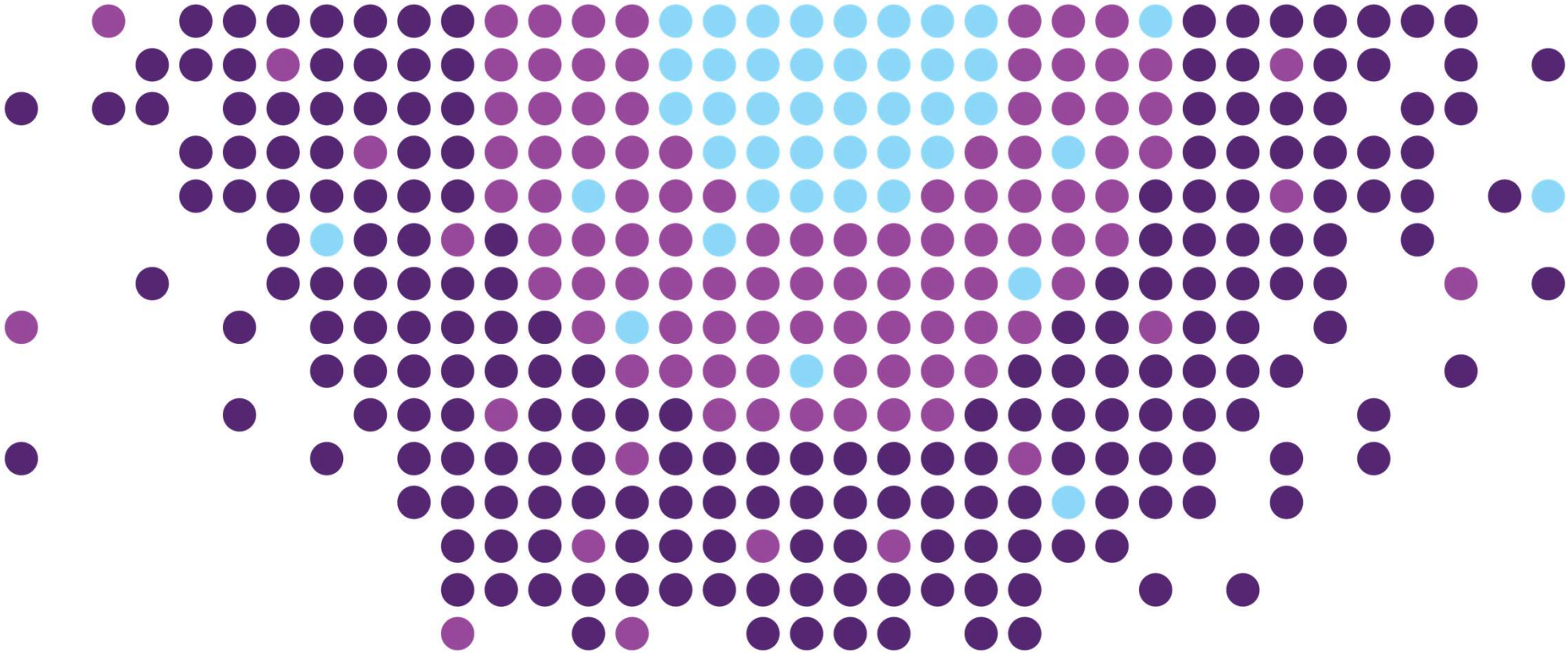

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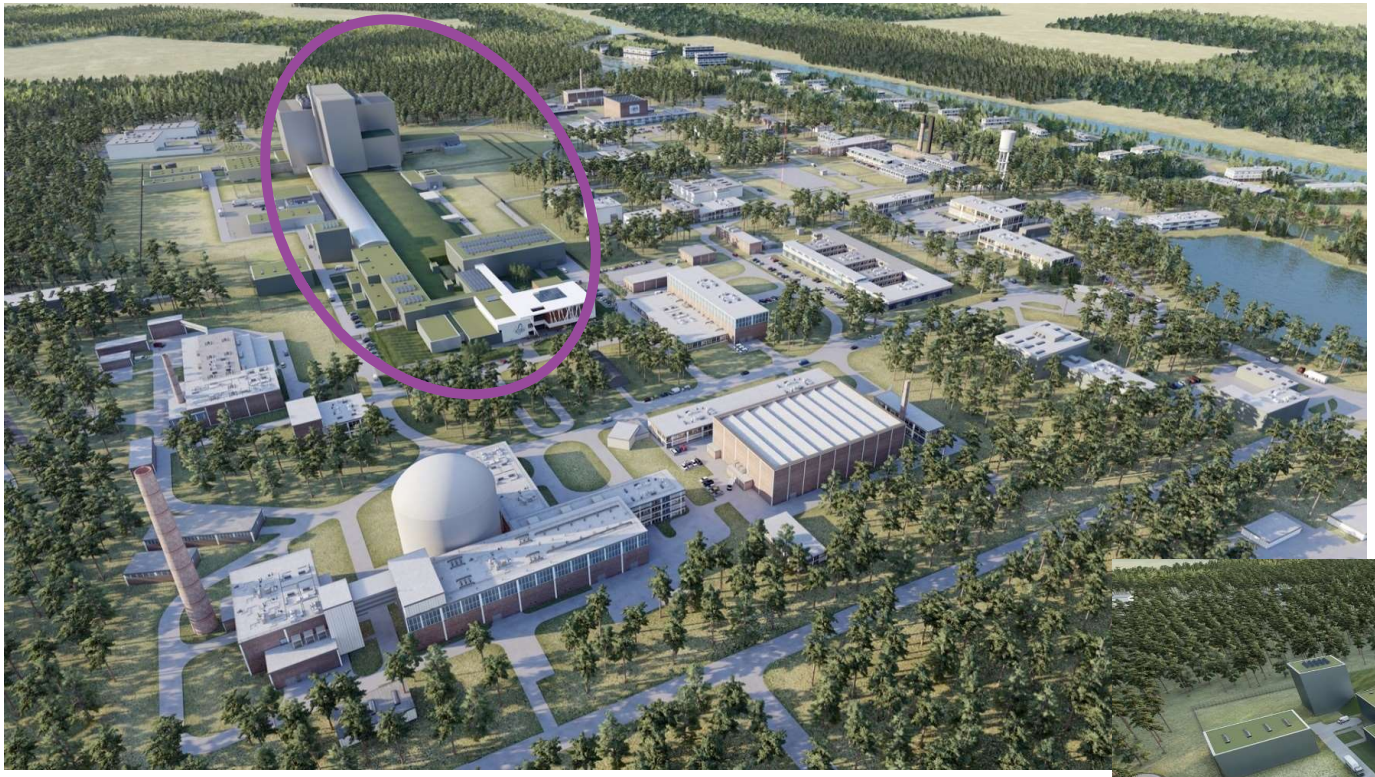
Angélique Gatera (angelique.gatera@sckcen.be)

