



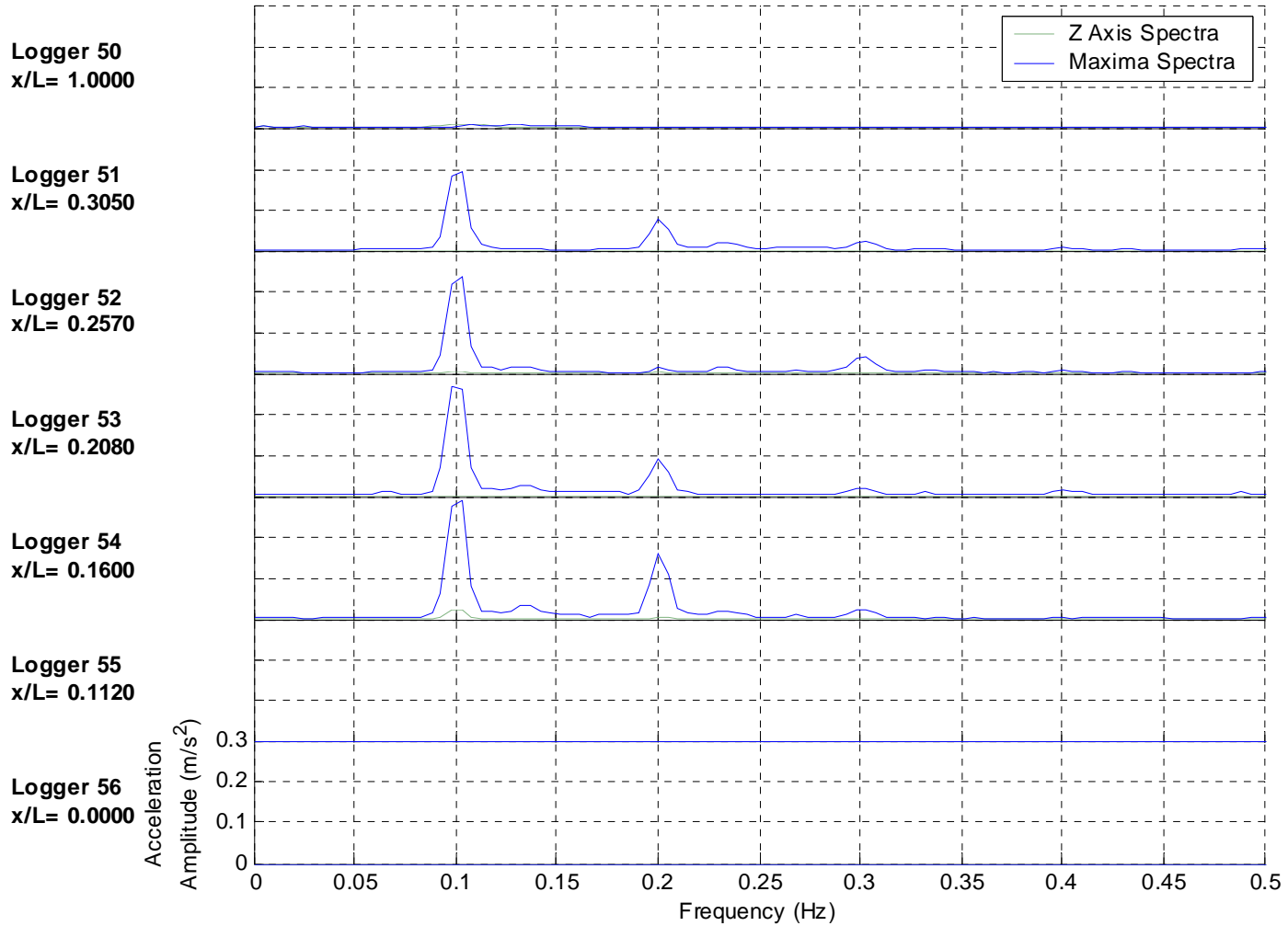
Higher Harmonics

- DeepStar test results should cause considerable concern
 - 3f and 5f harmonics
 - Fatigue damage 10-30 times primary cross flow responses
- Are these results applicable to real risers?



