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EDF R&D NEW TEST BENCH FOR LIQUID INDUSTRIAL FLOWMETER CALIBRATION

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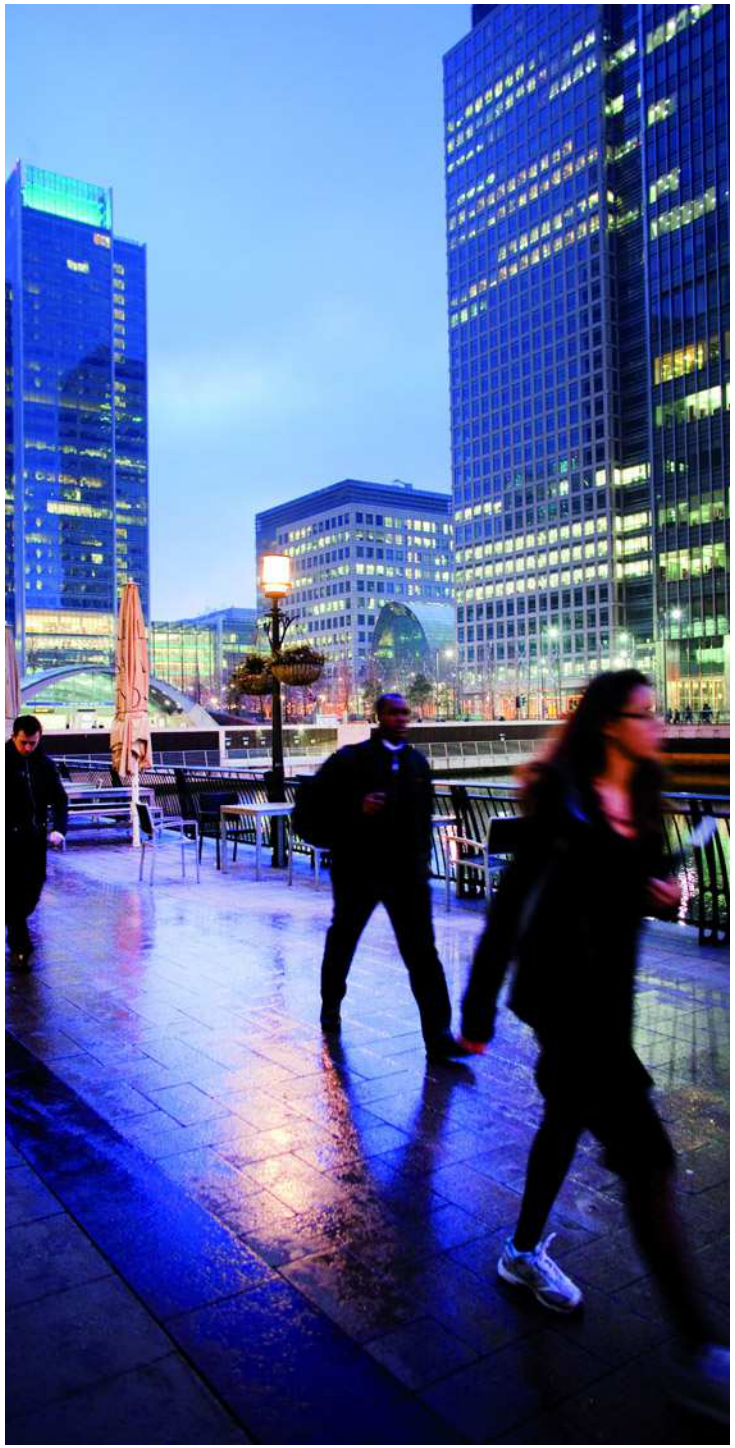


