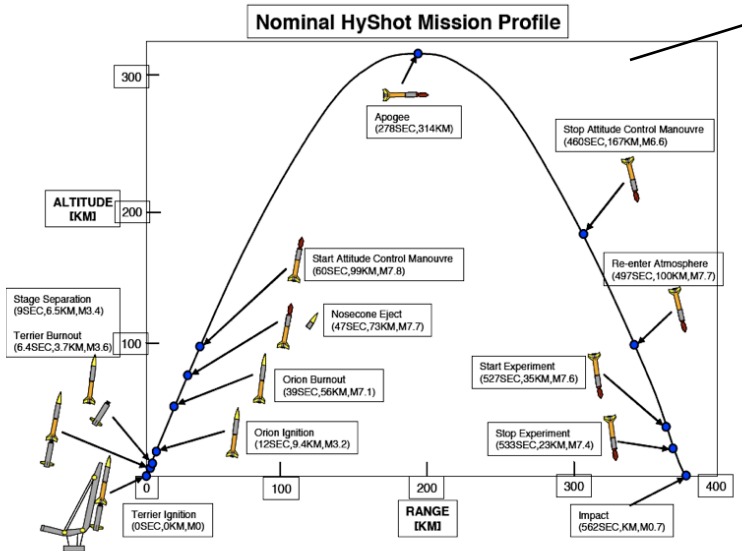
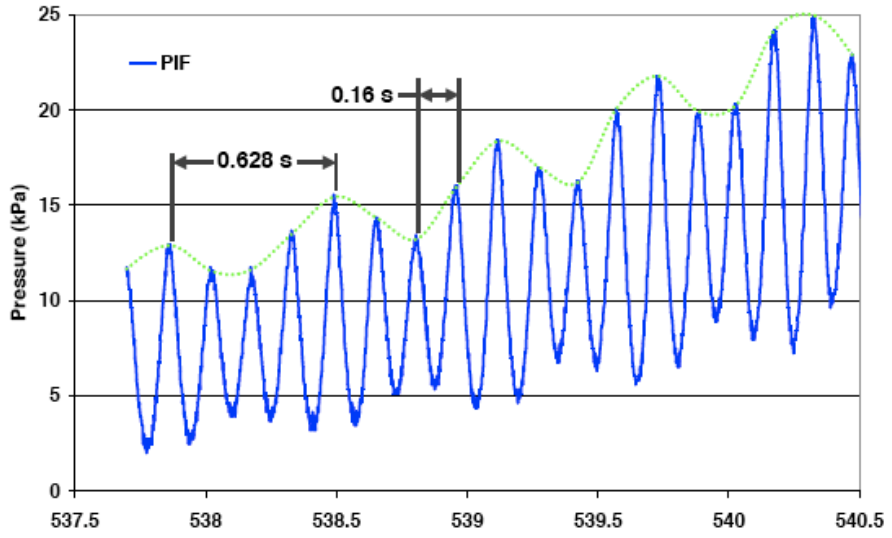
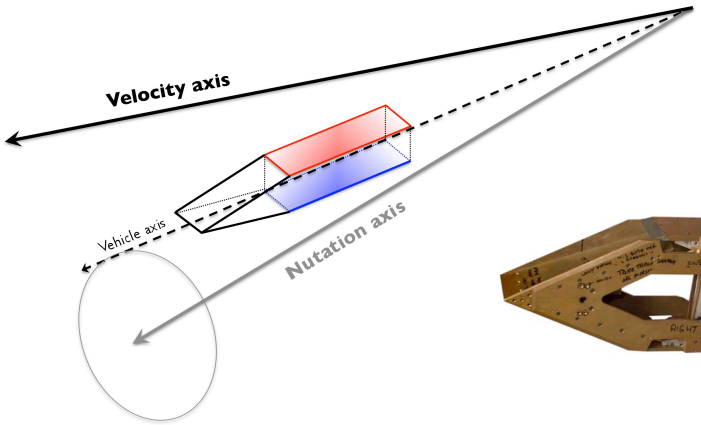
HyShot II – Flight Data Validation (revisited)

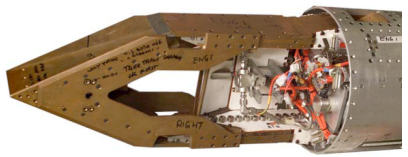
The flight conditions are **UNKNOWN**.

Extensive analysis by the Australian team attempted to back the flow conditions from a model of the trajectory!





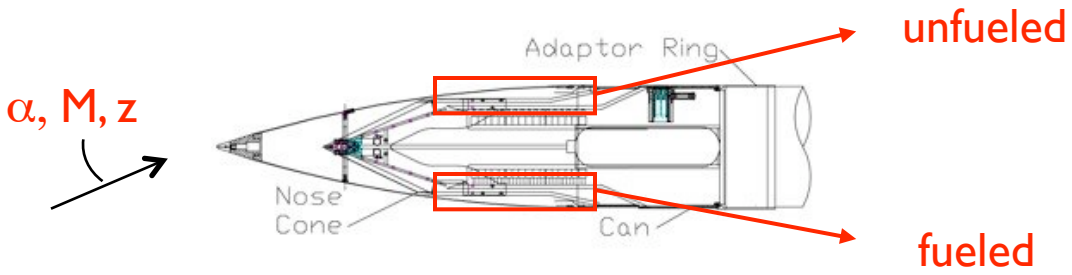




HyShot II – Stochastic Inverse Problem

Our approach is based on inference; we solve a stochastic inverse problem (Bayesian)

Observation: two chambers are present (fueled and unfueled data)

