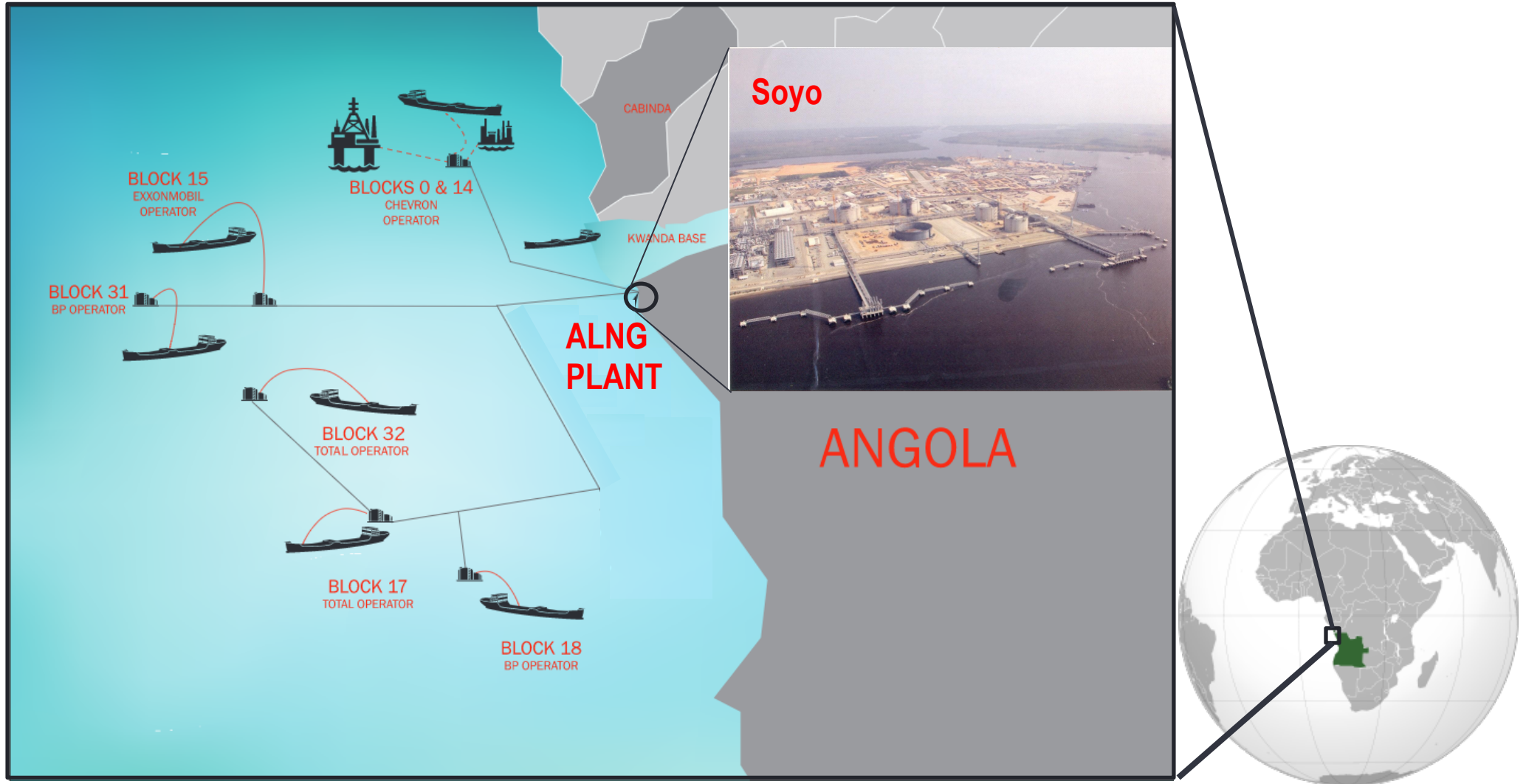


# Angola LNG Integrated Online Transient Simulation Solution for Subsea Pipeline Operations

# SOMG – Sociedade de Operações e Manutenção de Gasodutos S.A.

## Angola LNG Gas Gathering System



# Challenges for Operations

## Dense Phase Operation

- Varying Compositions
- Ensuring Nominations are Met

## Corrosion

- Future Presence of Sour Gas and Acid Gas
- Difficult to Inspect or Use Corrosion Coupons

## Leaks

- Large Transport Volumes
- Limited Isolation Valves

## Pigging

- Subsea Pigging
- Infrequent Pigging

## Hydrate and Liquids

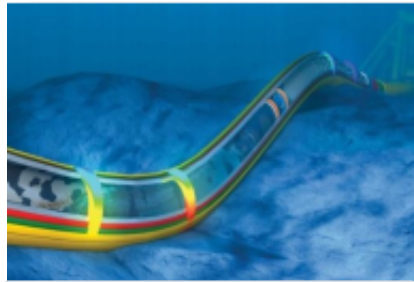
- Costly to Manage Unanticipated Liquids
- Costly to Remediate Hydrates

# Integrated Simulation Solution – Software Packages



- What-If Planning Tool
- Real-Time Monitoring for Multiphase Flow Situations
- Hydrate and Dew Point Monitoring
- Pig Tracking

