

RAILECT

ET AWARDS
The Institution of
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INNOVATION 
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The Solution for Volumetric Assessment of Aluminothermic Rail Welds

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Materials Joining and Engineering Technologies

A large, semi-transparent globe graphic is positioned in the bottom right corner of the slide. It shows the outlines of continents and latitude/longitude lines, with a focus on the European and Asian regions.

- Background and the market need for a new inspection system
- Requirements of the new (post-project) system
- Design and functionality of Railect system
- Inspection results

Aluminothermic Welds in the Railway Industry

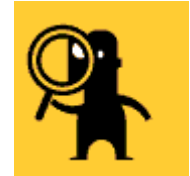
- The majority of field welding is carried out using aluminothermic welding. This casting method is :
 - widely used for in-track welding during re-rail and defect replacement
 - an effective, highly mobile and cost effective
- In the UK :
 - 65,000 new welds per year produced by Network Rail and up to 2% rejection rate
 - 1.5 million welds already on the main line railways
- In Europe:
 - 300,000 to 400,000 new welds made per year
 - 11 million welds estimated to be on track
 - 20% of all rail failures estimated to be caused by weld failures



Current Techniques of Inspection

- Visual Inspection

- Most of the time, only visual inspection is performed
- Surface and geometric flaws only are assessed
- Reliability? Performance? Assessment?



- Conventional Ultrasonics

- Manual ultrasonic procedure for inspection of rail welds: EN 14730-1:2006 Annex C
- Full inspection takes approximately around 1hour



- Radiography

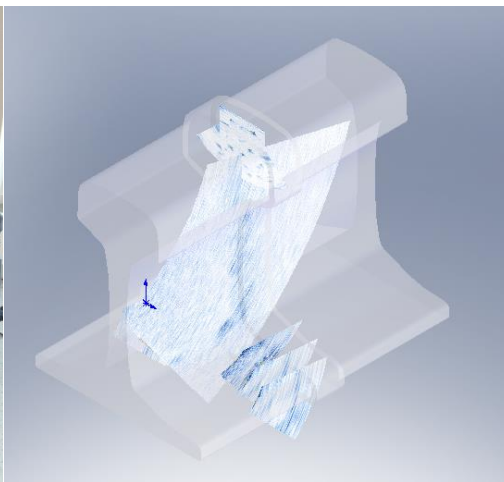
- Disadvantage of the exposure time and exclusion zone (especially for main line track)
- Full inspection takes approximately 30 minutes to 1hour