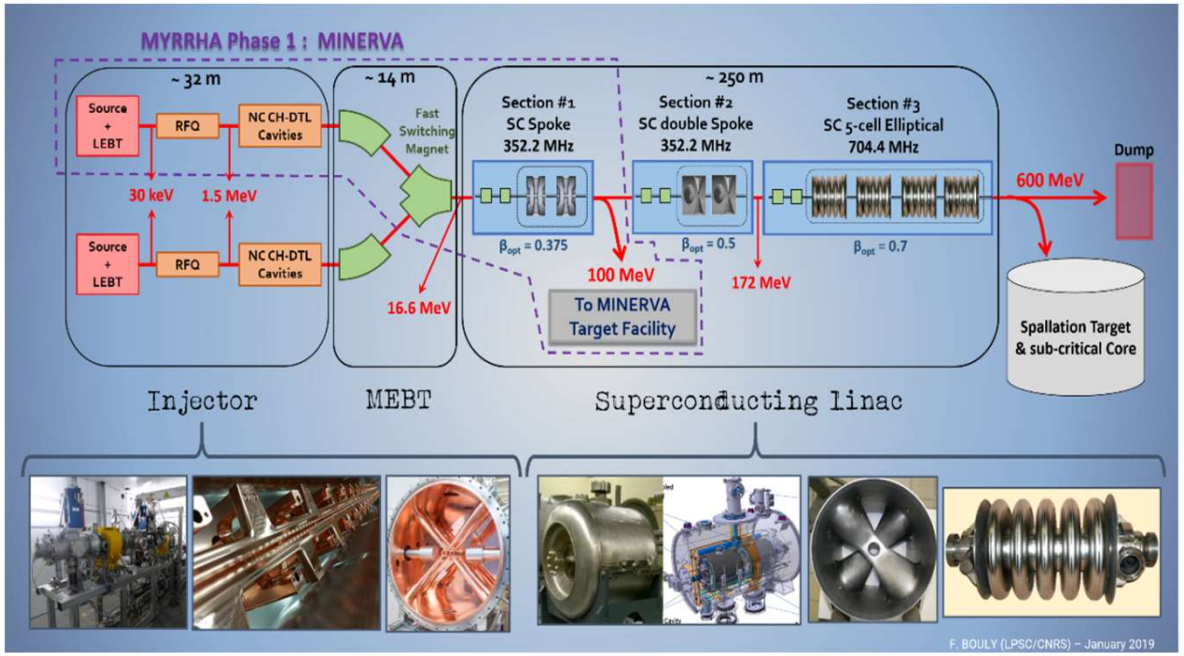
MYRRHA RFQ commissioning

Towards MYRRHA ADS



- **MYRRHA Phase 1 Implementation**
  - Also referred to as MINERVA

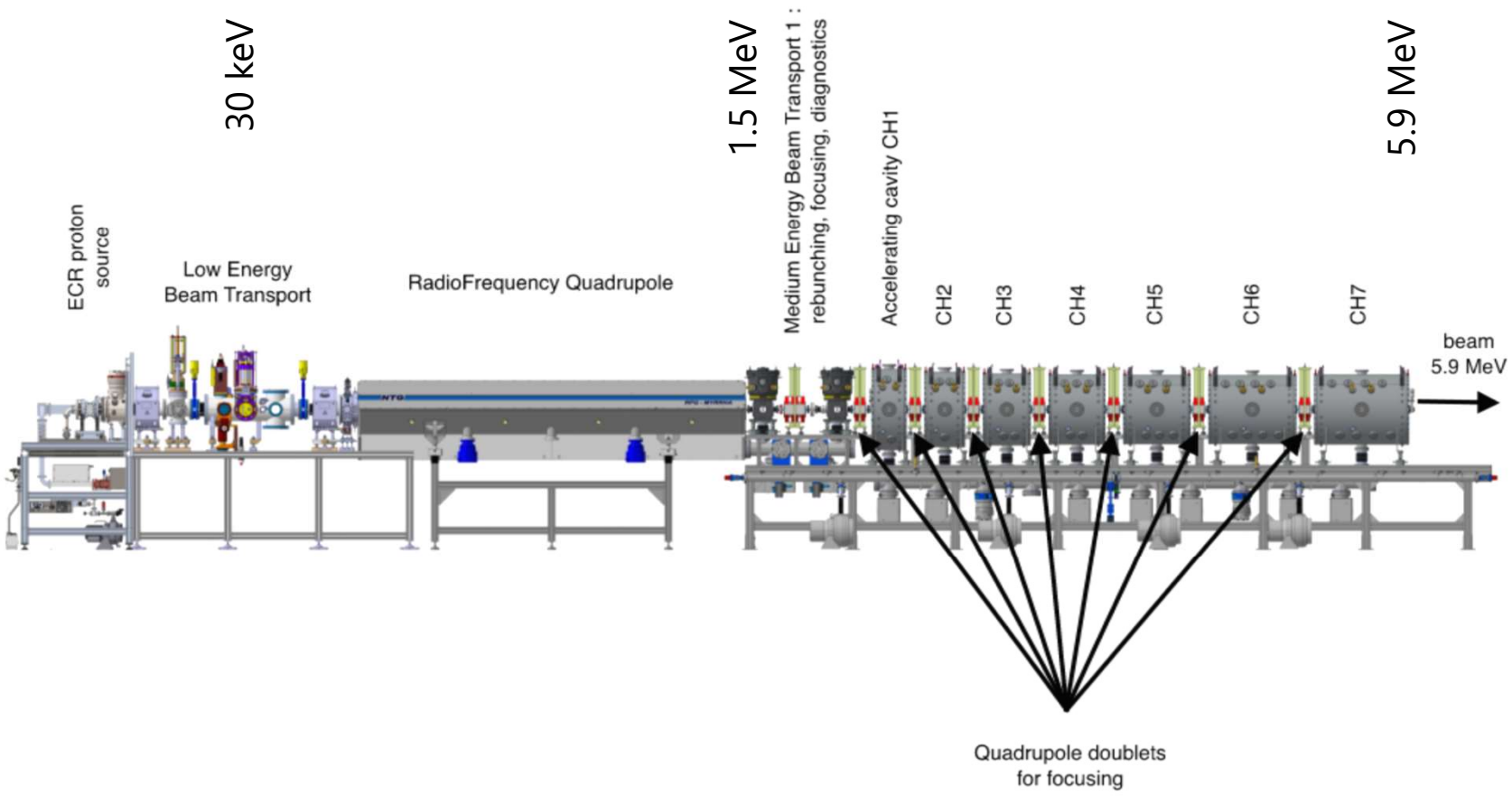
MYRRHA versus MINERVA LINAC



