

Linac4 – LEBT

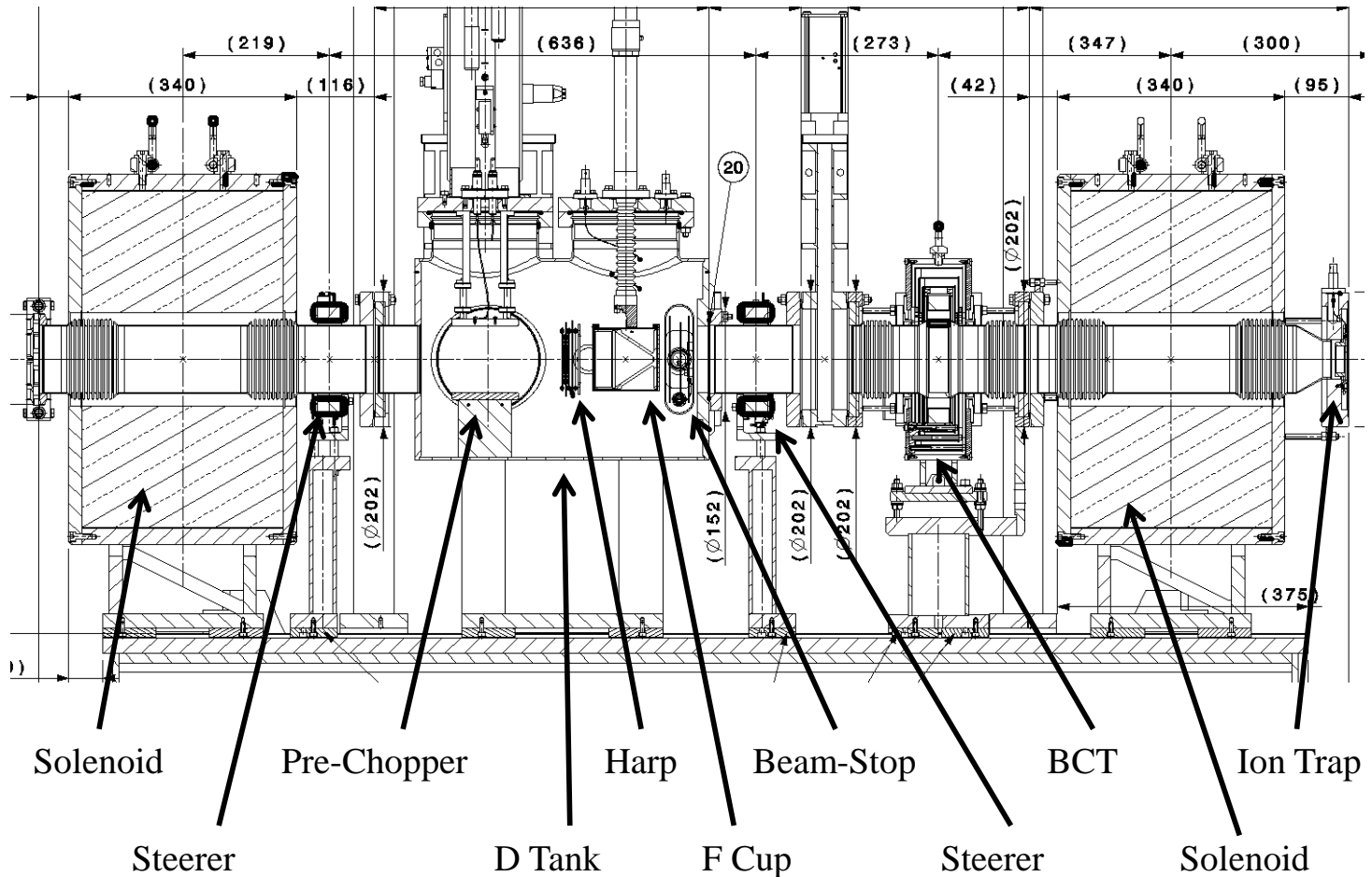
Linac4 – LEBT

R Scrivens

Ion Source Review, 14/11/2013

## Linac4 – LEBT - Status

- 2 LEBTs are installed.
  - The Linac4 LEBT is being hardware and beam commissioned.
  - Presently the Ion Source Test Stand LEBT has the second half replaced with the Emittance Meter.



