Upcoming Technologies (4d)

Aims:

- Exploring emerging technologies which have not yet been incorporated into the current research project in anticipation of the benefits they may bring

Background:

- What are the possible benefits of introducing these techniques in an in-between predictive framework?

Challenges:

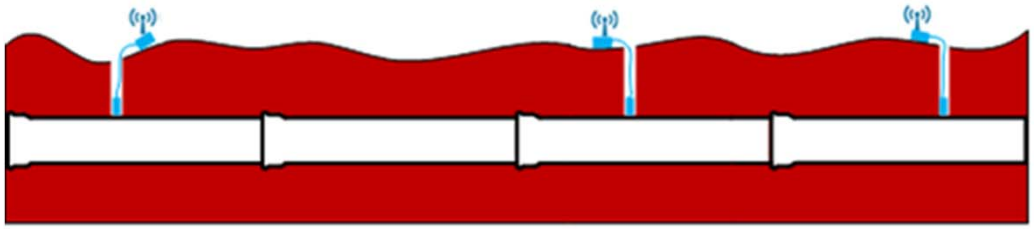
- Understanding technology
- Validating data (particularly continuous screening techniques)
- Integration and evaluation

Technology Screening

The research started with a desktop screening to review additional commercially available condition assessment technologies to narrow down possible options

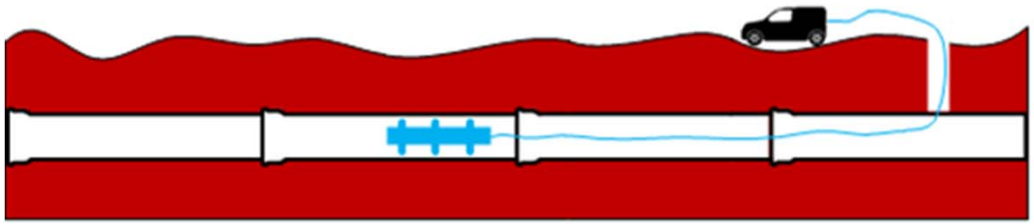
Echologics - ePULSE **Detection Services - p-CAT**	Group 1: Acoustics, non-dug-up
Breivoll - Pipescanner **JD7 - Pipescan ++** **JD7 - Pipescan +**	Group 2: Ultrasonics, in-pipe
Transkor - SKIF **SpeirHunter**	Group 3: Passive electromagnetics, non-excavation
Elorane - tesTAU **Elorane - (soil)** **Zensor - (soil)**	Group 4: Environmental analysis, non-excavation

