FWI for Ultrasonic Imaging

Flaw detection in steel weld

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supervised by
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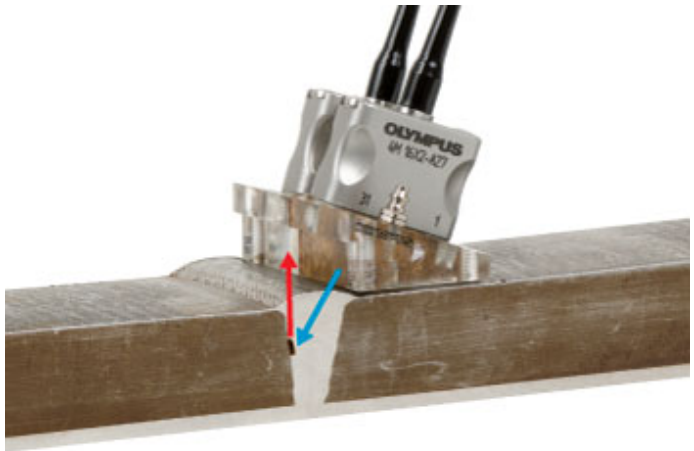
NDT for Welds

Pipeline test*



Echo mode testing**

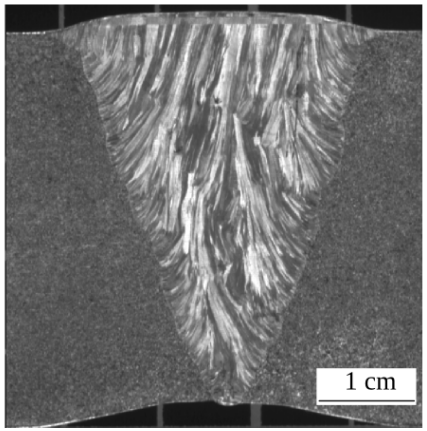
Non destructive testing for weld in :

- nuclear reactors (cooling system)
- oil and gaz pipelines

→ porosity, cracks, lack of fusion, corrosion, inclusions,. . .

Pictures from *Davidmack & **Olympus

NDT for Welds



Macrography of a weld*

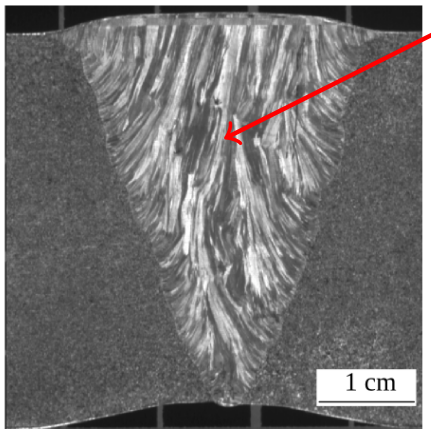
- delay and sum methods
- decomposition of covariance matrix (DORT)

Pictures from *Chassignole 2000, PhD thesis & **Gardahaut *et al.* 2014

NDT for Welds

Strong unknown anisotropy

$\hookrightarrow$ distorsion and splitting of the beam



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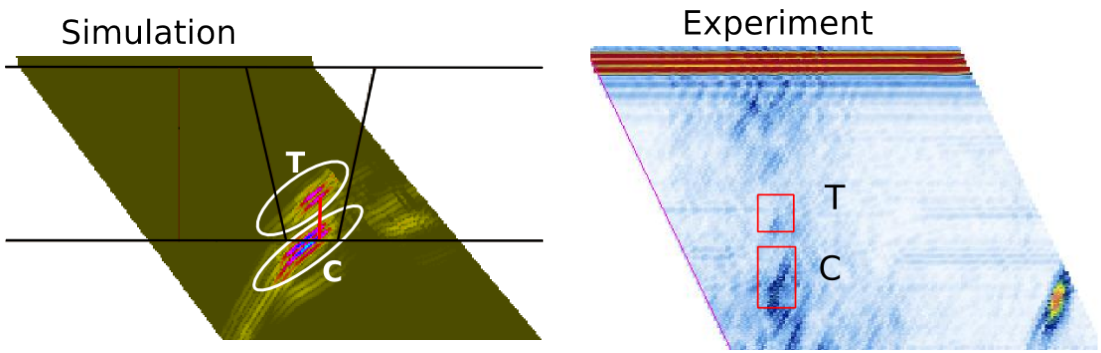

