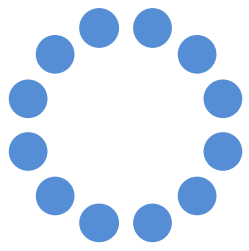


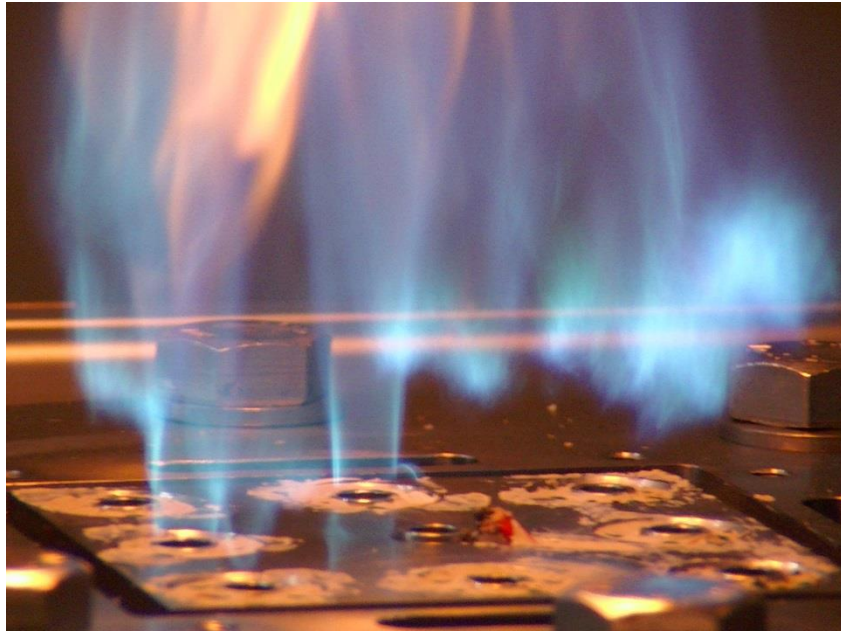
COMBUSTION BAY ONE

advanced combustion management



COMBUSTION BAY ONE

advanced combustion management

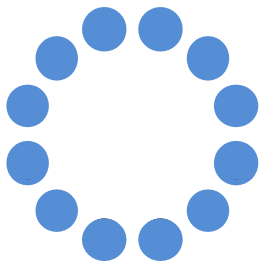


Combustion Bay One e.U.

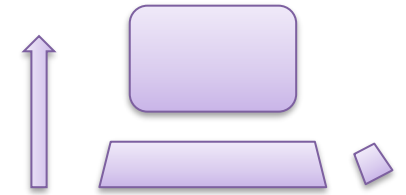
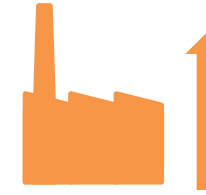
**Facilities
& technical resources**

Fabrice GIULIANI,
Nina PAULITSCH,
Andrea HOFER

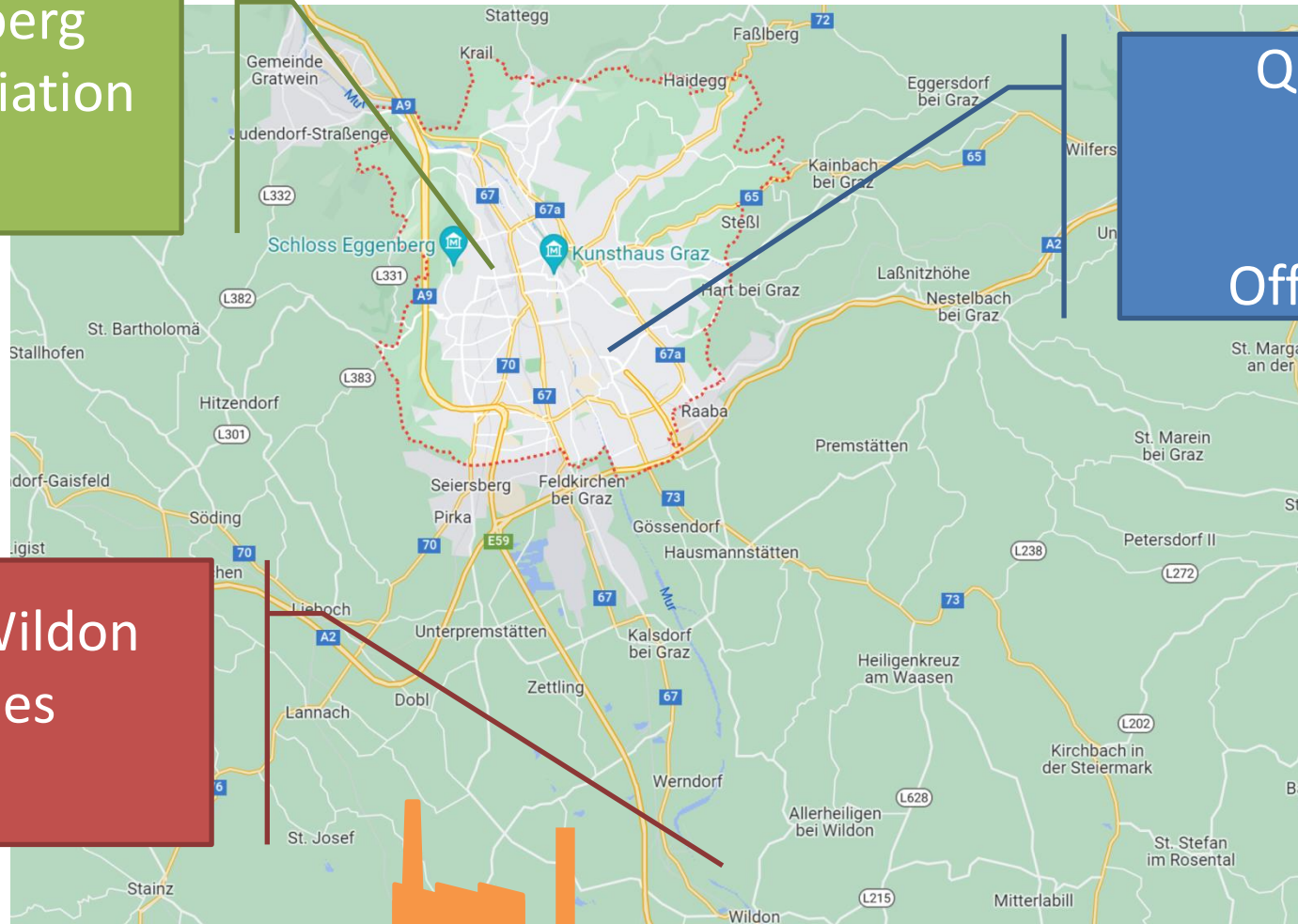
Combustion Bay One e.U.,
Graz, Austria
www.CBOne.at



CBOne's locations



Quartier Eggenberg
FH Joanneum / aviation
kW lab



Quartier Schiller
CBOne / HQ
CBOne / RD
Offices & small lab

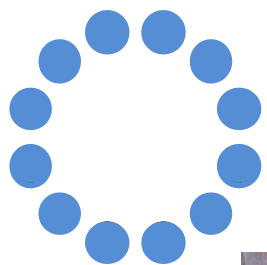
Industry Zone Wildon
P&P Industries
MW lab

TU Graz cooperation
Lectures
Competences
Instruments

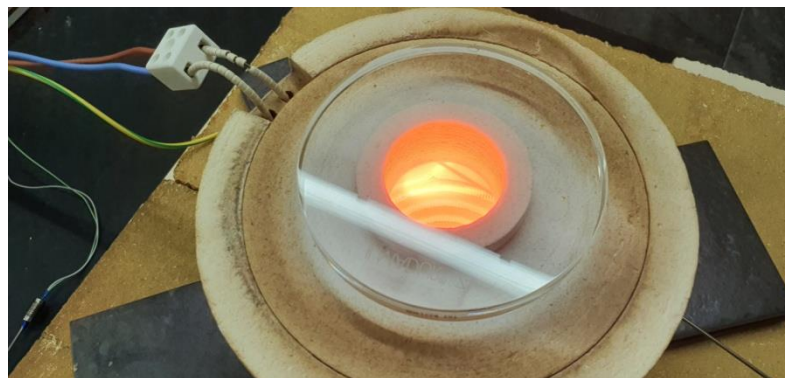
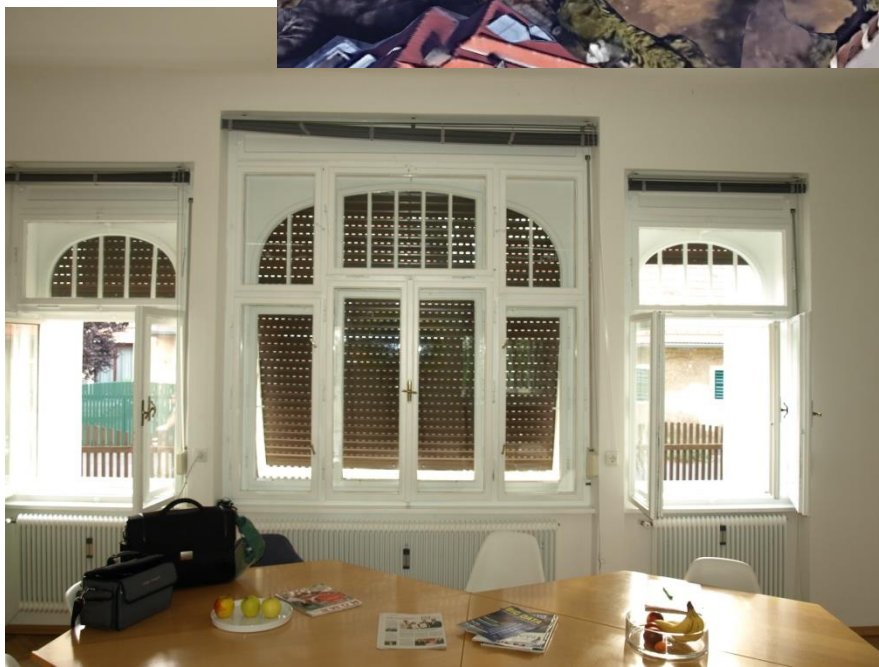
CNC parts, welding &
additive
manufacturing

