

Fire Investigation in Italian Waste Treatment Plant: lessons learned and future development

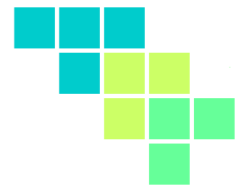
Ing. Alfredo Romano (General Manager TRR S.r.l.)
Ing. Giovanni Romano (General Manager RSM S.t.p.)



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TRR (TECNOLOGIA RICERCA RISCHI)



Who we are

TRR is a private, independent consultant company that operates in Health, Safety and Environmental field since 1984. Its headquarter is in Italy.

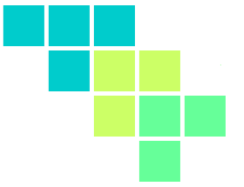


Where we operate

- ✓ Oil & Gas, Gas and Oil Field
- ✓ Storage and Refining
- ✓ Iron & Steel Industry
- ✓ Chemistry
- ✓ Transport of dangerous goods

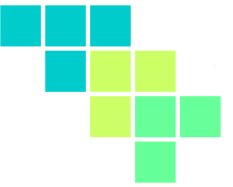
Our service

- ✓ Hazard and Operability Analysis
- ✓ Audit & Training (Existing Plant)
- ✓ Quantitative Risk Assessment (QRA)
- ✓ Safety and Integrity Analysis
- ✓ Fire prevention (Fire Engineering)
- ✓ Health, Safety and Environmental Engineering
- ✓ Modelling and software



SCOPE

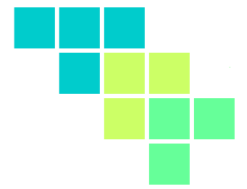
- ❑ In June 2017, in the north of Italy, a serious fire occurred in a waste treatment plant (entire warehouse was involved)
- ❑ The scope of this intervention is to present fire modeling in order to establish if the sequence of events leading up to the accident could be suitable with developing times of the fire event
- ❑ Results from the simulation have been compared with information and evidences collected on field



SUMMARY OF THE PRESENTATION

1. Fire Event description
2. Fire Data collection
3. Fire Modeling
4. Conclusions about incident investigation
5. Future Development

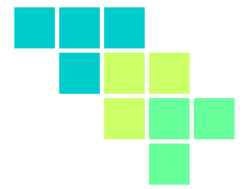
1. EVENT DESCRIPTION



- ❑ Warehouse site near industrial area (petrolchemical plant)
- ❑ Warehouse surface: 2960 m²
- ❑ Warehouse height: 12 m
- ❑ Fire duration: 5 hours



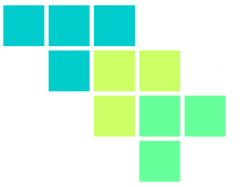
2. FIRE DATA COLLECTION



- Personell interview (after fire event)
- Fire Brigade and Local Authorities official report
- Management information and interview

FLASH OVER ($t > 900$ s)

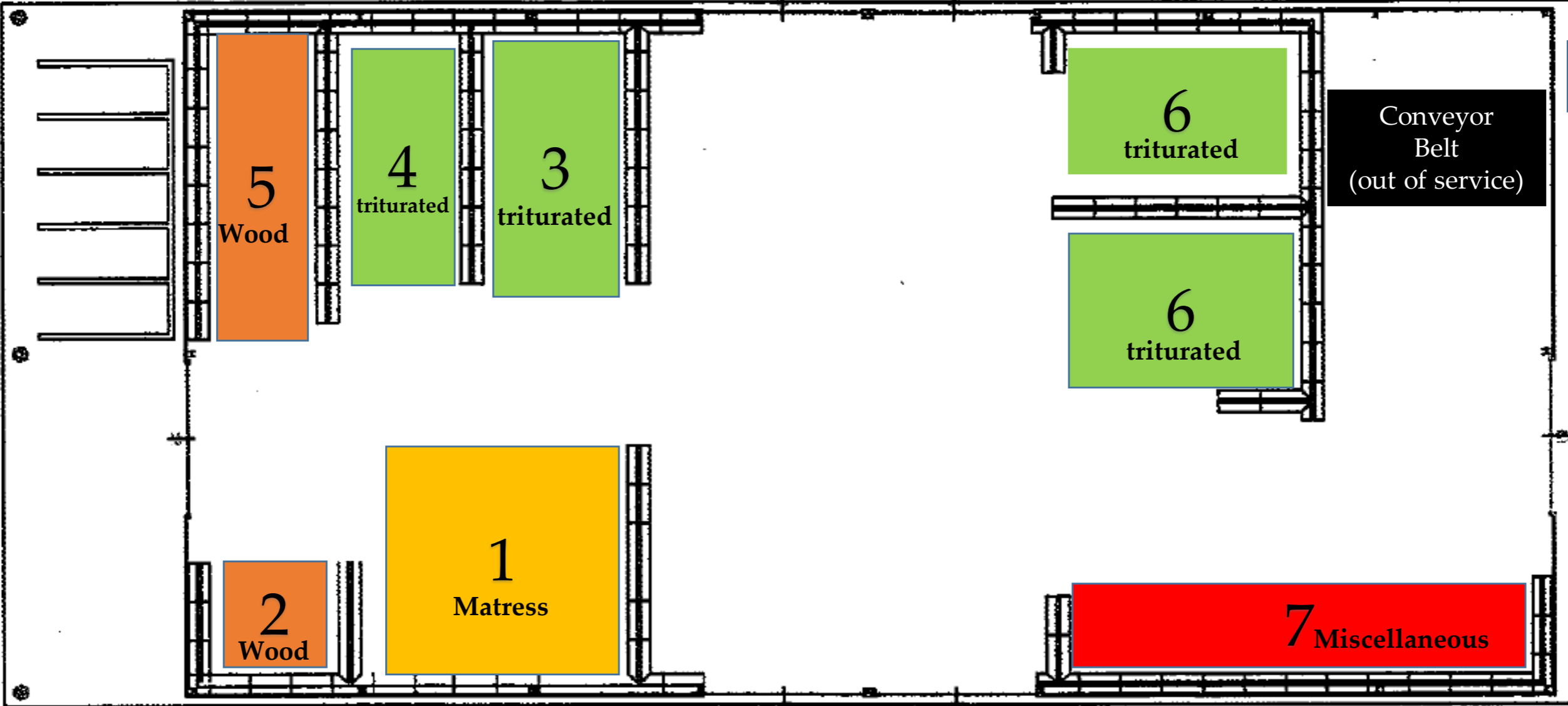
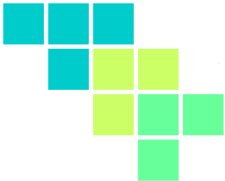
FIRE BRIGADE
EMERGENCY
TEAM
 $t = 600$ s

