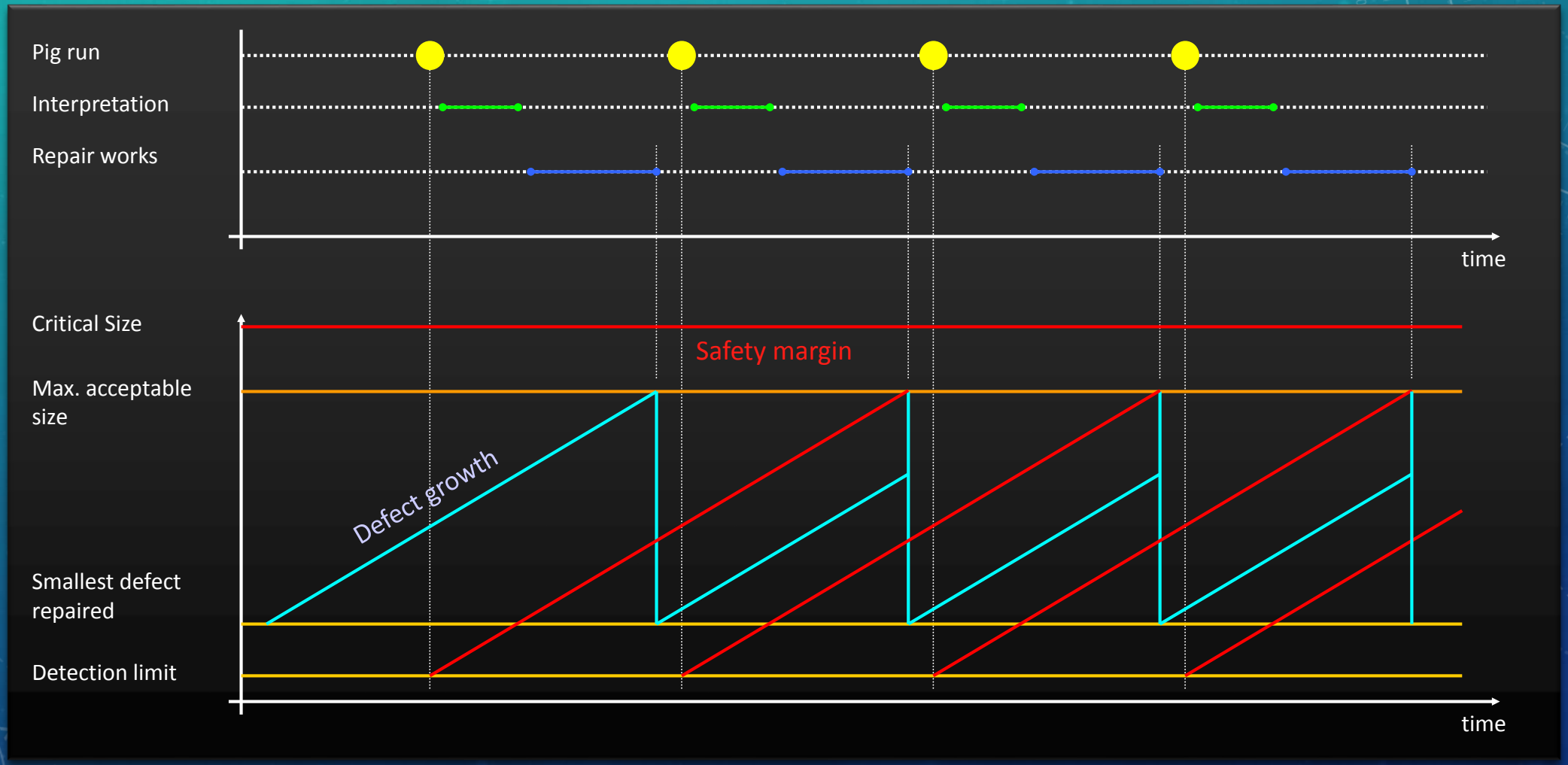
PIG RUN COMPARISON

A UNIVERSAL DATA FORMAT AND A SOFTWARE FOR OPTIMIZING PIPELINE INTEGRITY MANAGEMENT

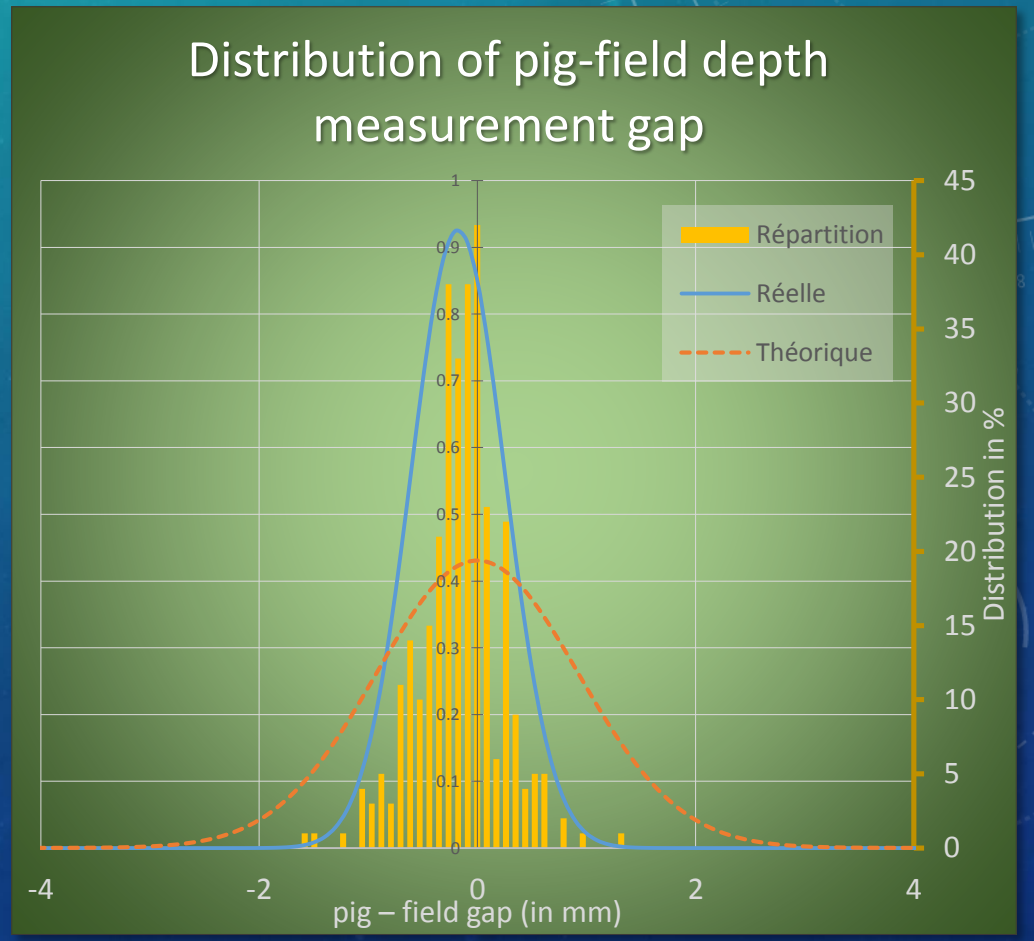
A PRESENTATION BY CÉCIL ADAM (SPMR)

MANAGING INTEGRITY WITH PIG RUNS



MANAGING INTEGRITY WITH PIG RUNS WHAT IS REQUIRED ?

- Rupture model: conservative but as little as possible, as easy to use as possible, useable with the limited data available from a pig run
- Growth model: again conservative but as close to reality as possible
- Statistical understanding of pig performances for defect measurement: detection limit, sizing accuracy, conservative bias introduced by vendor.



INTEGRITY MANAGEMENT EVOLUTION

- Pigging industry is constantly evolving :
  - Detection capabilities improving (less missed defects)
  - Detection limits decreasing (smaller defects brought into sight)
  - Defect discrimination improving (type of defect better known)
  - Defect sizing improving (dimensions more accurate)

- Safety requirements get harder
  - Acceptable failure probability diminishing
  - Potential consequence to be taken into account, need to consider High Consequences Area

ONE EXEMPLE
PIG EVOLUTION – MORE AND MORE DEFECTS

Year n			
Depth measured by ILI tool	depth ≥ 2 mm	1 ≤ depth < 2 mm	depth < 1 mm
Number of defects	0	87	7,391
% of total number of defects	0	1.16 %	98.84 %

Year n+4			
Depth measured by ILI tool	depth ≥ 2 mm	1 ≤ depth < 2 mm	depth < 1 mm
Number of defects	42	7,416	30,826
% of total number of defects	0.11 %	19.37 %	80.52 %