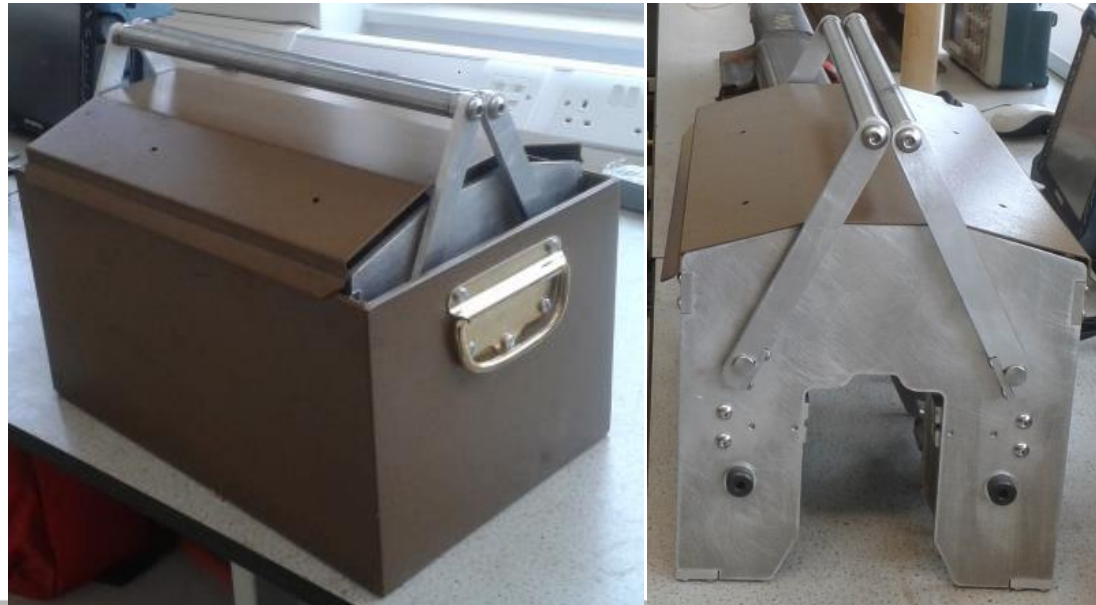
Need for new system of inspection

Requirements of the Railect System

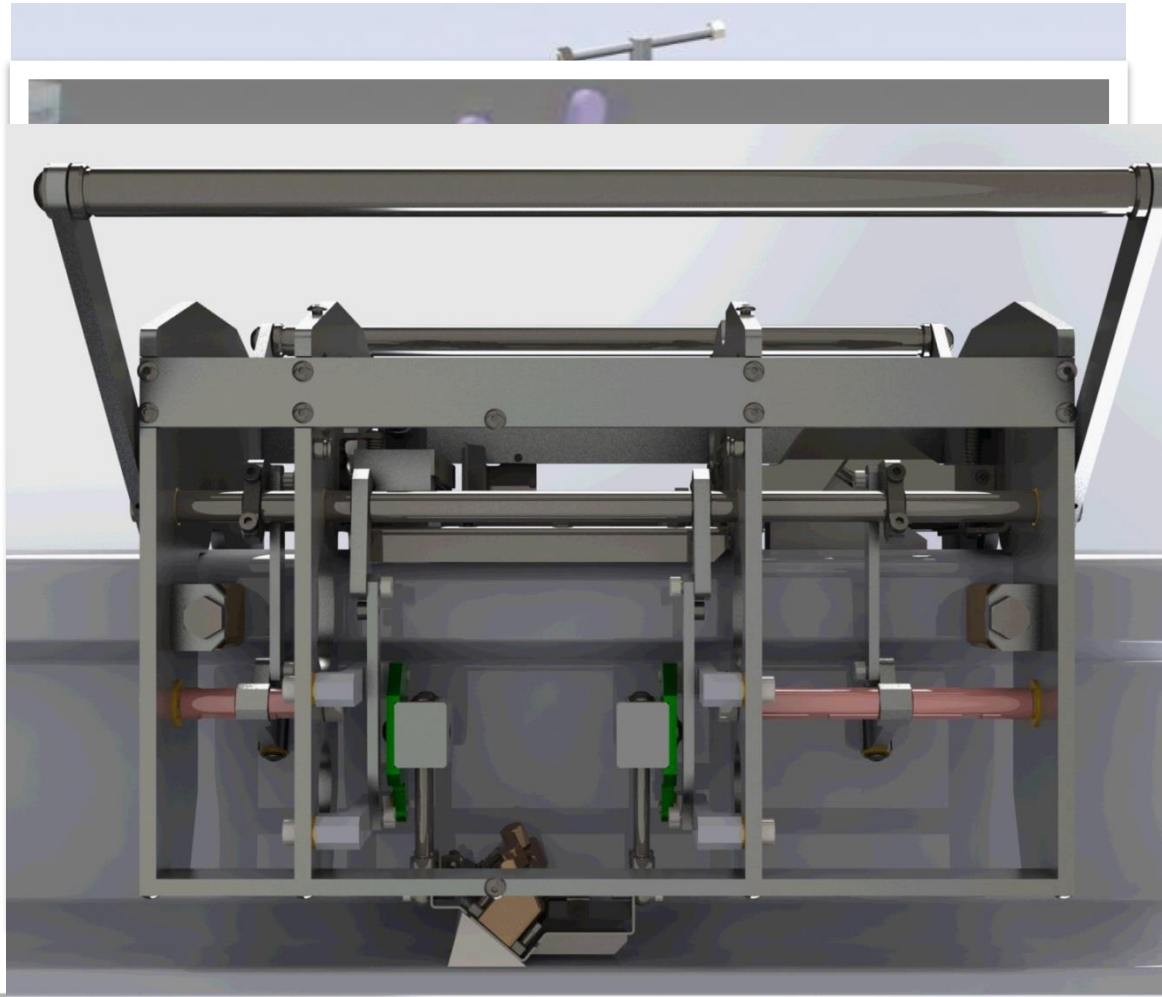
- Fully portable and easy to deploy
- Robust and weather proof
- Rapid volumetric inspection
- Give clear indications of defective welds
- Compatible with multiple rail profiles



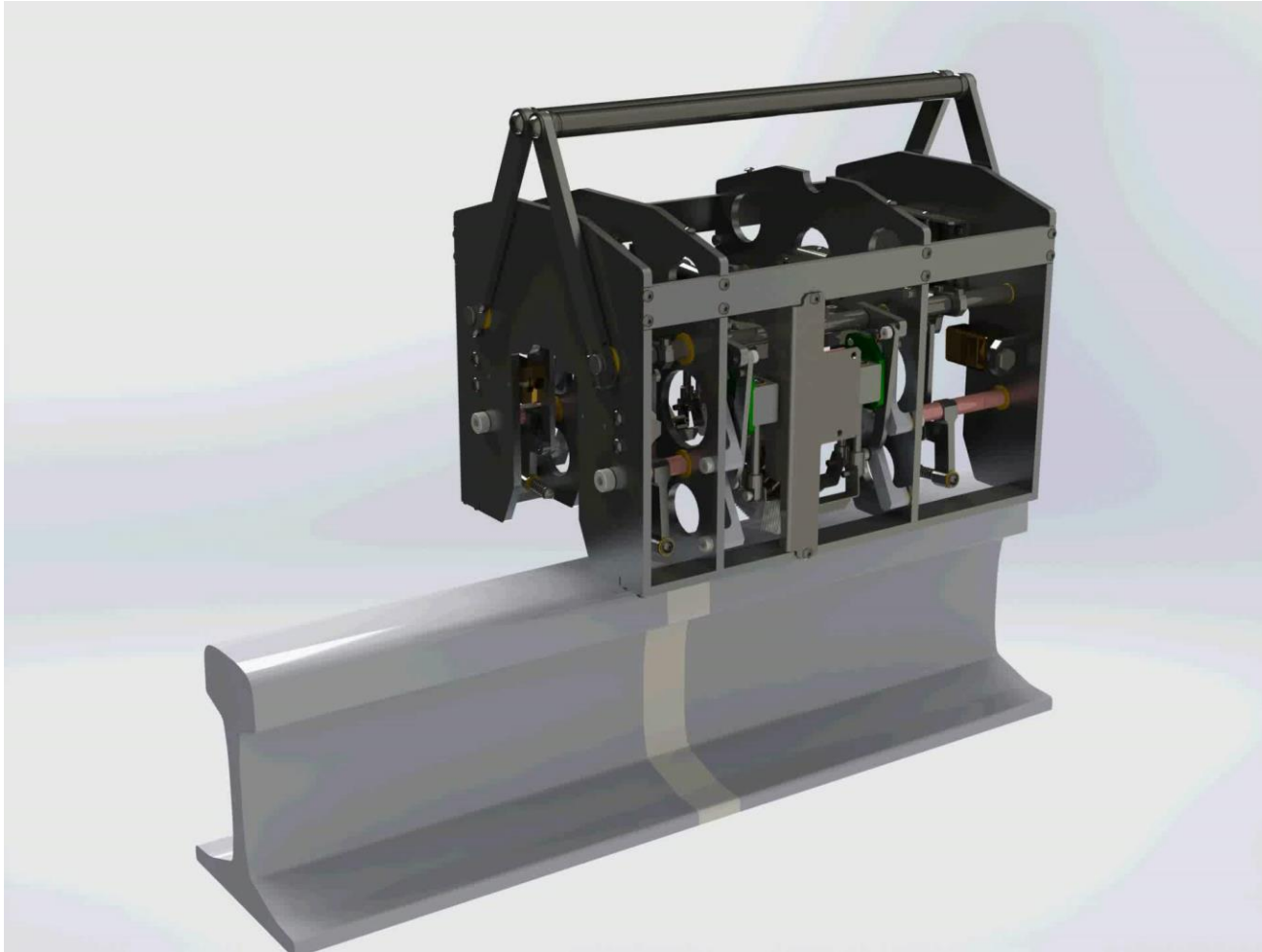
- Fully encased with carrying handles on both sides of outer case
- Total weight around 10kg
- Robust to be transported on railway trolley



