Practical Application of Structural Risk Assessment with SMART|DT

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Overview

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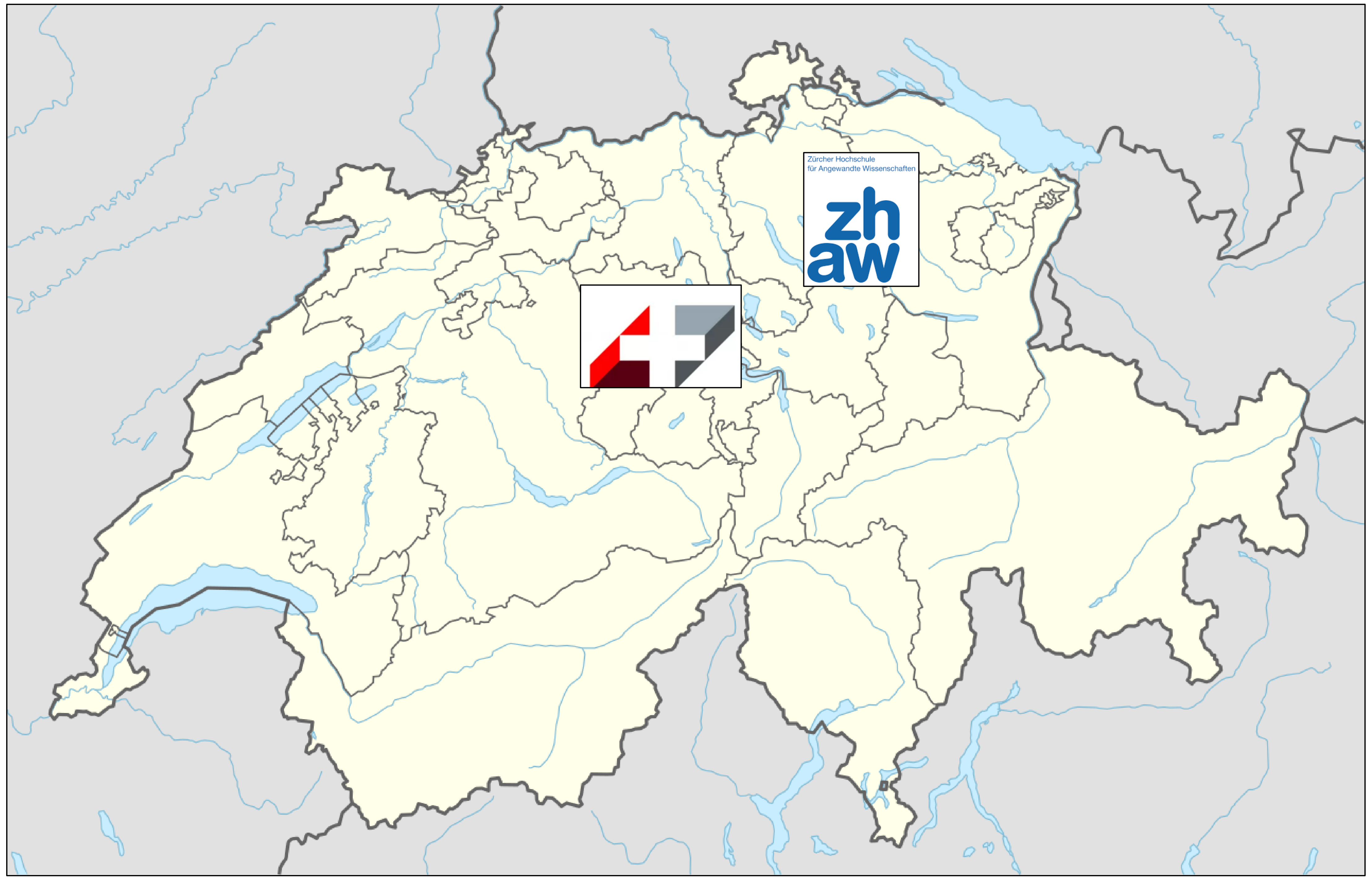