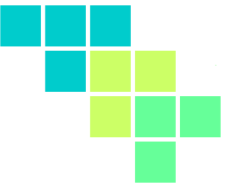


QUESTION ABOUT FIRE EVENT

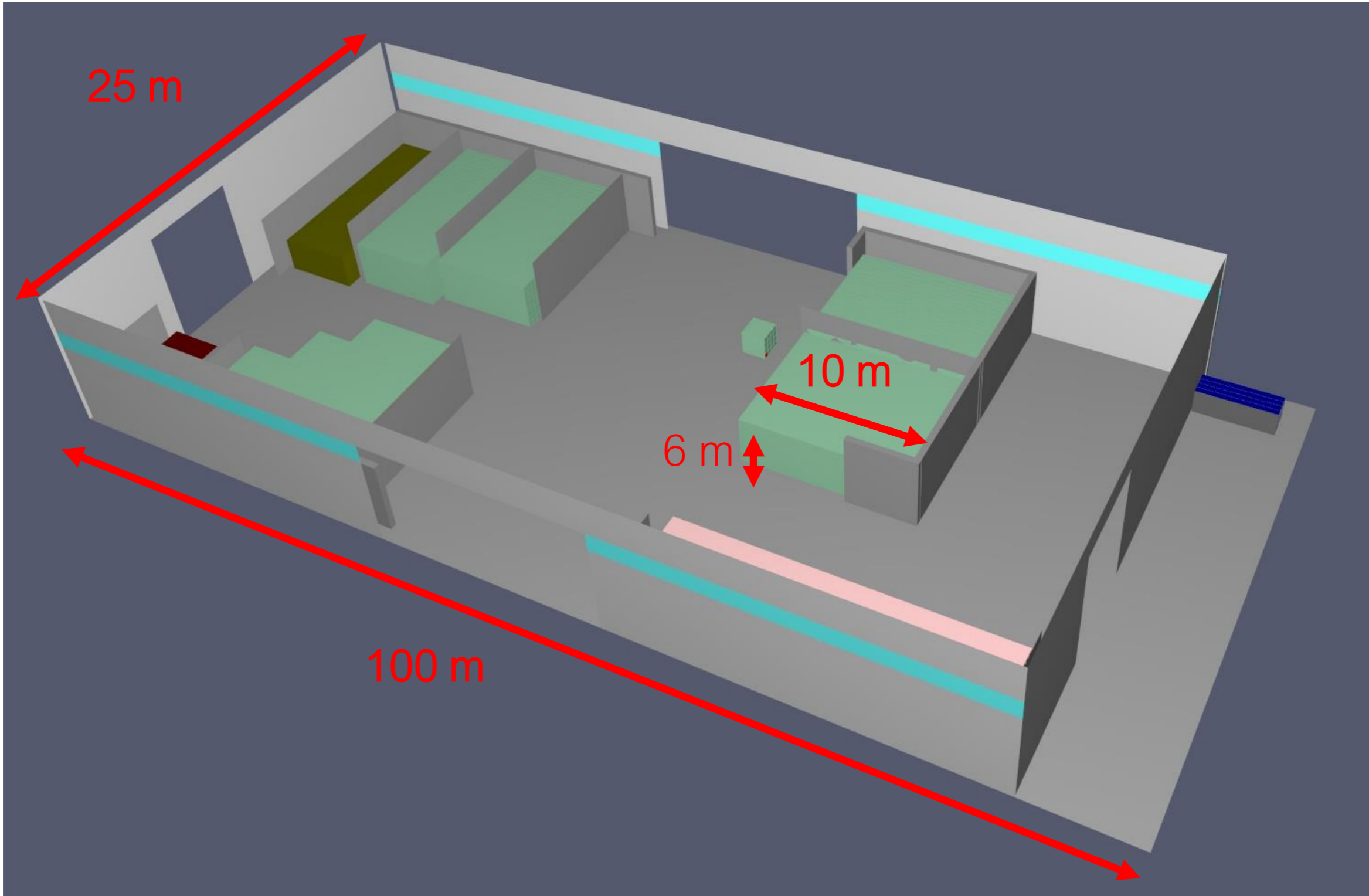
- a) **the fire in the warehouse was congruent in terms of propagation speed and intensity?**
- b) **if the fire in the outside container of combustible material was suitable with the development of the fire inside the warehouse ?**
- c) **probable causes that led to the fire?**

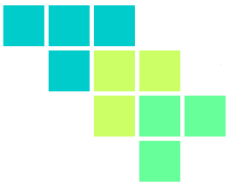
3. FIRE MODELING (layout&material parameters)





3. FIRE MODELING (3d layout)





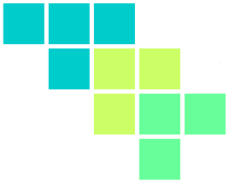
3. FIRE MODELING (material parameters)

Material	Density (kg/m ³)	Auto-ignition temperature (°C)	HRRPUA ¹ (kW/m ²)
Tritured	50	250	500
Wood	640	450	200
Tritured Wood	640	400	200
Miscellaneous	900	350	300
Rubber	1400	400	500

(1) HRRPUA: Heat Release Rate Per Unit Area

Material	Density (kg/m ³)	Heat conductivity (W/m K)
New Jersey barriers	2280	1,8
Sandwich panels	40	0,02
Polycarbonate glasses	1380	0,2

