



ALMA MATER STUDIORUM
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Analysis of Incident Occurrence Frequencies

ELVHYS Final Dissemination Conference

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Motivation

Providing input to a data basis for

- Identification of predominant failure systems
- Deduction of improvement measures with regards to safety
- Improvement of risk analysis in (L)H₂ installations

Methodology Challenges

- Identification of a sufficiently big set of input data
 - Access to a broad data base is paramount for statistical value (= getting the full picture)



- Comparability of data
 - Setting of comparison parameters was one of the most fundamental tasks in the beginning of the work

Choice of Data Sources

Different options have been analysed:

- HyCred (at the time of the analysis, it was not yet available to the public)
- HIAD (mainly major accidents with big consequences)
- Public databases on industrial incidents by Germany and USA (too few registered H₂ incidents, too big consequence threshold)
- NCR-database of DLR Institute of Space Propulsion (high relevance due to hydrogen installations, low threshold for entry, high number of reports)

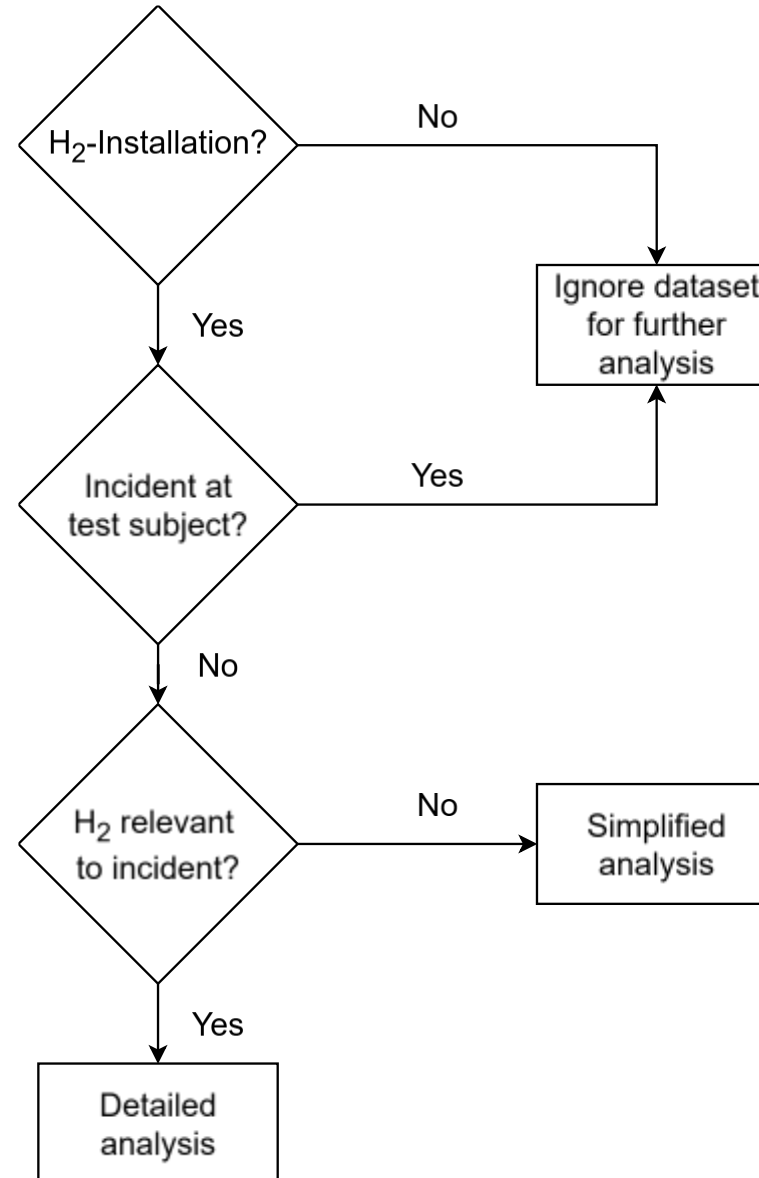
Parameters of the Analysis

Definition of relevant analysis parameters included:

- Phase state of H₂ the item was designed for:
Cryogenic; Gaseous; Mixed;
- Extent of the consequences of the incident:
Fatalities; Medical treatment required; Near miss; External repair support; Damage above normal wear and tear; Elevated risk level;
- Incident trigger in a statistically usable form:
Stationary equipment; Active equipment; Wrong handling; Force majeure;