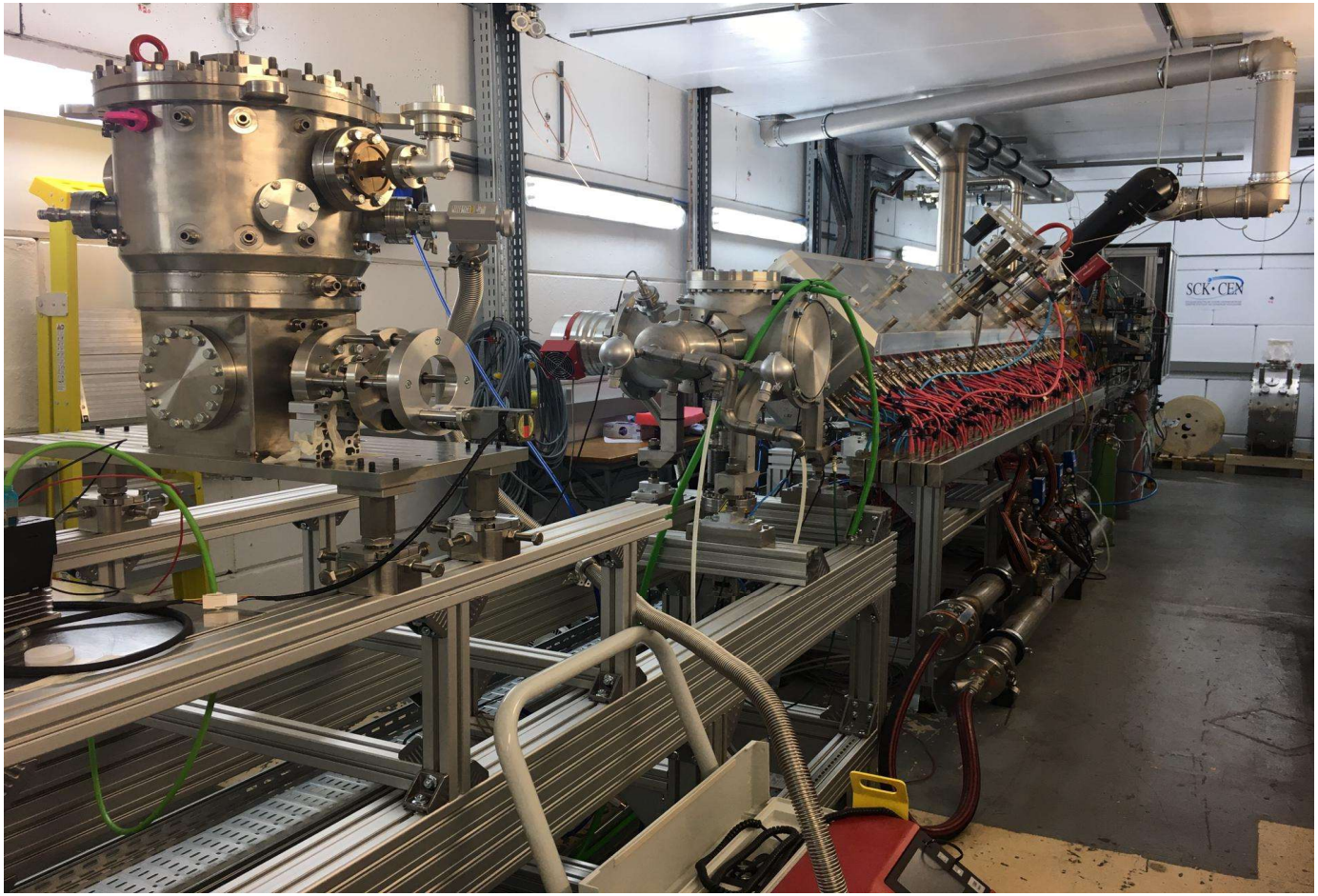
- beam particle : protons
- beam energy : 600 / 100 MeV
- beam intensity : 4 mA
- beam delivery : 2.4 / 0.4 MW CW (with regular holes)
- beam MTBF : 250 hours, a failure = a beam trip > 3 s