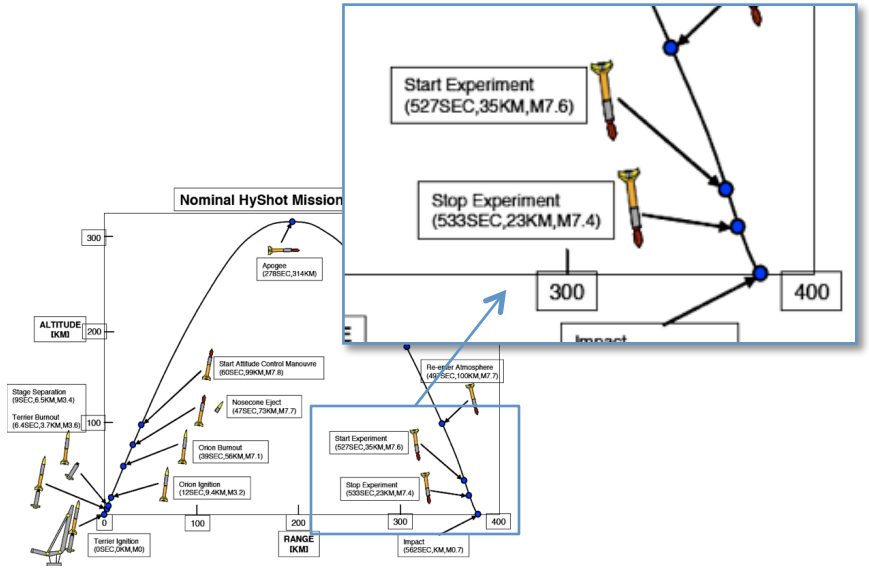


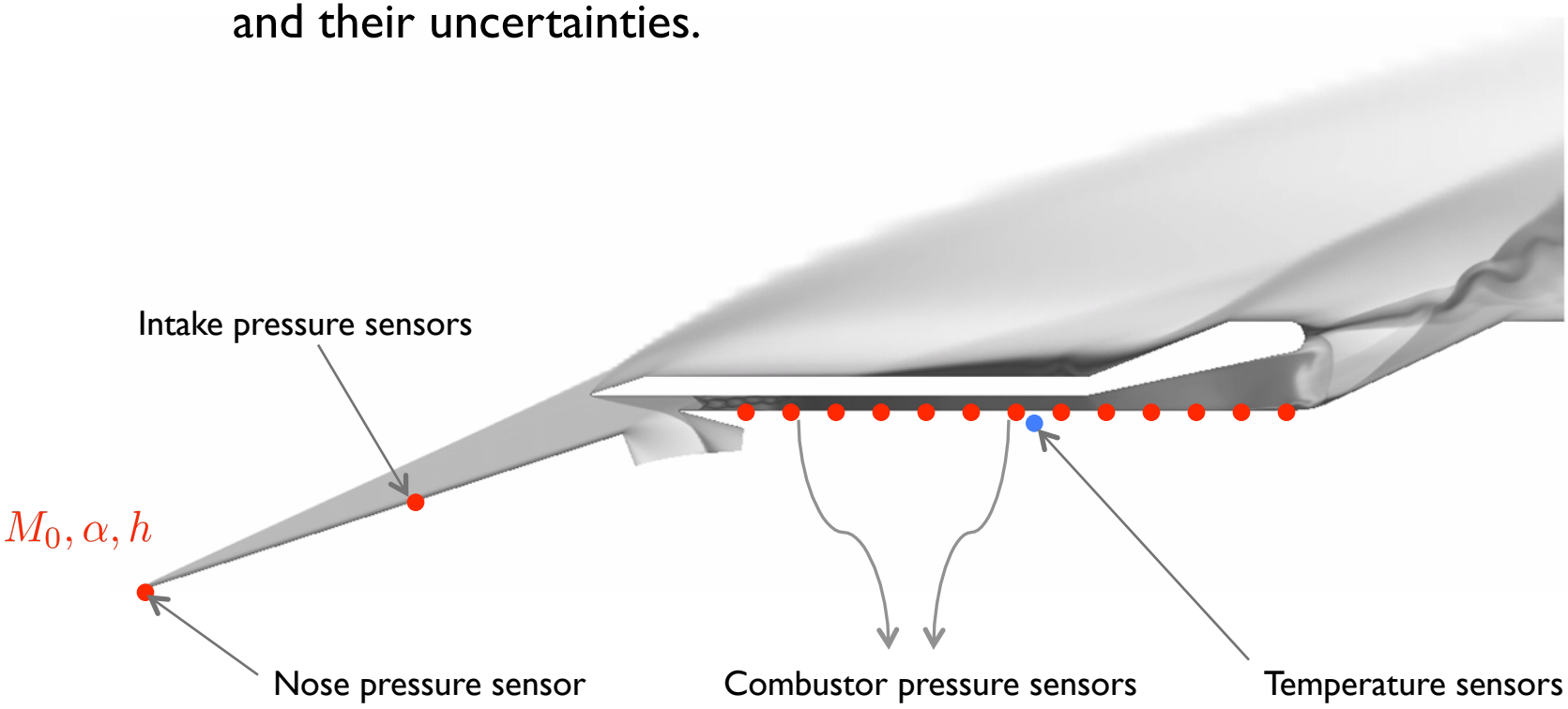
1. Build a forward model for the unfueled combustor
2. Use measurements to infer the flight data (conditioned by the forward model)
3. Predict the fueled side of the engine

HyShot II – Flight Data

Given noisy measurements of pressure and temperature infer:

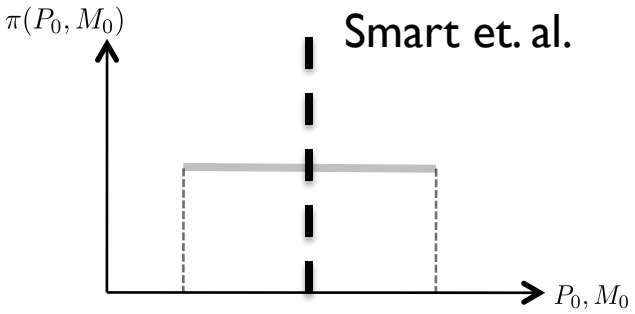
- Flight Mach number
- Angle of attack
- Vehicle altitude and their uncertainties.



