GTR EVS

'Thermal Propagation'

JRC - Ongoing Research

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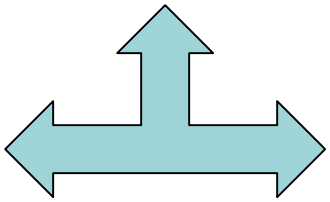
JRC.C.1, September 2017

Starting thoughts

A good regulatory test is repeatable, comparable, technology neutral and represents real life situations.

Which route do we want to take?



Scenario specific

Which initiation mimic scenario?

Is it technology neutral?

Scenario independent

Methods to initiate?

Are they equivalent?

Is a new method needed?

- Can we ensure the repeatability with one/few tests?
  - Does initiation method manipulate/tamper with device under test?
    - ?....

JRC experimental TP activity

Cell & material

Comparison of initiation techniques

- Trigger energy/ energy release
- Repeatability

+ ARC, DSC

Short stack

Analyse influential factors on the outcome

- Temperature, SOC…
- Cell configuration
- Spark source

Quantify hazards

Module

Analyse repeatability, reproducibility

- Check proposed test descriptions (also with testing bodies)
- Round robin tests
- Define pass fail criteria

Pack, Vehicle

Verification and finalization of method

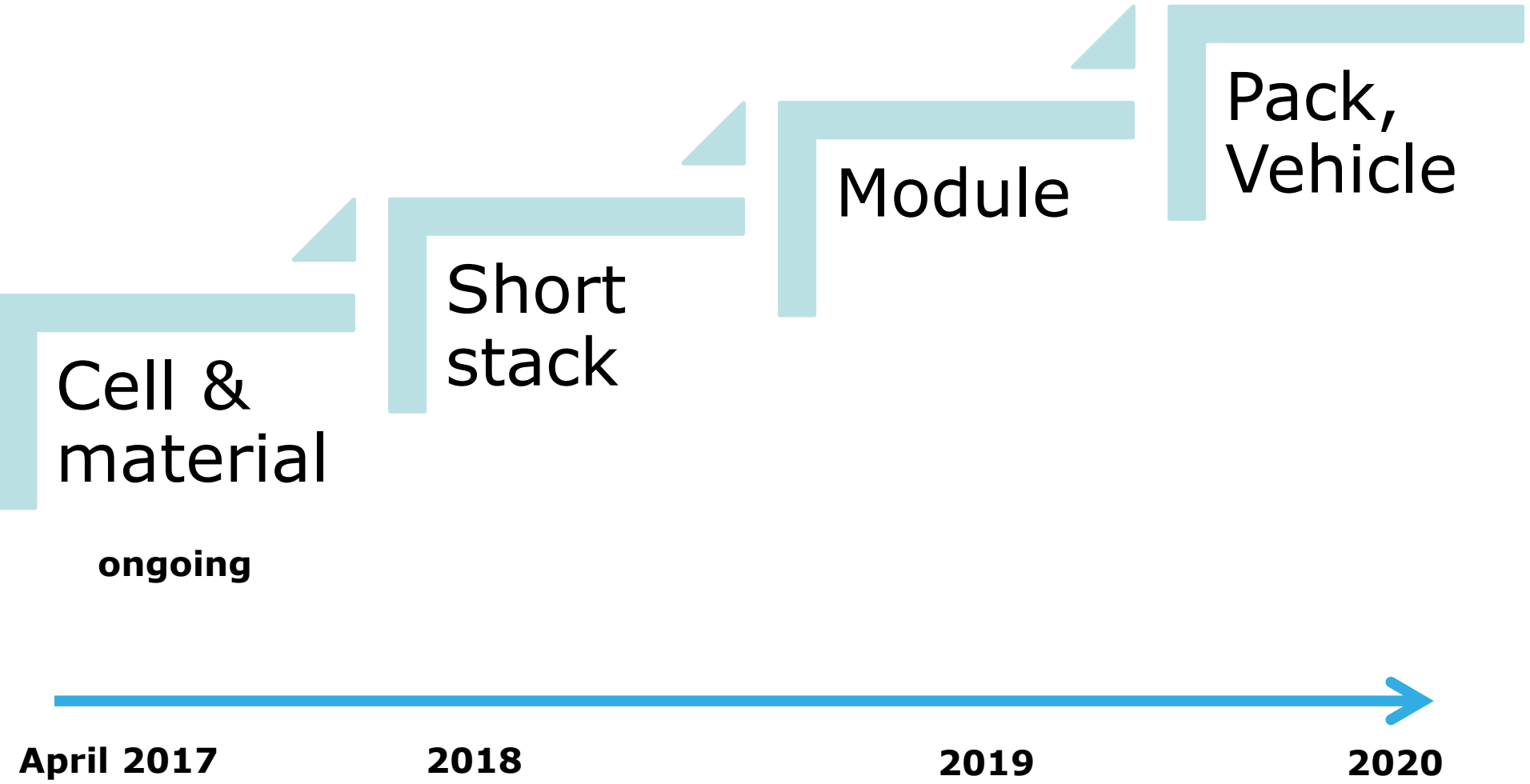
- Round robin tests
- Practical aspects
- Define robust evaluation methods (e.g. gas analysis)

