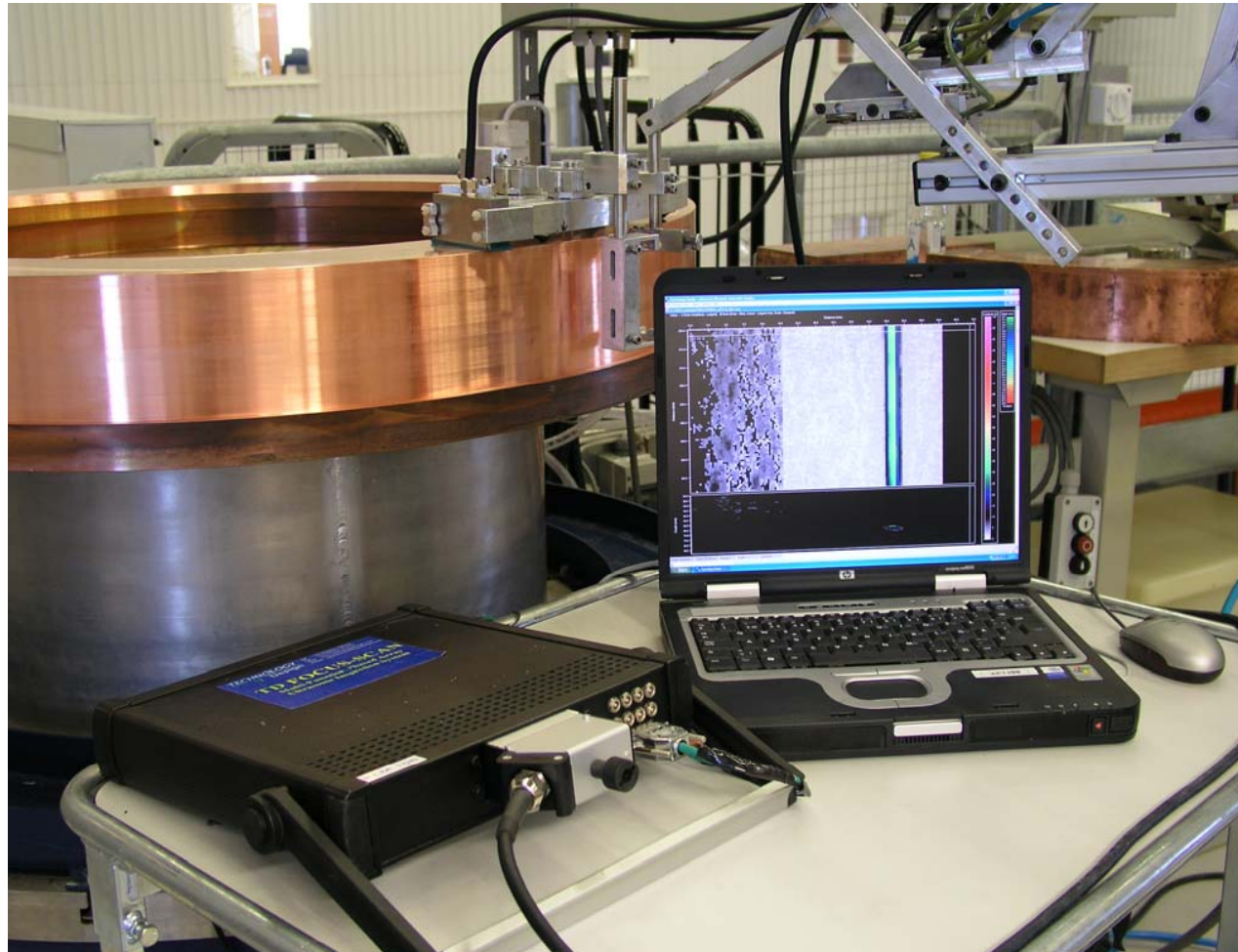


NDT of FSW in copper canister



FSW – What's that?