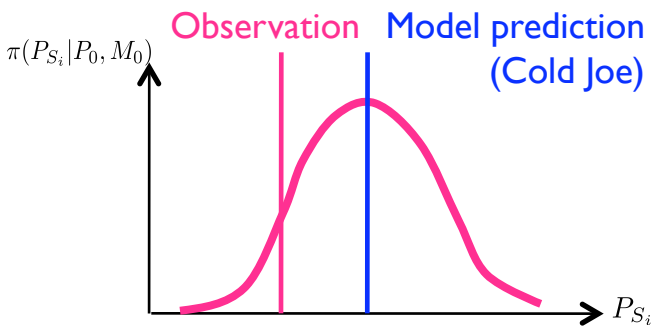


HyShot II – Bayesian Estimation

Prior distribution of parameters



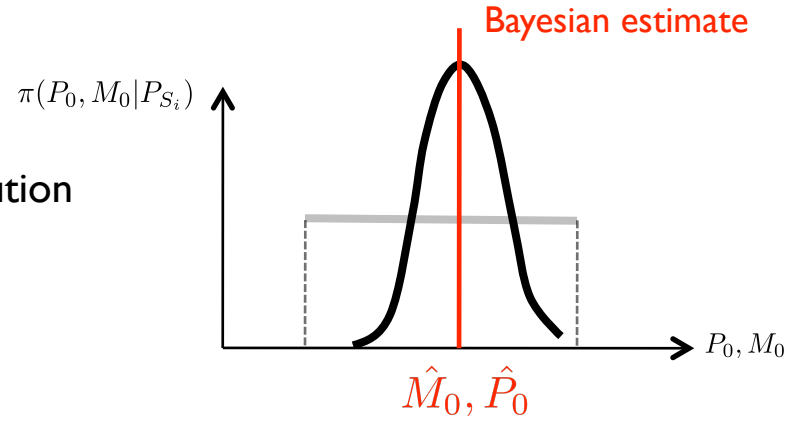
Measurement Uncertainties



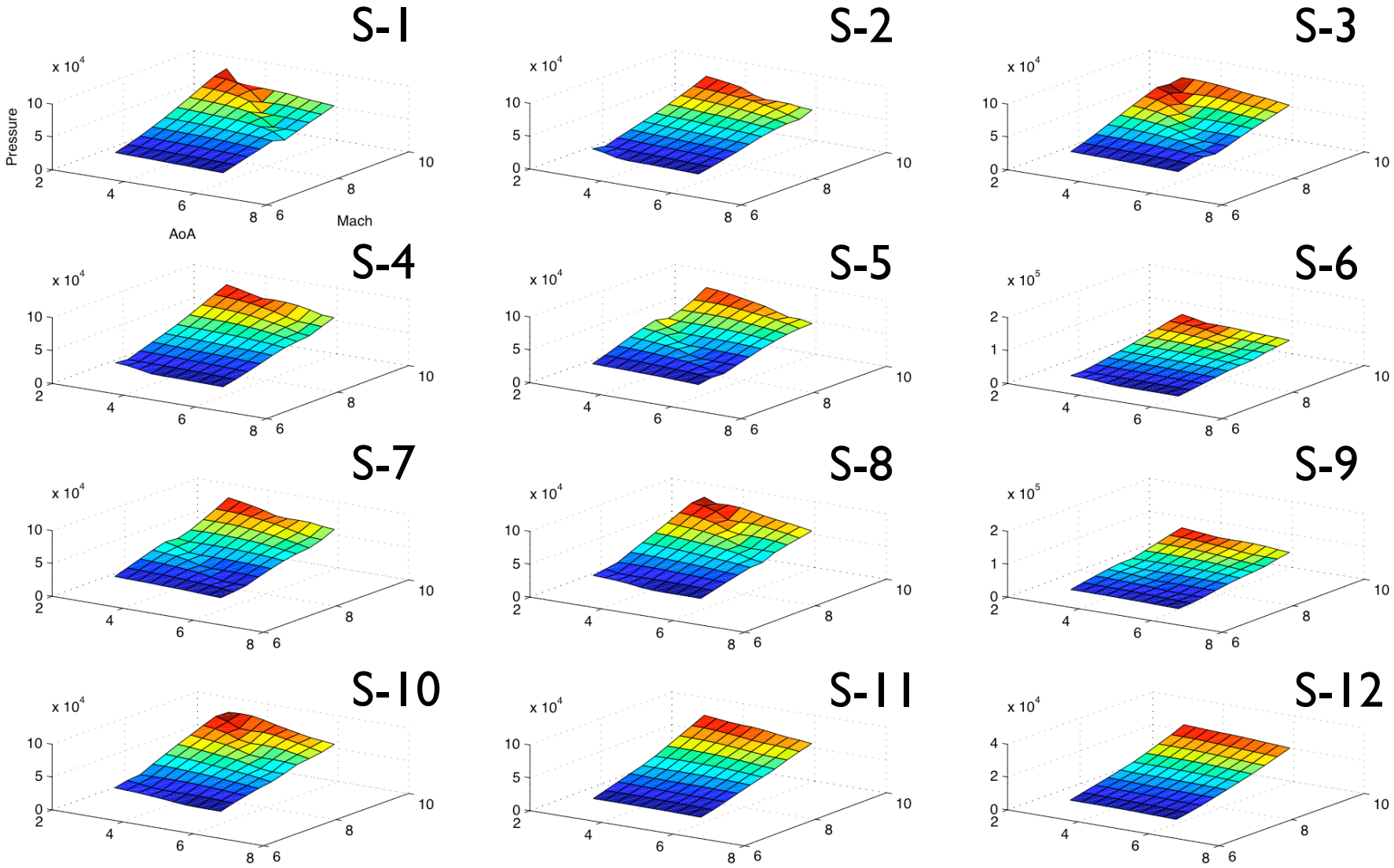
Bayes' Formula

$$\pi(P_0, M_0|P_{S_i}) \propto \pi(P_0, M_0).\pi(P_{S_i}|P_0, M_0)$$

Posterior distribution of parameters

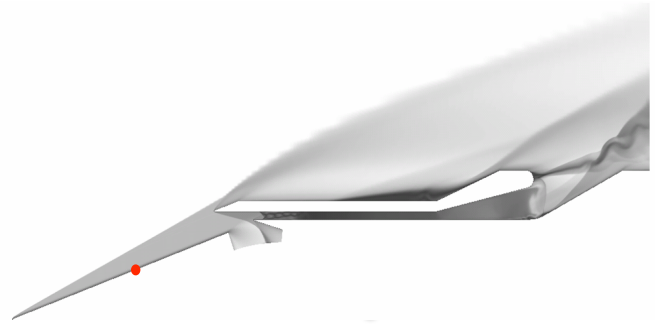


HyShot II – Forward Model