Development of Prototypes

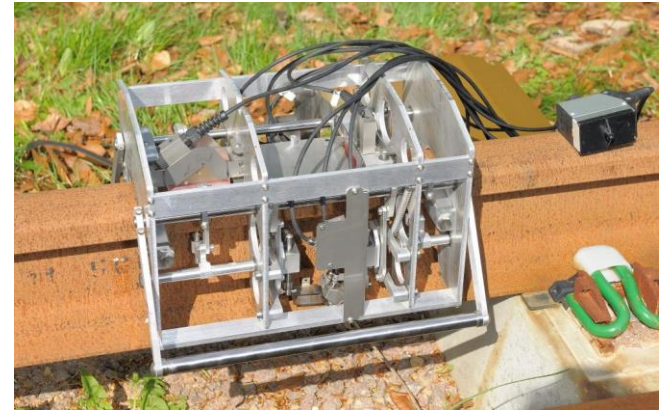


Deployment of Railect System



Robust and Weather Proof

- Aluminium frame and casing
- Covered top
- Computerised in ruggedised, laptop required

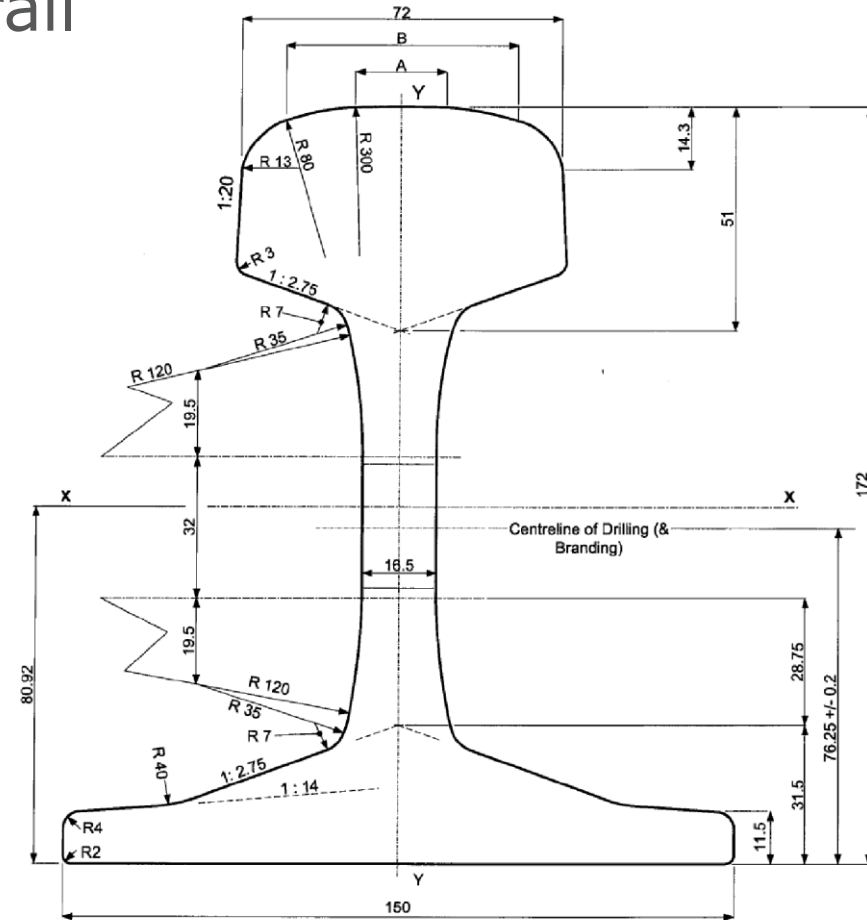
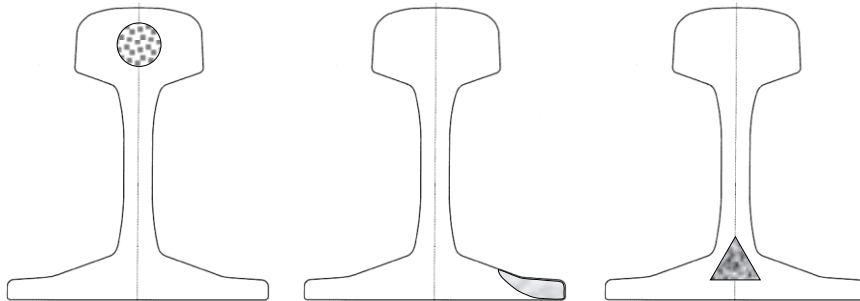