Two pig runs – same pipeline – same vendor – same technology, improved during the 4 years period

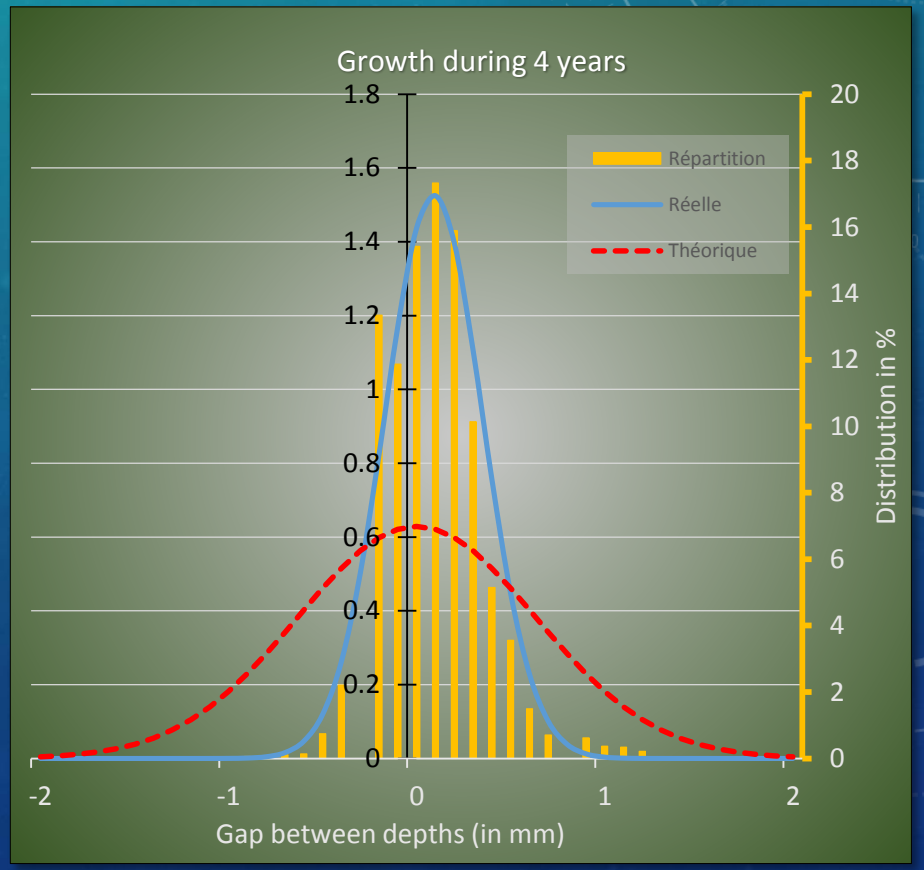
ONE EXAMPLE
PIG EVOLUTION – HOW TO REPAIR ?

- Initial Repair Criteria :
  - Depth ≥ 1 mm
  - Based on a fixed conservative growth rate and a conservative rupture model
- Year n :
  - 87 defects to repair.
  - Easy, rather cheap (2,6 M€), quick (1 year)
- Year n+4 :
  - 7,458 defects to repair – 2,818 pipe joints
  - Long (5 years), over expensive (141 M€), unrealistic

➢ Need to change something in criteria !

ONE EXAMPLE
UPGRADING REPAIR CRITERIA

- Rupture models: used model simple and conservative, others models hardly conservative and difficult to apply.
- Sizing accuracy: had to be demonstrated, this has been done, allowed to raise lower repair size limit, yet not enough to make things manageable.
- Growth rate: pig vendor was able to re-process year n pig data with year n+4 algorithm, observed mean growth rate dropped more than 10 times, rare fast growth defects could be isolated.
- New repair program : 72 pipe joints were repaired, 3 M€, one year work !



ONE EXAMPLE CONCLUSION

- Aging pipelines and high performances pigs lead to huge populations of signals to be considered
- Growth rate calculation is a major issue when building up repair plan
- Comparing successive pig runs give calculation of defect growth.
  Observed growth rates were much less conservative than commonly accepted growth rates out of literature.
- Run comparison was possible because the two runs were from the same vendor.
- Conclusion can be generalized to all type of defects, all type of pigs.