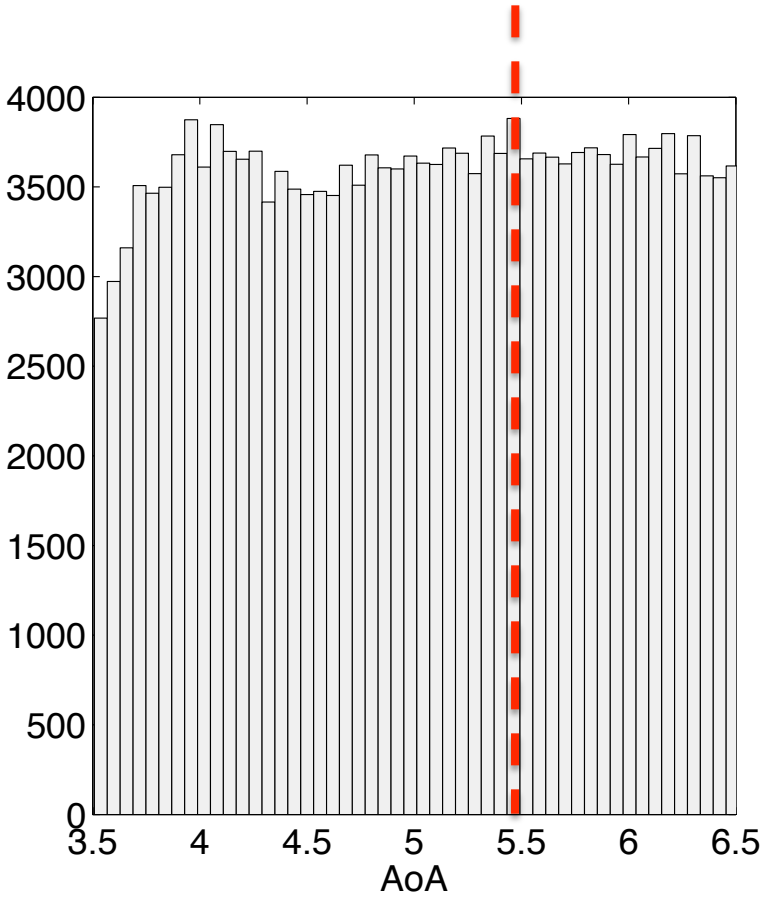


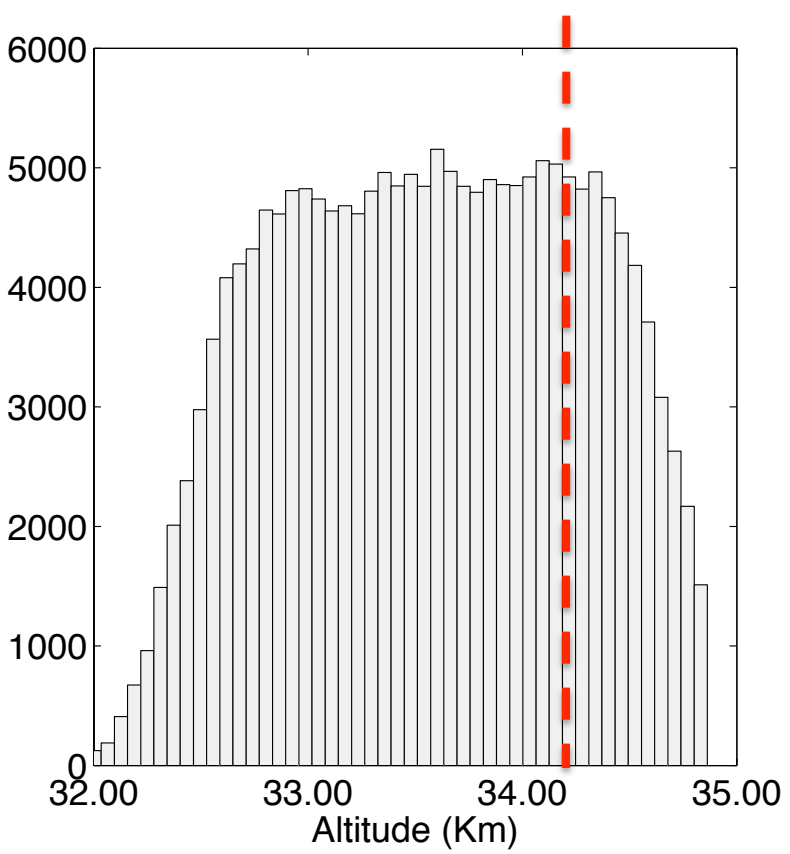
Computed pressure as function of flight Mach # and AoA (Fixed h=32km)

HyShot II – Inverse Analysis



Posterior Distributions





Intake Sensor

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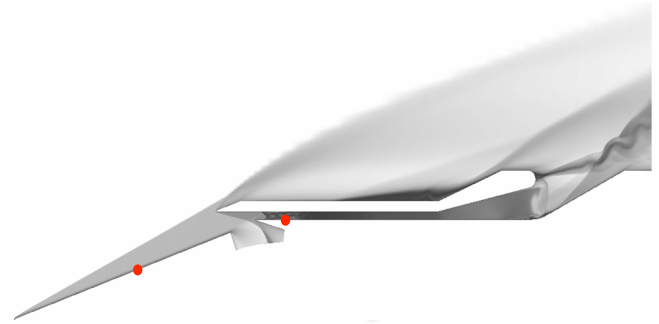
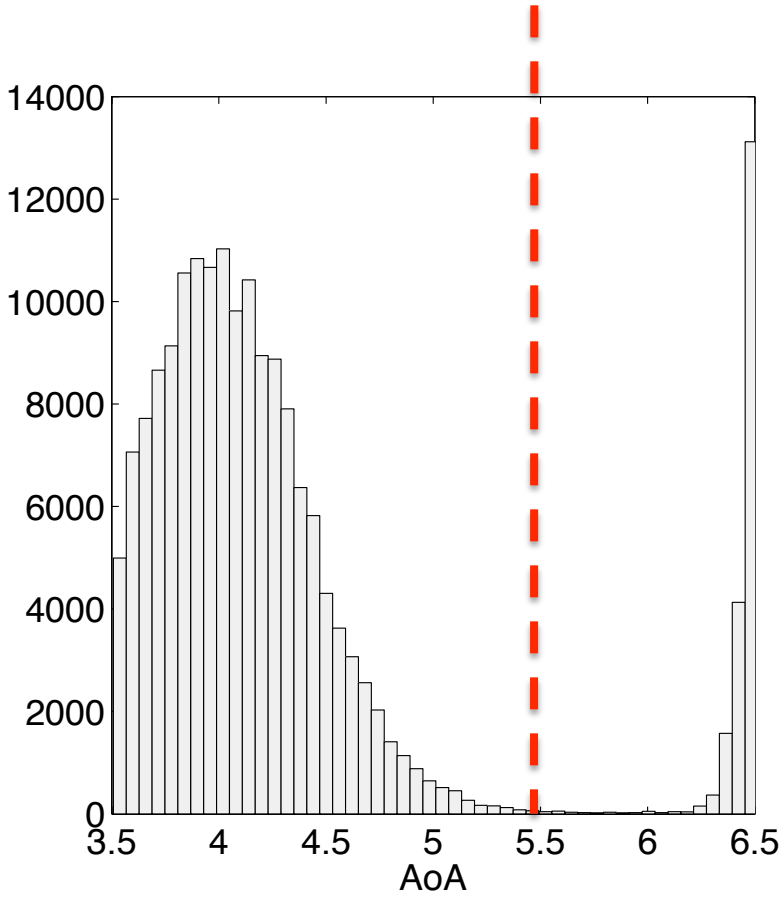
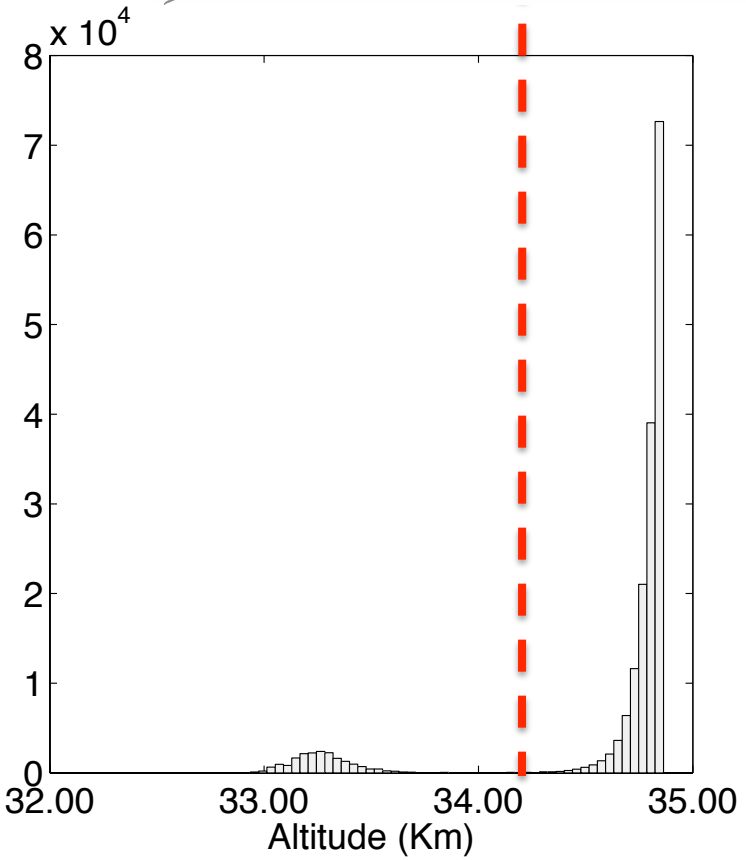
HyShot II – Inverse Analysis