Data Analysis Process

- Approximately 12'000 NCRs
- Stepwise analysis
 - H₂ -installation (ca. 12000)
 - Experimental activity (ca.11800)
 - H₂ -relevance for the incident (182)
 - Parameter analysis (199)

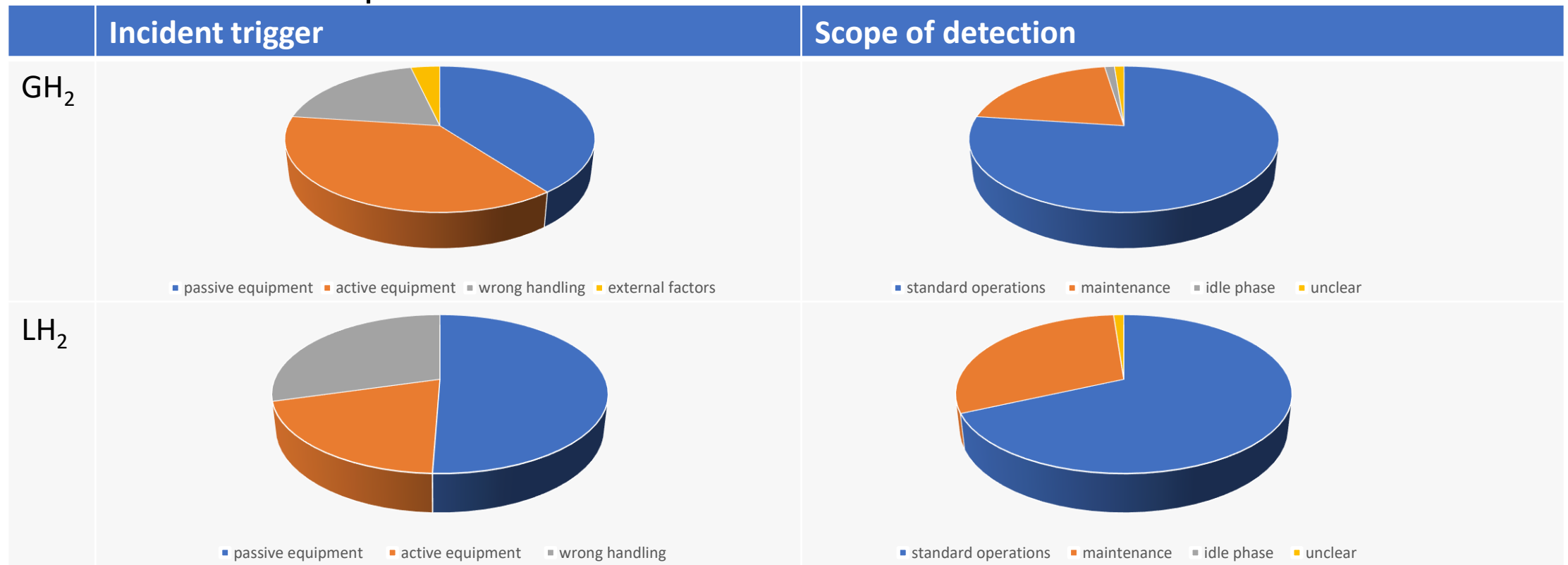


Result Analysis Keystones

- Simple methods for visualisation of the data:
Feasible for small data-sets, inappropriate for big data-sets
- Consideration of statistical significance:
Analysis question has to be relevant and answered based on sufficiently big data-sets
- Correlations and data subsets:
They can show trends, give hints for checking causations

Learnings from the Data

- Differences in safety parameters between GH₂ and LH₂ applications
 - Most frequent trigger of incident
 - Time and scope of incident detection



Future Analysis Questions

Future analysis of further data sets from independent installations should be conducted in order to work on the following topics:

- Are the most likely weak spots the same at other H₂ installations?
- Is the frequency of human error as triggering element comparable at different installations?
- ...

Learnings and Suggestions

Several requirements have been confirmed for analysis:

- Early definition of parameters is paramount (re-analysis of „time to fail“ was time-intensive)
- Heavy use of automated analysis tools is favorable for extensive analysis

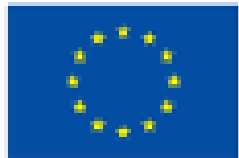
Different further work topics can be suggested:

- Use AI models trained with federated learning methods for future analysis for addressing confidentiality concerns
- Define/standardise a basic content for incident reports in order to simplify data integration



Thank you for your attention

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