La società cambia con la Trasformazione Digitale: Algoritmi Predittivi per ridurre gli NPT

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What and Why?

Non Productive Time

Well duration

OPERATIVE TIME + **NPT**

Any interruption of a planned operation, resulting in a time delay

The main causes of NPT are related to:

- **Well problems**
- Downhole equipment failure
- Surface equipment failure
- Rig failure

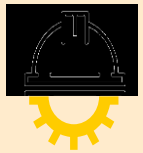
Well problems related NPT
have major impact on

Safety **Efficiency**

Creation of **predictive algorithms** based on **machine learning** able to prevent well problems related NPT using **100% of well data**

Impact on Business

Safety



Risk Reduction

NPT reduction

Improvement in the drilling performances

Efficiency

>130 Gb of raw data crunched

Several geographies

Machine Learning Models

>7.000 variables mapped

>1.000 events verified

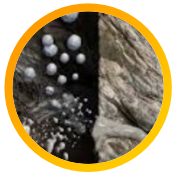
>200 wells analyzed

75% accuracy achieved

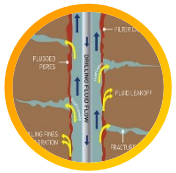
e-NPT: Suite of Predictive Models that Helps to Avoid NPTs Related to Well Problems

“e-NPT" objectives

Predict & prevent well problems NPTs



Fluid Influx



Circulation Losses

Wellbore Stability problems

Stuck-pipe

“e-NPT" tool characteristics

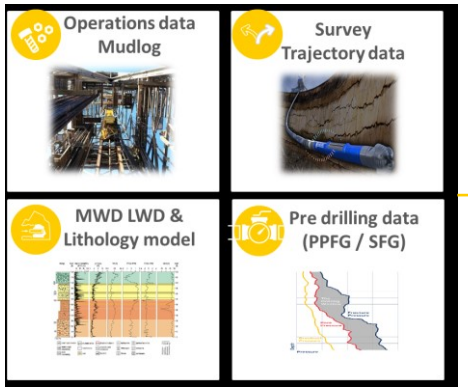
User friendly dashboard
for monitoring

Machine learning
predictive models

Prescriptive features
based on Eni procedures
and best practices

How Machine Learning Models Work: e-NPT Tool Example

1 **Past Wells data base**

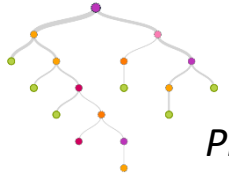


Model Offline Training

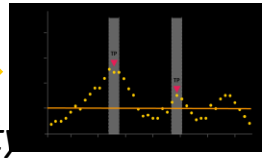
The prediction is done by constructing a set of **if-then split rules** with each variable to give the **probability of an NPT event occurrence**. These are organized in different levels to combine pairs of variables, forming a tree-like structure