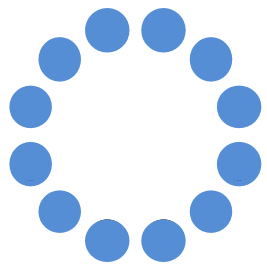
Computational power



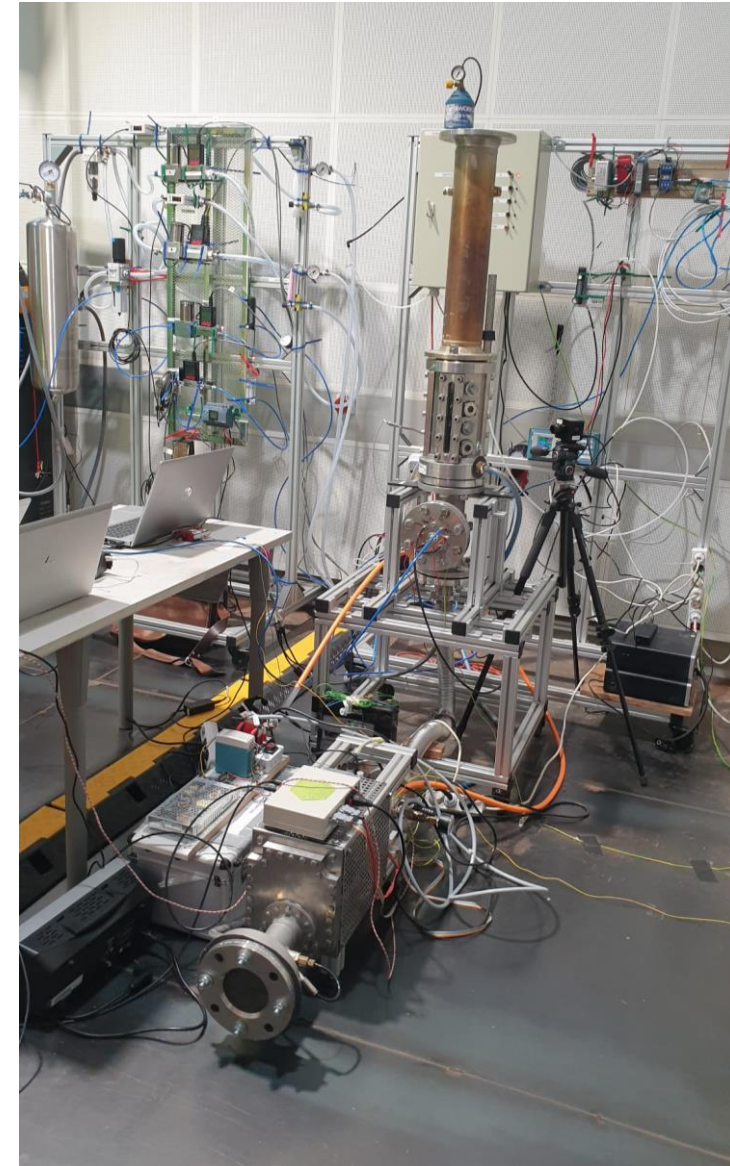


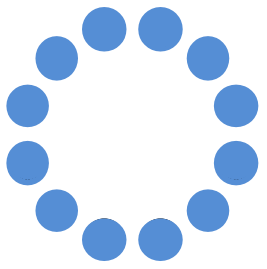
CBOne / RD



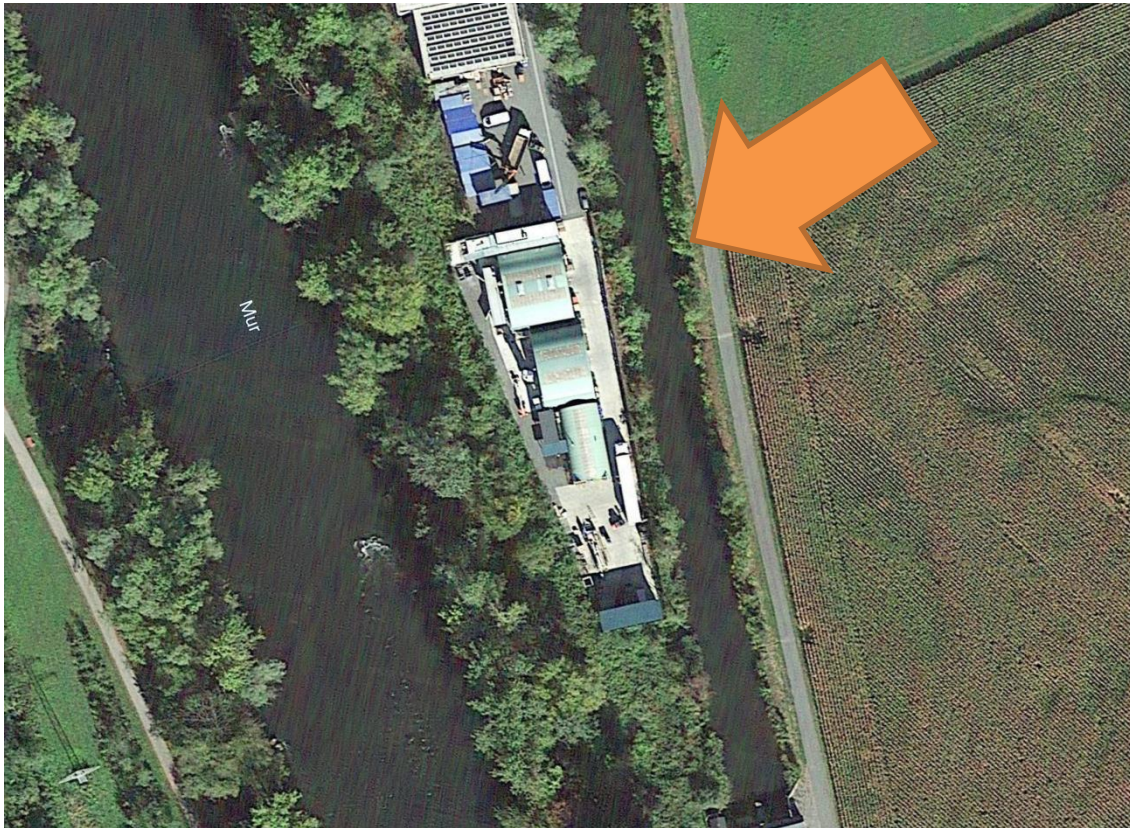


FH Joanneum / Aviation





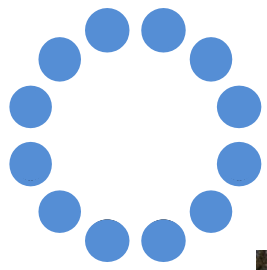
P&P Industries / Wildon



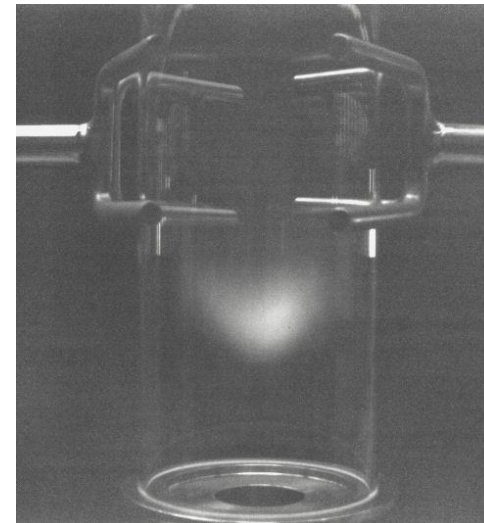
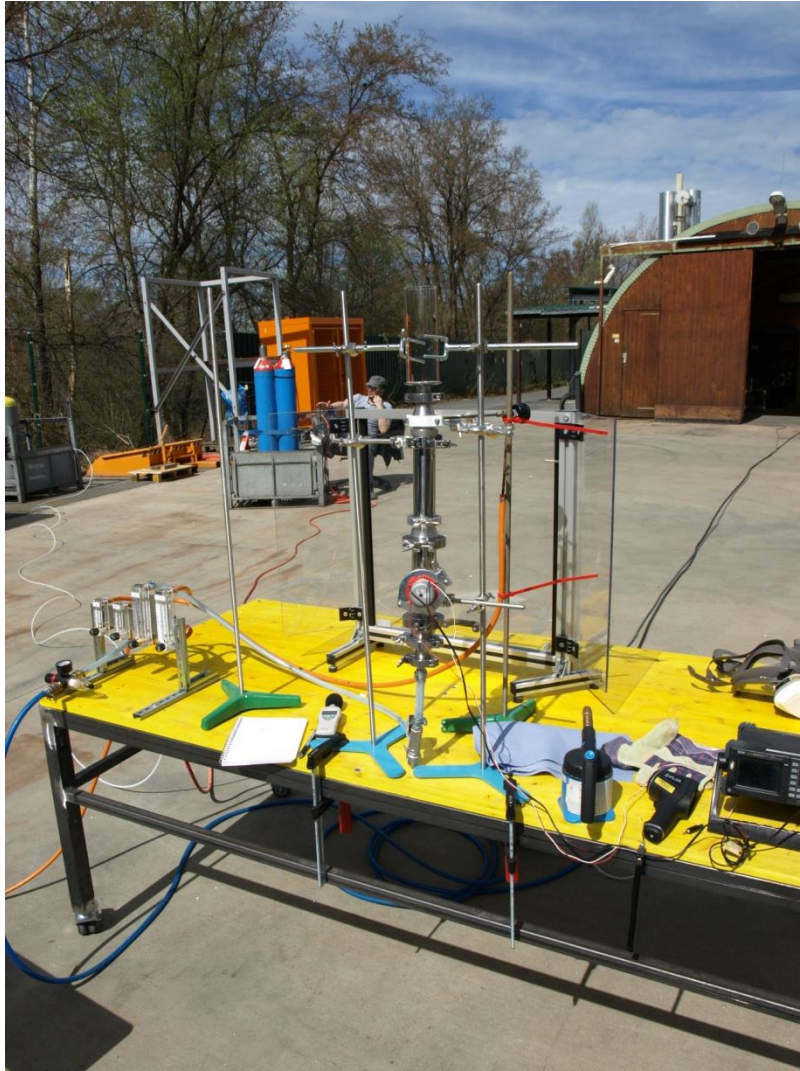
South of the Mellach power plant

