

# Overview of the Doel 3 and Tihange 2 Reactor Pressure Vessel Safety Cases

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**TRACTEBEL**



☐ Confidential ☐ Restricted ☐ Public ☐ Internal

# Doel & Tihange NPPs (Belgium)

7 PWR units operated by Electrabel (ENGIE)



1. Doel 1 - 433 MW
2. Doel 2 - 433 MW
3. Doel 3 - 1006 MW
4. Doel 4 - 1046 MW

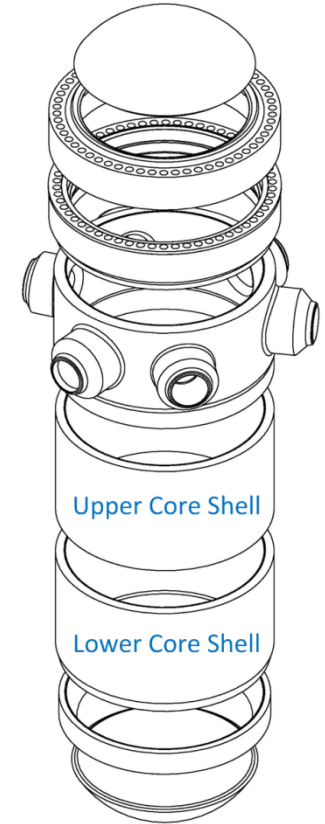


5. Tihange 1 - 962 MW
6. Tihange 2 - 1008 MW
7. Tihange 3 - 1046 MW

# Doel 3 & Tihange 2 Reactor Pressure Vessels

- Westinghouse 3-loop PWR design
- ASME Boiler & Pressure Vessel Code, Section III
- Steel type SA-508 Class 3
- RPV wall thickness 200 mm
- Stainless steel cladding

Reactor Pressure Vessel



# Troubles started in June 2012...

... when thousands of small quasi-laminar indications were found

2012

2013

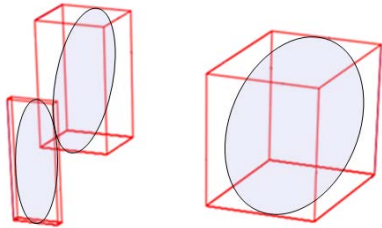
2014

2015

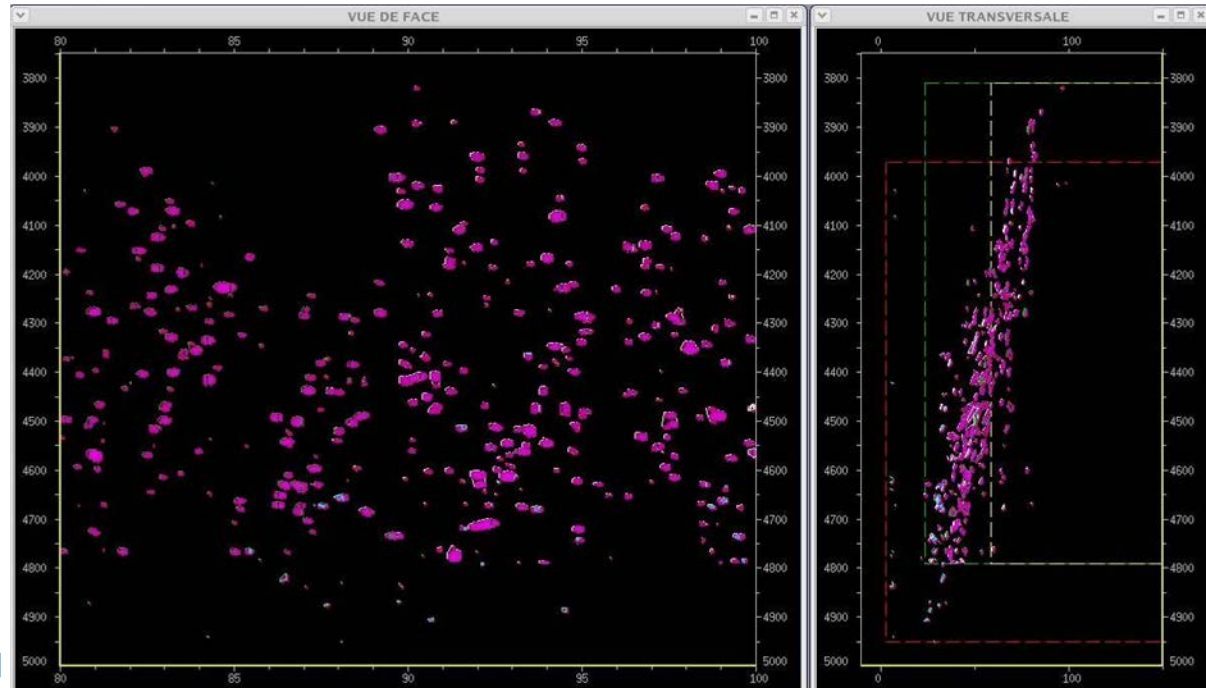
Operation

1<sup>st</sup> UT

Flake cartography  
3D boxes



[Courtesy Intercontrôle]



