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Transforming flare system performance and costs using dynamic digital twins

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Contents

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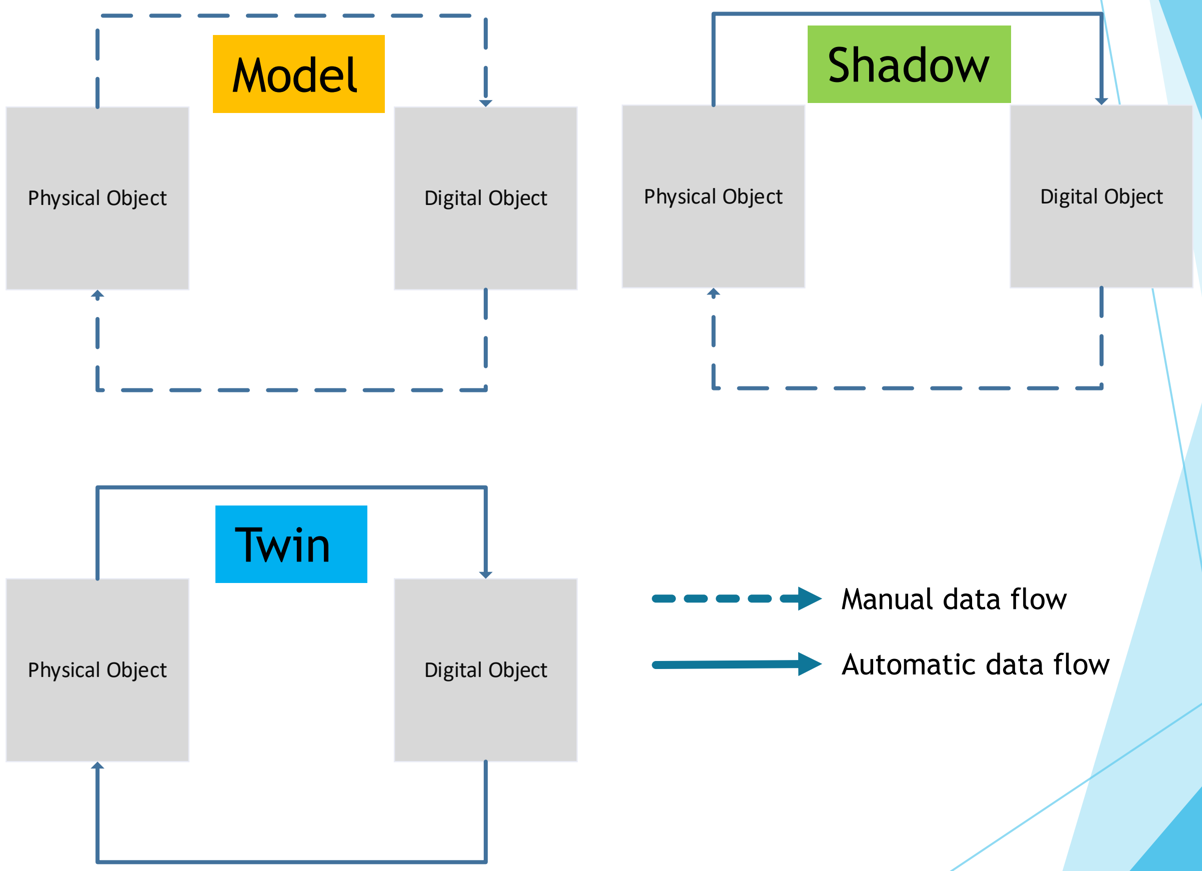
Digital Twin, Shadow or Model?

A ‘digital twin’ is a digital copy of a physical object collecting real-time data from the asset and deriving information not being measured directly in the hardware [1, 2]. Benefits include [4, 5]:

- Improved performance of assets;
- Reduce the likelihood of a major accident;
- Improvements on safety training, quality assurance, maintenance and inspection costs;
- Predict potential new changes in physical systems over time;

However, addressing as-built condition and changes in plant is a key challenge…..



