





# Outline of the presentation

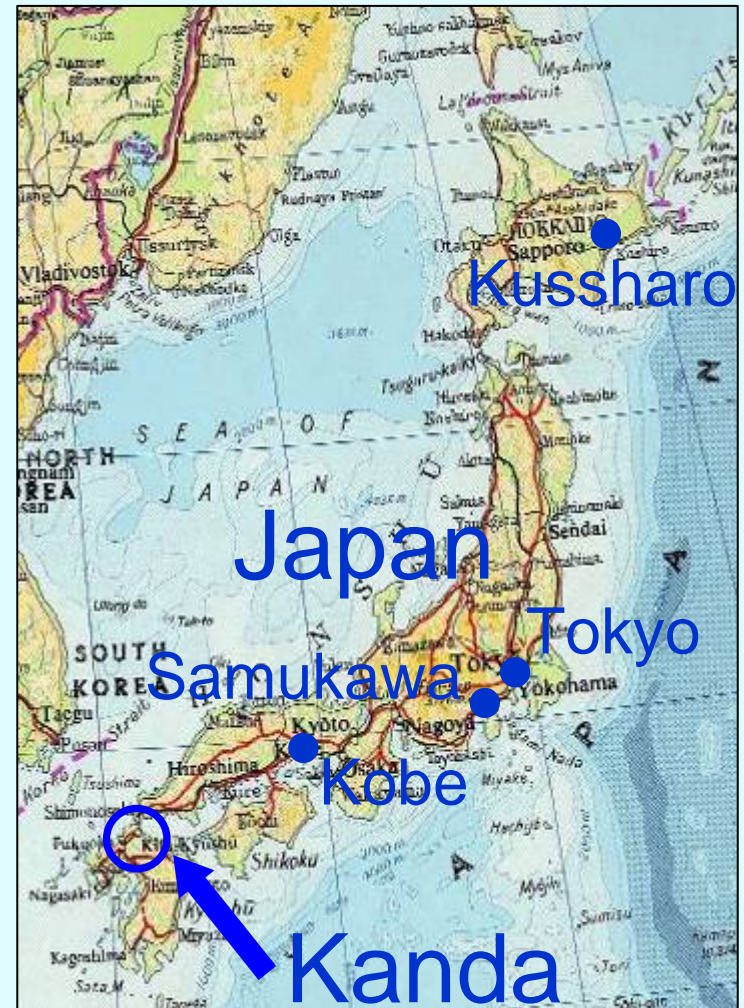
1. Overview of chemical weapons destruction in Kanda
2. Overview of DAVINCH system
3. Record of destruction
4. Improvements/findings

# 1. Overview of Chemical weapons destruction in Kanda

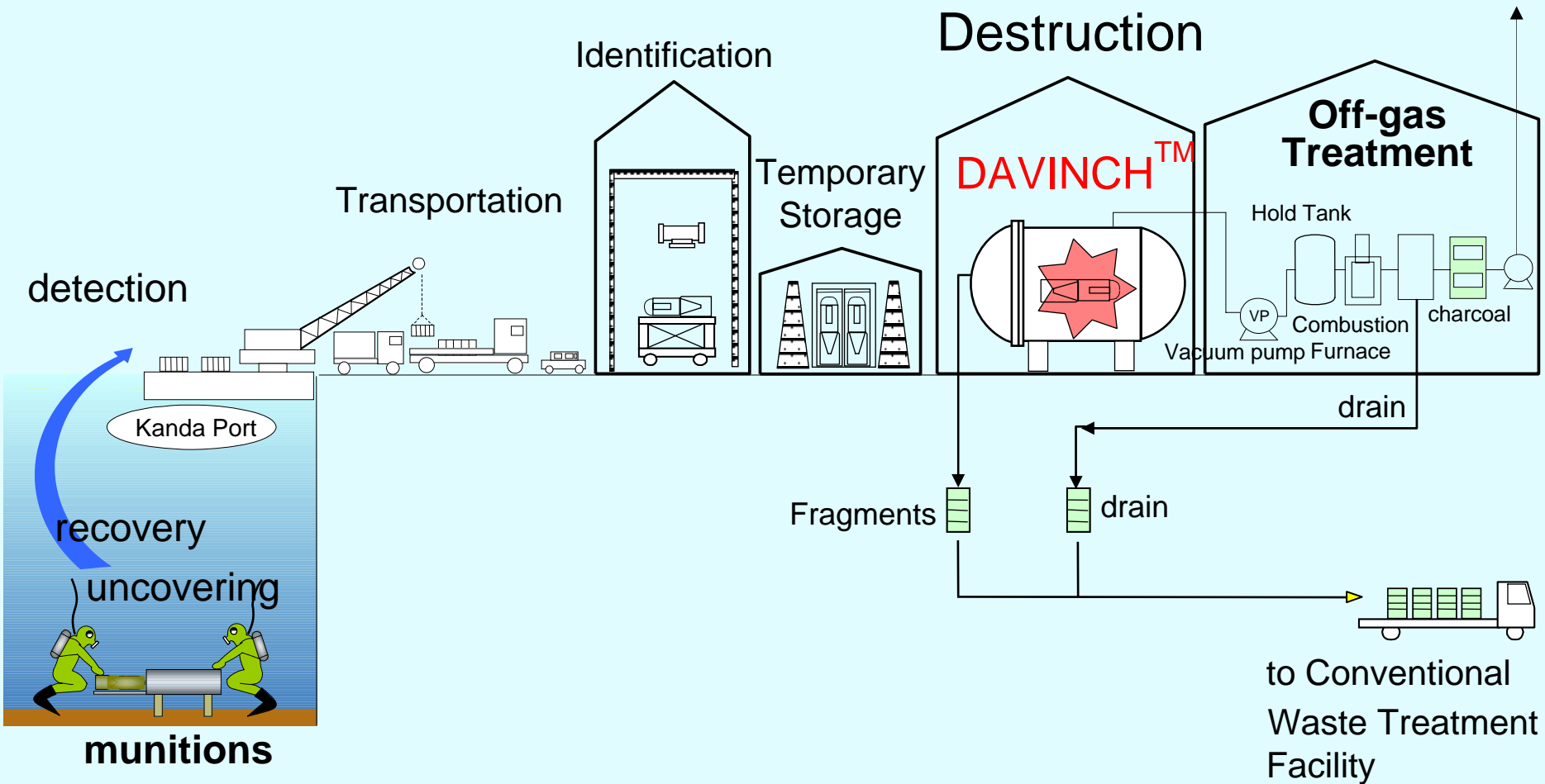
The operation includes;

- Detection
- Recovery
- Transportation
- Destruction

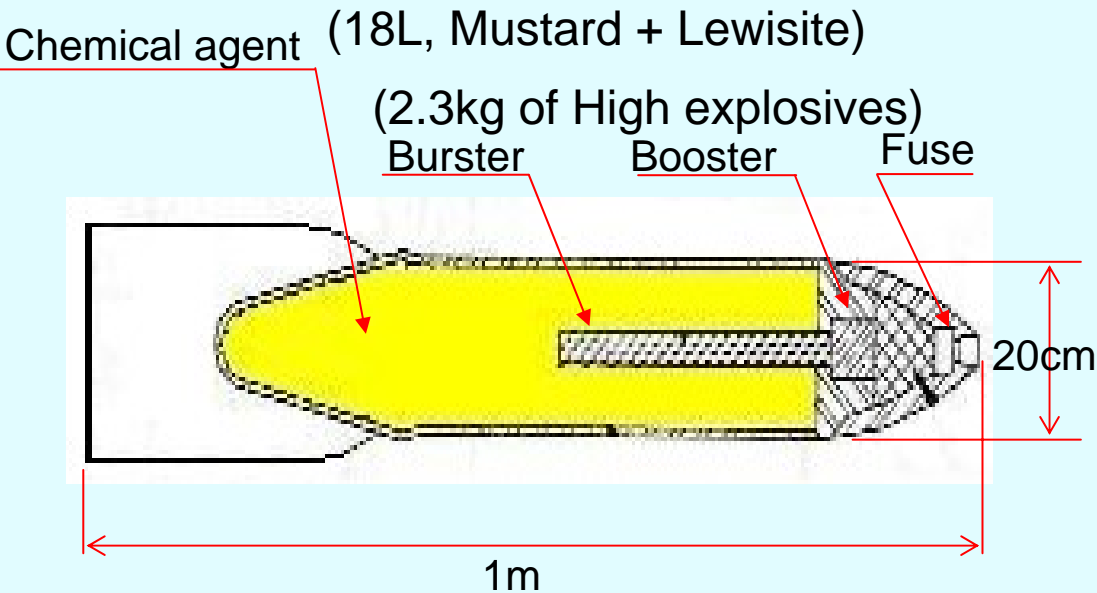
of sea-dumped OCW from  
WW2 in Kanda Port