## Linac4 – LEBT – List of Achievements

- Magnets
  - 2x2 Solenoids. 2x2x2 Trajectory Correctors. All Installed and Commissioned.
  - Solenoid field axis centred with vibrating wire technique + shims.
  - Power converters installed. Controls (almost) finished.
- Vacuum and LEBT gas injection
  - 2 LEBTs installed and leak tight.
  - Gas injection commissioned (beam measurements still ongoing).
  - Question of vacuum at 2Hz operation to be resolved.
- Pre-chopper
  - Deflection System redesigned to avoid insulator view of beam.
  - Driver installed in the Linac4 tunnel.
  - Briefly tested to >20kV in Linac4, with beam present. Permit system still to commission.
  - Test stand driver still to be installed.



## Linac4 – LEBT – List of Achievements

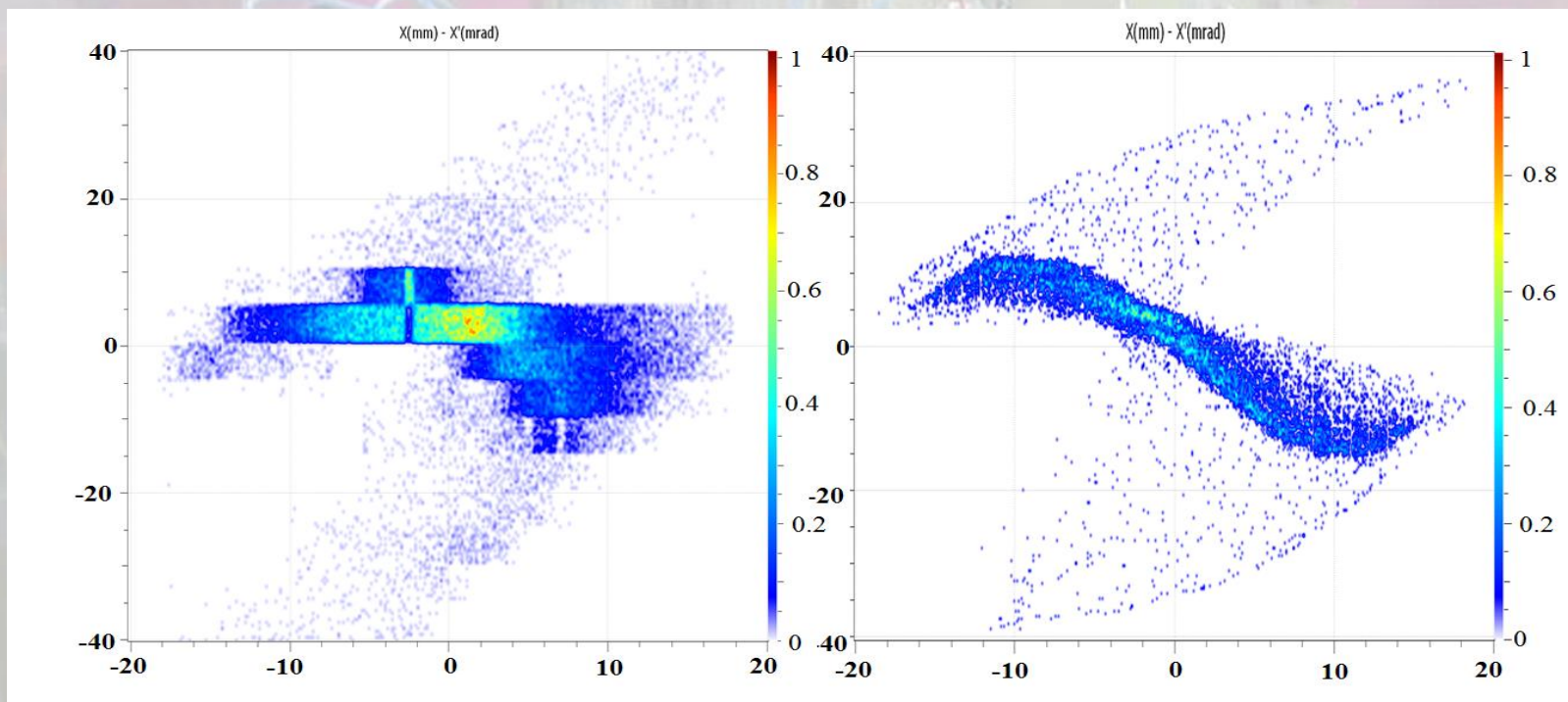
- Beams Instrumentation.
  - Faraday Cup – OK with  $\sim 20\text{mA}$  of H<sup>-</sup>.
  - Beam Current Transformer – Working.
  - SEMGrid (profile monitor). Secondary electron signal being understood.
  - Emittance meter. 1 meter dedicated to source measurements – installed in the test stand.
- Beam-stoppers.
  - Only 1 set are required. They are moved to the Linac4 tunnel.
- Ion trapping electrode.
  - Item installed, but is left grounded.
- Support and alignment.
  - Girder support is aligned to reference axis.
  - Each component has its mounting point toleranced to this reference.
  - Follow up of alignment is the “LEBT bench” as a whole.