Refer to Reference [3]

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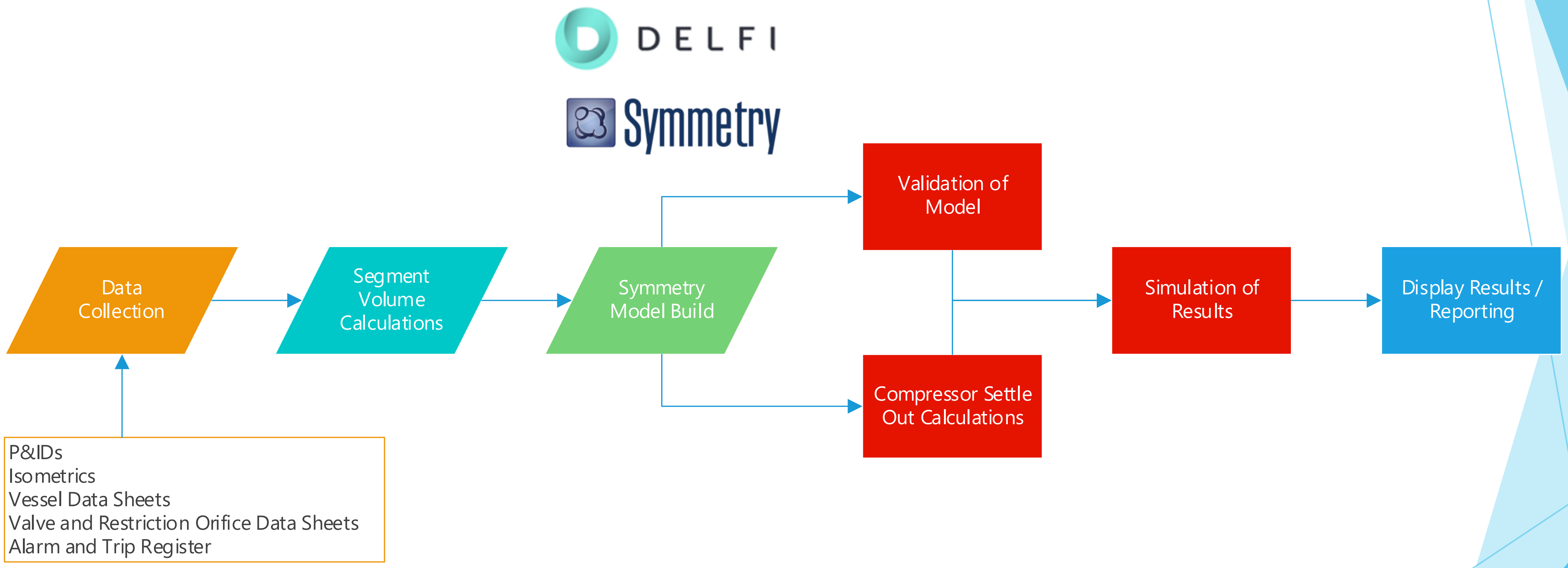
Building a Digital Twin



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Building a Digital Twin - Flare Assessment

RCLD were approached by an Operator of an Oil & Gas production platform in the UK North Sea to produce a dynamic digital model of the high-pressure flare network and system. The model was required to assess design limitations following proposed introduction of new subsea tie-backs and module:

- Maximum peak mass flow rates for coincident blowdown scenarios against a current design flare tip capacity of 140,000 kg/hr;
- Each individual blowdown segment performance standard criteria for safe depressurisation (API 521 requirements).
- Time-varying nature of Flare Event.
- Current software tools not able to model time-varying nature of relief and blowdown events.

Where design constraints were breached – recommend required design changes.