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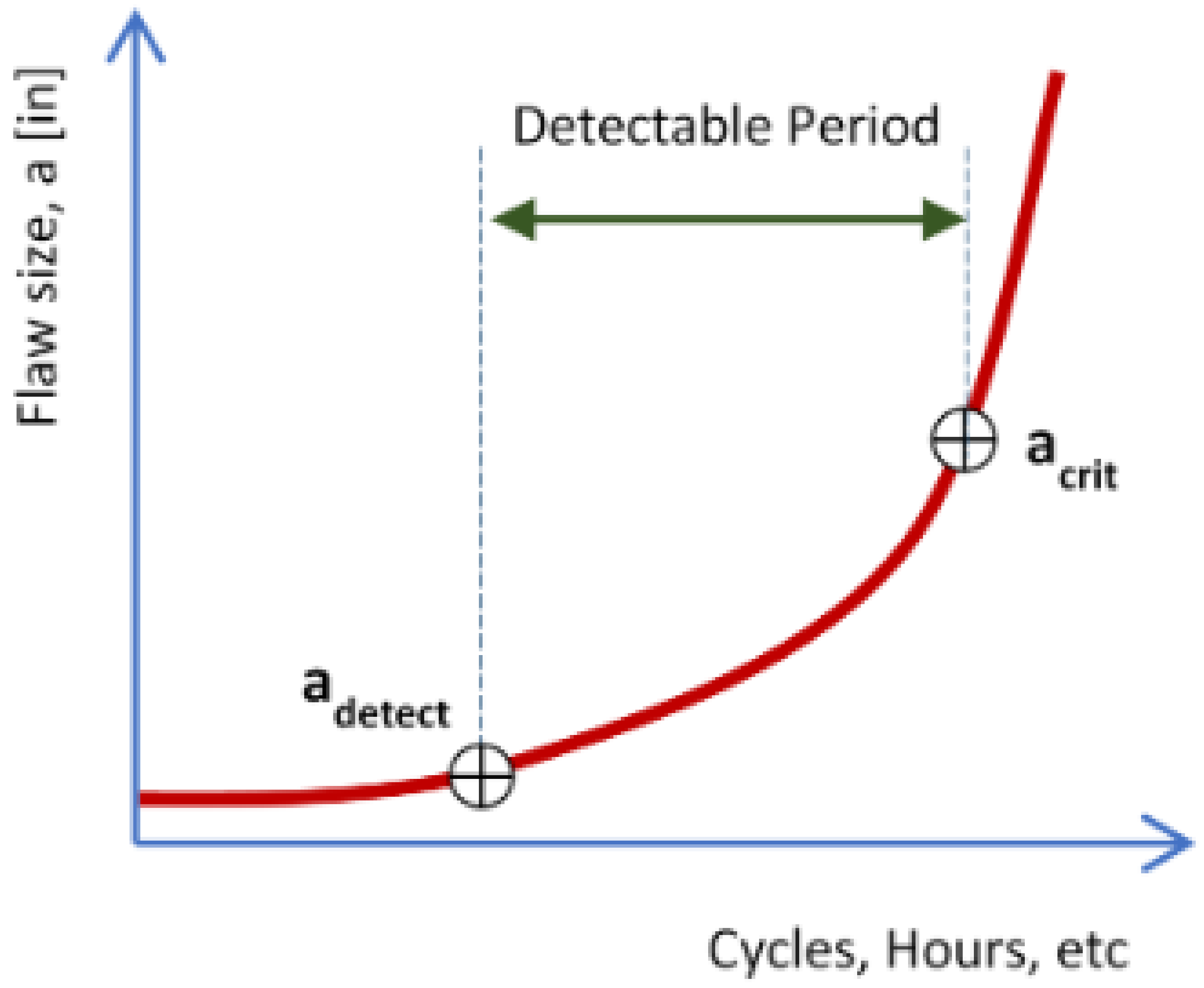
Background