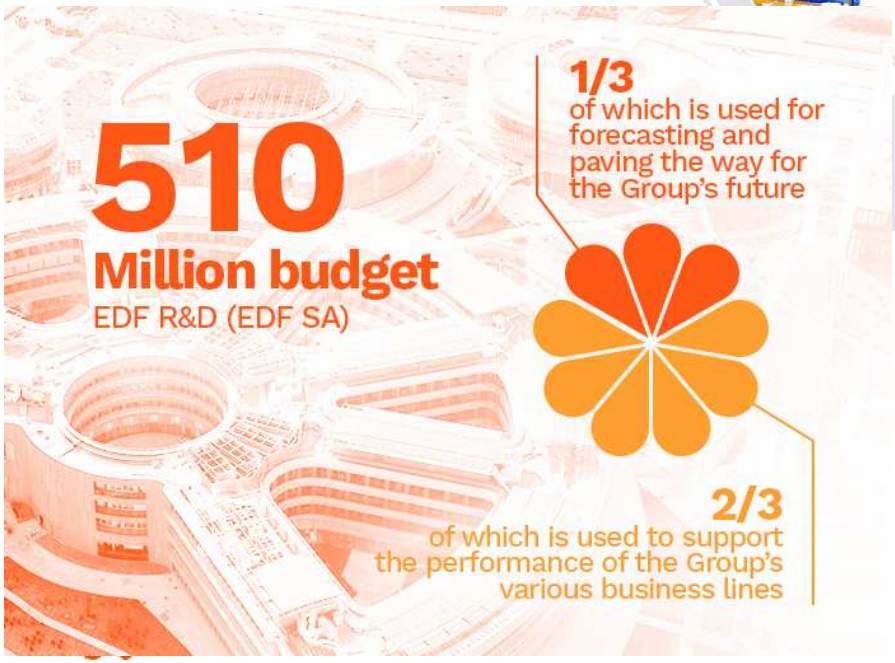
PRESENTATION OUTLINE

1. EDF R&D OVERVIEW
2. FLOWMETER CALIBRATION ISSUES FOR EDF
3. THE NEW EVEREST LOOP GLOBAL DESIGN
4. MONT-BLANC TEST BENCH LAYOUT AND PURPOSE
5. CONCLUSION AND PERSPECTIVES

EDF Research & Development

1900 employees in France

225 employees outside France



FRANCE

Île-de-France

EDF Lab Chatou

EDF Lab Chatou is a long-established R&D site with cutting-edge expertise in hydraulics, renewable energies, nuclear power and environment.

A FEW FIGURES

13 hectares

61,000 m² of testing rooms

More than 500 workstations

3 research departments

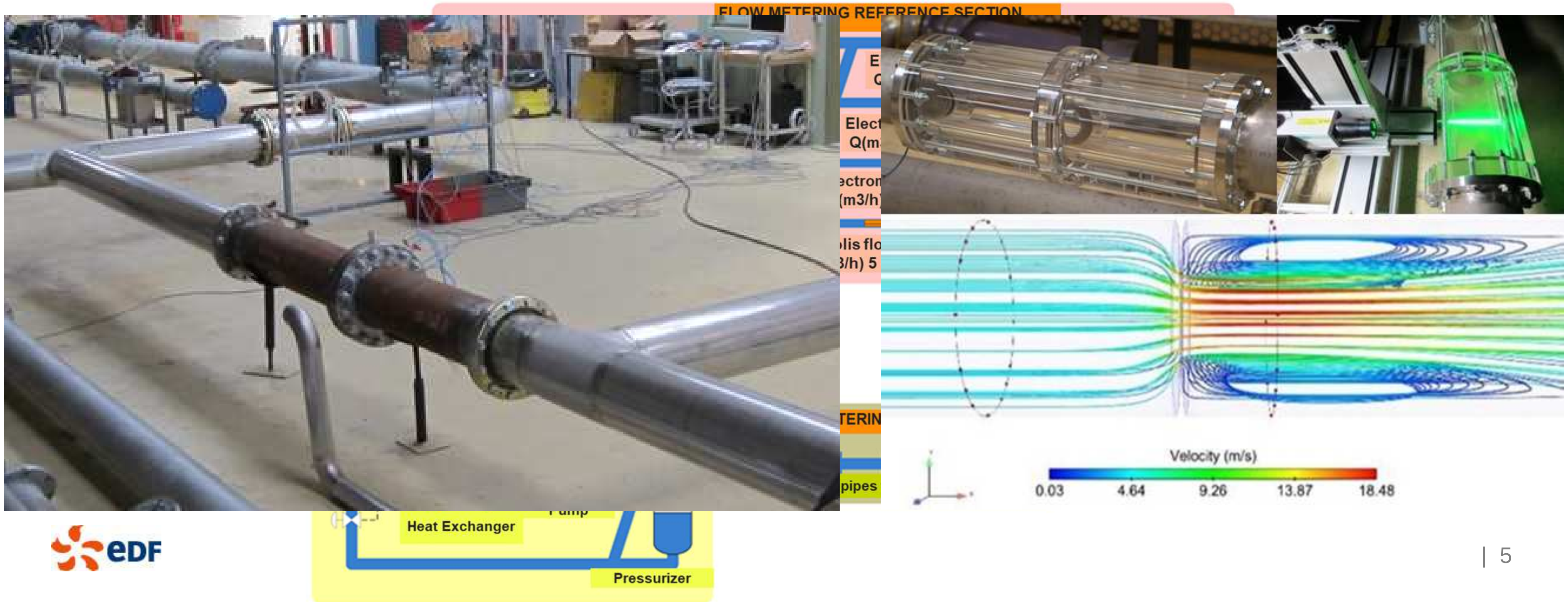
INDUSTRIAL FLOWMETER CALIBRATIONS AT EDF R&D