# Integrated Simulation Solution – Pipeline Management System



- Pressure
- Temperature
- Flowrates
- Composition

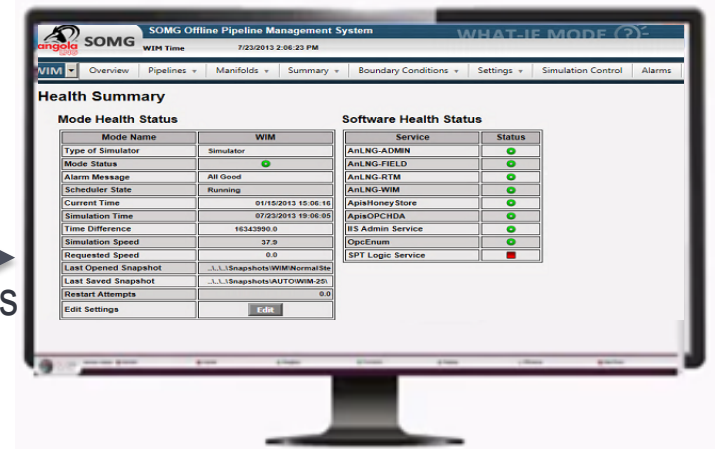
Field Data



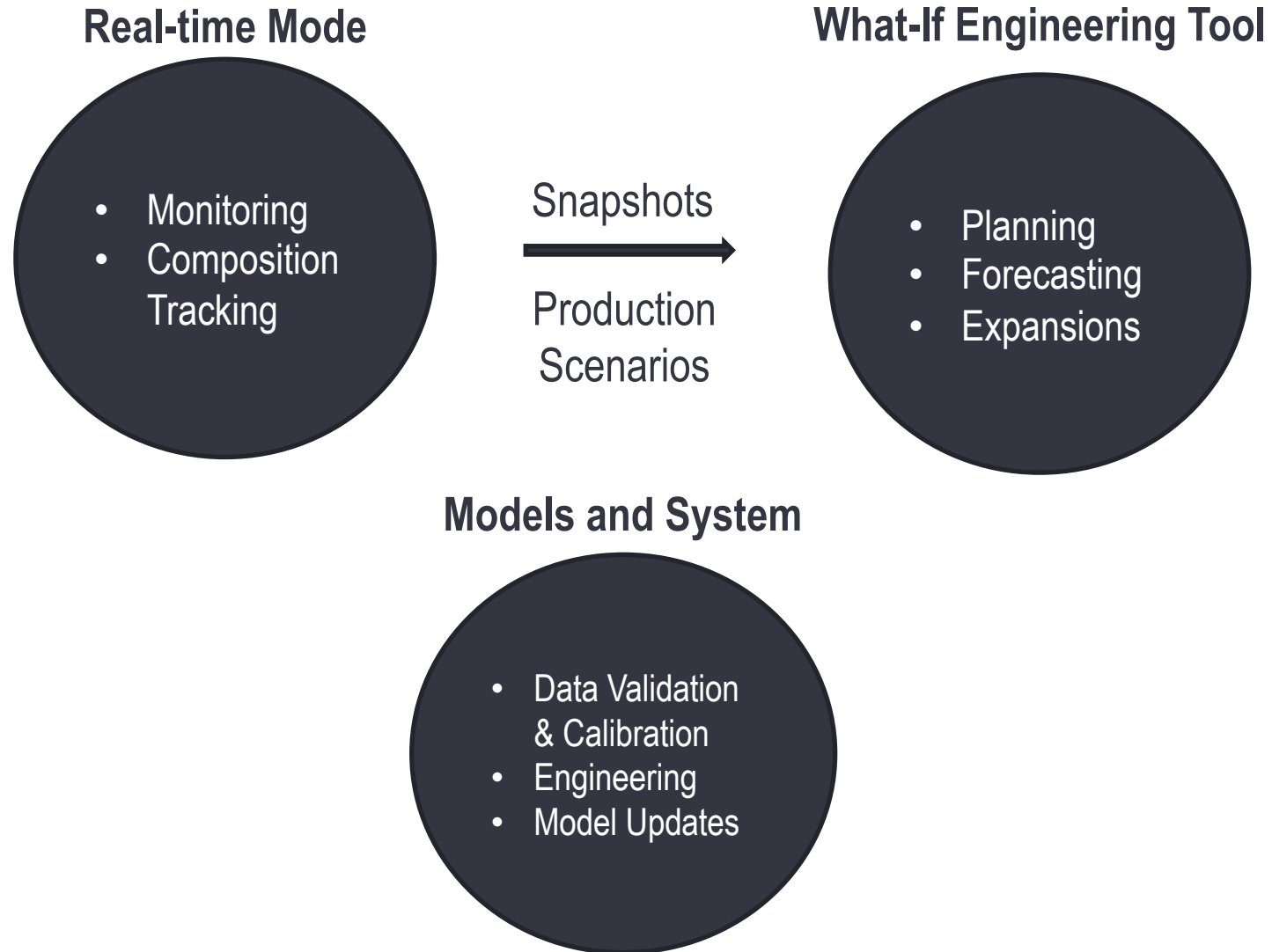
Dedicated Hardware  
Redundant Network

- Transient Models
- Multiphase
- Compositional

Results  
User Inputs

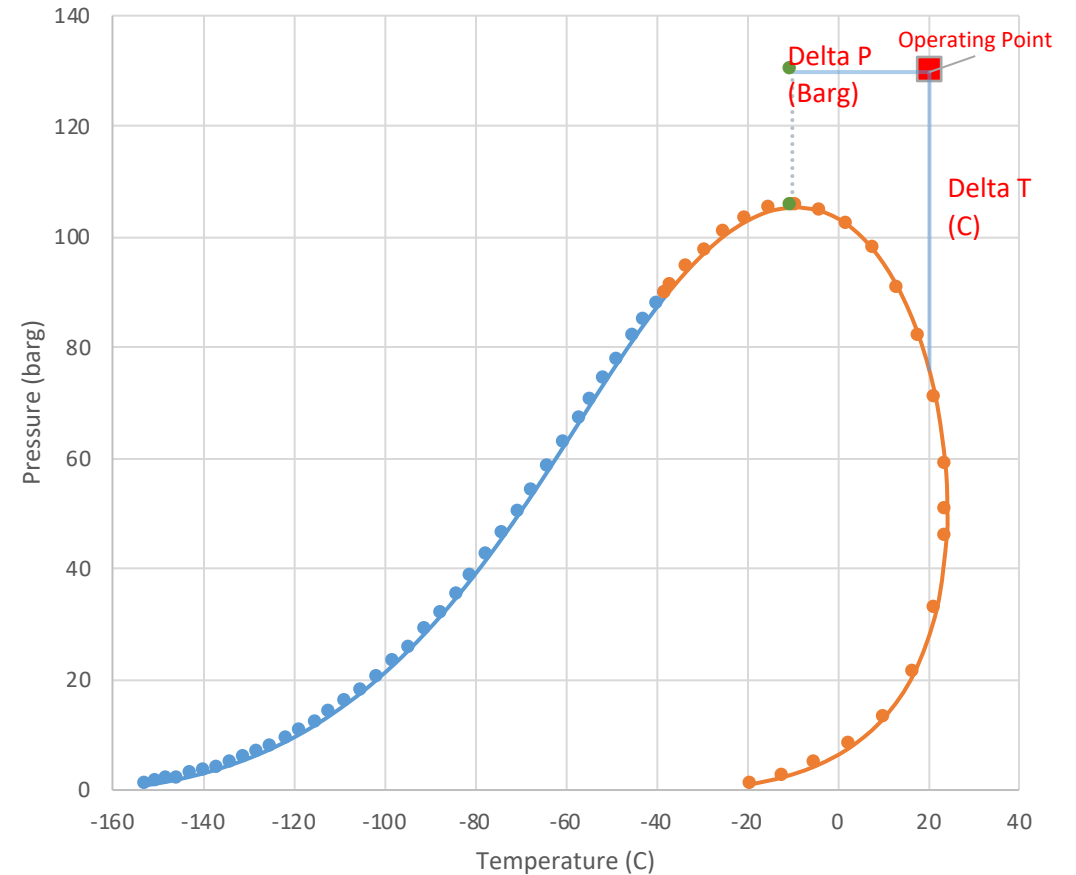


# Integrated Simulation Solution – Pipeline Management System



# Dense Phase Operations Solution

- Fully Compositional Model
- Dew Point Monitor
  - Delta T (C)
  - Delta P (Barg)
- Survival Time Calculations
- What-If Tool for Production Scenario Evaluations