Machine learning algorithms

Decision Tree



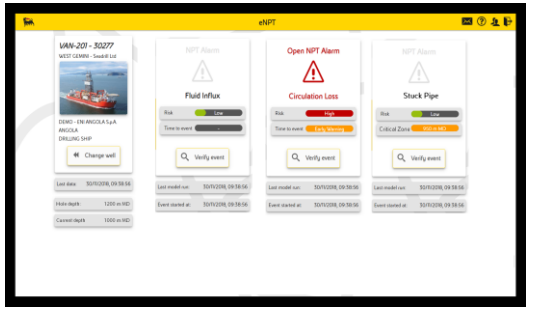
Probability



Alarm

Feedback

Dashboard on the rig



2 **Live Wells data**

e-Hawk

Data Standardization System

- Circulation Losses
- Fluid Influx
- Wellbore Stability
- Stuck-pipe

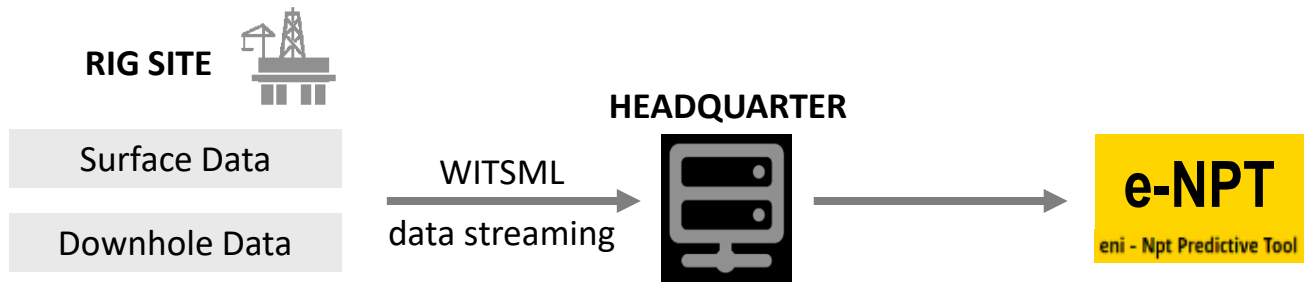
The algorithms give as output a **probability** of occurrence of the event that **triggers an alarm** if **above a pre-set** probability **threshold**

Big Data: Predictive Algorithm to Decrease NPT

Target
Non Productive Time events avoidance

- Predictive Algorithms to **prevent NPT related to well problems**
- **Currently available** for Stuck-pipe, Circulation losses and Fluid Influx events
- Additional Algorithm to reduce NPT: Borehole stability

e-NPT – Eni Proprietary tool for NPT predictive analysis in real time



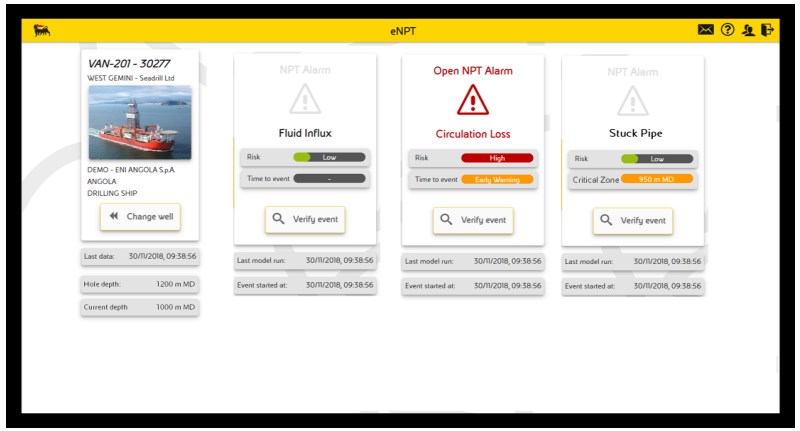
Tool capabilities

Big data approach to identify well problems related events using **100% real time data** from mud logging unit

Alert system to dedicated personnel via SMS/Mail

Real Time Analysis through Dashboard

Dashboard



New Way of Working for NPT Management

Up to date…

Reactive and experience based

Supervisor

NPT prediction | **NPT event** | **NPT solution**

Few preventive actions based on **Supervisor** alertness on precursor signals

Long Reaction time

Supervisor reacts to NPT and calls the superintendent if issues complex to be addressed

NPT Solved

…from now on!

Predictive alert & prescriptive support from NPT models integrating Supervisor experience

Supervisor

NPT model

NPT Prediction

Action time

Prescriptive tool

Solved?

