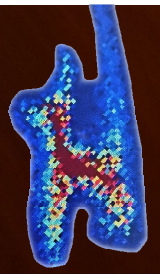
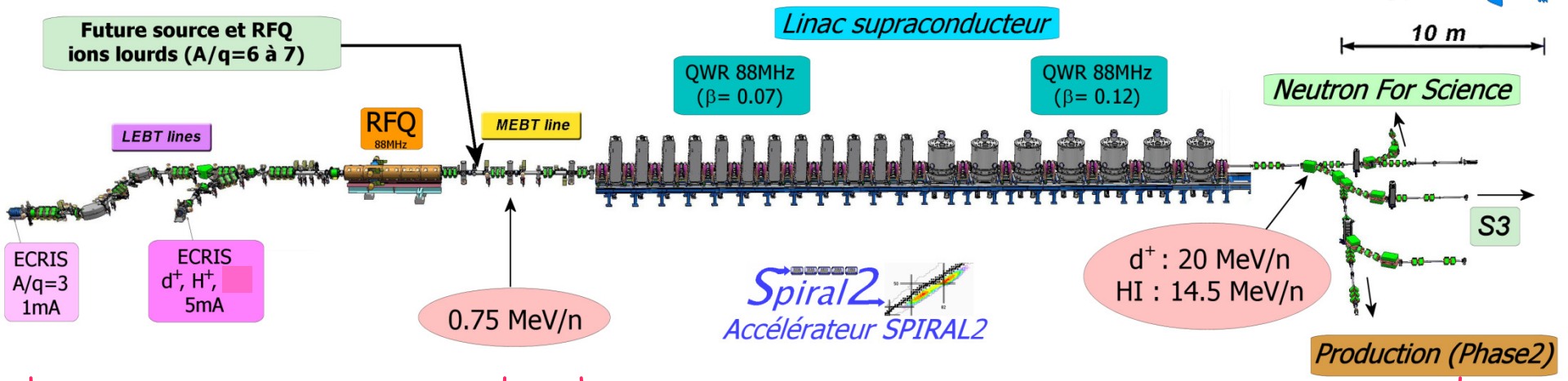



# SPIRAL2 Injector Commissioning

THPO047

Robin FERDINAND, Guillaume Normand; Marco Di Giacomo; Franberg Hanna; Omar Kamalou; Jean-Michel Lagniel; Alain Savalle; Didier Uriot; Franck Varenne

# SPIRAL2 accelerator




Started

Cool down started. RF when safety authorization

| Particles | $H^+$ | $D^+$ | ions | option |
|---|---|---|---|---|
| A/Q | 1 | 2 | 3 | 6 |
| Max I (mA) | 5 | 5 | 1 | 1 |
| Max energy (MeV/A) | 33 | 20 | 15 | 8.5 |
| Max beam power (kW) | 165 | 200 | 45 | 51 |

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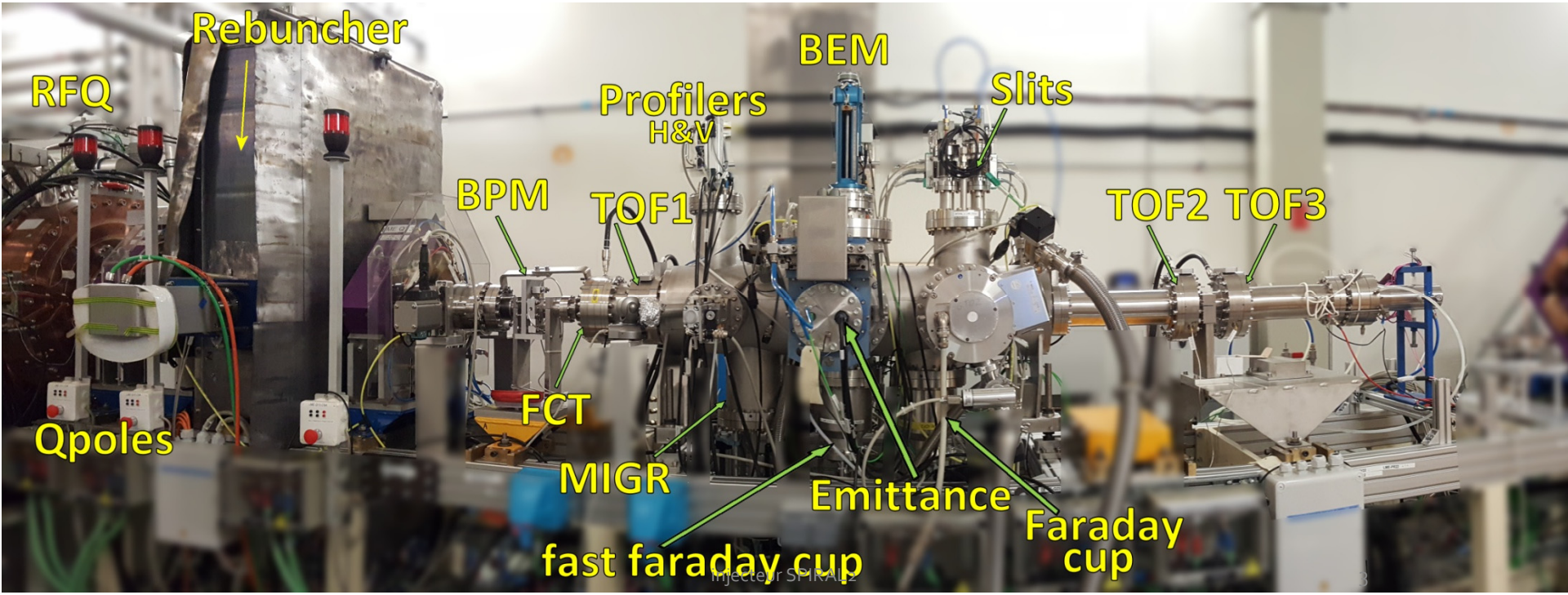
# Test Bench


