Engine Dynamic and NVH Simulation in ADAMS

Yeongching Lin, Ph. D.
Neal Berner
Mike Aimone
FORD Motor Company

ADAMS User's Conference 1999 in Berlin

Dynamic Analysis Capability

* Crank/Block Dynamic Analysis
* Timing Chain Dynamics
* Valve Train Dynamics
* Front End Accessory Belt Drive Tool

Objective

- To Provide engineers with the capability to analytically evaluate the engine dynamics and NVH performance.
- Reduce development cost and time
- Reduce warranty cost

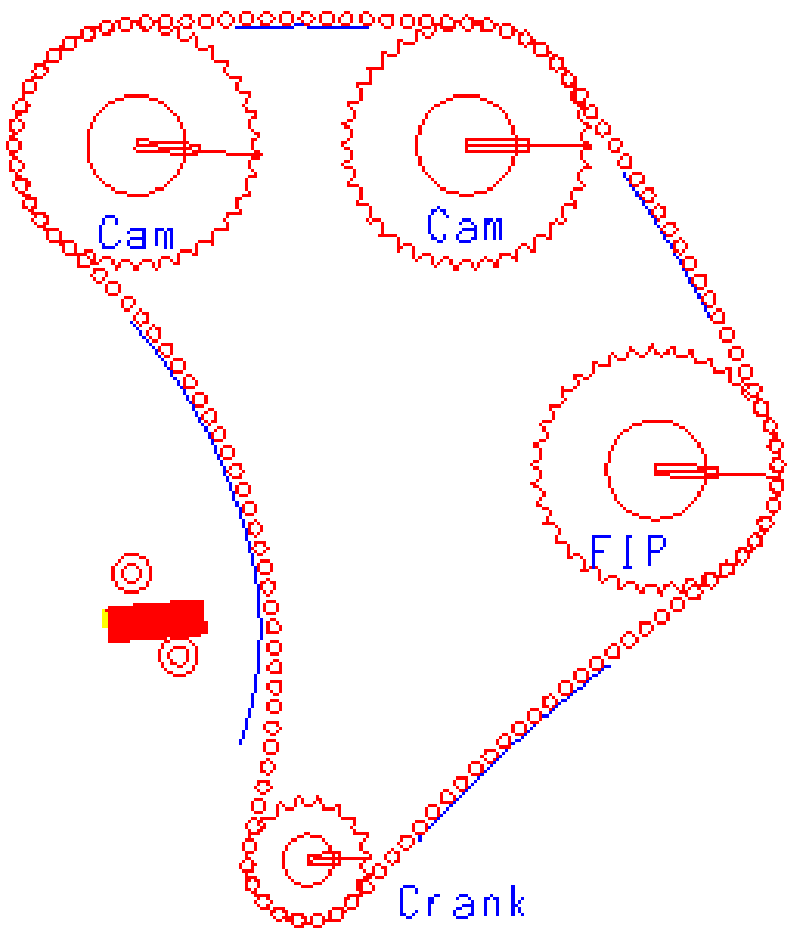
Timing Chain System

* Hydraulic Tensioner
* Static and Dynamic Friction
* Chain Tension
* Roller Chain and Silent Chain
* Primary and Secondary Chain Drive System
* GUI Interface
* Transient and Steady-State Analysis