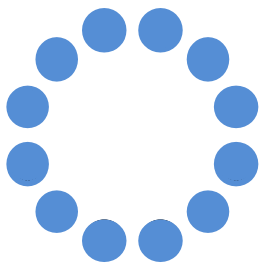
Zone industry II

Manipulation of H₂, NH₃ and SH₂ granted

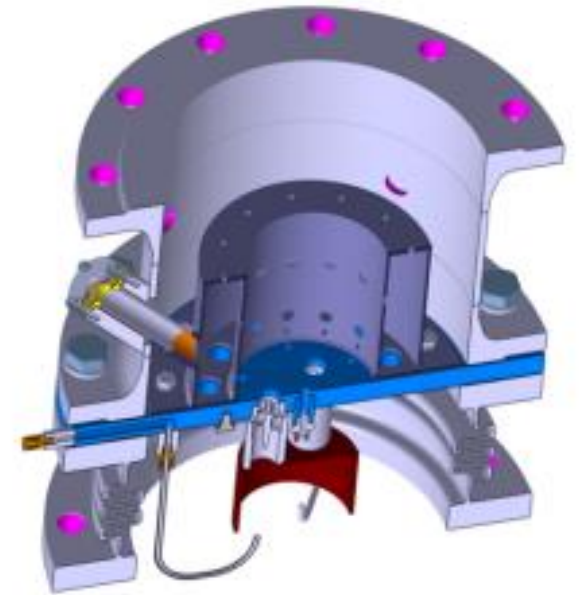
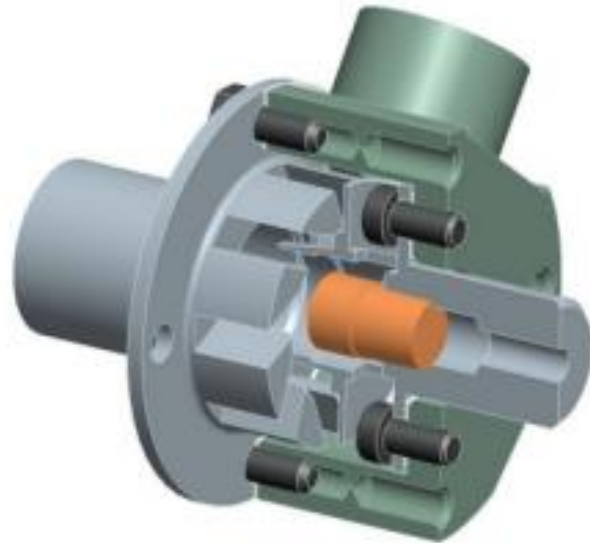
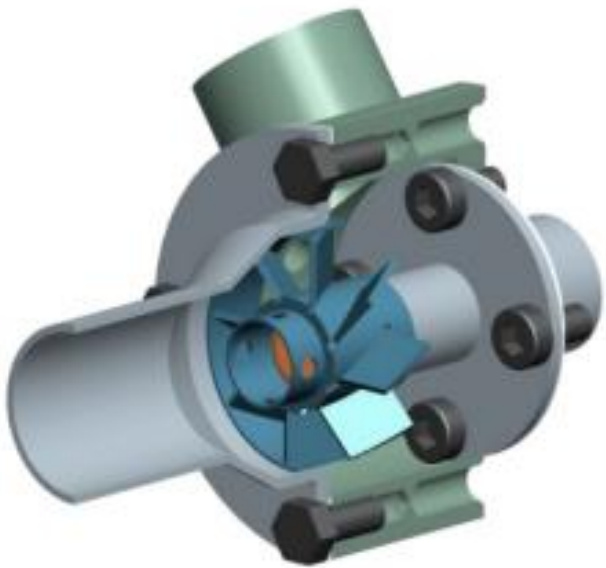


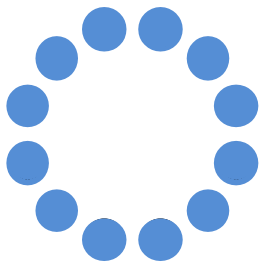
P&P Industries / Wildon



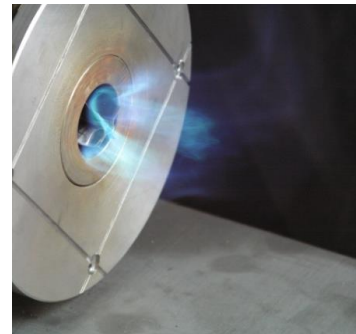
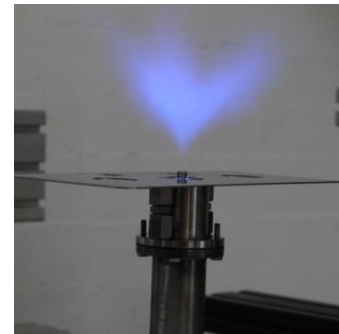
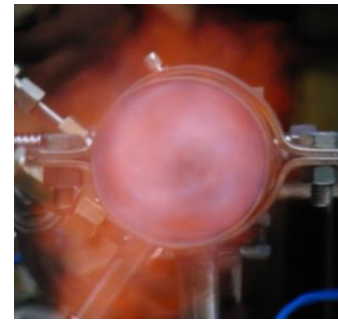
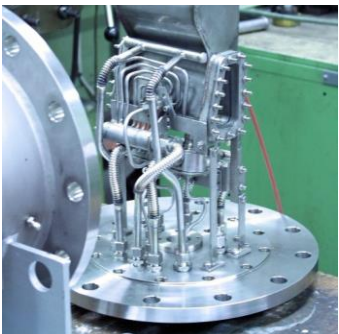
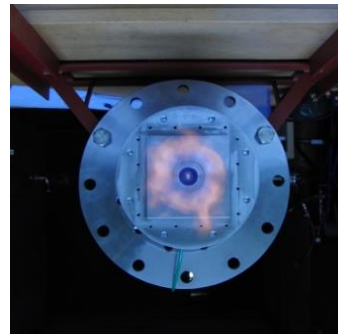
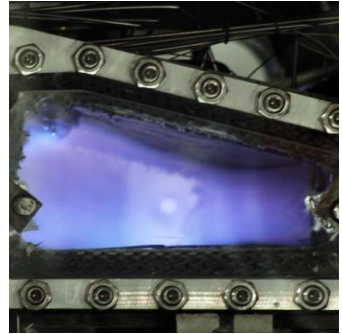
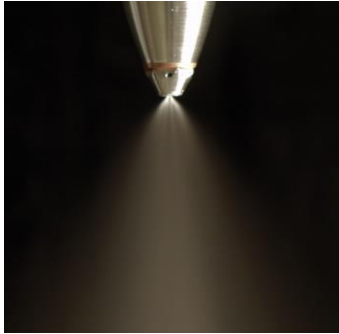
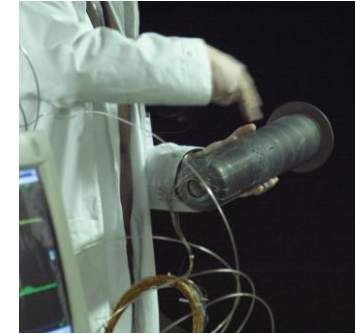
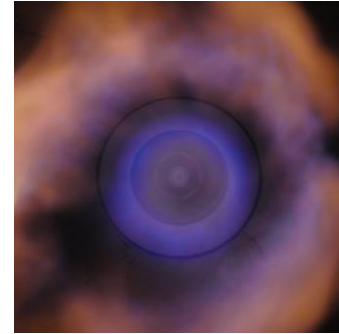
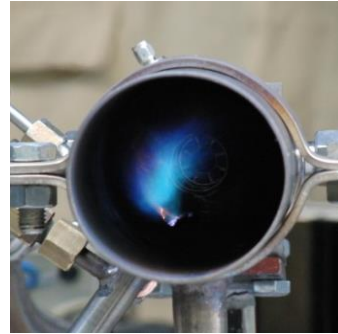
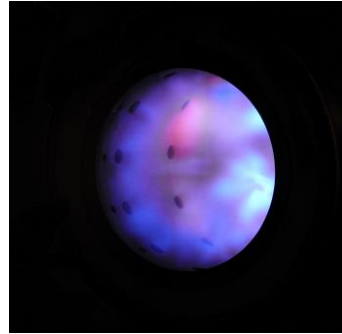
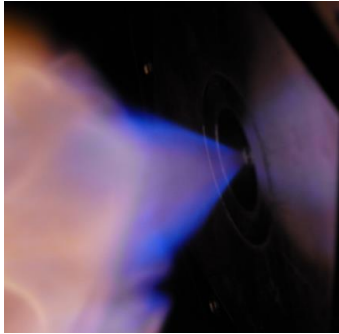


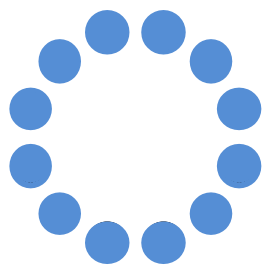
Drafting, manufacturing & testing our own designs



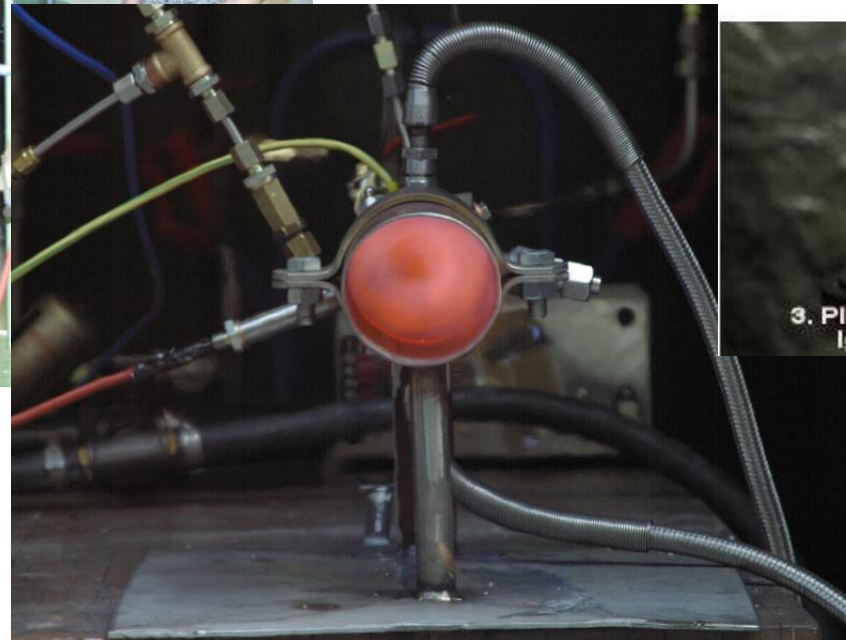
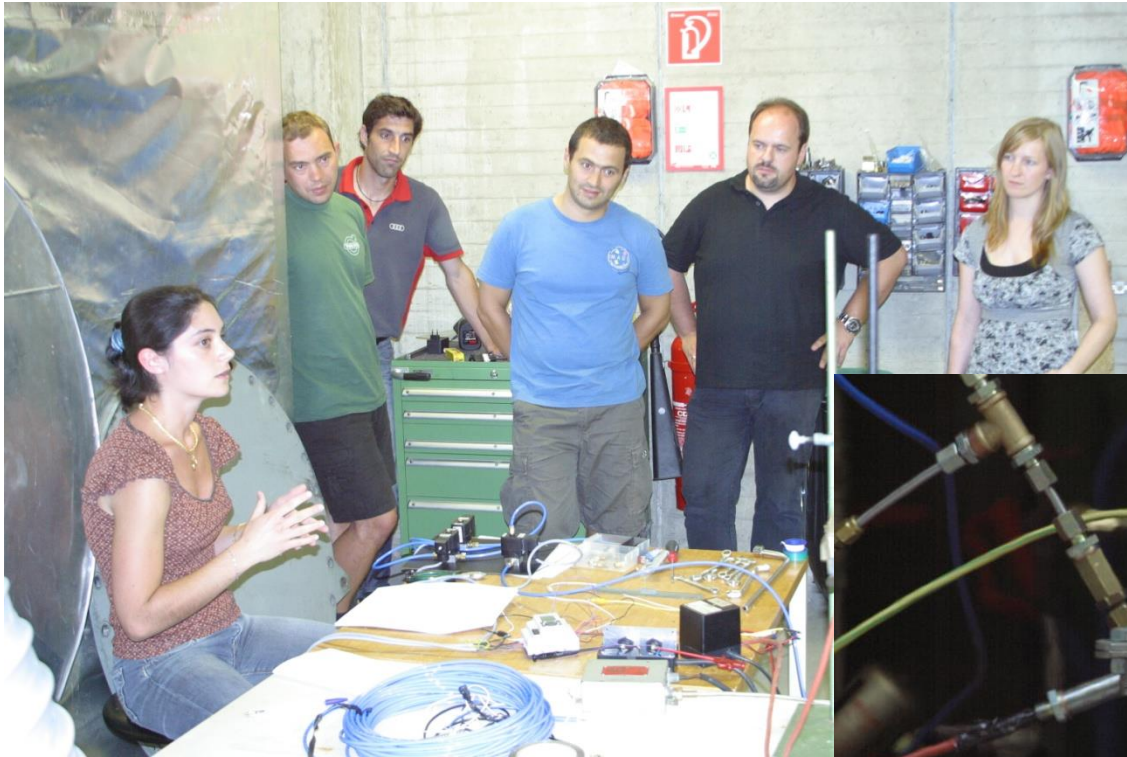