# Pigging Solution

PLAN

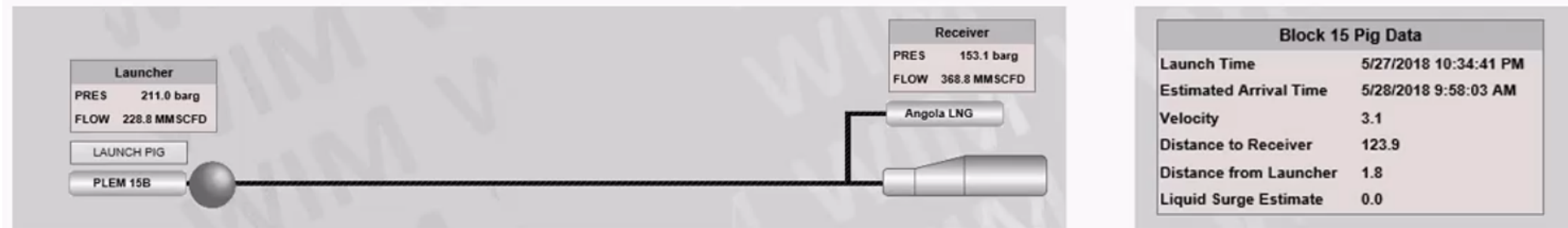
## What-if Engineering Tool

- Simulate Pig Travel Times
- Test Different Flowrates And Pressures

EXECUTE

## Pigging Monitor

- Predict Arrival Times
- Track Pig Location And Velocity in Real Time