Technology Screening



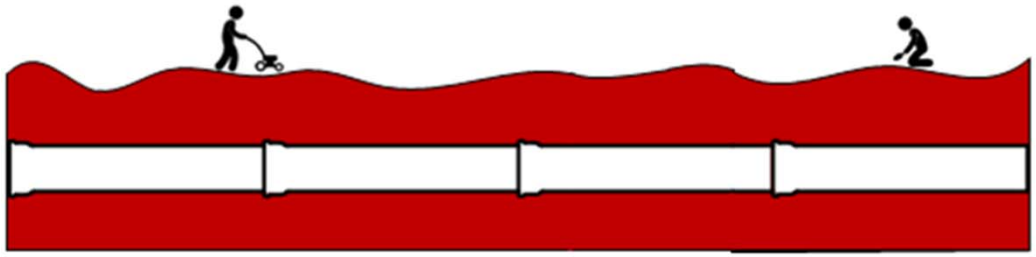
non-dug-up ✓
non-excavation ✗
in-pipe ✗

ePULSE
pCat



non-dug-up ✓
non-excavation ✗
in-pipe ✓

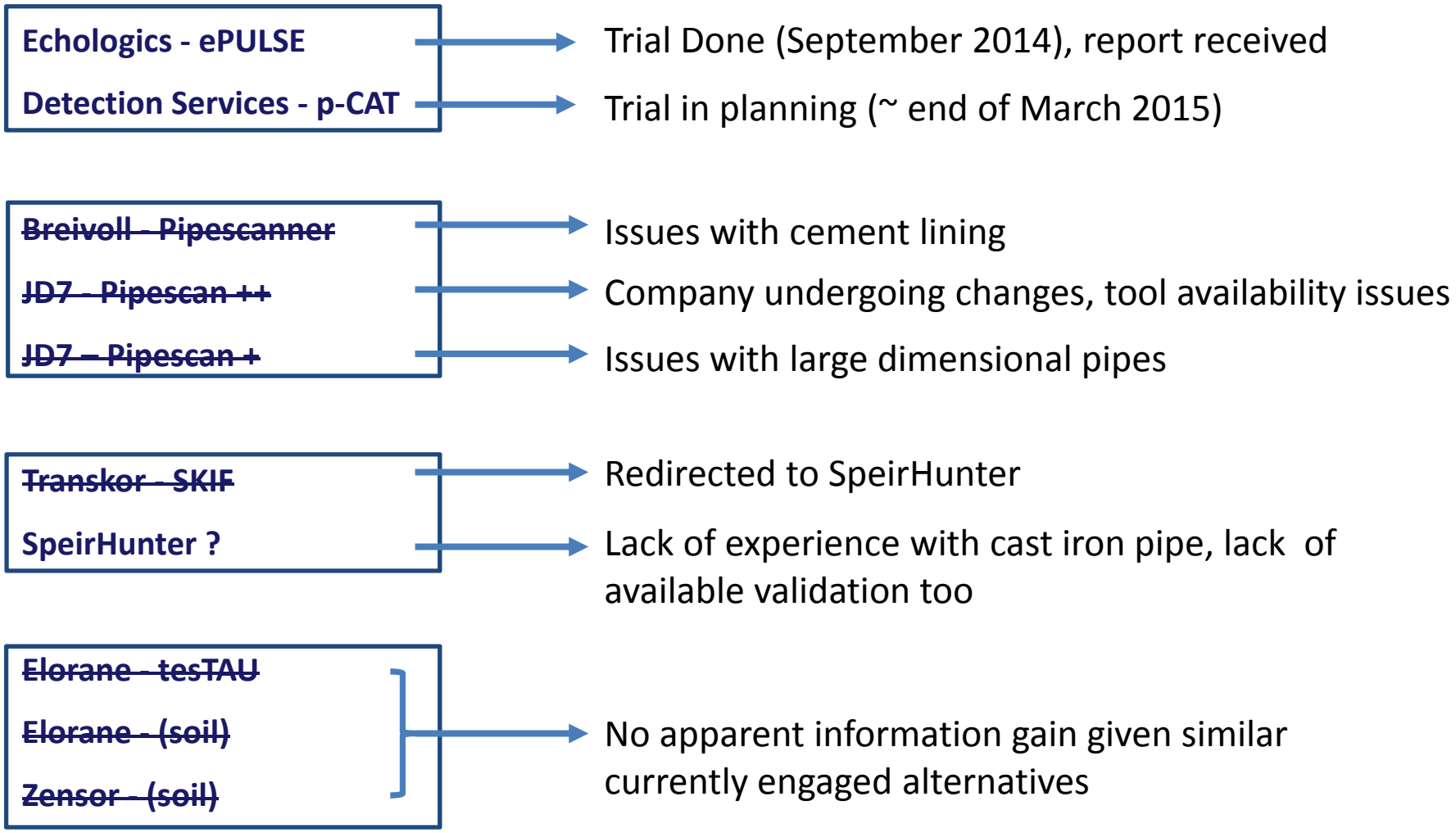
Pipescanner
Pipescan +
Pipescan ++



non-dug-up ✓
non-excavation ✓
in-pipe ✗

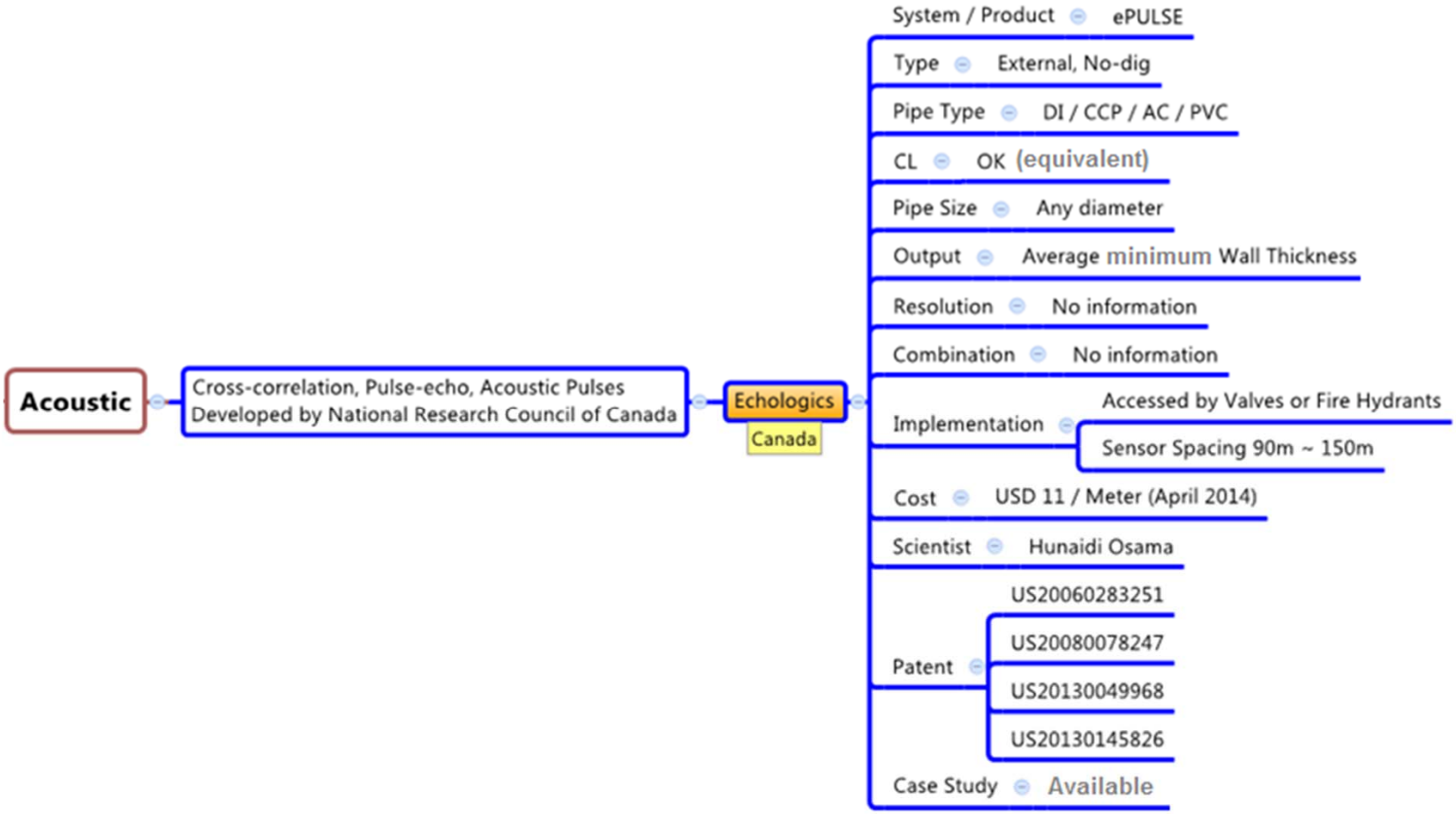
Transkor
SpeirHunter
Elorane
Zensor

Technology Screening



Understanding the Technology: PCA-Echologics ePulse