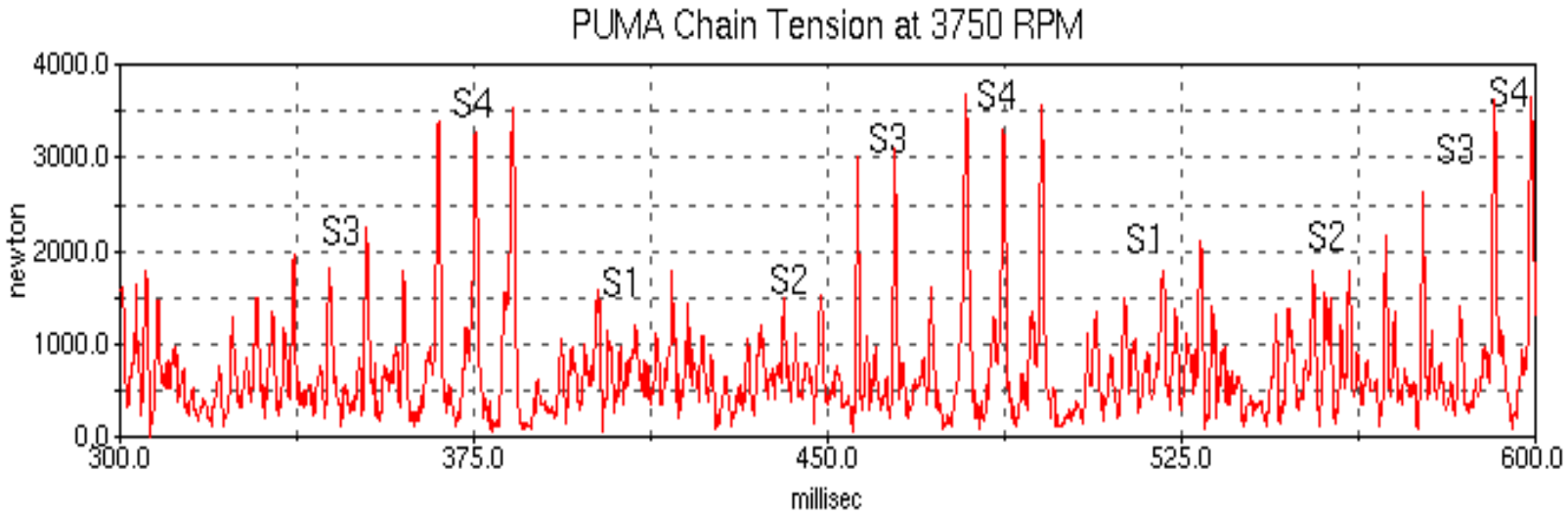
Chain Drive Application

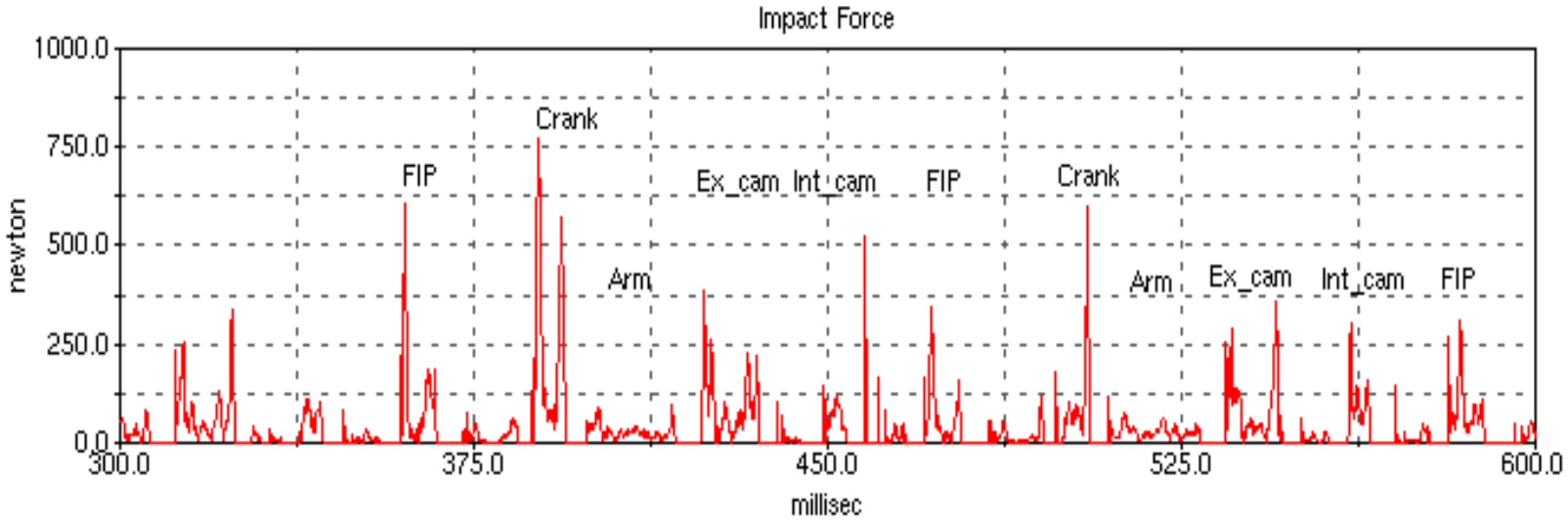
* Predict chain tension
* Calculate impact force to reduce face wear
* Chain noise prediction - transfer function
* Bearing Load calculation

