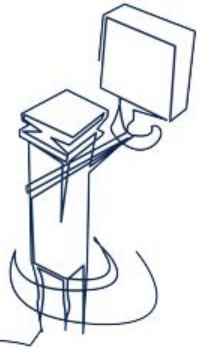
Laser Cutting Solutions for Nuclear Decommissioning



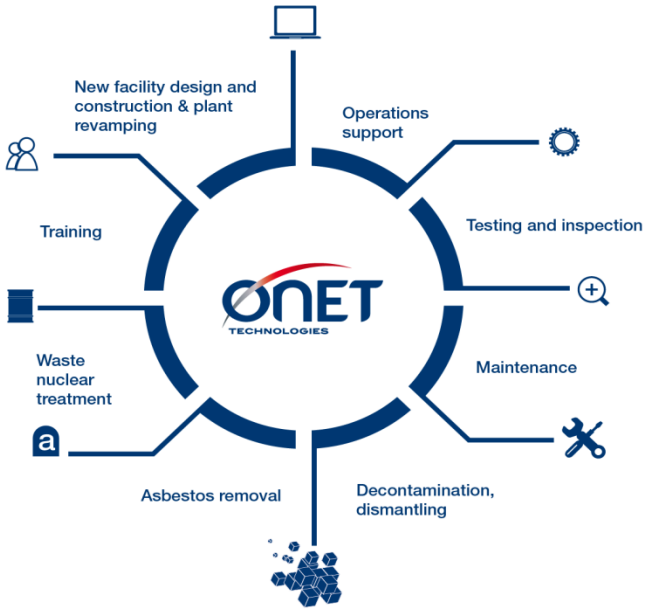
R3 OPTIONEERING, CONCEPT DESIGN AND EIAR DEVELOPMENT

Workshop “Experience of Reactor Dismantling”

INPP

08/11/2018

ONET TECHNOLOGIES AT A GLANCE



€271 million in sales volume

4 operating divisions

30 facilities in France

400 engineers with expertise in multiple fields

2,800 employees

8 businesses

Active throughout **the entire life cycle of industrial installations**

A presence in **8 countries**

2017 Data

Laser Cutting Solutions For Nuclear Decommissioning

CONTENTS

New Challenges Need Innovative Technologies

Nuclear Decommissioning Market is expanding

➢ New decommissioning challenges are arising
- Increasing number of reactors to be decommissioned safely
- Fuel cycle facilities with high levels of hazard to be decreased
- Reactors damaged by nuclear accidents to be managed

➢ Cutting technologies must be (re-)invented to
- Be deployed remotely where human access is impossible
- Be robust, reliable, flexible and safety compliant
- Improve decommissioning projects in terms of cost, time and safety

➢Remote cutting is a mandatory step for any decommissioning project with very high levels of radioactivity

Cutting Key Challenges
- Material thickness
- Cutting speed
- Tool compactness and versatility
- Underwater cutting
- Wear parts replacement
- Secondary waste generated (chips, dust, fumes)

LASER CUTTING INNOVATION

Innovative Cutting Technology

- Laser is widely used in the industry for cutting or welding works -> but not in the field of nuclear decommissioning
- High power lasers are now commercially available off the shelf and at reasonable prices
- The French CEA started a R&D program to develop an innovative laser cutting tool for its own decommissioning challenges

KEY BENEFITS OF LASER CUTTING FOR DECOMMISSIONING

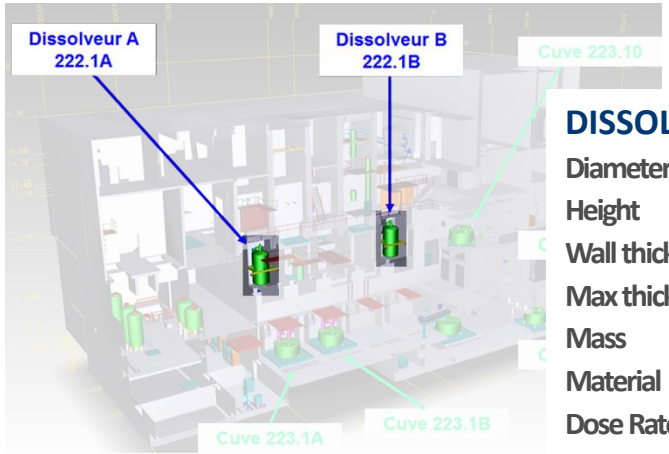
- **Excellent cutting performance** on metallic / ceramic material with a cutting capability of up to 150mm in thickness
- **Cleaner** than most of other thermal techniques, especially in respect of dust & fumes
- **Technique minimizing slag production** (secondary waste production)
- **Has been paired with a selection of manipulators** for various applications in nuclear decommissioning
- **Proven performance** and long life in highly radioactive environments