# 2012 Safety Case was built and submitted before Christmas

2012

2013

2014

2015

Operation

1<sup>st</sup> UT

UT  
Validation

Root Cause Analysis  
D3/T2 Hydrogen Flaking

Embrittlement curves 2012

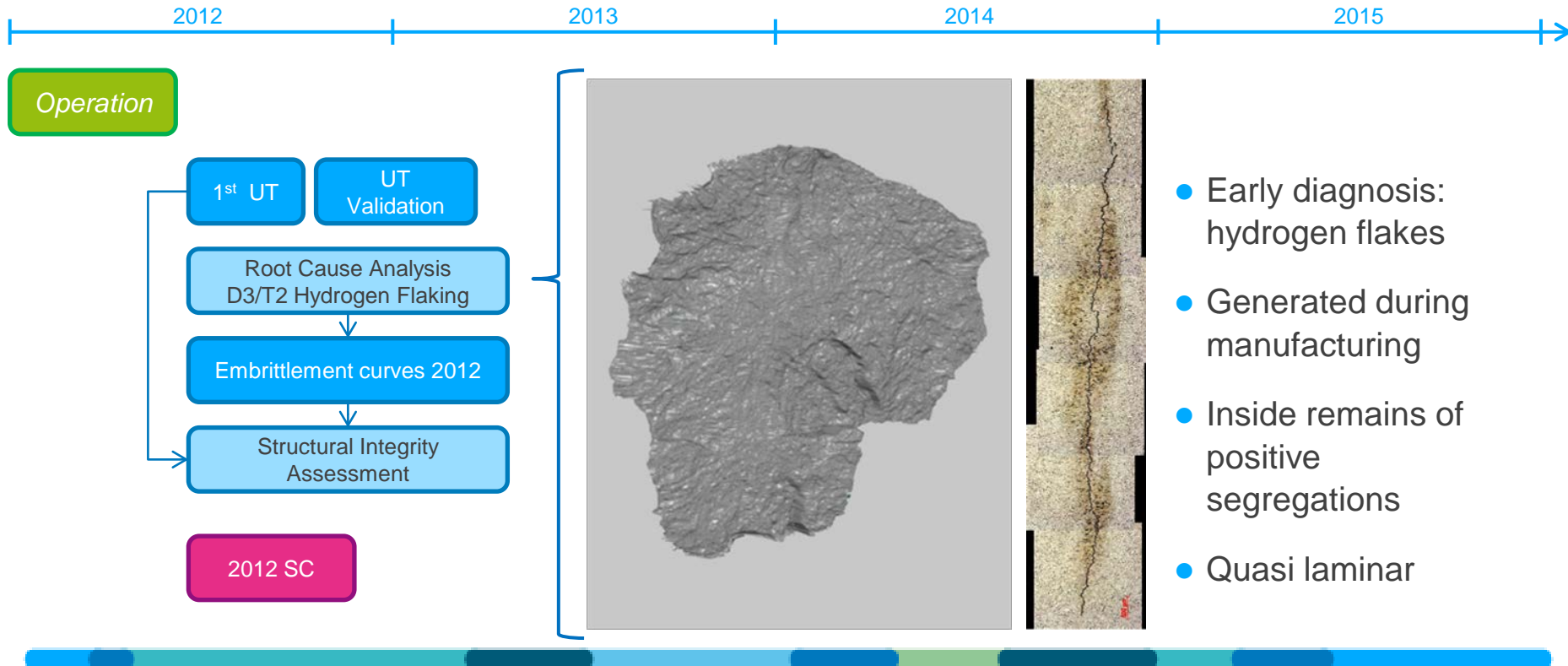
Structural Integrity  
Assessment

2012 SC

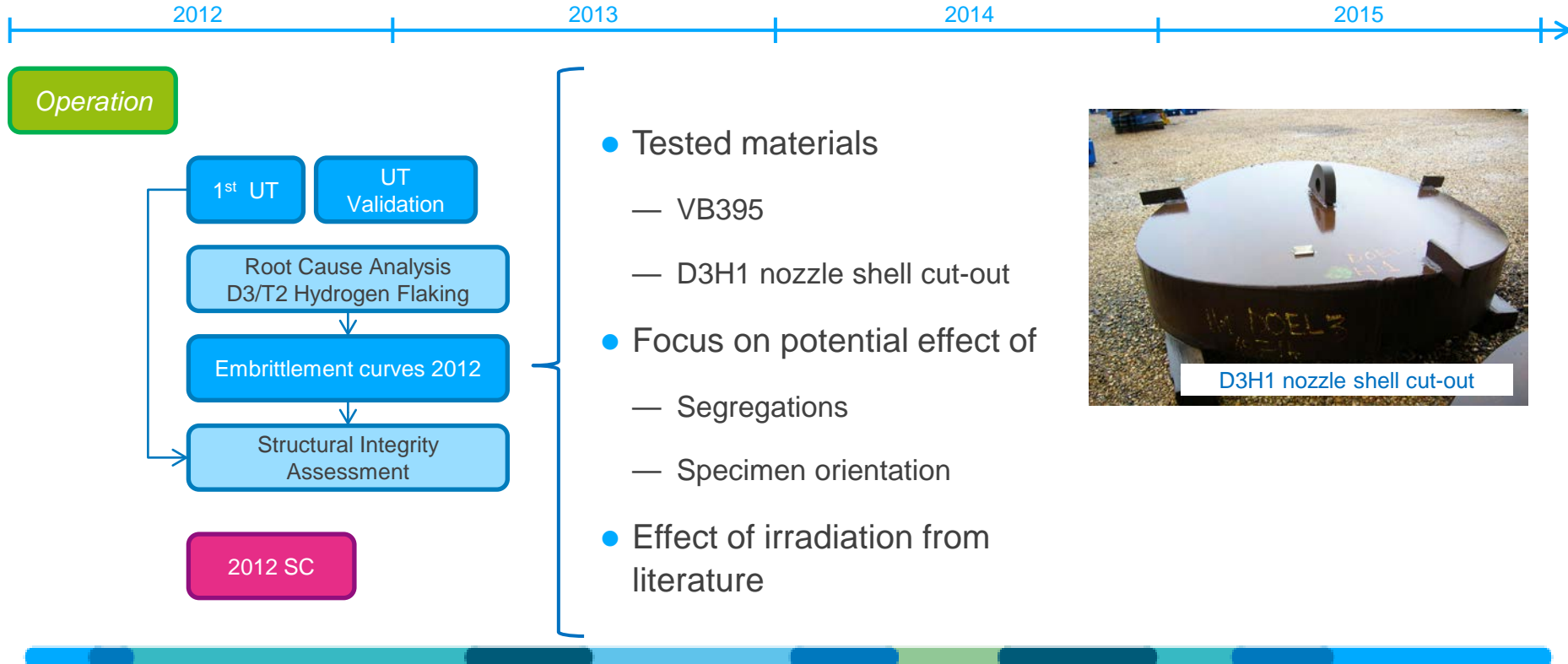


- Steam generator shell rejected in 2012 because of hydrogen flaking
- Size and material similar to RPV shells
- Hollow ingot

# 2012 Safety Case was built and submitted before Christmas



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# 2012 Safety Case was built and submitted before Christmas