Medley engineered solutions

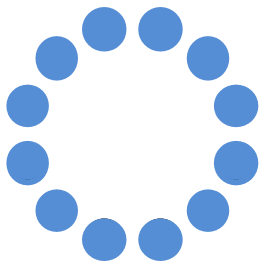




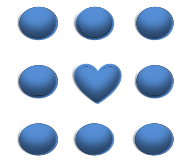
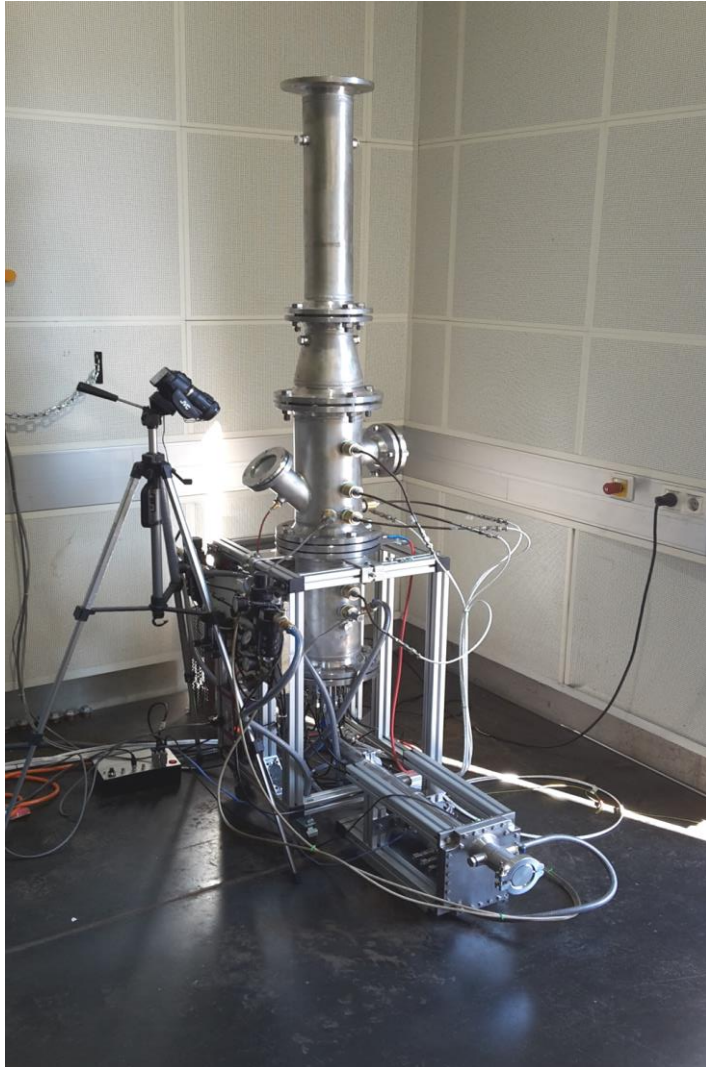
Example: Safe, Smart, Smooth & Reliable ignition system (S3R)



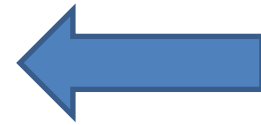
Early works by A. Camps.
2008 @ TU Graz



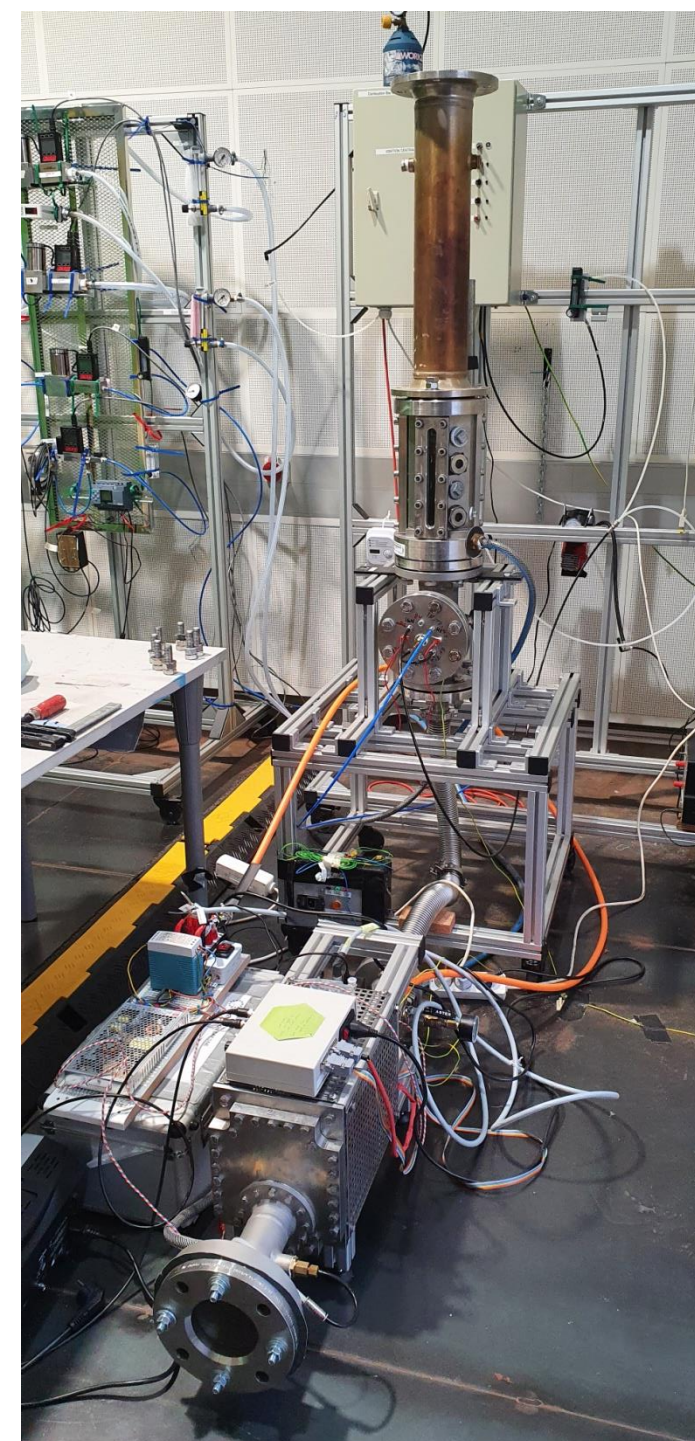
Example: the MethaNull and emootion test rigs