Roller/Silent Chain System Validation



Puma Engine Chain Drive System

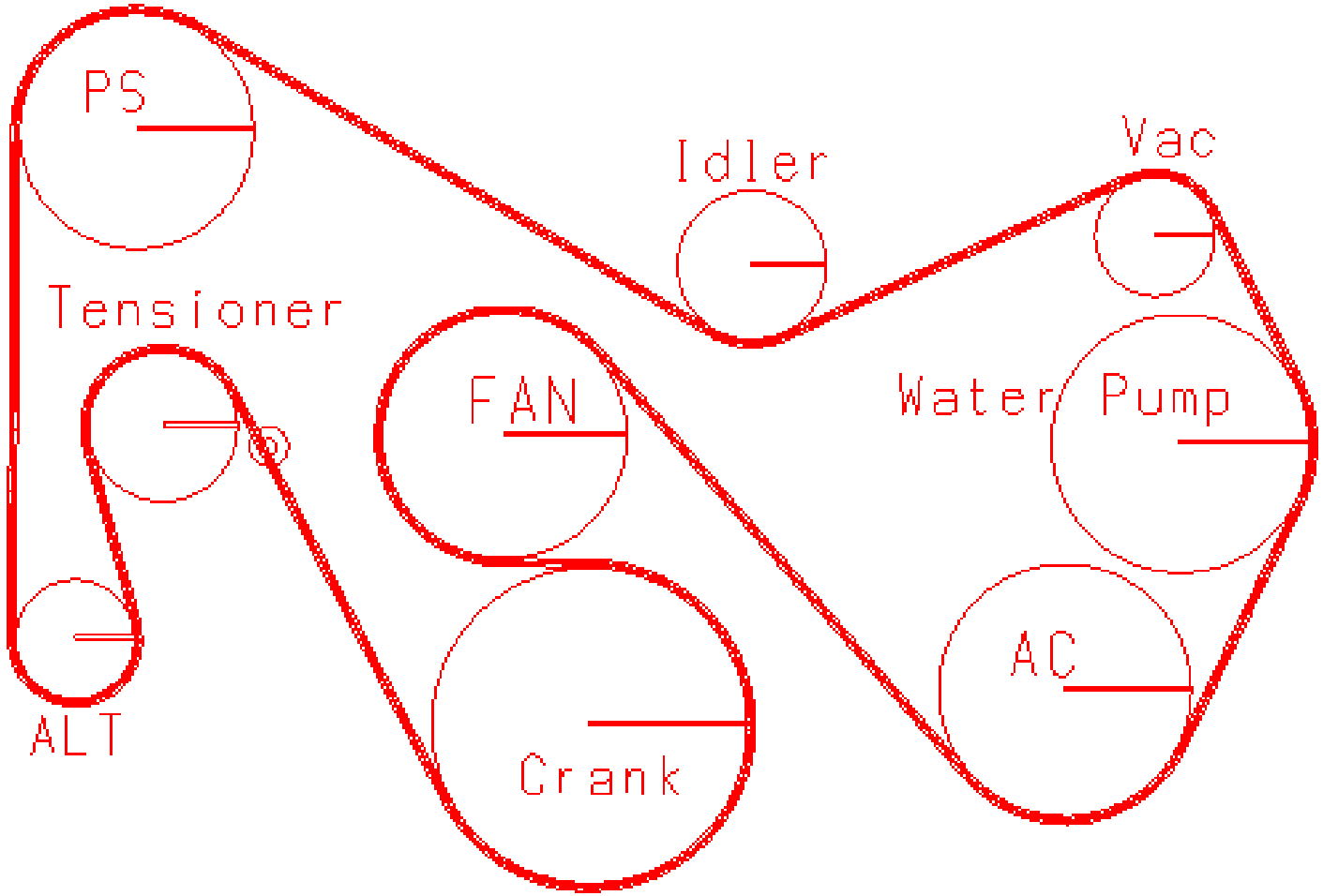

PUMA Chain Tension at 3750 RPM
4000.0
3000.0
2000.0
1000.0
0.0
newton
300.0
375.0
450.0
525.0
600.0
millisec
S4
S3
S1
S2
S3
S4
S1
S2
S3
S4


Impact Force
1000.0
750.0
500.0
250.0
0.0
newton
300.0
375.0
450.0
525.0
600.0
millisec
FIP
Crank
Arm
Ex_cam
Int_cam
FIP
Crank
Arm
Ex_cam
Int_cam
FIP