- Concentrate on one rail profile

- CEN60E1

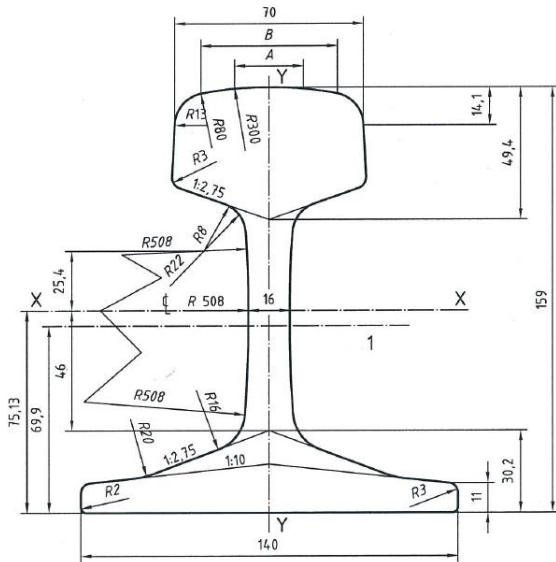
- Selection of flaws

- Porosity in the head
 - Lack of fusion in the foot
 - Shrinkage defect in the web



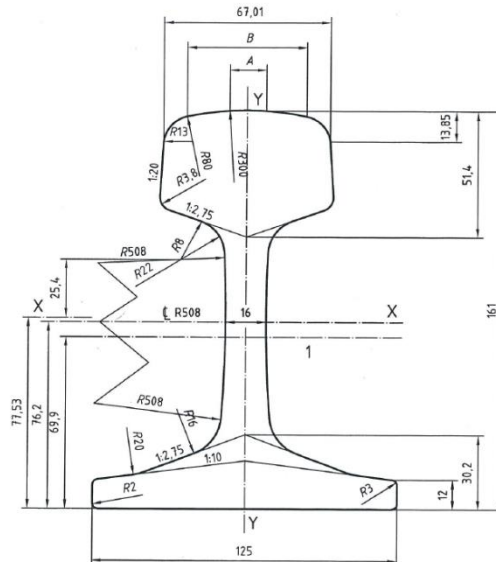
Compatible Profiles --- New

- Designed for 3 additional profiles: 54E1, 54E2, and

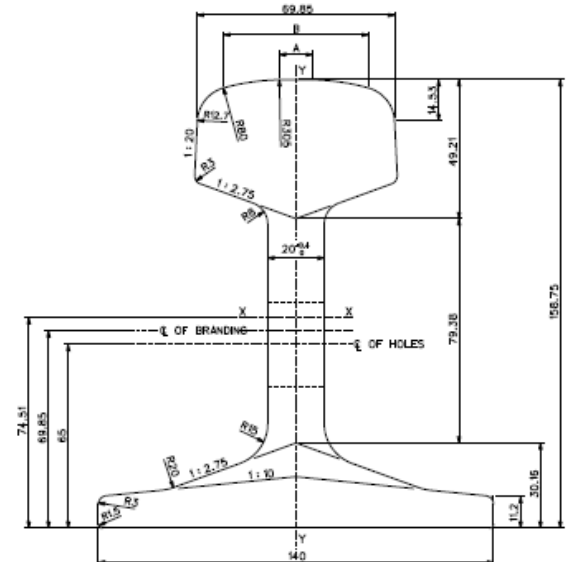


54E

1



54E2



56E1

Range of Height: 158mm to 172mm
 Range of foot width: 125mm to 150mm
 Range of head width: 67mm to 72mm
 Range of head height: 49mm to 51mm

- The most common volumetric defects for AT welding are:

Porosity



Lack of fusion

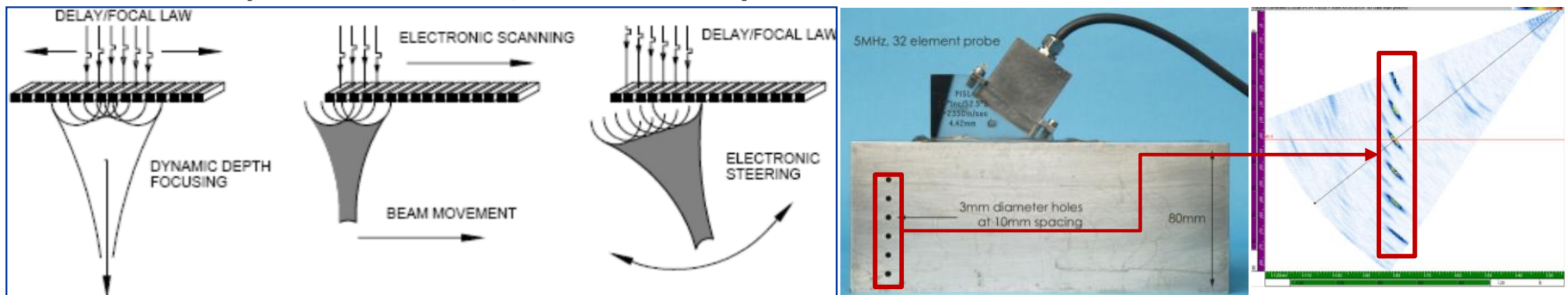


Shrinkage



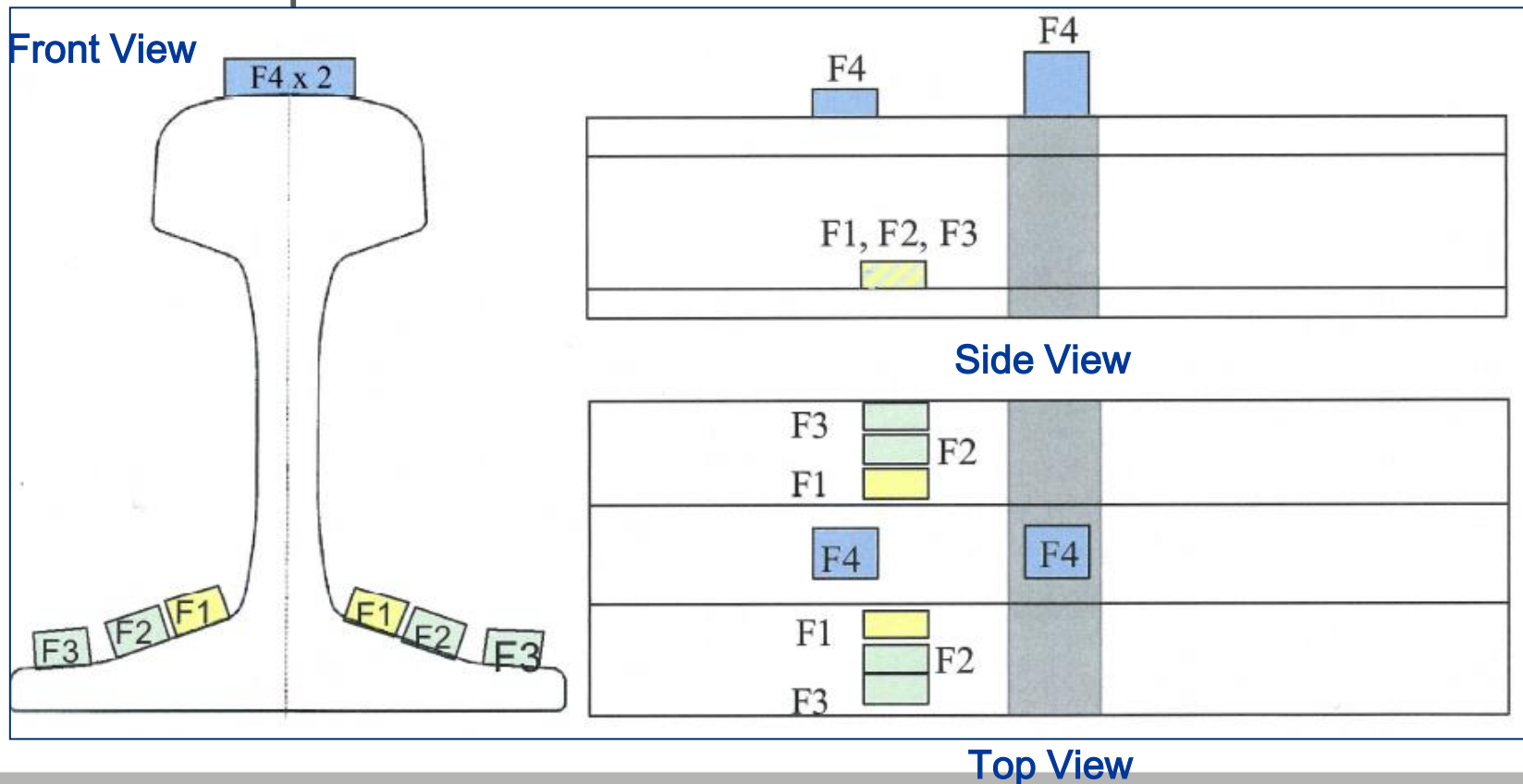
- These defects can cause welds to fail in months rather than years resulting in risk to safe operation and track closures for repairs

- Phased array techniques
 - To steer, focus and scan beams with a single transducer assembly, 32:128 multiplex
 - Focal laws were developed via modelling and trials
- Hardware consists of :
 - 8 phased array probes
 - Cables and connector box
 - Computerised instrument for data acquisition and display
 - Clamp on device, Railect system