2012

2013

2014

2015

Operation

1<sup>st</sup> UT

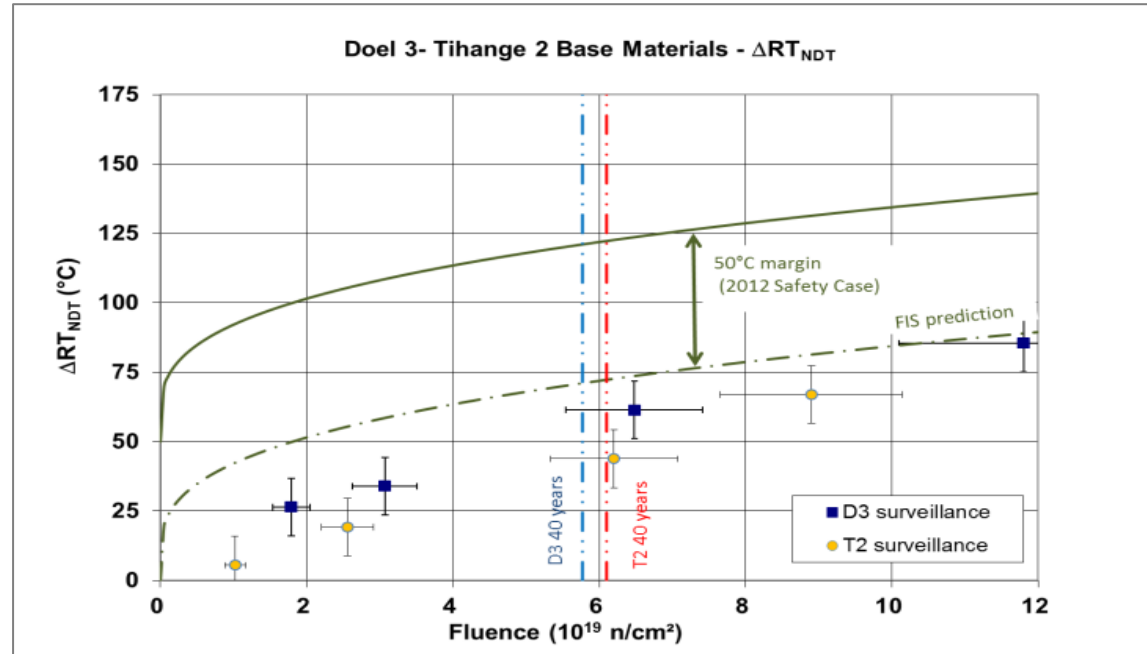
UT  
Validation

Root Cause Analysis  
D3/T2 Hydrogen Flaking

Embrittlement curves 2012

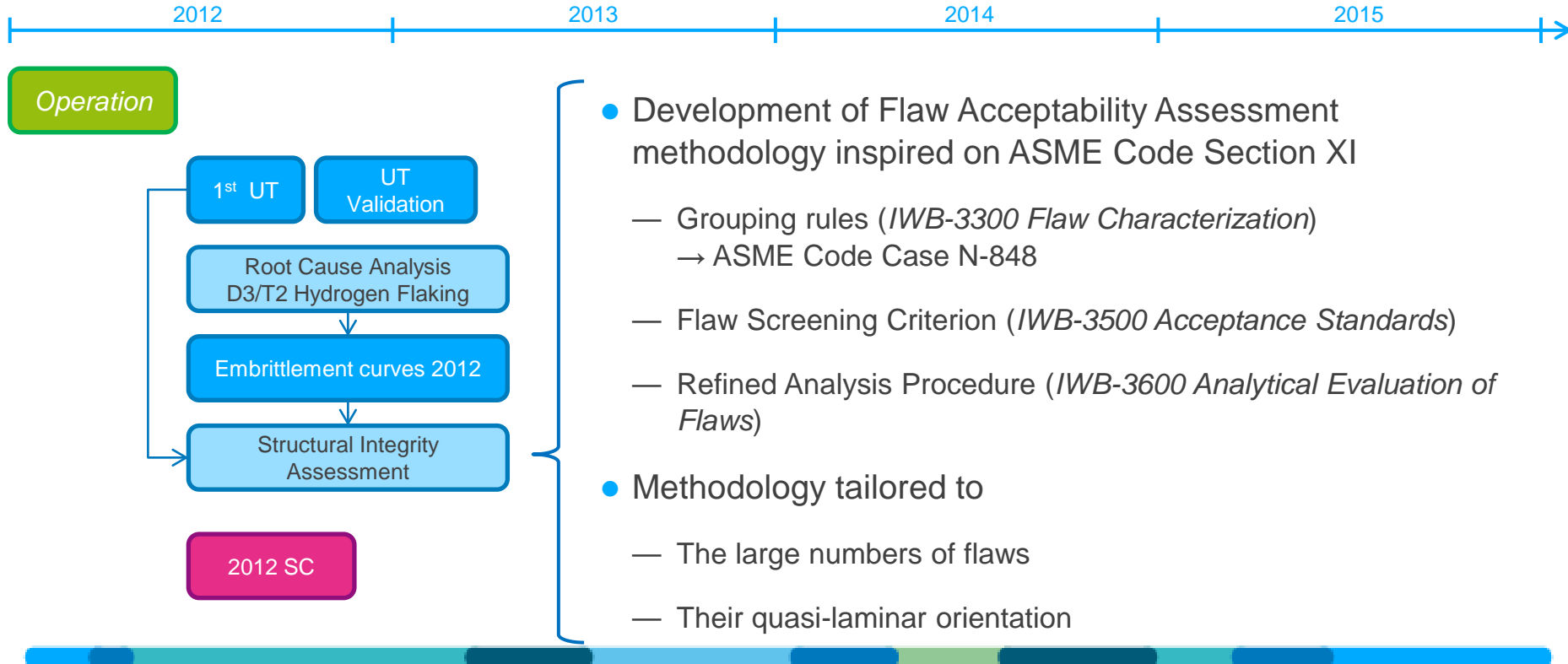
Structural Integrity  
Assessment

2012 SC