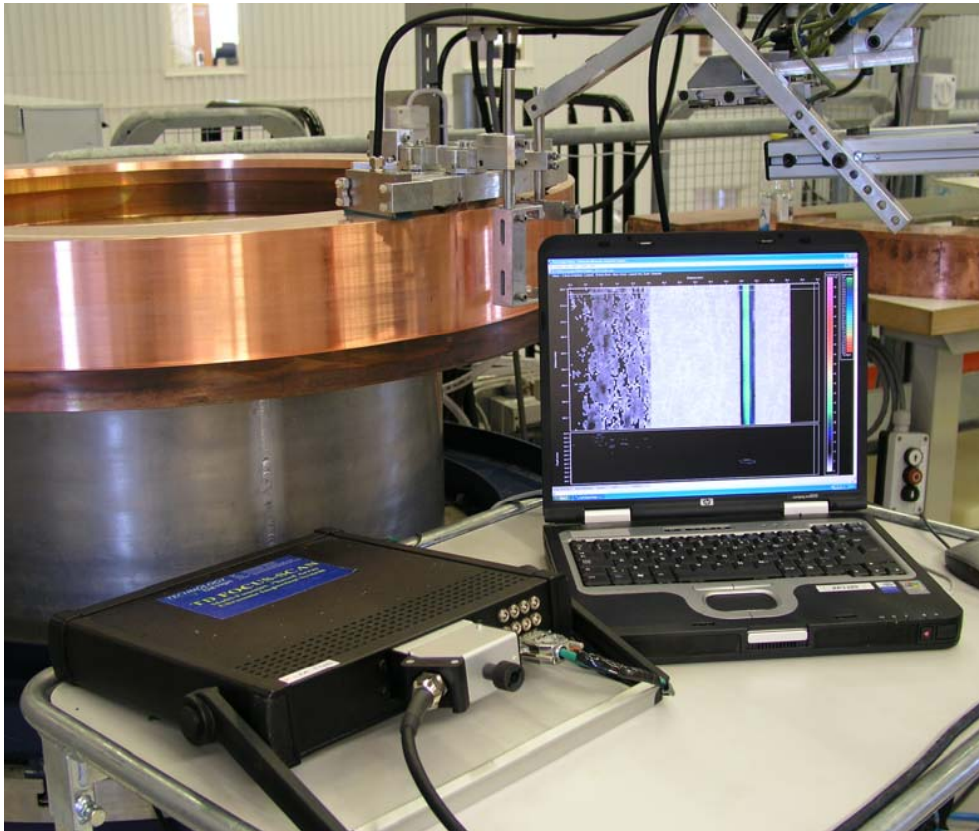
- New technique?
- New application!
- Material properties!
- Defects!

NDT – Why?

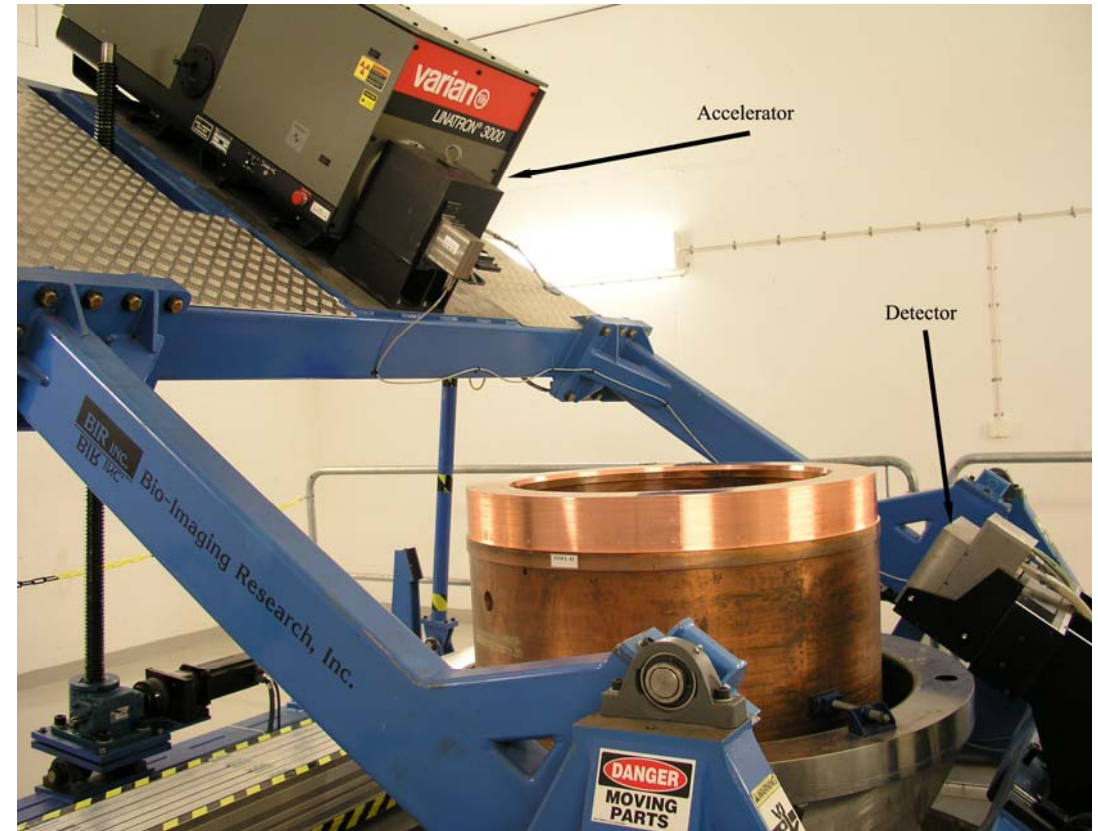
- Verify the canister as corrosion barrier
- Verify safe handling from sealing to deposit
- Verify the mechanical strength in the deep deposit