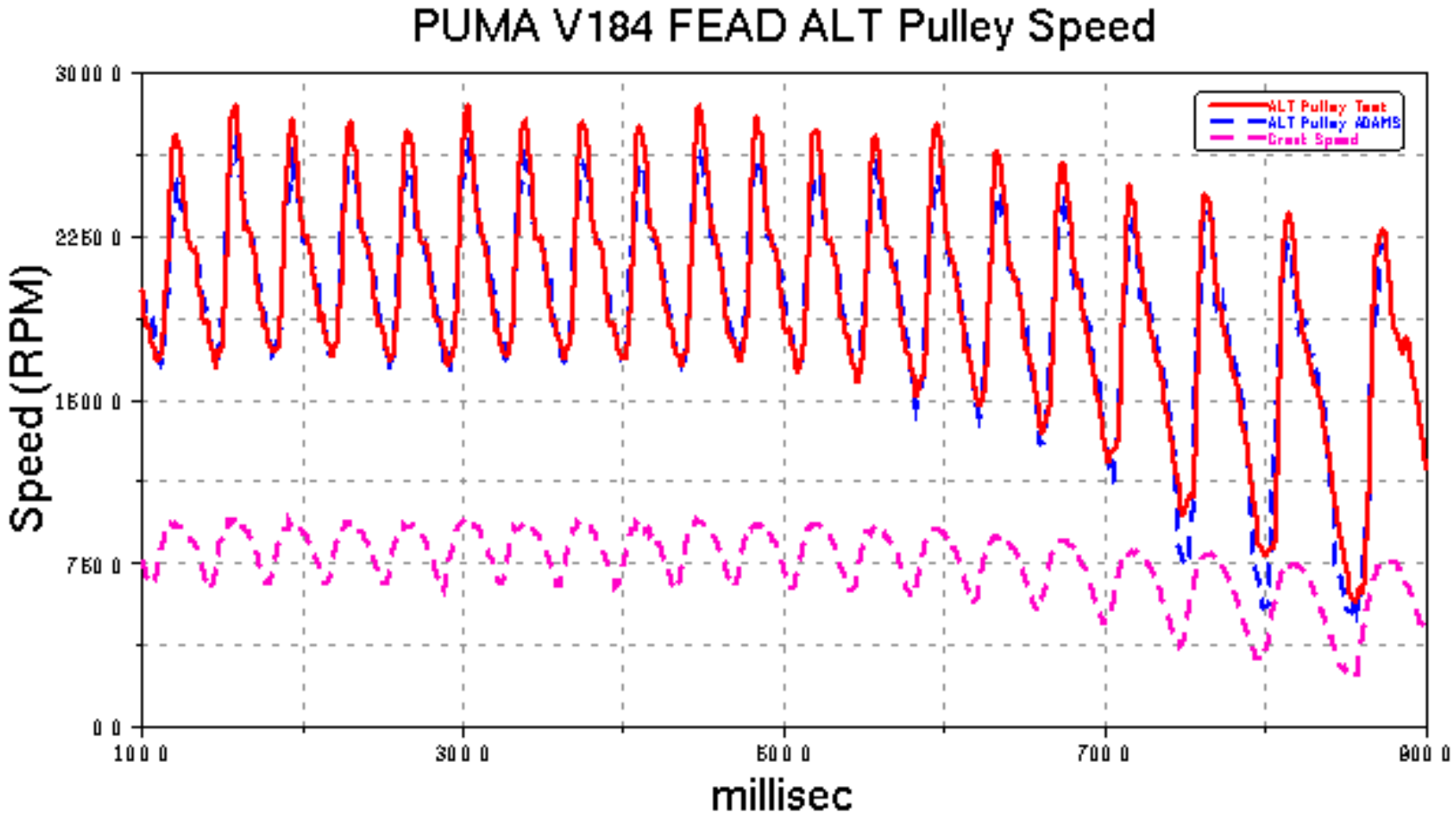
FEAD Analysis Tool

* Non-linear Stiffness (Kc + Ks)
* Static and Dynamic Friction
* Large Deflection
* Belt Slippage
* Belt Span Vibration
* Belt Span Tension
* Belt squeal
* Clutch Dynamic Response
* Transient and Steady-State Analysis