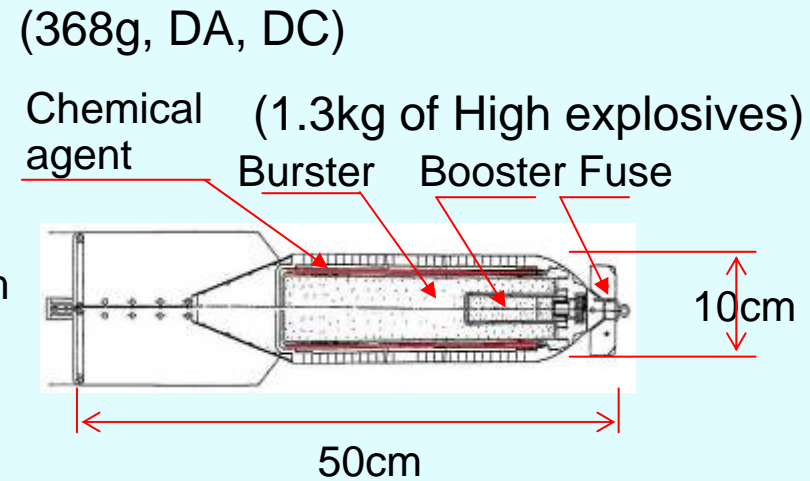
# Schematic Flow of Kanda Chemical Weapons Destruction Facility



# Chemical Bombs Recovered in Kanda Port



50kg yellow bomb



15kg Red Bomb



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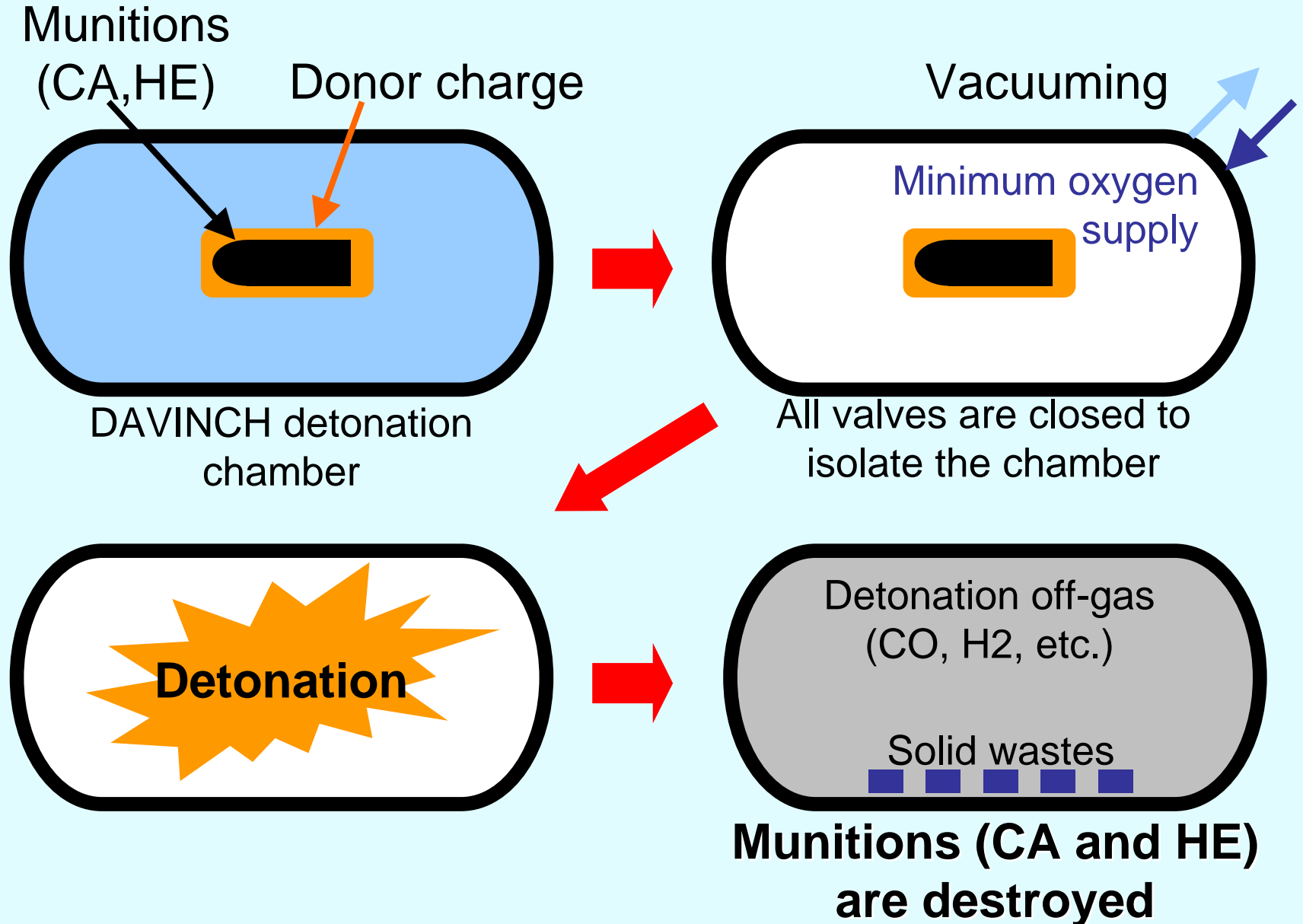
# Overview of DAVINCH™ system

Detonation of Ammunition in a Vacuum Integrated Chamber



Controlled detonation system developed for chemical weapons destruction

# How does it work ?



# High Destruction Efficiency

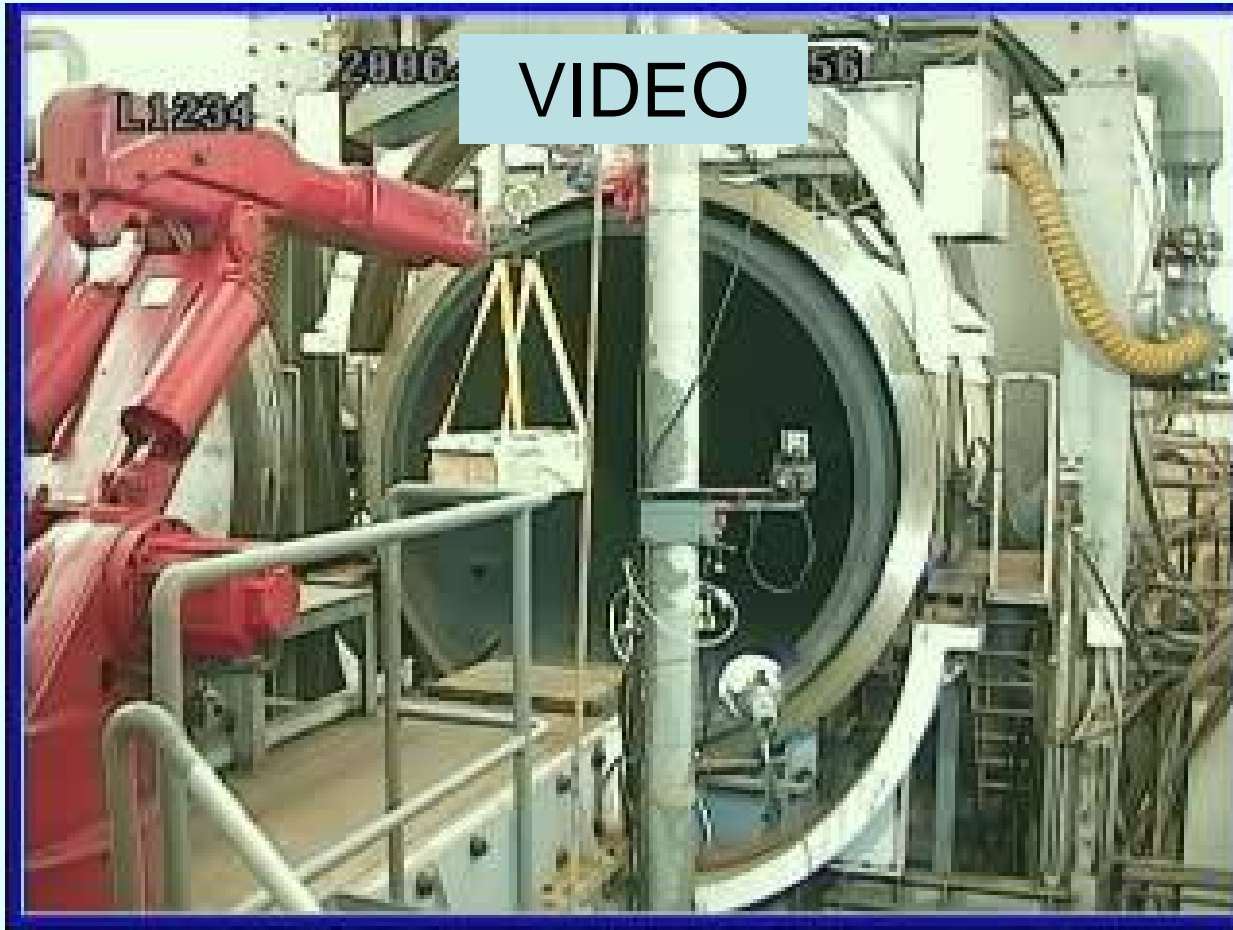
By utilizing explosive energy for destruction of chemical agent