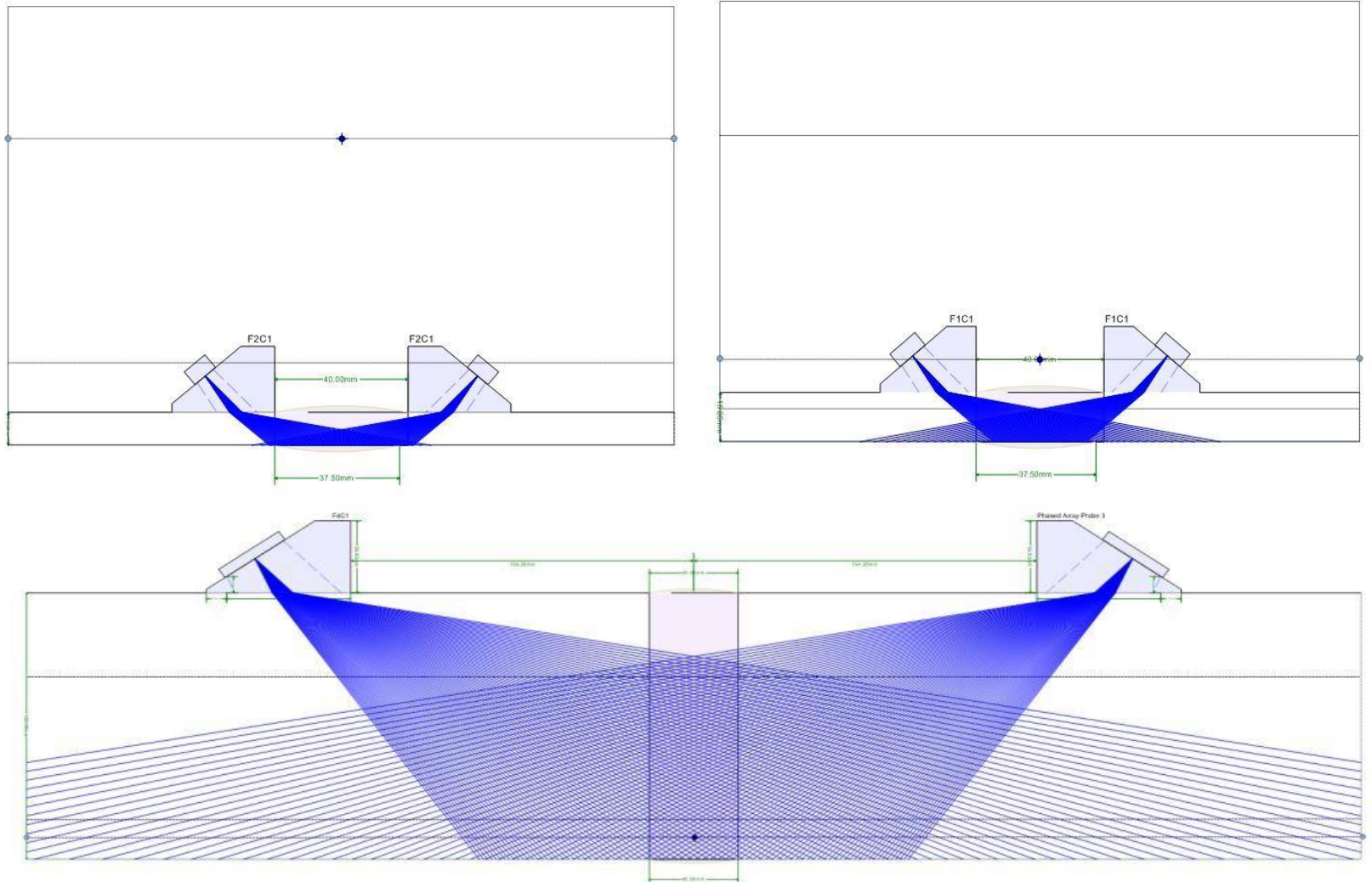


Inspection Technique

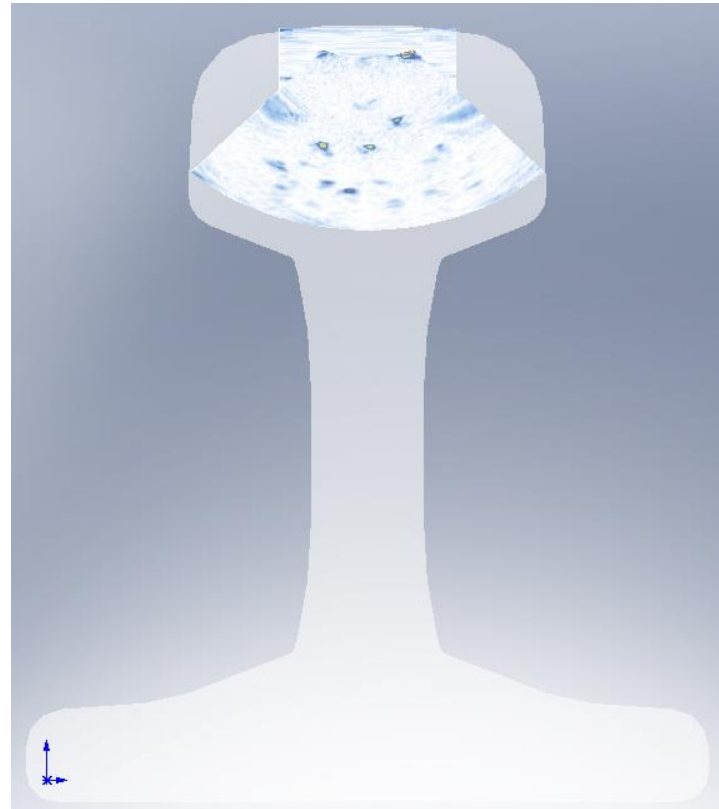
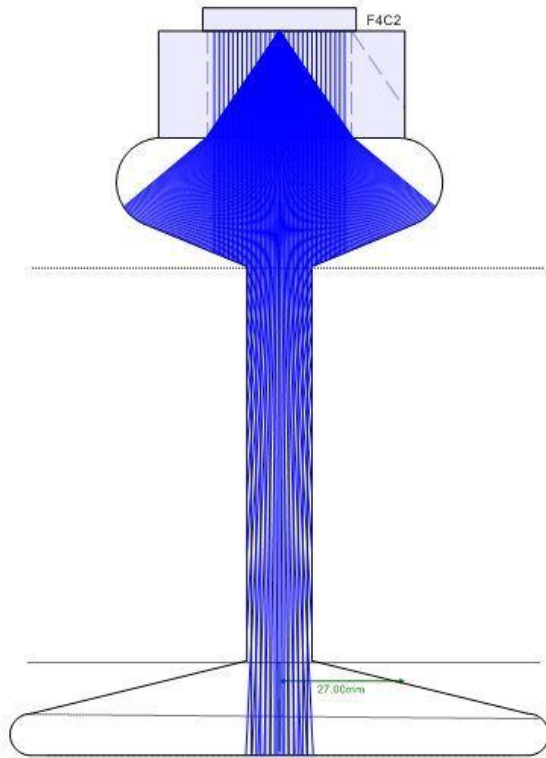
- 8 multiplexed probes (inspect one side)
- On profiles with narrower foot, F1 probes can be