3. FIRE MODELING (software&tools)

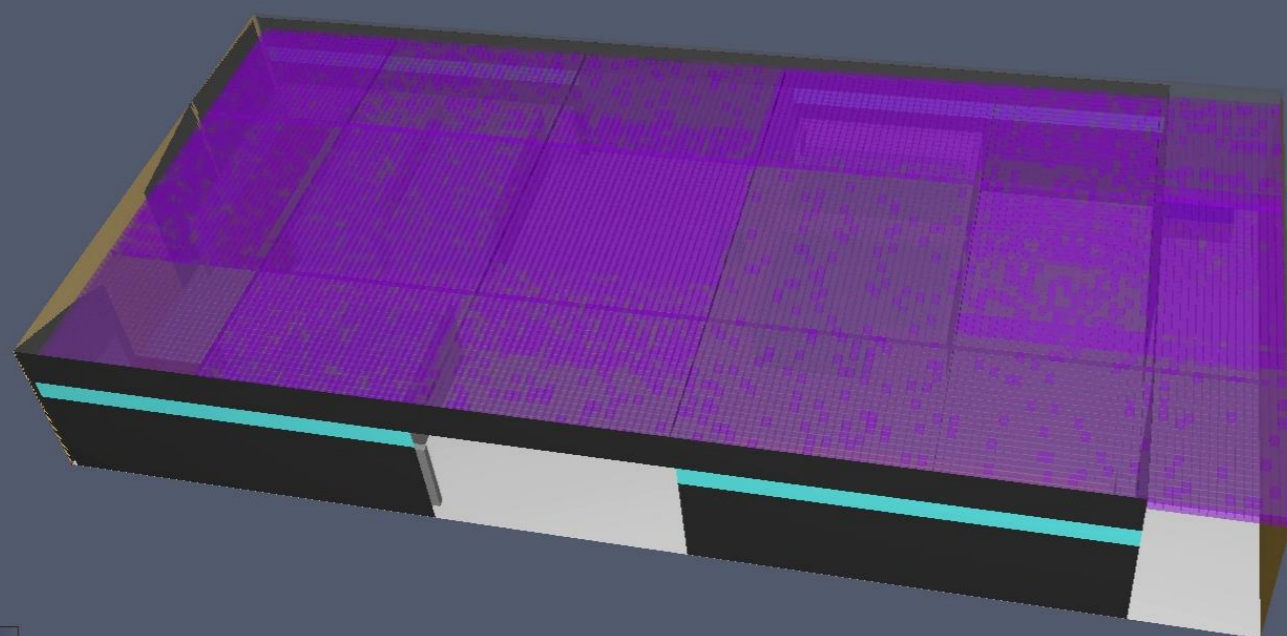
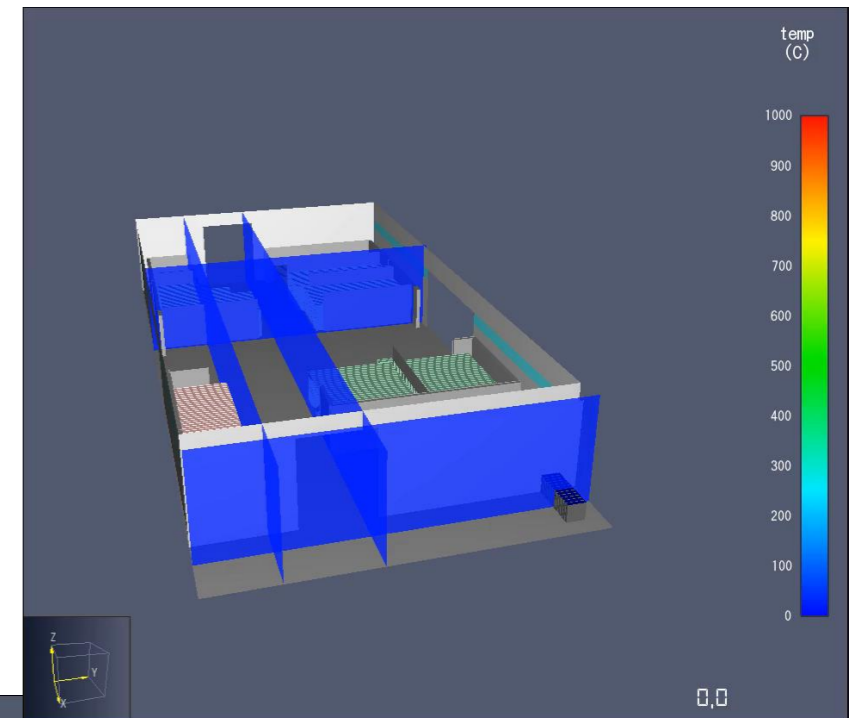
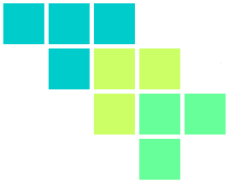


- ❑ Software used: FDS (NIST) /Pyrosim (Thunderhead Engineering)
- ❑ 400.000 Mesh element
- ❑ Parallel CPU usage
- ❑ Machine type: Intelcore i7- 8 core
- ❑ Simulation time (machine): 90 hours

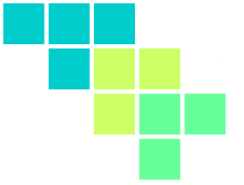
FDS employs the material characteristics of the elements of the survey domain, in order to estimate the growth and spread of the fire

The ability of the FDS model to predict accurately the temperature and speed of the gases developed by the fire was previously evaluated by the NIST by conducting appropriate experiments, both on a reduced scale and in a real scale and the subsequent analysis of the data from the field.

3. FIRE MODELING (results)



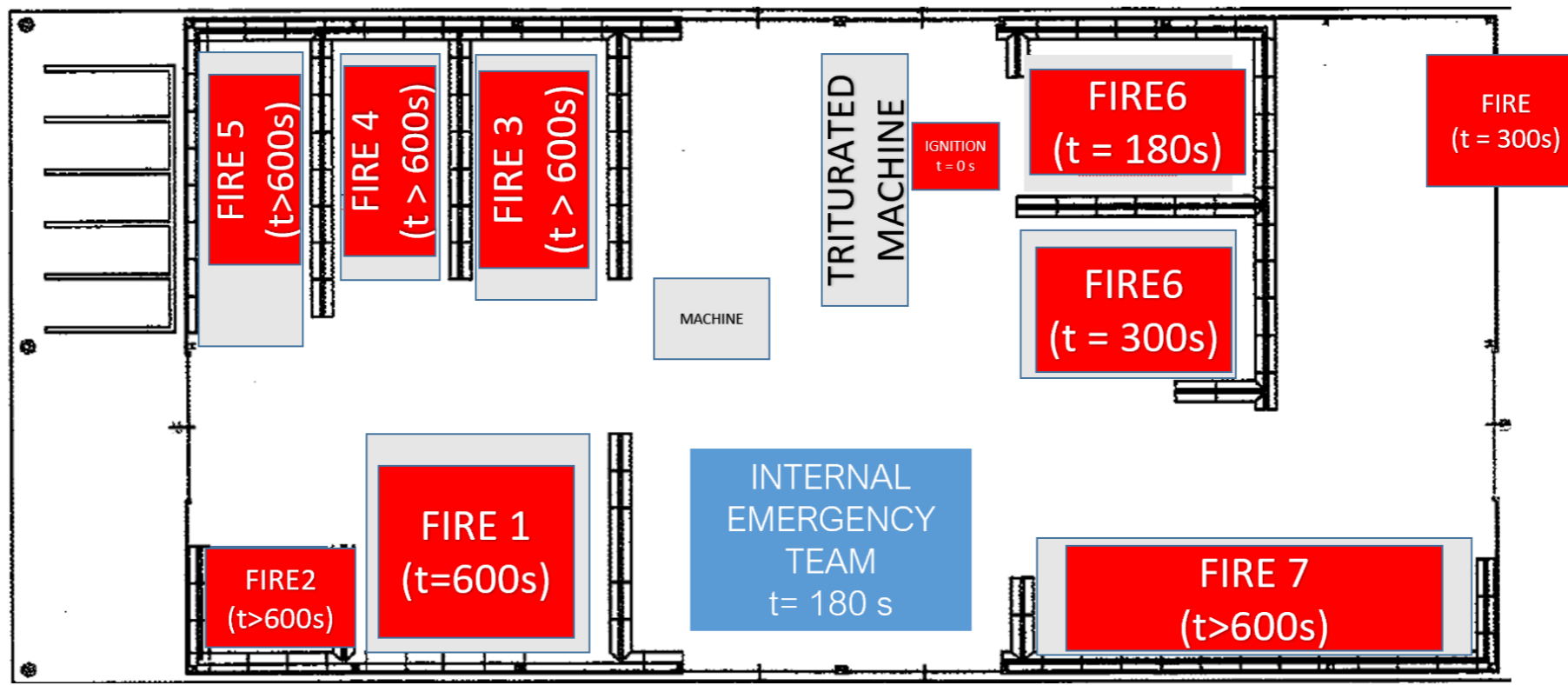
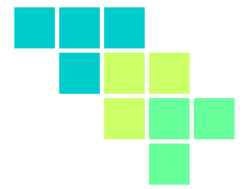
4. CONCLUSION