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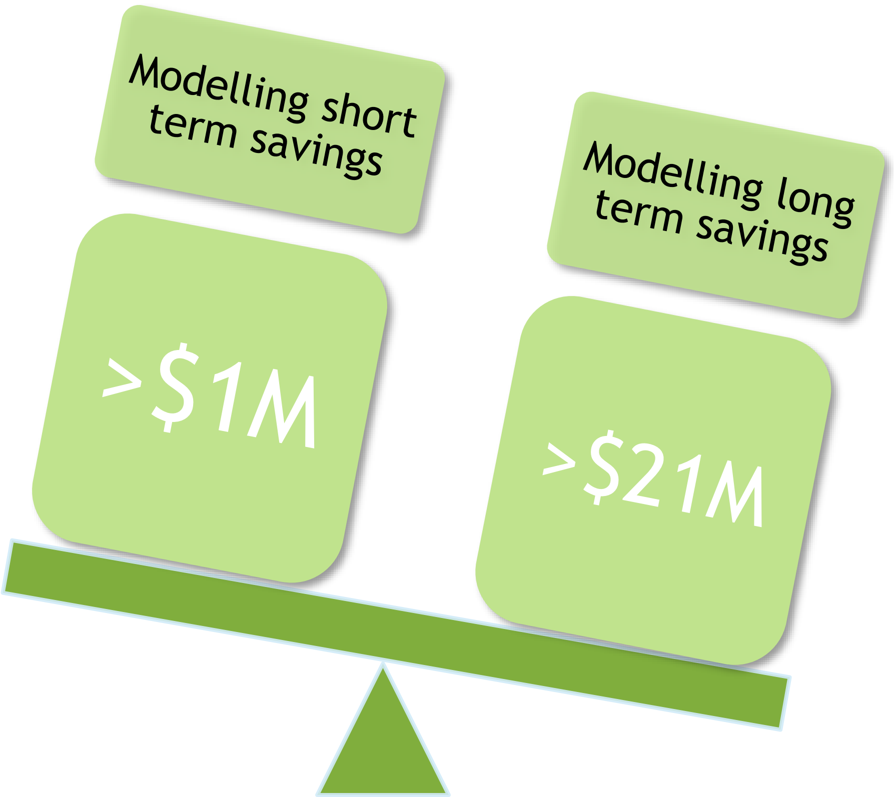
What was at Stake?

Over $1M project spend on radiation shielding in the short term.

Major flare boom re-design and constructions costs of over $21M in the long term.



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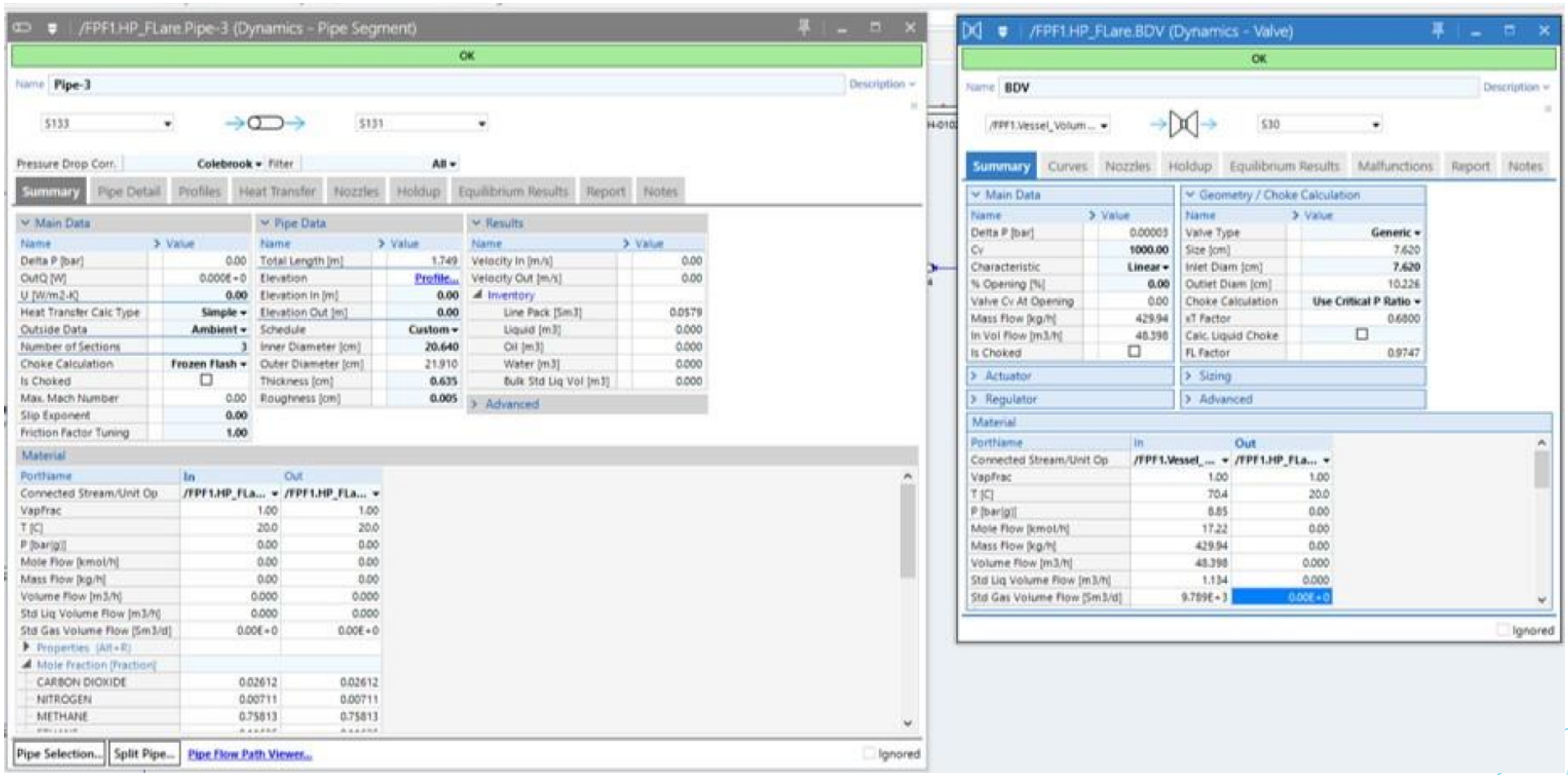
Digital ‘Twin’ - HP Flare System