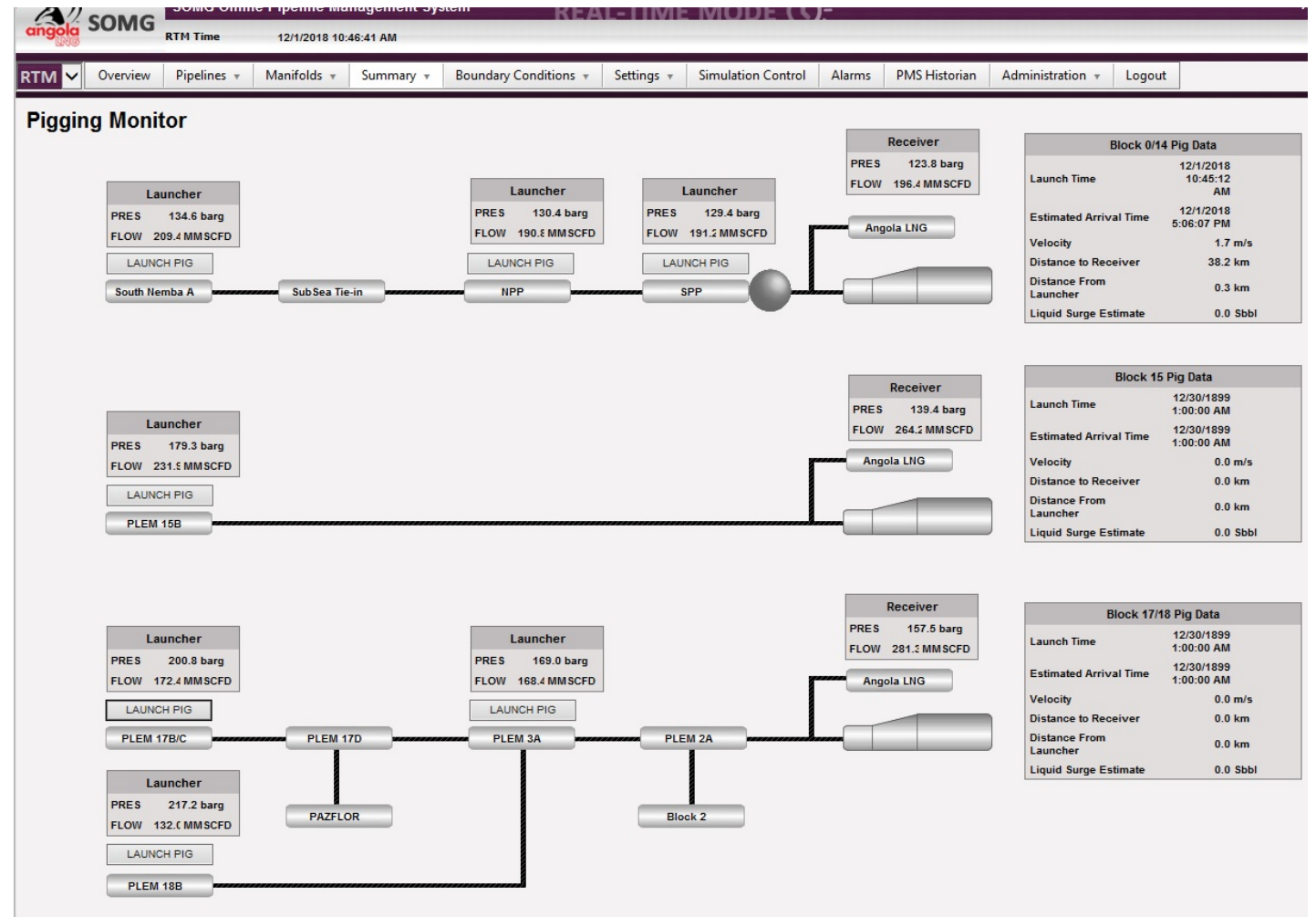




# Pigging Performance

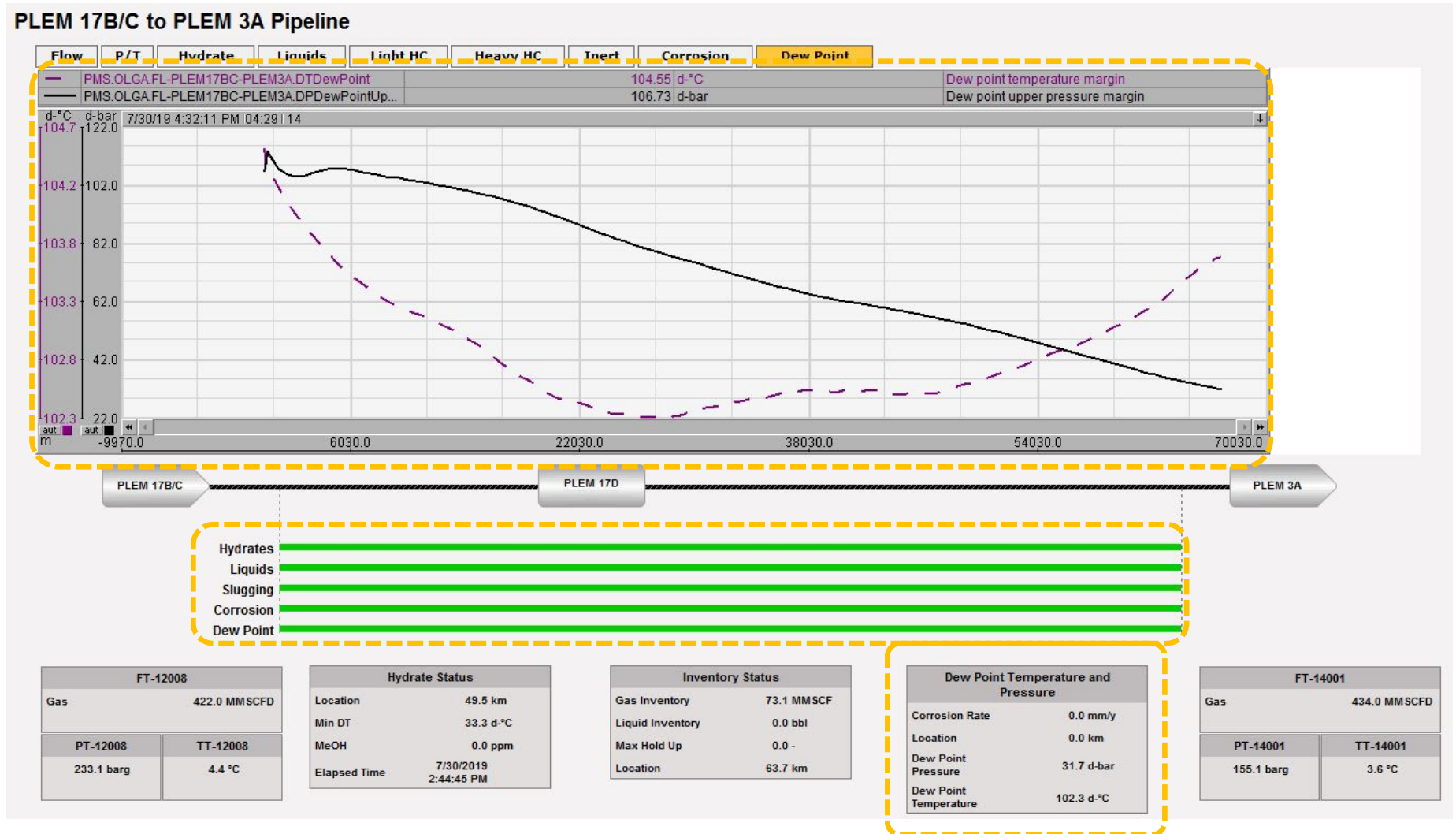
	Launch Time	Arrival Time	Travel Time
Actual	10:45	17:09	6.4 hrs
Calculated	10:45	17:06	6.35 hrs
% Error			0.8 %