Posterior Distributions







Intake Sensor + 1 Combustor Sensor

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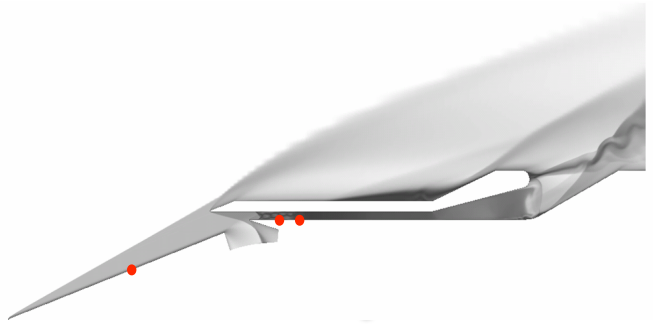
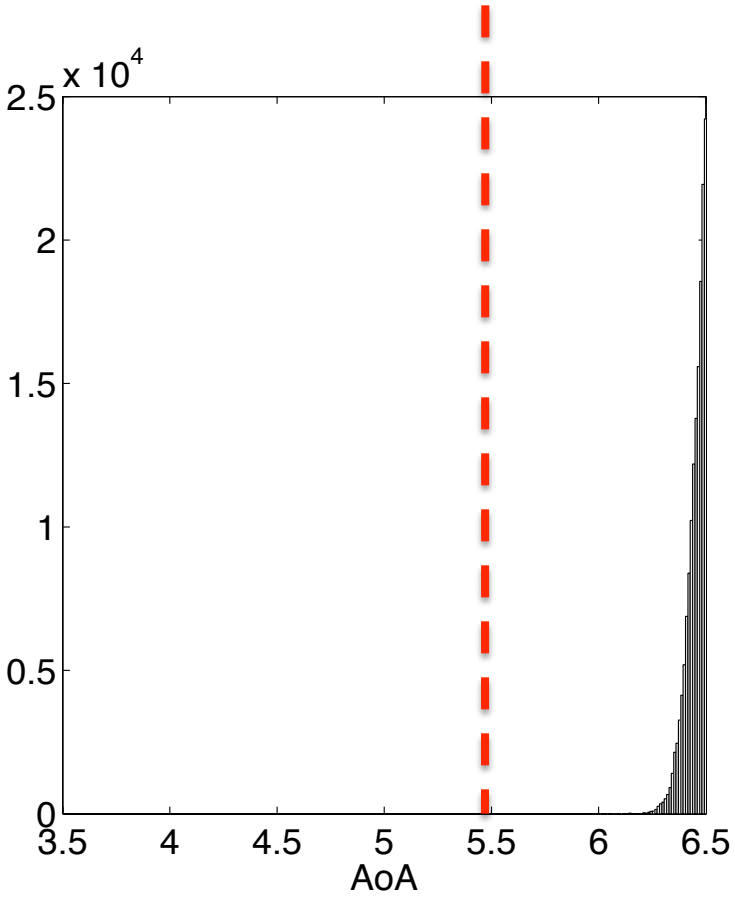
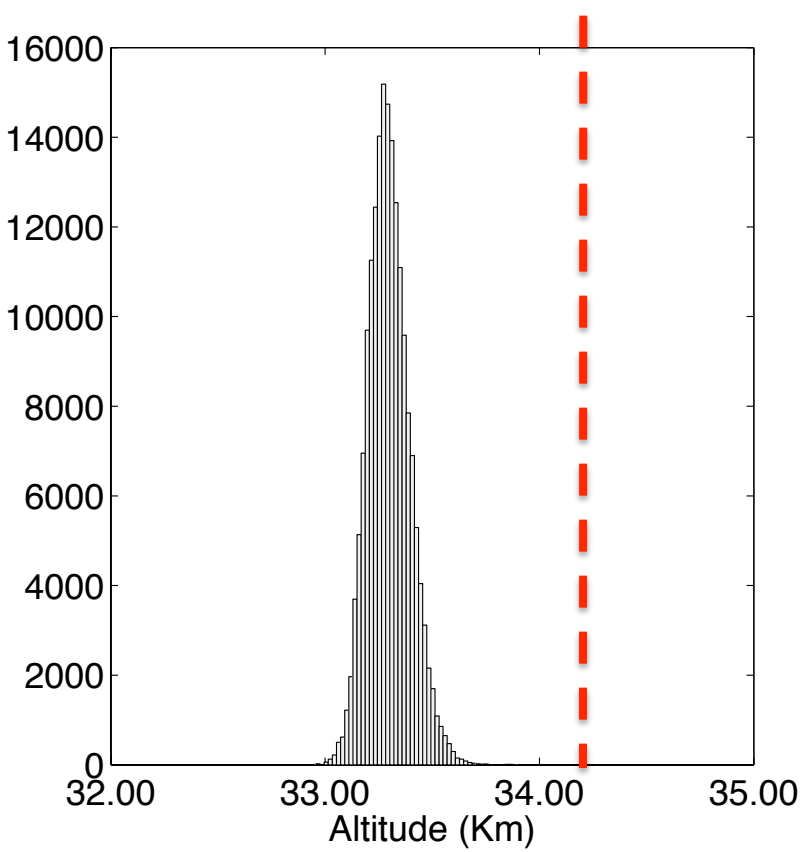
HyShot II – Inverse Analysis