Comparison of ray based model and experiment result**

- delay and sum methods
- decomposition of covariance matrix (DORT)

→

✗ need to know c in advance

✗ strong artefacts

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NDT for Welds

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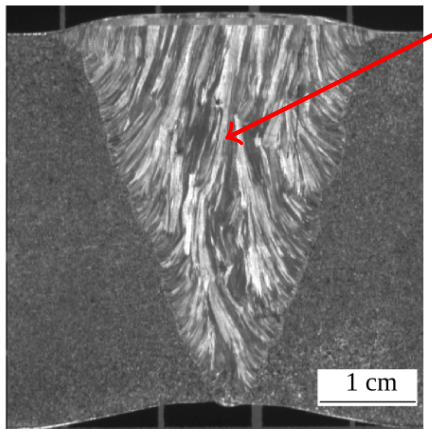

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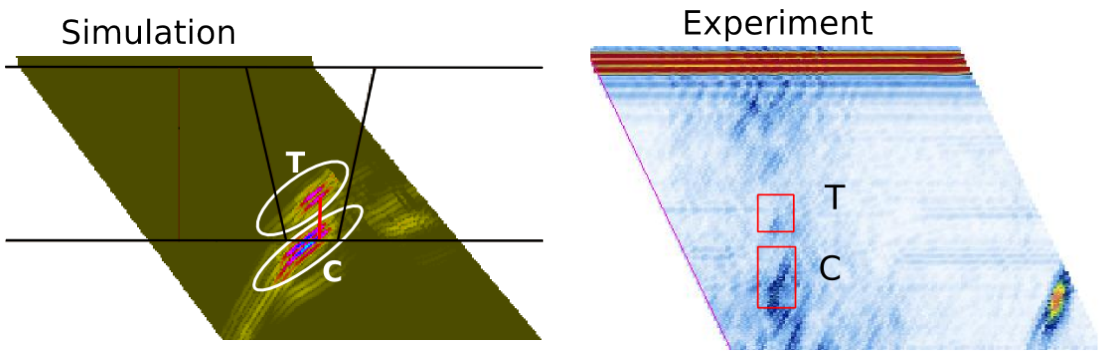


Comparison of ray based model and experiment result**

- delay and sum methods
- decomposition of covariance matrix (DORT)

$\rightarrow$

✗ need to know c in advance

✗ strong artefacts

- solving NL optimization problem

$\rightarrow$

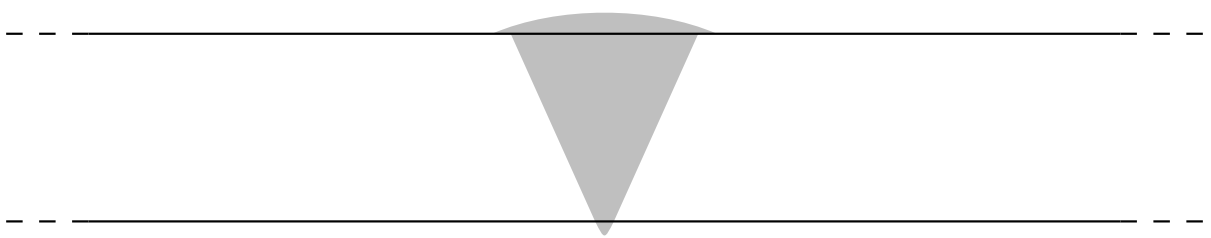
▶ contour reconstruction : *Dominguez et al.*, *Rodriguez et al.*

✓ C_{ij} reconstruction : FWI

Pictures from *Chassignole 2000, PhD thesis & **Gardahaut *et al.* 2014

What is specific to weld imaging ?