No

Yes

NPT Avoided

NPT detected

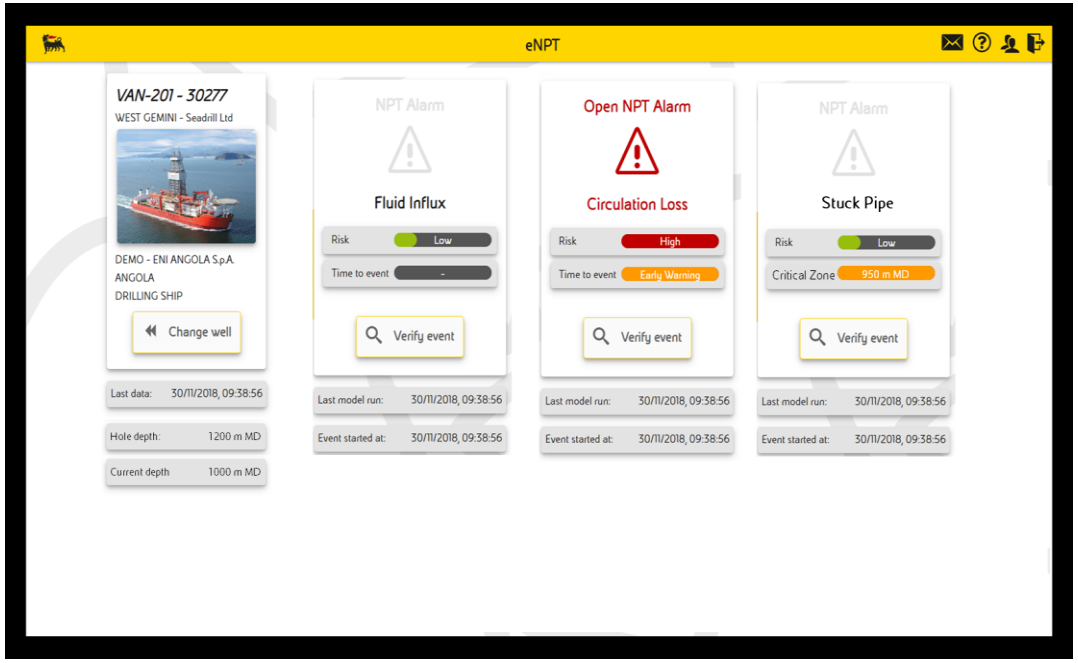
Faster Reaction time

NPT Solved

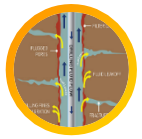
Reminder Eni Std procedures to be implemented based on tool classification from detection model features