Posterior Distributions





Intake Sensor + 2 Combustor Sensors

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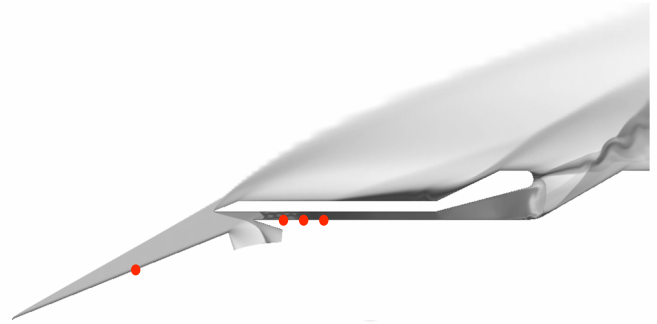
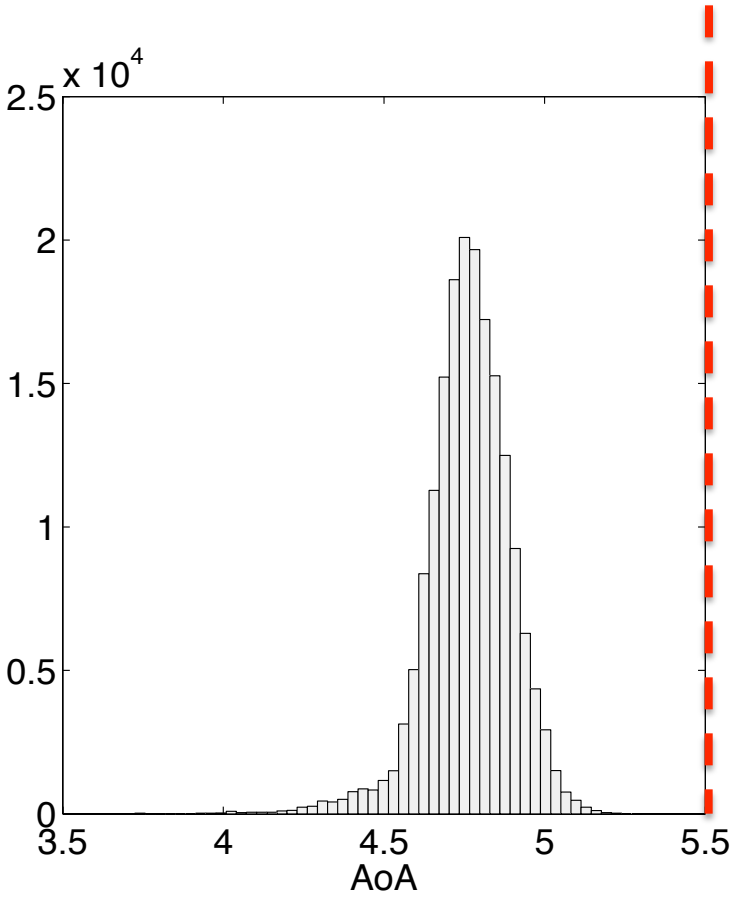
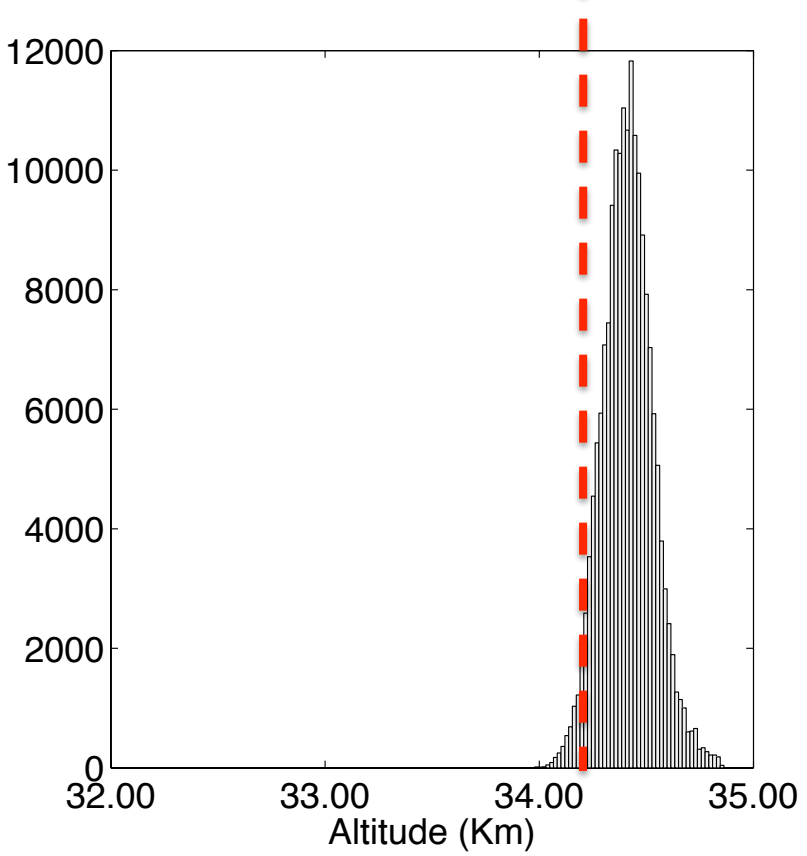
HyShot II – Inverse Analysis