LEBT1
Ion source (Q/A=1/3)
LEBT2
H & D source
chopper, Slits
Emittance Meas. H&V
Faraday cup, DCCT
LEBTc
RFQ
3 qpoles
Rebuncher
MEBT
BPMs, TOF, BEM, MIGR, prof., FFC, Emit H&V, FC
D-plate


Rebuncher
RFQ
BEM
Profilers
H&V
Slits
BPM
TOF1
TOF2
TOF3
FCT
Qpoles
MIGR
Emittance
Faraday cup
fast faraday cup


RFQ conditionning

# RF RFQ conditioning

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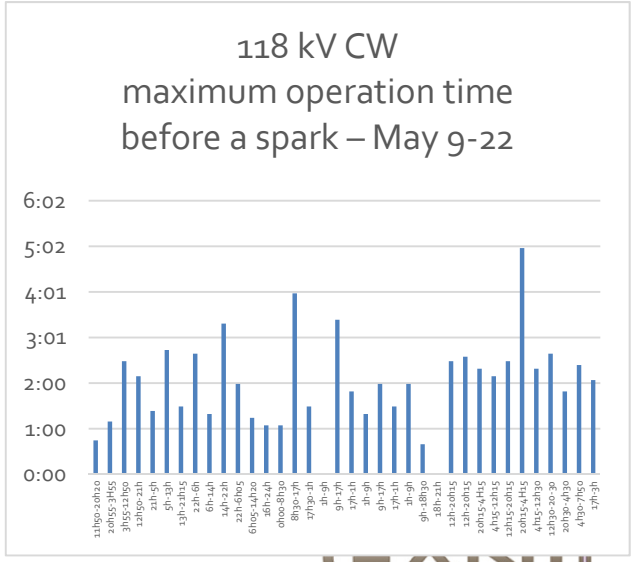
- Significant efforts to obtain results, conditioning now coming to an end
  - Started on October 2015… far from full time
  - Not finished but on a good path, mainly because we have a better conditioning procedure

- New procedure – LLRF improvements
- Hold the nominal A/Q = 3 voltage (114kV) for a few hours, enough for beam measurement
- Integration of a PLL