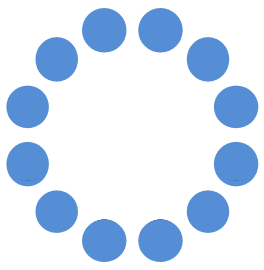


METHANULL

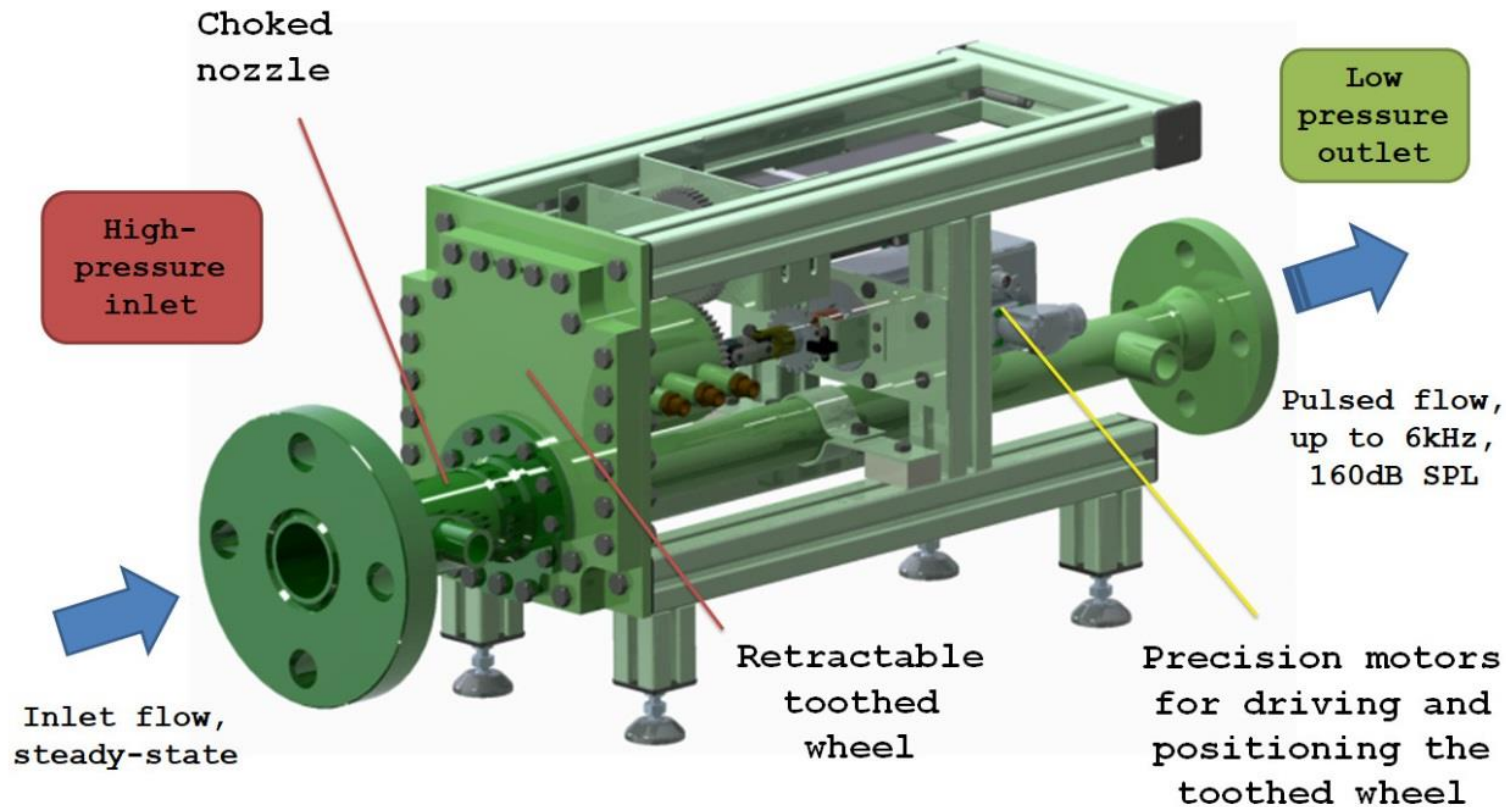


emootion





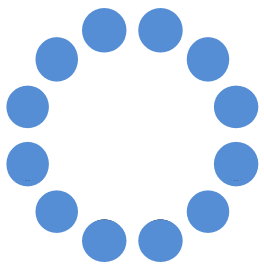
Example: CBOne's siren-type flow pulsator



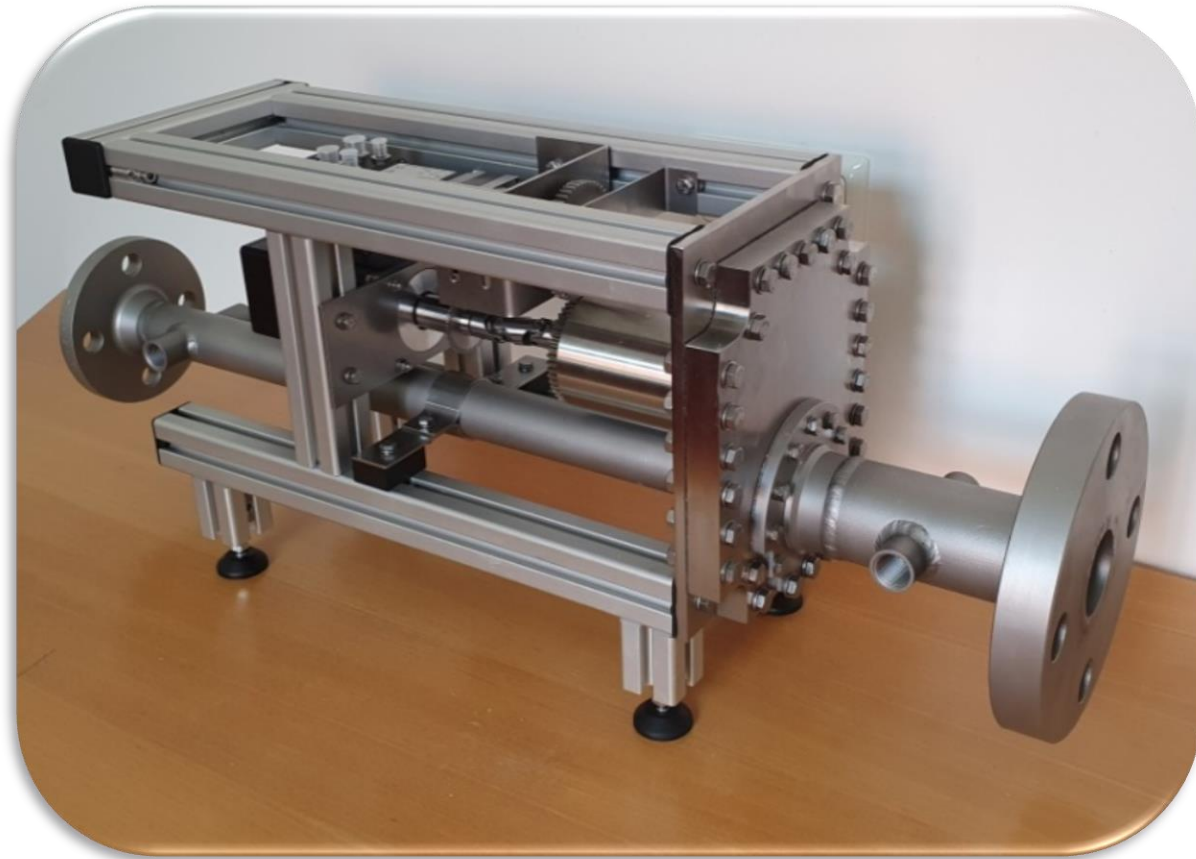
- High pressure side up to **80bar**

- Low pressure side up to **40bar**

- Pulsation frequency up to **6000Hz**

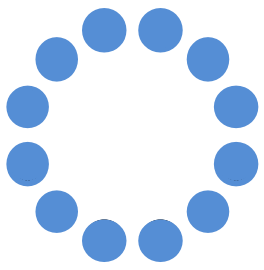


Example: CBOne's siren-type flow pulsator

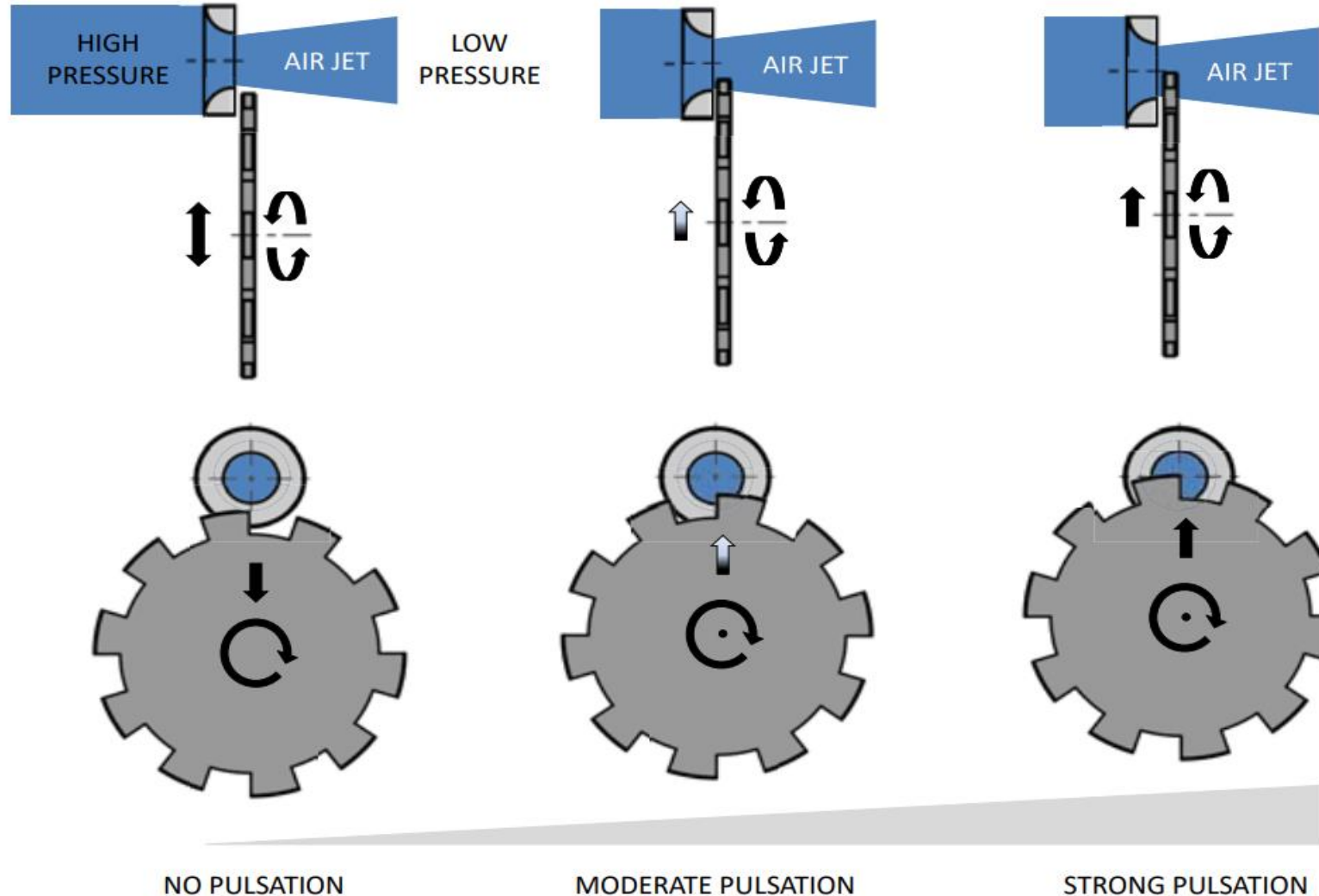


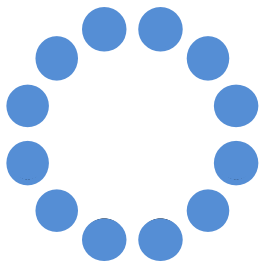
- Air mass flow rate up to **3kg/s** under maximum pressure drop and 30% pulsation

- Noise levels up to **160 dB SPL**



Example: CBOne's siren-type flow pulsator





Example: CBOne's siren-type flow pulsator

Surface ratio of disc ϕd	3/4	1/2	1/4
Slot shape			
Width (% d)	63.5%	40.4%	19.8%
Surface of circumscribing rectangle $d * h$	92.8%	97.2%	99.3%