- Test-bed inspection undertaken Sept'14
- Acoustic technique: provides (generally) one measurement every 100 meters



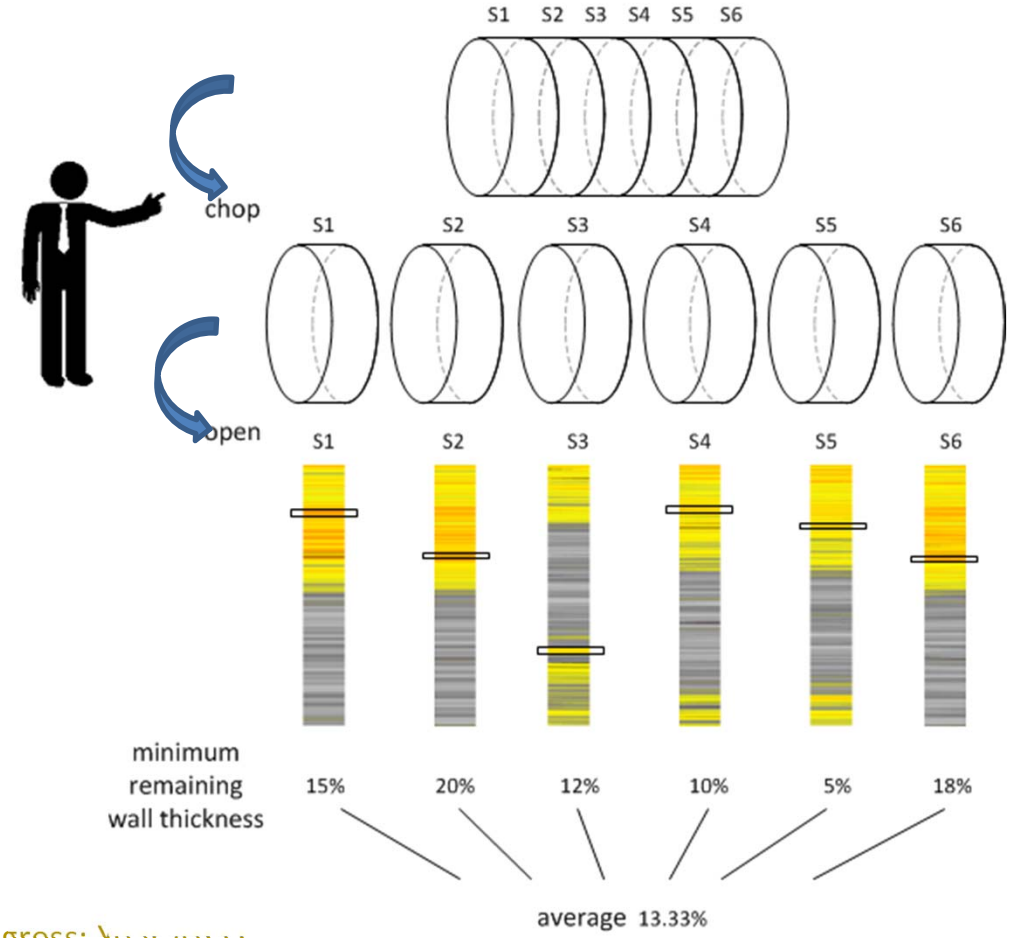
Understanding the Technology: PCA-Echologics ePulse

First upcoming technology trial - with PCA-Echologics - has been completed during September 2014. This was planned at varying access point spacing to better assess the influence of spatial resolution.

