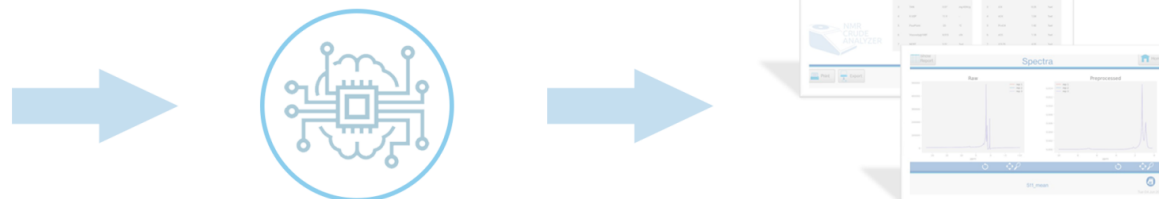




DEVELOPMENT OF AN NMR ANALYZER FOR REFINERY APPLICATIONS

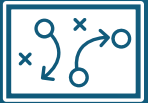
Increasing data availability for improved process operations



Drivers



Innovation is key for action to recover efficiency and optimize operations and processes

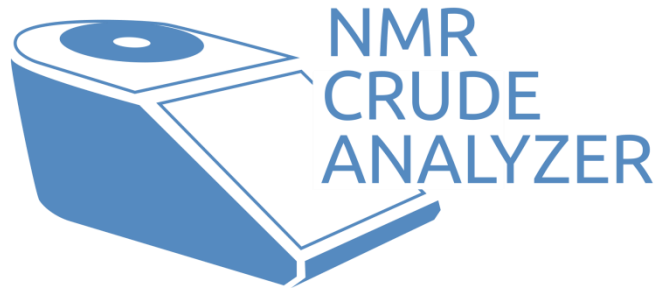


Exploit technological progress in sensor technologies, data treatment and data analysis to increase competitiveness and sustainability



Develop process control solutions to assure high quality standards and optimal operations in terms of a more efficient use of resources





Innovative multi-property analyzer

- Process analytical technologies
- Low-field **Nuclear Magnetic Resonance** (NMR) – Nanalysis Corp.
- **Machine Learning** (ML) algorithms

First application:

Rapid and accurate analysis of **Crude Oil** and **Residues (AR, VR)**
for any crude and CDU feedstock processed at the refinery



Process control of industrial operations has a major role in assuring high quality standards and optimal operations in terms of resource use and economic viability



Project Rationale



Availability of accurate and frequent process data is necessary for more reliable and sustainable industrial operations.



Need for characterization:

- Process Efficiency
- Plant Optimization
- Increase Margins



Market drivers:

- High value products
- Process heavy crudes
- BBT



Poor data availability :

- Assay frequency
- Crude management
- On Line analyzers



Laboratory Methods:

- Elaborate
- Expensive
- Time consuming
- Too lengthy



Project Challenges

Application



Complexity of the sample matrixes:

- Information content
- Handling requirements
- Required accuracy



Crude:

- Data at the refinery gate
- Process and QC



Residue:

- Upstream CDU
- No distillation
- Process

Technology



Sensors:

Exploit a commercially available low-field NMR spectrometer for process analysis



Algorithms

- Accuracy / Precision requirements
- Data handling
- Model Automation



Human Machine Interface

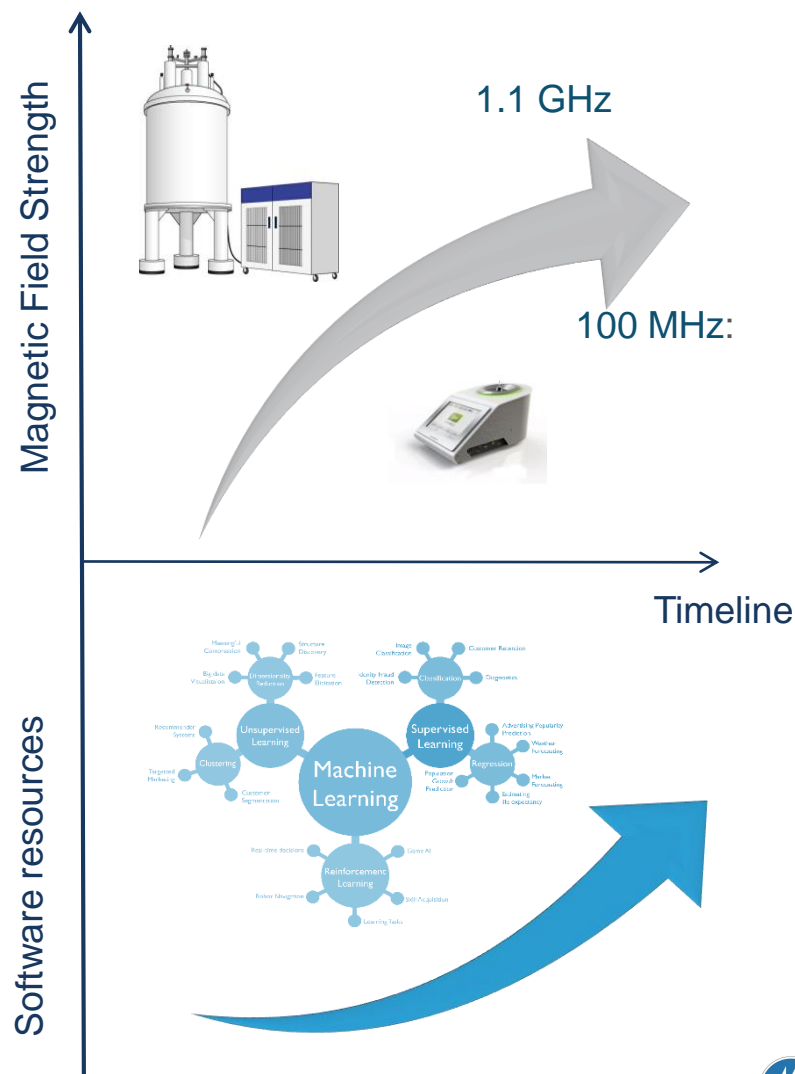
- Automation
- Semplicity
- Immediacy



Develop a reliable and affordable process analyzer alternative to the current market options



Background



- High linearity between absolute signal area and sample concentration. (Matrix independence)
- NMR signal areas can be directly used for concentration quantification
- Machine Learning to extract information from sensors
- Copes with lower resolution and ruggedness of process/production environment

New advances in permanent magnet technology and Machine Learning allow the development of a new tool for process control



Project Outline



POC
300 MHz
Crude /Resid



300 MHz
Resid



POC
60 MHz
Crude/ Resid



60 MHz
Live

- Developmet of Crude oil Application
- Prototyping Resid Application no distillation



- Developmet of Enhanced Resid Method
(EP20160188167)
- User friendliness
- Inexpensive



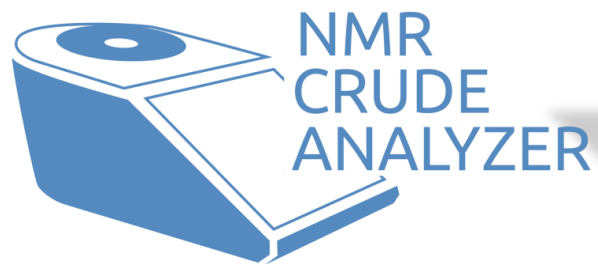
- Prototyping of Crude oil Application
- Prototyping of Resid Application
- User friendly
- Reliable



- Development HMI (human machine interface)
- Development of diagnostics
- Advanced Algorithms
- On Line Use



From proof of
concept (POC)
to Field Test



Crude Analyzer:

- Crude Oil
- Residue (AR, VR)

Analysis time: 12 min
40+ properties at once
User friendly



- Composition:
CHNS *
Aromatics,
MCRT *
Asphaltenes *
TAN *



- Bulk:
API *
Pour Point
Viscosity *



- Distillation:
Yields



- Metals
(V, Ni, etc) *



Applications



Crude distillation units (CDU) operations

- e.g. Increased distillation capacity, Increased CDU yield



Crude loading, receipt and storage

- e.g. Fast check of crude receipt from tanks, ships or loading terminals to detect quality variations



Crude blending

- e.g. Better segregation and crude compatibility management



Short term planning and scheduling

- e.g. Better tuning (Actual Vs. estimated TBP Yields)



Not only for
CDU Optimiaztion



Benefit



Less lab work, more information



Better insight of the process



Better use of feeds



Opportunity for going online



Accurate, rapid and
inexpensive tool to
secure data availability



Benefit to a wider society



Positive fallouts throughout the process industry



Cross-sectorial application of process analyzer technology and product measurement techniques

- Petrochemical
- Chemical
- Pharma
- Food
- etc

...where process control and quality assurance of final products are extremely sensible topics



The Crude Oil application represent a extreme use case
Many similarities with application in adjacent industries



Sustainability



Crude oil management and bottom of the barrel processing strategies lie at the heart of sustainable production in refining:



Operations (i.e. CDUs)

- Increased distillation capacity/Yields
- Reduced energy consumption
- Safeguarding product quality avoiding reprocessing



LP and Scheduling Models

- Better tuning (Actual Vs. estimated TBP Yields)
- Improved continuity between planning, scheduling and optimization



Increased effect when Analyzer technology used within the appropriate process control framework



The future is changing, and refining enterprises have to insist on sustainable development (optimum use of equipment, raw materials, and energy).



Conclusions



The project

Tackles with success complex and cogent issues spanning different topics at the heart of the process industry with a smart innovative solution.



The crude oil analyzer will deliver its highest value applied online :

- Real time process control for operations,
- Real time decision-making support tools for engineers and operators,
- Safer, more reliable and sustainable process operations.



Next step:
Development of the
online analyzer



THANK YOU !

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Abbreviations and terms



- AR: Atmospheric Residue
- CHNS: Carbon, Hydrogen, Nitrogen, Sulphur
- CDU : Crude Distillation Unit
- HMI : Human Machine Interface
- LP : Linear Programming
- MCRT : Micro Carbon Residue Test
- ML : Machine Learning
- NMR : Nuclear Magnetic Resonance
- TAN : Total Acidity Number
- TBP : True Boiling Point (Distillation)
- VR : Vacuum Residue