PIG RUN COMPARISON

- Important to optimize integrity management program
- Need to be able to switch from one vendor to another, in order to limit pig run cost
- Need to address all pig technologies

➢ Need for detailed and universal reporting

THE PIPELINE OPERATORS FORUM

- *“A forum to share pipeline integrity experience and good working practices with the ultimate purpose of improving the quality of pipeline integrity management at every level, hence protecting people, the environment and operational integrity of pipelines globally”.*
- Pipeline companies from Europe and all World.
- Issues technical guidelines and specifications for pipeline inspection equipment, inspection procedures, such as the “**Specifications and requirements for in-line inspection of pipelines**”.
- So far : report specified as a “pipe tally”, boxed pig signals.

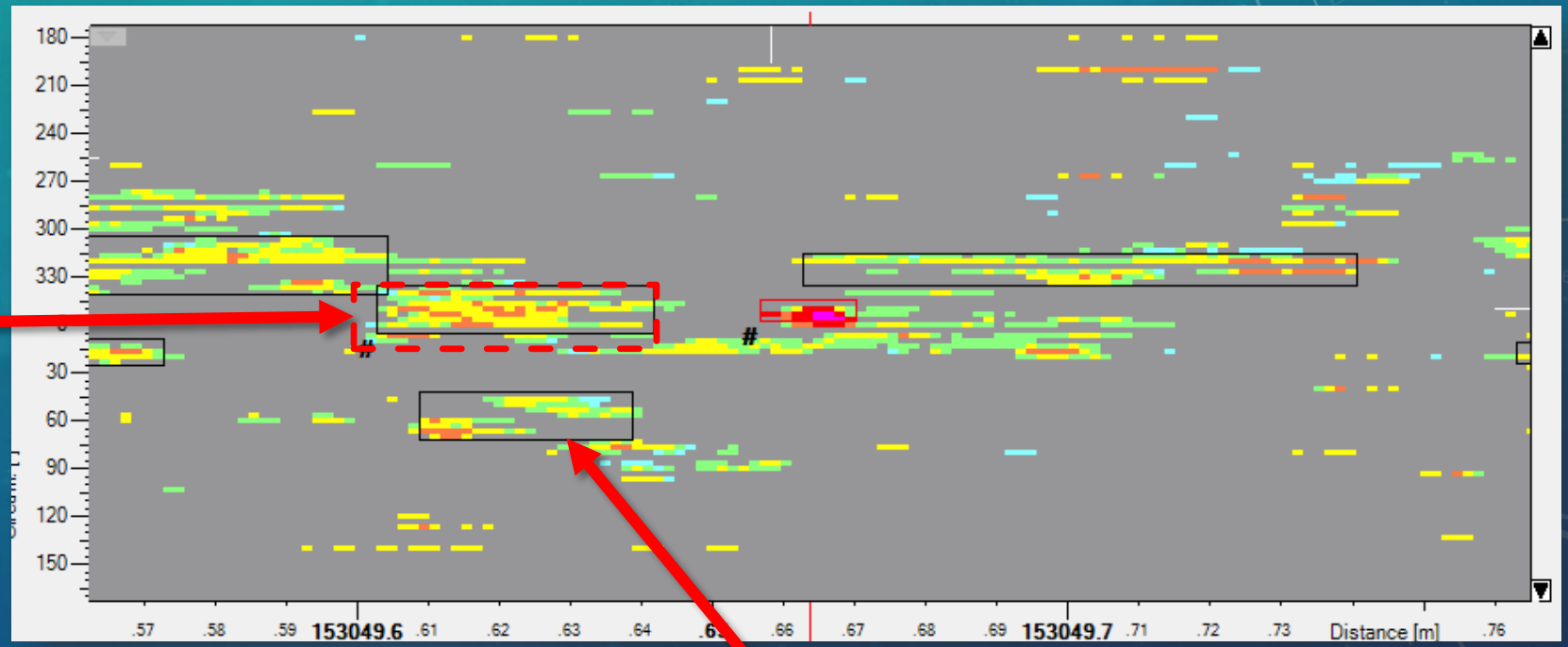
LIMITATIONS OF THE PIPE TALLY

- Include pipe features : welds, valves, …
- Pig Signals described by : type, box coordinates, depth, length, width, …
- Boxing reduces precision and defect growth understanding :
  - Boxing not repeatable process due to statistical dispersion of measurements and to human interpretation. Boxes sizes may evolve just due to clustering of new indications
  - Experience show some boxing result are questionable : very long clustered defect

➢ Easy to cope with when only a few defects, process of huge population of defects is difficult if not impossible

BOXING POTENTIAL LIMITATIONS

Box could be a little higher / longer ?