UNIVERSITY OF TECHNOLOGY SYDNEY

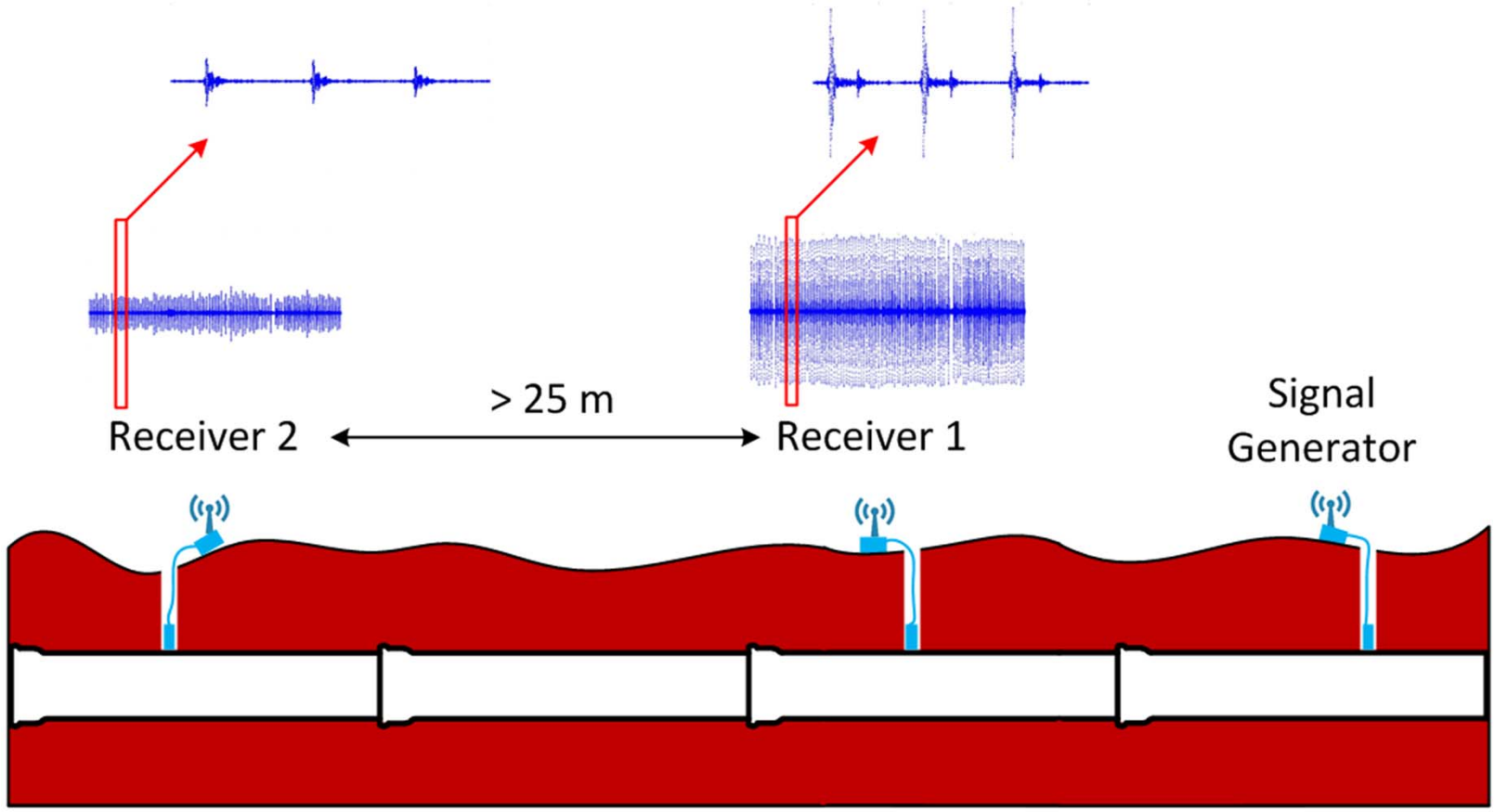
Understanding the Technology: PCA-Echologics ePulse

Example: if ePulse reports **13.33 %** as nominal wall thickness, what does it reflect?
PCA-Echologics explanation:



Understanding the Technology: PCA-Echologics ePulse

- ePulse measures **the speed of certain acoustic wave** transmitted between two receivers