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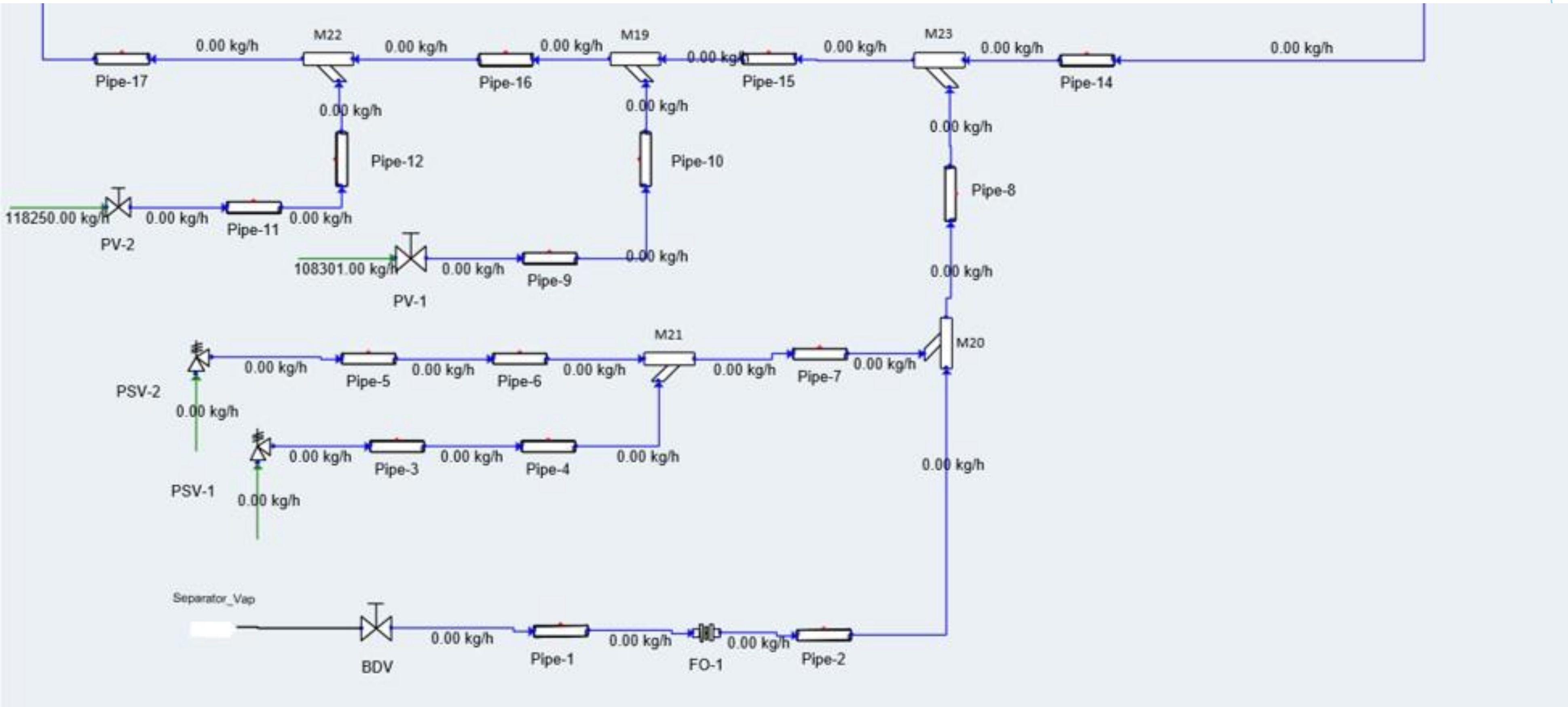
Digital 'Twin'- HP Flare System