Key : Fault Tolerance

Integrated prototyping : LLN test platform

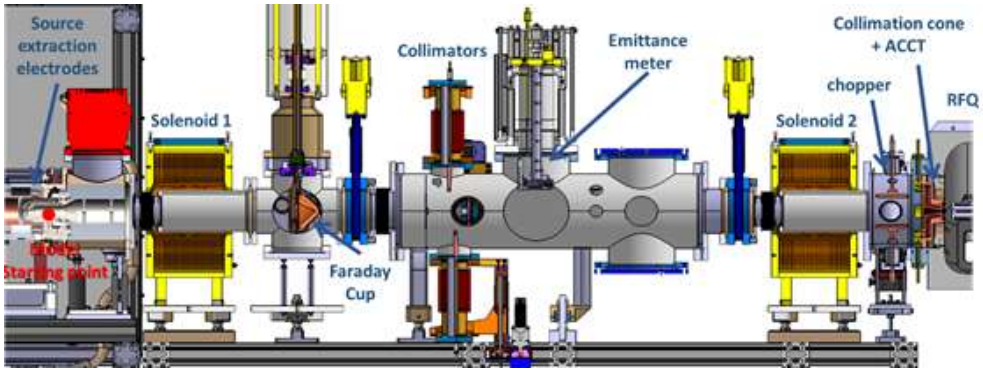


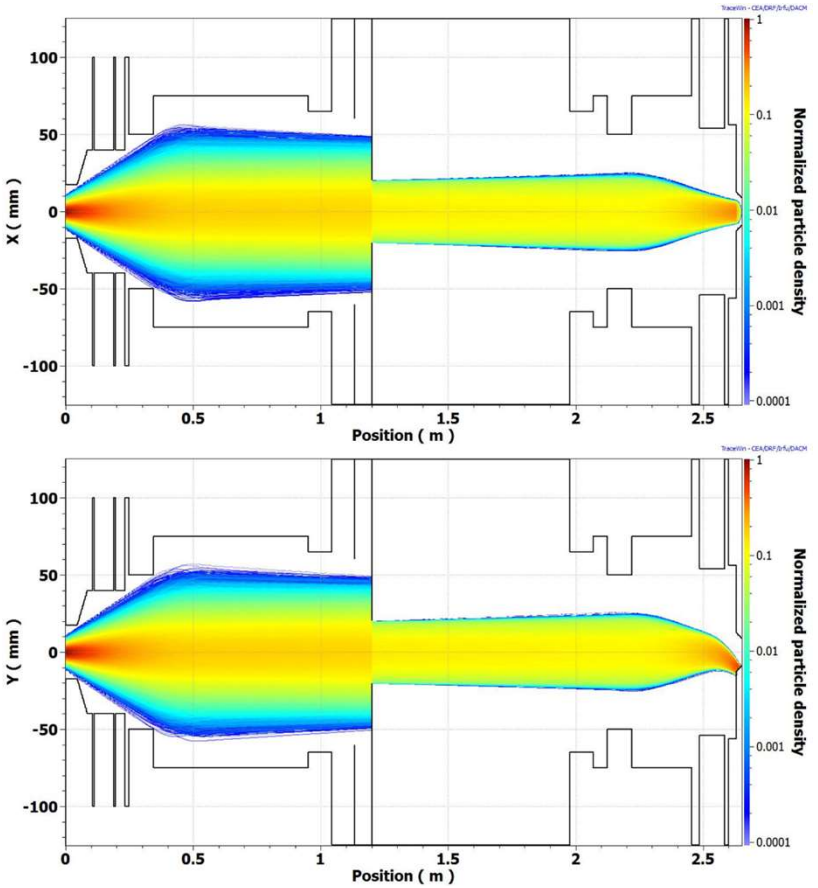
LLN installation today