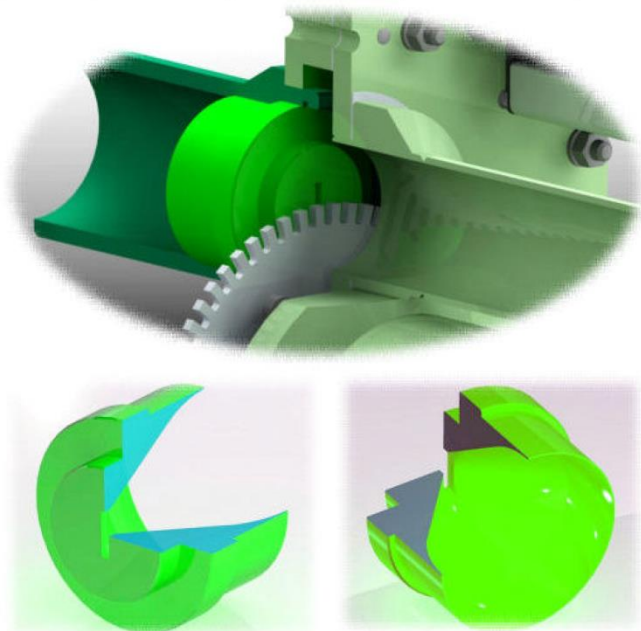
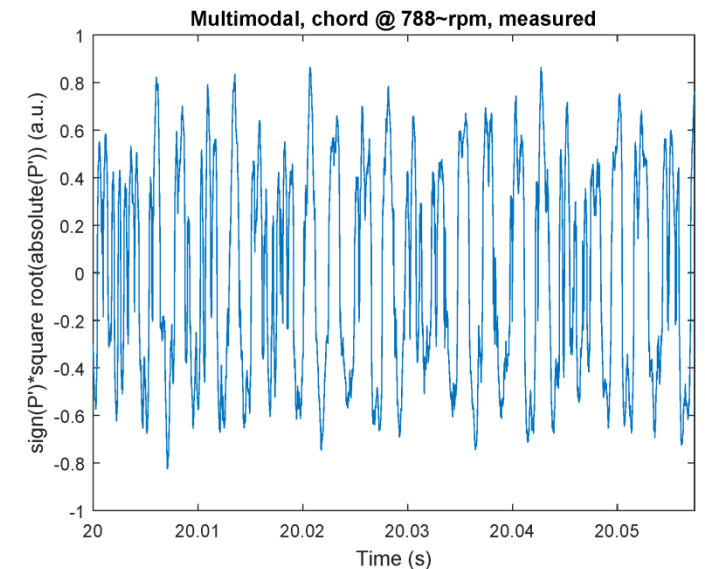
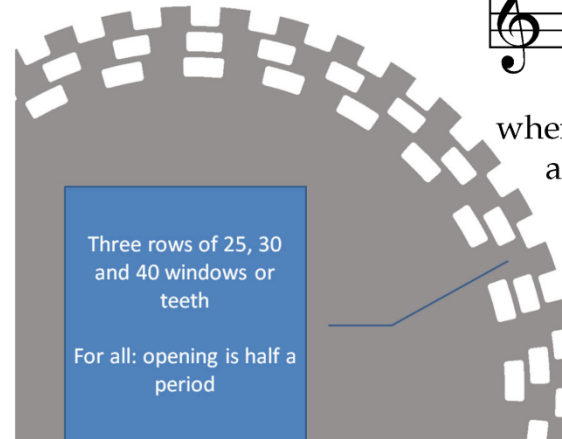
← Calibrated pulsation until 6 kHz

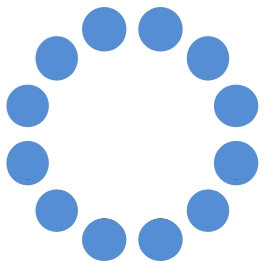
Multimodal sound ↓

This wheel plays

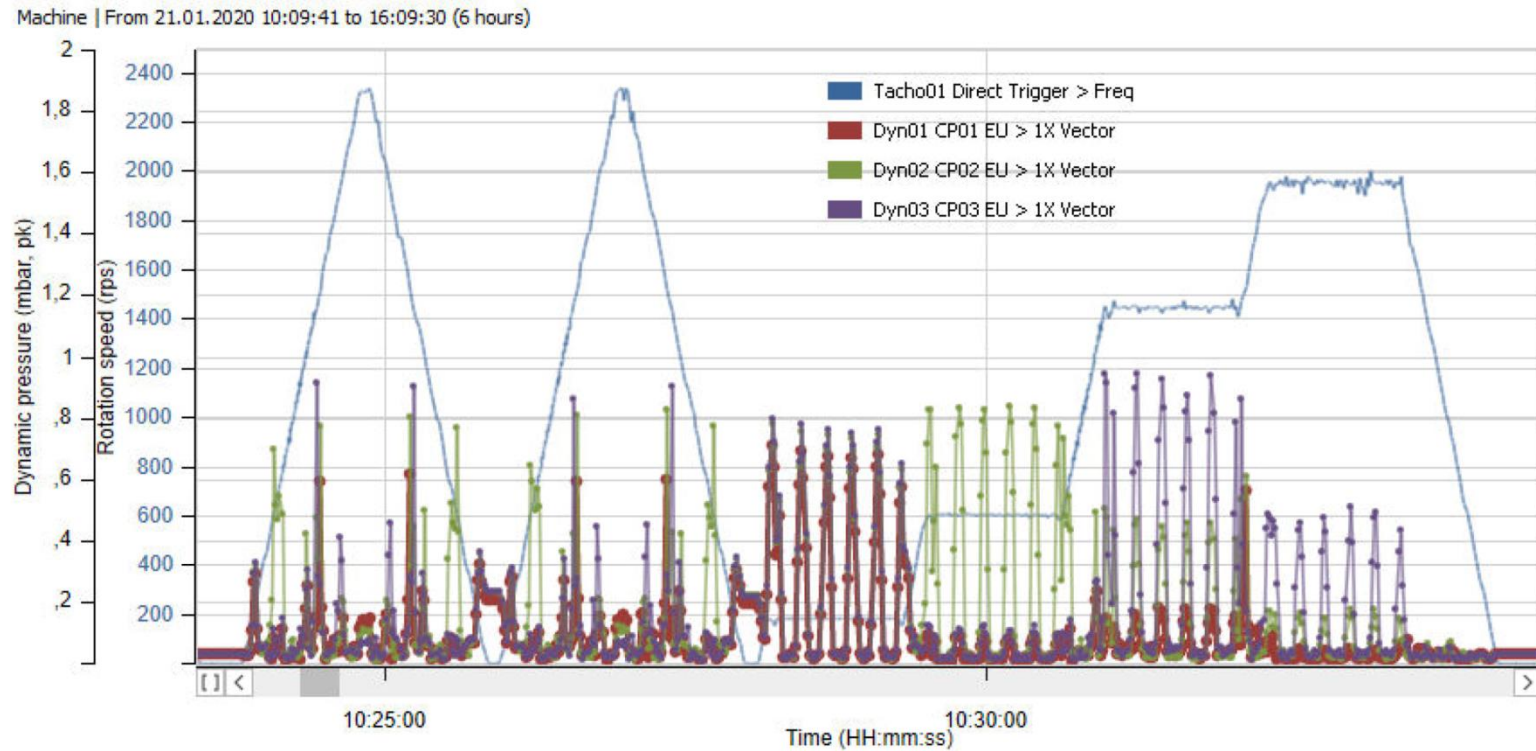
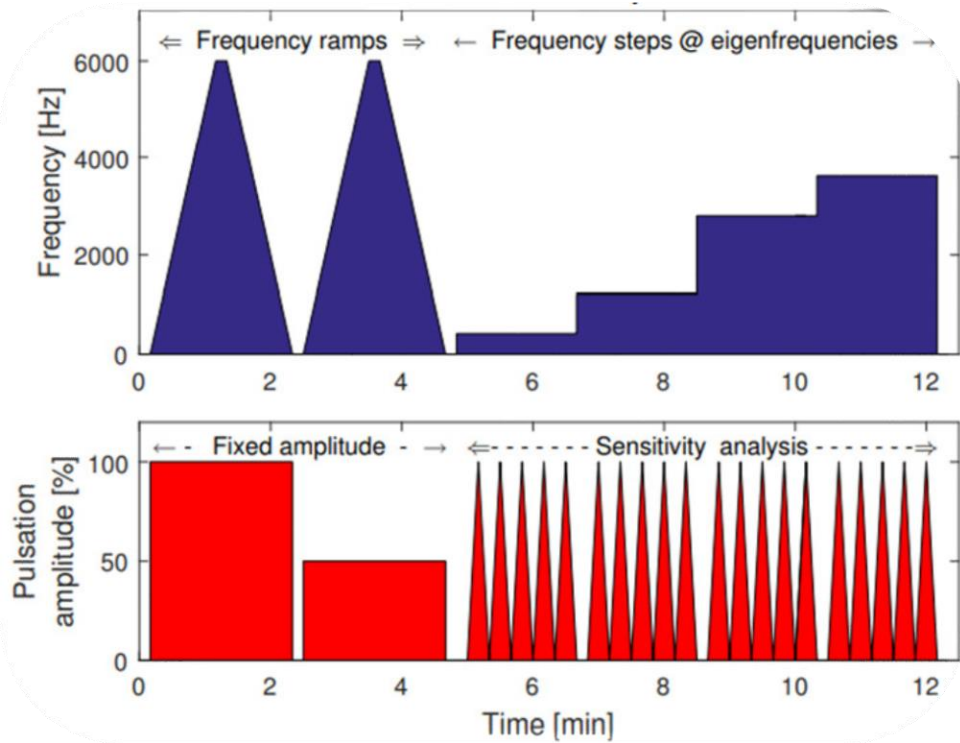


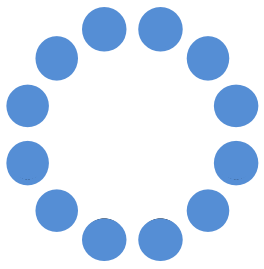
when rotating at 788 rpm.