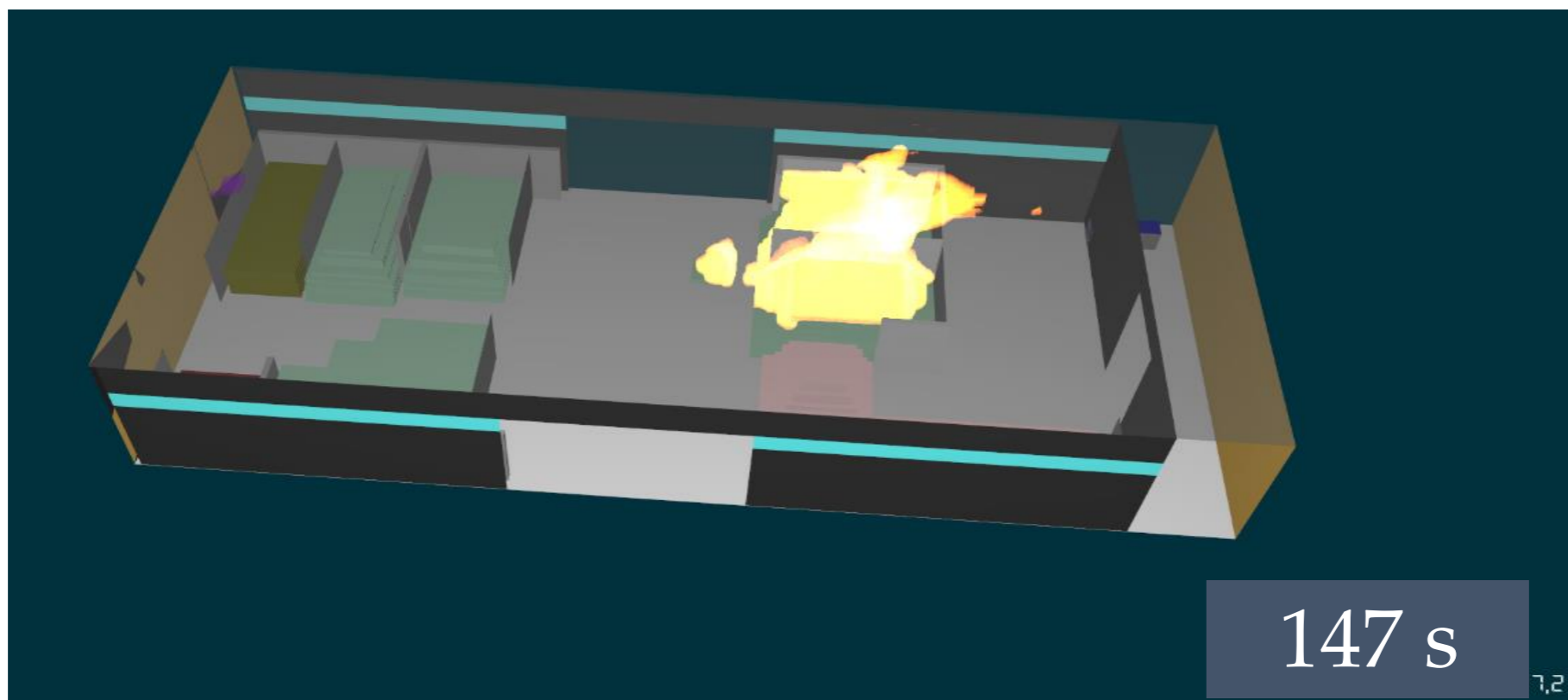
a) the fire in the warehouse was congruent in terms of propagation speed and intensity?