Source & LEBT commissioning

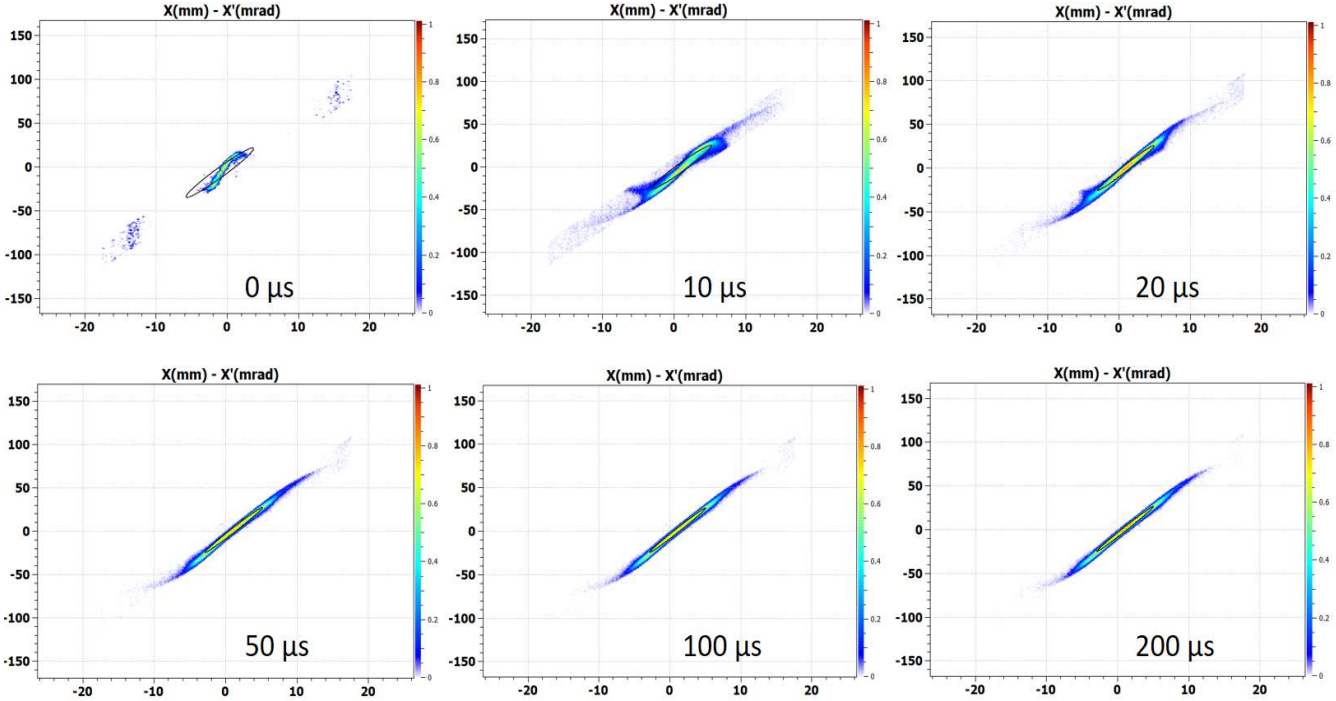
- Beam transmission
- Beam stability
- Beam matching
- Space charge compensation studies