Next run picture may be quite different without any real growth of defects

One or two boxes / defects ?

GOING FURTHER THAN THE PIPE TALLY : A UNIVERSAL DETAILED DATA FORMAT

- Based on the initial work of a French JIP aiming to develop a software solution to compare pig runs.
- Structured using a open data file format.
- Based on sensor readings from any technology used by pigs : UT, Hall Effect, Geometry …
- Recording processed raw data but not interpreted, with max spatial resolution allowed by the pig.

PROJECTS STATUS

- Data format definition (POF) :
  - Specifications for data format defined in a draft document
  - Draft under review by POF, will be presented to pig vendors T2 2018
  - To be referenced into official specifications issued by POF
- Pig run comparison software (French JIP) :
  - Using POF Universal Data Format
  - Software specifications issued (not public)
  - Software development on-going and nearly finished

THE SOFTWARE : FUNCTIONALITIES

- Run comparison steps :
  - Align pipe tallies, position of the pig signals on a common basis
  - Associate pig signals from two runs
  - Compare pig signals from the two runs
  - Calculate individual and mean evolution rules in sizes and depths
- Products :
  - Growth rules defined for specific signals, pipe sections, overall pipeline
  - Synthetic graphs to present the results of analysis
  - Export of computed data

THE SOFTWARE : A FEW PICTURES

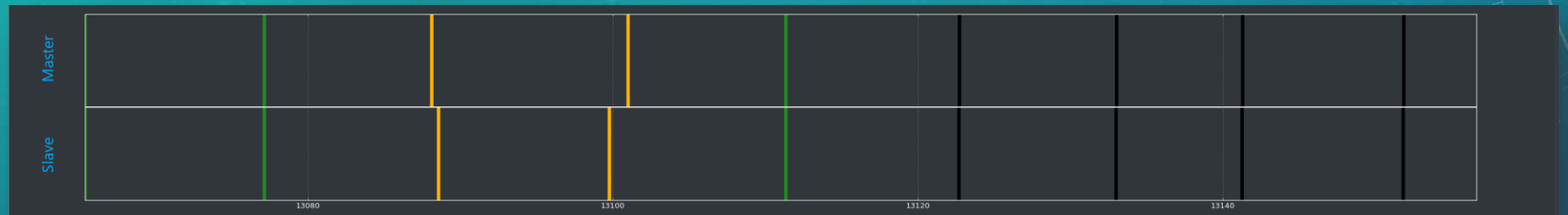


Tableau des soudures

Synchroniser l'alignement