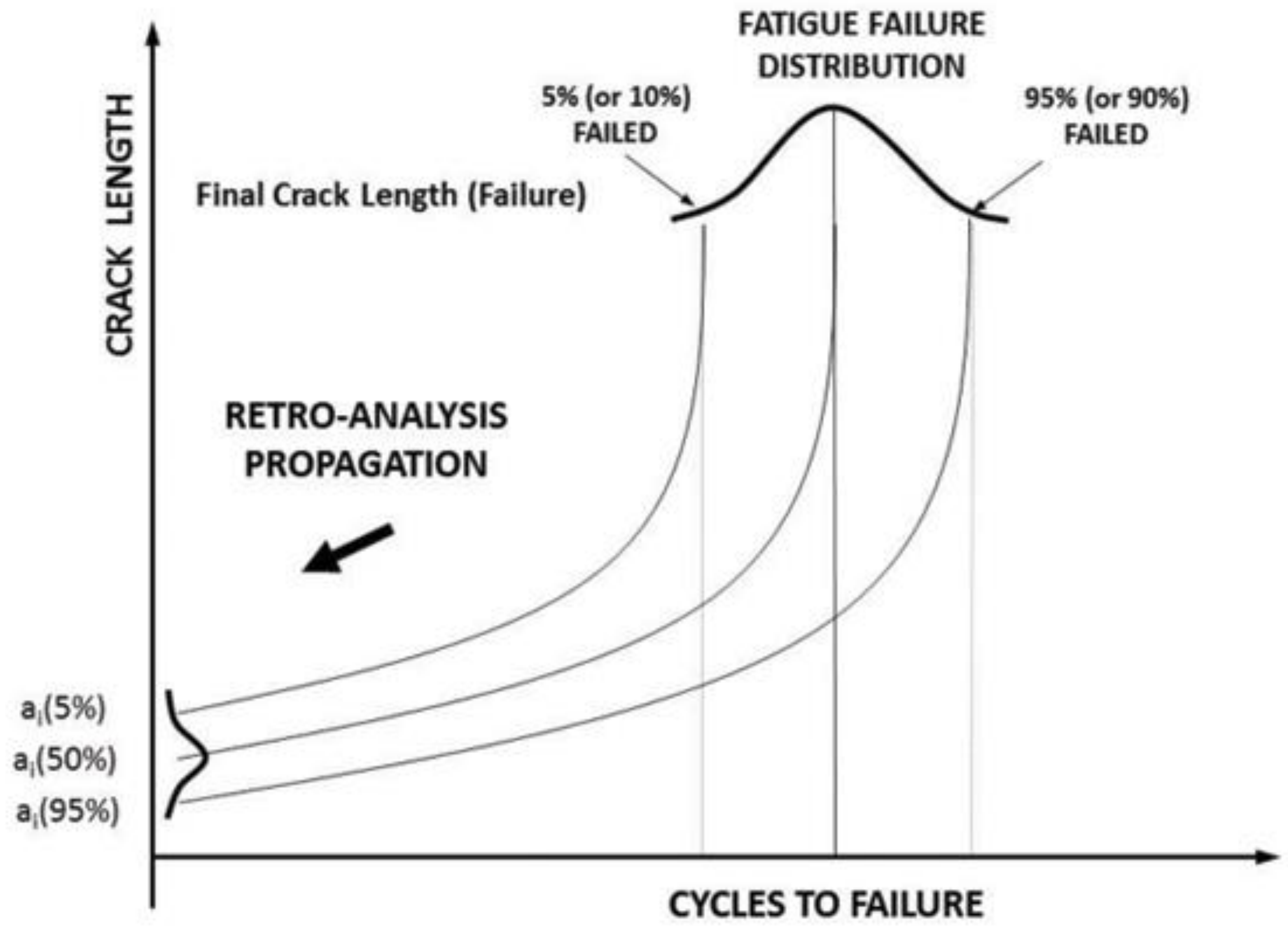
Motivation

Damage Tolerance



Challenges for RUAG:
- Very short DT life of structural items
- Impossible to inspect at very short intervals (accessibility, fleet availability, costs)
- Ageing aircraft