YES

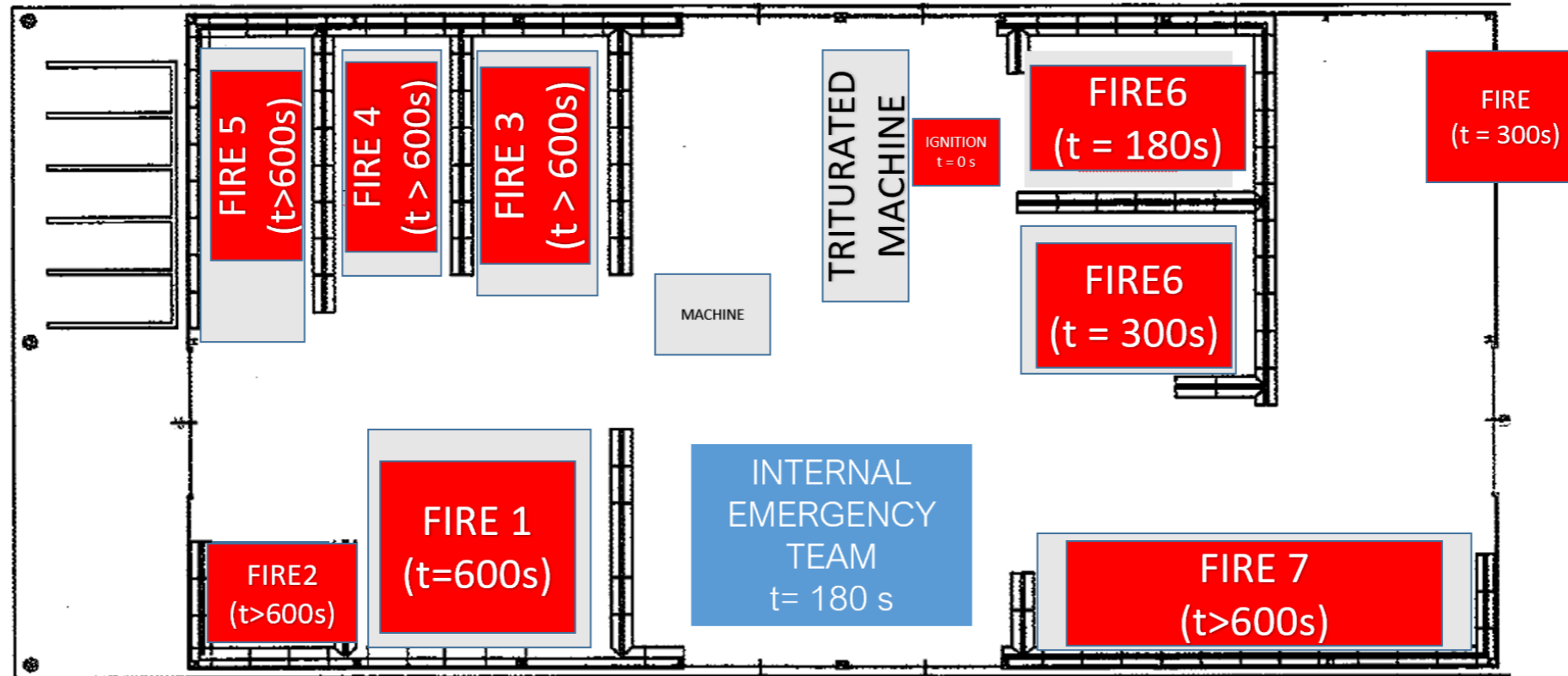
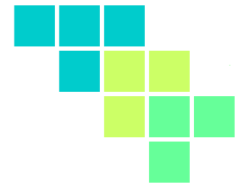
4. CONCLUSION



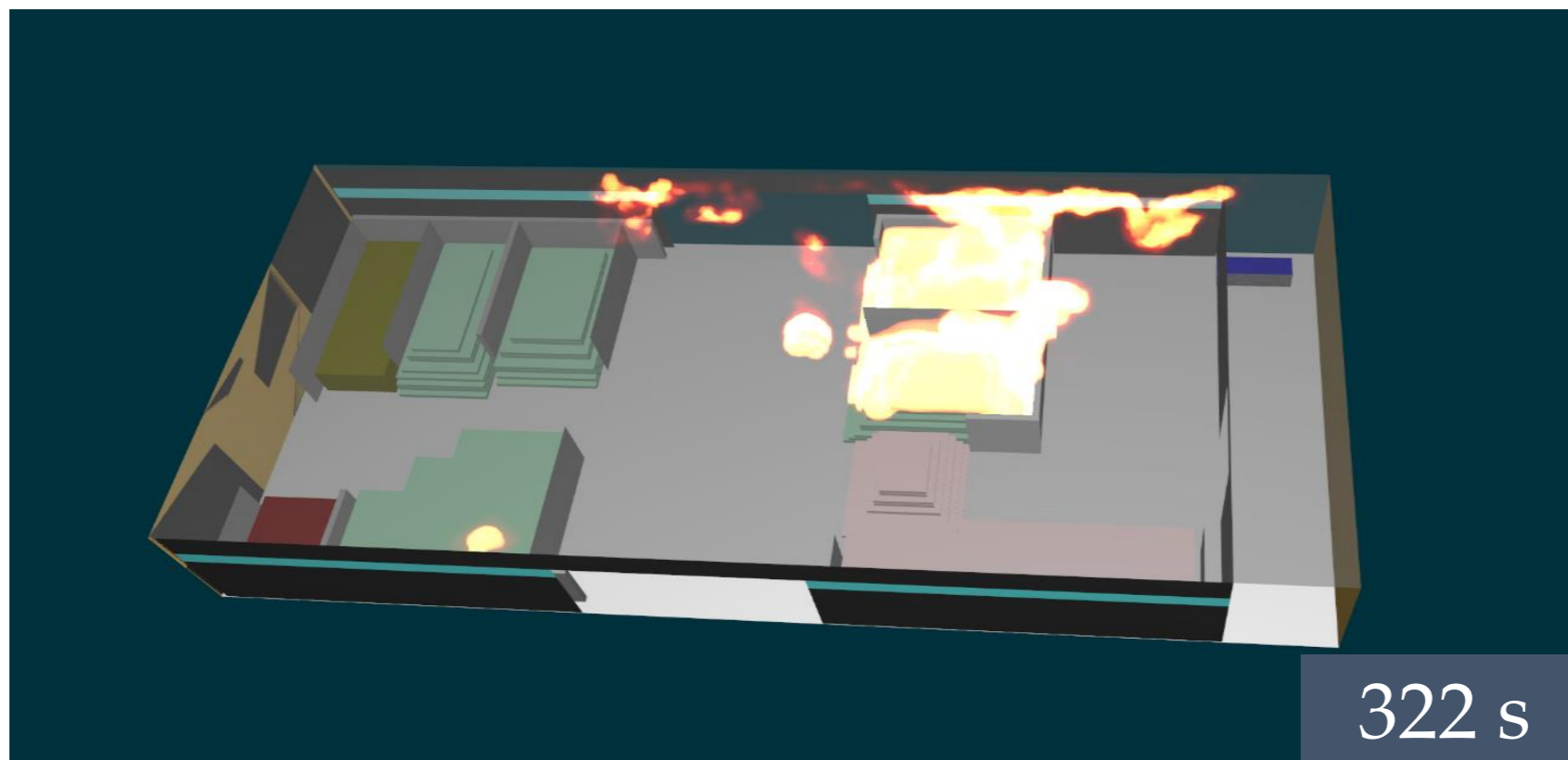
Time 200 s: the fire was extended to the compartment 6/6 near the pile of combustible material

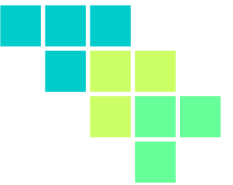


4. CONCLUSION



Time 300 s: the fire was extended to the compartment 1 (matress)