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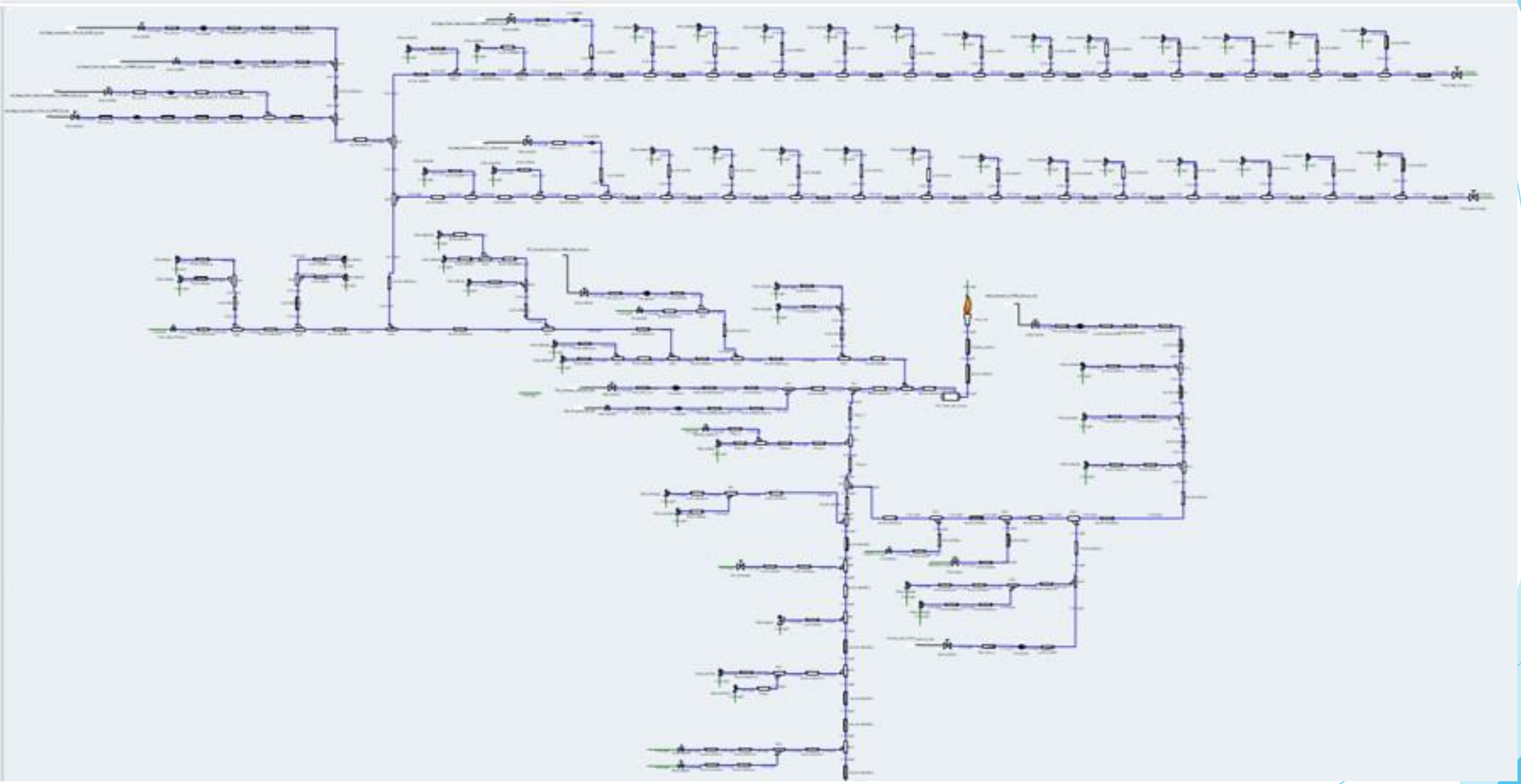
Digital ‘Twin’- HP Flare System