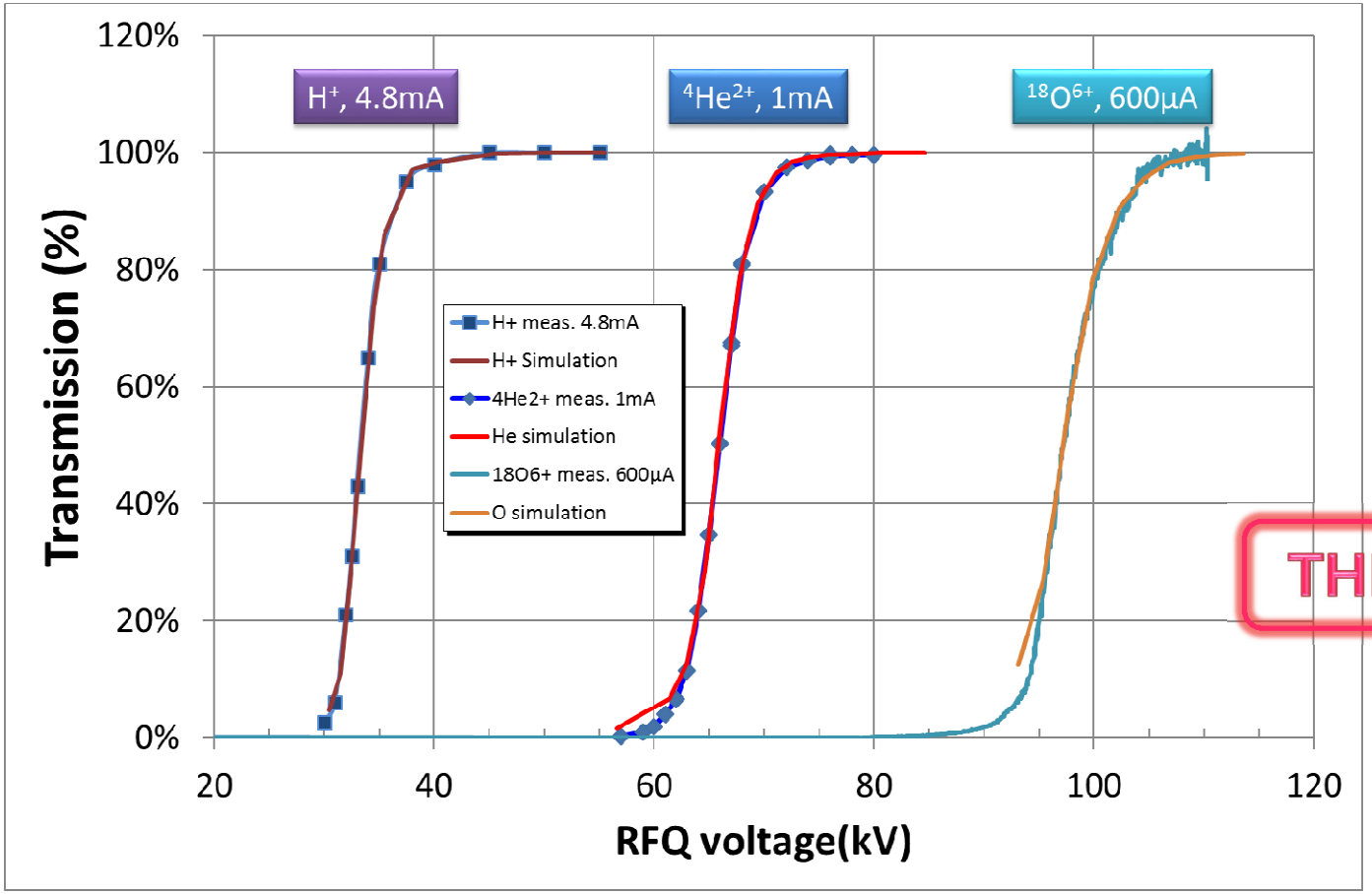


# Beam commissioning : Nominal beam out of the RFQ

5mA Out

5mA In

# Transmission comparison with calculation

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rf operation stable and reliable for Proton/Helium, Oxygen

# Recent results with $^{18}O^{6+}$

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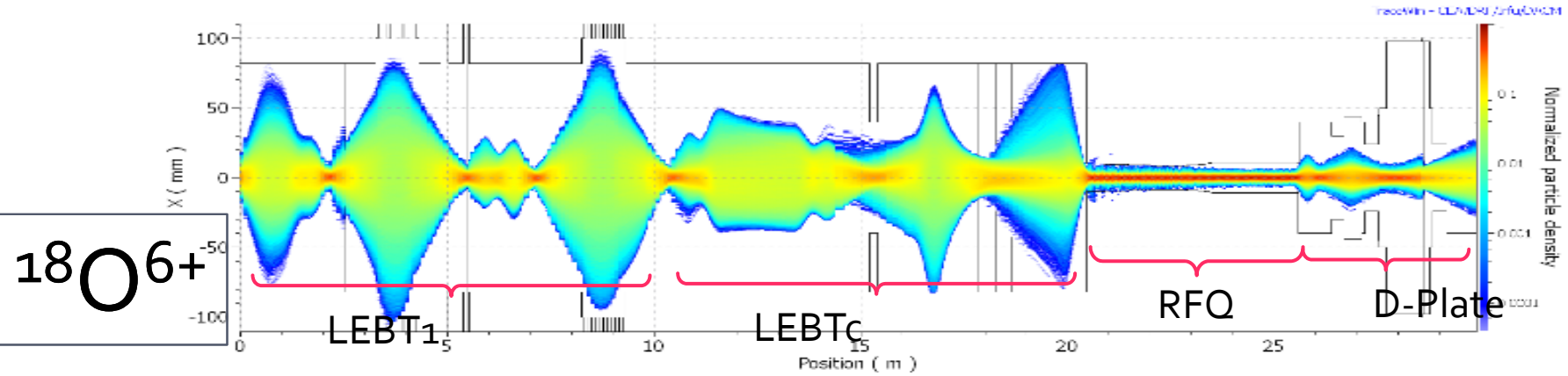

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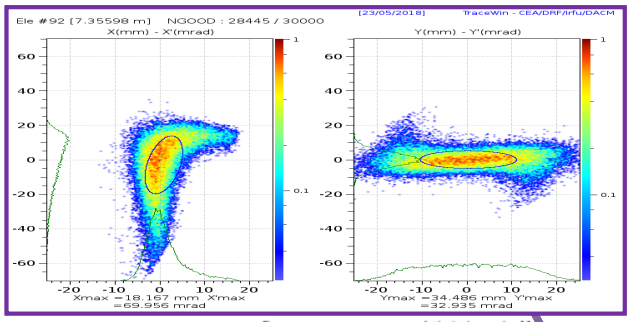
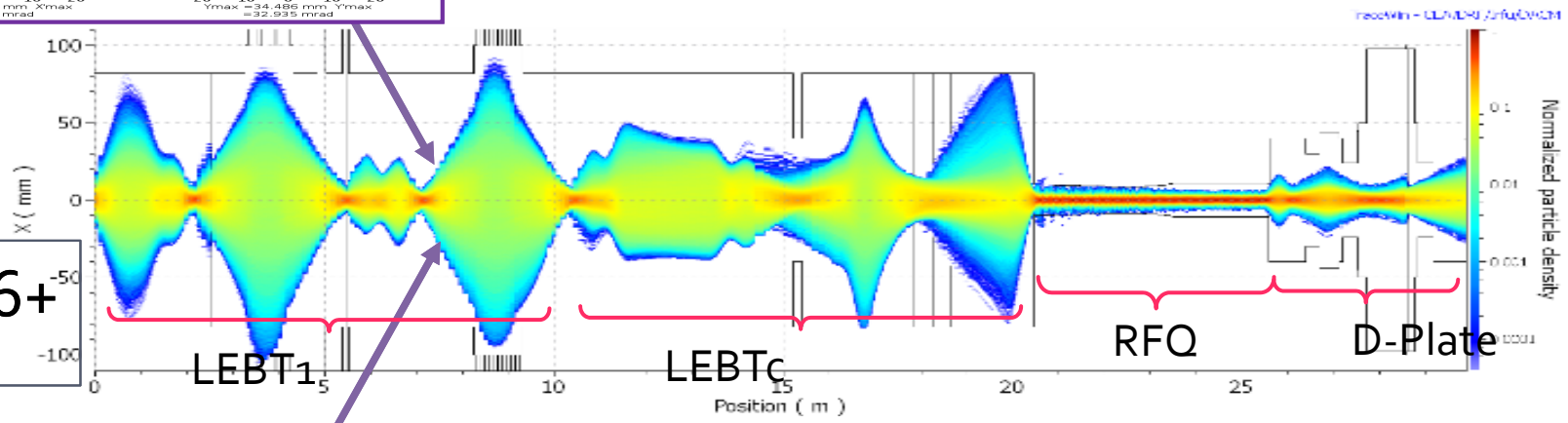
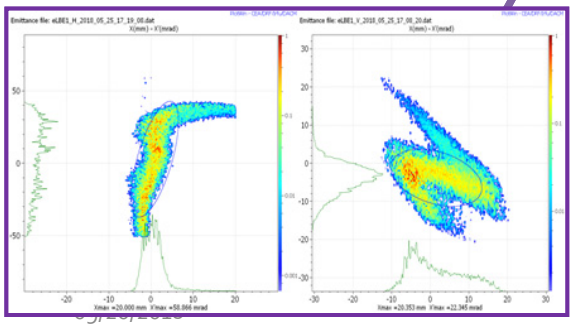