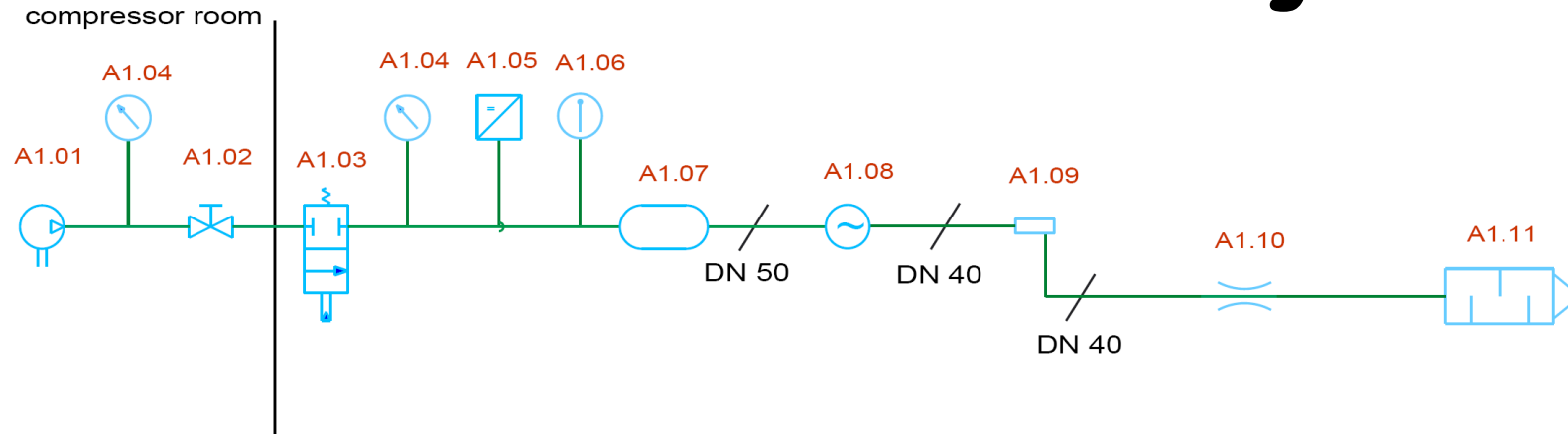


Example: CBOne's siren-type flow pulsator





The siren as a fast pressure transducer calibration system



Typical Parameters @ $T_{atm}=293K$

mass flow air = up to 3000 g/s
 volume flow air = up to 150 m³/min
 $P_{lowPressure}$ = 40 bar
 $P_{highPressure}$ = 80 bar
 $P'_{lowPressure}$ = 180 dB

- A1.01: Compressor - 80 bar
- A1.02: Manual shut-off valve
- A1.03: 2/2-way valve with return spring
- A1.04: Pressure manometer
- A1.05: Mass flow meter
- A1.06: Temperature sensor
- A1.07: Settling chamber
- A1.08: Siren
- A1.09: Probe carrier (total pressure)
- A1.10: Throttle
- A1.11: Silencer/Muffler

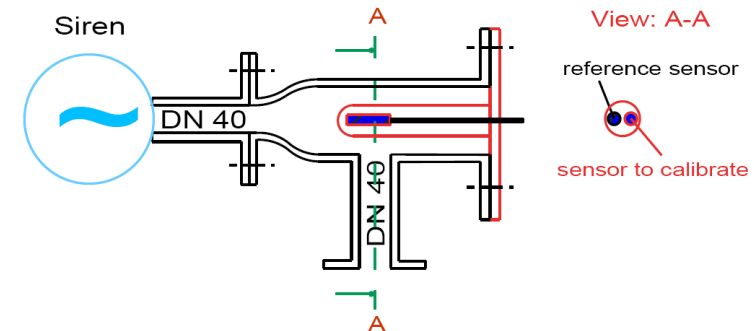
Detail - A1.10 Throttle:

Recommendation:
 Use the same type of nozzle as mounted in the siren with the double cross section area for the throttle

siren nozzle:
 80 --> 40bar

throttle nozzle:
 40 --> 1bar

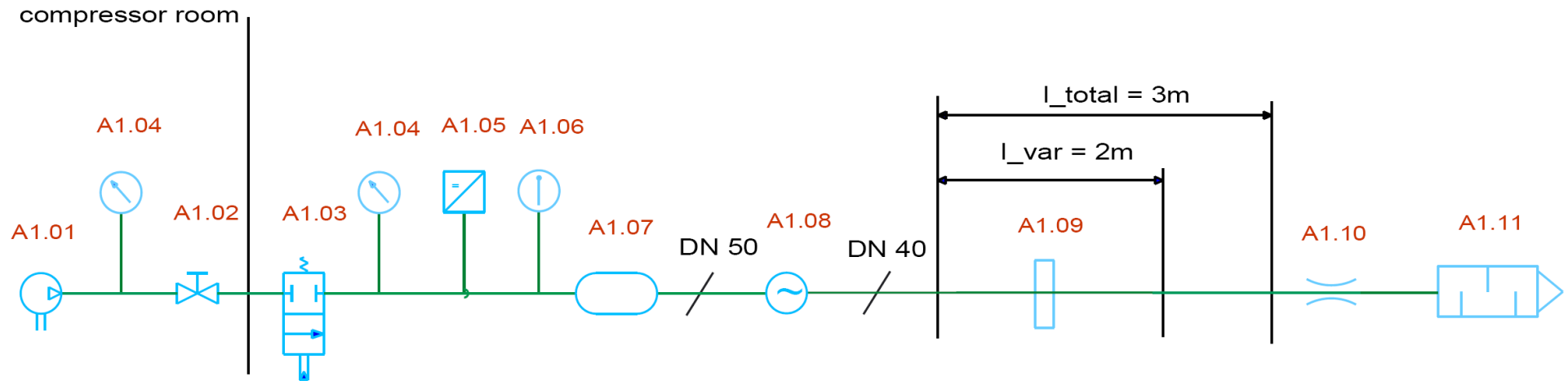
Detail - A1.09 Probe Carrier (total pressure):



Recommendation:

The probe carrier should be mounted as near as possible to the outlet of the siren

The volume flow has to be isokinetic - the same flow velocity everywhere:
 - divergent (DN40 --> DN65)
 - length of divergent min. 6xD (approx. 300mm)
 - following pipe DN40



Typical Parameters @ $T_{atm}=293K$

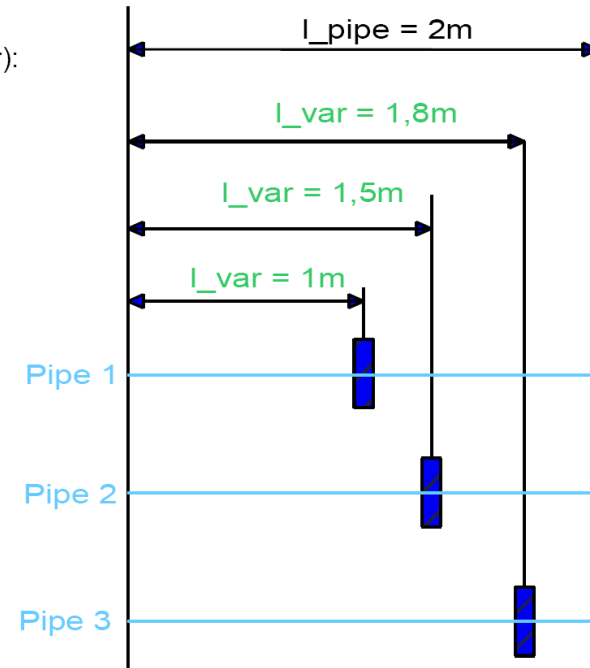
mass flow air = up to 3000 g/s
 volume flow air = up to 150 m³/s
 $P_{lowPressure}$ = 40 bar
 $P_{highPressure}$ = 80 bar
 $P'_{lowPressure}$ = 180 dB

- A1.01: Compressor - 80bar
- A1.02: Manual shut-off valve
- A1.03: 2/2-way valve with return spring
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- A1.07: Settling chamber
- A1.08: Siren
- A1.09: Probe carrier (resonator)
- A1.10: Throttle
- A1.11: Silencer/Muffler

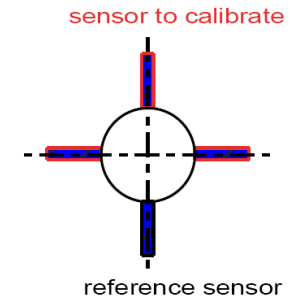
Detail - A1.09 Probe Carrier (resonator):

Recommendation:
 Pipe after the siren is mounted with a flange connection (PN40).
 The first 2m length of the pipe is interchangeable. The last 1m is fix.

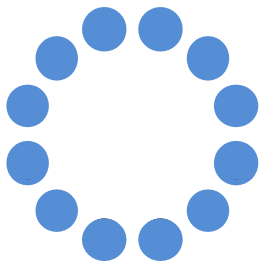
3 different locations of the probe carrier on the interchangeable pipe to avoid the possibility of measuring the zero crossing of the acoustic wave. Therefore 3 different pipes with mounted probe carrier, which distributes 3 sensors to calibrate and 1 reference sensor around the circumference.



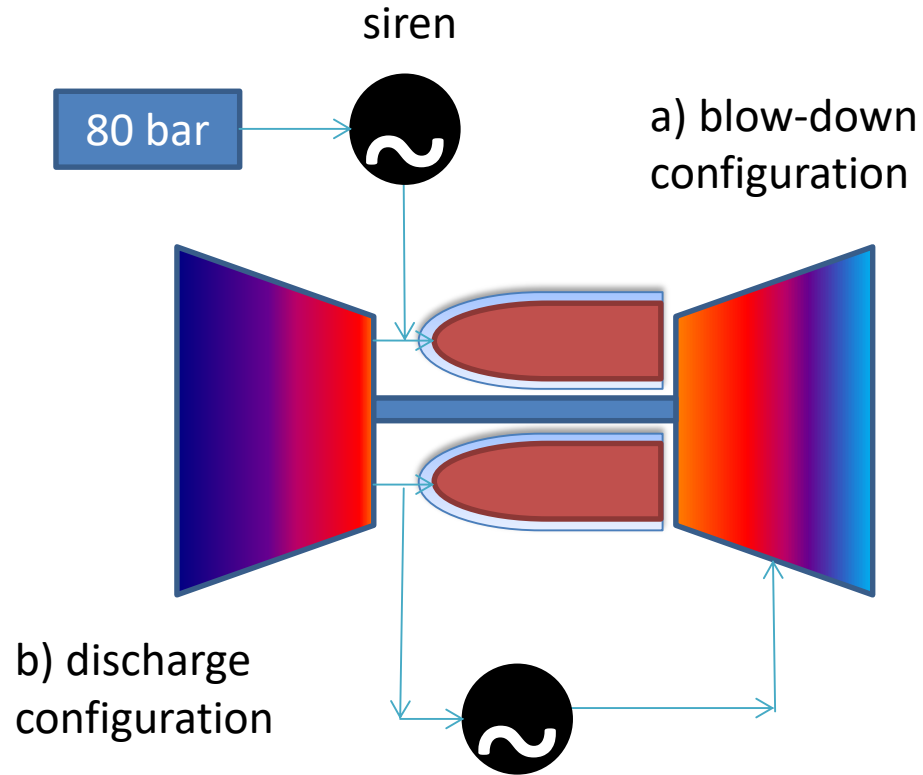
3 probe carrier pipes with different location of the probe carrier