DECOMMISSIONING OF UP1 DISSOLVERS

Decommissioning Experience

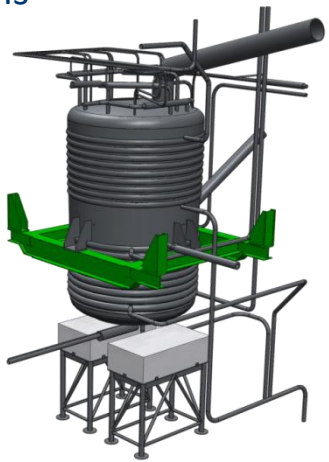
ONET has applied CEA developments to the decommissioning of reprocessing plants

- UP1 is a French fuel reprocessing plant stopped in 1997
- Two dissolvers were used for continuous dissolution of Fuel to separate Pu from U and FPs
- Fully remote access and operations was requested due to high radiation
- Thicknesses and shapes implied complex cutting operations



DISSOLVER : INITIAL STATE

Diameter	: 1.9 m
Height	: 3.6 m
Wall thickness	: 12 to 18 mm
Max thickness	: 47mm
Mass	: 4600 kg
Material	: URANUS 65
Dose Rate	: up to 1 Gy/h



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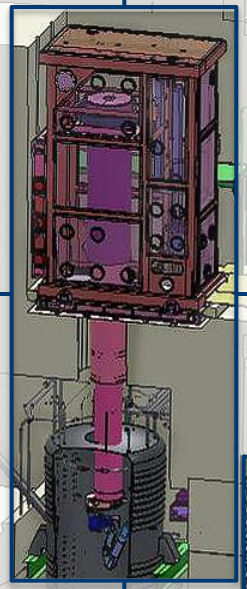
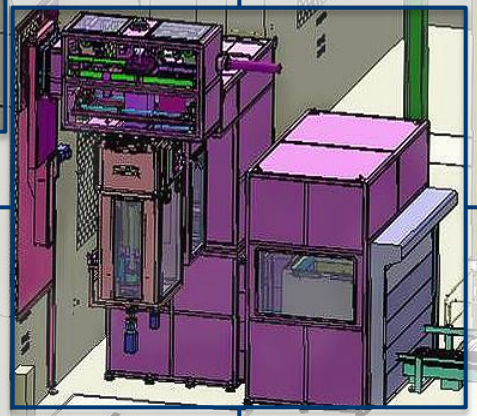


Remotely-Operated Handling & Cutting Unit



Waste Extraction & Conditioning Unit

KEY FIGURES

11 metric tons of primary waste
60 metric tons of secondary waste

Decom. Experience

- Remotely controlled
- Mass : 6 metric tons
- Size : 2,5 x 1,6 x 4 m
- Telescopic mast :7m
- Maestro arm : 100 kg capacity

- Laser cutting system
- Grinder (emergency)
- Cameras
- Nuclear measurement
- Gripper Maestro

- Remotely controlled
- Mass : 50 metric tons
- Size : 8 x 5,5 x 6,5 m
- Debris transfer and characterization
- Packaging in primary container (CP)
- CP characterization
- CP packaging in final container
- Extraction out of the unit

Laser Cutting Solutions For Nuclear Decommissioning

Operating Feedback

100 days for laser cutting (including remote operations)

4.5 tons cut by laser (30cm x 30cm pieces)