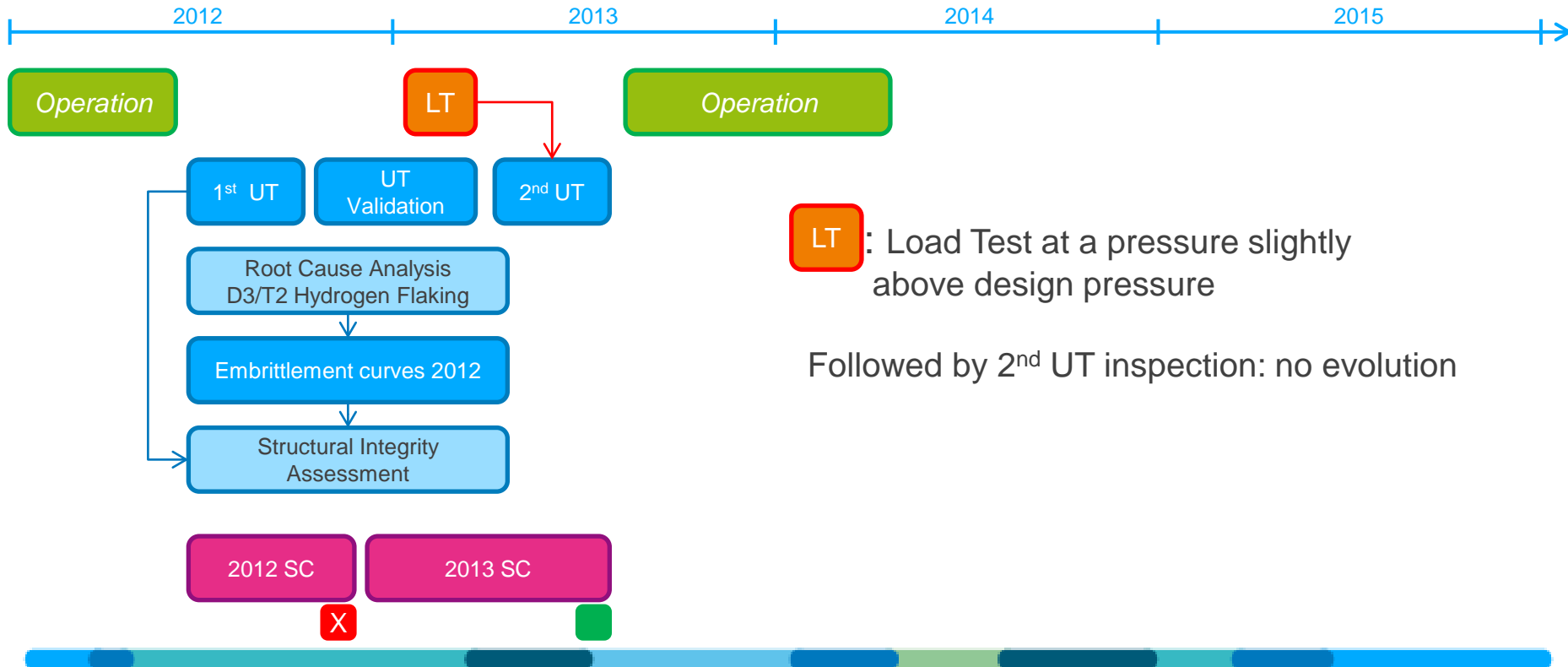


# 2012 Safety Case was built and submitted before Christmas

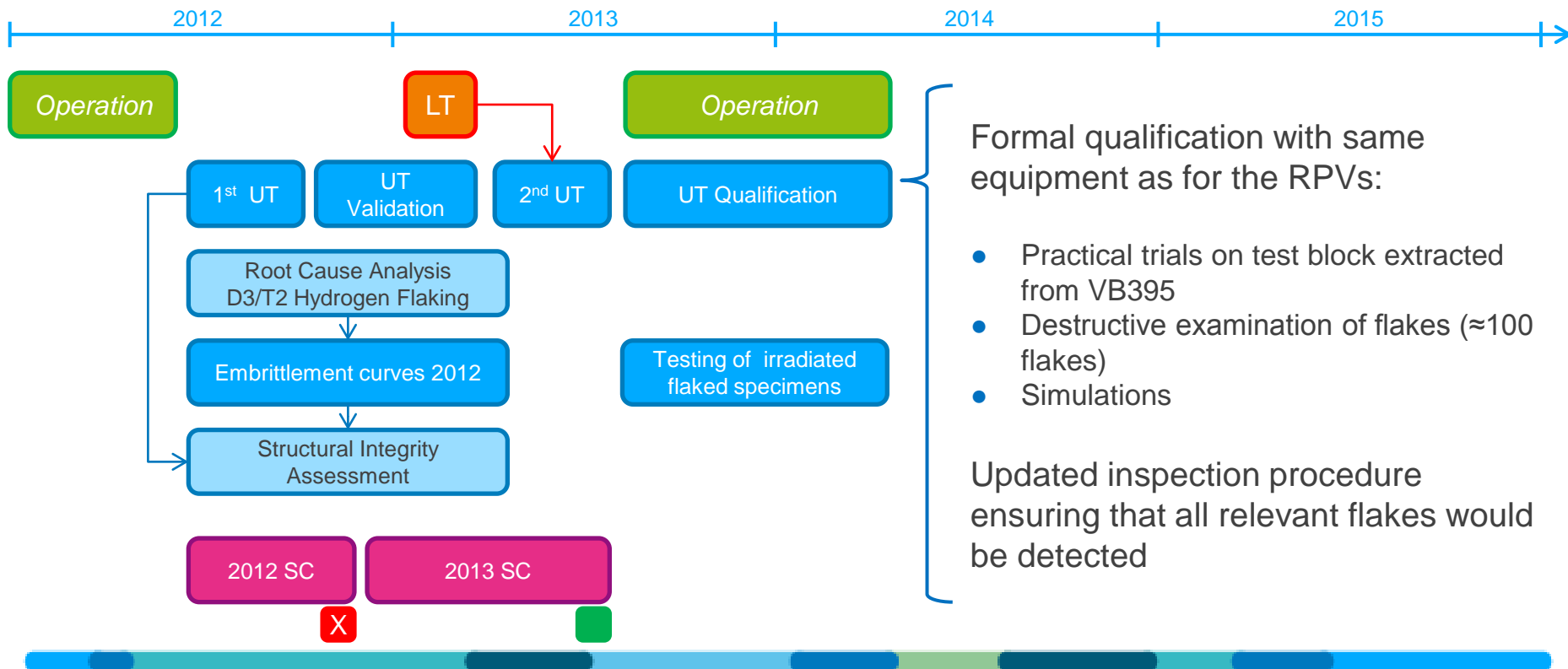


# 11 Short-Term actions addressed in 2013 Safety Case Addenda

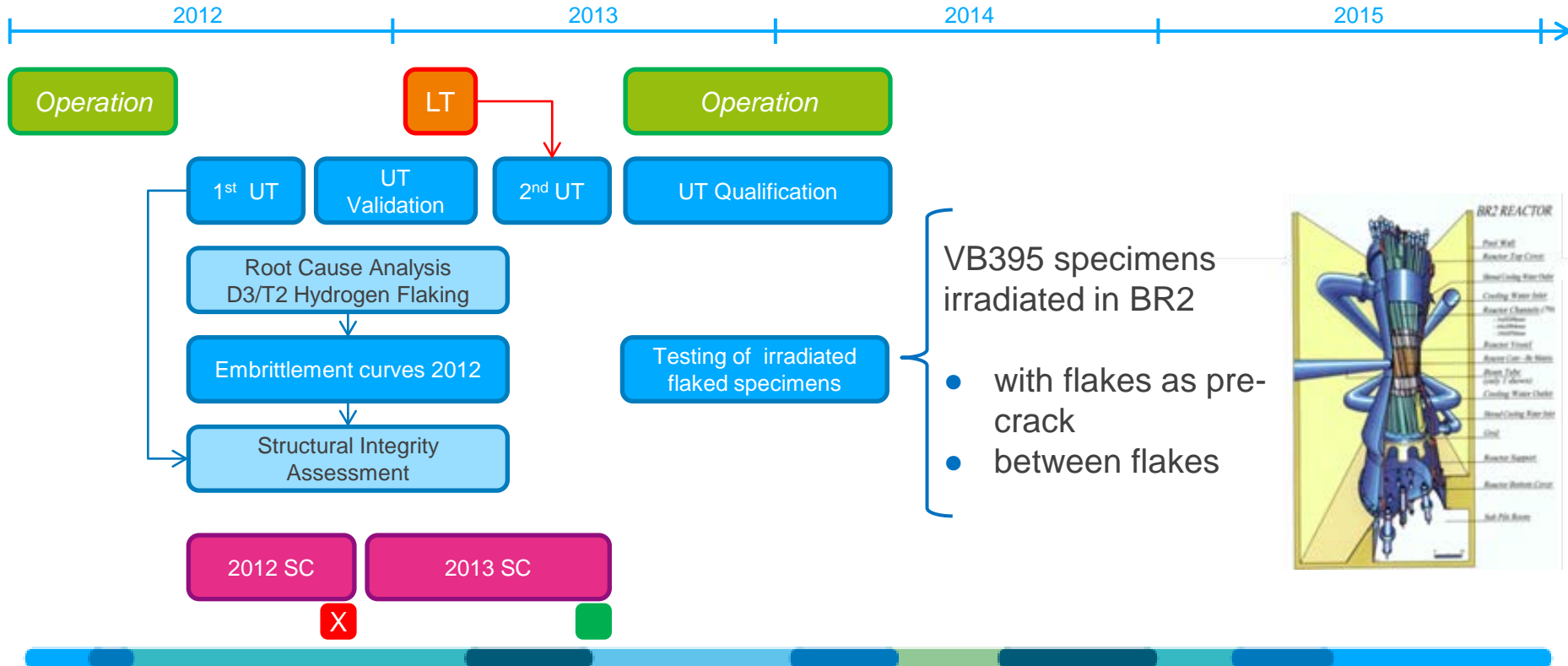