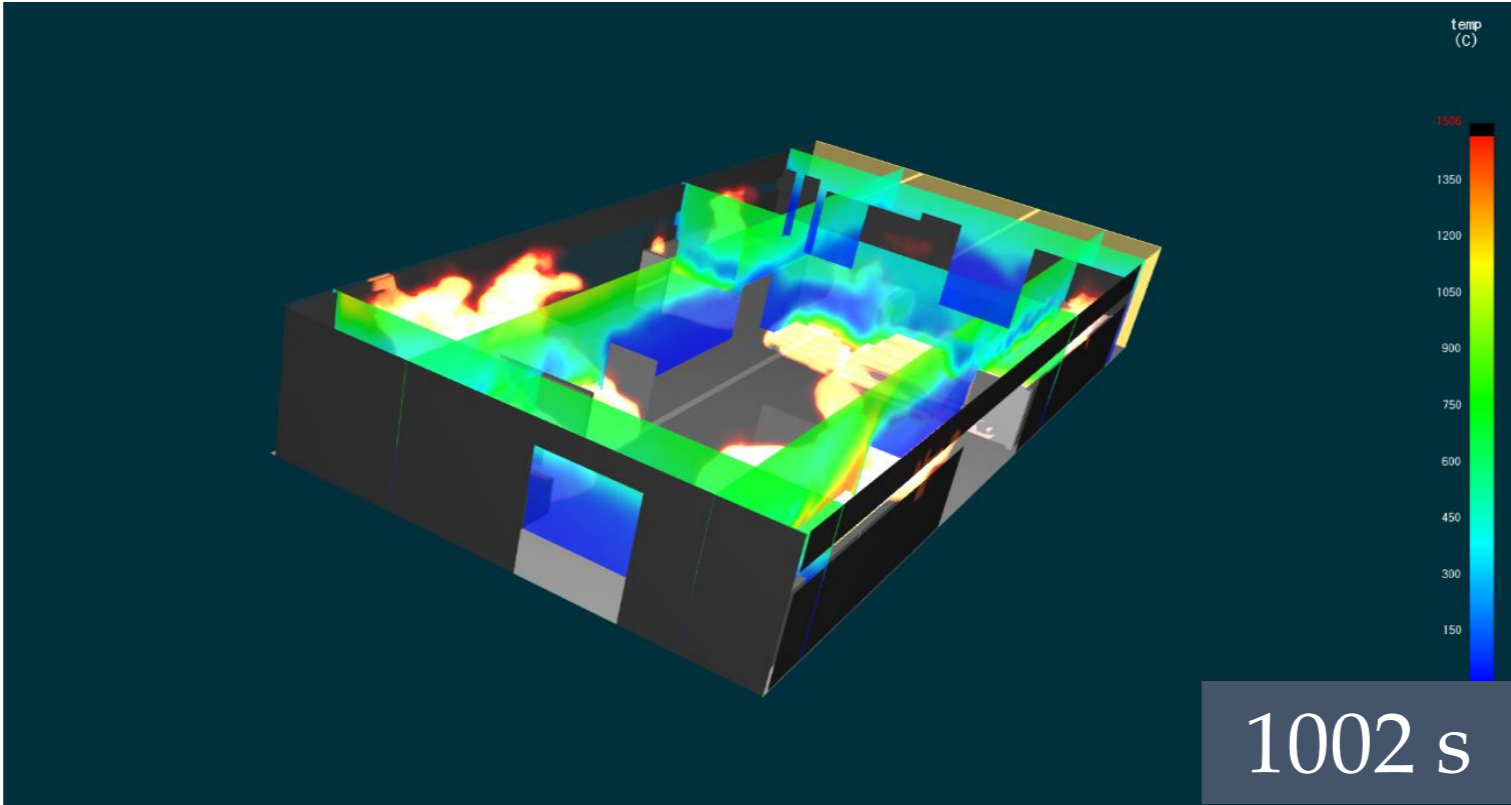




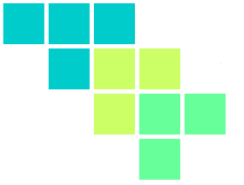
4. CONCLUSION



Time >1000 s: the fire was extinguished – the warehouse not collapsed



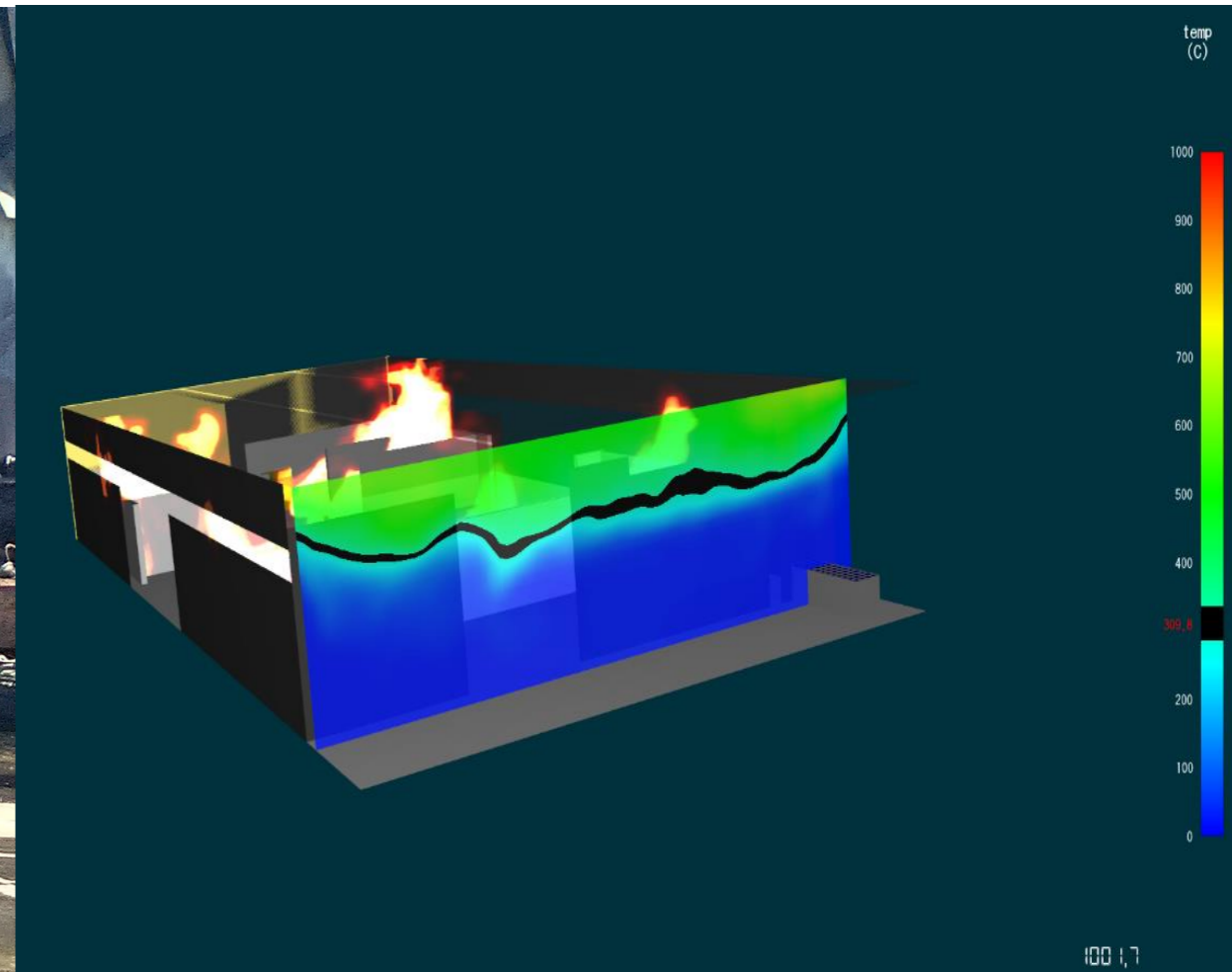
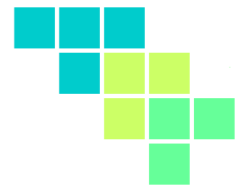
4. CONCLUSION