Decommissioning Experience

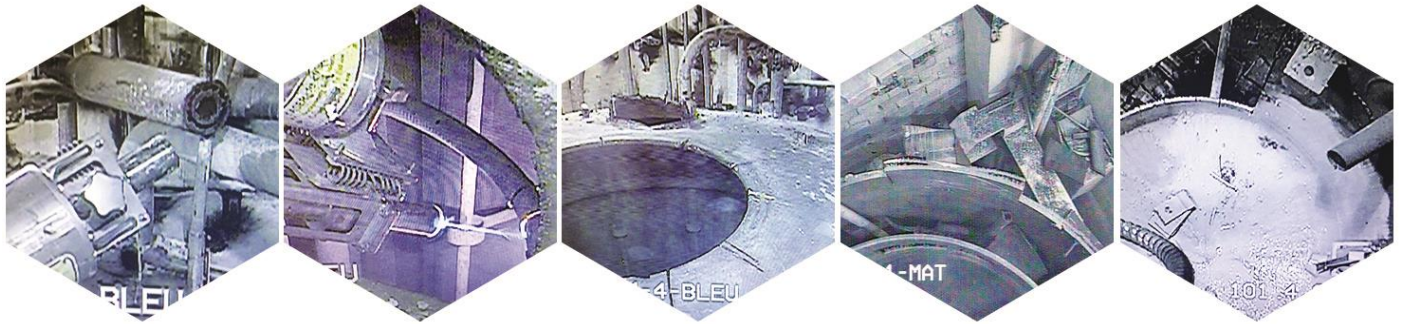
Dissolver A cutting completed mid-2017

No safety event during the operations

Laser cutting tool availability **> 80%**

Cutting tool **robustness** confirmed

6kW laser power limits the process
-> **10kW considered as a better option**



OPERATING FEEDBACK

VIDEOS OF CUTTING WORKS IN ACTUAL CONDITIONS

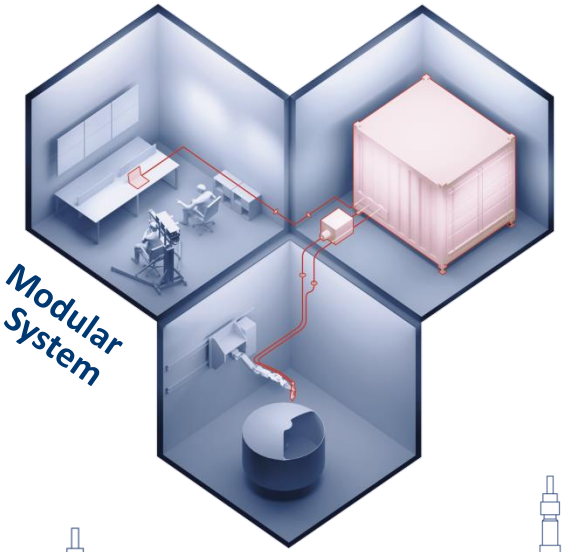
Piping

Vessel

Laser Cutting Solutions For Nuclear Decommissioning

ONET TECHNOLOGIES

L.DCom laser cutting

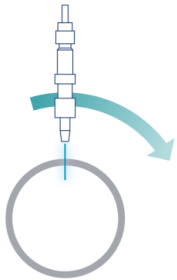


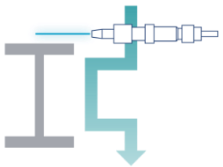
Performance

- ✓100mm cut at 20 mm/min with 10kW laser*
- ✓Over 150mm achieved with 14kW laser*
- ✓Multi-layer and various material cutting

Features

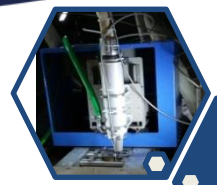
- ✓Air cooled / only two hoses to feed the tool
- ✓MTBF > 1000 h
- ✓Radiation resistance > 1000 Gy





** Trials done by* cea

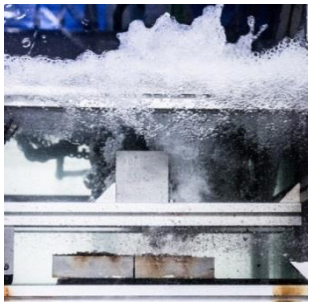
UNDERWATER CUTTING



New develop-ments

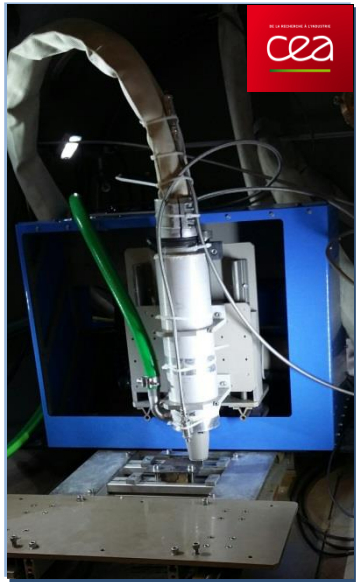
Underwater cutting provides great advantages in respect of radioprotection, but laser is not adapted to the environment