## ...Allowing restart of both units



# Another 5 Medium-Term actions to be addressed before RFO

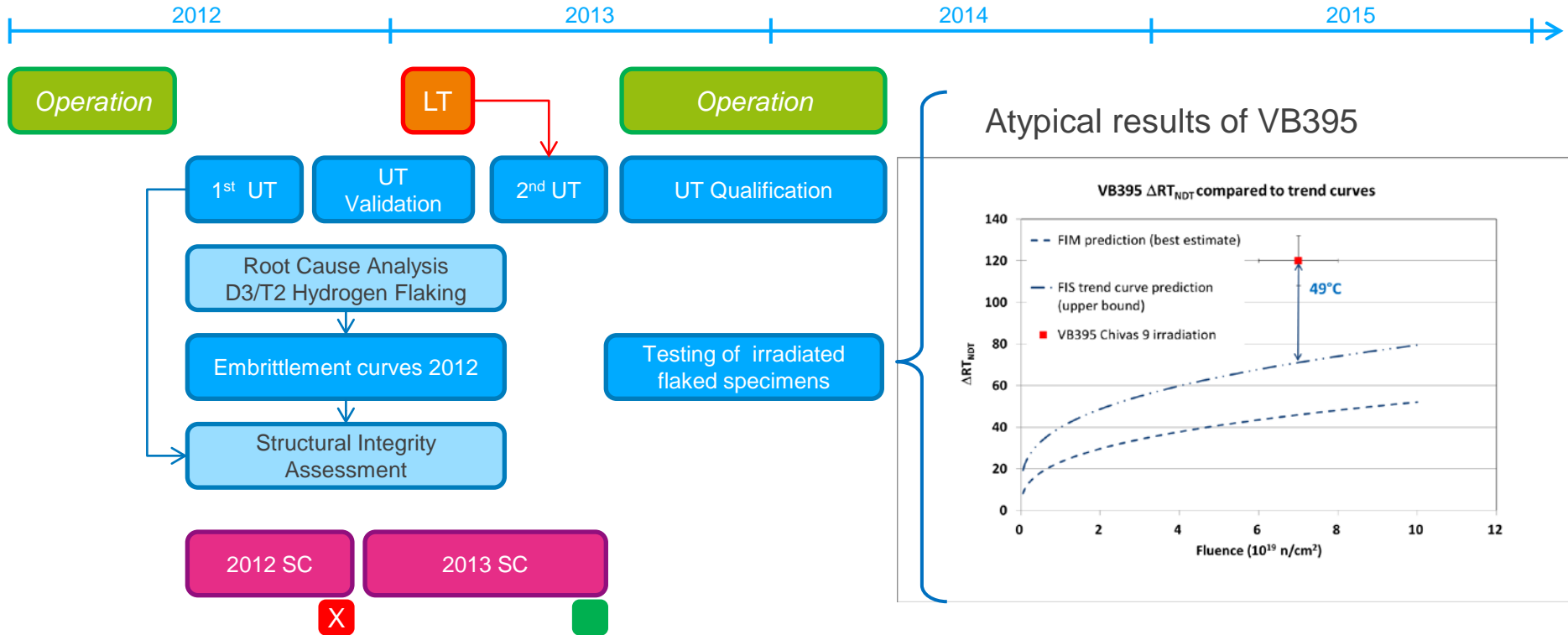


# Another 5 Medium-Term actions to be addressed before RFO



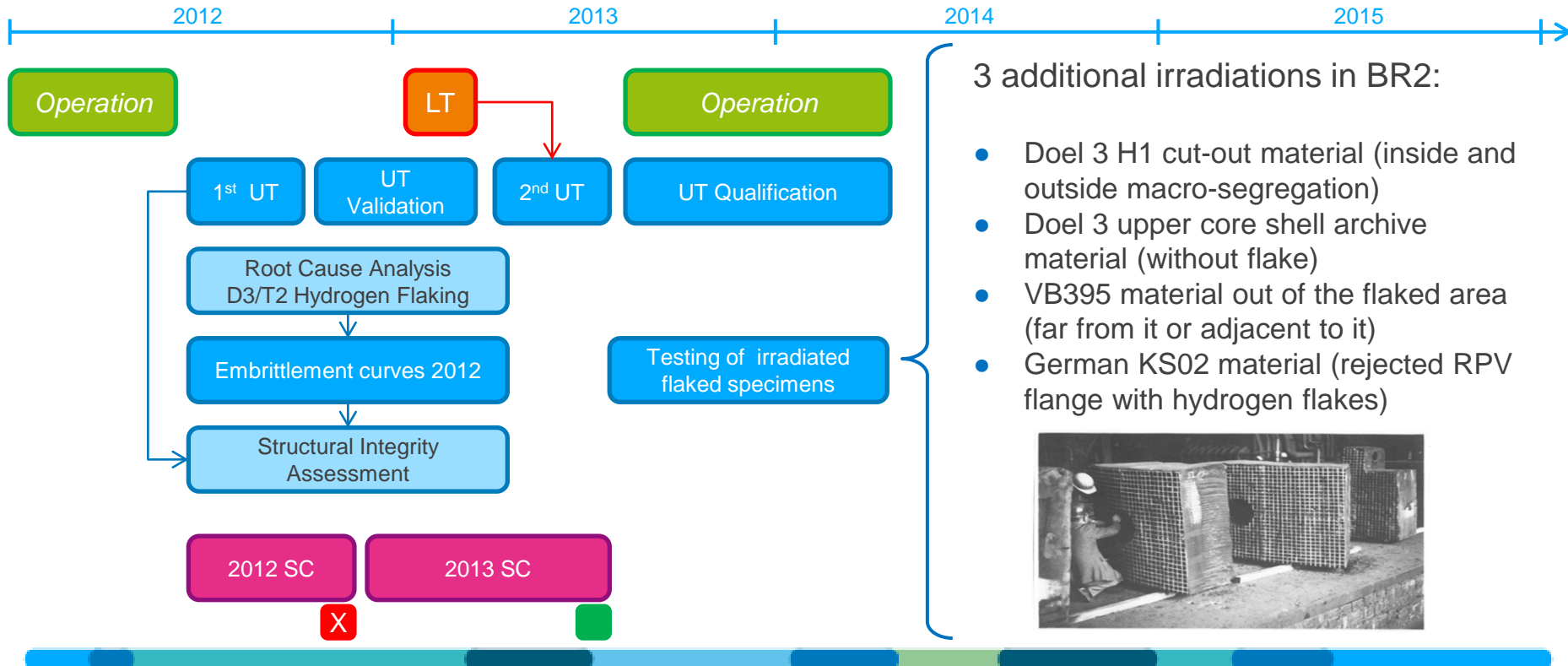
# Another 5 Medium-Term actions to be addressed before RFO