Posterior Distributions





Intake Sensor + 3 Combustor Sensors

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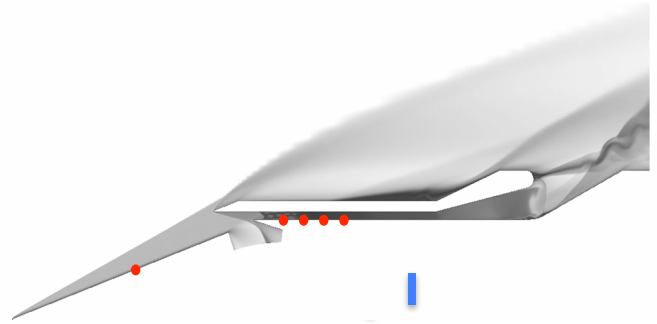
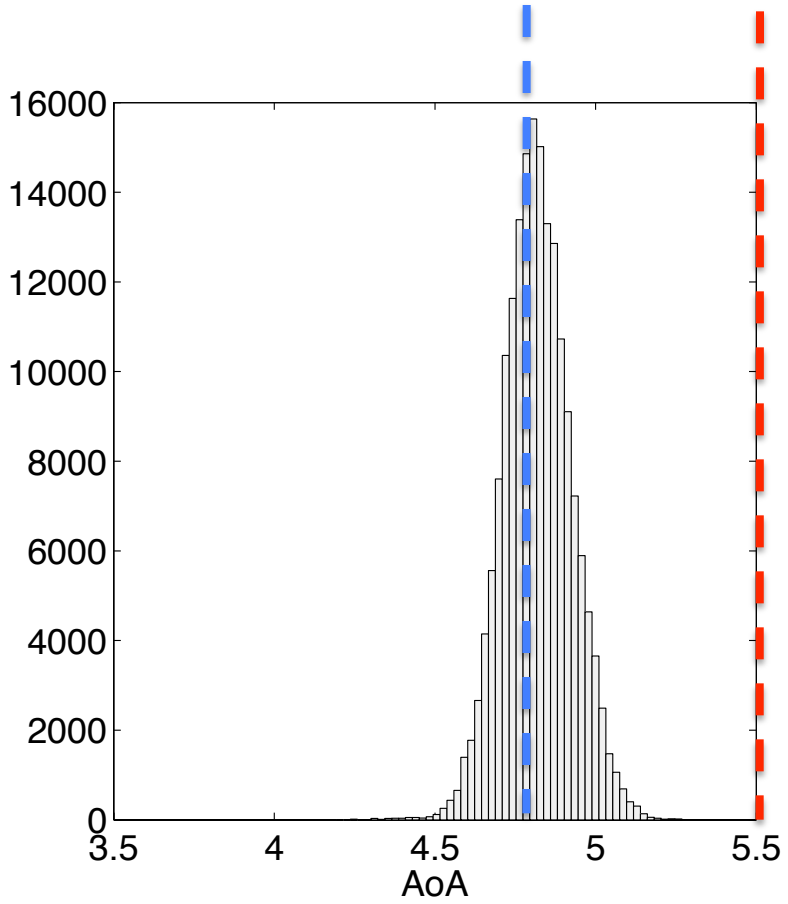
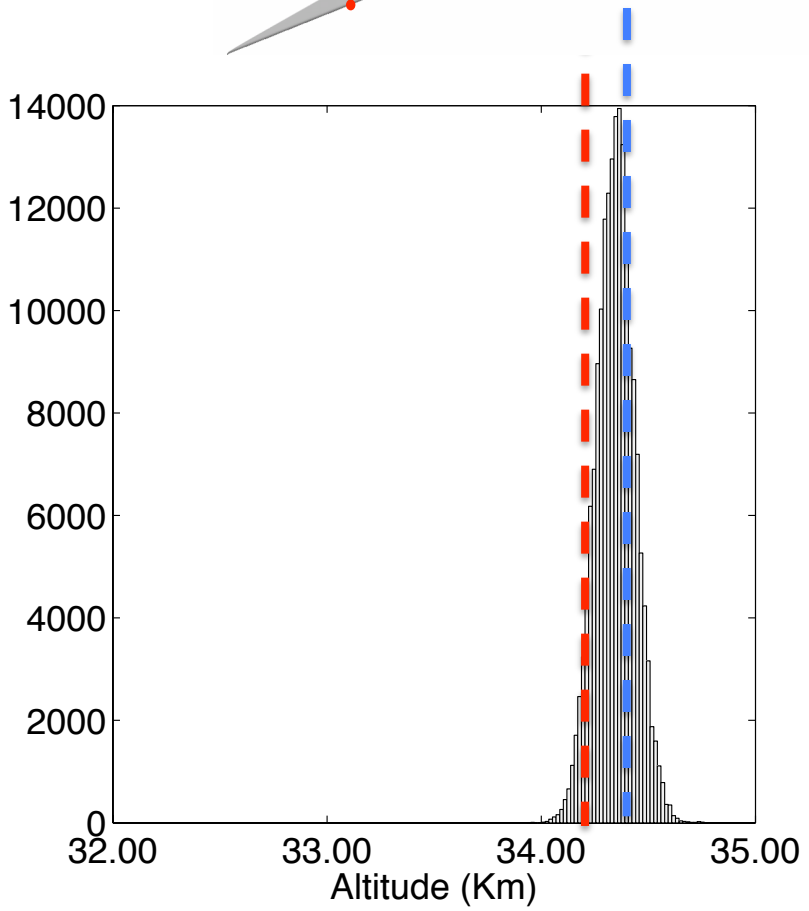
HyShot II – Inverse Analysis