- On-going development with the CEA of a new laser head able to operate both in air and underwater
- A prototype is now operational with good cutting performance :
  - Up to 100mm thickness cut under shallow depth of water
  - 50 mm thickness cut under 5m of water

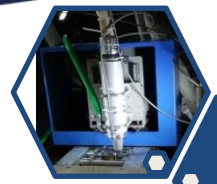


Key facts

- Developed to rise to Fukushima Daiichi decommissioning challenges
- Multiple possibilities of application in the field of reactor decommissioning
- Operational tool to be available soon for commercial applications



NON-EMERGING CUTTING (DEEP GOUGING)



New develop-ments

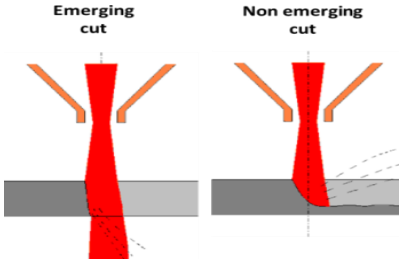
In some cases, the material is too thick for the laser to cut through it

✓This is especially the case of Fukushima Corium, which is expected to be formed of massive blocks

✓On-going development with the CEA of a new laser head able to create kerfs in a massive material so as to remove small blocks

✓Trials are on-going since 2015 with promising cutting performance :

- Up to 40/50mm deep cut in air



Fukushima Corium Retrieval

Further challenges : Fukushima

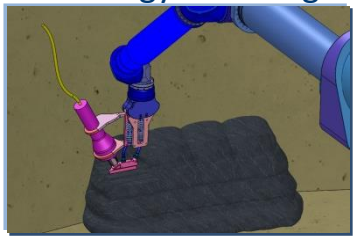
One of the toughest decommissioning challenges in the world is the retrieval of the corium in the damaged Fukushima units

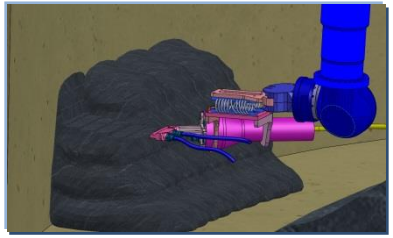
✓About 900 tons of molten fuel containing various material is expected to be found inside and below the damaged vessels of the reactors

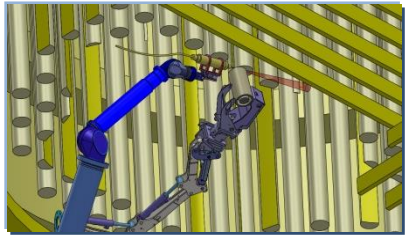
✓Corium is a very complex material, characterized by an extreme hardness and heterogeneous material contents

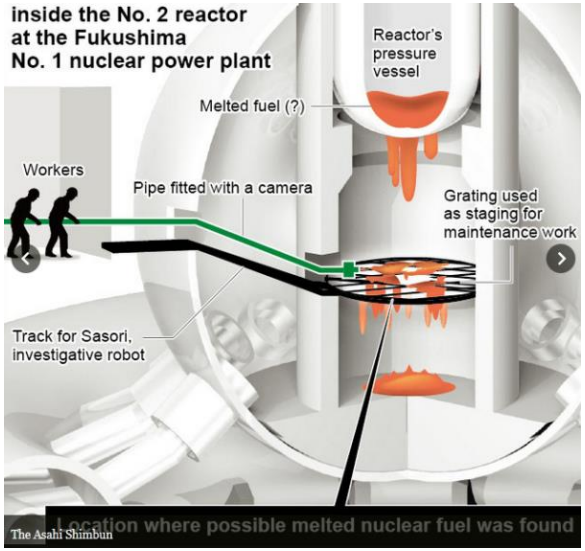
✓Laser cutting technologies are well suited for such cutting works and several systems are under development, through subsidies from the Japanese government (METI)