- High Pressure=10GPa
- High temperature=3000K



	for off gas	for fragments and dust
Destruction Efficiency	> <b>99.9999%</b>	> <b>99.99%</b>

# DAVINCH<sup>TM</sup> in operation



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### 3. Record of destruction

#### - Old Chemical Bombs Destroyed in Kanda

- About 670 chemical bombs were destroyed in 2006
- Total of more than **1200** chemical bombs since 2004

		Red Bombs	Yellow Bombs
2004	57 bombs	17	40
2005	538 bombs	466	72
2006	659 bombs	560	99
total	1,254 bombs	1,043	211

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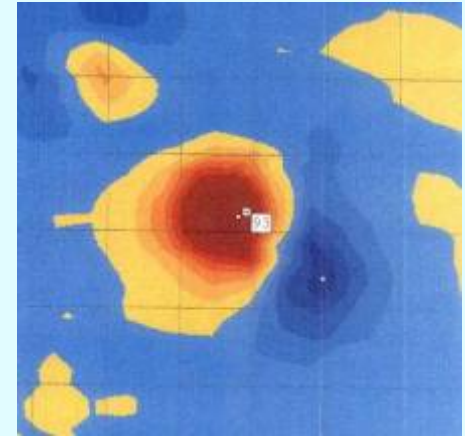
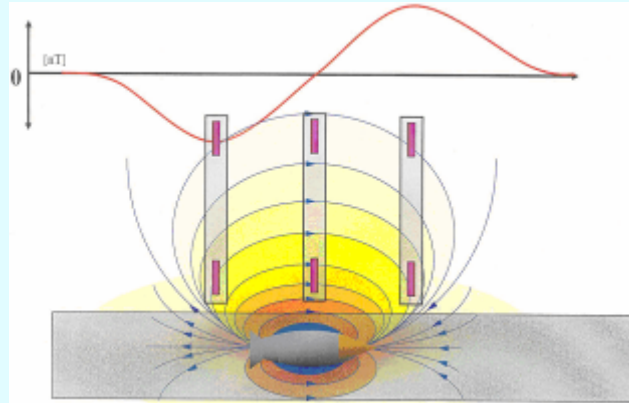
## 4. Improvements/findings

- High accuracy magnetometer detection-software improvement
- Two multi detonation modes - sequential and simultaneous multi detonation
- Behavior of arsenic on chamber material
- Demonstration of Cold Plasma Oxidizer for off-gas treatment