Posterior Distributions





Intake Sensor + 4 Combustor Sensors

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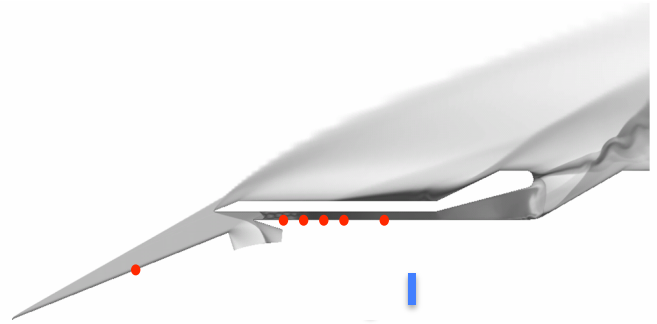
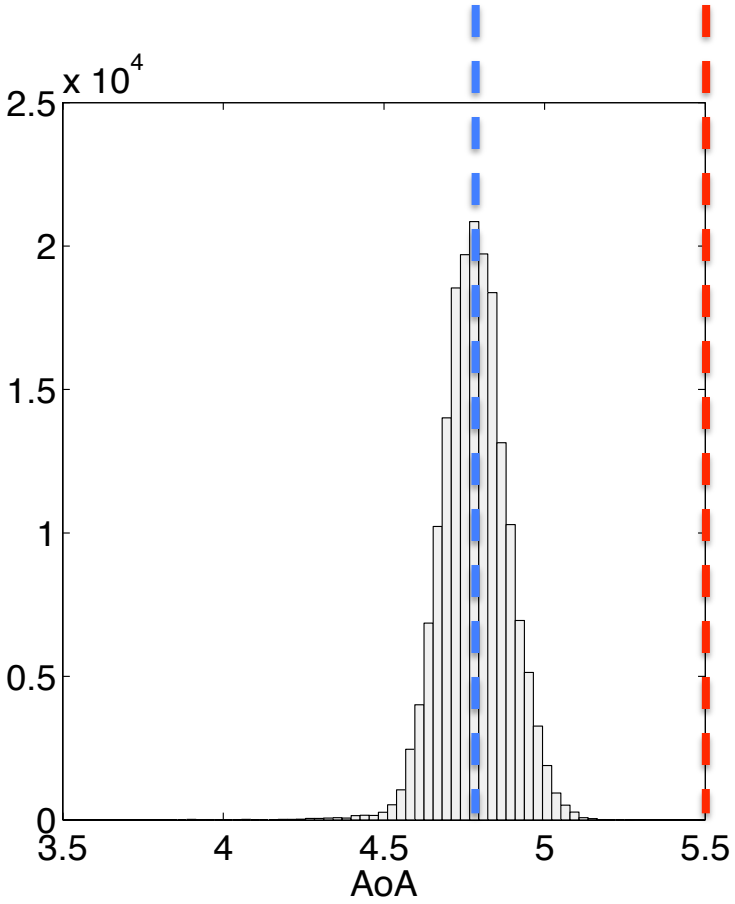
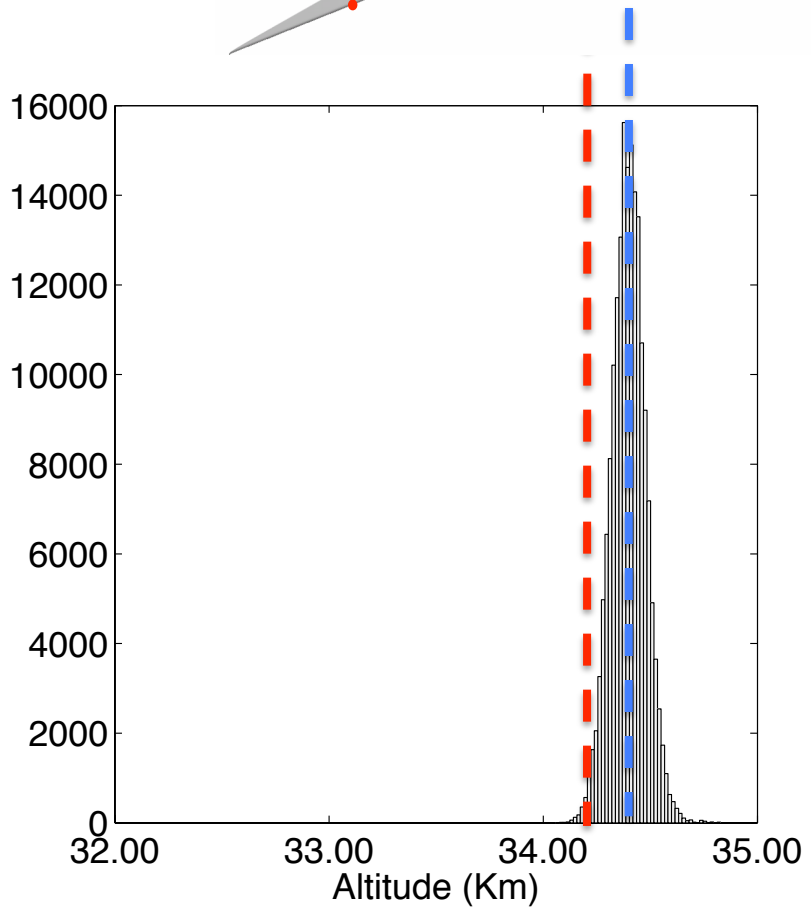
Bayesian

HyShot II – Inverse Analysis



Posterior Distributions





Intake Sensor + 5 Combustor Sensors

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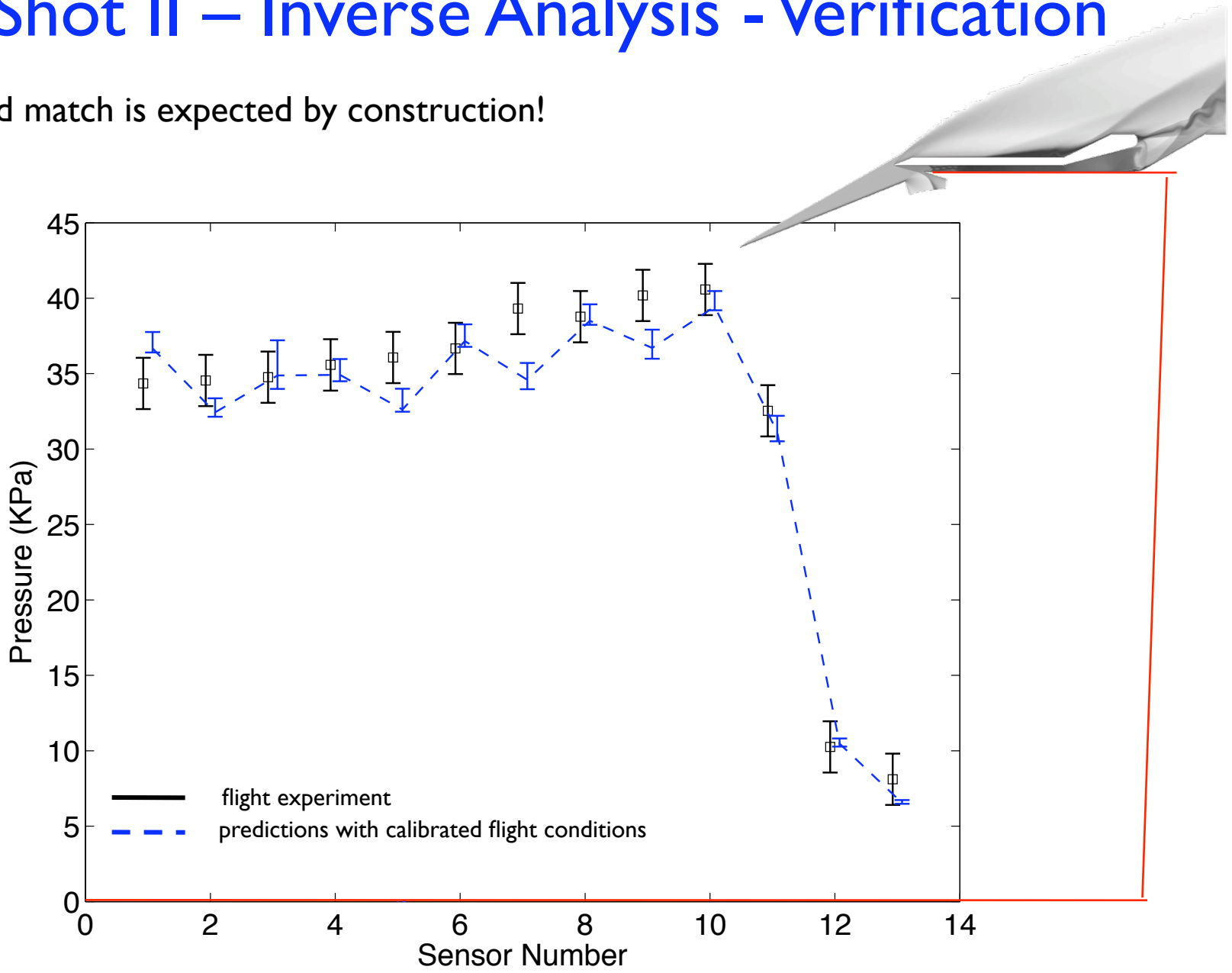
Bayesian

HyShot II – Inverse Analysis - Verification

A good match is expected by construction!



HyShot II – Inverse Analysis - Verification