Drilling Riser Response

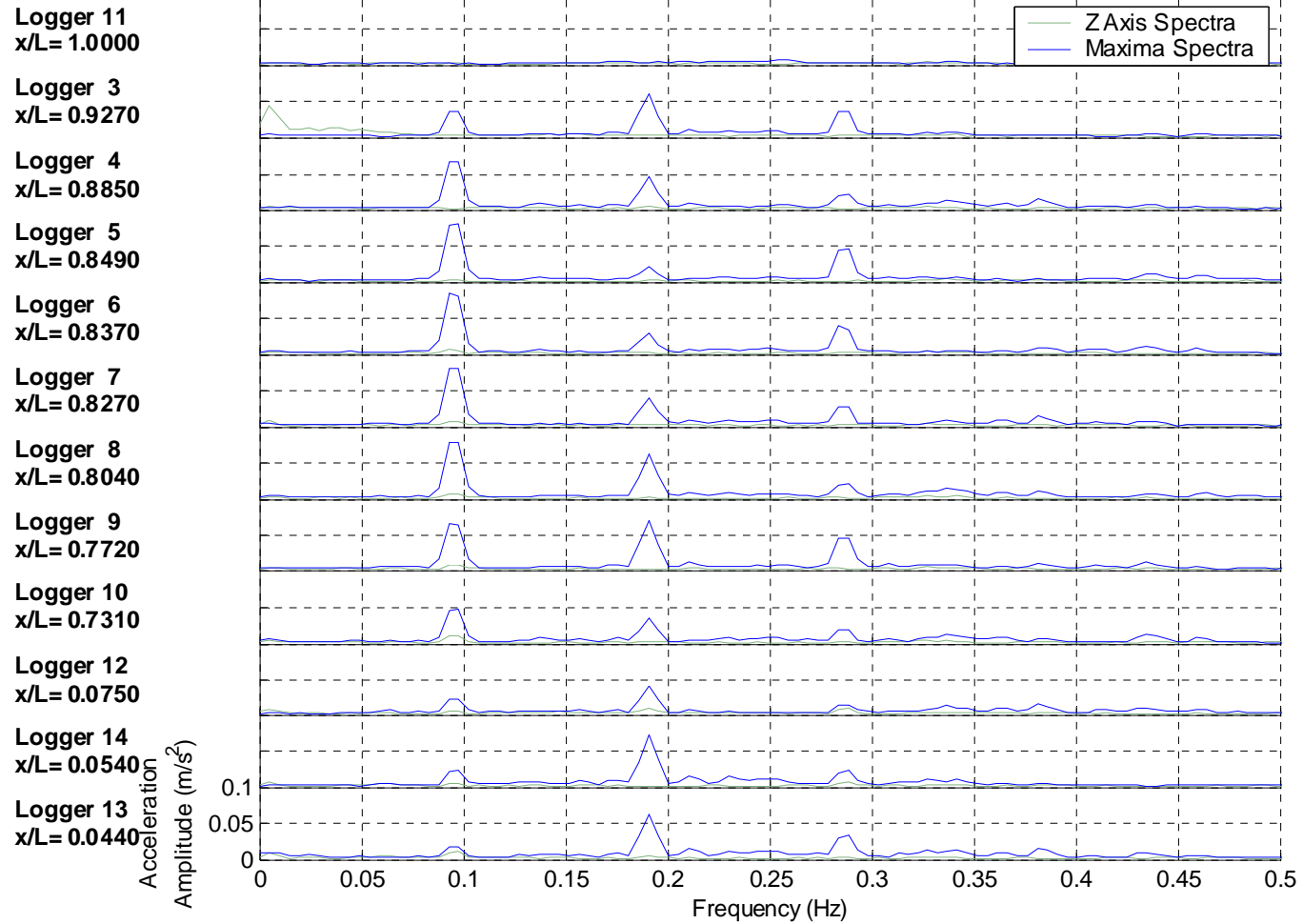
Schiehallion Event 601 - Magnitude of Peak Response vs. Frequency





