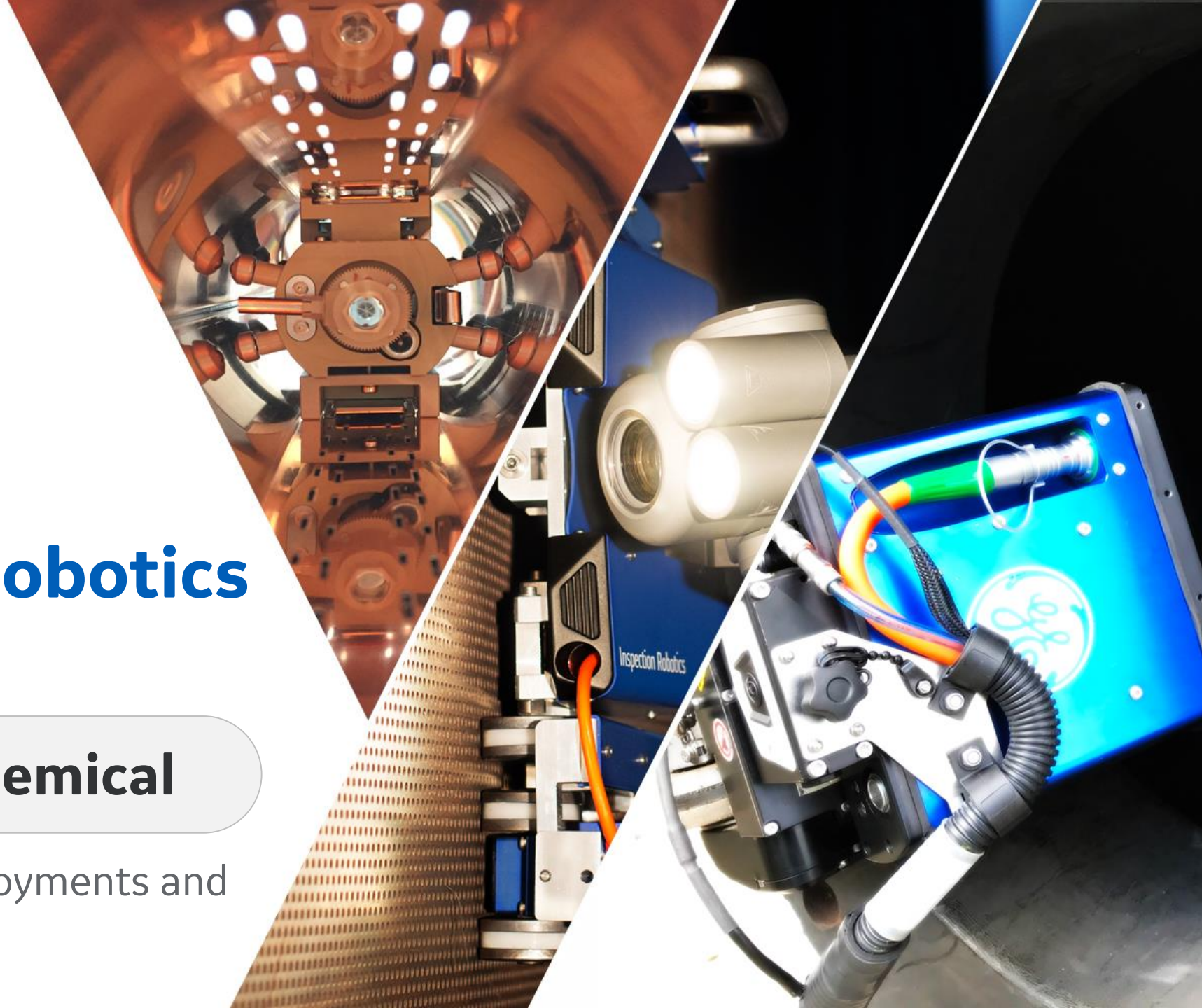




GE Inspection Robotics

Robotics in Petrochemical

Successful commercial deployments and future developments



The BIKE platform

the ultra mobile inspection robot

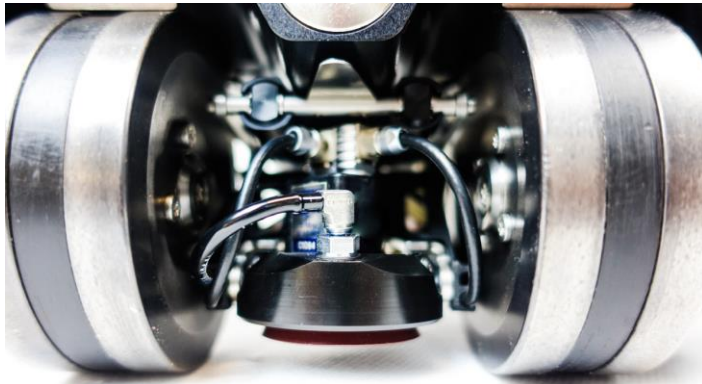


BIKE Features & Capabilities

UT module

- 5 Mhz or 10Mhz dual crystal probe for accurate thickness measurement
- Actuated remotely by couplant pressure
- Couplant pump included