# High Accuracy Magnetometer Detection



**Magnetometer Detection Probe**



**Magnetic Anomaly Map**

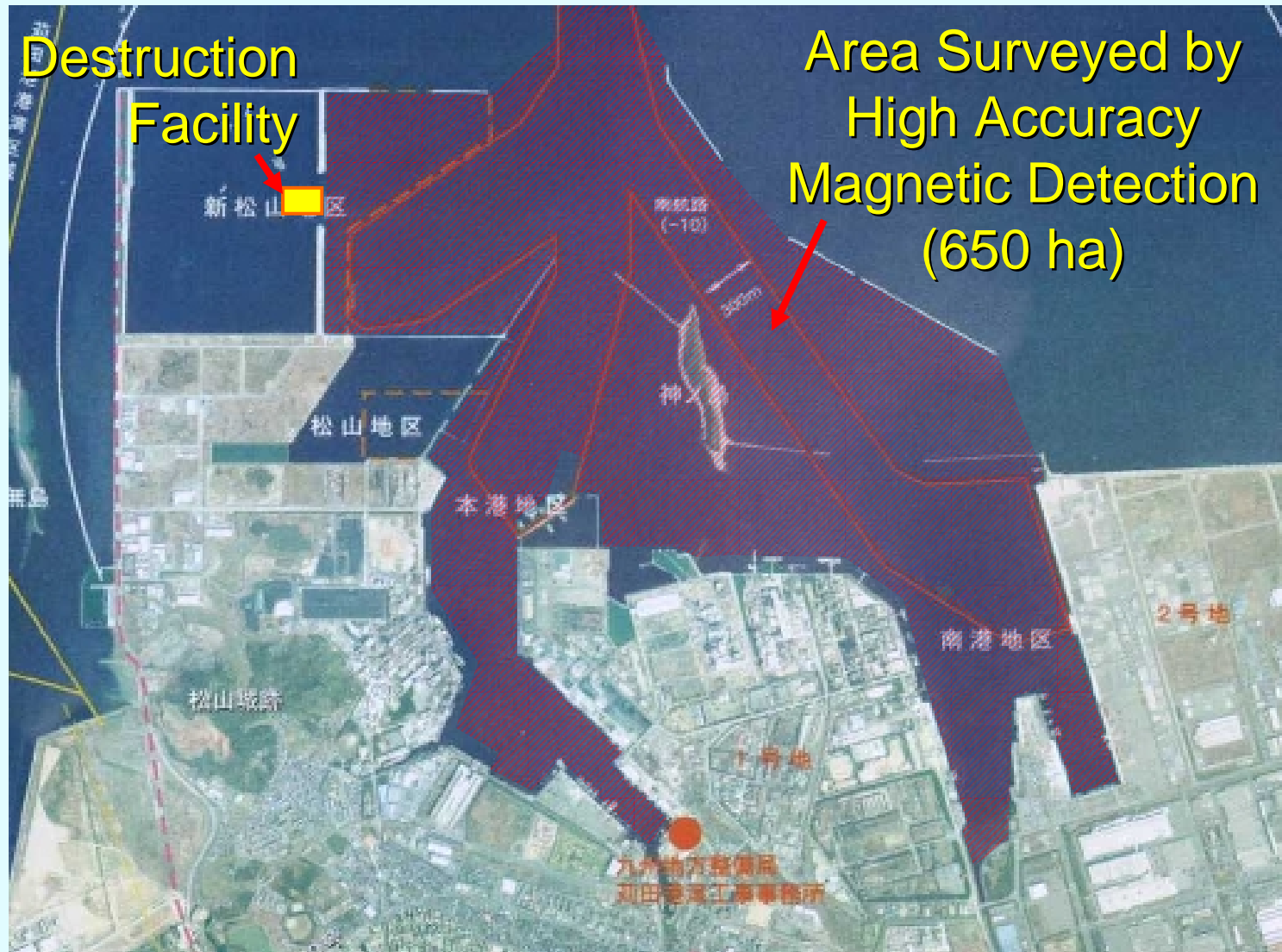


**Data Recorder**



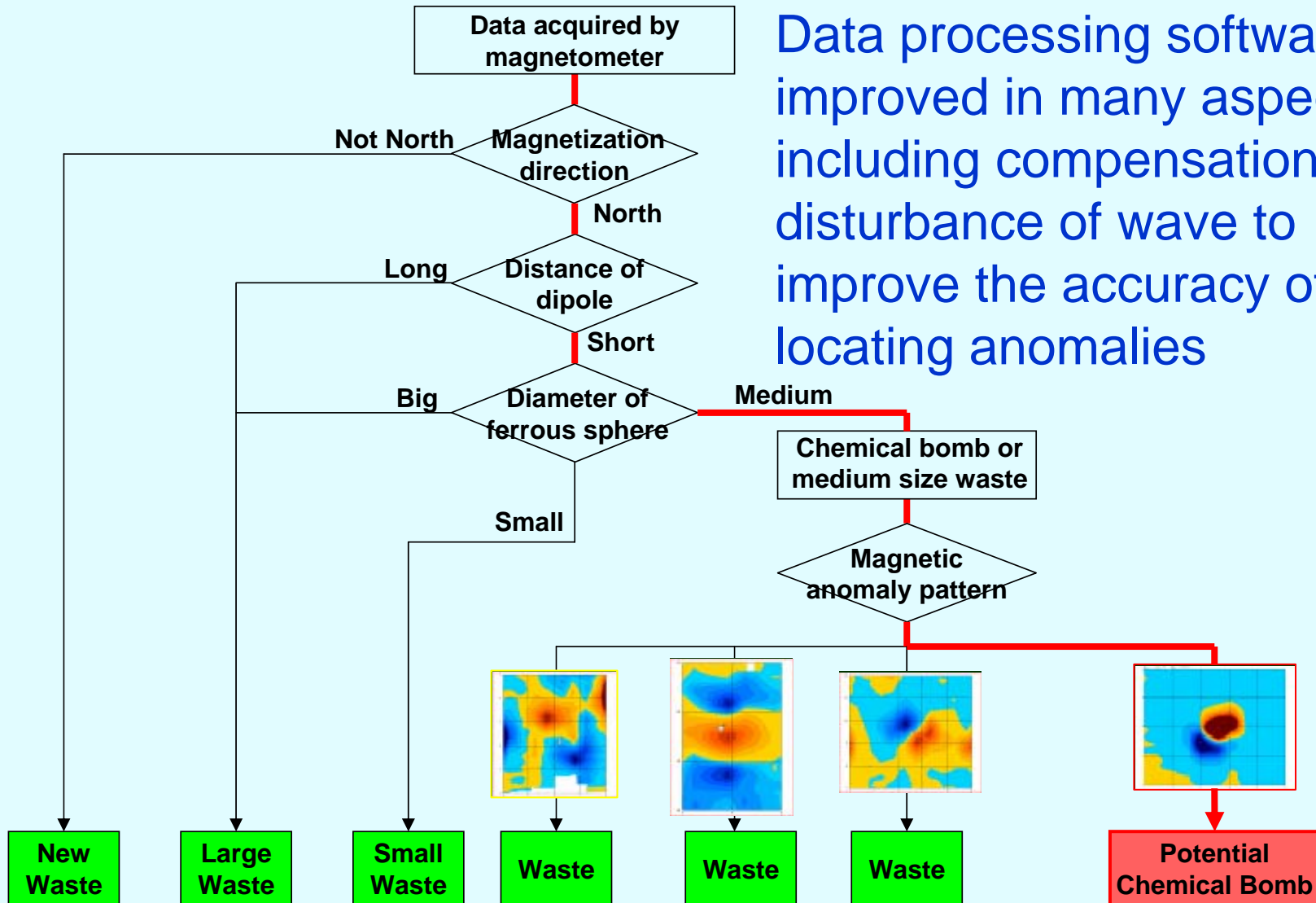
**Detection Operation**

# Location of Work Area



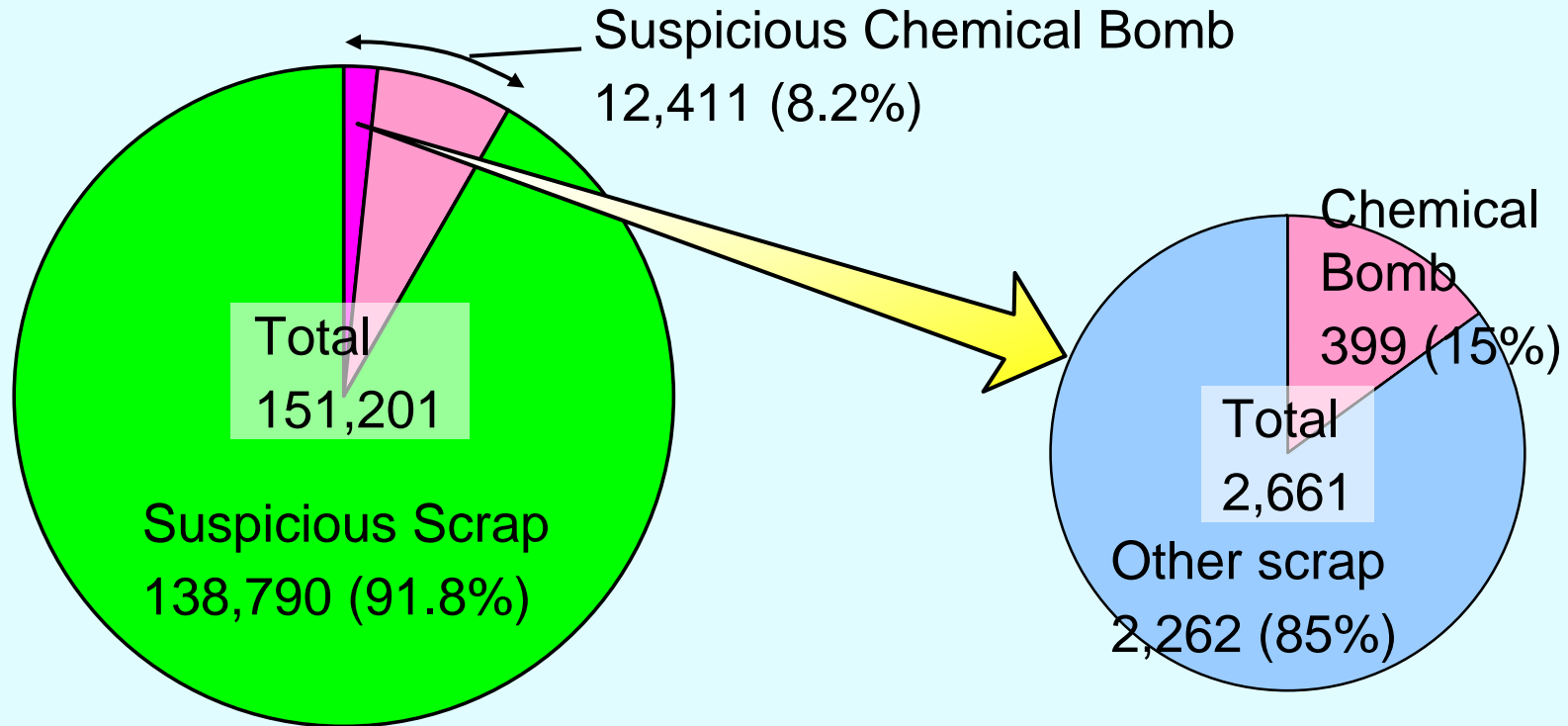
Kanda Port, Fukuoka Pref. Japan

# Identification Flow Chart



Data processing software was improved in many aspects including compensation of the disturbance of wave to improve the accuracy of locating anomalies

# Result of Magnetic Detection and Uncovering



**Results of Magnetic Detection**

**Results of Uncovering by Divers**

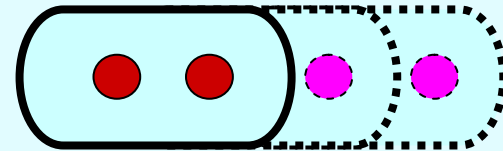
Total magnetic anomaly points	151,201
Points of suspicious chemical bomb	12,411

Uncovered points up to March 2007	2,661
Points where chemical bombs were found	399

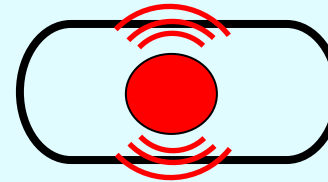
# Multi Detonation

- One of the basic feature of DAVINCH detonation chamber
- Enables larger throughput without enlarging the diameter
  - Longer chamber for more charges, larger throughput
- Reduces the impact and damage to the chamber
- Two modes
  - sequential detonation:

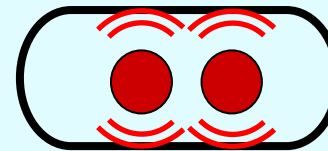
For higher throughput



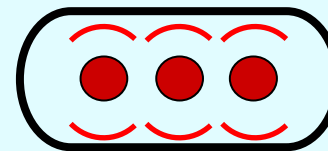
Impact reduction (example of detonation of 30kg-TNTeq.)



