

# Diagnostic tools for X-Ray 3D-CT

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- Marco Bontempi, Istituto Ortopedico Rizzoli, Bologna, Italy

**Place of Work:**


- Department of Physics and Astronomy, University of Bologna

**Collaborations:**

- INFN TT\_CHNet
- INFN CNAF & INFN\_TTLab
- Sistema Museale di Ateneo, Università di Bologna
- Istituto Ortopedico Rizzoli, Bologna
- ION+, Roma
- ENEA, Frascati
- Max Planck Institute for Evolutionary Anthropology, Leipzig, Germany

# Diagnostic tools for X-Ray 3D-CT

## Project main goal and results achieved in 2017



### CT Systems



Hardware and software upgrade of the mobile CT systems



Design of a new CT for the "Science And Heritage@Fermi" project

### CT Applications



Radiographies and Tomographies *in situ*:

- Human skeletal remains for Anthropology
- Pontormo paintings
- Egyptian sarcophagus
- Ancient Japanese masks

### Outreach



European Researchers' Night 2017

# Diagnostic tools for X-Ray 3D-CT

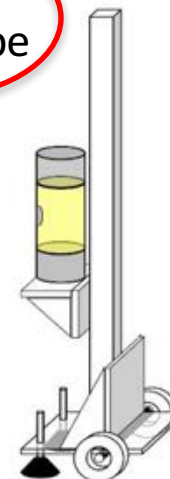
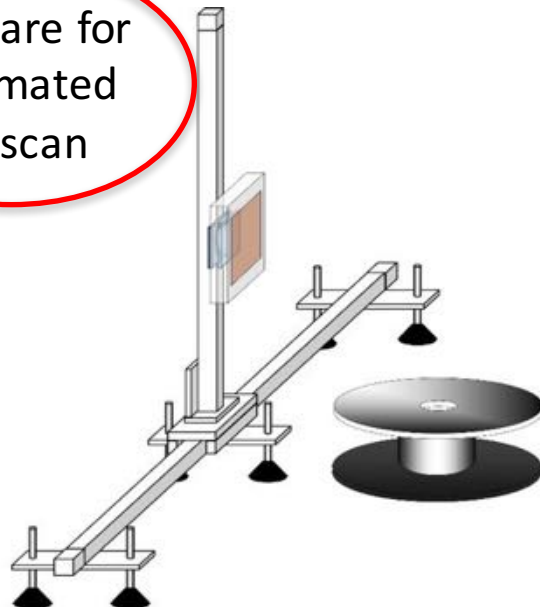
## Project main goal and results achieved in 2017

CT  
Systems

Hardware and software upgrade  
of the mobile CT system  
for large-scale objects

