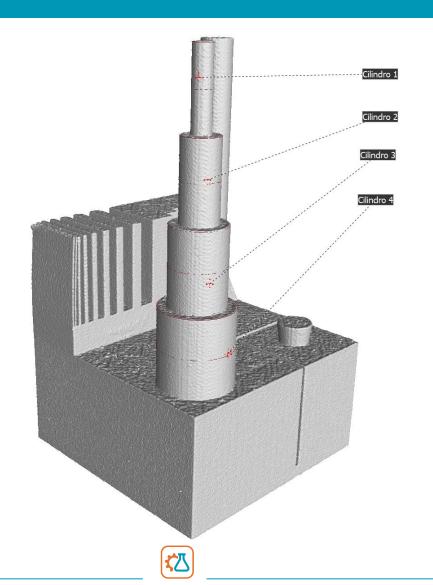


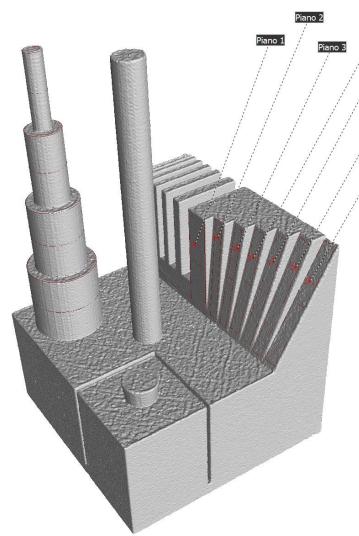






CASE STUDY 2: DIMENSIONAL EVALUATION



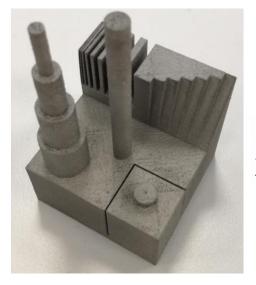


Name	Type	Source A	Act. value [mm/deg]
Feature 1	Diameter	Cylinder 1	3.01 mm
Feature 2	Diameter	Cylinder 2	6.00 mm
Feature 3	Diameter	Cylinder 3	8.99 mm
Feature 4	Diameter	Cylinder 4	11.97 mm
Feature 5	Coaxiality	Cylinder 2	0.09 mm
Feature 6	Coaxiality	Cylinder 3	0.19 mm
Feature 7	Coaxiality	Cylinder 4	0.23 mm
Feature 8	Angle	Plane 2	4.99 deg
Feature 9	Angle	Plane 3	9.99 deg
Feature 10	Angle	Plane 4	14.98 deg
Feature 11	Angle	Plane 1	19.96 deg
Feature 12	Angle	Plane 1	24.93 deg
Feature 13	Angle	Plane 7	30.88 deg





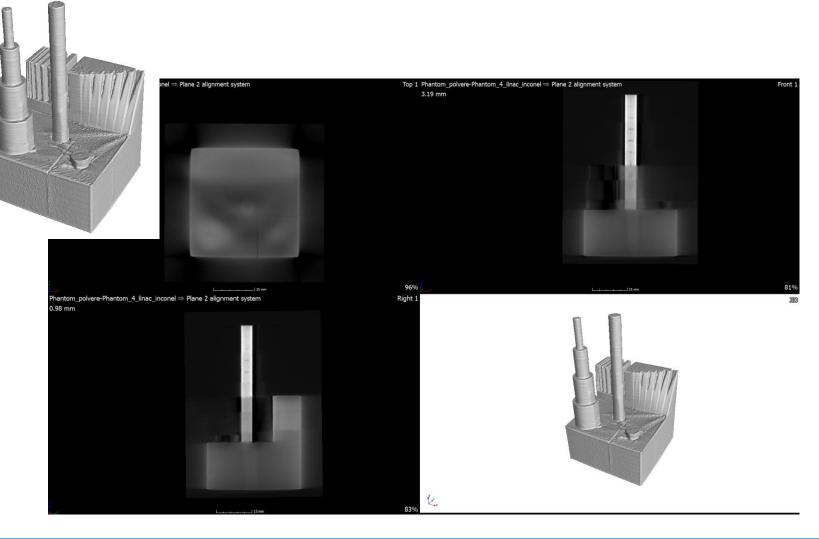
CASE STUDY 2: NI ALLOY RQI DESIGN



CT Scan: X7500 System

Scan performed on X7500 system. High noise, non-rebuildable surface.