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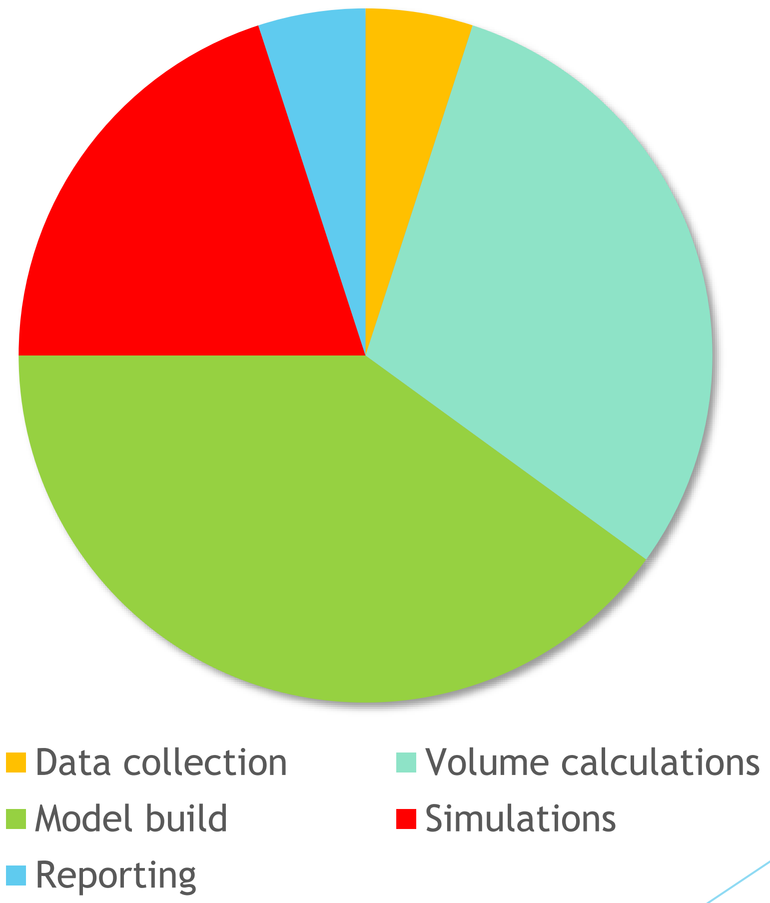
Building a Digital Model/Shadow

Typical Historical Data Sources Required:

- P&IDs
- Isometrics
- Vessel Data Sheets
- Valve and Restriction Orifice Data Sheets
- Line list (design constraints)
- Alarm and Trip Register
- Aspen HYSYS model
- Process Upset scenarios
- As built status of plant
- Historian data



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Flare Assessment – Challenges

Challenges:

- Peak mass flows were breaching the flare tip capacity of 140,000 kg/hr and radiation limits; duration unknown.
- Dynamic behaviour of the plant e.g. HP compressors upon shutdown do not blowdown at the HP trips but instead at settle out conditions.
- Liquid levels and heat inputs.

Solutions:

- Dynamic modelling of the HP Flare System allowed for flare packing to take place. Flare packing enables the inflow to be delivered throughout the system – currently unique to Symmetry.
- The settle-out behaviour of the HP compressors was modelled dynamically using Symmetry where each compressor blowdown segment was isolated at the inlet and outlet SDV's.
- The heat inputs were determined as per API 521 for the two cases; with and without prompt firefighting and adequate drainage.