Software for  
automated  
x-y scan

New  
X-ray tube



**SMART EVO 200D**  
- Yxlon -

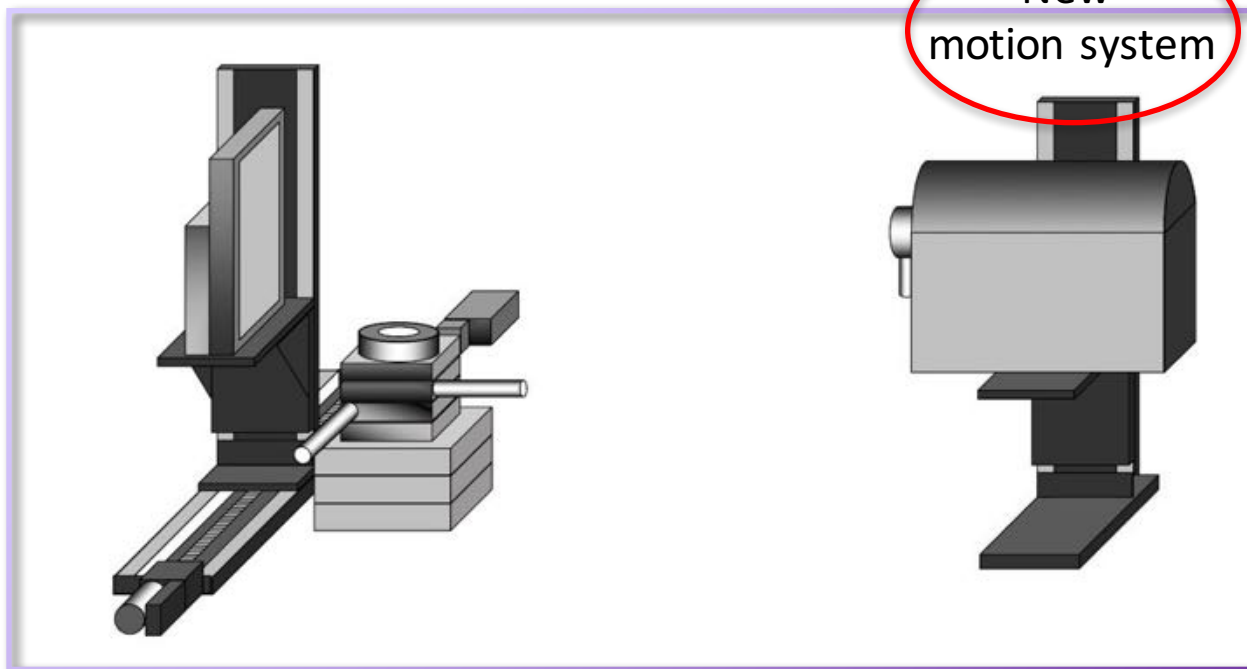
- ❖ 30-200 kV
- ❖ 0.5 – 6 mA
- ❖ 750 W
- ❖ 1 mm focal spot
- ❖ 23 kg

# Diagnostic tools for X-Ray 3D-CT

## Project main goal and results achieved in 2017

CT  
Systems

Hardware and software upgrade  
of the mobile CT system  
for medium-size objects



New  
motion system

**M521-DD**  
Linear stage  
- PI -

- ❖ 204 mm range
- ❖ 0.1  $\mu\text{m}$  resolution
- ❖ 100 kg max. load

# Diagnostic tools for X-Ray 3D-CT

## Project main goal and results achieved in 2017

CT  
Systems

A new CT system for  
"Science And Heritage@Fermi" project



**X-ray Cabinet**

- ❖ 2.64 x 2.20 x 2.30 m
- ❖ Up to 200 kV
- ❖ 7-14 mm Pb



**X-ray Tube  
SITEX D3206**  
by Teledyne ICM

- ❖ 90-320 KV
- ❖ 1-6 mA
- ❖ 60x40 beam angle
- ❖ 2.5x2.5 mm focal spot



**X-ray Detector  
XRD 1622**  
by Varian (now Varex)

- ❖ 41 x 41 cm
- ❖ 200  $\mu$ m pixel
- ❖ 14 bit
- ❖ 1 fps

# Diagnostic tools for X-Ray 3D-CT

## Project main goal and results achieved in 2017



Pontormo  
 Palazzo Vecchio Firenze



Pontormo Project (IPERION call): Radiography and tomography investigation of 20 wooden paintings by Jacopo Pontormo. Painted in the 1514, were originally part of the “Carro di San Giovanni Battista”, the main wagon of the “Funzione degli Omaggi” procession – 24 June.