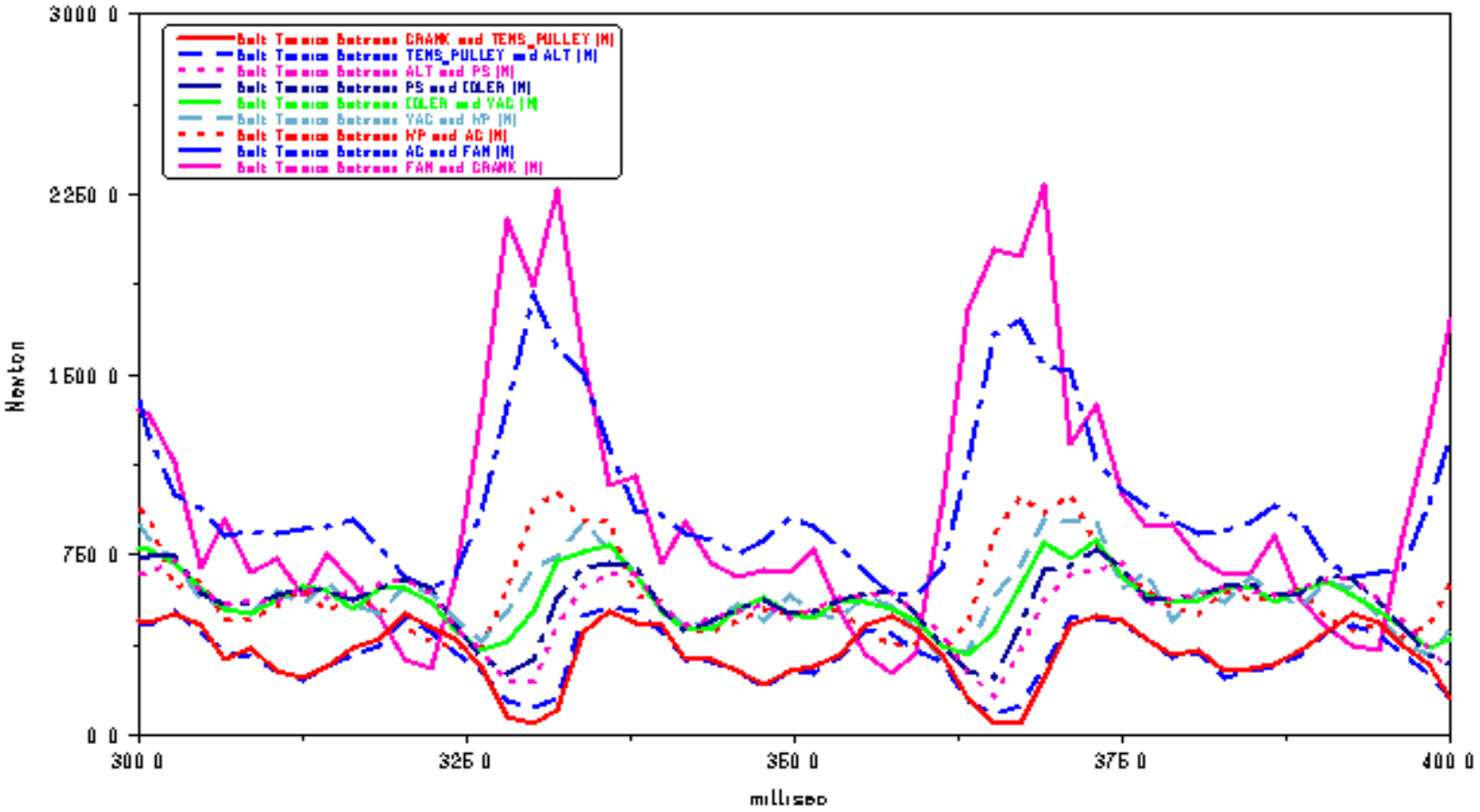
FEAD Validation



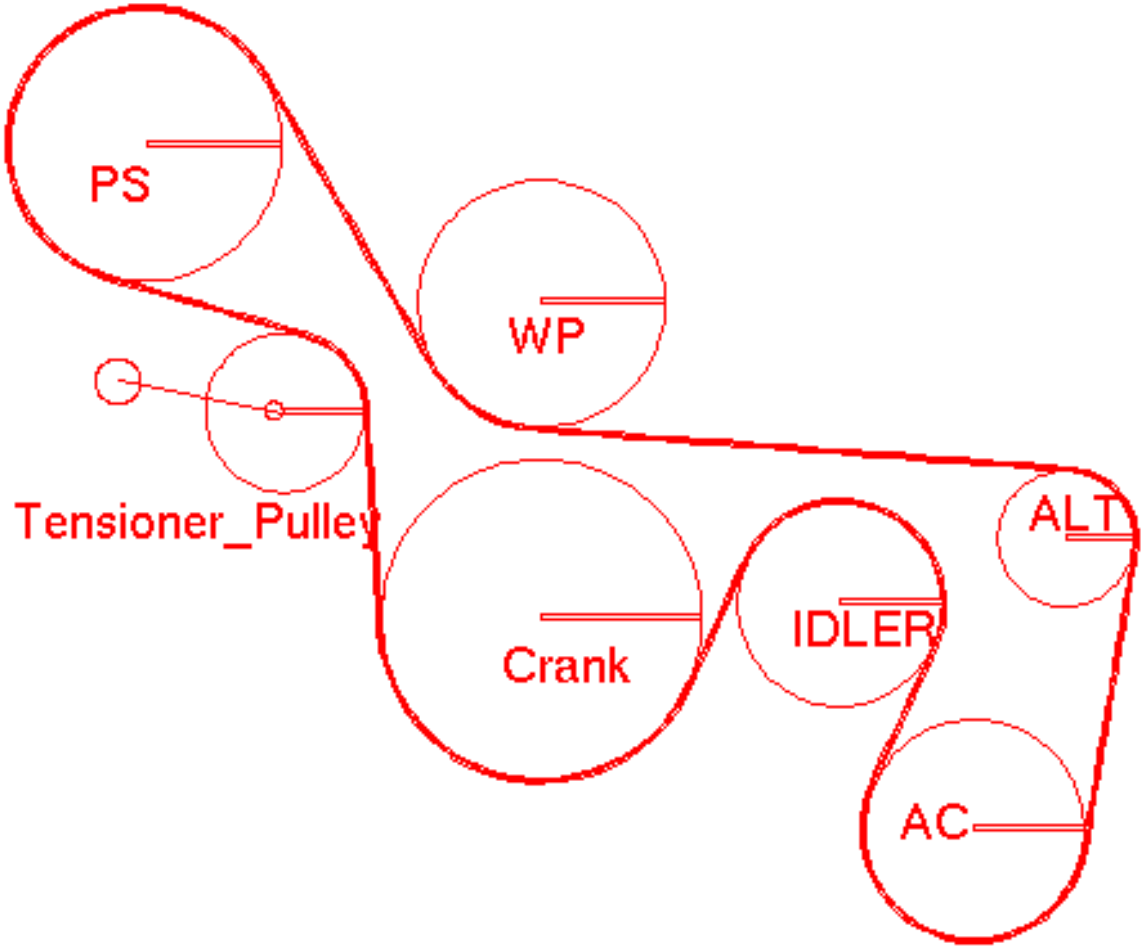
FEAD Configuration A


PUMA V184 FEAD ALT Pulley Speed
Speed (RPM)
millisec
ALT Pulley Test
ALT Pulley ADAMS
Crank Speed