$^{18}O^{6+}$



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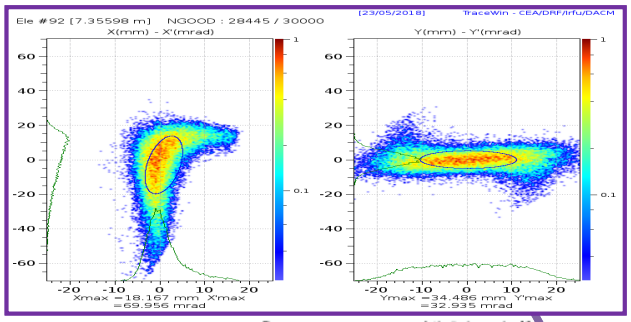
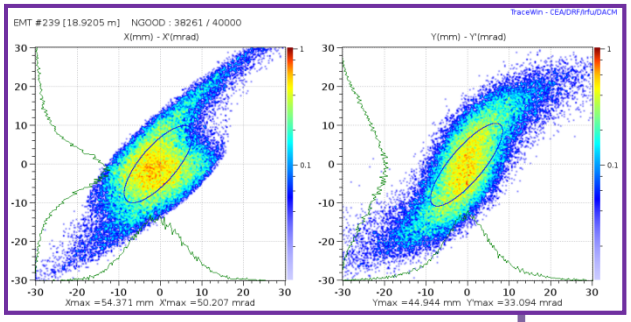
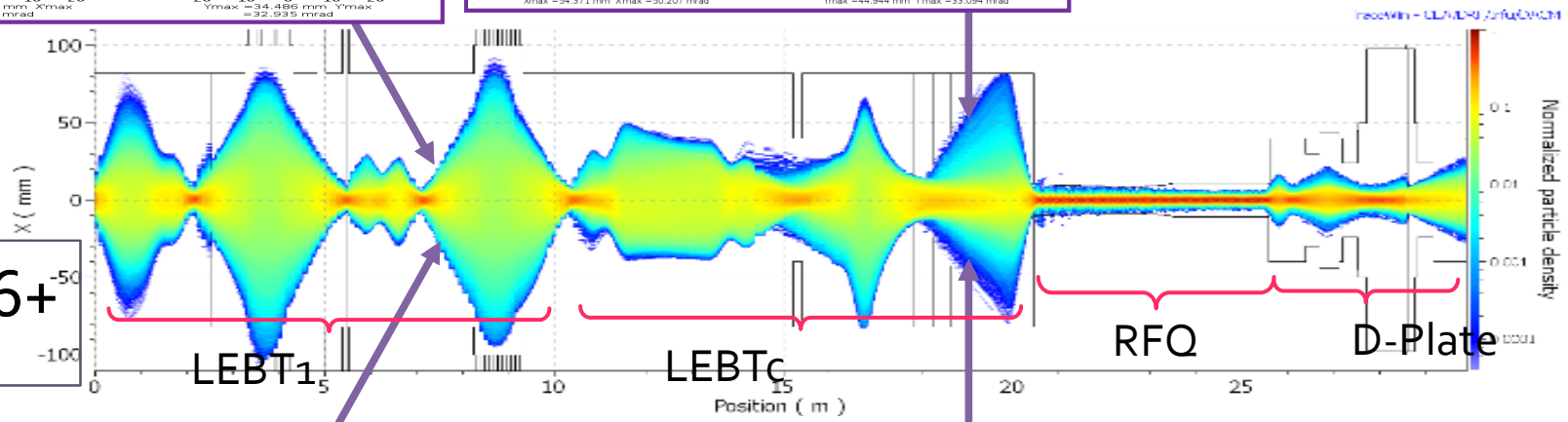
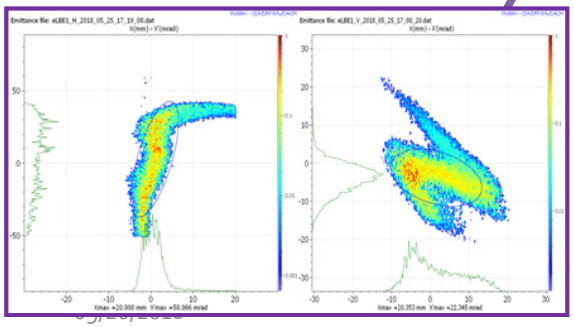
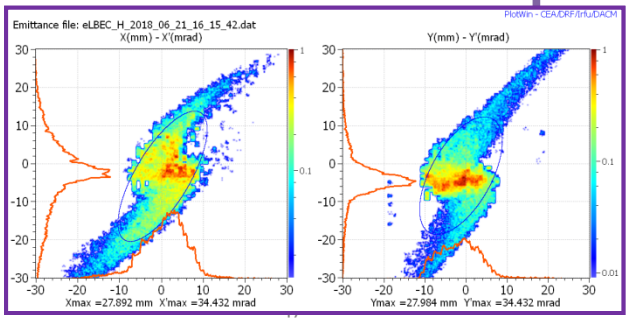