## ... unexpected results leading again to shutdown of both units

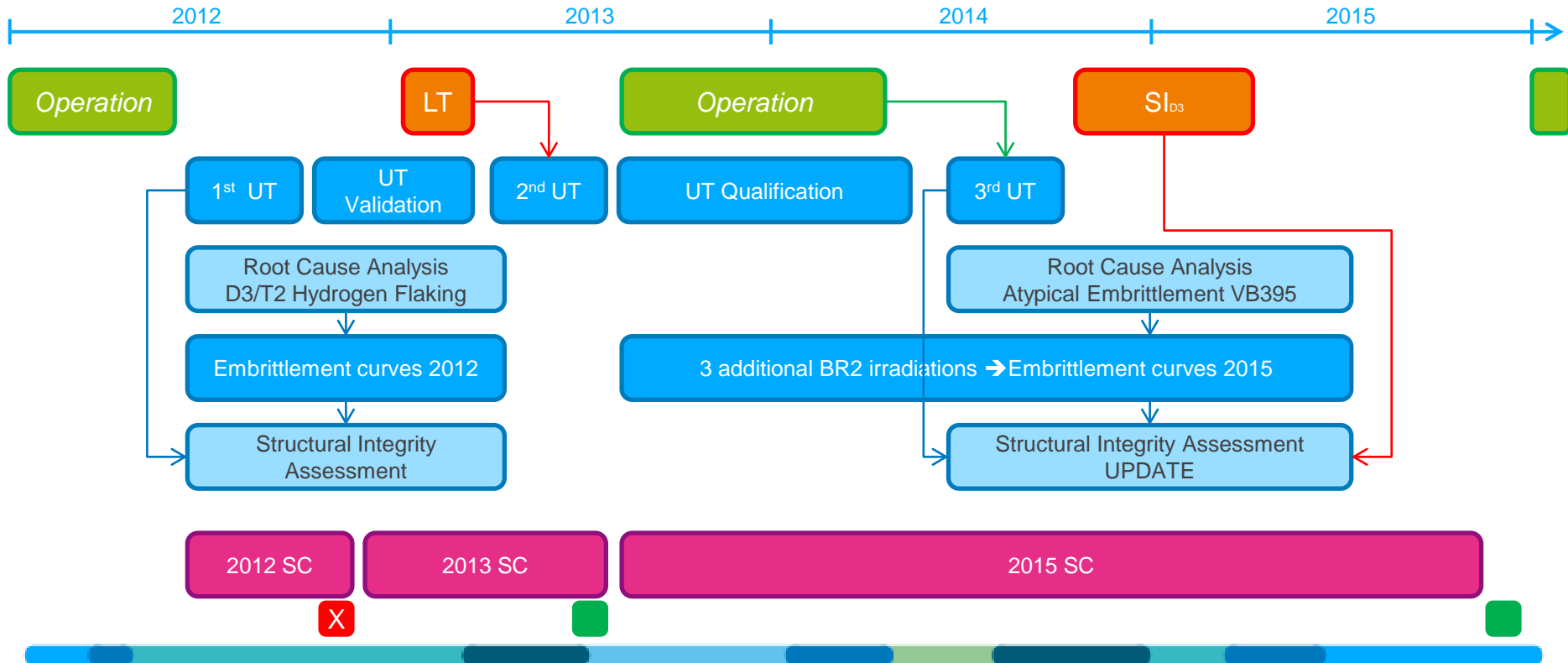


# Another 5 Medium-Term actions to be addressed before RFO

## ... unexpected results leading again to shutdown of both units



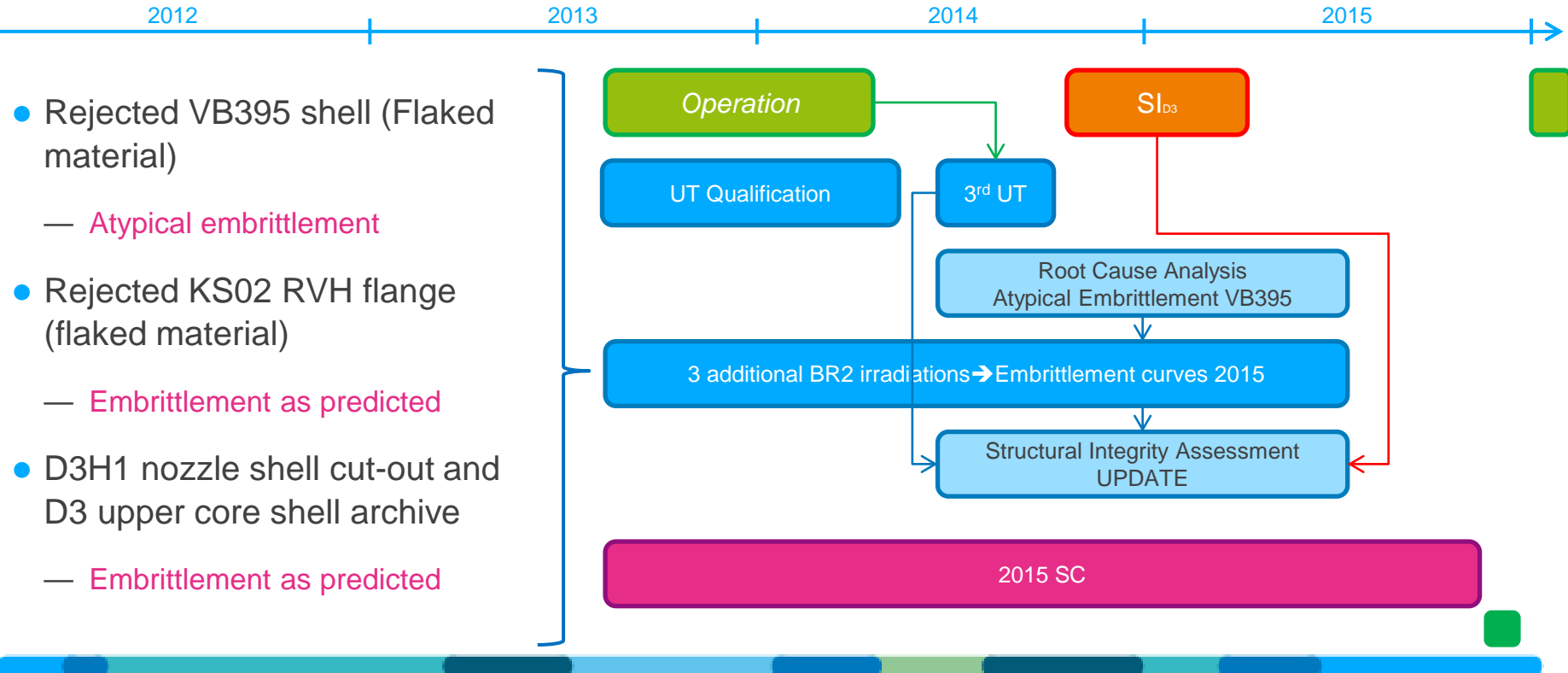
# Another 5 Medium-Term actions to be addressed before RFO ... leading to complementary material investigations and testing