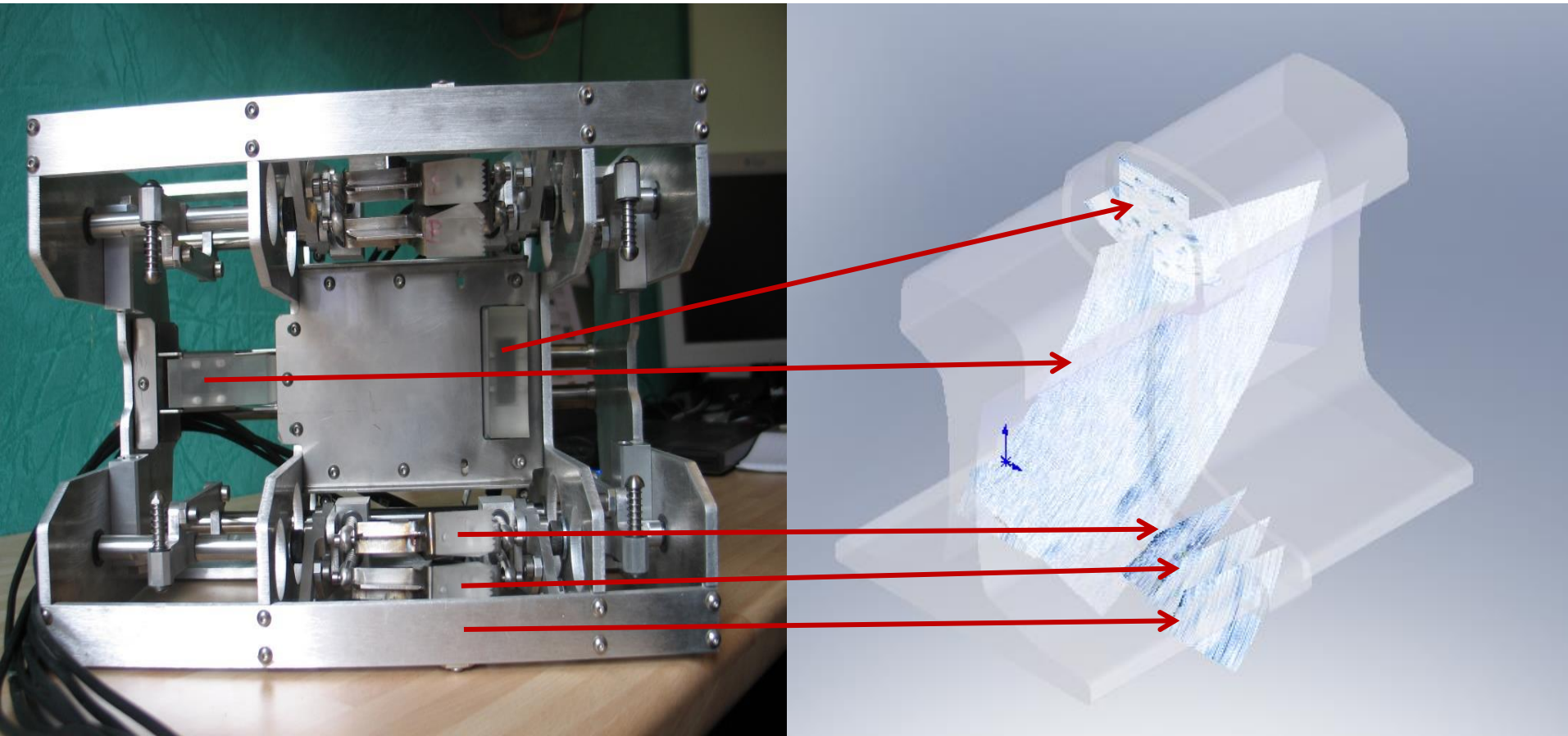
Inspection Coverage



Inspection Coverage



Head Probe

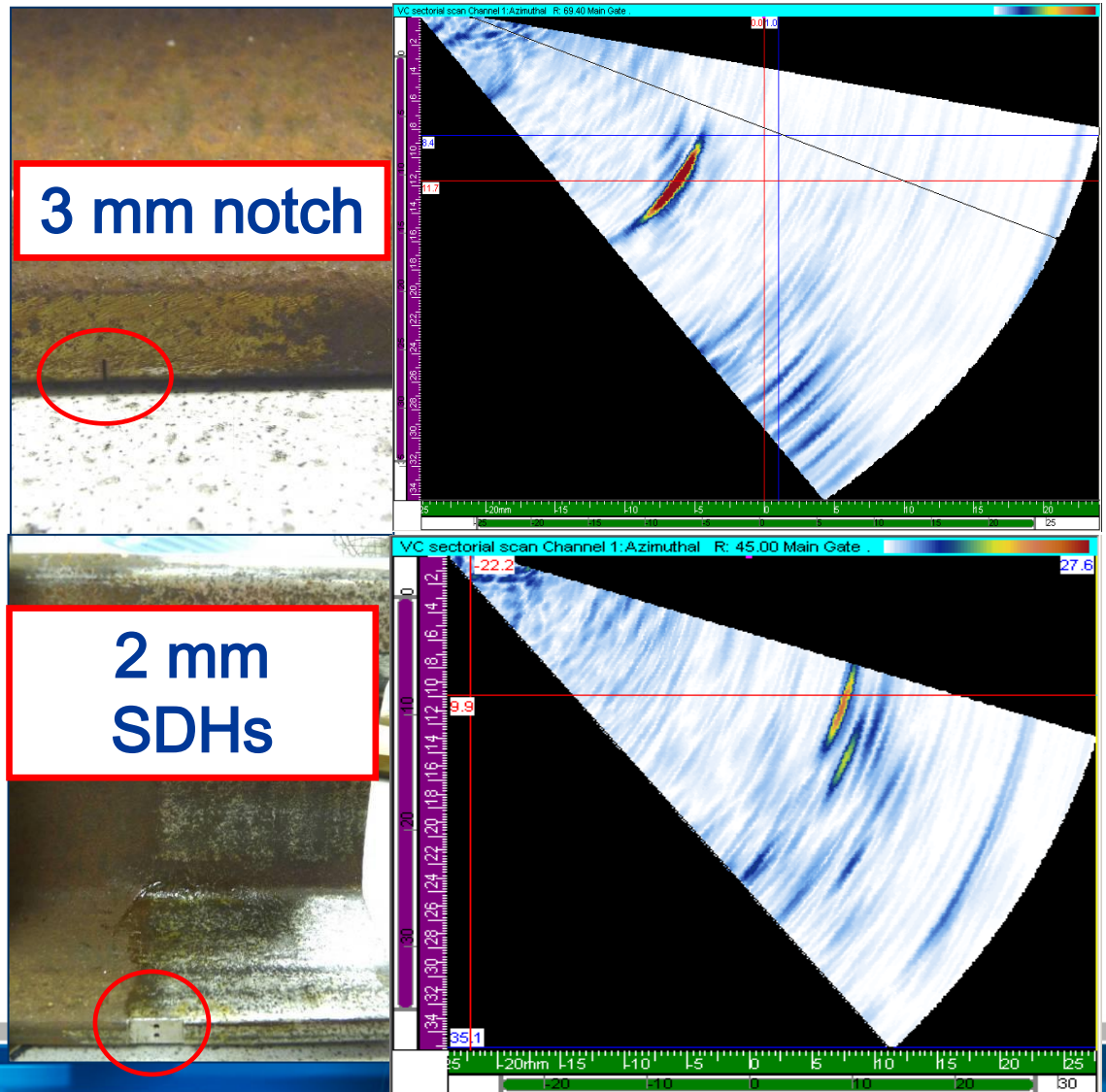


The coverage of each probe

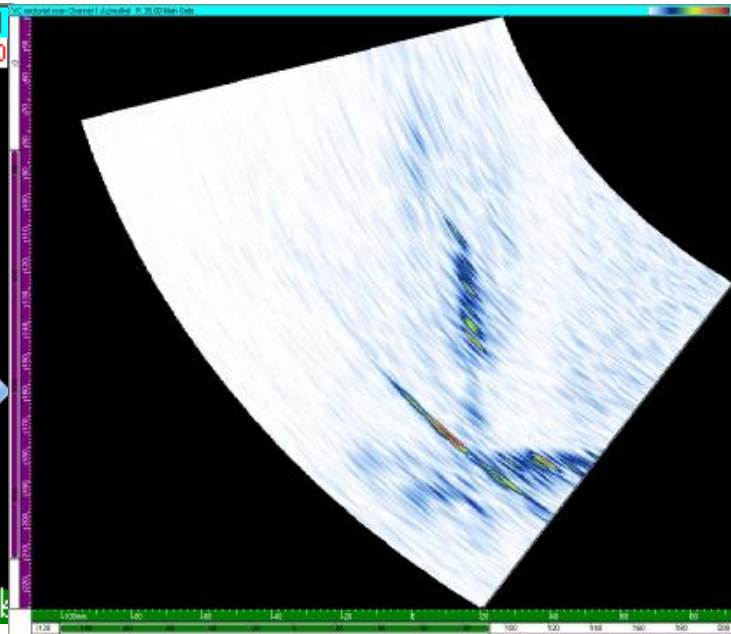
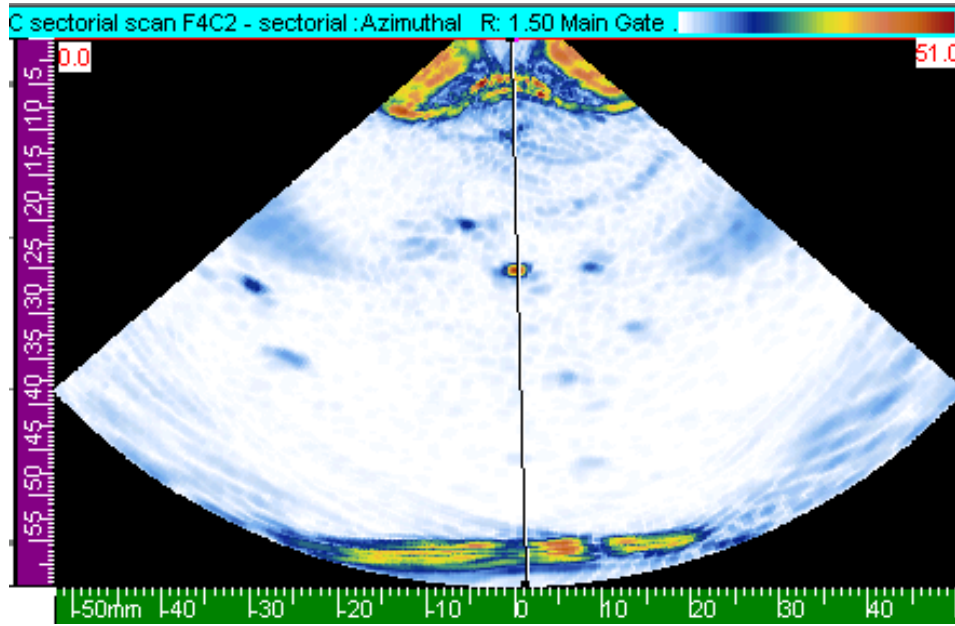
TWI Inspection of the Ankle of the Rail Foot

Transducer and focal laws parameters:

- 16 elements
- 5 MHz
- Sectorial scan 55°- 75°
- Step 0.5° degree



Inspection of Rail Head and Web



Transducer and focal laws parameters:

- 32 elements
- 5 MHz
- Sectorial scan -50° to 50°
- Step 0.5° degree

Transducer and focal laws parameters:

- 32 elements
- 5 MHz
- Sectorial scan 35° - 69.8°
- Step 0.3° degree

- Additional features of the new system
 - Laptop is not needed for inspection
 - More robust and weather proof
 - Compatible with 3 more profiles
- Current Work
 - Delivery of unit for Hong Kong MTR
 - Proposal(s) to be submitted for development
- Future Work
 - Perform more site trials
 - Establish Acceptance Criteria (automate sentencing)
 - Customised phased array instrument
 - Extension to vertical flaws – flash butt welds