1 detonation  
(1 x 30kg)

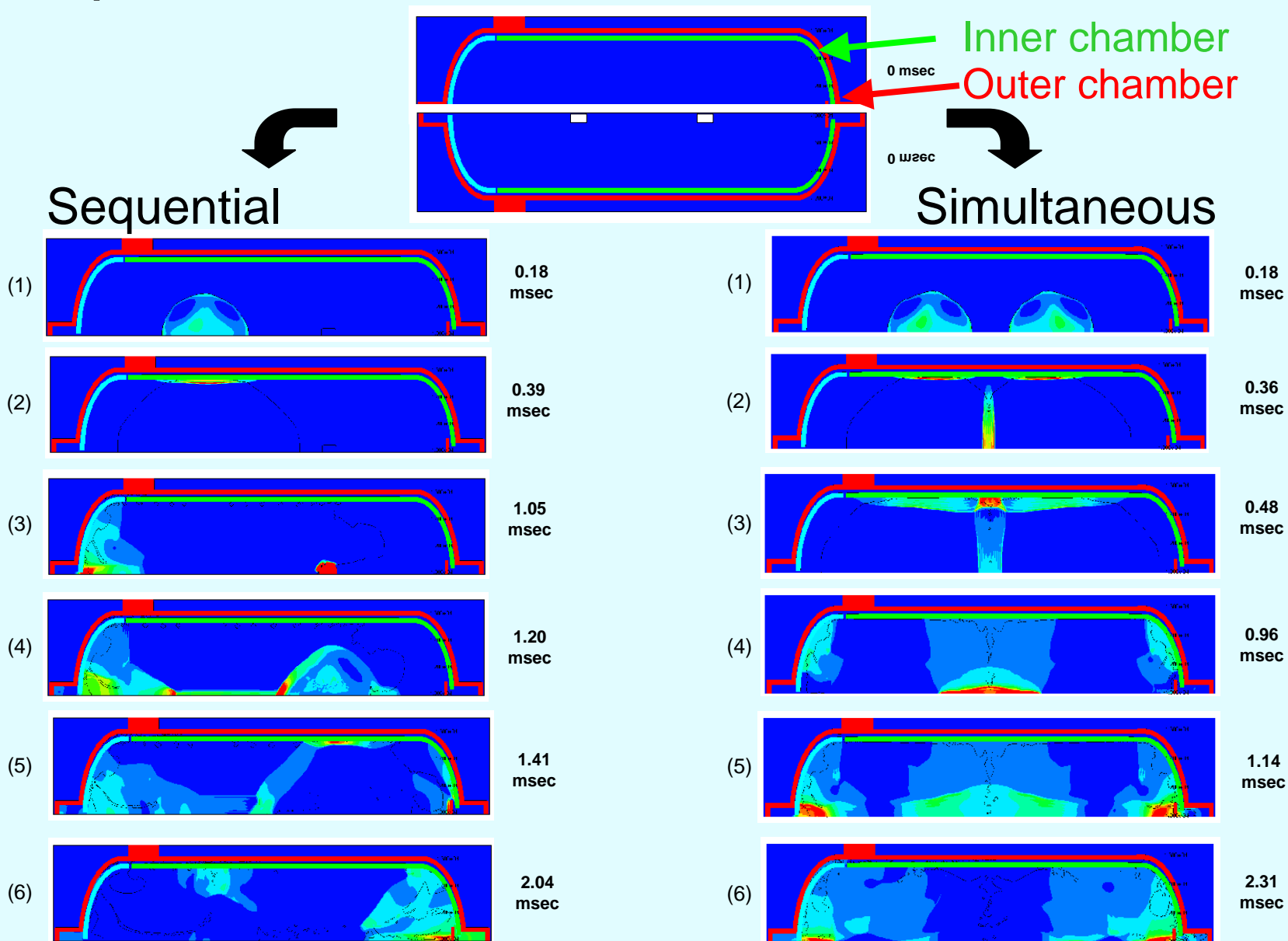


2 detonations  
(2 x 15kg)



3 detonations  
(3 x 10 kg)

# Sequential and simultaneous multi detonation



(a) Sequential Multi Detonation

(b) Simultaneous Multi Detonation

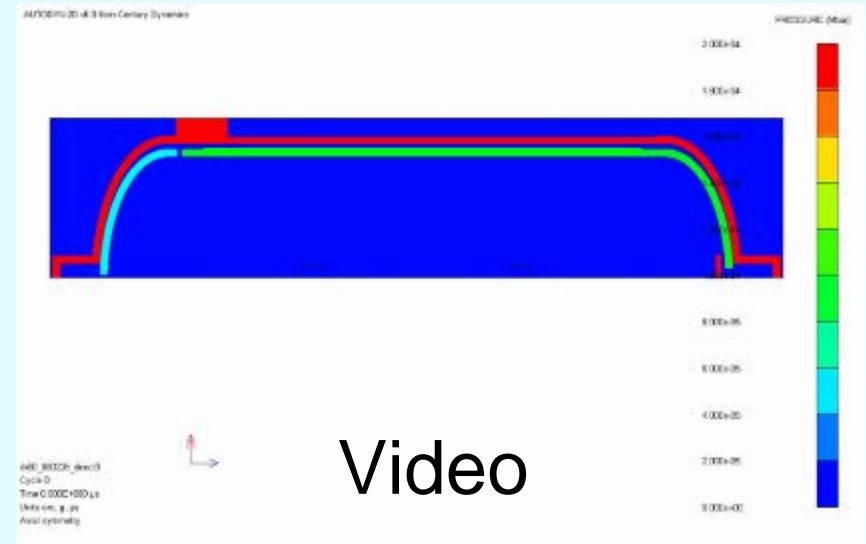
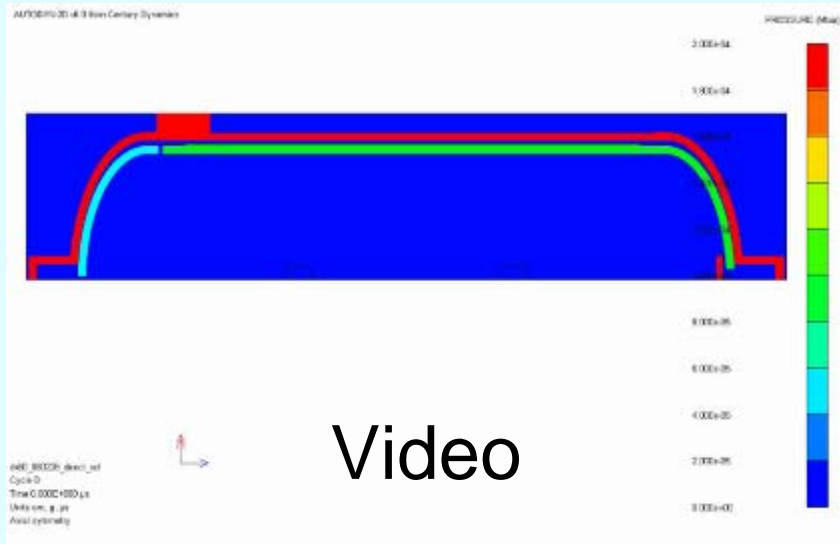
# Sequential and simultaneous multi detonation simulation result