Absence of features detectability



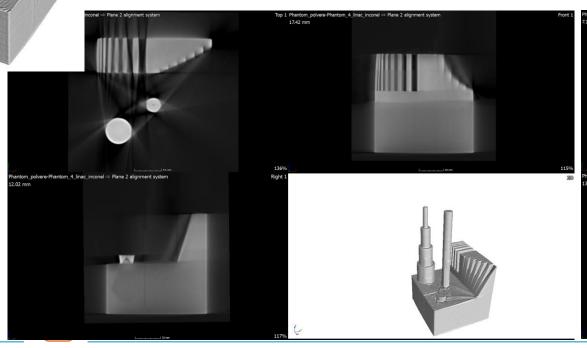


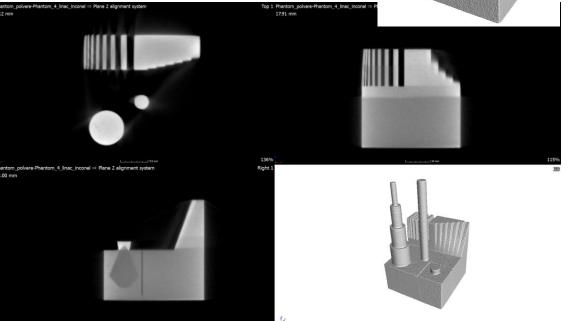




CASE STUDY 2: X7500 VS LINAC



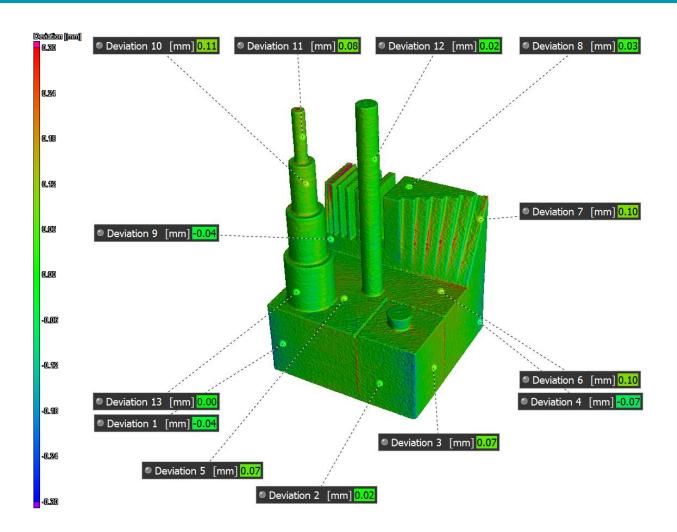








CASE STUDY 2: NI ALLOY RQI CAD COMPARISON LINAC









CONCLUSIONS

- CT technology currently has far fewer reference standards than other non-destructive techniques
- The validation of tomographic systems is mostly done through best practices and scans of components with known or artificial discontinuities.
- Additive technology, with the possibility to engineer artificial discontinuities represents a paradigm shift in the validation of tomographic systems, which until now depended on unrepresentative RQI or EDM holes that do not represent real discontinuities
- The implementation of more and more precise reference standards, combined with additive technology, will allow the CT to fill, in the short term, the current regulatory gap compared to other techniques







Per ricevere la presentazione completa scrivere a <u>marketing@tec-eurolab.com</u>







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