UT spot check in confined spaces



Camera carrier

- Attachments for borescopes and cameras of most brand
- Mentor Visual iQ
- Inuktun Spectrum 45
- Wöhler VIS 700

Detailed close-up inspection and measurements



Coating Option

- Rubber coated wheels can be combined with additional field magnets to drive on coated surfaces (up to 3mm)
- Coated wheel configuration

Inspection of coated assets without damaging surface



BIKE Features & Capabilities

HD onboard camera

- Full HD Tilt Zoom camera
- Integrated Software
- Parallel laser for distance measurement

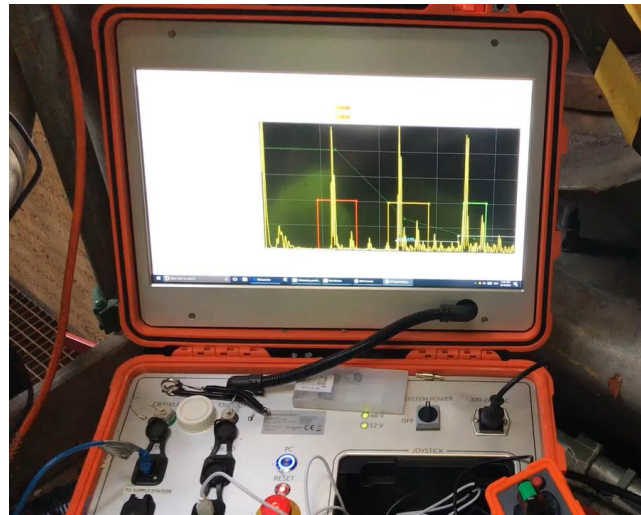
High Quality visual inspection and connectivity to feed the Digital Twin



Integrated UT

- UT acquisition unit onboard
- Less noise, less cables
- Integrated Control Software

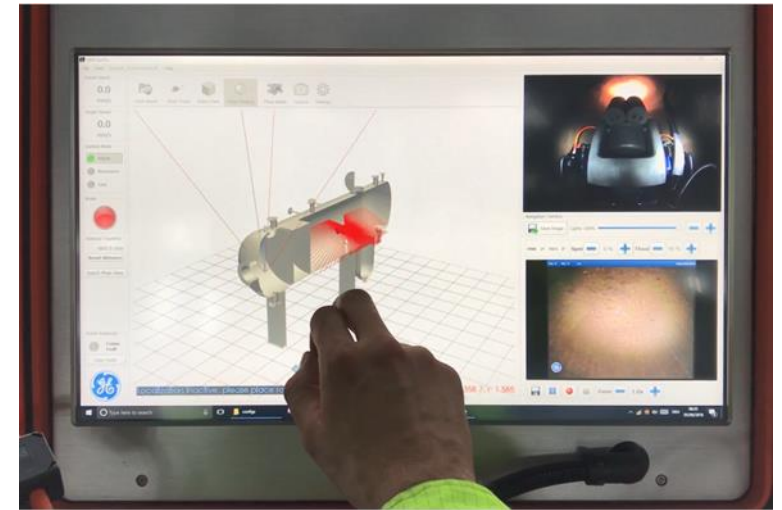
Seamless UT inspection and connectivity to feed Digital Twin



3D LOC

- Localization sensor add-on
- Assetbuilder
- RoboSim
- 3D Control & Reporting Software

Seamless Inspection Procedure from FAST RVI to BIKE



BIKE – Use Cases

Confined spaces

- Drive into confined spaces through manways or nozzles
- Minimum diameter is 12”

Detailed inspection supporting FAST RVI



Elevated pipes

- Inspect pipes at elevation
- UT spot readings at bends, reducers, around welds

Avoid scaffolding and rope access



Corrosion mapping

- Use 3D structured light as “digital pit gauge” for corrosion mapping

Digital data on asset condition

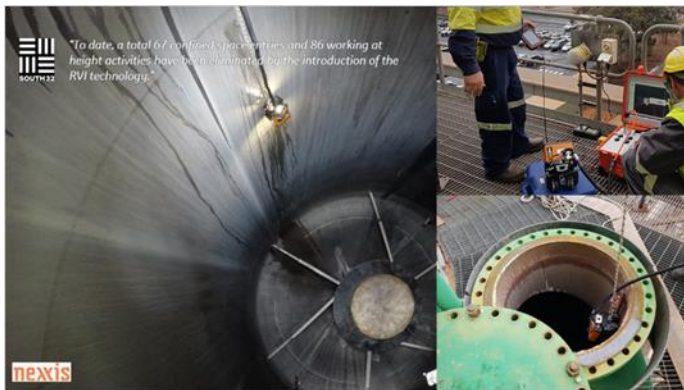


BIKE – Customer Examples

Confined spaces

- 5 Mhz or 10Mhz dual crystal probe for accurate thickness measurement
- Actuated remotely by couplant pressure
- Couplant pump included