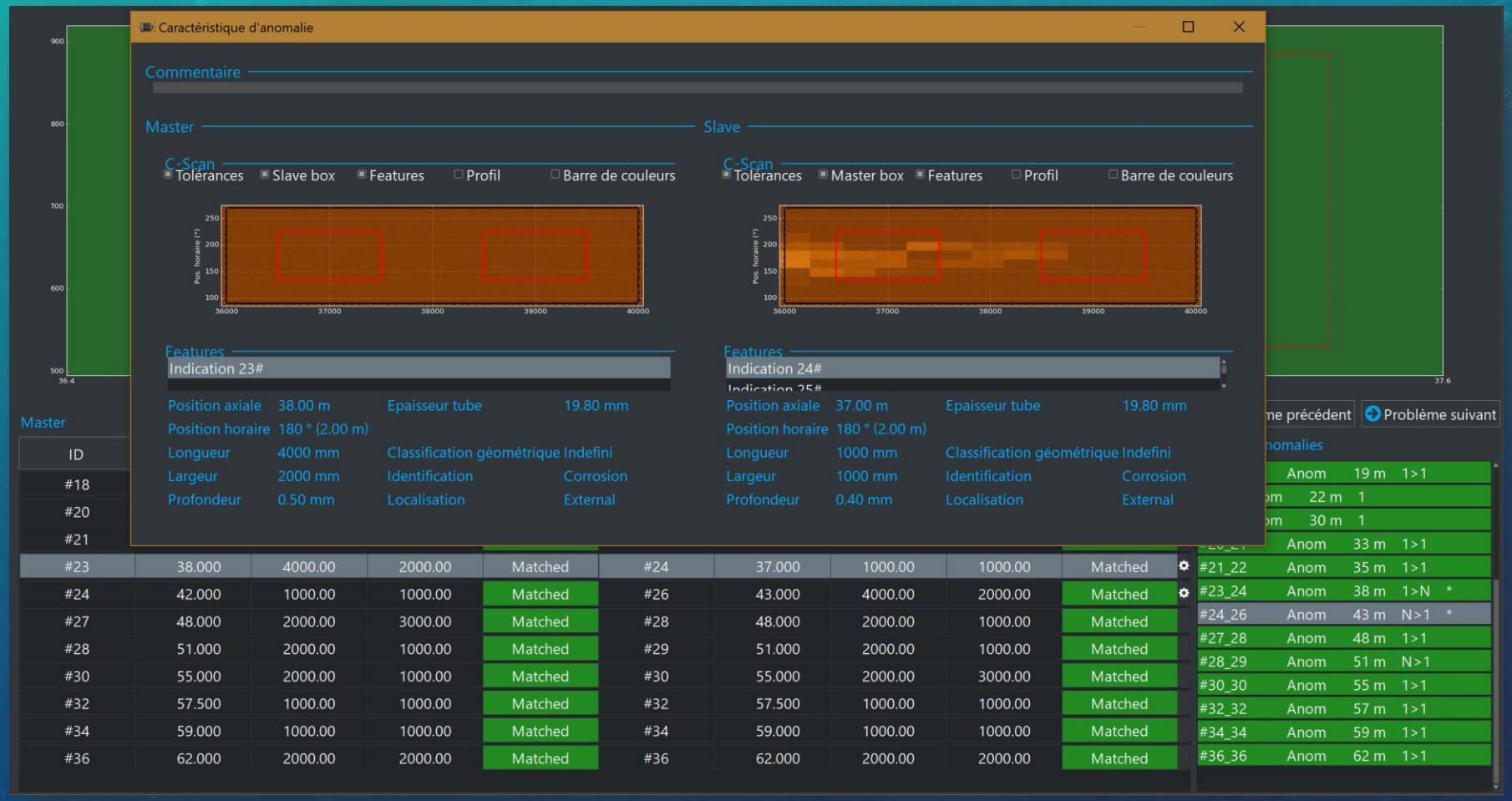
Master ILI run

Soudure	Commentaires	Distance (m)	Etat	Longueur (m)
1107		12919,8	Matched	11,645
1108		12931,6	Matched	11,772
1109		12942,4	Matched	10,803
1110		12953,9	Matched	11,516
1111		12964,7	Matched	10,837
1112		12975,6	Matched	10,909
1113		12976,7	Matched	1,091
1114		12988,3	Matched	11,6
1115		13000	Matched	11,662
1116		13011,7	Matched	11,723
1117		13022,9	Matched	11,201
1118		13034,1	Matched	11,218
1119		13045,5	Matched	11,374
1120		13056,4	Matched	10,905
1121		13067,9	Matched	11,519
1122		13079,7	Matched	11,774
1123		13090,7	Repair	10,972
1124		13103,6	Repair	12,882
1125		13113,9	Matched	10,345
1126		13125,3	Indéfini	11,378
1127		13135,6	Indéfini	10,305
1128		13143,9	Indéfini	8,284

Slave ILI run

Longueur (m)	Etat	Distance (m)	Commentaires	Soudure
11,62	Matched	12890,2		1108
11,75	Matched	12902		1109
10,76	Matched	12912,8		1110
11,51	Matched	12924,3		1111
10,81	Matched	12935,1		1112
10,9	Matched	12946		1113
1,09	Matched	12947,1		1114
11,59	Matched	12958,7		1115
11,64	Matched	12970,3		1116
11,73	Matched	12982		1117
11,19	Matched	12993,2		1118
11,19	Matched	13004,4		1119
11,37	Matched	13015,8		1120
10,89	Matched	13026,7		1121
11,51	Matched	13038,2		1122
11,77	Matched	13050		1123
11,43	Repaired	13061,4		1124
11,17	Repaired	13072,6		1125
11,54	Matched	13084,1		1126
11,35	Indéfini	13095,5		1127
10,3	Indéfini	13105,8		1128
8,28	Indéfini	13114		1129

THE SOFTWARE : A FEW PICTURES



THE SOFTWARE : A FEW PICTURES

THANKS FOR YOUR ATTENTION

QUESTIONS ?