NDT Techniques

Phased array ultrasound

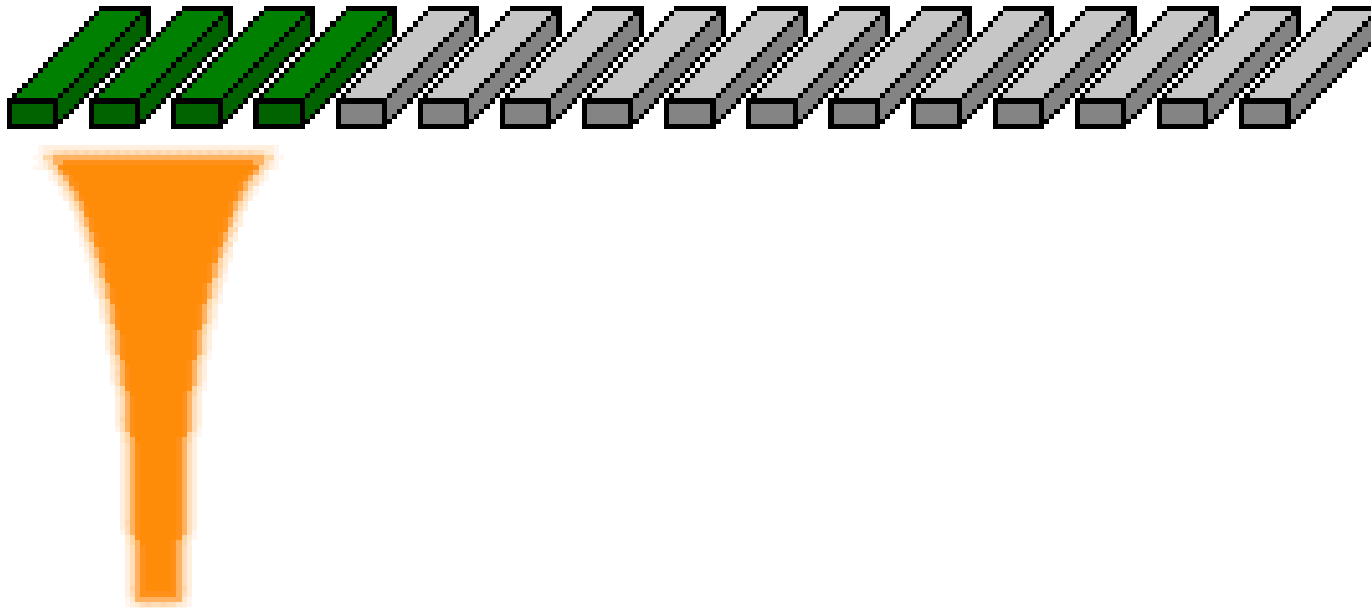


High-energy digital radiography



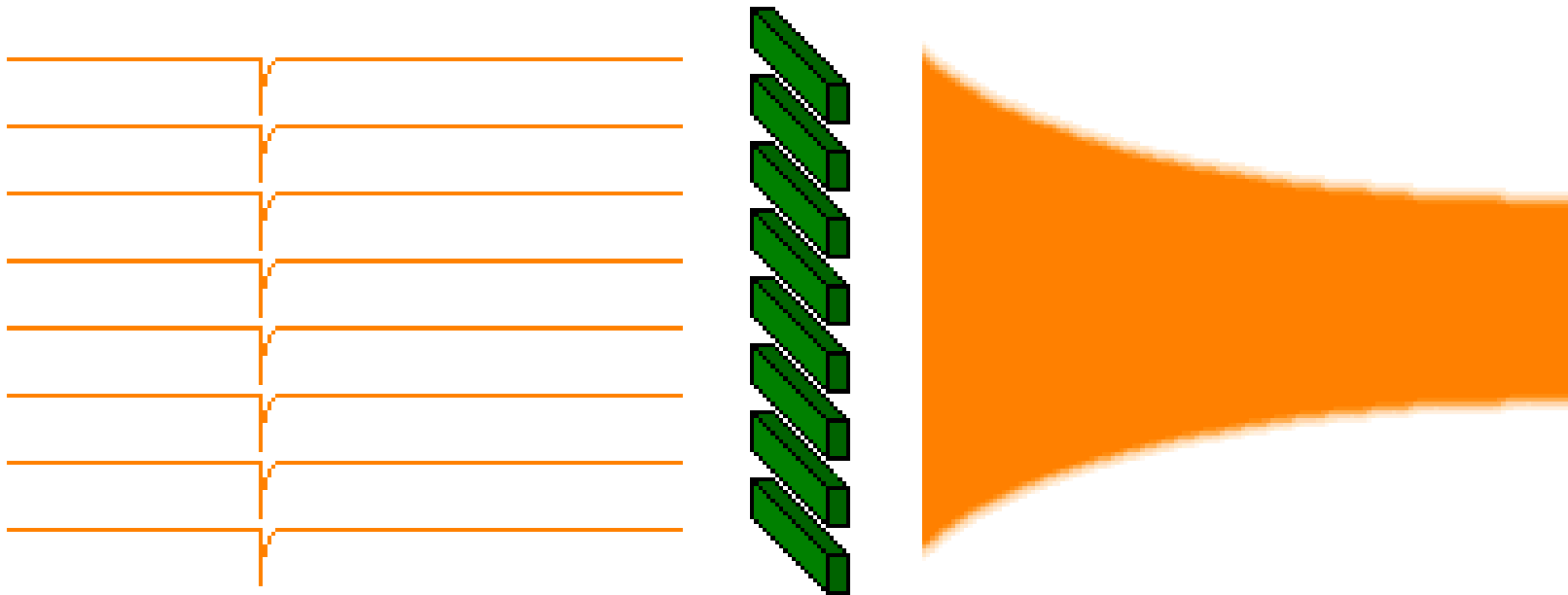
Phased array ultrasound

Electronic scanning