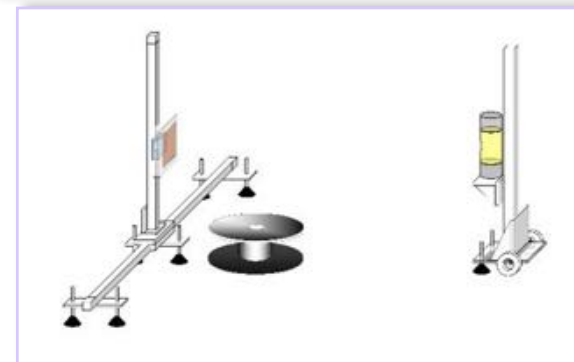


CT  
 Applications



Roma, March 2018 - PTA

Mobile CT system for large-size objects

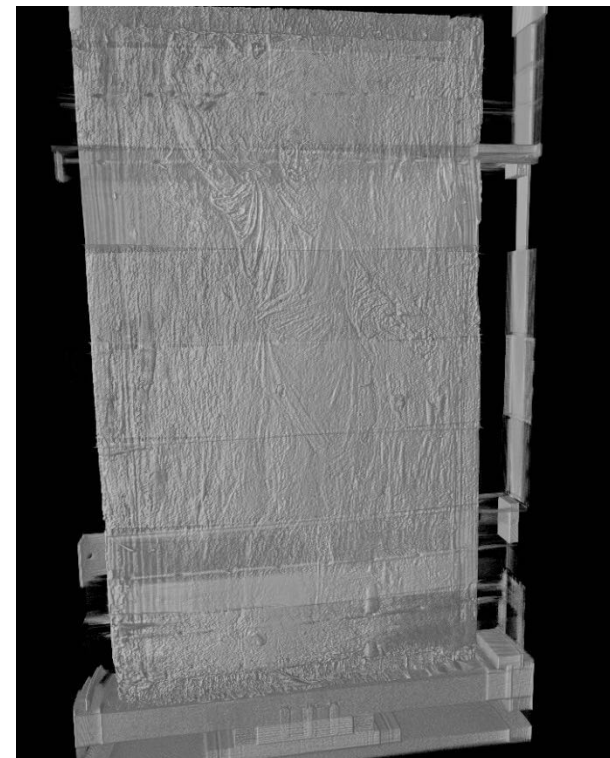
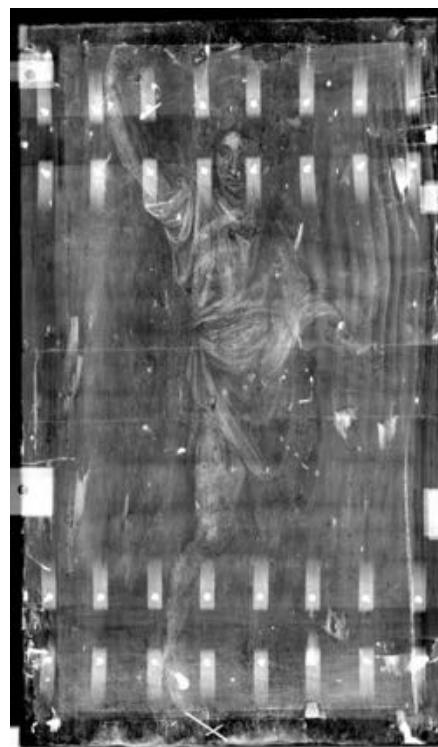


**Radiographies:** 35 KV and 3 mA  
 1 fps and 200  $\mu$ m

**Tomographies:** 100 KV and 1,8 mA  
 5 fps and 338  $\mu$ m

# Diagnostic tools for X-Ray 3D-CT

## Project main goal and results achieved in 2017



San Giovanni Battista  
74 x 43 x 2.8 cm<sup>3</sup>  
(stitch. 9 x 6 FOV)