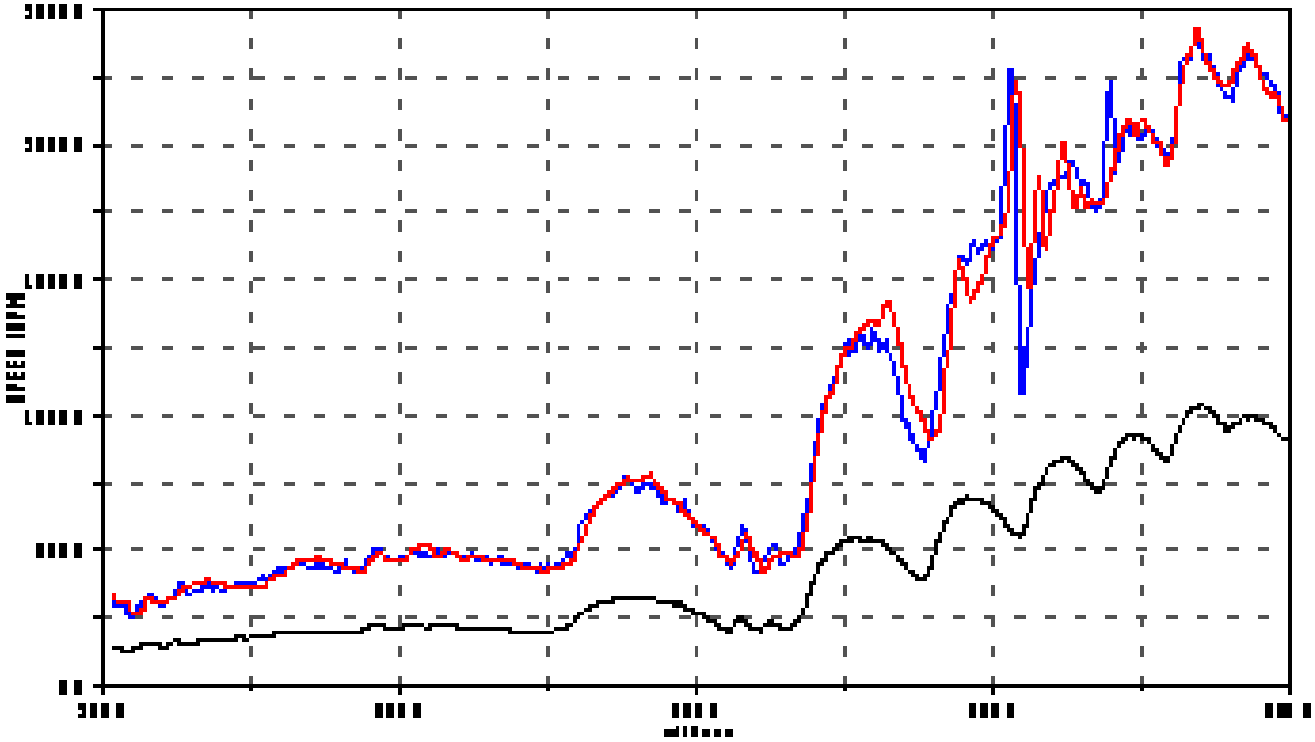
Belt Tension



FEAD Configuration B

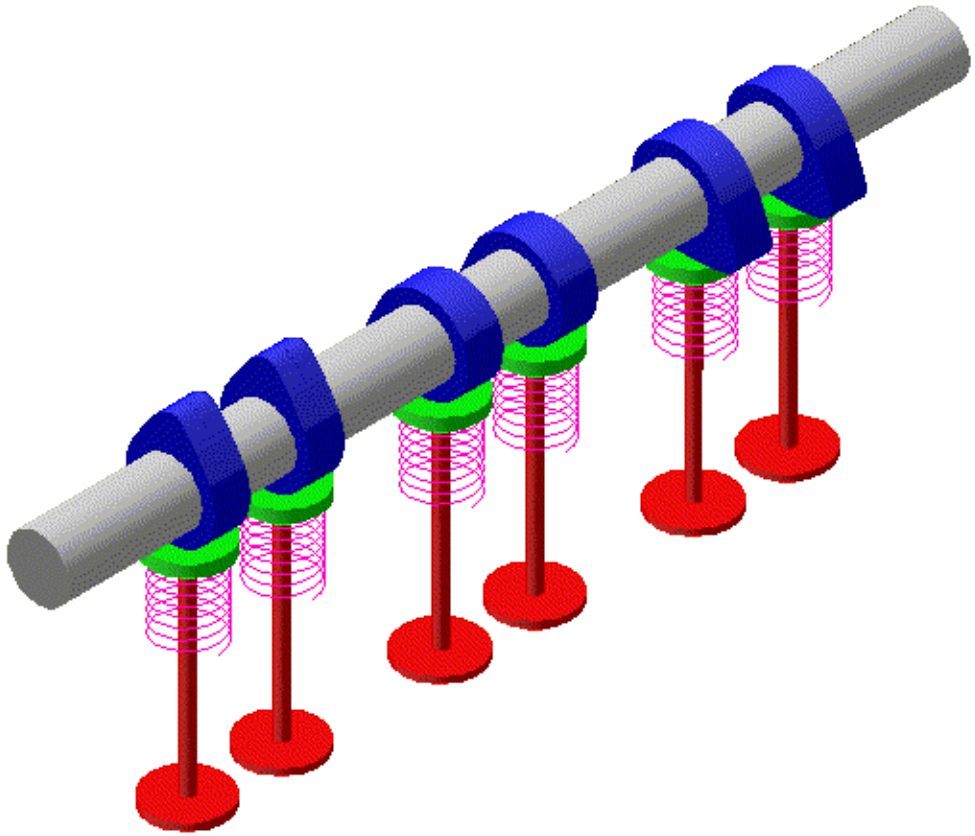


Validation