Probabilistic Damage Tolerance

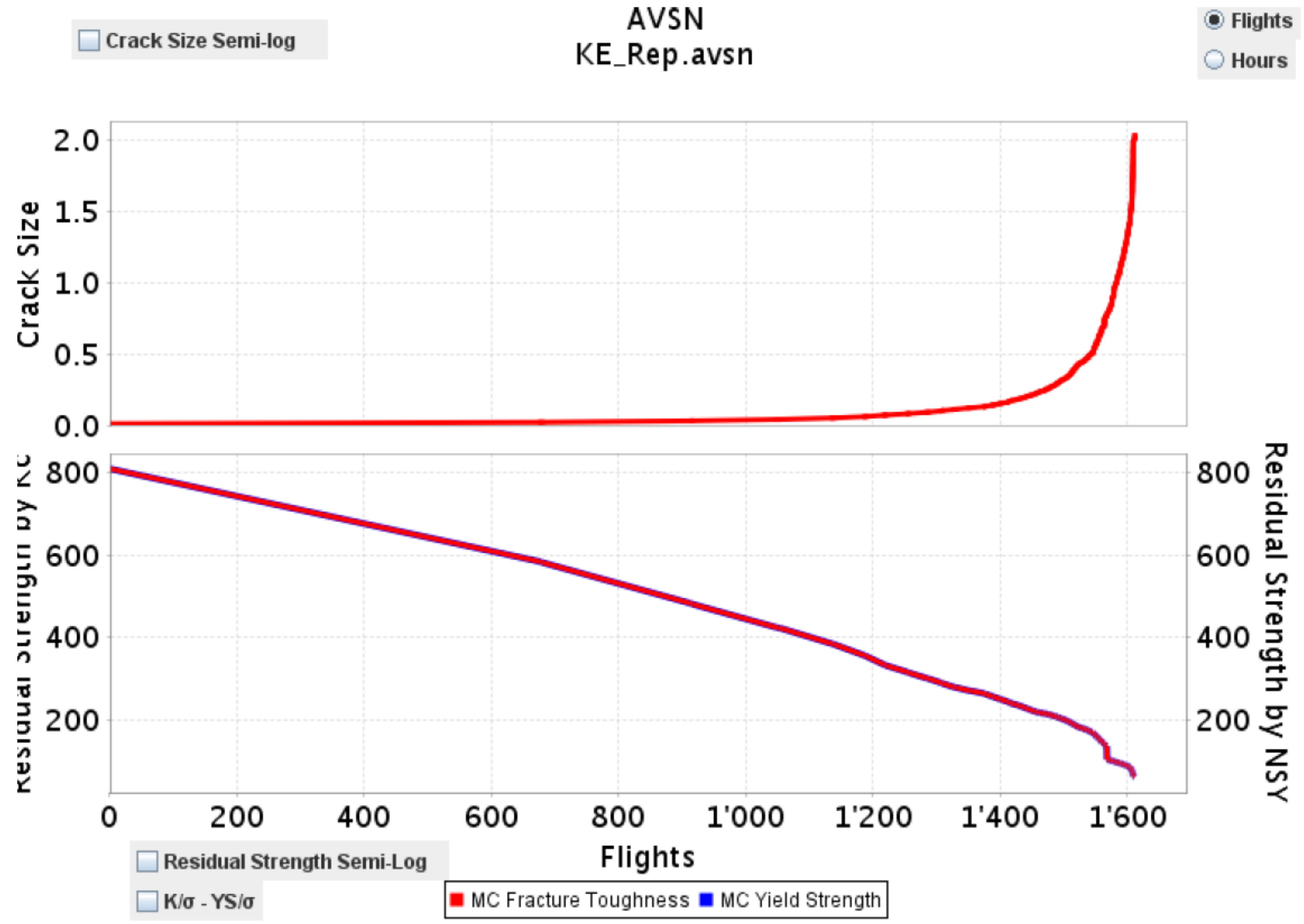


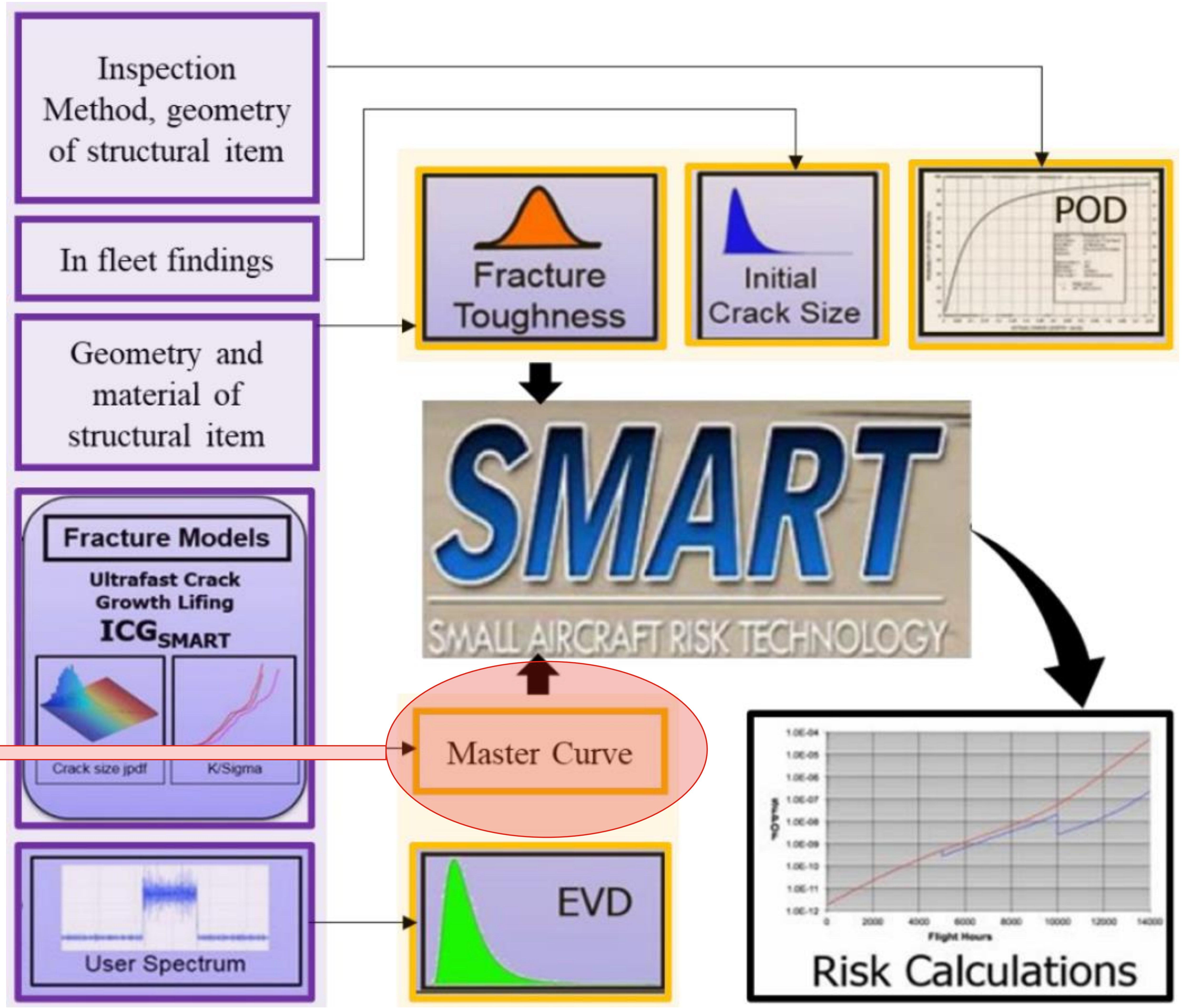
Advantage:
- Risk as increasing probability of failure
- Improve maintenance schedules and fleet availability
- Variation in operational data and material is included in the risk calculation