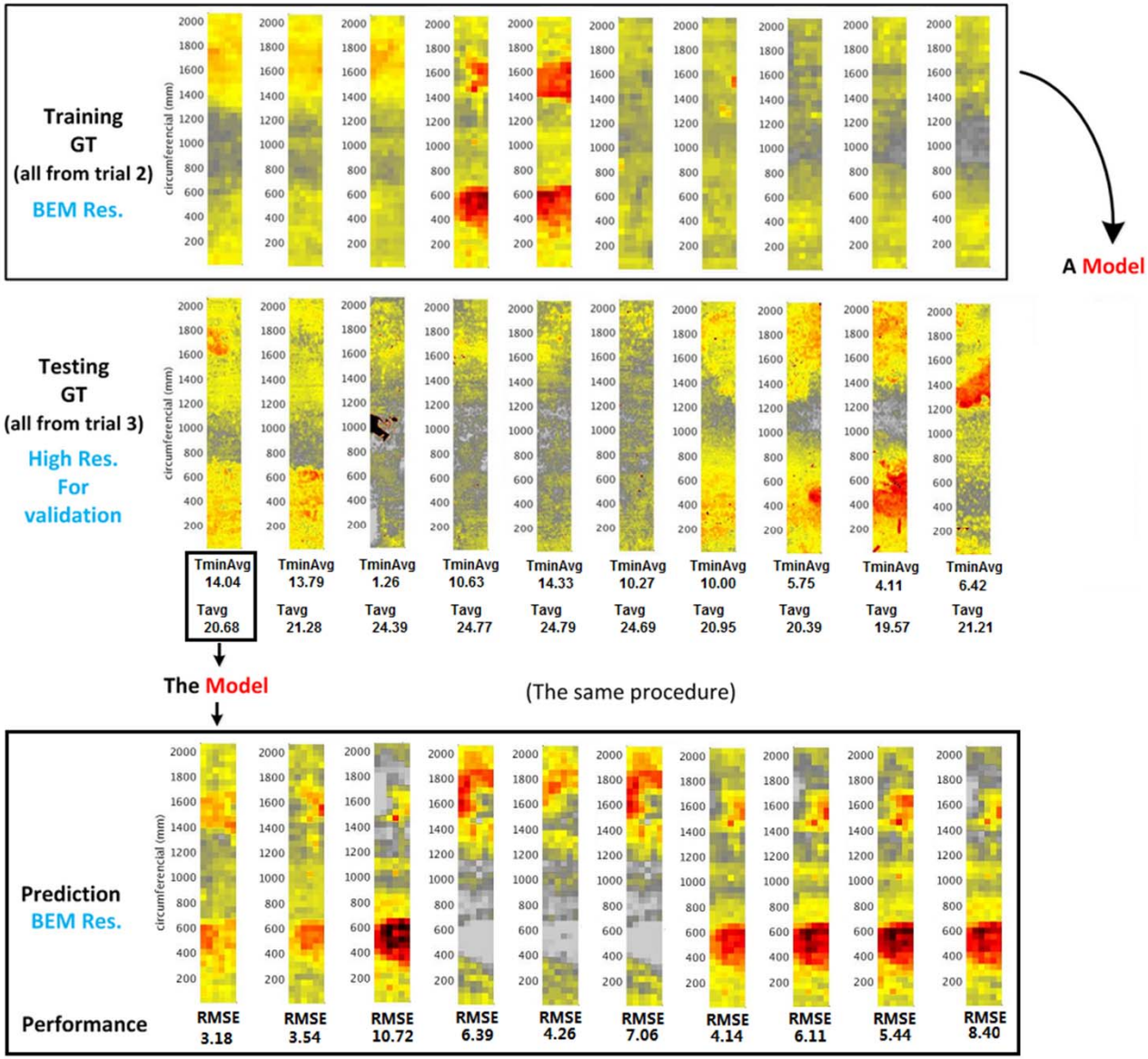
Understanding the Technology: PCA-Echologics ePulse

- Theoretically, the measured **speed of certain acoustic wave** represents a measurement of the remaining wall thickness
- Many parameters need to be accurately fixed/known beforehand

$$v = \sqrt{\frac{K_w/\rho_w}{1 + K_w\left(\frac{(D-e_p)(1-\mu^2)[(D^2+e_p^2)(1-\mu)+2\mu De_p]}{E_p De_p(D-e_p)(1-\mu)+ E_l e_l[(D^2+e_p^2)(1-\mu)+2\mu De_p]}\right)}}$$

v	velocity of acoustic waves in the pipe
K_w	bulk modulus of elasticity of water
ρ_w	density of water
E_p	Young's modulus of the pipe
D	internal diameter of the pipe
e_p	metal thickness of the pipe
E_l	Young's modulus of the cement lining
e_l	thickness of the cement lining
μ	Poisson's ratio, assumed to be the same for ductile iron and the cement lining