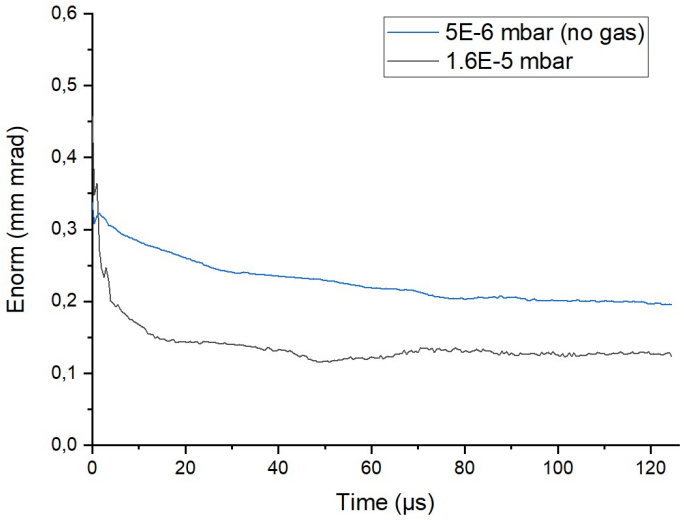




LEBT commissioning : RFQ beam matching and SCC transients

- Transverse emittance measurements with Allison scanners



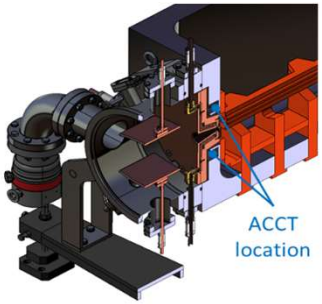


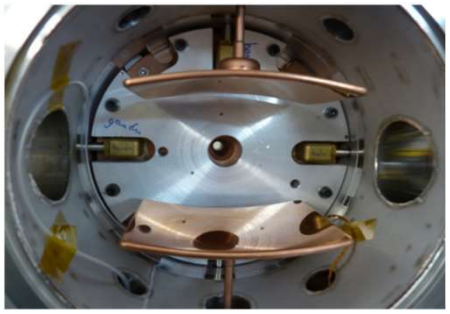
Commissioning output: source RF amplifier upgrade

- Strong beam current instabilities caused by underuse of the 2 kW magnetron (300 W required)
- Magnetron successfully replaced by a 900 W / 2.45 GHz SSA (incl. software upgrade)
- **Clean and stable beam current** mandatory for the RFQ beam tests and the whole linac

MYRRHA's RFQ

Parameter	Unit	Value
RFQ type	---	4-Rod RFQ
Frequency	MHz	176.1
E_{in}	keV	30
E_{out}	MeV	1.5
Length	m	4
Beam current	mA	5
Voltage	kV	44
R_p	kΩm	73
Power losses	kW	106
Specific power loss	kW/m	26.5
Kilpatrick factor	---	1.05
m_{max}	---	2.2
a_{min}	cm	0.31
Cell number	---	244
Transmission	%	98.6
$\varepsilon_{out,rms,100\%,N}$ (x)	π mm mrad	0.21
$\varepsilon_{out,rms,100\%,N}$ (y)	π mm mrad	0.21
$\varepsilon_{out,rms,100\%,N}$ (z)	keV deg	0.41





RF system commissioning steps

RFQ

- Low level tests (Q_0, β, flatness, pick-up coupling, tuning range)
- Vacuum and cooling leak tests

SSA

- Qualification tests on matched/mismatched load
- Run test on matched load

LLRF

- Open/closed loop tests
- RF measurements calibrations (Pt, Pfwd, Pref)

RFQ + SSA

- RFQ conditioning (multipactor barriers, discharges)
- X-ray measurements (Eacc)