Method

Overview

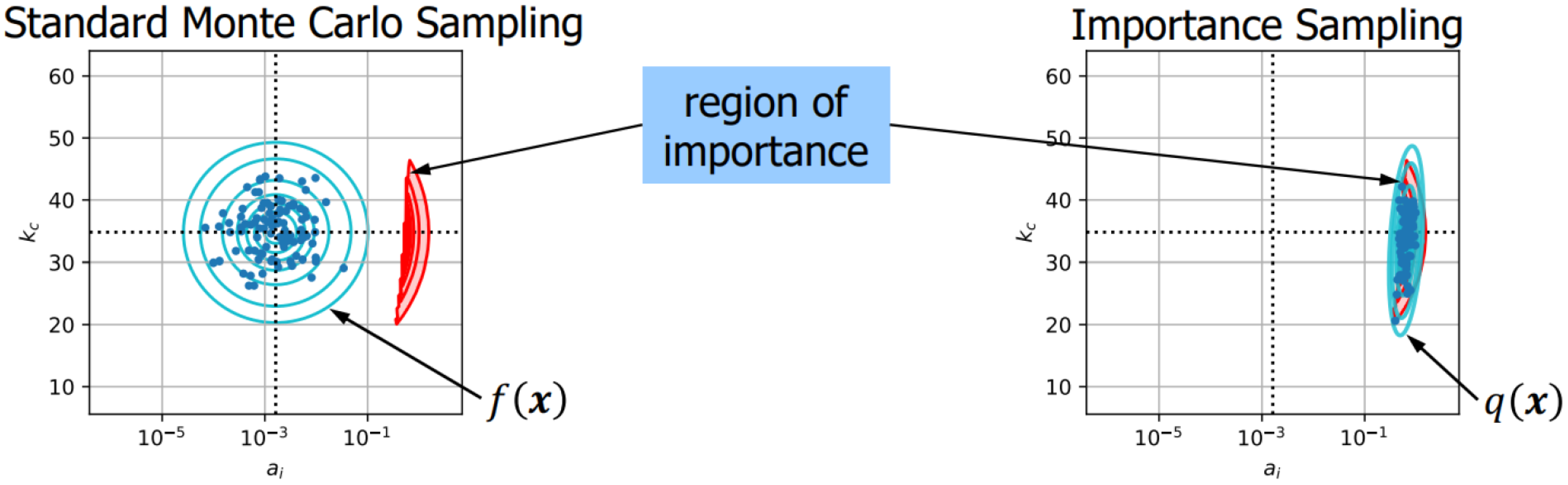
- The data is taken from operation, analyses and material properties
- The data must be prepared for application in the PRA





Method

Monte Carlo vs. Importance Sampling



With an adequate sampling distribution q(x), only relevant samples can be generated for the PRA.
The region of importance shows the samples which mostly affect the calculation of the POF