How can ePulse be Integrated within an In-Between Framework? (Real) Example

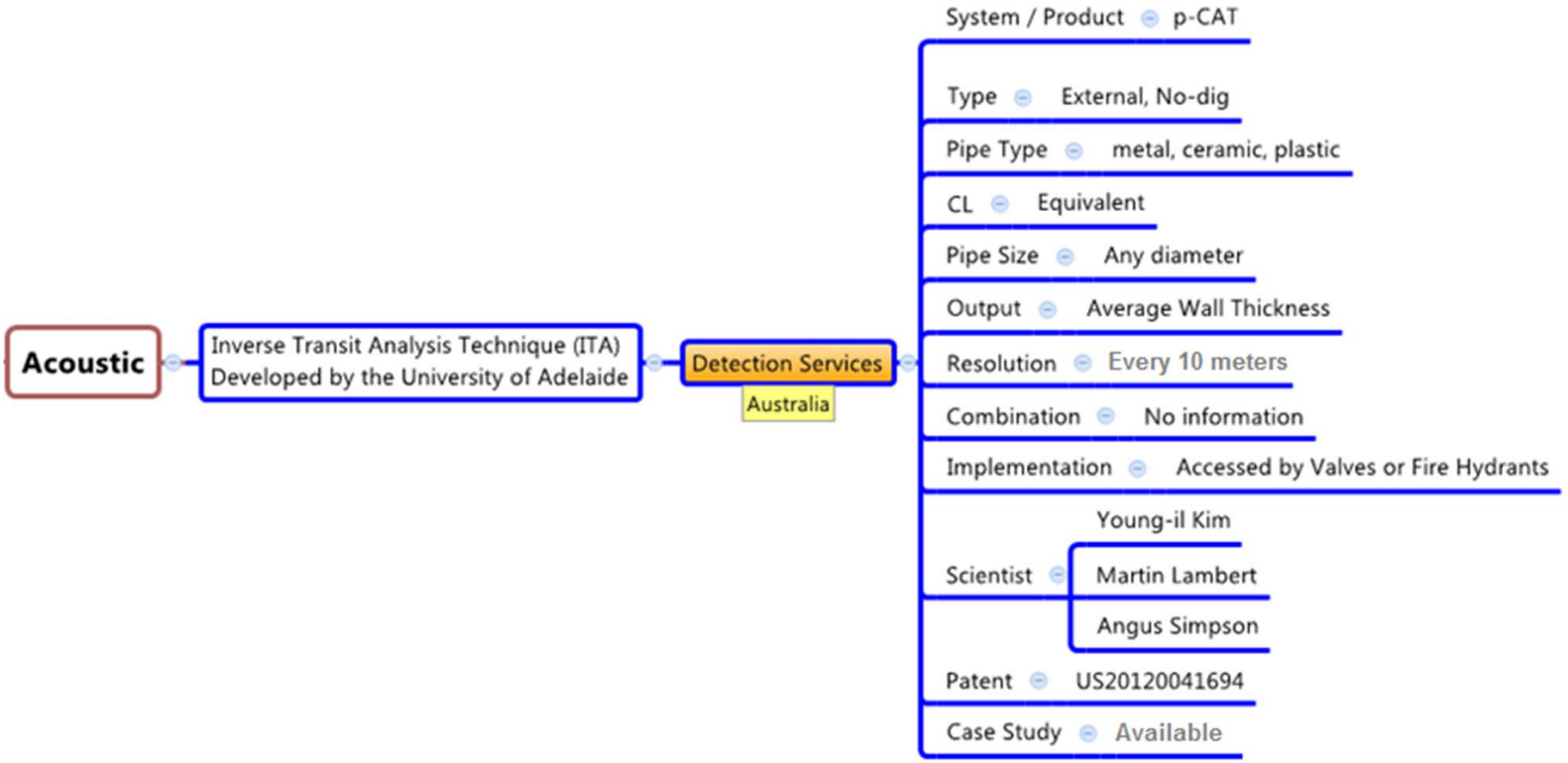


Understanding the Technology: Some PCA-Echologics ePulse Findings So Far

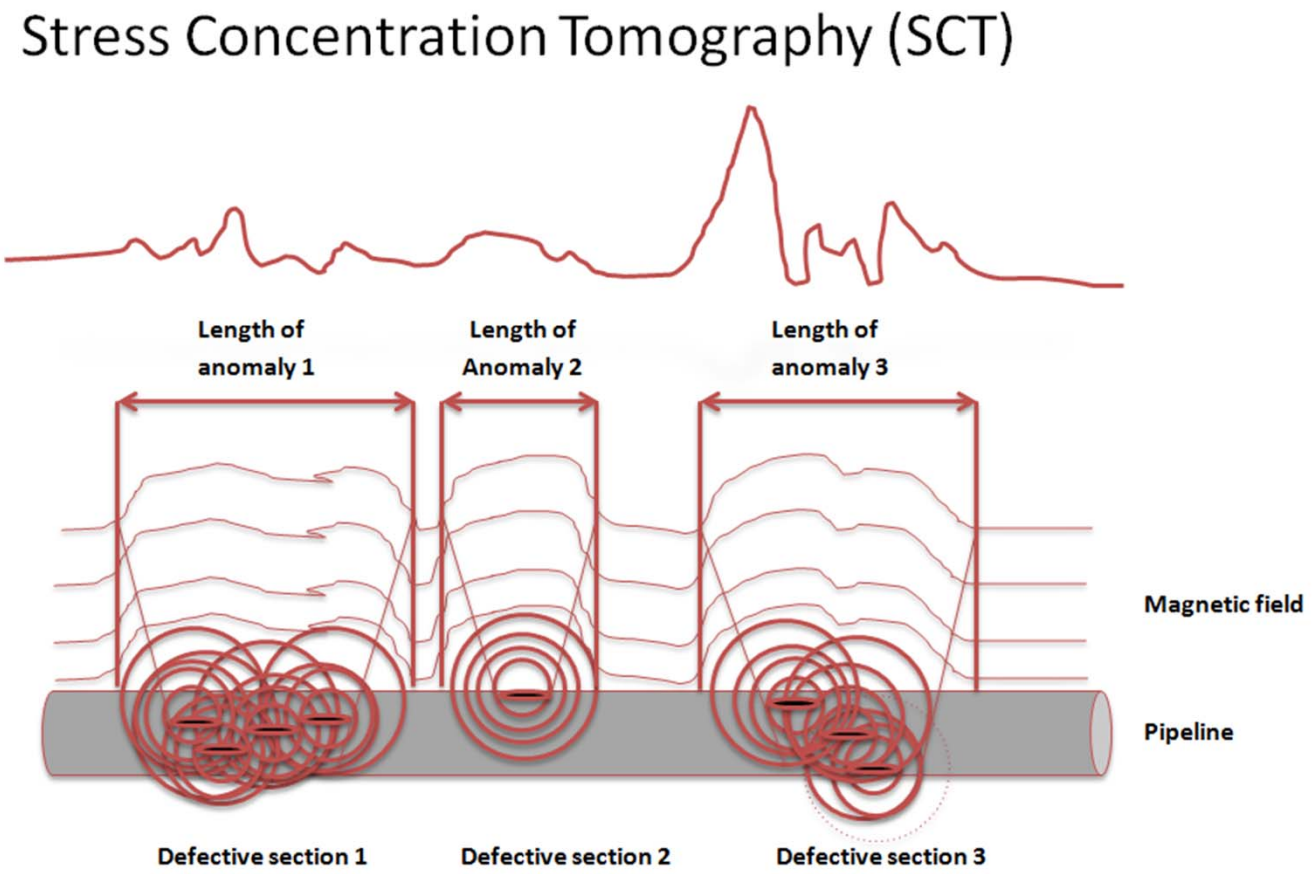
- ePulse measures “Average minimum wall thickness”, this can not be readily “validated”. PCA-Echologics cannot either
- There is an important “spatial resolution” issue (how to “slice” the pipe?). Different alternatives would produce different interpretations
- PCA-Echologics has limited confidence on sensor spacing results of less that 25 meters, and does not recommend it
- ePulse results are generally affected by air pocket in the pipe
- For measurements with > 25 meters sensor spacing, test-bed trial results from ePulse do not contradict the averaging results provided by Russell NDE (yet validation of the latter is still rather limited)