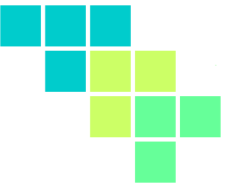
b) the fire in the outside box (tyre/rubber) was compatible with the development of the fire inside the warehouse?

NO

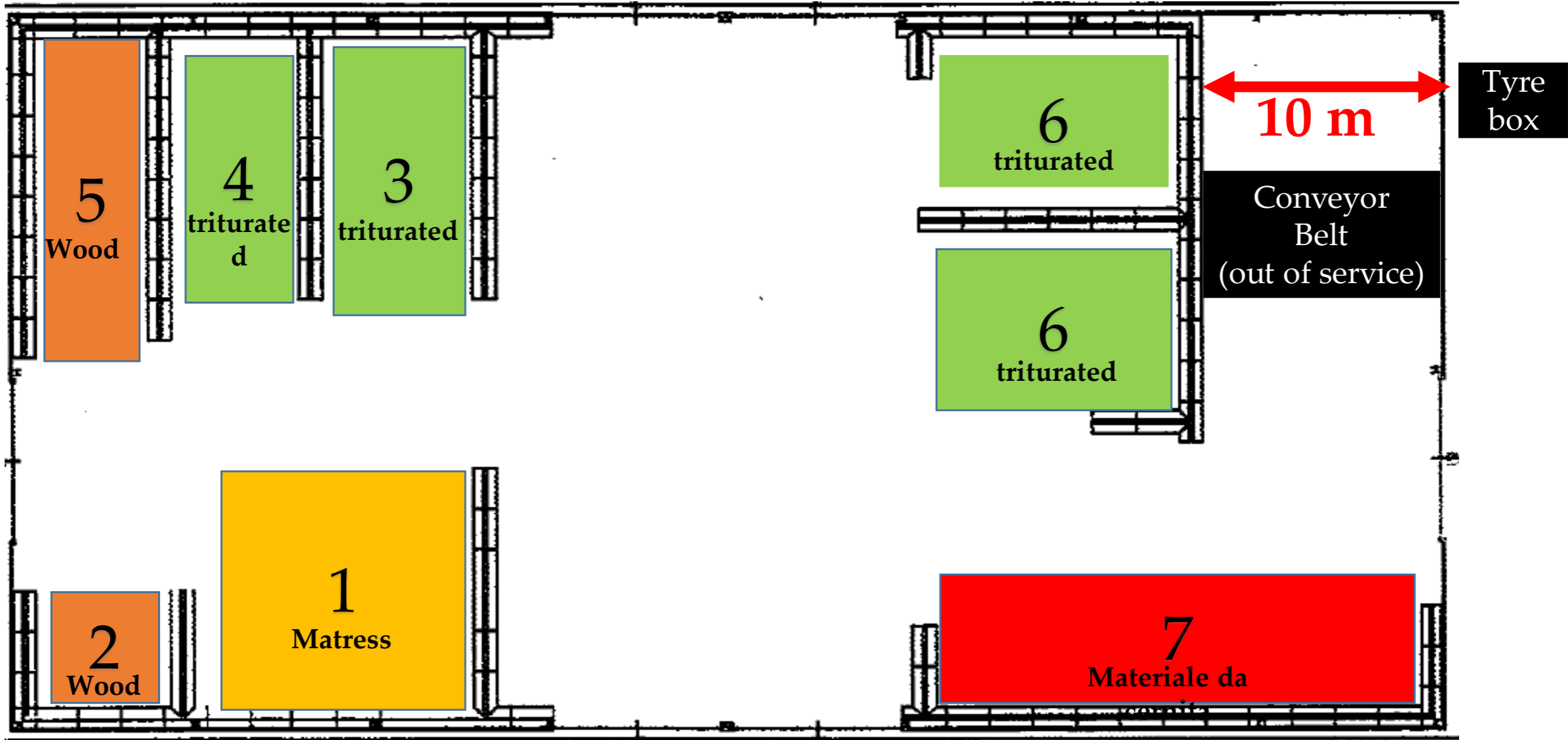
4. CONCLUSION



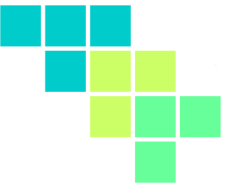
- ❑ The development of the fire is congruent with the available elements.
- ❑ The temperature profile detected with a virtual plane on the tire caisson leads to low temperature values not able to develop the degradation of the rubber, in order to facilitate ignition.
- ❑ The fire continues even if the piles of crushed material to the next compartments begin to decrease in consistency and the flames are lowered with consequent reduction of the temperatures



4. CONCLUSION



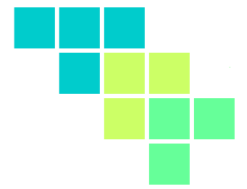
4. CONCLUSION



c) **causes that led to the fire?**

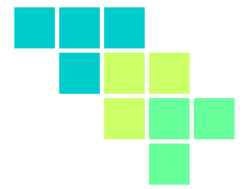
UNDER INVESTIGATION

4. CONCLUSION



**Potential ignition source:
flame rocket in triturated material (shredder waste) ?**

4. CONCLUSION



Campione 20173630-003– Dettaglio ispezione torta



Campione 20173630-003– potenziali "inneschi" ritrovati.



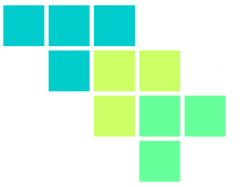
Campione 20173630-003– dettaglio potenziali "inneschi" ritrovati.