Sensitivity analysis

Variation on data / uncertainties

Data	Mathematical description	Influencing factors
Crack growth curve	Exponential or linear	Fleet scatter, load spectrum, material properties
Initial crack size	Lognorm and Weibull distribution	Material quality, notch geometry, crack geometry
Max stress per flight	EVD	Usage spectrum
Fracture toughness	Normal and lognormal distribution	Grain orientation, material and geometry
POD	Log-logistic distribution	Inspection method, crack location and size, human factors
Inspection intervals	List of FH with respective interval	DT analysis, maintenance capabilities

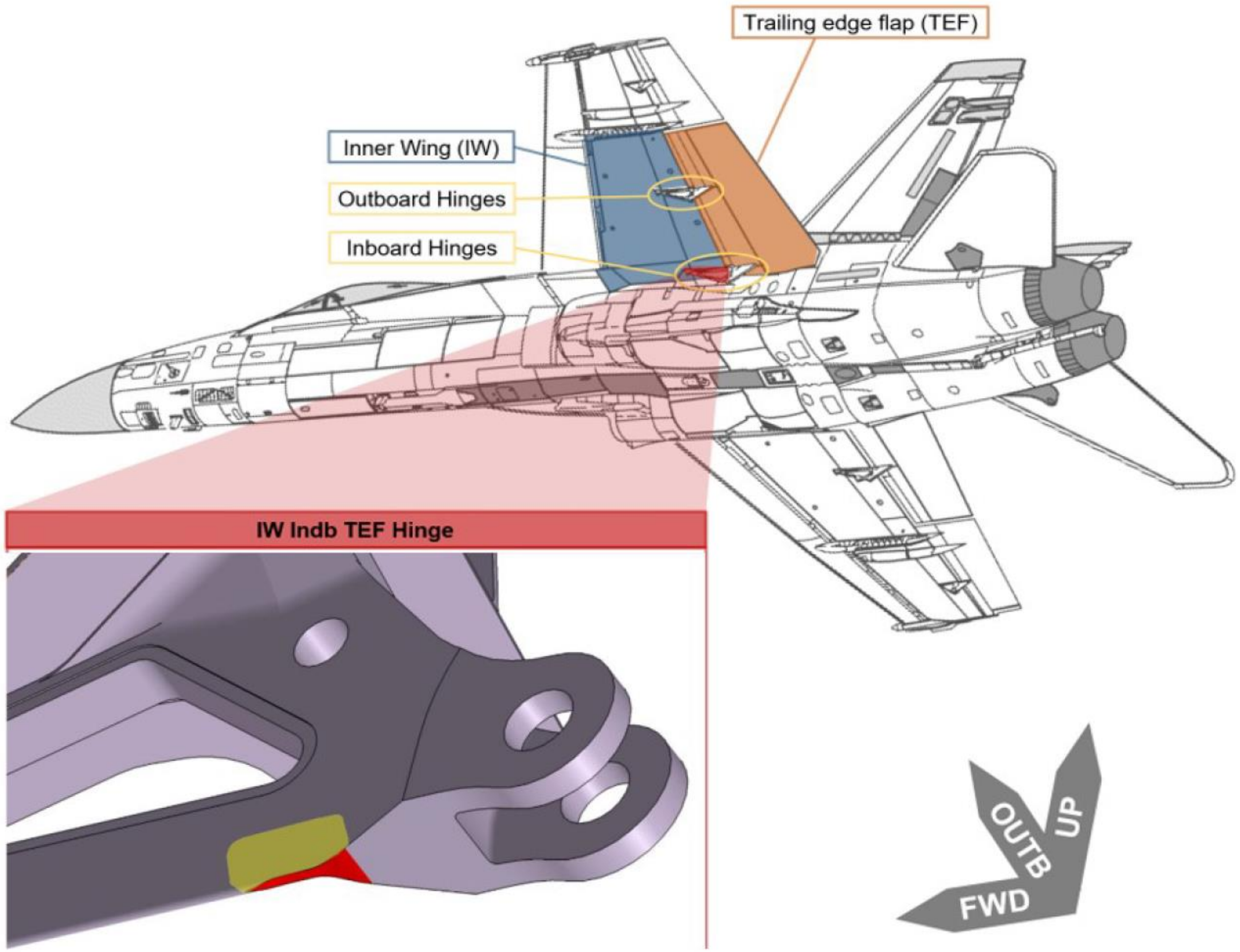
- **More data can be included in PRA, e.g. repair crack size and geometry factors.**
- **The more data is included, the more variation/uncertainty is added to the analysis**

Case Study

Overview

Motivation

- Most critical location on the IW INBD TEF
- DT analysis was performed with an initial inspection at 1350FH
- 10 findings with cracks between 0.08in and 0.2in
- Findings also in the USN and RCAF fleets