SCR Response

Allegheny Event 86 - Magnitude of Peak Response vs. Frequency



Higher Harmonics

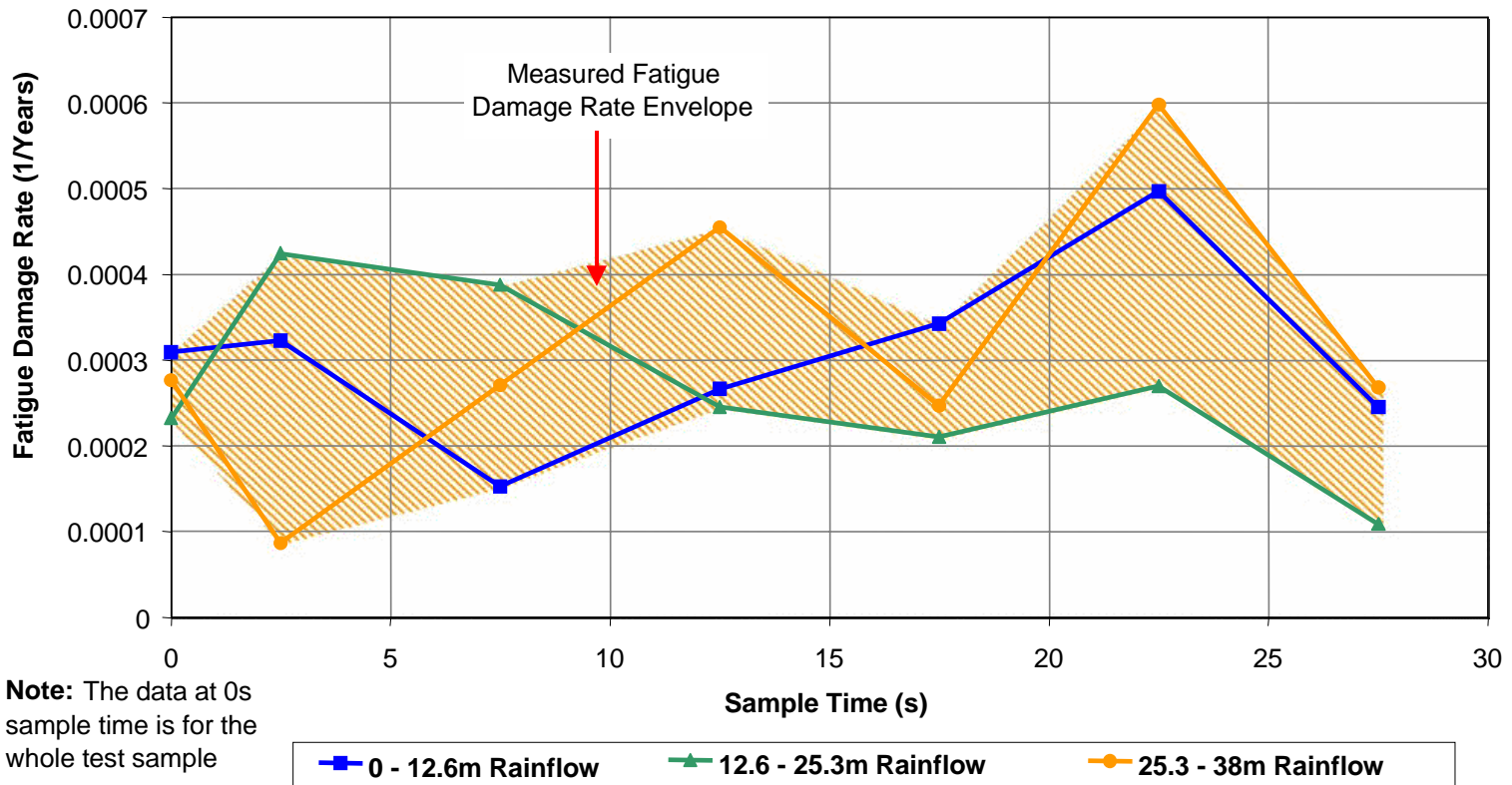
- DeepStar test results should cause considerable concern
 - 3f and 5f harmonics
 - Fatigue damage 20-30 times primary cross flow responses
- Are these results applicable to real risers?
- Yes, but how severe?
 - Drilling riser – low
 - SCR – medium
 - Drill string – medium
 - NDP high mode/DeepStar - high
- How variable from riser type to riser type and one flow regime to another?
- Implied need to measure response of different riser types

Variability in Response

- Field measurements show high variability in response
- Tests also show high variability
- What is the extent of variability?
- What is an appropriate measure of response?
 - Some sort of mean and maximum variation
- Significance of the variability
 - Averaging can underestimate fatigue
- How should this be captured by design software?