Distance Traveled: ~ 38 km



# Dew Point Monitoring

Profiles  
Delta T  
Delta P



Flowline Status

Advisor Summary

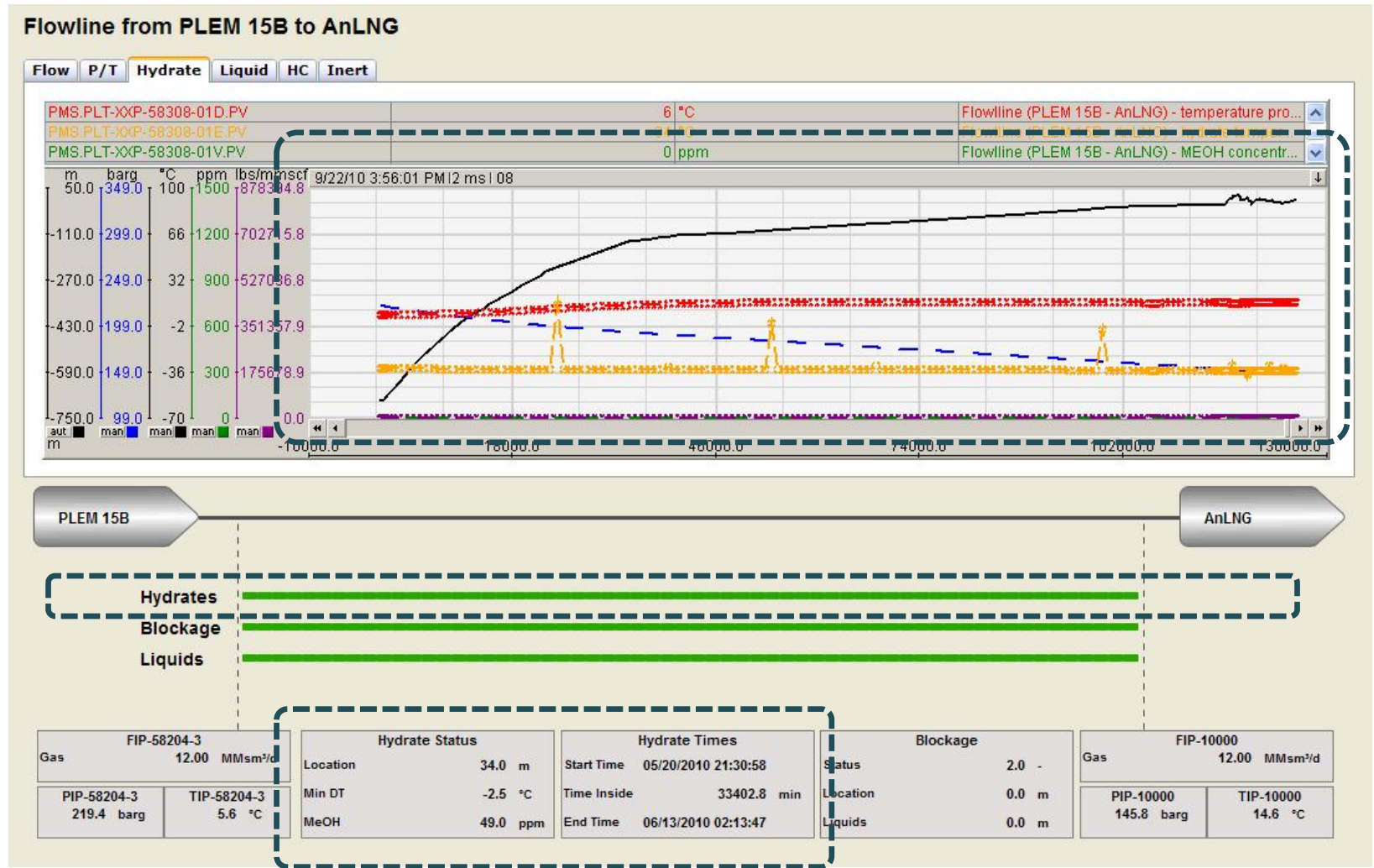
# Hydrate and Liquids Solution

## Profiles

- Temperature
- Hydrate Formation
- Pressure
- Elevation
- H2O

## Flowline Status

## Advisor Summary

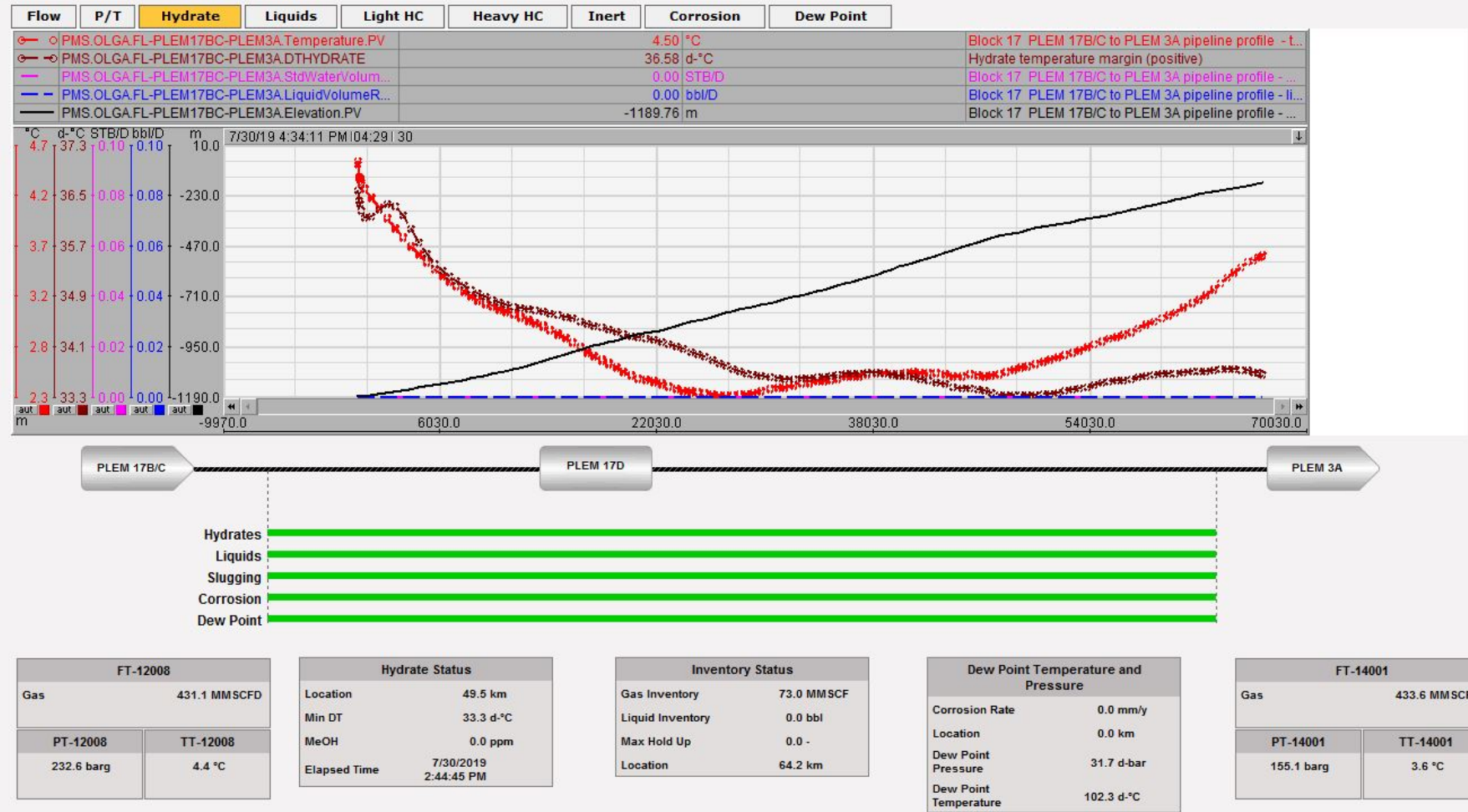