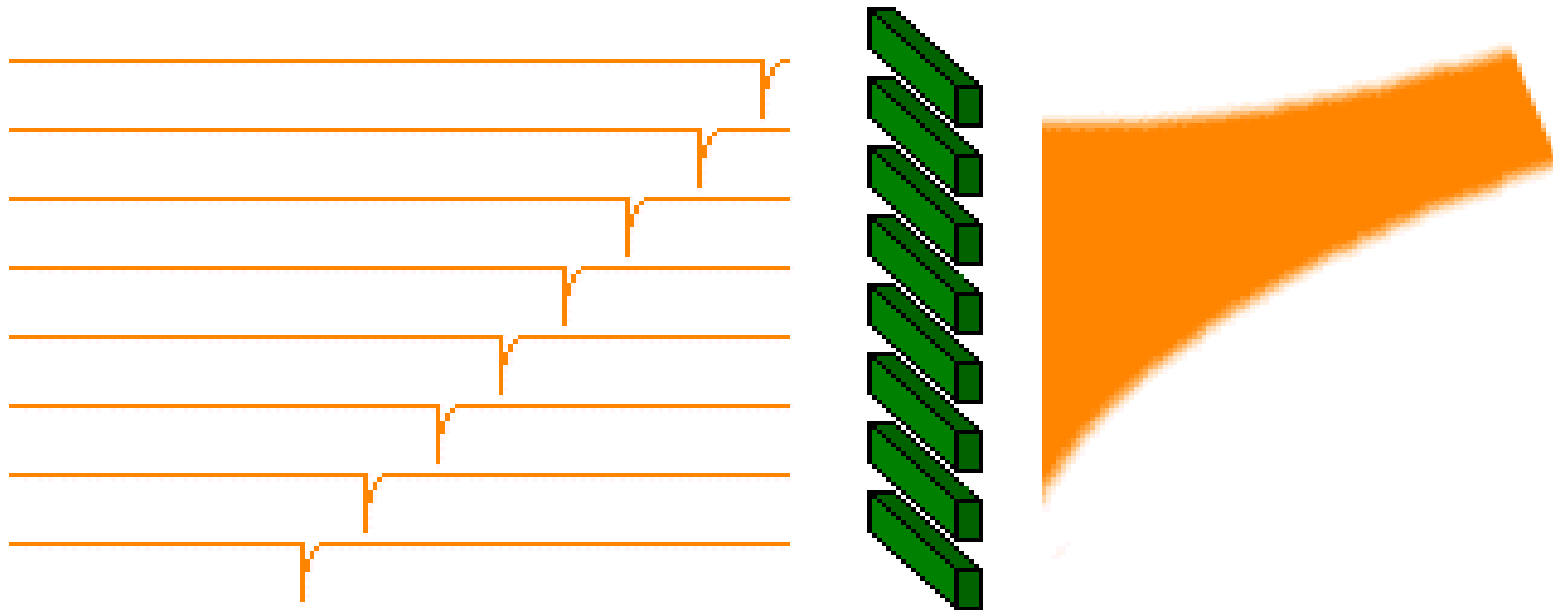
Phased array ultrasound

Depth focusing

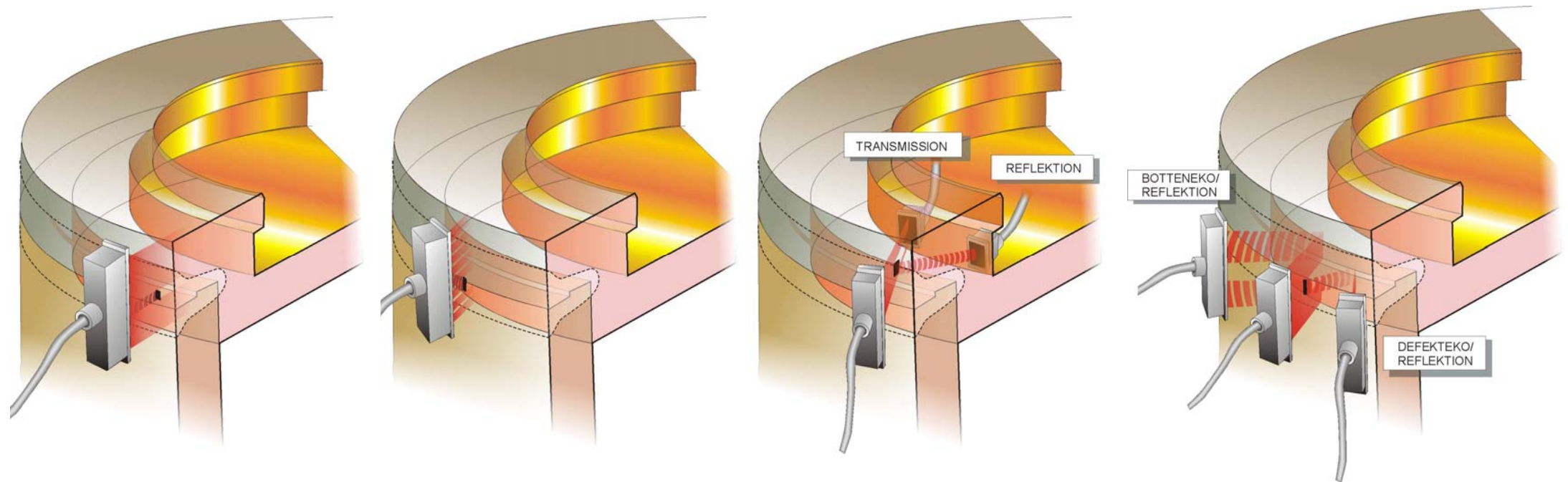


Phased array ultrasound

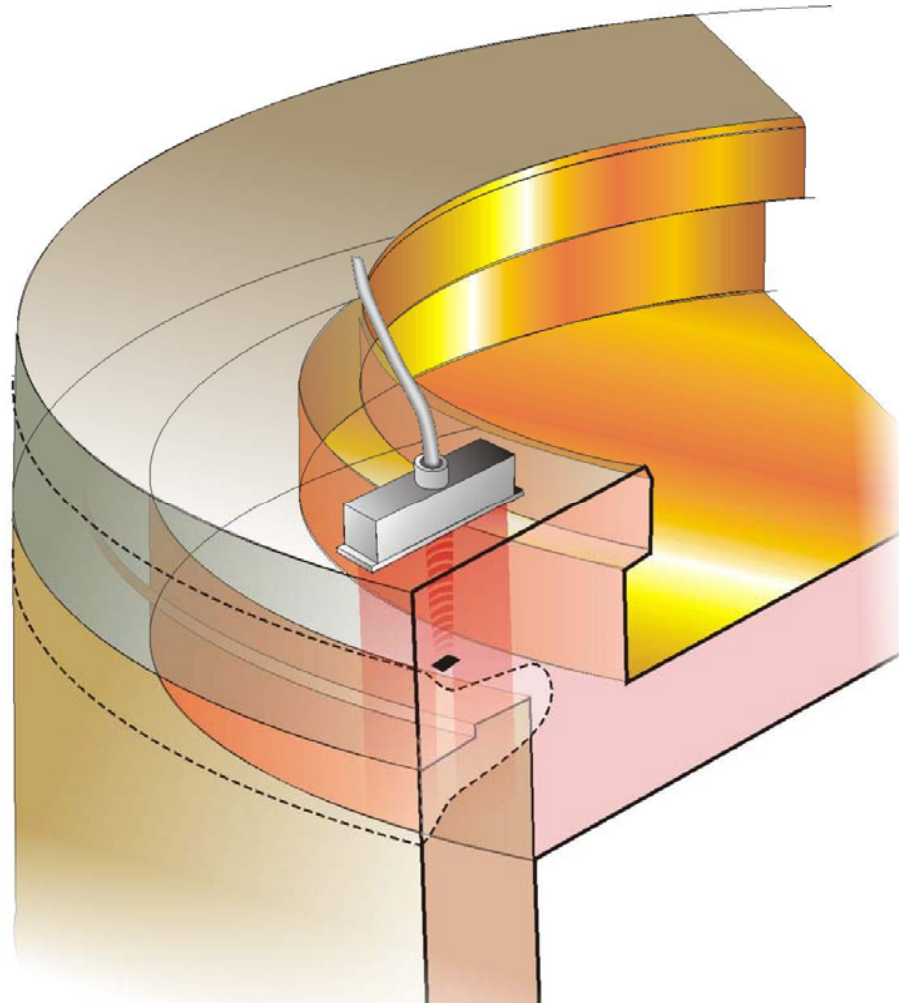