- 2 free surfaces : more information $\leftrightarrow$ non-linear inversion



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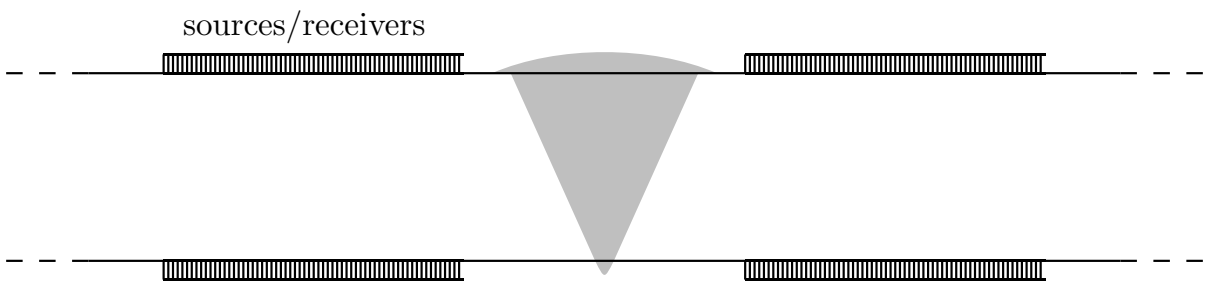
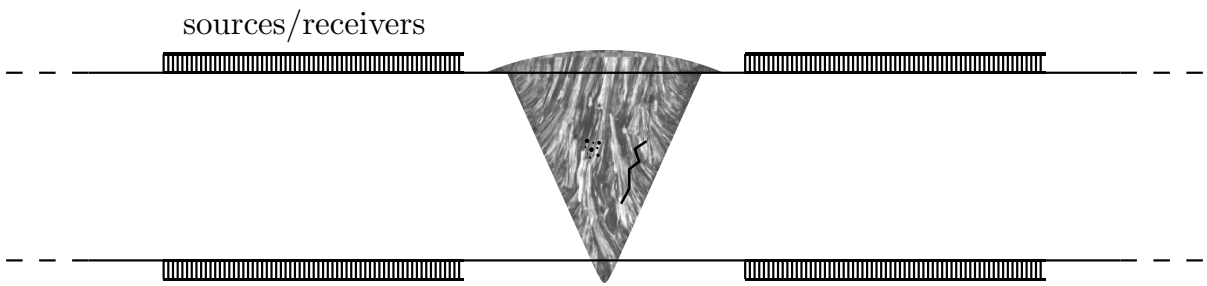