No significant difference in strain of the chamber

Example of simulation result – pressure contour

Sequential

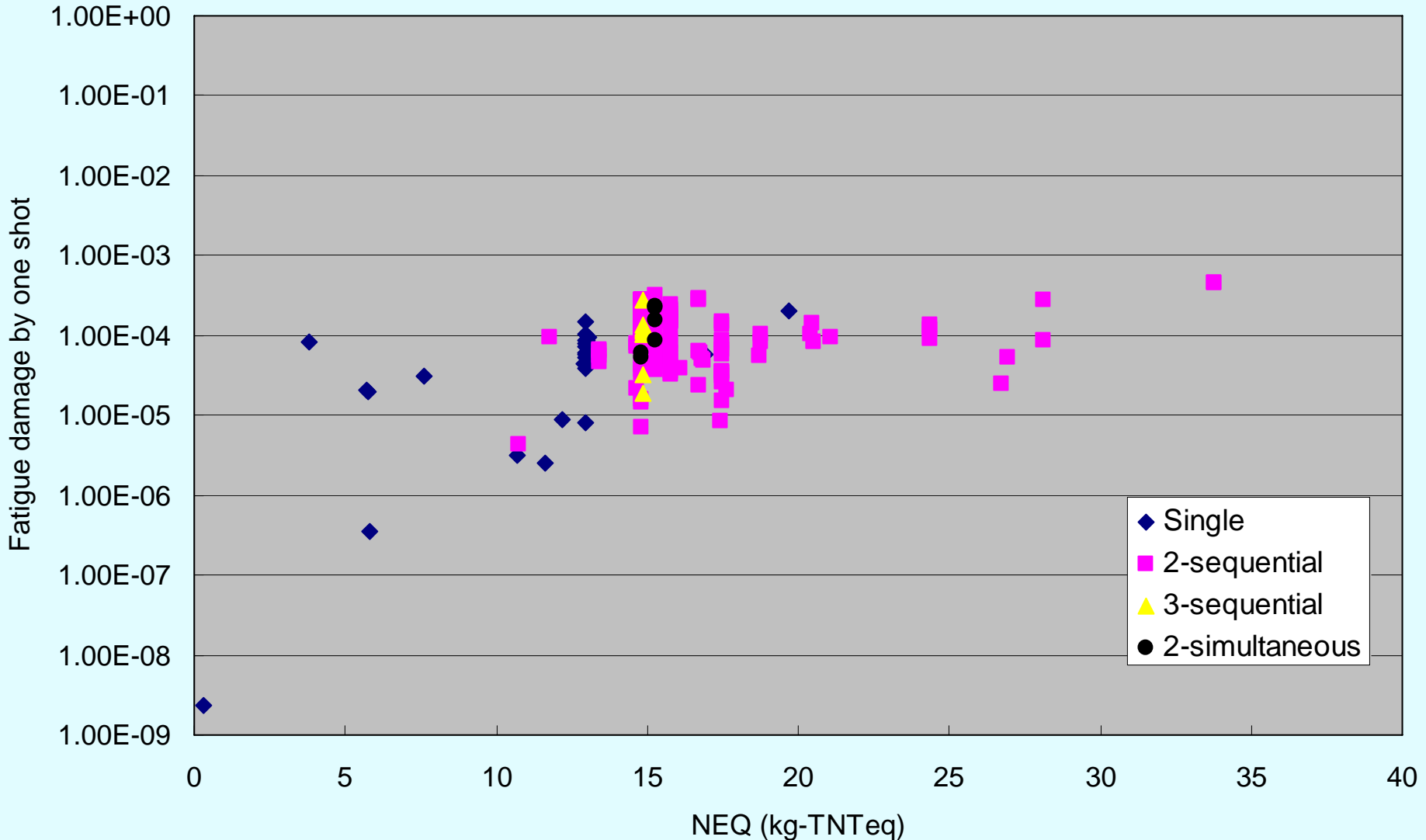
Simultaneous



Tested on actual detonation chamber (next slide)

# Sequential and simultaneous multi detonation - no significant difference in fatigue damage

Fatigue damage by best-fit curve (bottom of nozzle on head)



# Behavior of arsenic in metallic composition of inner chamber



Outer View of Inner Chamber  
(test piece removed)



Inner Wall

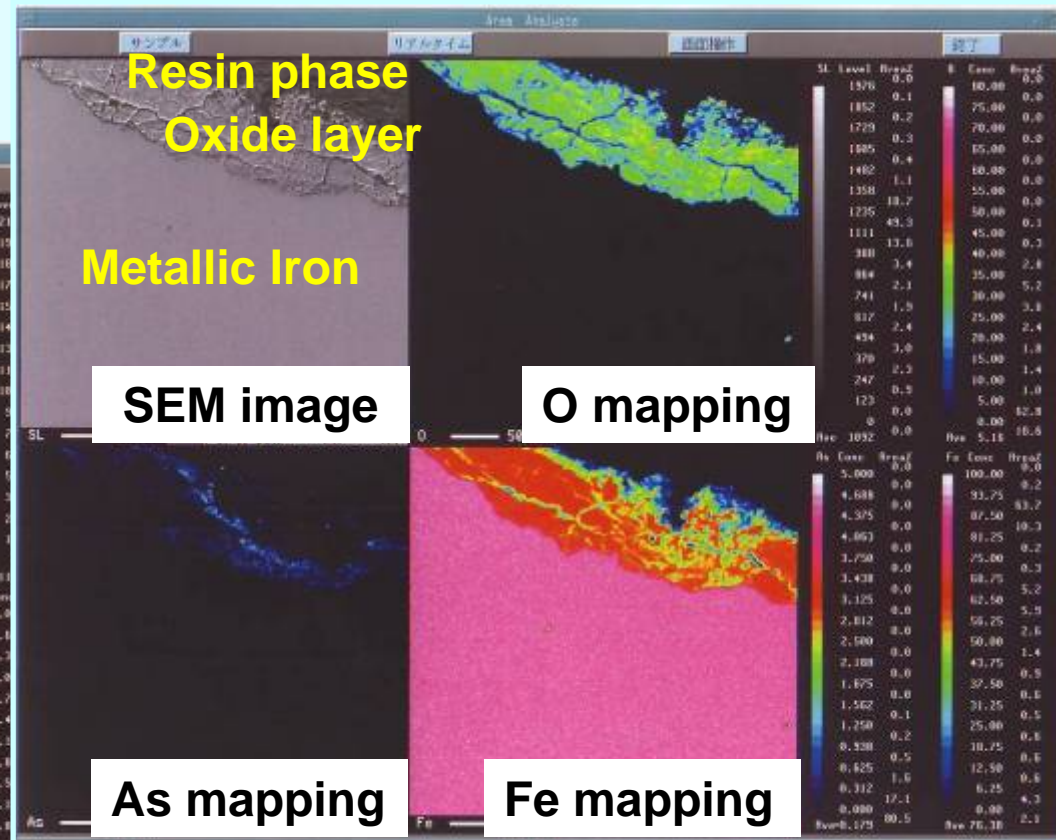
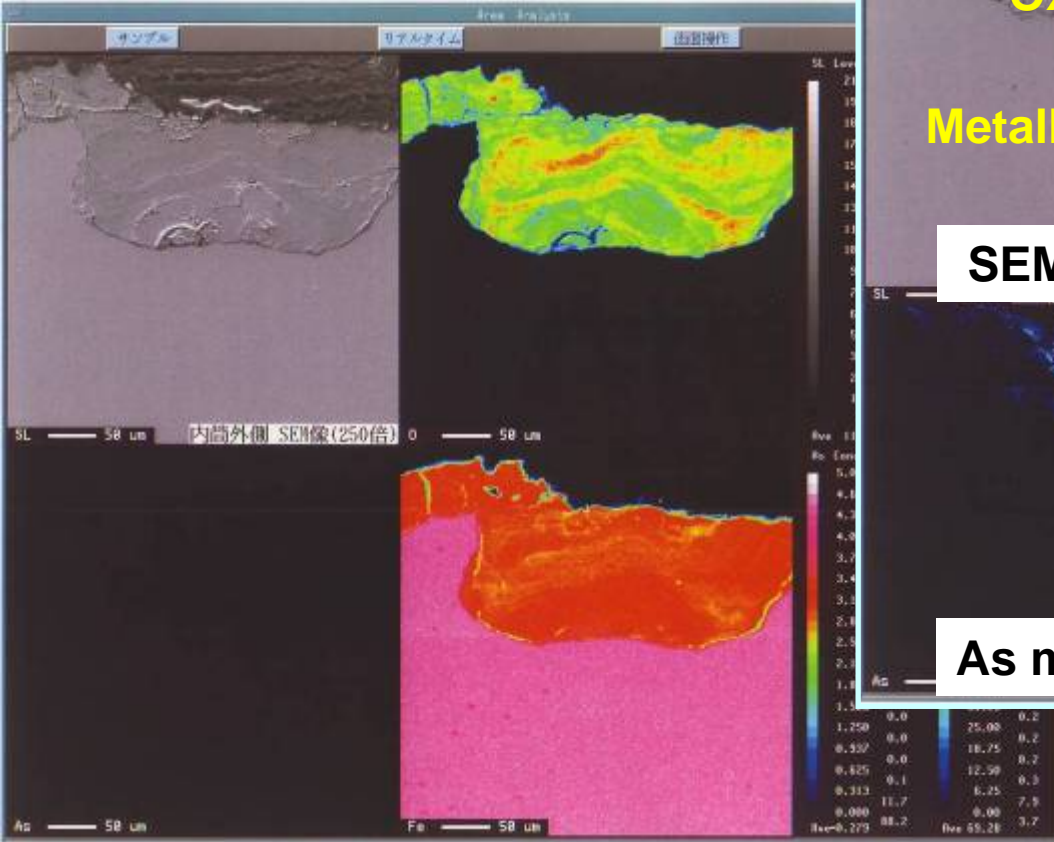
- After 280 shots, no big damage was found.
- Test pieces were cut from the inner chamber to be investigated, no arsenic intrusion in the chamber material
  - No limitation for disposal
  - No embrittlement of the material