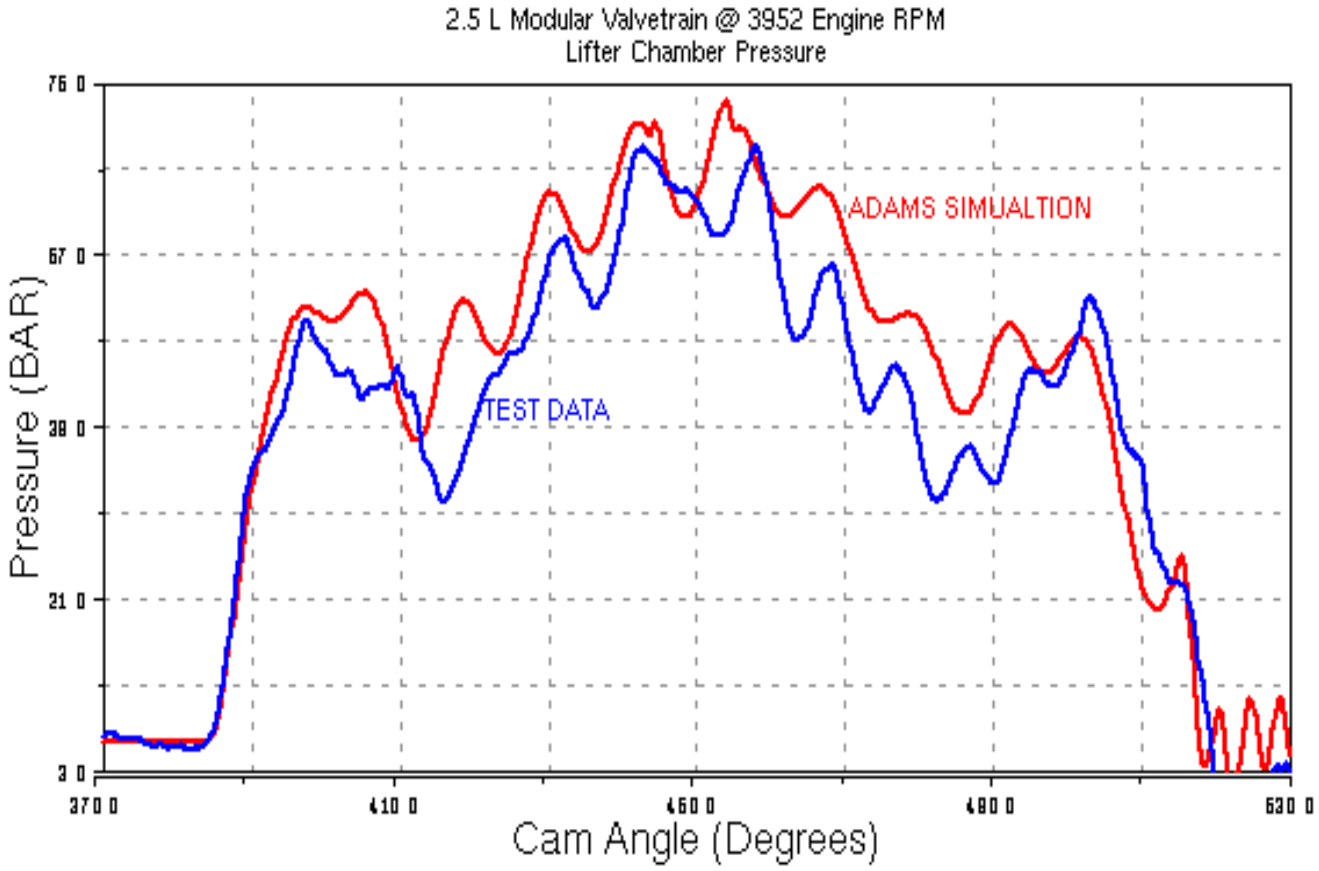
Blue - Alternator Speed (ADAMS):Red - Alternator Speed (Test Date)
Black - Crank Speed (RPM)