$^{18}O^{6+}$





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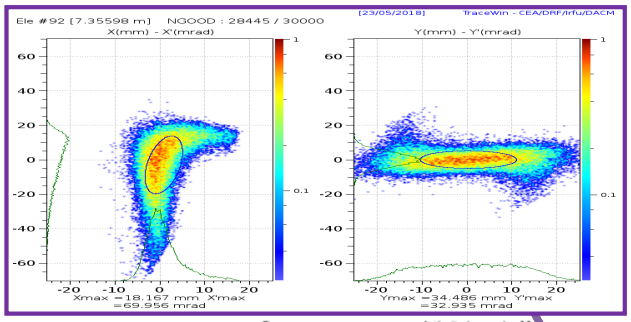


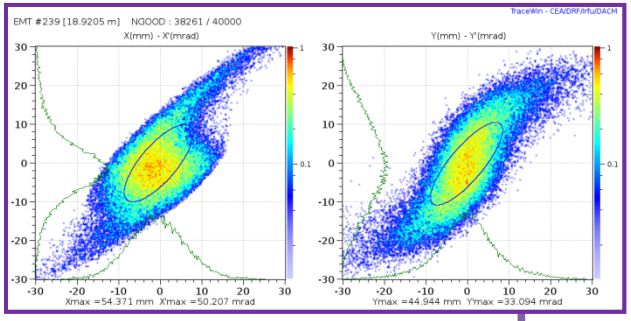


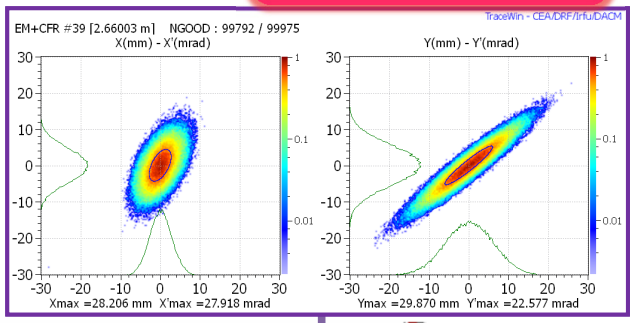


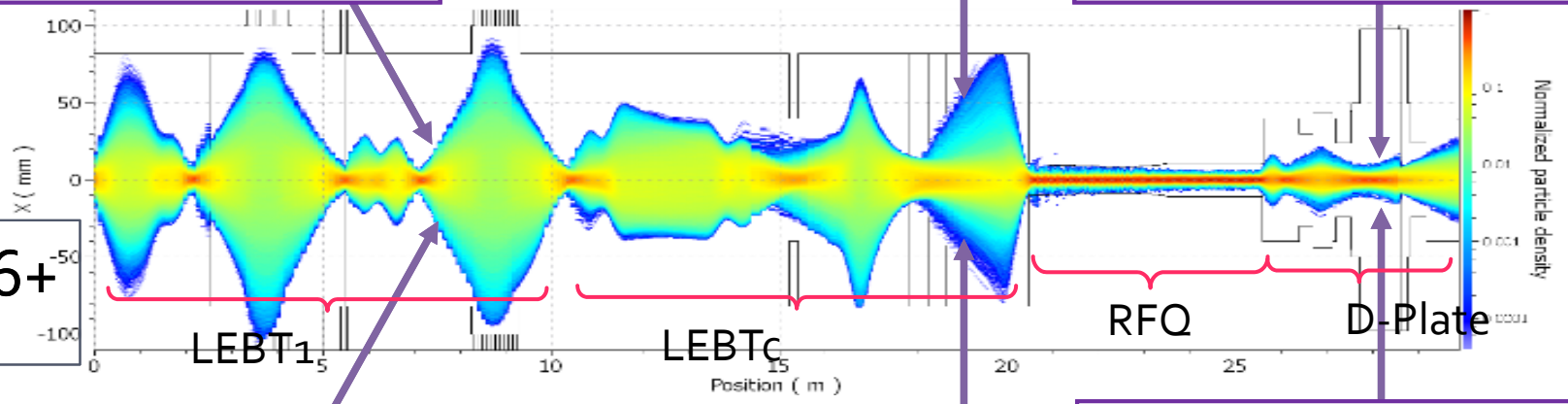


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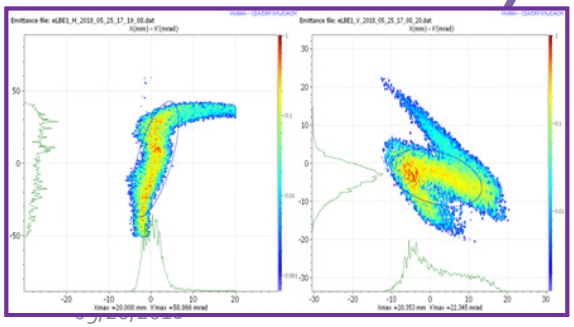