Data

- Validated AFGROW model
- Known material properties of aluminum 7050

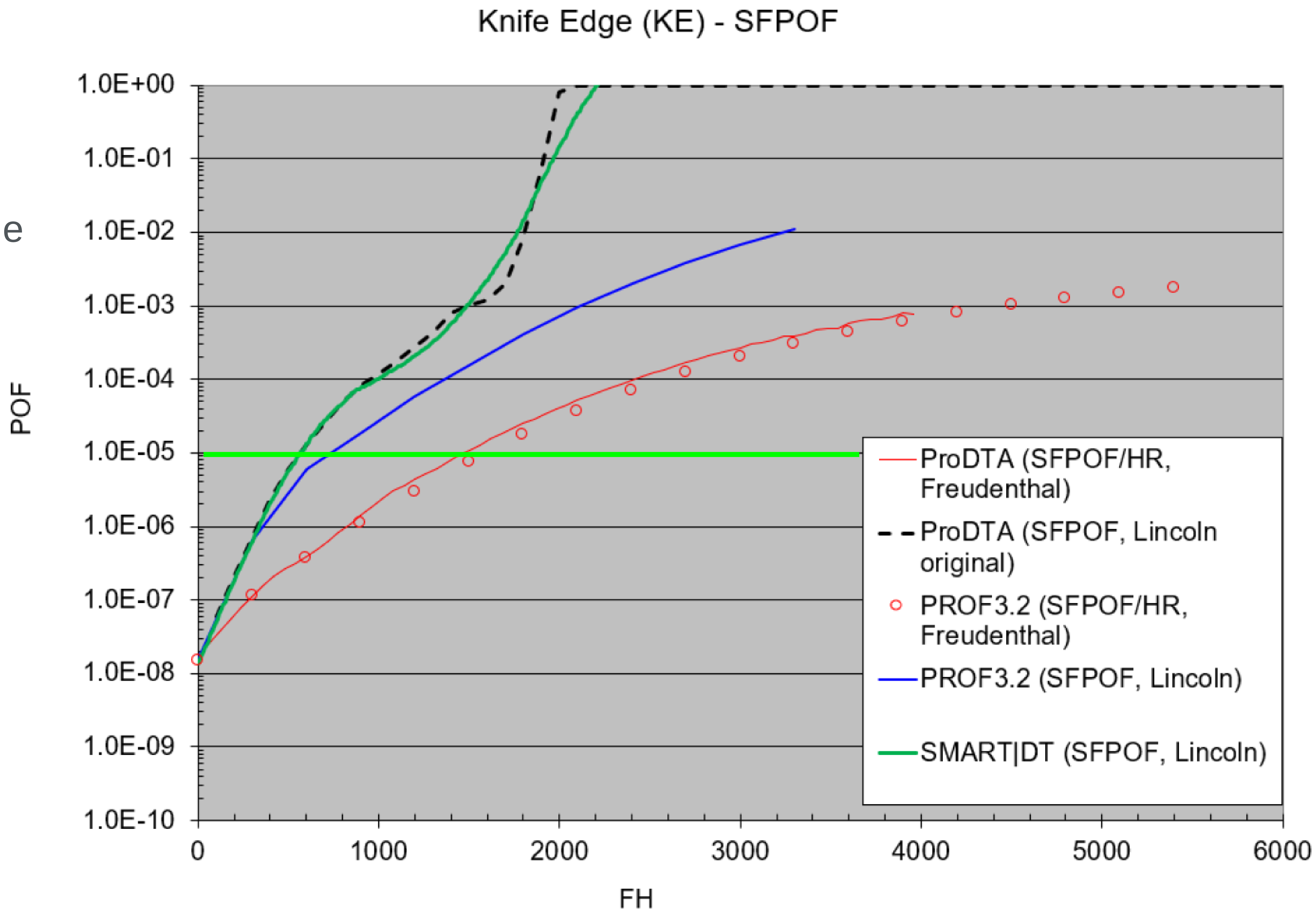
- Fleet spectrum
- Inital crack size distribution from literatur
  (Molent, Sun, Green, Characterisation of equivalent initial flaw sizes in 7050, 2006)

Case Study

Results (Part 1)

Data exchange with NRC
Comparison between **SMART|DT**, **ProDTA** and **PROF3.2** made possible

SMART|DT
= to ProDTA with original Lincoln equation
+ conservative in comparison to Freudenthal equation