Campione 20173630-003– dettaglio potenziali "inneschi" ritrovati.

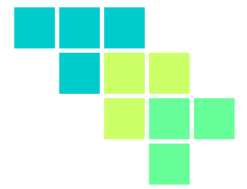
- ❑ Potential ignition source: combustibile and flammable material inside triturated material
- ❑ Further investigation to be completed

5. FURTHER DEVELOPMENT

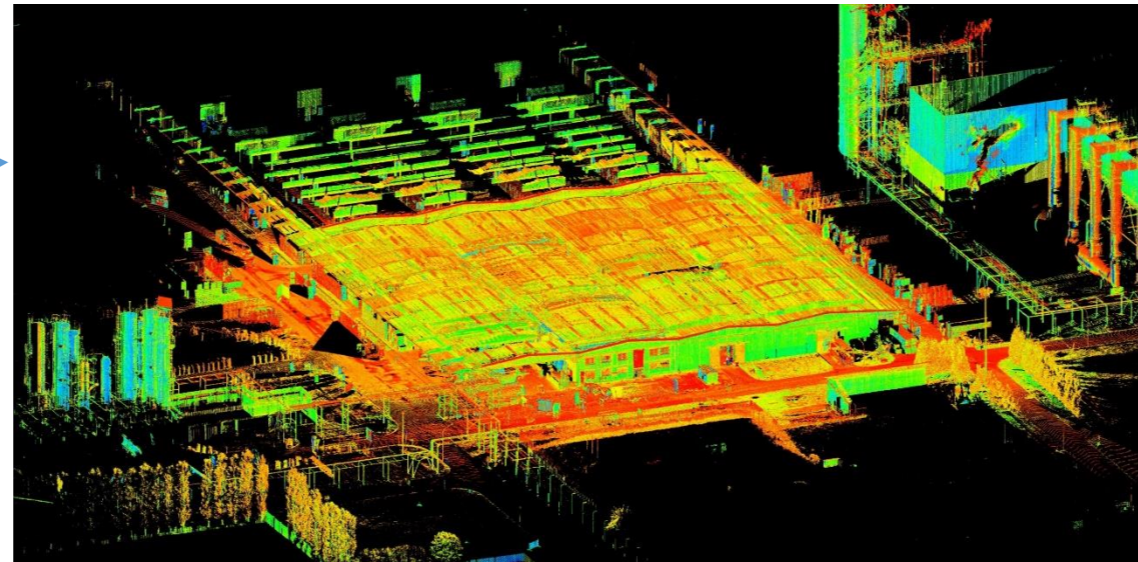


- ❑ In the last few years, many similar fires occurred (**about 260 fire event**) in Italy and, for that reason, the Italian Ministry of Environment has recently issued a first version of a “**Guideline**” according to risk management.
- ❑ These accidents and the results of the analyses will probably lead to a review of **fire-prevention design criteria of these plants**.
- ❑ During the analysis it was found that, at a design level, some measures could be taken, such as for example passive protection or the insertion of a dedicated sprinkler system, even limited to a portion of the warehouse.
- ❑ The fire and/or smoke detection could be considered even if the intervention of the team was timely and the high fire risk processes are carried out during the personnel supervision. Regarding the modeling of the fire, the experimental starting data of the materials should be analyzed, in order to better characterize the phenomenon.

5. FUTURE DEVELOPMENT



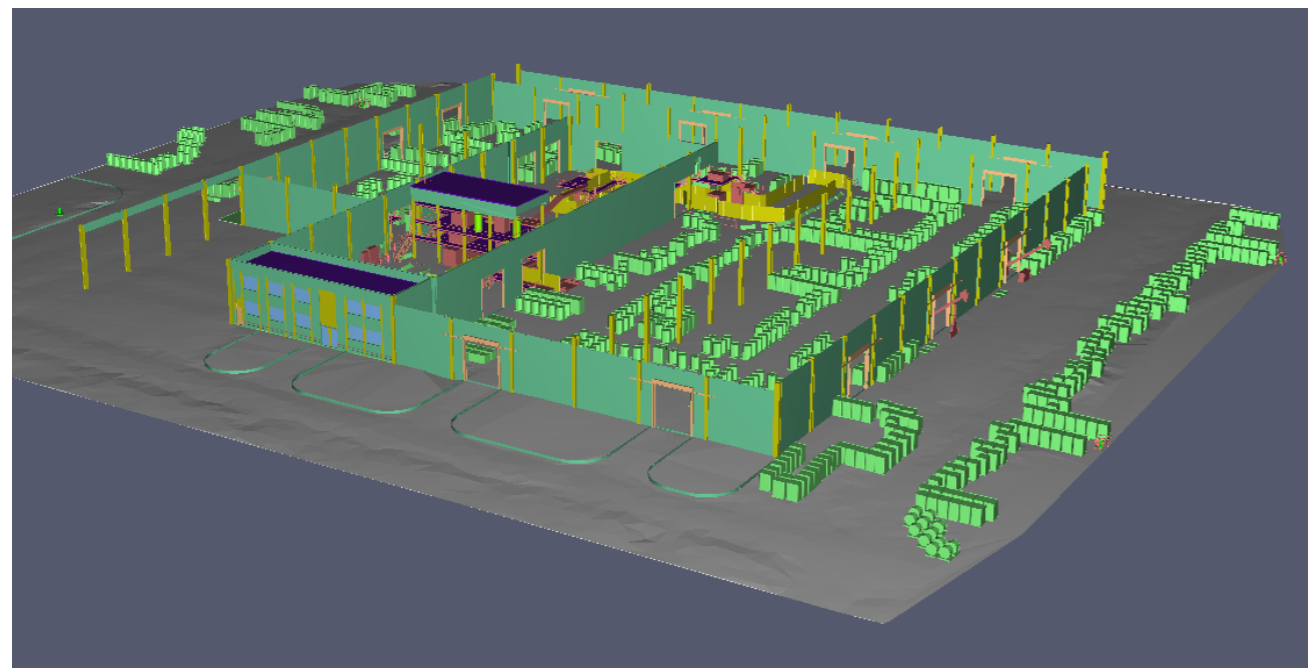
LASER SCAN



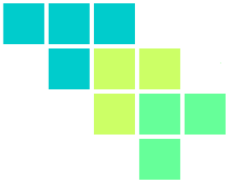
3D POINT CLOUD



3D MODEL IN POINT CLOUD (bubble view)



FIRE SIMULATION SOFTWARE (PYROSYM/FDS)



Thanks for your attention

And Special Thanks to



Ing. Alfredo Romano
Ing. Giovanni Romano



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