Narrow down init. methods

Refine test description

Select equivalent test(s)

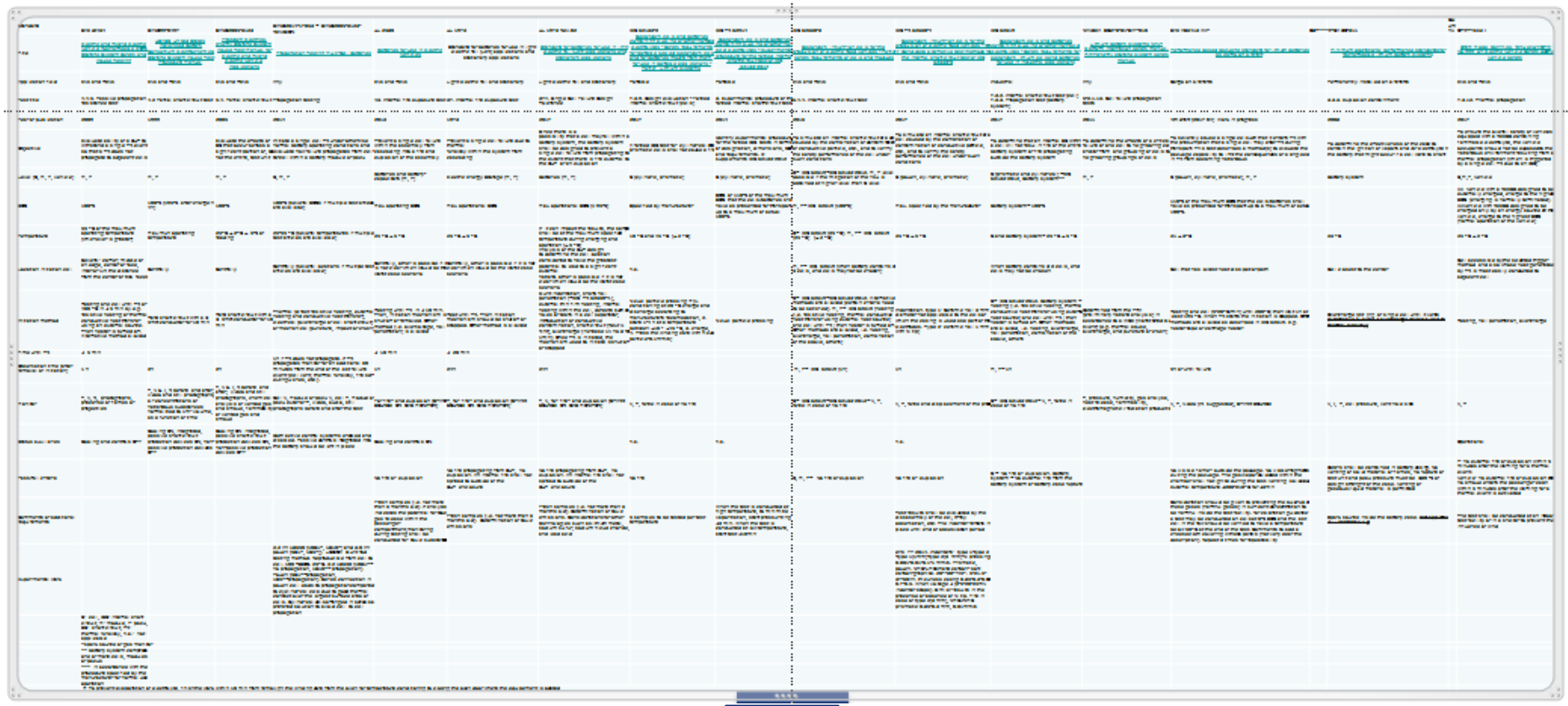
Estimated timeline



Analsysis of standards

Work on analysis on exisiting standards applying propagation-type tests has been started

Consolidation expected 1st half 2018



Analsysis of standards

Example

Standard	SAE J2464
Title	Electric and Hybrid Electric Vehicle Rechargeable Energy Storage System Safety and Abuse Testing
Application field	EVs and HEVs
Test title	4.4.5. Passive propagation resistance test
Year of publication	2009
Objective	Evaluate ability of a DUT to withstand a single TR event so that a TR does not propagate to adjacent cells
Level (C, M, P, vehicle)	M, P
SOC	100%

Temperature	55 °C or the maximum operating temperature (whichever is greater)
Location initiation cell	Several: corner, middle of an edge, center of face, interior 1/4 the distance from the center of two faces