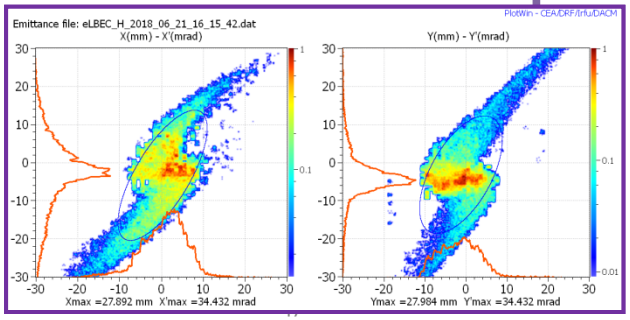


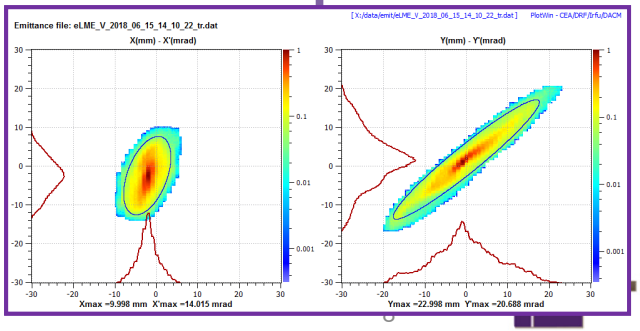

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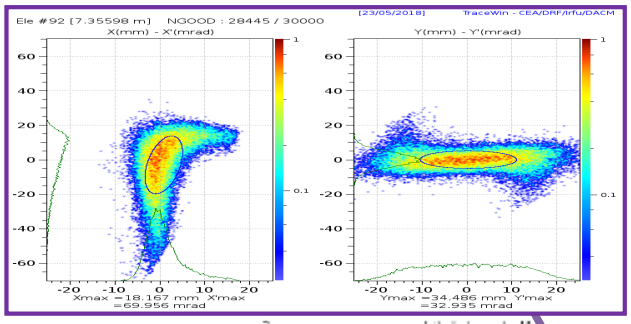
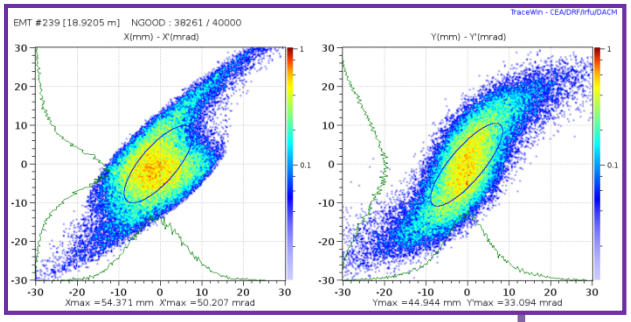
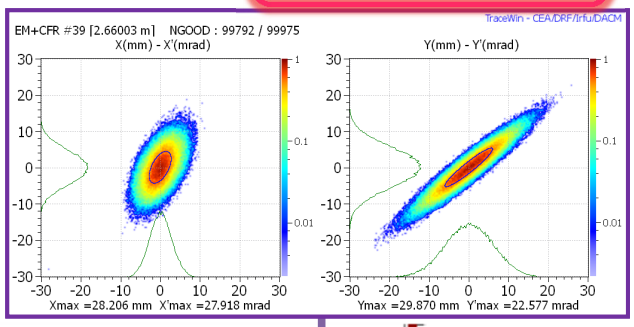
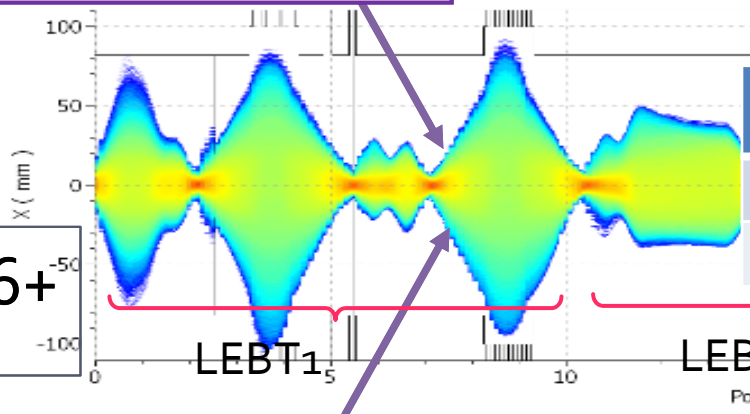