UT spot check in confined spaces



Corrosion under insulation

Using a PEC (pulsed eddy current probe) to inspect remotely for material thickness under insulation

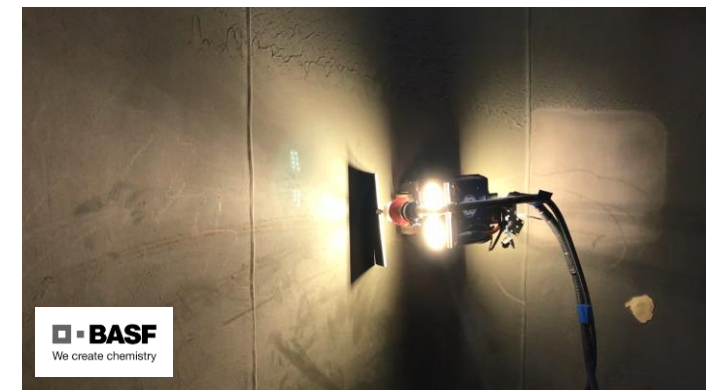
Good combination of two advanced technologies



Spark / Holiday Testing

Using conventional holiday / spark testers in rubber coated vessels / tanks for coating integrity check

Transition from manual to automated remote inspection



Latest Deployment

BIKE: Offshore Inspection in the Gulf of Thailand



- > 4 Vessels inspected in 2 days
- > 1 day for mobilization and demobilization



Digital Strategy – GEIR Competitive Advantage

From manual inspection to robotic inspection and the digital twin

Mobile Robotic Platforms

Hardware



- reliable / industrial / heavy duty
- platform design / adaptable / versatile
- agile and easy maneuverable
- inspection & maintenance

Software & Control

3D Control



- Simulation & 3D planning software
- 3D interactive control & inspection
- Tagging inspection data to 3D position
- Automated / autonomous inspection & re-inspection