# Analysis of arsenic in inner chamber material

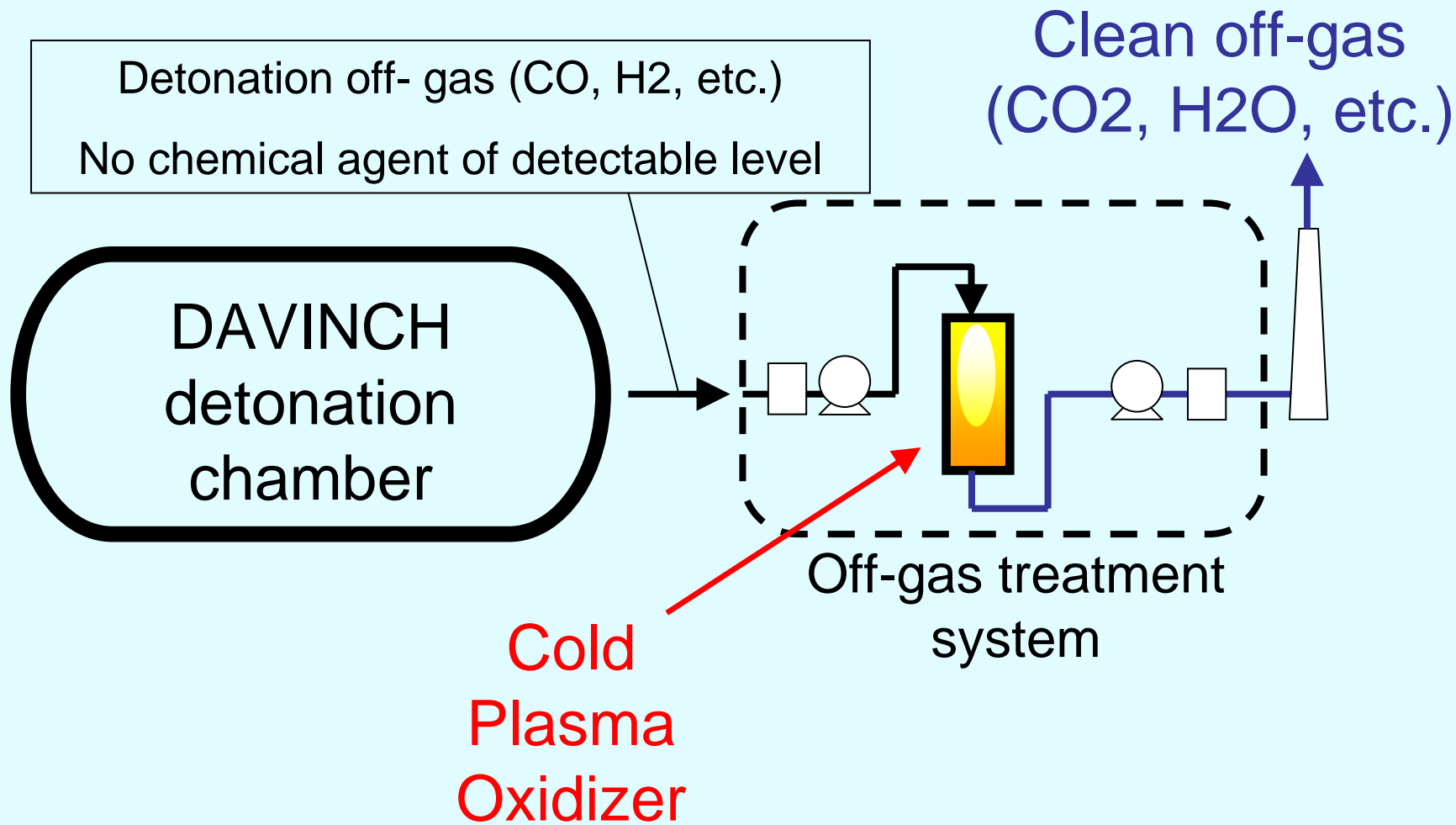
- no intrusion to the chamber material

## Inner surface

## Outer surface



# Demonstration of off-gas treatment by Cold Plasma Oxidizer

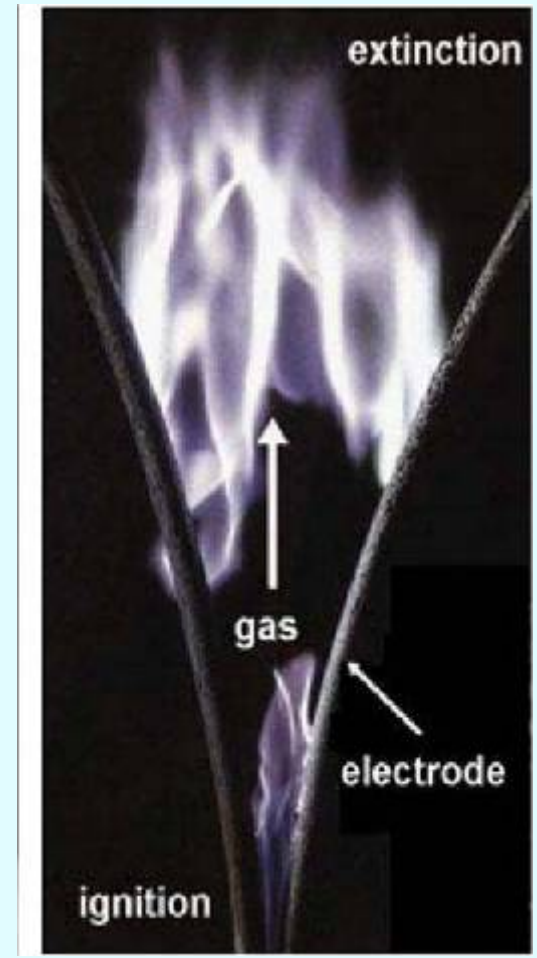
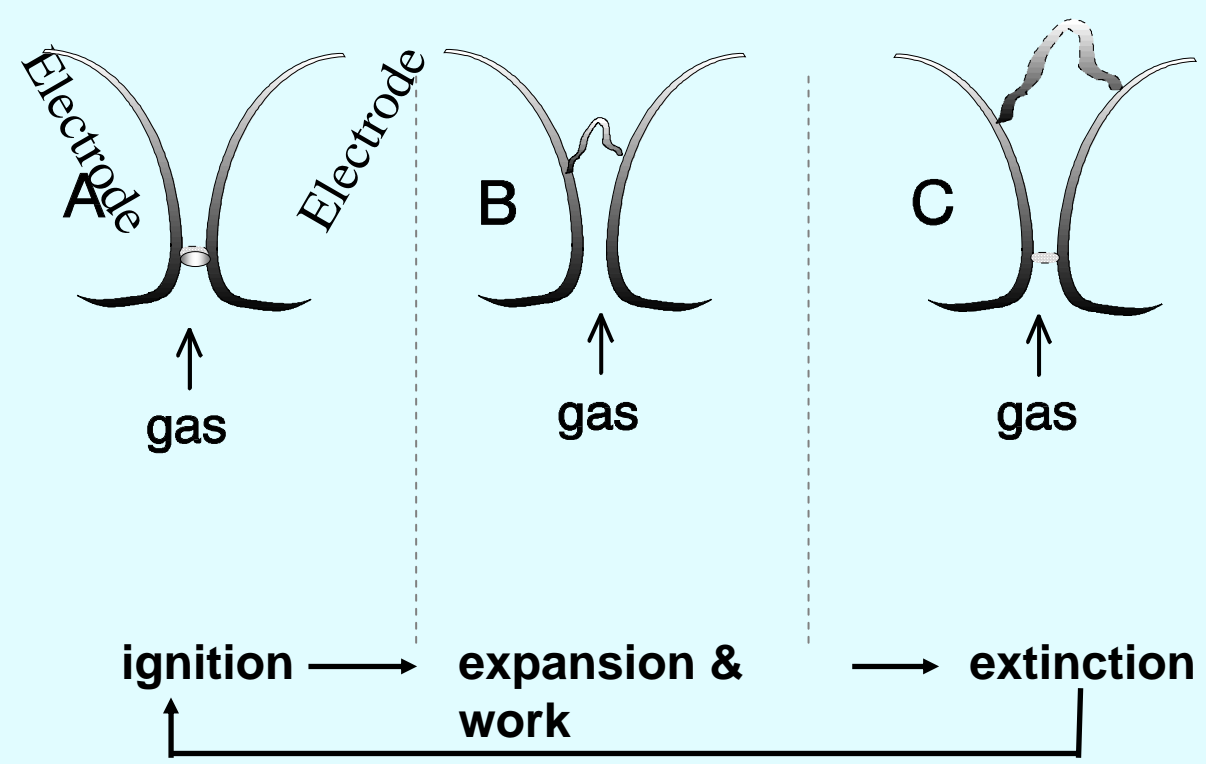