Valve Train Dynamics

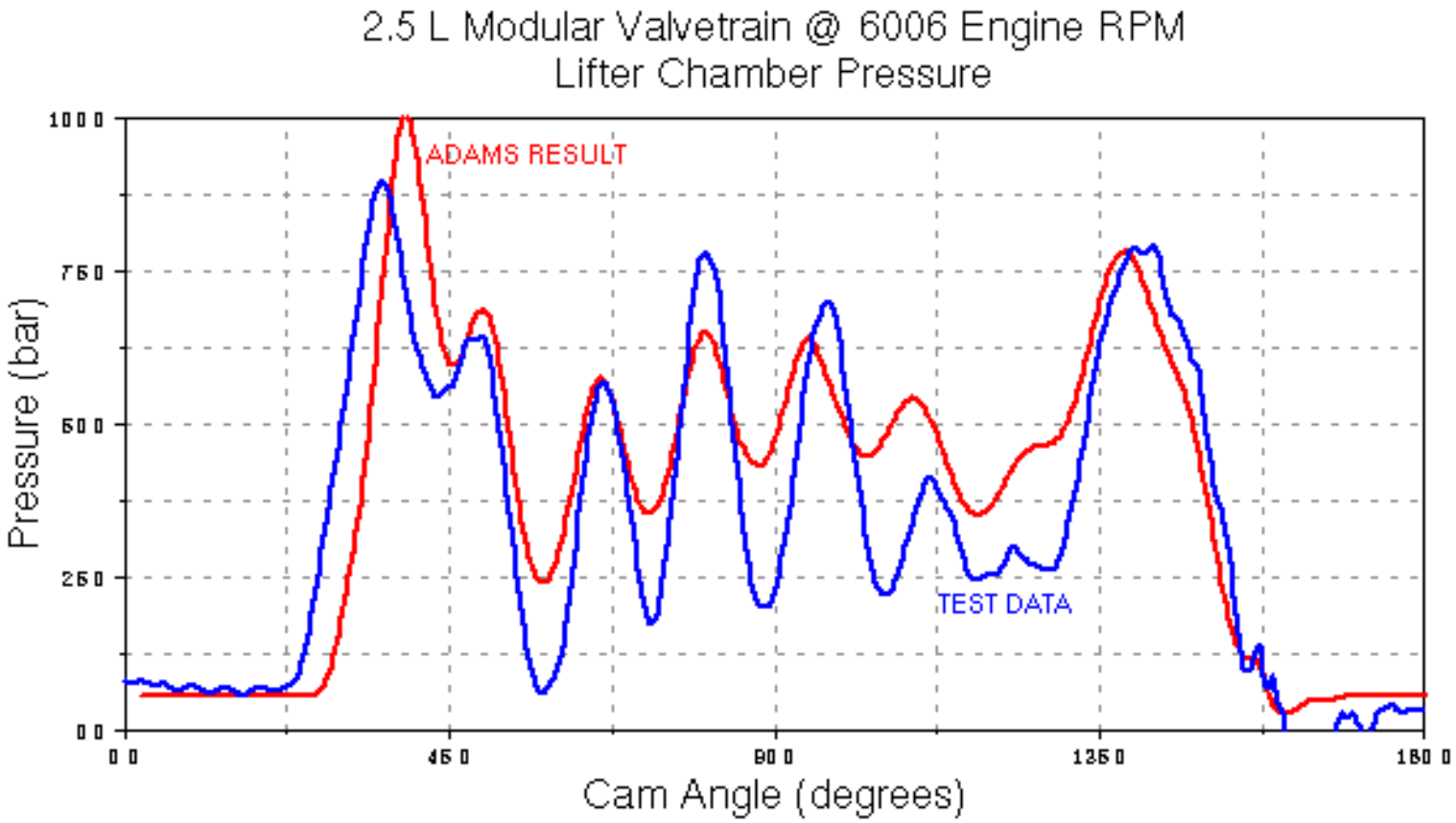


Valve Train Configuration

Valve Train Validation



Valvetrain Validation



Status of ADAMS Cam Drive Development

* Over head valve train is completed
* RFF configuration validation is finished
* *Coupling between chain and valve train - on going*
* *NVH calculation - on going*
* *Timing Belt modeling - on going*

Future Work

* Need further developments in noise prediction and life cycle calculation
* Incorporate modeling efficiencies in order to reduce run time
* Complete engine dynamic analysis