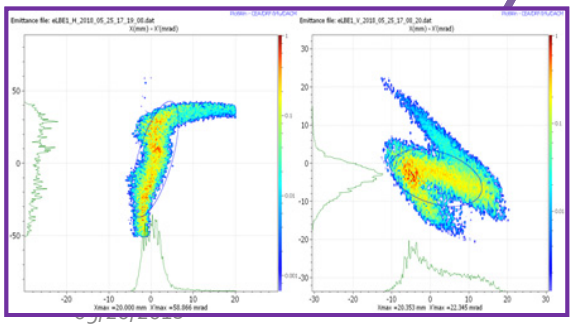



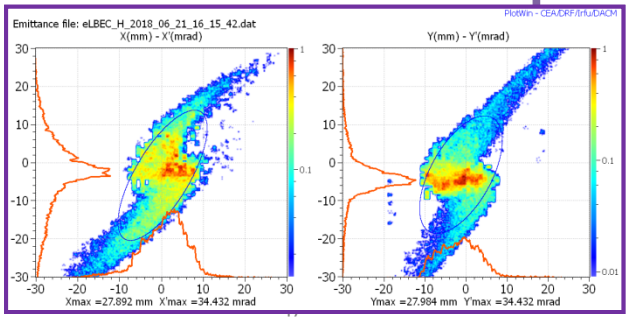



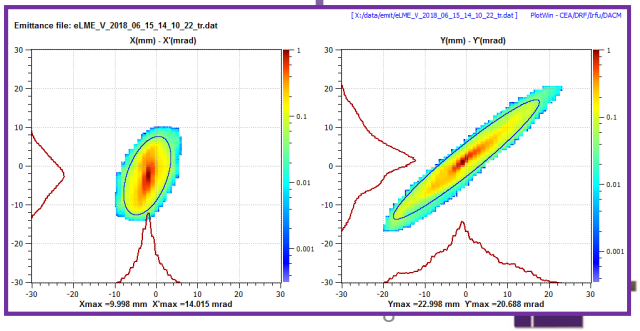




$^{18}O^{6+}$

| | $\varepsilon_{xx'}$ / $\varepsilon_{yy'}$ (π.mm.mrad) | $\beta_{xx'}$ / $\beta_{yy'}$ (mm/π.mrad) | $\alpha_{xx'}$ / $\alpha_{yy'}$ |
|---|---|---|---|
| Simulation | 0.40 / 0.41 | 0.7 / 3.5 | -0.6 / -3.0 |
| Measurement | 0.40 / 0.58 | 0.6 / 4.0 | -0.5 / -3.3 |



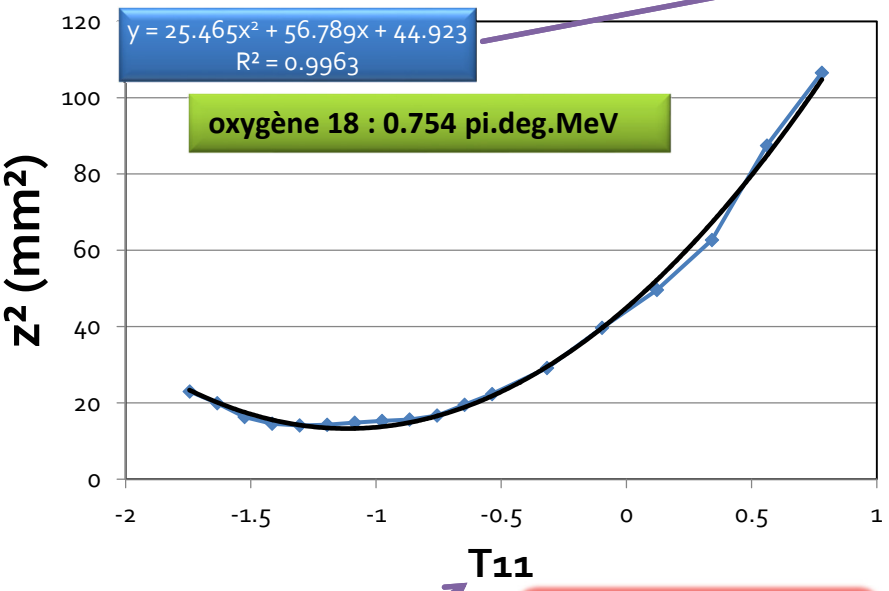


# Longitudinal emittance measurements

## Results

Make an second order fit of the curve: $z^2=f(T_{11})$




$$Y = \langle x^2 \rangle_i X^2 + \frac{2L}{\gamma^2} \langle xx' \rangle_i X + \frac{L^2}{\gamma^4} \langle x'^2 \rangle_i$$

$$\varepsilon_{zz'} = \sqrt{\langle z^2 \rangle \langle z'^2 - \langle zz' \rangle^2}$$

numeric method (Linear approach)

$$T_{11} = 1 - \frac{2\pi L q f V}{mc^2 (\beta\gamma)^3}$$

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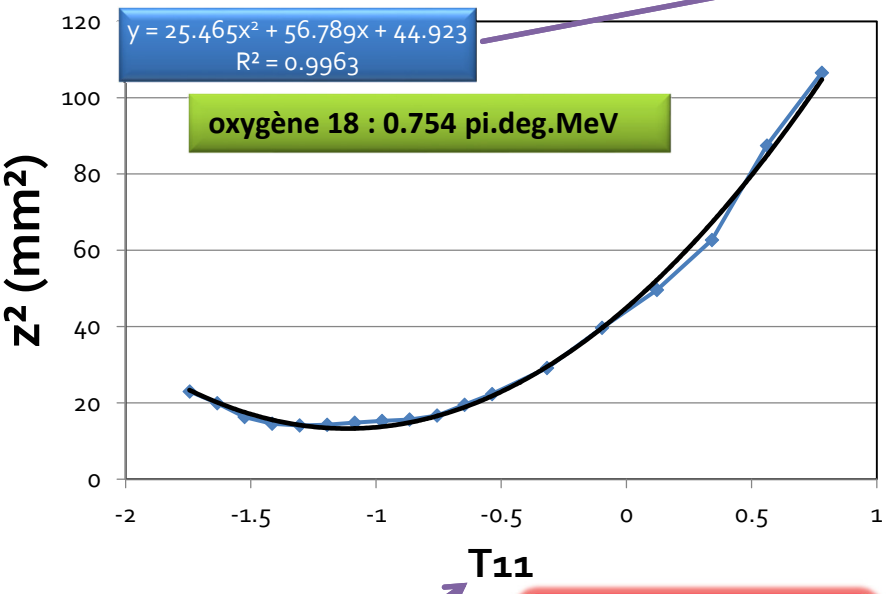