# Hydrate and Liquids Solution

## Dew Point

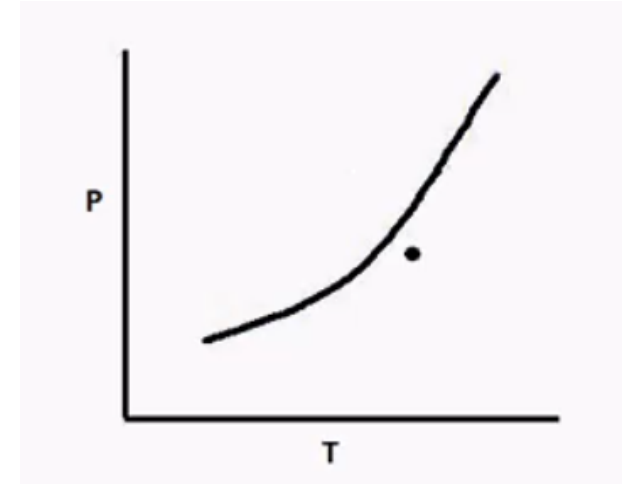
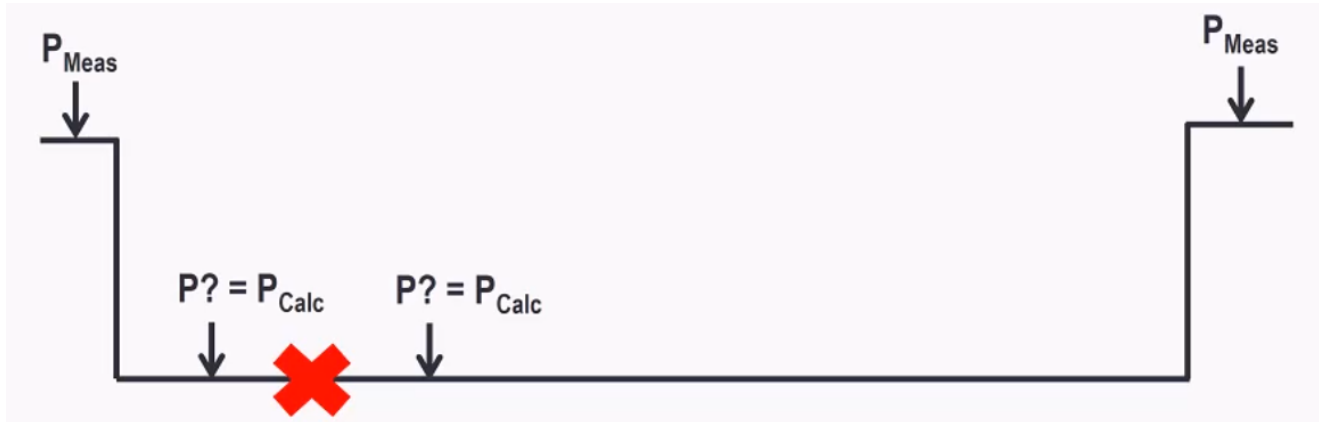
- Hydrate – Proximity to Hydrate Curve
- Liquid – Liquid Holdup
- Slugging – Hydrodynamic Slug Flow Regime
- Coverage – All Pipeline Segments and Locations

PLEM 17B/C to PLEM 3A Pipeline



# Hydrate Remediation

Hydrate Formed During Start Up  