# 2015 Safety Cases

## Materials investigated - Results



# 2015 Safety Cases

## Embrittlement curves 2015

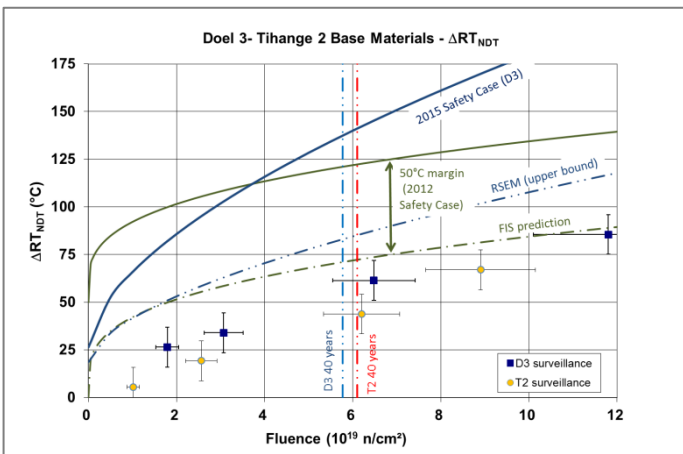
2012

2013

2014

2015

- Very unlikely that D3-T2 RPV would exhibit same atypical embrittlement as VB395
- Additional VB395 embrittlement was nevertheless added to trend curve



Operation

UT Qualification

SI<sub>D3</sub>

3<sup>rd</sup> UT

Root Cause Analysis  
Atypical Embrittlement VB395

Embrittlement curves 2015

Structural Integrity Assessment  
UPDATE

2015 SC

# 2015 Safety Cases UT Qualification

- Upgraded inspection procedure
- 3<sup>rd</sup> UT inspection
- Updated flake cartography

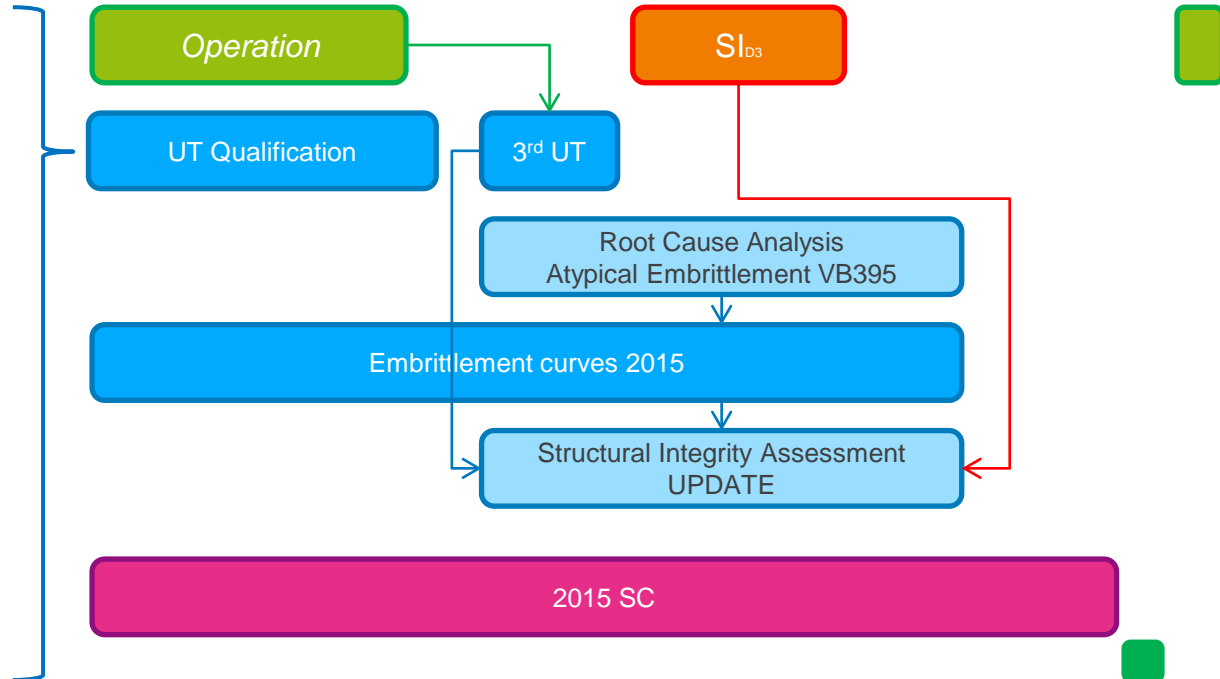
	Doel 3	Tihange 2
UCS	1440	3064
LCS	11607	85