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| Particle | Tracewin (π.deg.MeV) | Measured (π.deg.MeV) | Diff. |
|---|---|---|---|
| Proton | 0.034 | 0.039 | +15% |
| Helium | 0.19 | 0.13 | -32% |
| $^{16}O^{6+}$ | 0.72 | 0.64 | -11% |
| $^{18}O^{6+}$ 105kV | 0.73* | 0.74 | +1% |
| $^{18}O^{6+}$ 113kV | 0.78 | 0.81 | +4% |

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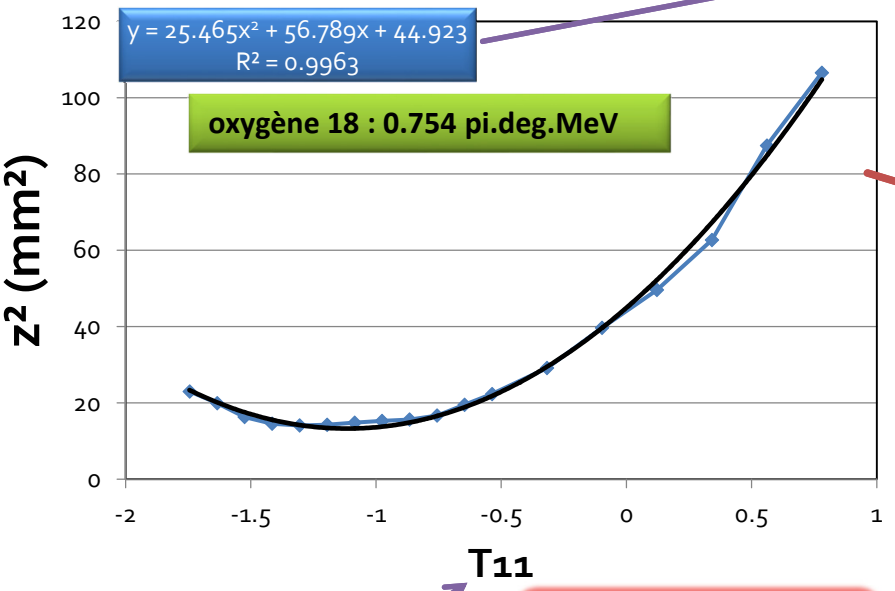


$$T_{11} = 1 - \frac{2\pi L q f V}{mc^2(\beta\gamma)^3}$$

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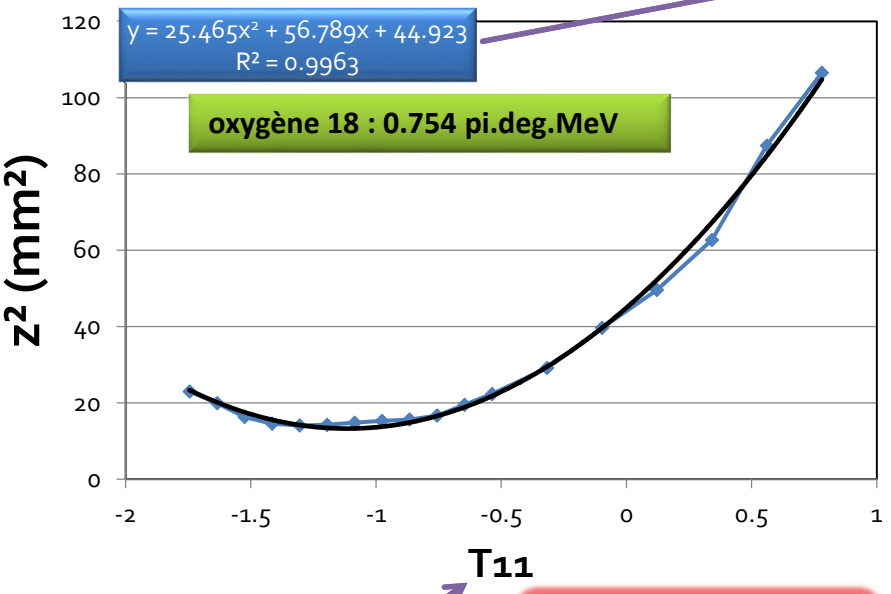


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* Removing the tail


Conclusion

# Conclusion

- RFQ cavity conditioned at nominal voltage (114kV)
- RFQ specifications reached (100% trs, CW) and RFQ beams as expected.
- Very good agreement measurements vs TraceWin simulations for our three reference particle beams
  - RFQ simulations are relevant enough to be used as starting point for linac injection.
- Next :
  - Ready for the linac !
- Come and see us at the poster **THPO047 !**


Thank you for
your attention