What-If Engineering Tool Used To Assist With Remediation



# Finding Value Through Model Mismatch

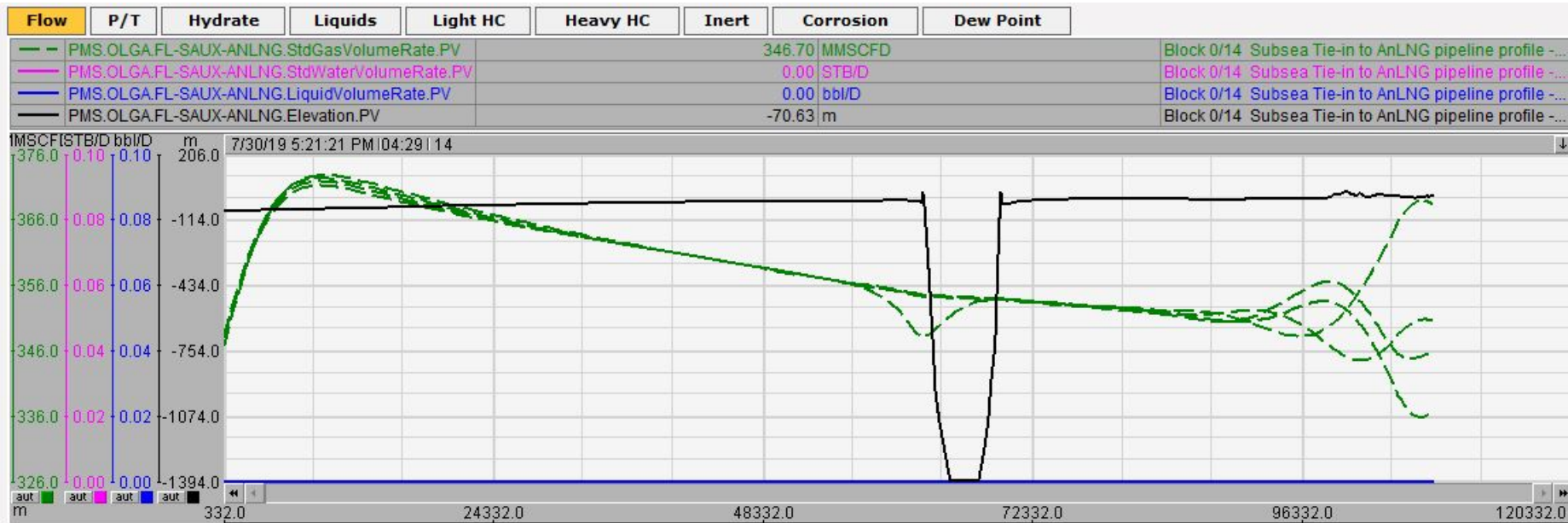
Block 17/18 Status	
Corrosion	<span style="color: green;">●</span>
Hydrates	<span style="color: yellow;">●</span>
Liquids	<span style="color: red;">■</span>
Slugging	<span style="color: green;">●</span>