Fatigue in Uniform Flow

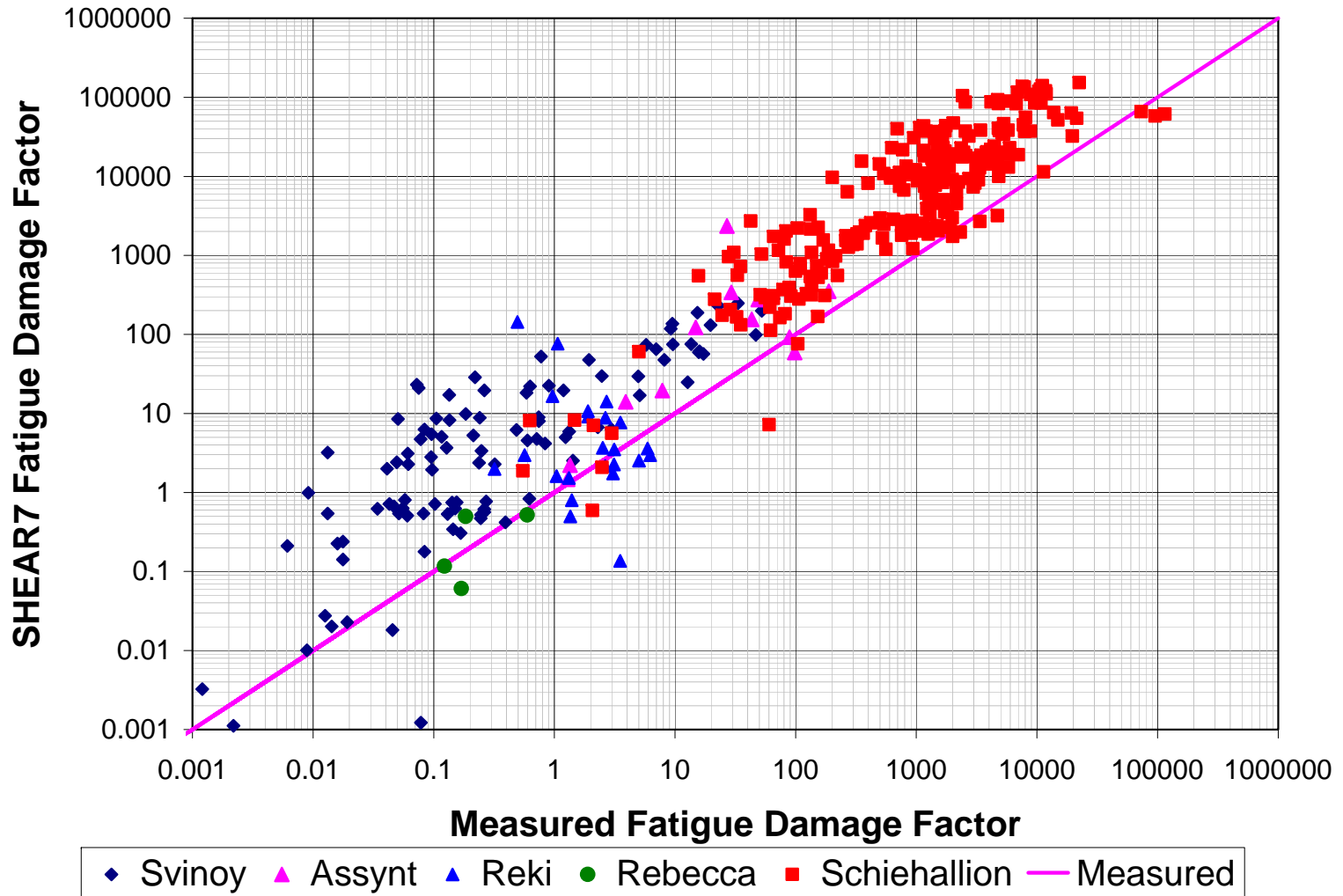
NDP High Mode VIV Test Data
Measured Cross Flow Fatigue Damage Rate Envelope



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Fatigue Damage Overprediction



Data Required

- More data required from real risers
 - Unsuppressed?
 - Different types
 - Suggestions - P18 SCR

- Suppression - infinite possibilities
 - Field data shows strakes to be hugely effective
 - Agreement on targets may be difficult

- Monitoring Methods
 - Rationalise cost to improve breadth
 - On-line needed?
 - Characteristics from tests to date may be inferred

Design and Safety Factors

- Safety factor of 10, 20 – enough or too much?
- Need to tie together:
 - Variability
 - Accumulation
 - Higher harmonics
 - Analysis methods
 - Safety factors
- Need to close loop in an iterative manner, with urgent attention to first loop