2012

2013

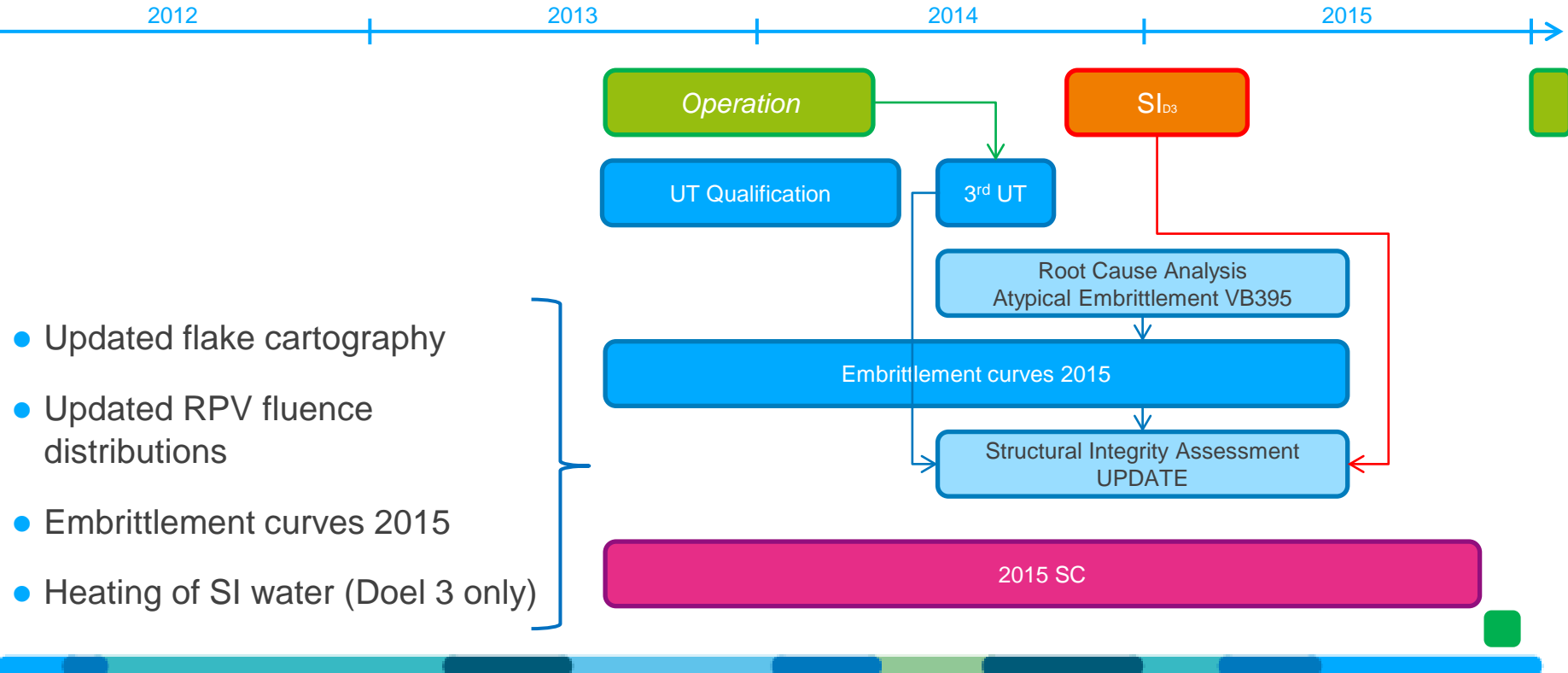
2014

2015

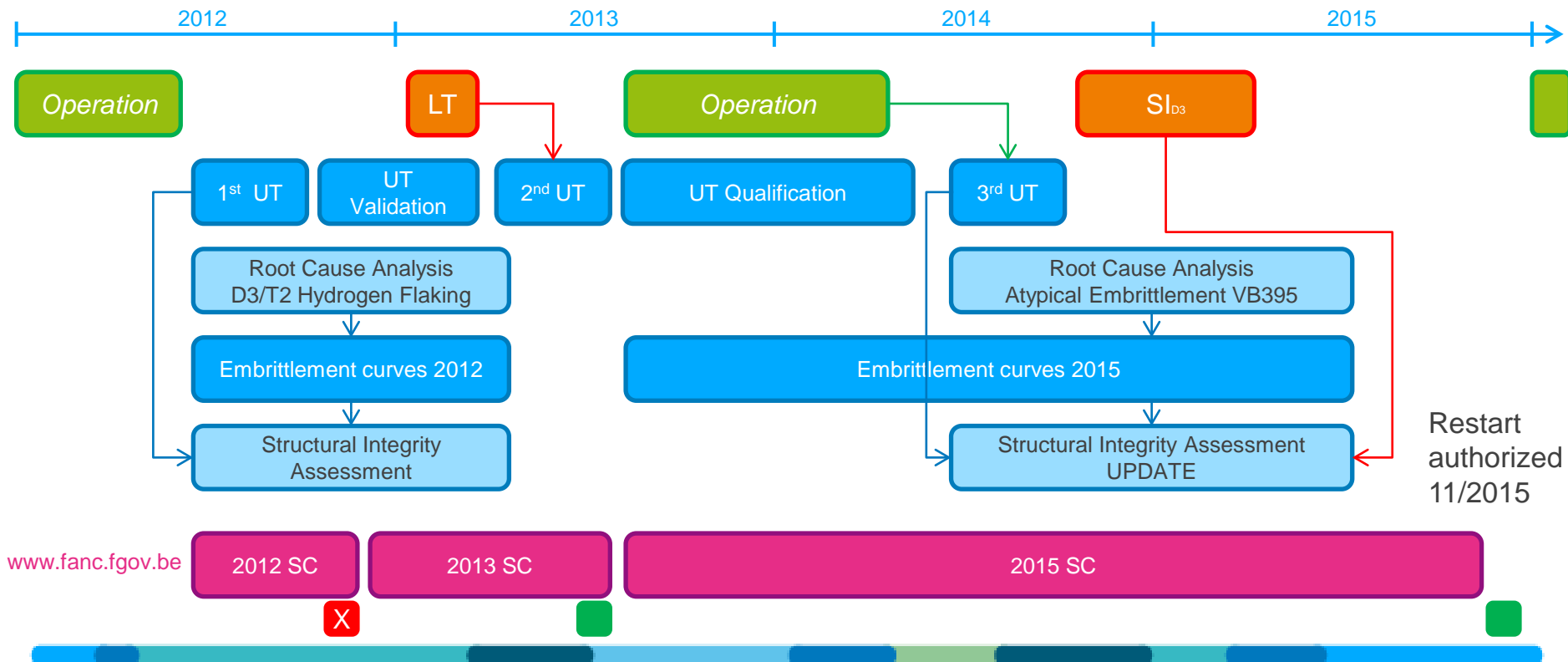


# 2015 Safety Cases

## Structural Integrity Assessment Update



# Doel 3 & Tihange 2 RPV Safety Cases



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**Thank you for your attention ! Any questions ?**  
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More information: Proceedings of the 2016 ASME PVP conference (PVP2016-63878)  
*Overview of the Doel 3 and Tihange 2 Reactor Pressure Vessel Safety Cases*  
*M.De Smet, J.Van Vyve*