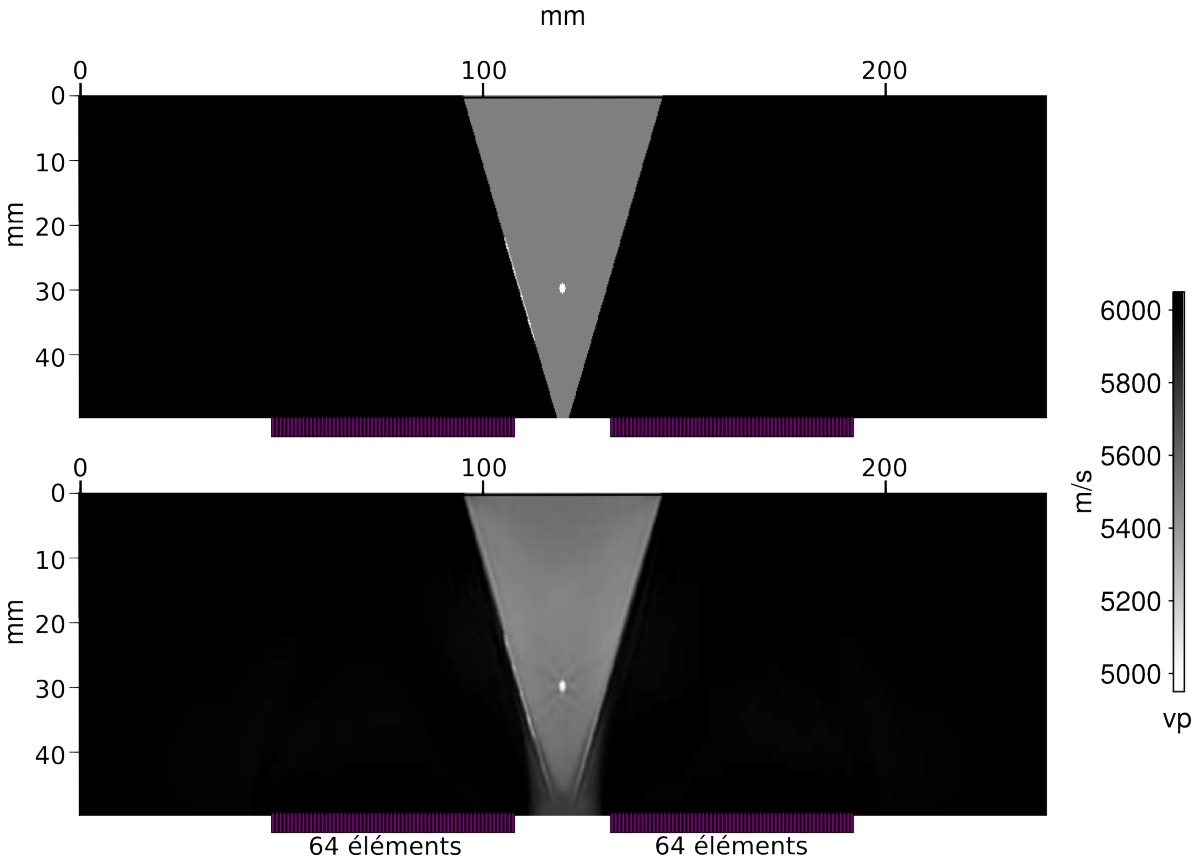
What is specific to weld imaging ?

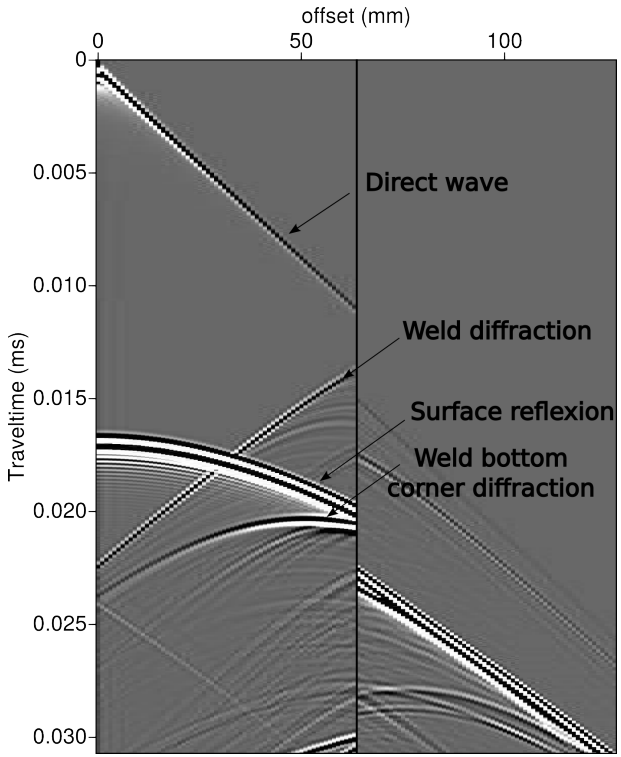
- 2 free surfaces : more information $\leftrightarrow$ non-linear inversion
- surface acquisition only
- anisotropy $\rightarrow$ multi-parameter inversion
  ($C_{ij} \times 6$: weld + defects)



To do

- 2D acoustic approximation (mono/multiparameter)
  - isotropic weld ($\boxed{v_p}$, $\boxed{\rho}$)
  - transverse isotropic weld (v_p, ρ, $\boxed{\epsilon}$, δ, θ)
- 3D elastic inversion (mono/multiparameter : $C_{ij} \times 6$)
  - isotropic weld : $\boxed{v_p}$
  - anisotropic weld
  - real data





2D isotropic case : monoparameter inversion of v_p
100kHz $\rightarrow$5MHz