LLRF + SSA

- Tests on matched load and closed loop

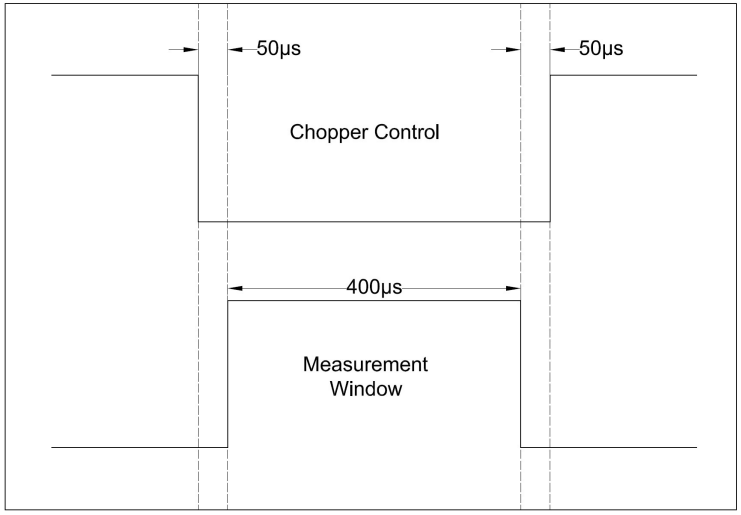
LLRF + SSA + RFQ

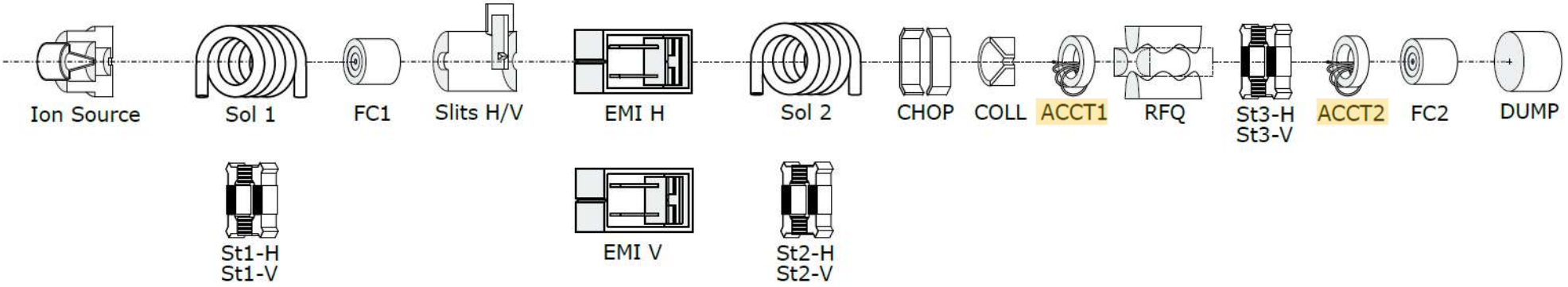
- Operation of the full RF system
- Long run tests

READY FOR THE BEAM TESTS

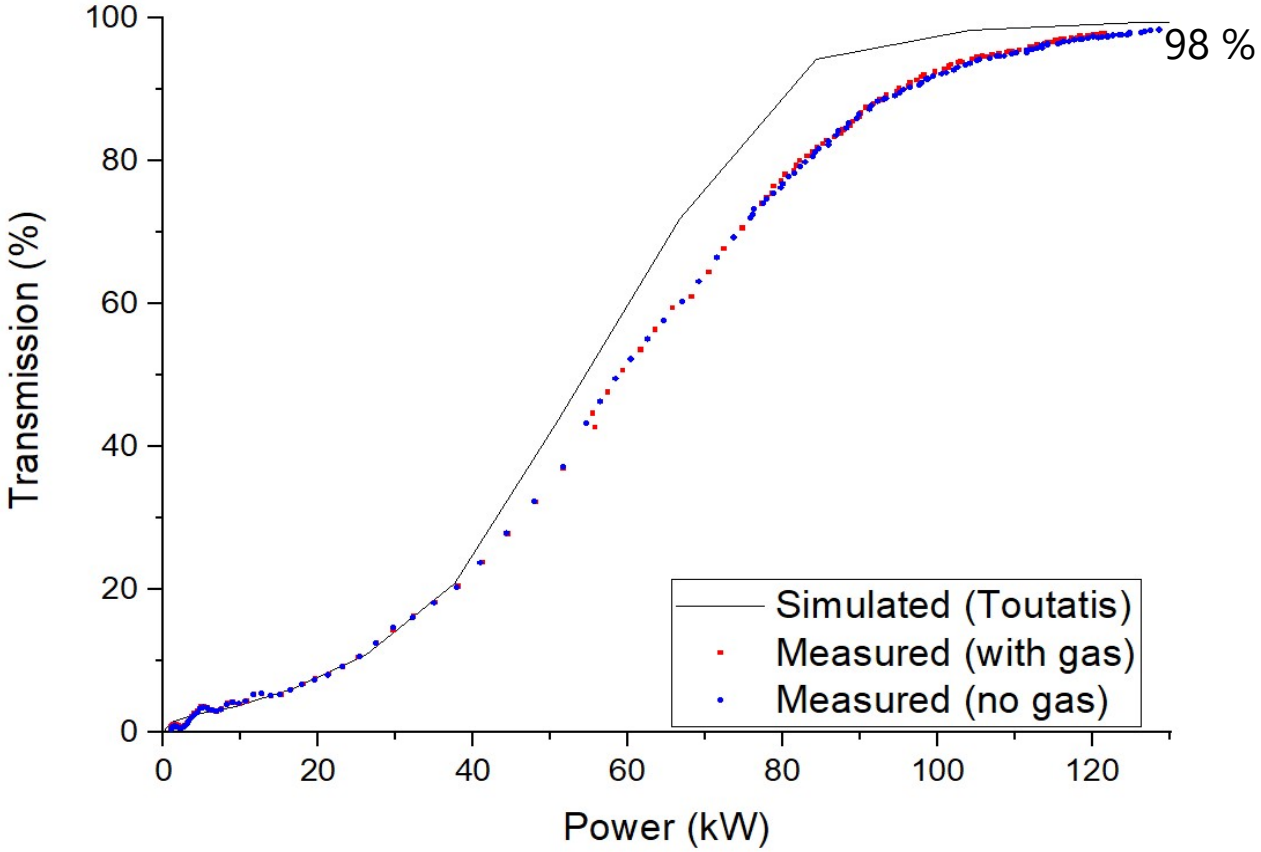
Transmission Measurement – Beam Parameters