FIT-6390	
Gas	332.5 MMSCFD 332.5 MMSCFD
PIT-6390	TIT-6390
153.4 barg	40.2 °C
152.8 barg	40.9 °C

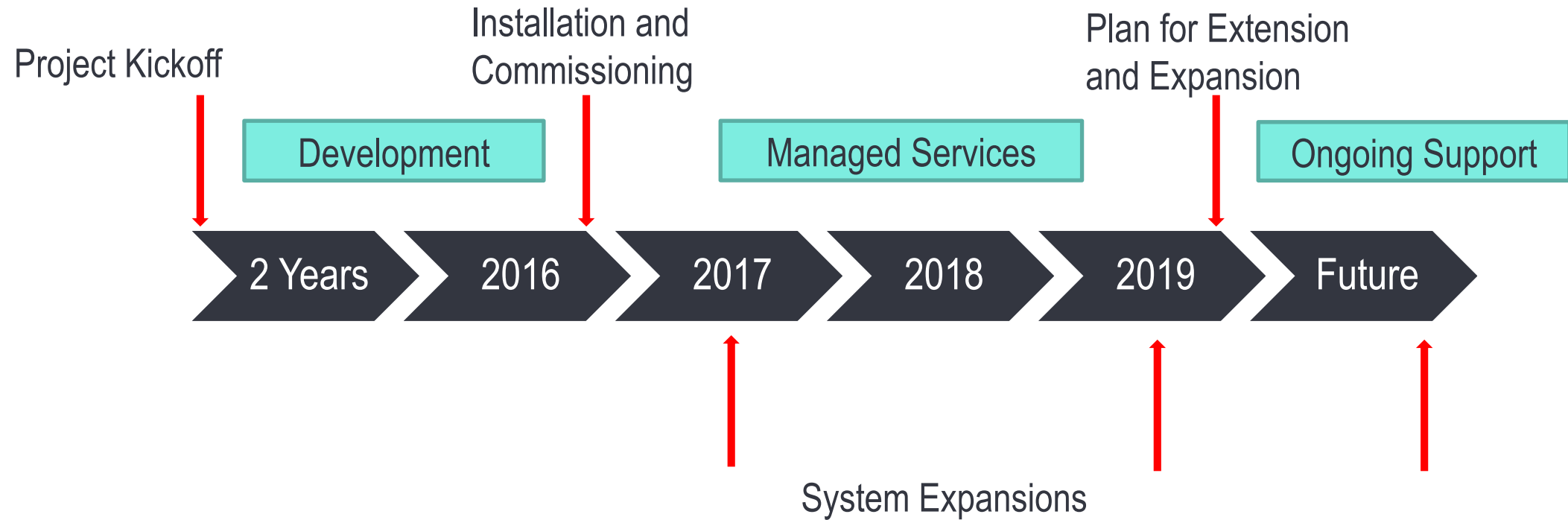
FY-11154	
Gas	336.5 MMSCFD 314.8 MMSCFD
PI-11155	TI-11156
123.4 barg	16.8 °C
123.2 barg	28.5 °C

FY-11134	
Gas	474.9 MMSCFD 437.5 MMSCFD
PI-11135	TI-11136
127.8 barg	15.9 °C
128.0 barg	18.3 °C



FY-11114	
Gas	79.0 MMSCFD 92.5 MMSCFD
PI-11115	TI-11116
141.8 barg	22.3 °C
141.8 barg	24.5 °C

# System Development and Installation Timeline



# Conclusion

## Added Value

- What-if Tool For Hydrate Remediation And Pigging
- Results Available Anywhere In The Pipeline System
- Data Quality Assessment Through Model Mismatch
- Simple Interface for Operators

## Proven Accuracy

- Real Time Pig Tracking
- Dew Point And Liquid Prediction

## Risk Management

- Planning Pigging Operations With What-if-tool
- Gas Composition And Hydrate/Dew Point Monitoring
- 24/7 Availability With Uptime Of Over 99%





Questions ?