Understanding the technology: Detection Services - pCAT

- Acoustic technique: provides one measurement over long distances, e.g. 100 meters
- It then reports average wall thickness every 10 meters

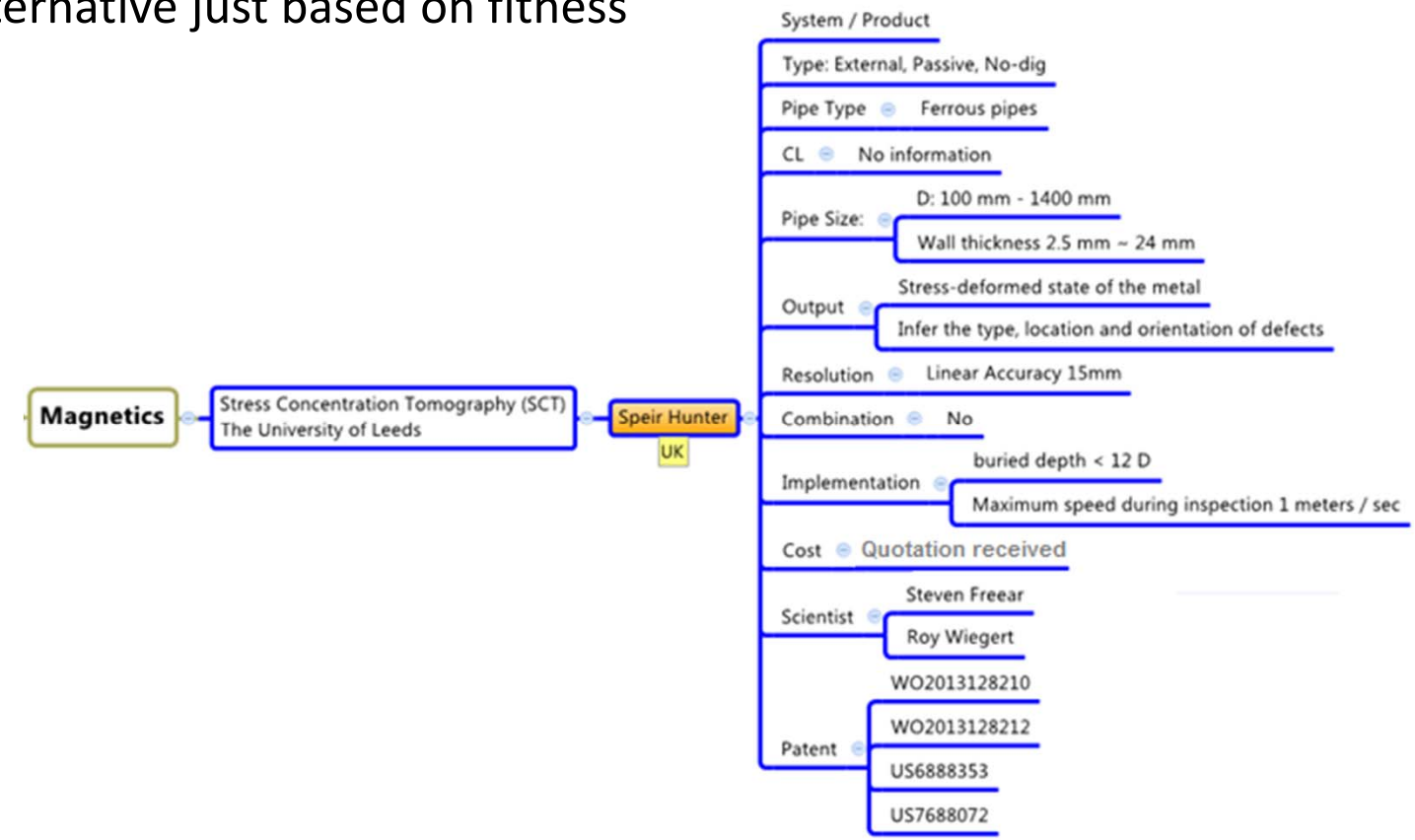


Understanding the Technology: SpeirHunter

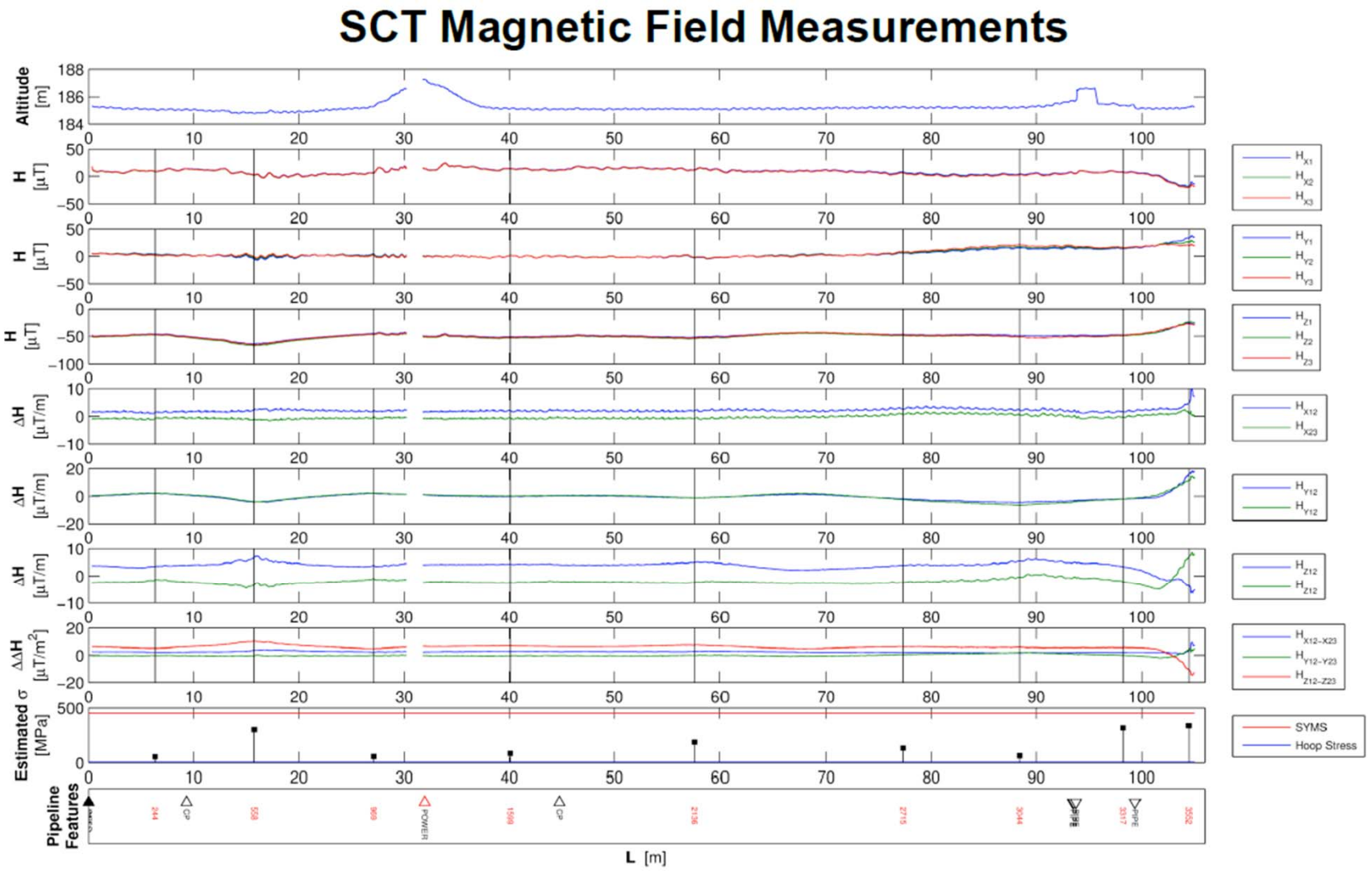


Understanding the Technology: SpeirHunter

- Magnetostrictive technique: pipe stress creates variation in surrounding earth magnetic field
- Test-bed inspection quotation received (not expensive)
- SpeirHunter has no experience with cast iron pipe – currently doubtful alternative just based on fitness



Understanding the Technology: SpeirHunter



UNIVERSITY OF TECHNOLOGY SYDNEY

Future Goals

Goal	Status
Detection Services is planned to do a CA inspections on the test-bed (likely beginning April)	In progress
Speir Hunter is too uncertain for CI at the moment. Discussions point towards more suitable to very high-level screening technique for MS pipes	In progress
Evaluation of PCA-Echologics ePulse for suitability of using their measurements for in-between framework	In progress
Continue conversations and investigation of alternative technologies suitable for in-between framework	In progress