Data & Connectivity

Digital Twin



Inspection Report

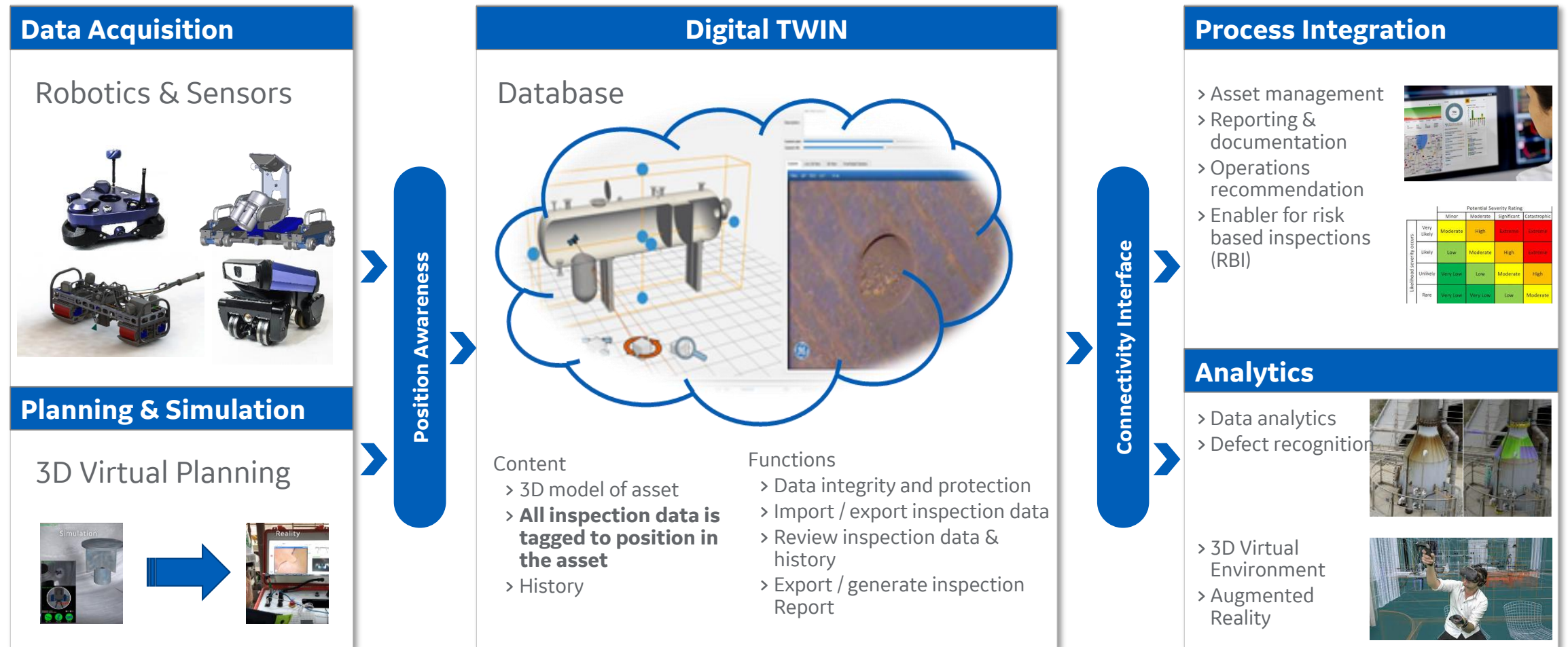


- Virtual asset assessment
- Automated on-site report generation
- Data analytics
- APM systems integration

All building blocks to cover the full value chain from autonomous robotic inspection to digital asset management

Digital Strategy – The Digital Twin

Bearing Point to Support Asset Performance Management

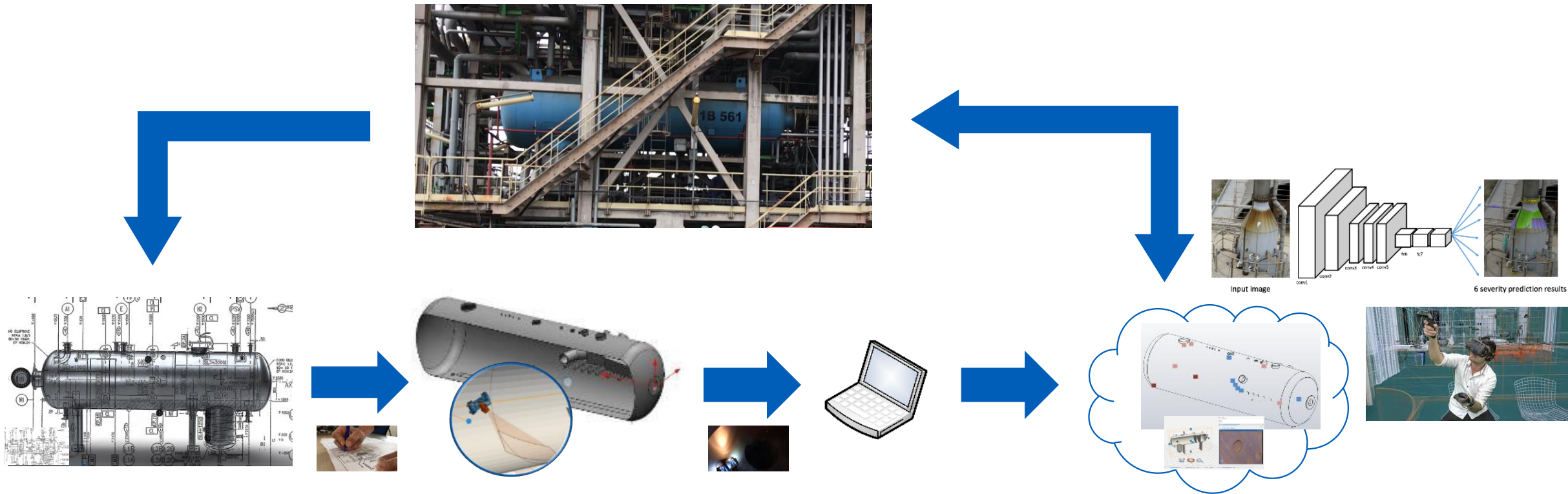


From the Physical Asset ...



... to a Digital Twin

A Digital Twin of a Pressure Vessel



▪ 3D Virtual Vessel

- 3D CAD Model
- LADAR Point Cloud
- Simplified Modeling

▪ Robotic Inspection:

confined space robotic asset inspection

▪ 3-D localization:

- model based localization of
- Robot
- Camera Field of View
- Inspection Sensor Position

▪ Tagging:

Position, assetID and timestamp association to the data

▪ Storage:

continuous, safe and consistent data storage during the inspection

▪ Upload Interface:

authorization, asset identification data transfer

▪ **Database:** Assets, Models, Inspection Data , History, Customer Site Integration

▪ **Visualization:** 3D asset and data representation, user experience

▪ **Data Analytics:** Automated defect recognition



Inspection Robotics