Initiation method	Heating one cell until TR or 400 ºC in < 5 min by e.g. resistive heating or thermal conductive heat transfer using an external source. Then heater is turned off. Alternative method allowed
Time until TR	< 5 min
Observation time (after removal of initiation)	1 h
Monitor	T, V, R, photographs, presence of flames or projectiles
…	

Cell and material level

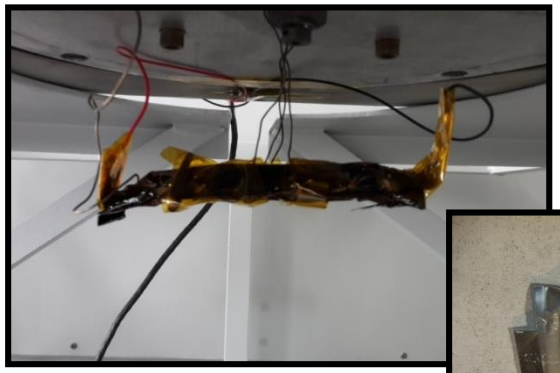
Done/under tests

- Comparison of heating and overcharge in ARC
- DSC study on components and the effect of SOC (including >100%)

DSC in glovebox system (in Petten)

2 ARCs (in Petten)

Preliminary test results



Cell and material level

Future work

- Overcharge, ceramic nail, heating: study isolation, chemistry, SOC etc.
- Rapid heating: effect of cell geometry, energy input, etc.
- Other initiation methods
- Do we need to initiate TR or mimic a scenario (i.e. ISC)?