Avoid NPT & Faster Reaction Time

e-NPT Dashboard



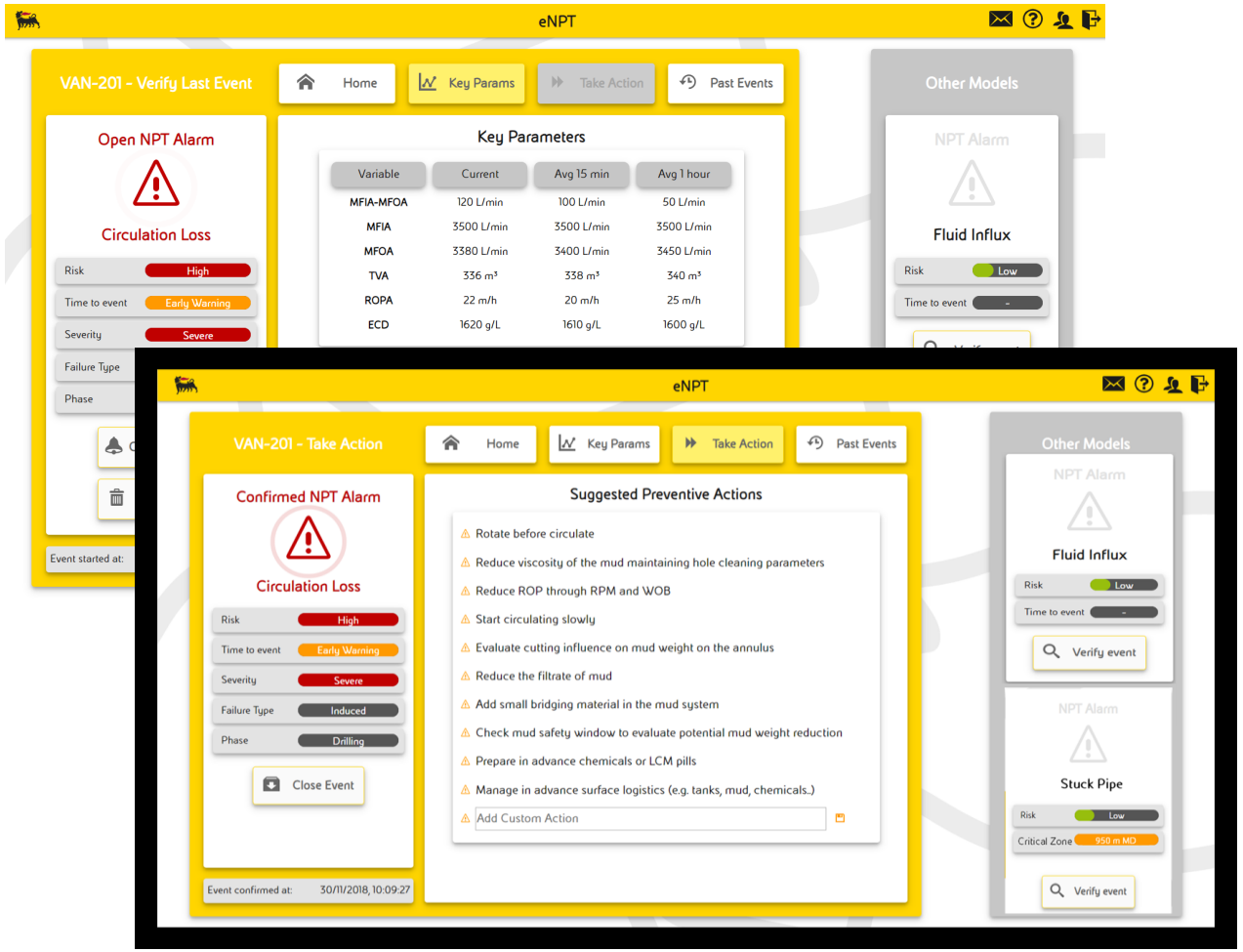
Fluid Influx



Circulation Losses

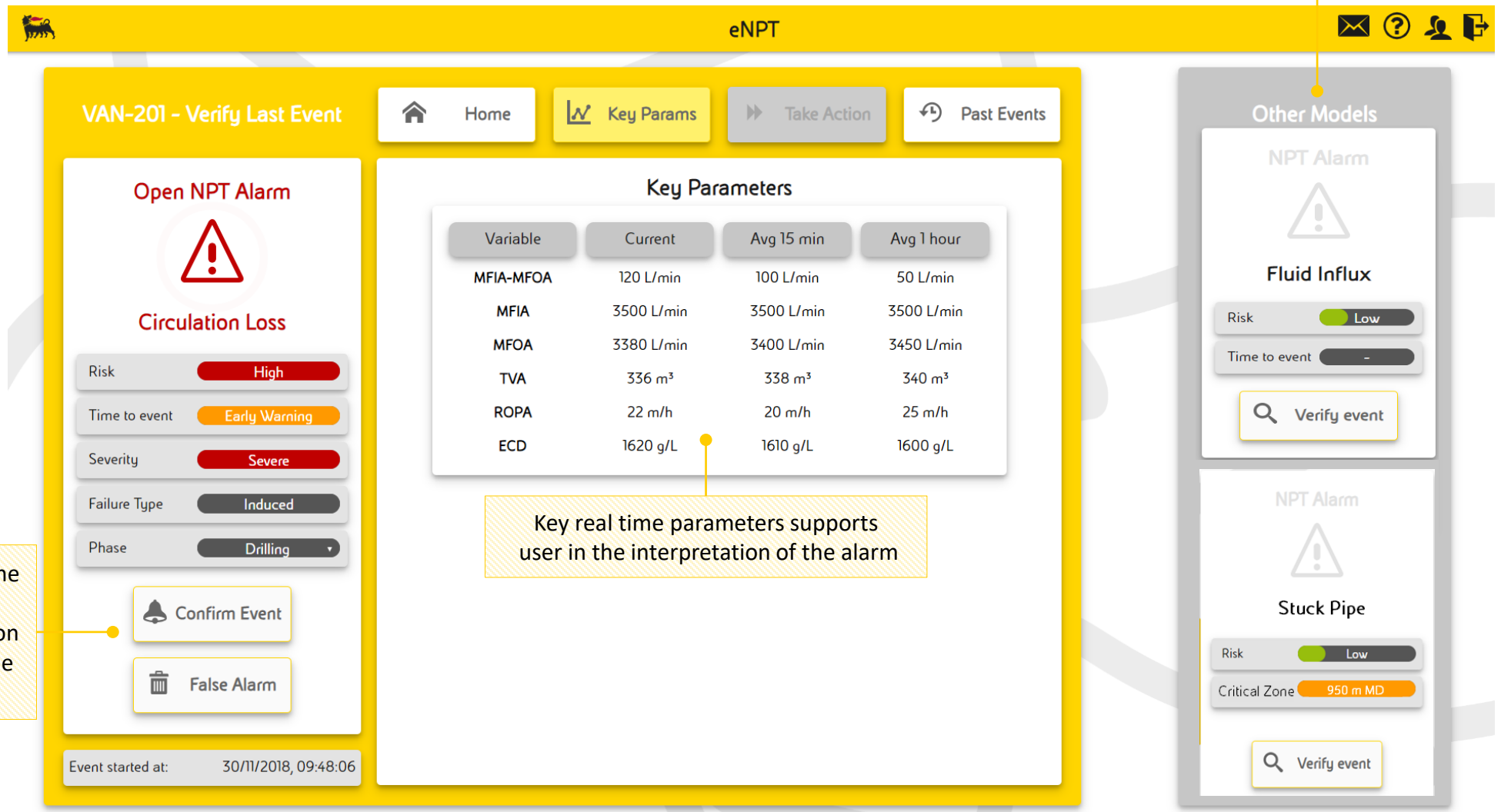
Wellbore Stability problems

Stuck-pipe



Verify Alarm through tailored key parameters

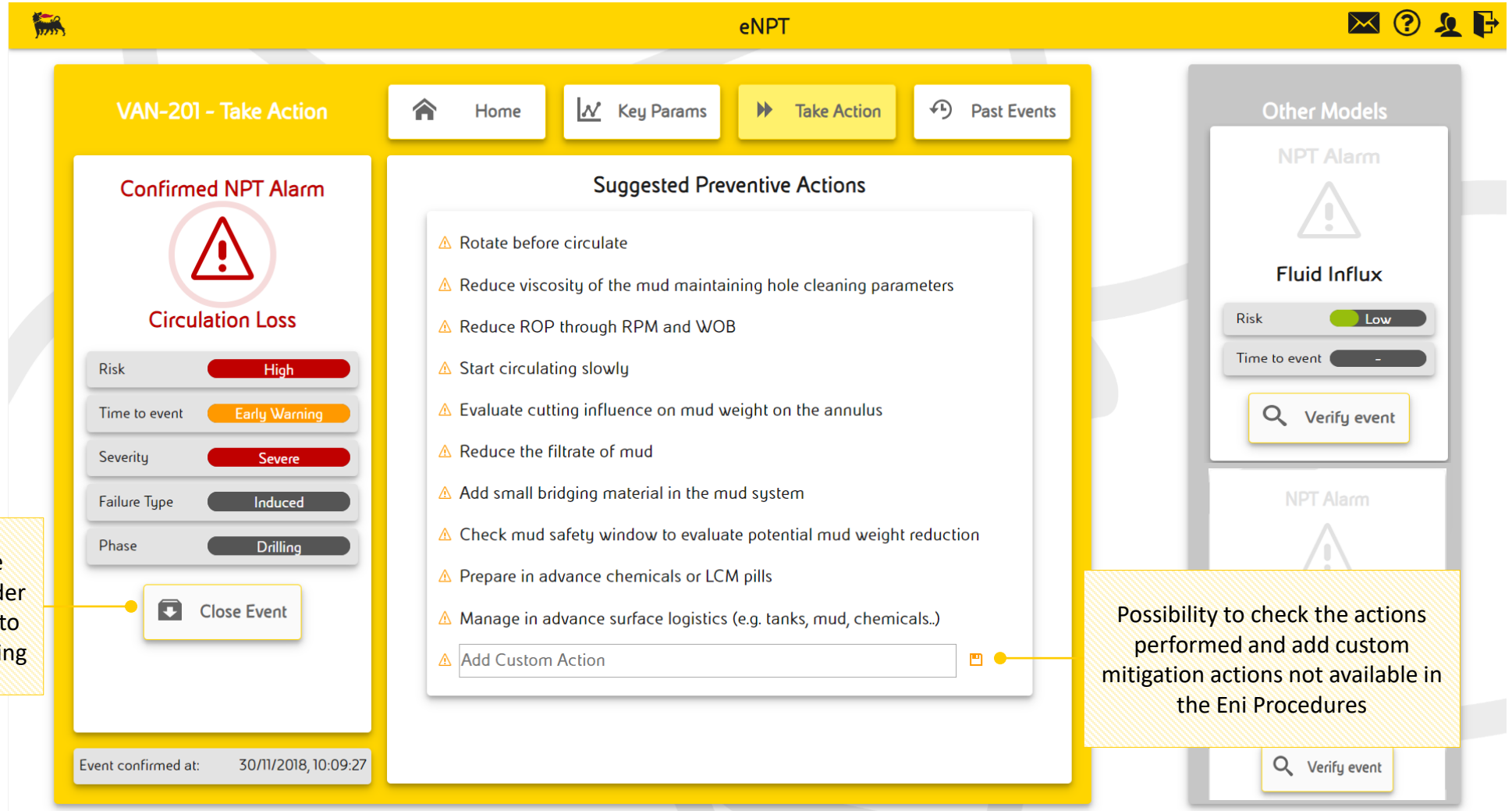
Other models are always visible to maintain a 360° vision on potential NPT



Key real time parameters supports user in the interpretation of the alarm

User can confirm the alarm to receive suggested mitigation actions to avoid the NPT

Take actions in order to anticipate NPT event



User can close the warning event in order to allow the model to re-start the monitoring

Possibility to check the actions performed and add custom mitigation actions not available in the Eni Procedures

Predictive Algorithms Roll Out

Achievement up to date

First NPT Predictive Algorithms (Stuck pipe Model) on **~ 26 complex wells**
No Stuck Pipe events recorded

Suite of predictive algorithms for well problems completed
(first roll out Angola)

Angola
Ghana
Cyprus
Egypt

5 M€

100 % Cost saving

Pakistan
Norway
Morocco
USA

Deep offshore well
Angola

ACTION

True alarm
Fluid Influx

Event started at: 03/02/19 – 05:45

Alarm triggered a flow check and a gain of 46 bbl registered, lower annular BOP has been closed and riser circulated → **NPT mitigated**

ACTION

True alarm
Circulation losses

Event started at: 03/02/19 – 09:25

Preventive LCM pumped (65 bbl) → **NPT mitigated**

ACTION

True alarm
Circulation losses

Event started at: 10/02/19 – 08:55

Slowed down ROP (5m/h); controlled flow rate (700 gpm); preventive LCM pumped (32 bbl) → **NPT avoided**