✓ONET, the CEA and the IRSN are working together to develop such technology including the collection of dust and fumes









Integration of technologies in complex systems applied to the dismantling of highly radioactive components

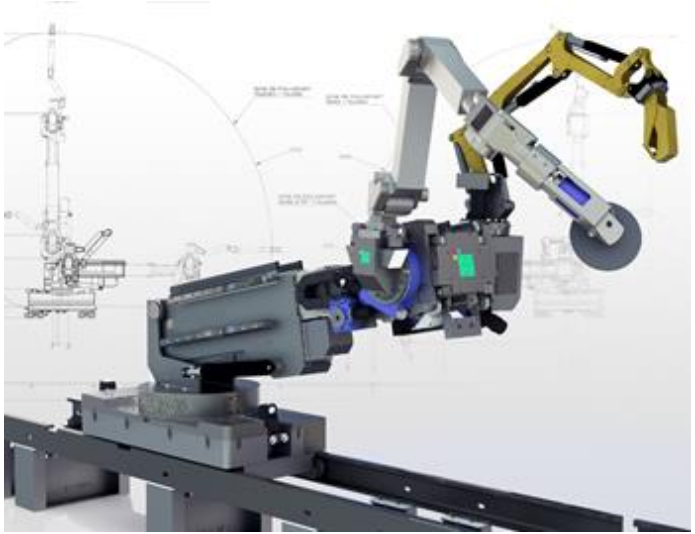
Dismantling of HLW Pilot Cell n˚419 in APM Building n˚214 (CEA Marcoule)

✓Development (2 years)

✓Design , Manufacture and Testing of remotely-operated carrier for a dual-arm robot :

- ✓ A dexterous robot
- ✓ A manipulator arm
- ✓ A telescopic carrier with a hemispherical reach of over 6 m
- ✓ 21 axis of movement
- ✓ Auxiliary carrier for the transport of tools and waste

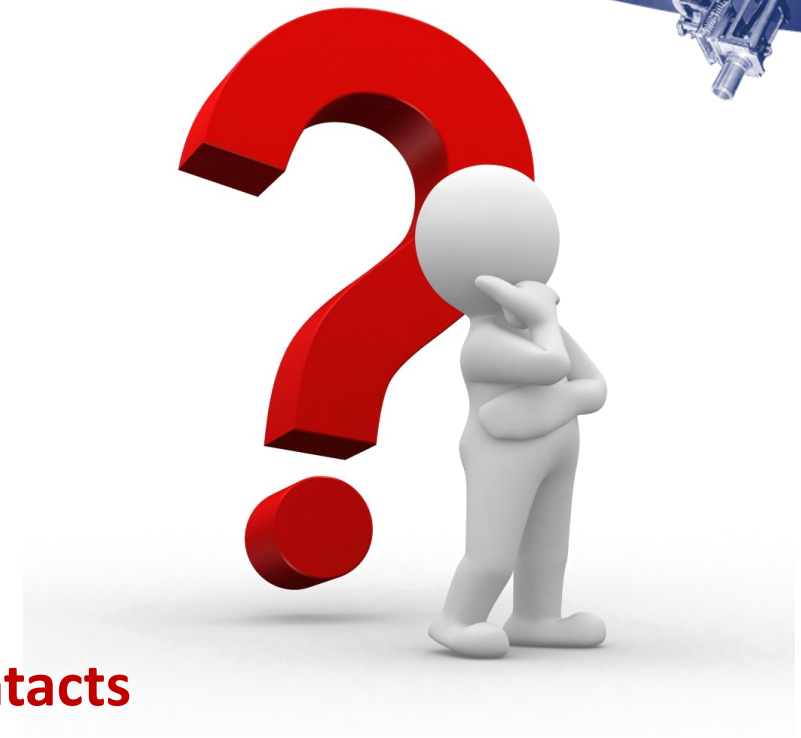
✓Dismantling of highly radioactive components



Videos

The Model

The Trials (Completed this summer)



Looking for more?

- Laser cutting tool
- Pieces of cut material
- More videos of laser cutting
- Technical data sheets

L.DCom laser cutting

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