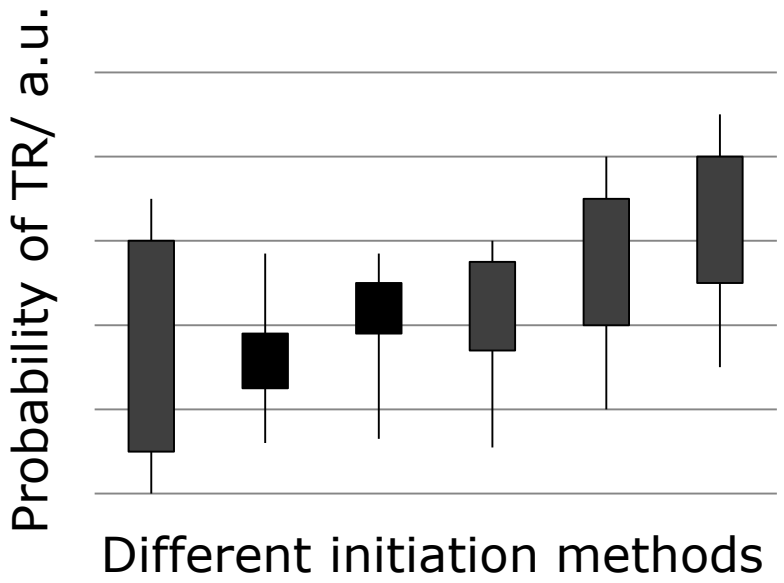
Cell and material level

Effect of inserted heat on probability of TR

When the triggering energy increases, the cell goes to TR at higher probability.
The extra added energy may render the outcome drastically.

Selection of initiation method critical (in line with goal of test)

Schematic graph

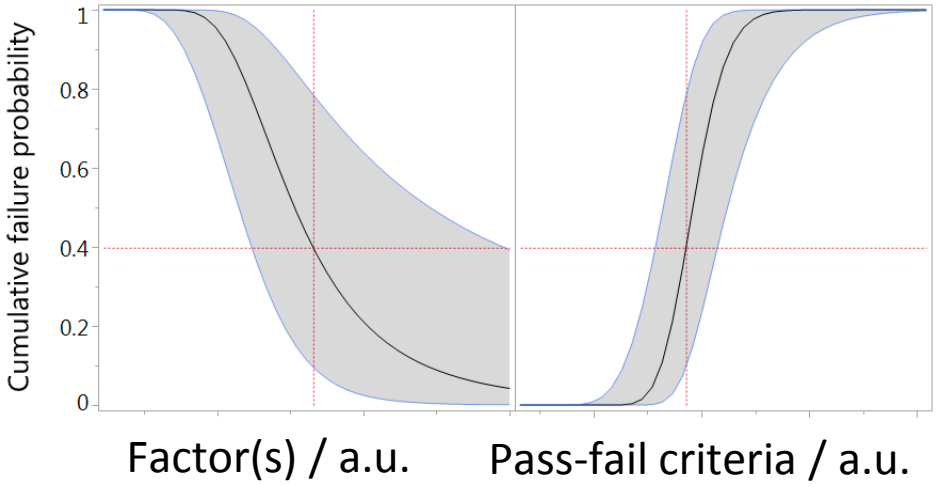


Short stacks and modules

Majority of tests is done in this phase

- Using high energy NMC PHEV1 format automotive cells
- Determine influential factors: position, configuration of initiation etc.
- Quantify hazards and failure probability of influential factors
- Define and refine test descriptions: initial condition, pass-fail
- Validate test description by round robin tests

Statistical analysis



Reproducibility of the test to be evaluated as a function of the factors (e.g. trigger energy) and the pass-fail criteria (e.g. egress time).

Pack and Vehicle level

Key issues

- Reproducibility and repeatability:

  Round robin tests
- Validation of pass-fail criteria
- Practicality study on different REESSs
- Check test robustness against tampering/manipulation of test
- Definition of acceptable testing levels (vehicle, pack,…)

Overall targets

- To evaluate feasibility of a TP test for regulation and
- To define
  - Trigger method(s)
  - Pass-fail criteria
  - Testing level(s)
  - Test conditions
- Technology neutral unambiguous test description