Distribution of the sensors around the circumference

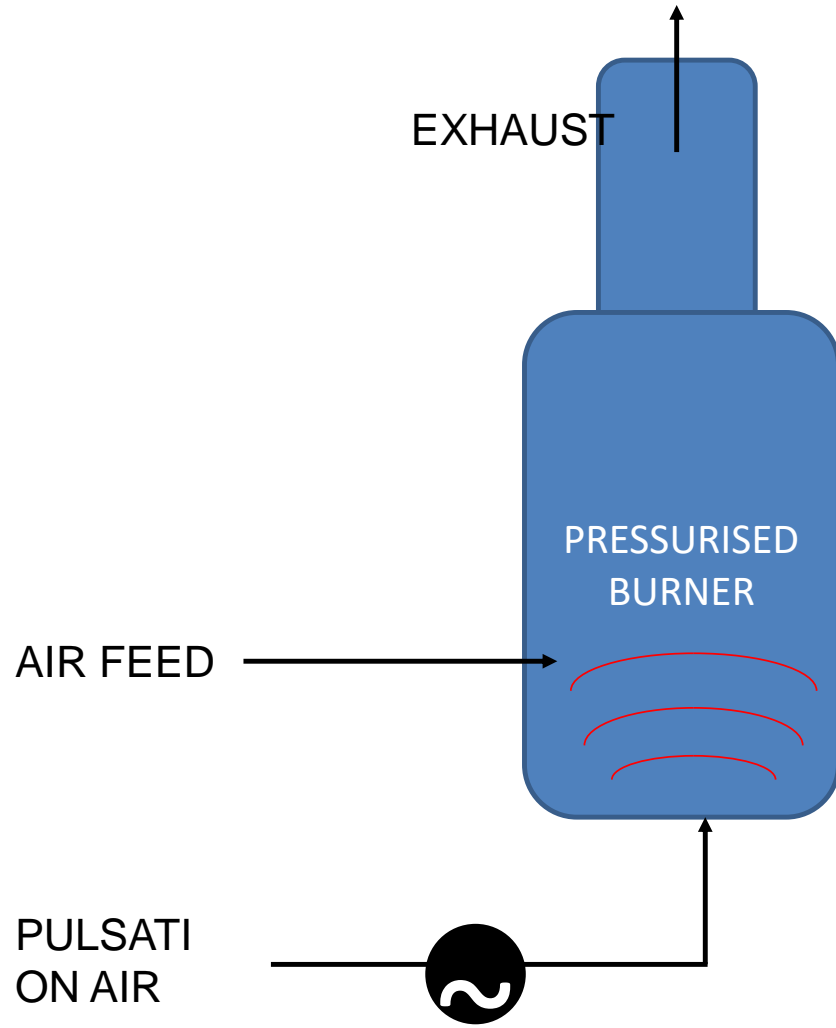


Operating the rigs under pressure

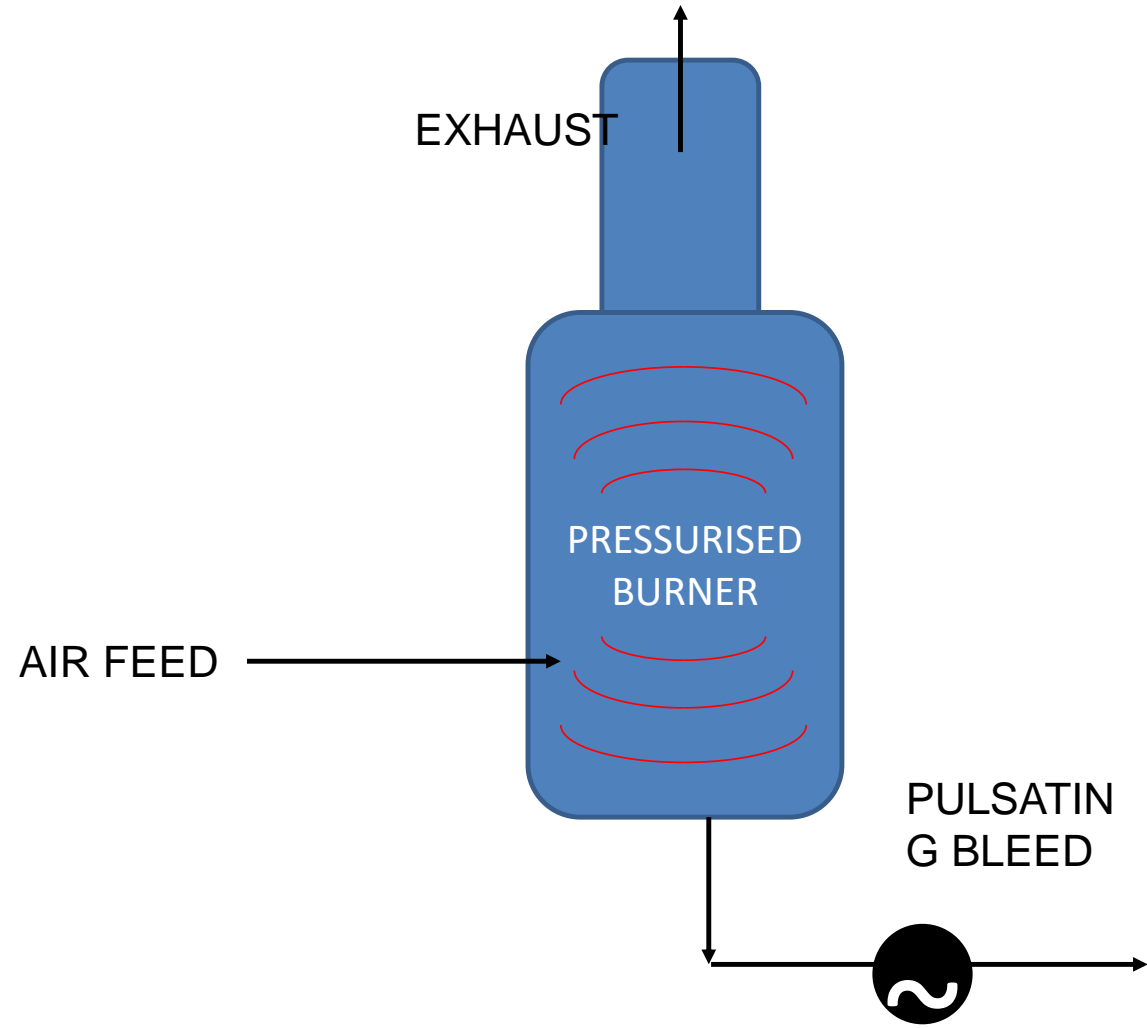


Main noise source: the siren, until the flame catches-up

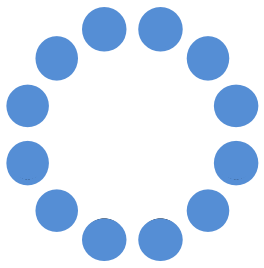
Noise source: any element in the combustor susceptible to resonate



**BLOW-DOWN EXCITATION (CONVENTIONAL)
(NEW)**



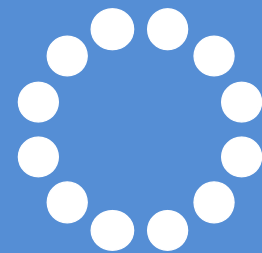
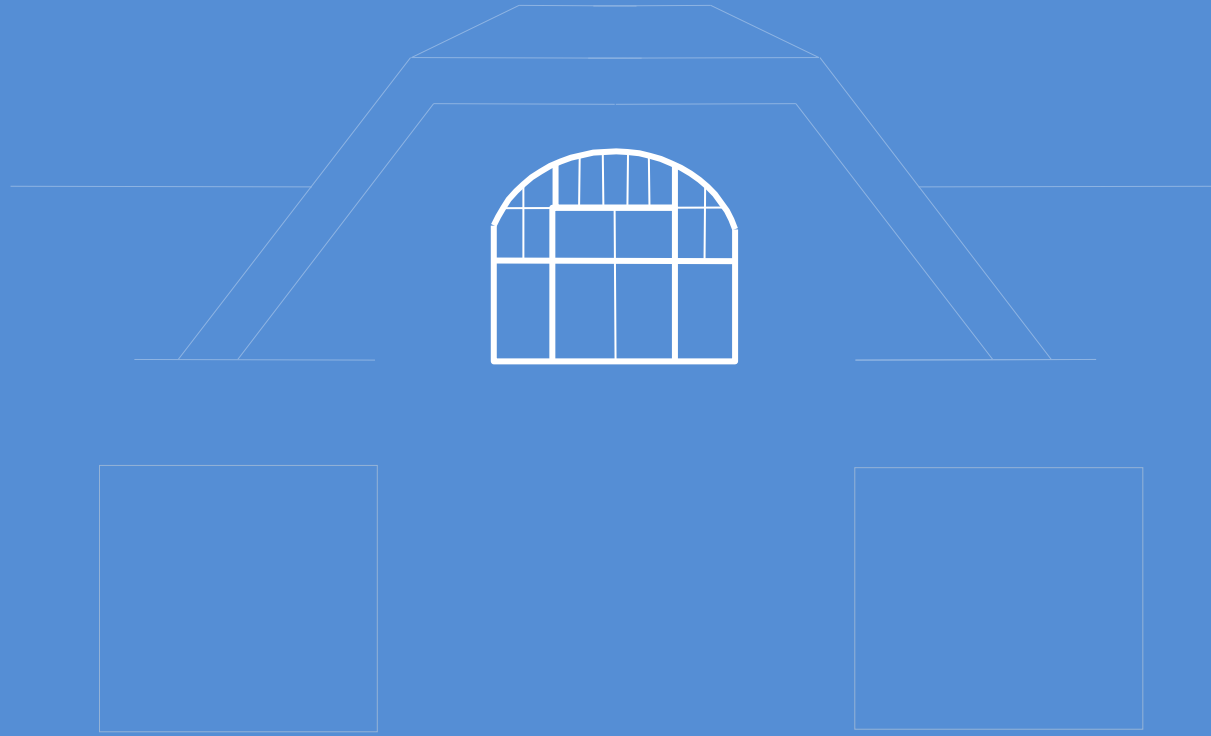
DISCHARGE CONFIGURATION



Bibliography

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- Giuliani F., Reiss H., Stuetz M., Moosbrugger V. and Silbergasser A. Readings on specific gas turbine flame behaviours using an industrial combustion monitoring system. Proceedings of the ASME Turbo Expo 2016: Turbine Technical Conference and Exposition July 13-17th, 2016, Seoul, South Korea. GT2016-56166
- F. Giuliani, M. Stuetz, N. Paulitsch, L. Andracher. Progress on forcing pulsation for acoustic, thermoacoustic or flow control purpose in a pressurised vessel by means of a siren. In Proceedings of the ASME 2020 Turbo Expo, Virtual Conference, Sept.21-25 2020. GT2020-16015
- L. Andracher, F. Giuliani, N. Paulitsch & V. Moosbrugger. Progress on combined optic-acoustic monitoring of combustion in a gas turbine. Proceedings of the ASME 2020 Turbo Expo, Virtual Conference, Sept.21-25 2020. GT2020-16007.
- Lang, A., Lecourt, R., and Giuliani, F. Statistical evaluation of ignition phenomena in turbojet engines. In ASME Turbo Expo 2010: Power for Land, Sea and Air (Glasgow, UK, June 2010). GT2010-23229.

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