# Cold Plasma Oxidizer

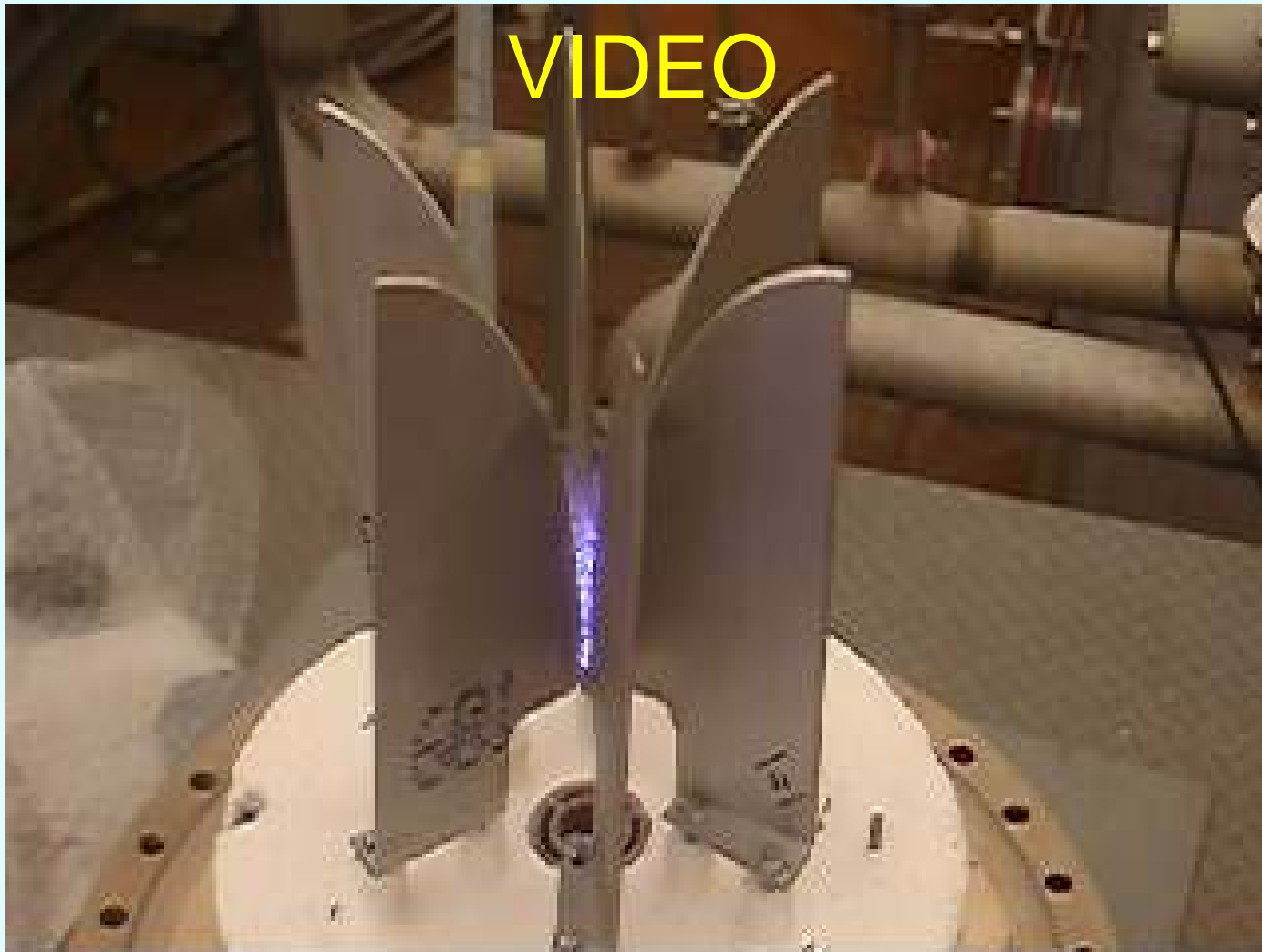
- Compact
  - 1/5 in size compared to conventional combustor
- Smaller exhaust gas volume than conventional combustor
  - No supplementary fuel necessary
- High efficiency
  - CO, H<sub>2</sub> = ND
- Low power requirement
  - 600W
- Rapid start-up
  - 20 - 30 min



# Cold Plasma GlidArc Operating Principle

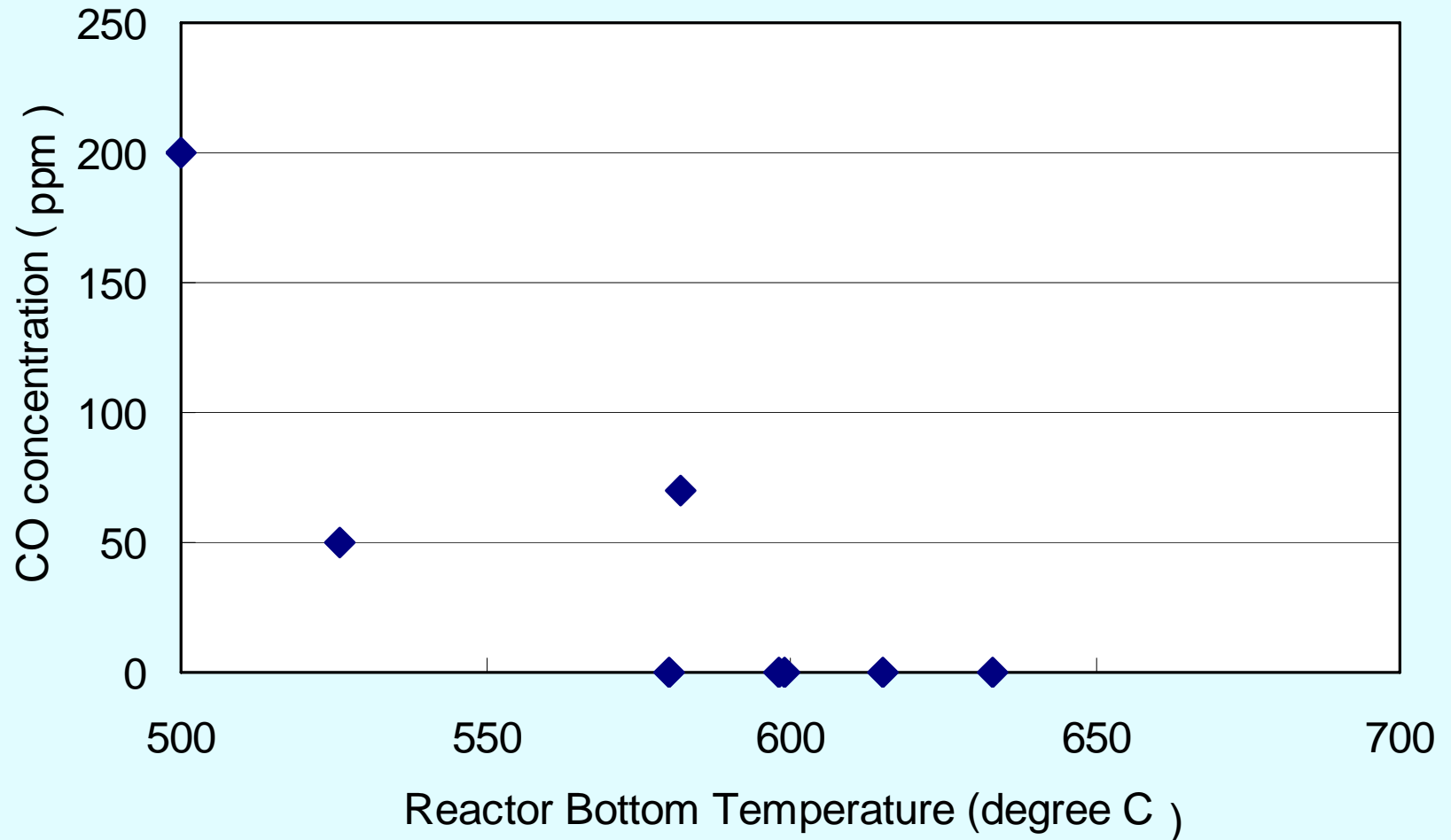


# Cold plasma arc



- Electron temperature 10,000 deg.C
- Combustion temperature 1,700 deg.C (with oxygen)  
1,500 deg.C (with air)

# CO concentration of output gas



# Summary

- About 670 chemical bombs were destroyed successfully in 2006, more than 1,200 in total since 2004
- Magnetometer detection system including data analysis software was further improved
- Simultaneous multi detonation was tested and there was no significant difference in fatigue damage compared to sequential detonation
  - Detonation system can be further simplified
- Behavior of arsenic on inner chamber material was investigated, no arsenic intrusion into the inner chamber material
  - No limitation for disposal arise from arsenic
  - No effect to the strength
- The capability of Cold Plasma Oxidizer to treat detonation off-gas was demonstrated

Thank you for your  
attention  
Any question ?