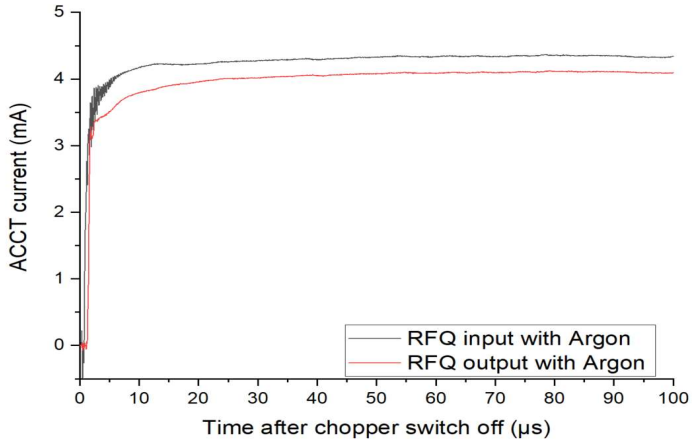
- Higher beam pulse repetition rate (53Hz)
- Longer beam pulse (500µs)
- Measuring window shorter than beam pulse (400µs)
- Nominal beam current: 4 mA

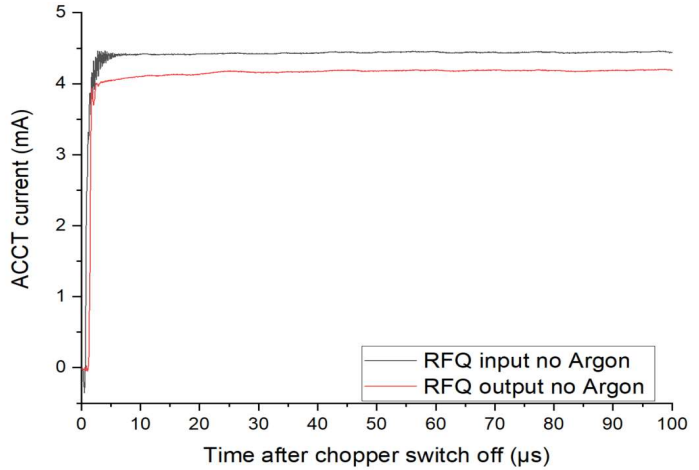




RFQ transmission measurement

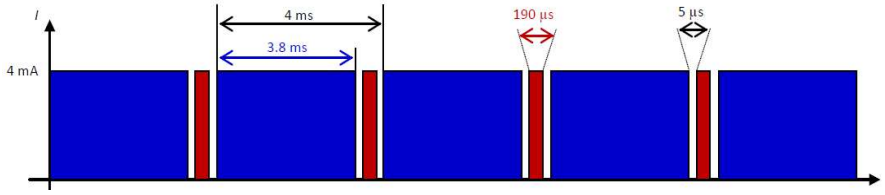






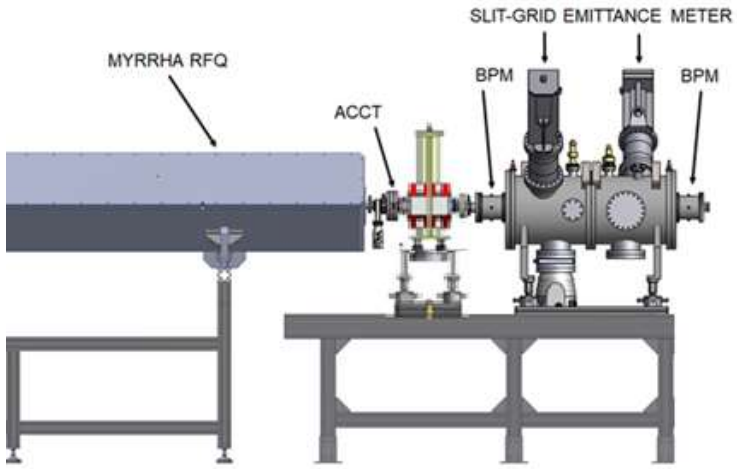
Quasi CW beam commissioning

- MYRRHA beam structure :
  - 3.8 ms pulses for reactor
  - short pulses for ISOL



Next steps : Beam characterization

- Measure beam energy and energy spread using a dipole spectrometer (delayed Covid)
- Measure beam position and XX' - YY' emittances using BPMs and a slit-grid emittance meter (delayed Covid)



- Measure bunch shape (Feschenko under procurement)

Summary and outlook

- So far, all the measured performances are according to expectations
  - The transmission at nominal power (110 kW ~ 44 kV) is 95%. It can be increased to 98% from 125 kW (48 kV)
  - No problems encountered when pushing duty cycle to CW
  - RFQ transmission not affected by space charge compensation in the LEBT

- Accelerated beam characterization (transverse and longitudinal) to be expected in the coming months

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Studiecentrum voor Kernenergie
Centre d'Etude de l'Energie Nucléaire

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