Beam steering



Evaluated configurations

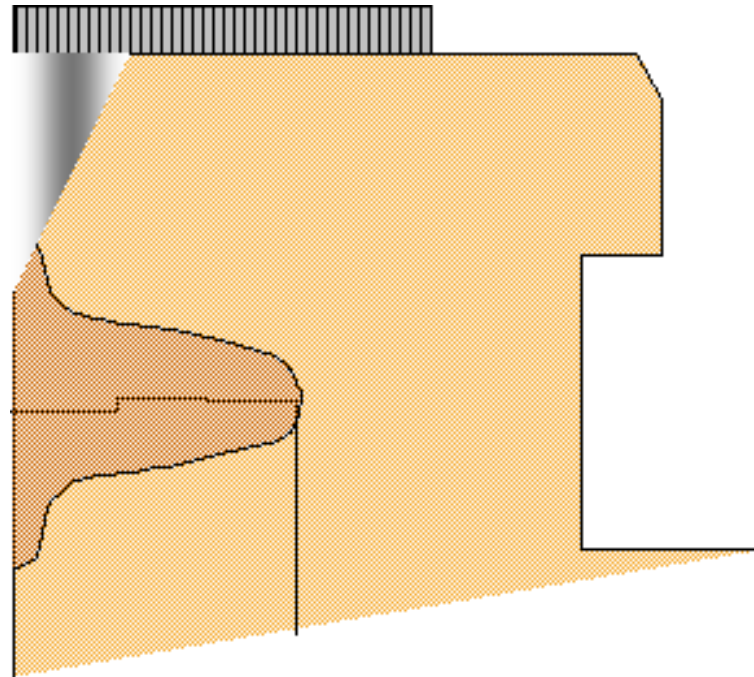


Phased array pulse-echo



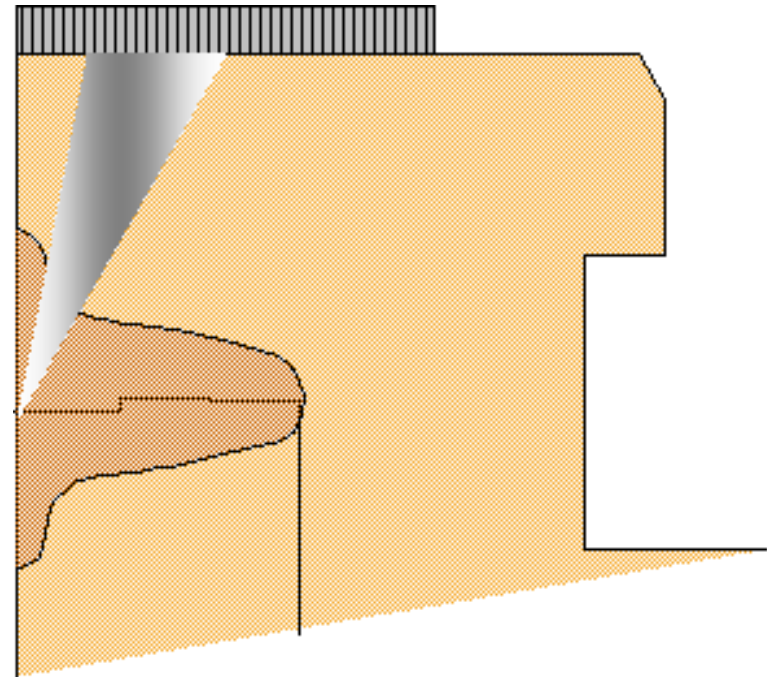
Phased array configurations

- 80 element linear array
- Focus depth 50/60 mm with dynamic depth focus at the receiver side
- Frequency 5 MHz
- Electronic scan in the radial direction while the canister rotates
- UT angle 0° , $0-30^\circ$