# Diagnostic tools for X-Ray 3D-CT

## Project main goal and results achieved in 2017

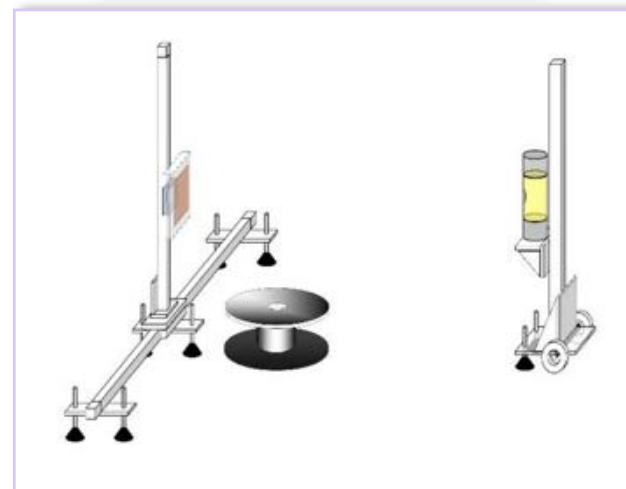


Egyptian sarcophagus  
Museo Civico Archeologico di Bologna



CT  
Applications

Mobile CT system for  
large-size objects



**Tomographies:** 150 KV and 2,2 mA  
5 fps and 336  $\mu\text{m}$



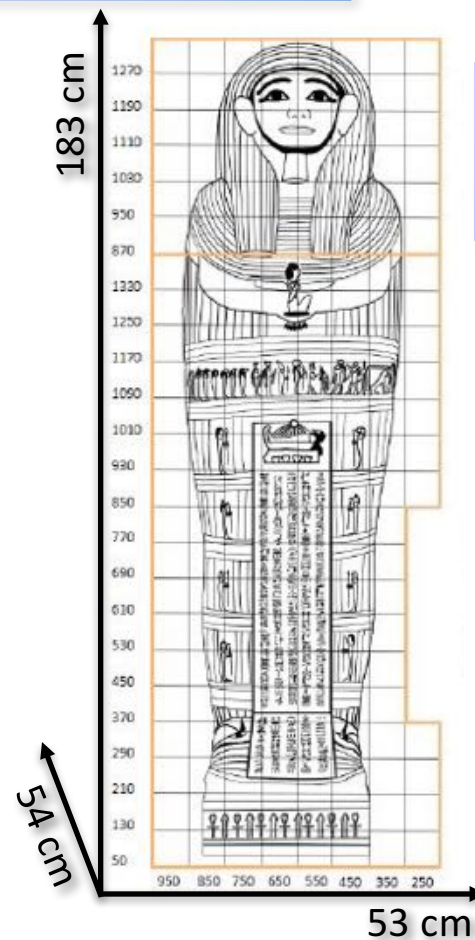
# Diagnostic tools for X-Ray 3D-CT

## Project main goal and results achieved in 2017

Stitching of  $8 \times 23$  FOV for  $53 \times 54 \times 183 \text{ cm}^3$



Egyptian sarcophagus  
Museo Civico Archeologico di Bologna



$8 \times 23$  FOV  
184 Tomographies  
3 min each  
17 h

CT  
Applications

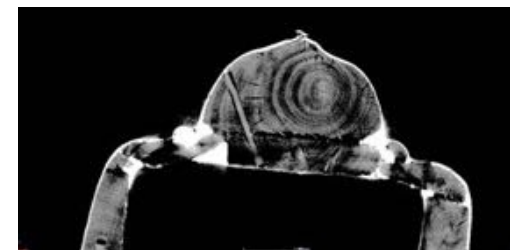
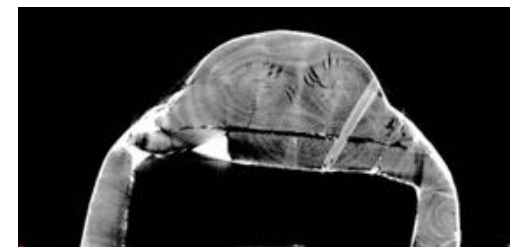
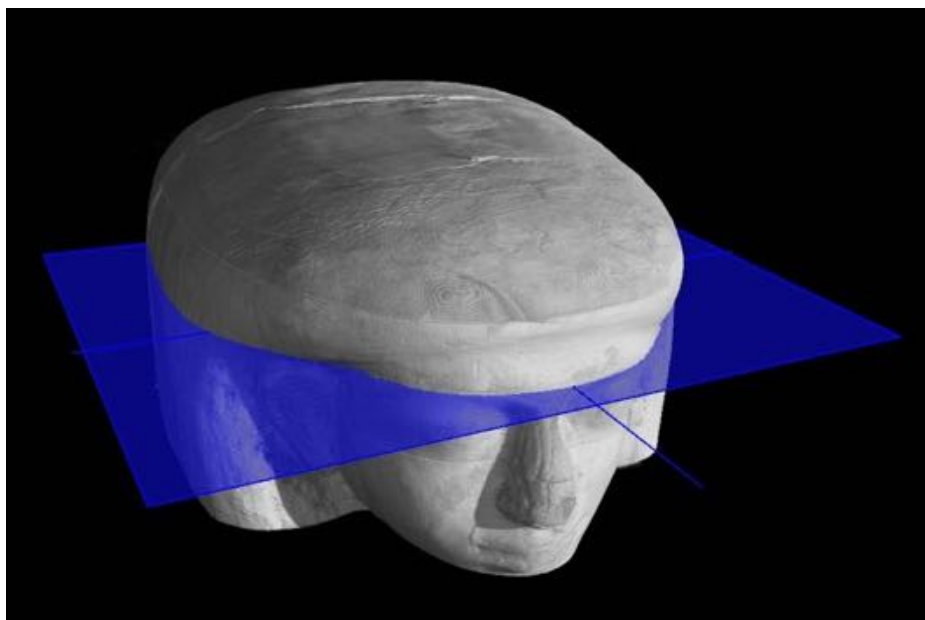
# Diagnostic tools for X-Ray 3D-CT