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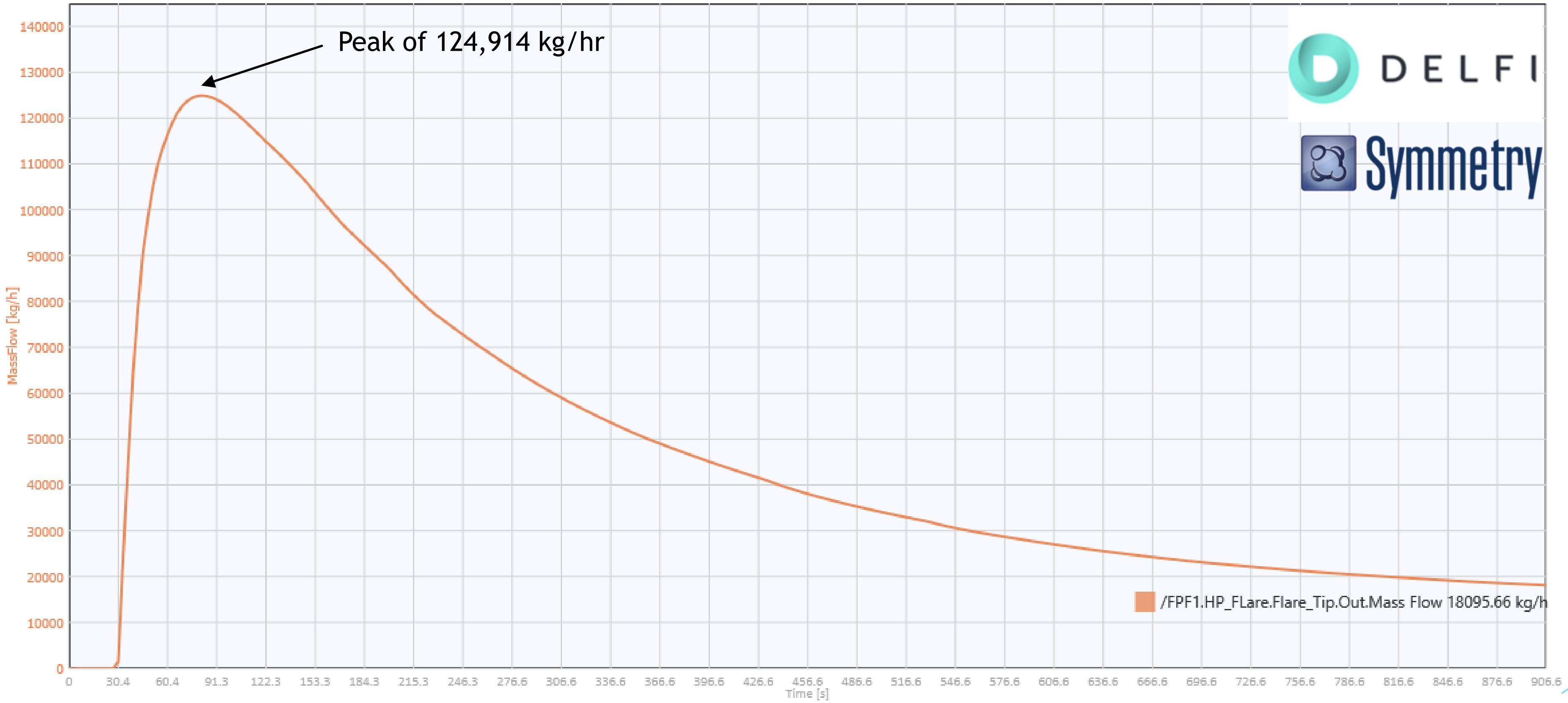
Flare Assessment – Results



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Conclusions

- Digital Twins, Shadows and Models have different characteristics
- Building a Digital Twin takes time and a variety of data inputs.
- Dynamic modelling in Symmetry accounts for flare packing and realistic mass flowrates at the flare tip.
- Hydraulic and Radiation limits in **API 521 all achieved.**
- Digital Twins create value - **No modifications to the existing plant needed saving >$20M.**

Q&A

Thank-you

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References

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[2] - Wanasinghe, T., Wroblewski, L., Petersen, B., Gosine, R., James, L., De Silva, O., Mann, G. and Warrian, P., 2020. Digital Twin for the Oil and Gas Industry: Overview, Research Trends, Opportunities, and Challenges. *IEEE Access*, 8, pp.104175-104197.

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[5] - Madni, A., Madni, C. and Lucero, S., 2019. Leveraging Digital Twin Technology in Model-Based Systems Engineering. *Systems*, 7(1), p.7.

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