EDF R&D calibration test bench for:

- assessing flowmeters metrological behaviour in semi real industrial conditions prior to on-site installations
- testing innovative flowmeters metrological performance
- providing experimental data to validate Computational Fluids Dynamics (CFD) software in liquid industrial pipe flow configurations

An original design concept of EVEREST (1997) with two main objectives:

- to duplicate the behaviour of an industrial liquid pipe flow process as closely as possible
- to generate an accurate and steady reference flow rate



INDUSTRIAL FLOW METER CALIBRATIONS AT EDF R&D

EVEREST (1997-2017) limitations

- reference flow rate uncertainties need an upgrade
  - ➢ 0,3%-0,5% is no longer relevant for current R&D investigations
- increase of bench maintenance costs due to ageing piping
  - ➢ no stainless steel pipe in the operation section
- new environmental challenges
  - ➢ to decrease test benches environmental impact by efficiently managing water consumption

⇒ a complete revamping of the EVEREST test bench is needed

THE NEW EVEREST LOOP GLOBAL DESIGN(S)

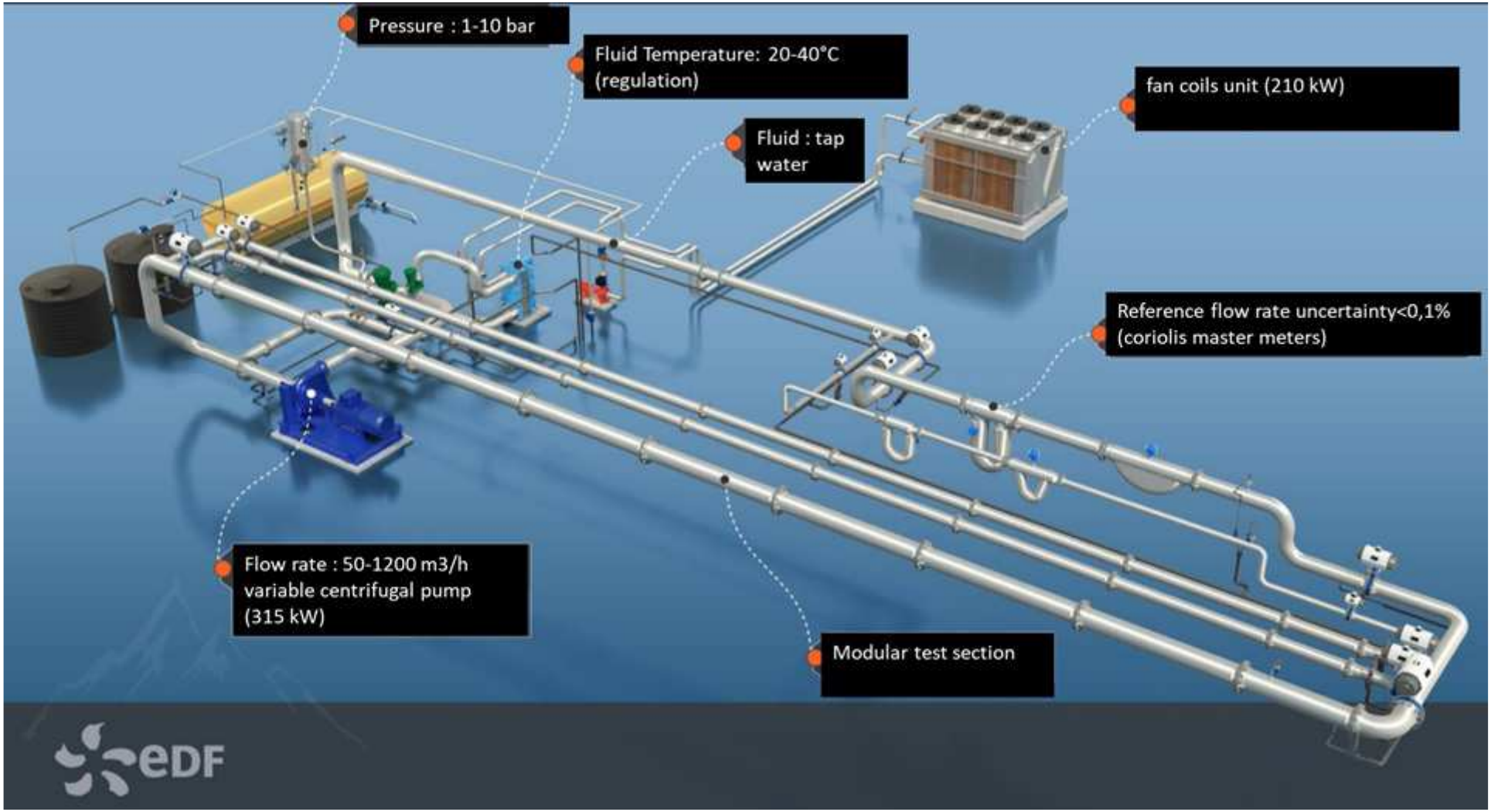
Two objectives:

- to maintain the specificity of the previous version
  - ➢ generation of a steady liquid flow rate for test/calibration purposes in a semi-industrial scale
- to add new features such as
  - ➢ increasing the accuracy of flowmeter calibrations
  - ➢ providing tools for liquid velocity profile characterisation for realistic pipe flow configurations
  - ➢ efficiently managing of the experimental loop environmental impact

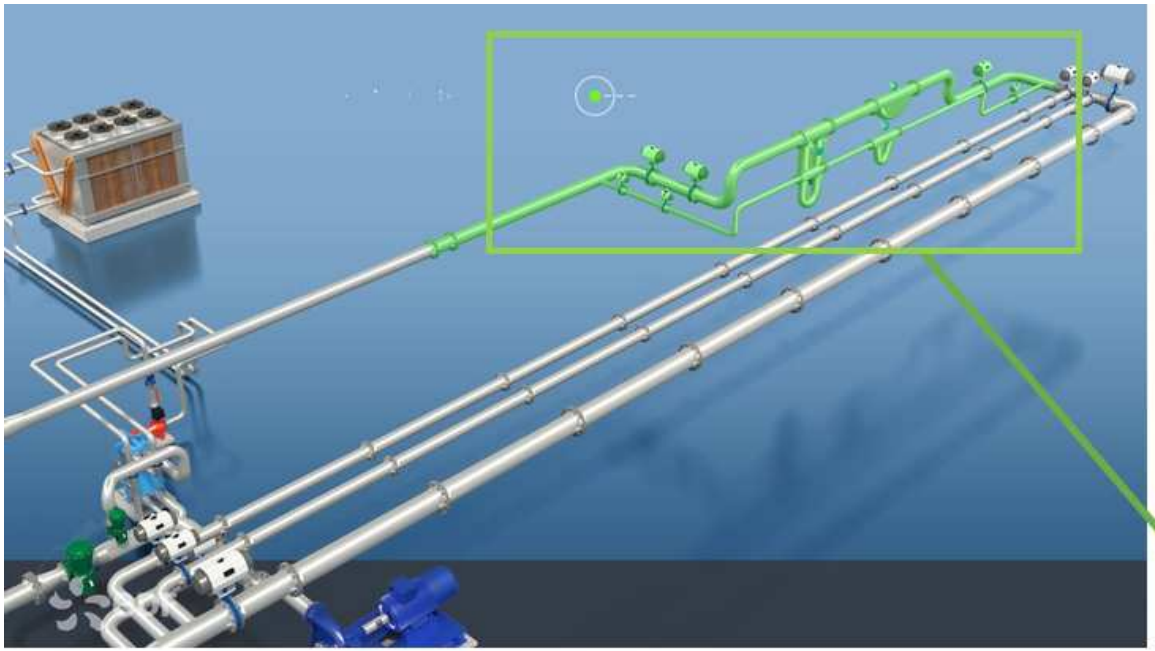
⇒ These objectives have been achieved in 2019 with not one but two test benches:

- ❑ EVEREST (version 2019)
- ❑ MONT-BLANC (small version of EVEREST for velocity measurements (and calibration too!)

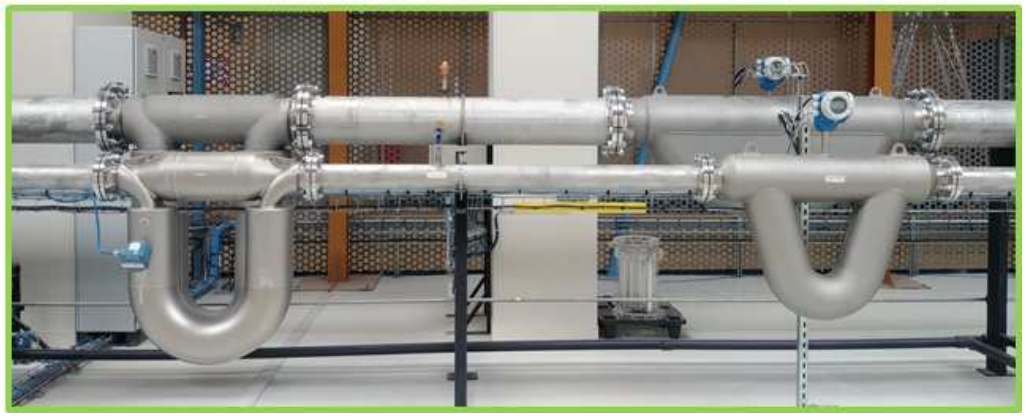
EVEREST (2019): GLOBAL DESIGN



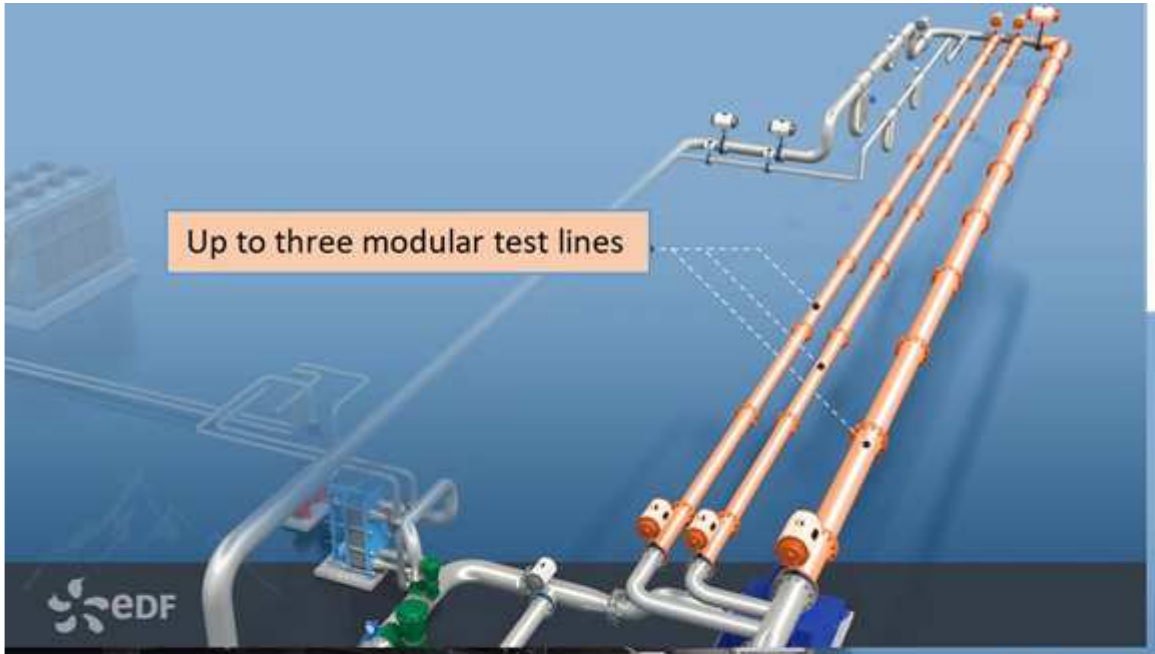
EVEREST (2019): REFERENCE SECTION

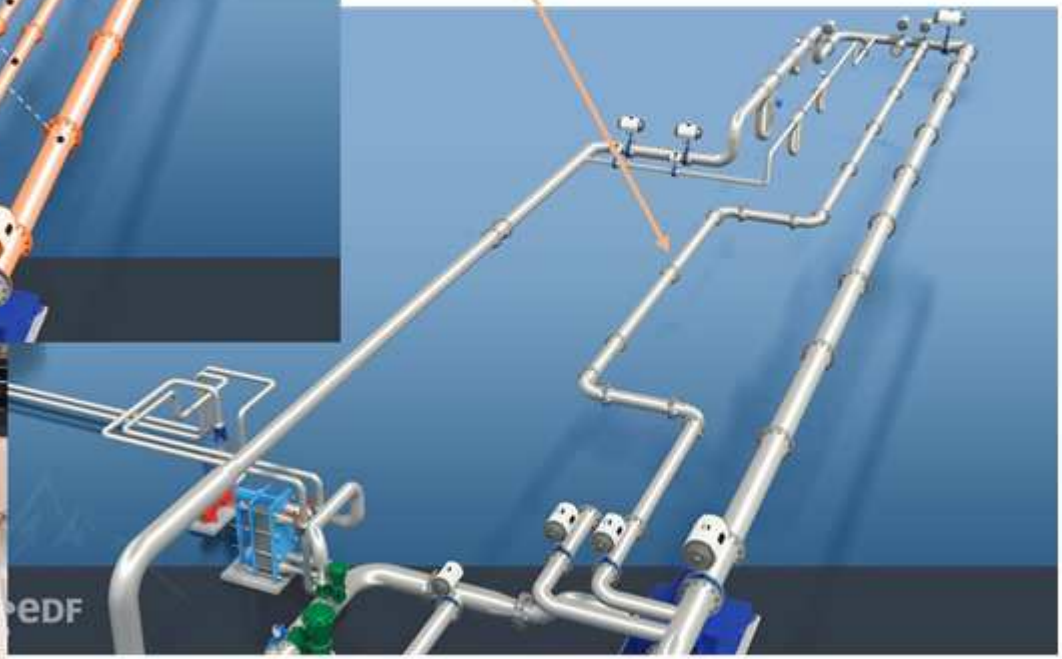


EVEREST Reference Section



EVEREST (2019): MODULAR TEST SECTION





MONT-BLANC LOOP: FOR EASIER VELOCITY PROFILE MEASUREMENTS IN PIPES

Two main purposes:

- to investigate flowmeters uncertainties under low flow rates
  - ➢ from 13 m^3/h up to 150 m^3/h
- to prepare and adjust velocity measurement systems prior to any experimental campaigns on EVEREST
  - ➢ smaller pipe size for better laser-based velocity measurements all over the inner pipe diameter
  - ➢ easier management of pipe configuration setting changes

MONT-BLANC LOOP: FOR EASIER VELOCITY PROFILE MEASUREMENTS IN PIPES

Current laser based velocimetry test configuration on MONT-BLANC

Square section Plexiglas pipe for future 3D3C PIV investigations (work in progress)

CONCLUSION

EDF R&D has upgraded its flow rate experimental tools:

- EVEREST loop for industrial flowmeter uncertainty investigation under a realistic semi-industrial environment
- MONT-BLANC to characterise velocity profile of flows in any industrial pipes configurations

The next steps:

- to achieve an official recognition for our know-how through ISO17025 accreditation (by COFRAC : the French accreditation committee)
- to perform flow velocity measurements in circular pipe settings with a 3D3C PIV system

Thank you for your attention