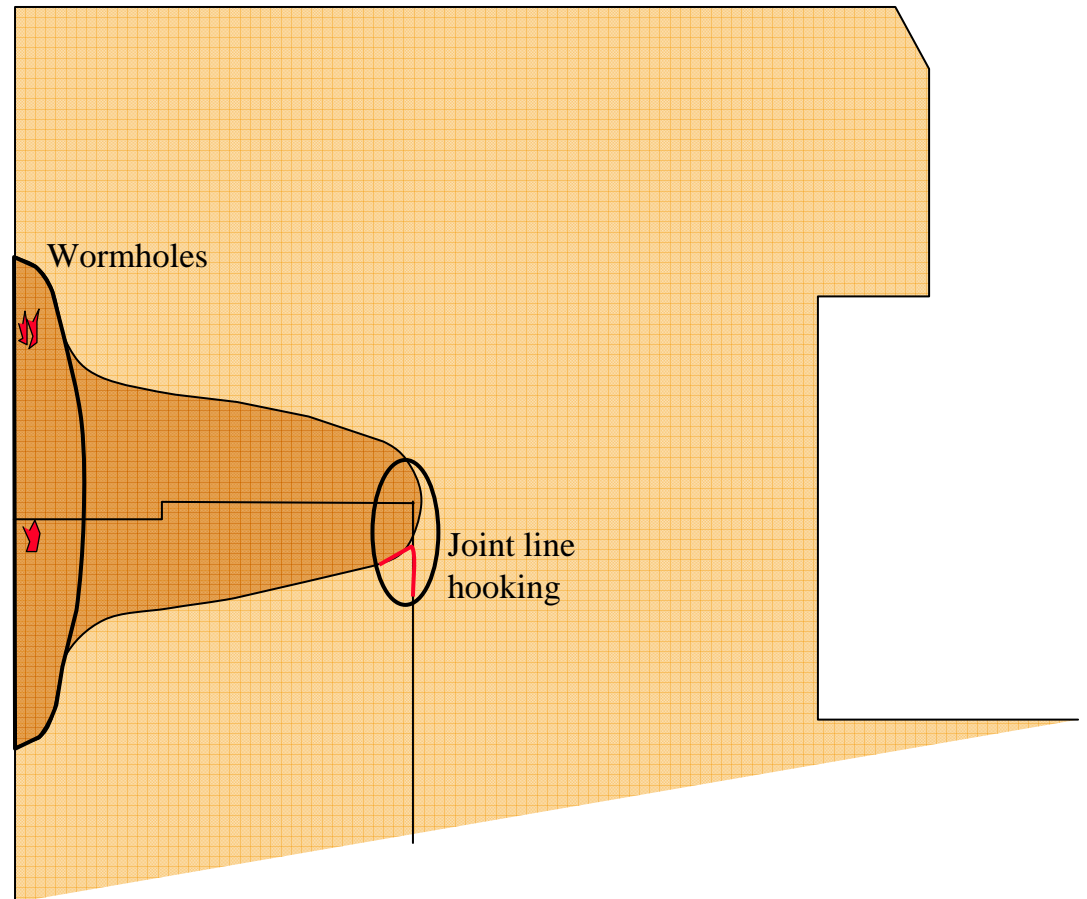
Phased array configurations

- 80 element linear array
- Focus depth 60 mm with dynamic depth focus at the receiver side
- Frequency 5 MHz
- Electronic scan in the radial direction while the canister rotates
- UT angle 0° , $\pm 10^\circ$, $\pm 20^\circ$

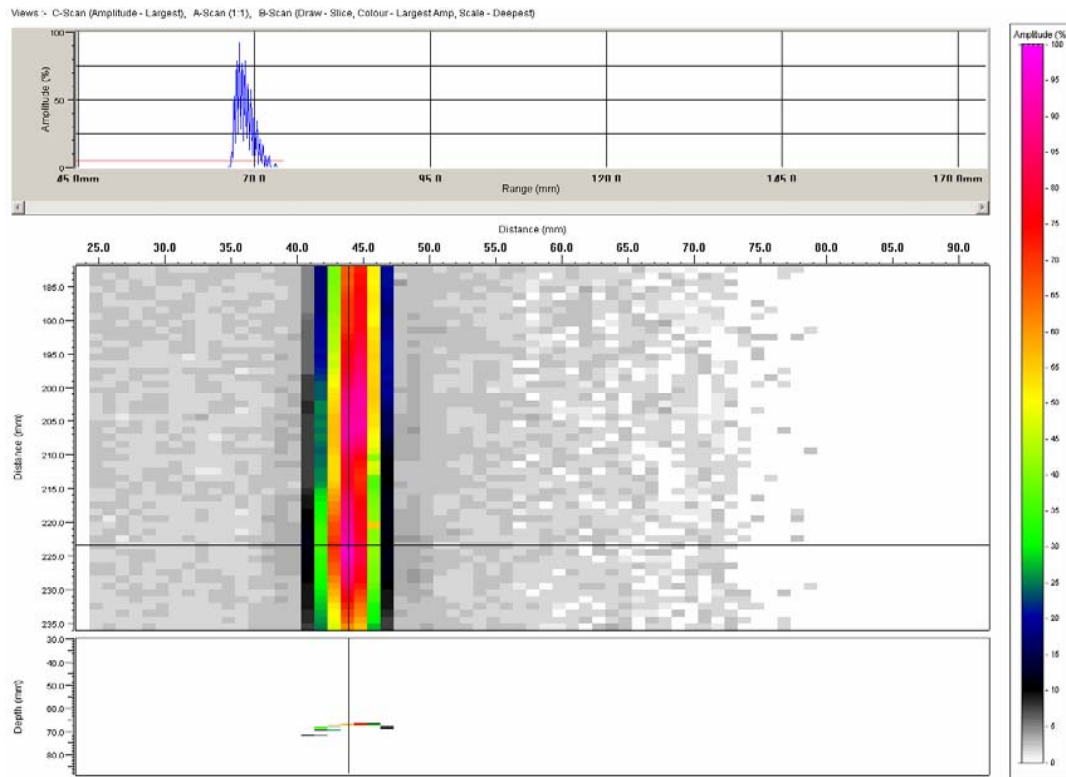


What to find?

- Root defects – joint line hooking (JLH)
 - Non-volumetric
- Surface or near-surface defects
 - Non-volumetric
 - Volumetric