Project main goal and results achieved in 2017



# Diagnostic tools for X-Ray 3D-CT

## Project main goal and results achieved in 2017



# Diagnostic tools for X-Ray 3D-CT

## Project main goal and results achieved in 2017



Ancient Japanese masks  
 Istituto Superiore per la Conservazione e il Restauro - Roma



MATEGIAPPI Project (IPERION call): Tomography investigation of 7 of a series of 13 wooden Japanese mask, from 1662 to XIX century covering all variety of ancient Japanese theater



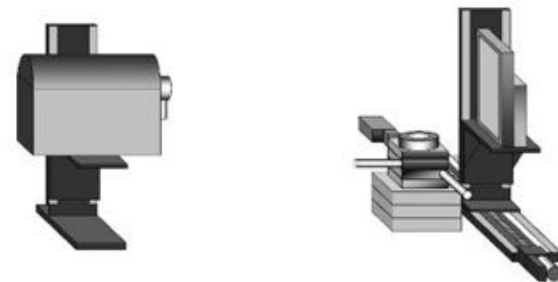
IPERION CH

CT  
 Applications



Roma, March 2018 - PTA

Mobile CT system for medium-size objects



**Tomographies:** 100 KV 160  $\mu$ A  
 2 fps 98  $\mu$ m  
 Usually stitching of 2 FOV for 20 x 18 cm

# Diagnostic tools for X-Ray 3D-CT

Project main goal and results achieved in 2017



# Diagnostic tools for X-Ray 3D-CT

## Project main goal and results achieved in 2017



Karasu Tengu  
XIX century

(21.5x17,2x16,7 cm<sup>3</sup>)

# Diagnostic tools for X-Ray 3D-CT

Project main goal and results achieved in 2017



# Diagnostic tools for X-Ray 3D-CT

## Project main goal and results achieved in 2017



Outreach

- European Researchers' Night 2017
- Holographic box to show CT rendering
- Holographic box for smartphone and tablet







## CT Systems

### Milestones 2018

- Hardware upgrade of the mobile CT system for large-scale objects

- Hexapod motors for alignment



- CT for "Science And Heritage@Fermi"

- Final design & construction

### Plan of activities 2018-2020

- New (& lighter) X-Y stage



- Fully operational Lab

## Milestones 2018

## Plan of activities 2018-2020




CT  
Applications




Tomographies *in situ*



 Statue Polimateriche  
(Massa)



 Ecce Homo  
Antonello da Messina

## Milestones 2018

## Plan of activities 2018-2020



Outreach

- ❏ European Researchers' Night 2018
- ❏ Japanese masks exposition in Rome

# Diagnostic tools for X-Ray 3D-CT

## Expected funding in the 3-year period



### ➤ Request of funding by Centro Fermi

- *Grant: 1 for 2018-2019*
- *Specific Consumables: 15 k€ per year*
- *Inventory: Contribution for an high-energy gantry-type tomographic facility 30 k€*

### ➤ Potential external funding

- INFN TT\_CHNet: 20 K€

# Diagnostic tools for X-Ray 3D-CT

&

# Dynamic AngioThermography (DATG)



**Thank you for your attention**