Case Study

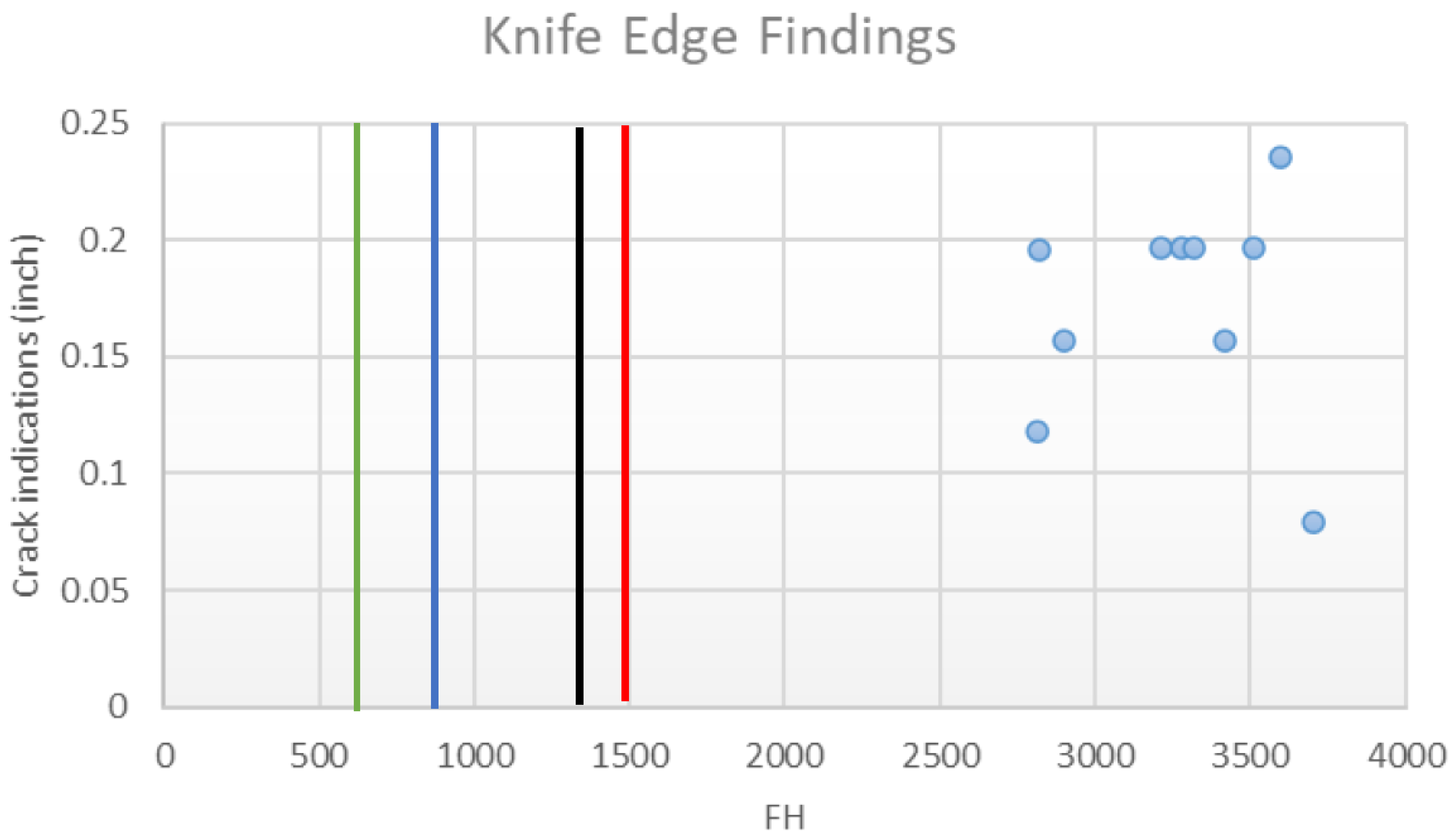
Results (Part 2)

Threshholds at 1e-5:

- SMART|DT @ 600FH
- PROF3.2 (Lincoln) @ 800FH
- DT Analysis @ 1350FH
- ProDTA and PROF (Freudenthal) @ 1500FH

○ In fleet findings

➢ **Freudenthal equation is the most appropriate for this case study**



Conclusion

Practical application of PRA with SMART|DT

General Takeaway
- Important to have a big data pool
- Involve as many operators as possible
- Perform more case studies to aquire more know-how

Takeaway RUAG
- Application of PRA is a challanging task
- Know-how increased over the past 2 years
- Initial crack size and probability of detections difficult to derive
- Small fleet size (30) might lead to inaccurate statistical data

For the future
- Start early collaborations between operators and OEM
- Potential for being applied to support structural fleet integrity

Thank you for your attention 😊