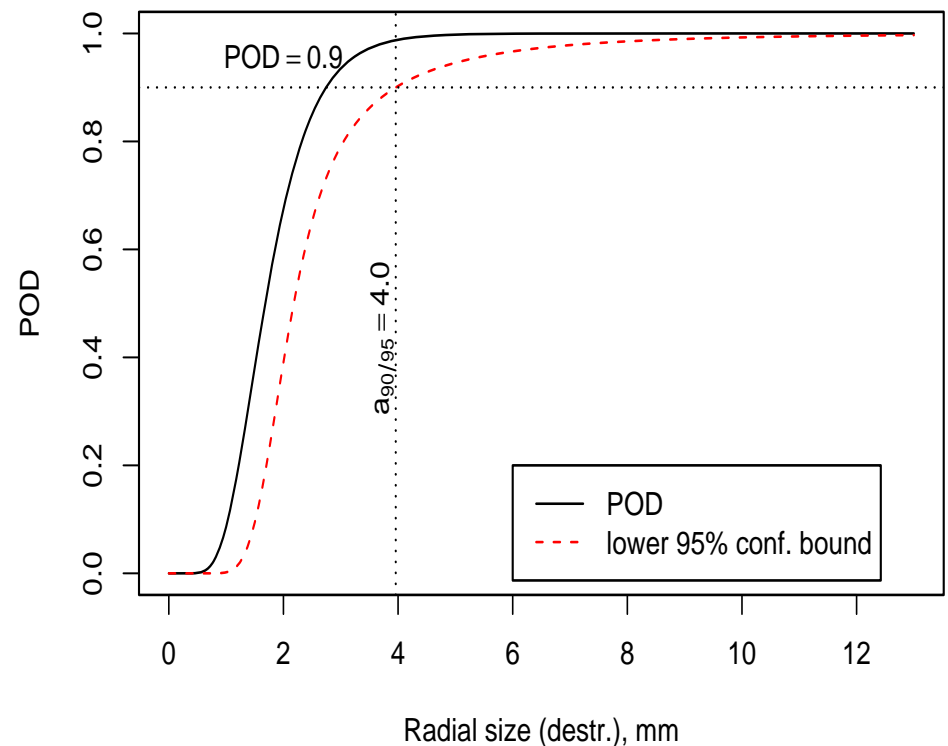


UT results, joint line hooking



Reliability project at BAM

- 3 year project at BAM
- Data input
 - Identification of relevant defects
 - NDT data
 - Destructive data
- Data analysis by reliability codes based from US Military
- POD values for UT
 - Joint line hooking, 4 mm
 - Wormholes, 5 mm
- Sizing capabilities
 - Better than 2 mm



Conclusions

- Ultrasound is suitable for the FSW seal weld of the copper canister
- The FSW process is very stable.
- The reliability of the NDT-methods is enough.

Considerations

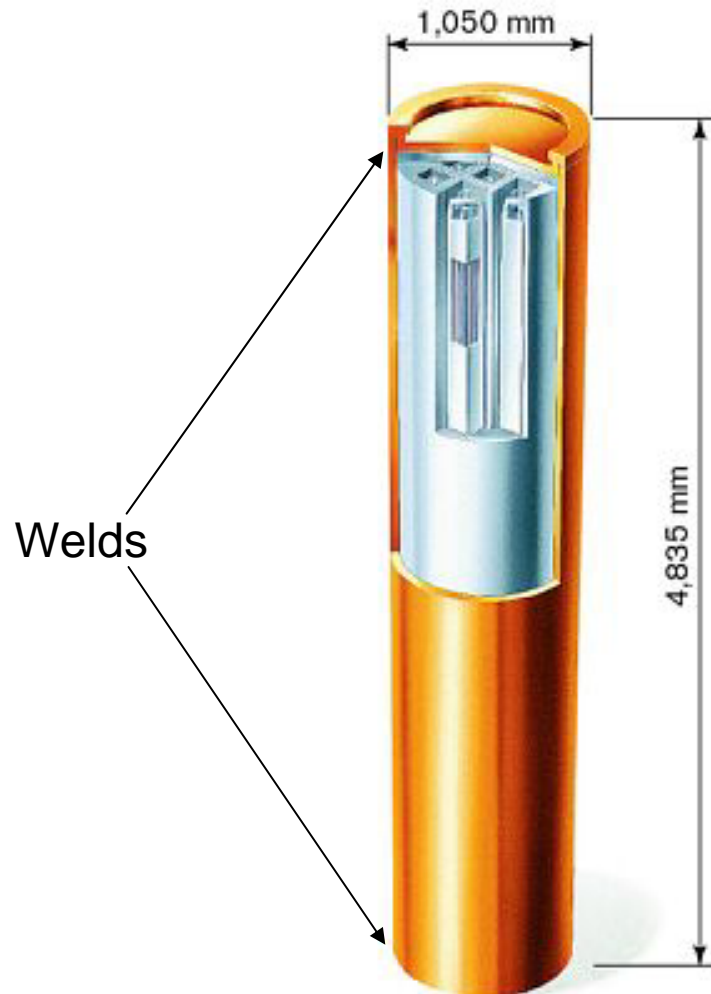
Modified FSW-process requires:

- Adapted inspection technique due to.
 - Joint line hook shape
 - Near-surface material structure

Further actions

- Optimization of the inspection procedures.
- Verification of the procedures by UT modelling.
- The major work will be focused on the NDT of the canister components.

The copper canister – not only the welds!



Manipulator for NDT of copper tubes and cast iron insert



Publications

Reports at www.skb.se -*Publications*

- SKB R-06-26

Reliability in sealing of canister for spent nuclear fuel

Ronneteg, Ulf 1); Cederqvist, Lars 2); Rydén, Håkan 2); Öberg, Tomas 3); Müller, Christina 4)
2006

- SKB R-06-06

Kapsel för använt kärnbränsle. Oförstörande provning av svetsar

Svensk Kärnbränslehantering AB
2006