## Linac4 – LEBT – Measurements

Comparison of measured and simulated H- in the LEBT.  
Measurement is of phase space.  
Simulation is from source extraction to emittance meter, with secondary particles providing compensation.

Measurement

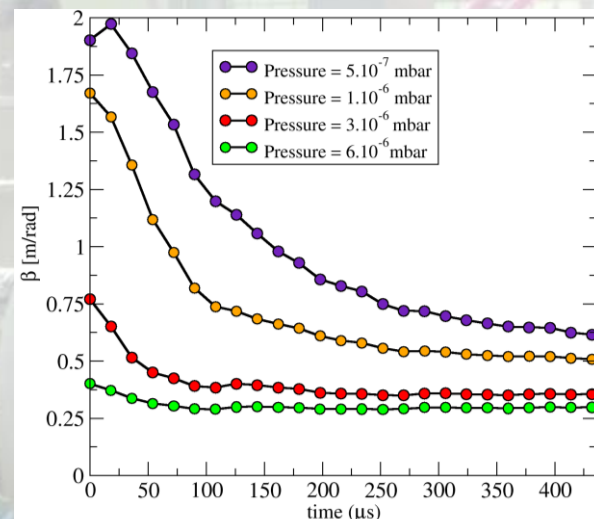
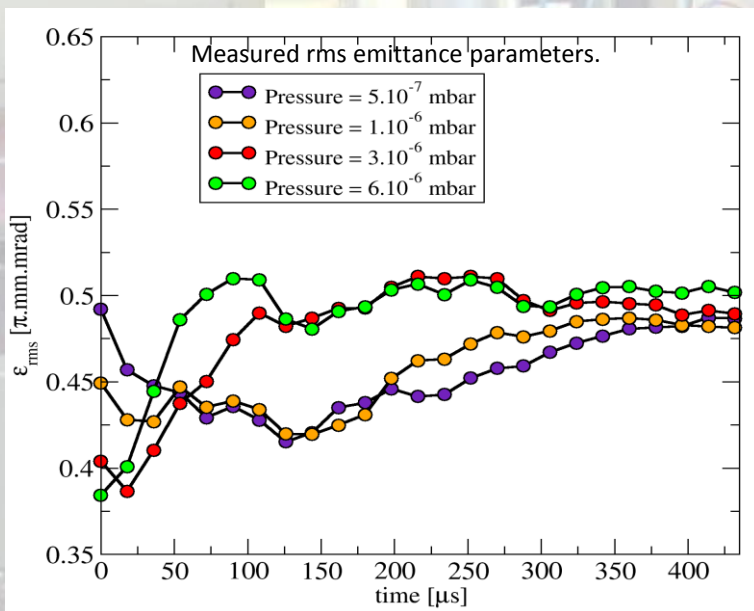
Simulation



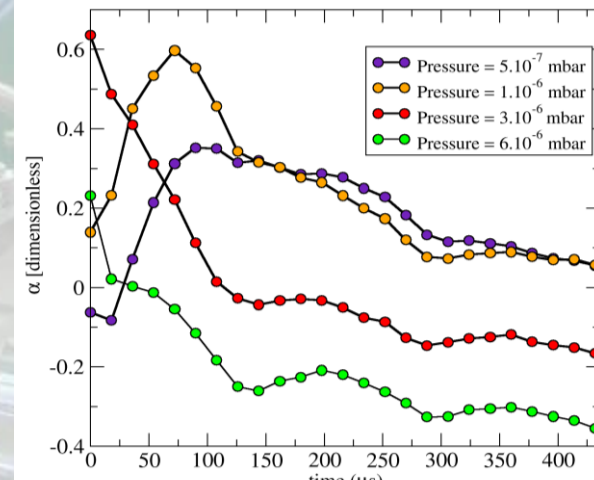


## Linac4 – LEBT – Measurements

- The LEBT is the beam measurement system for the source.
- Emittance – Limited measurement time so far with H-, just ~2 weeks when the source was working with H-, and the RFQ was not connected.

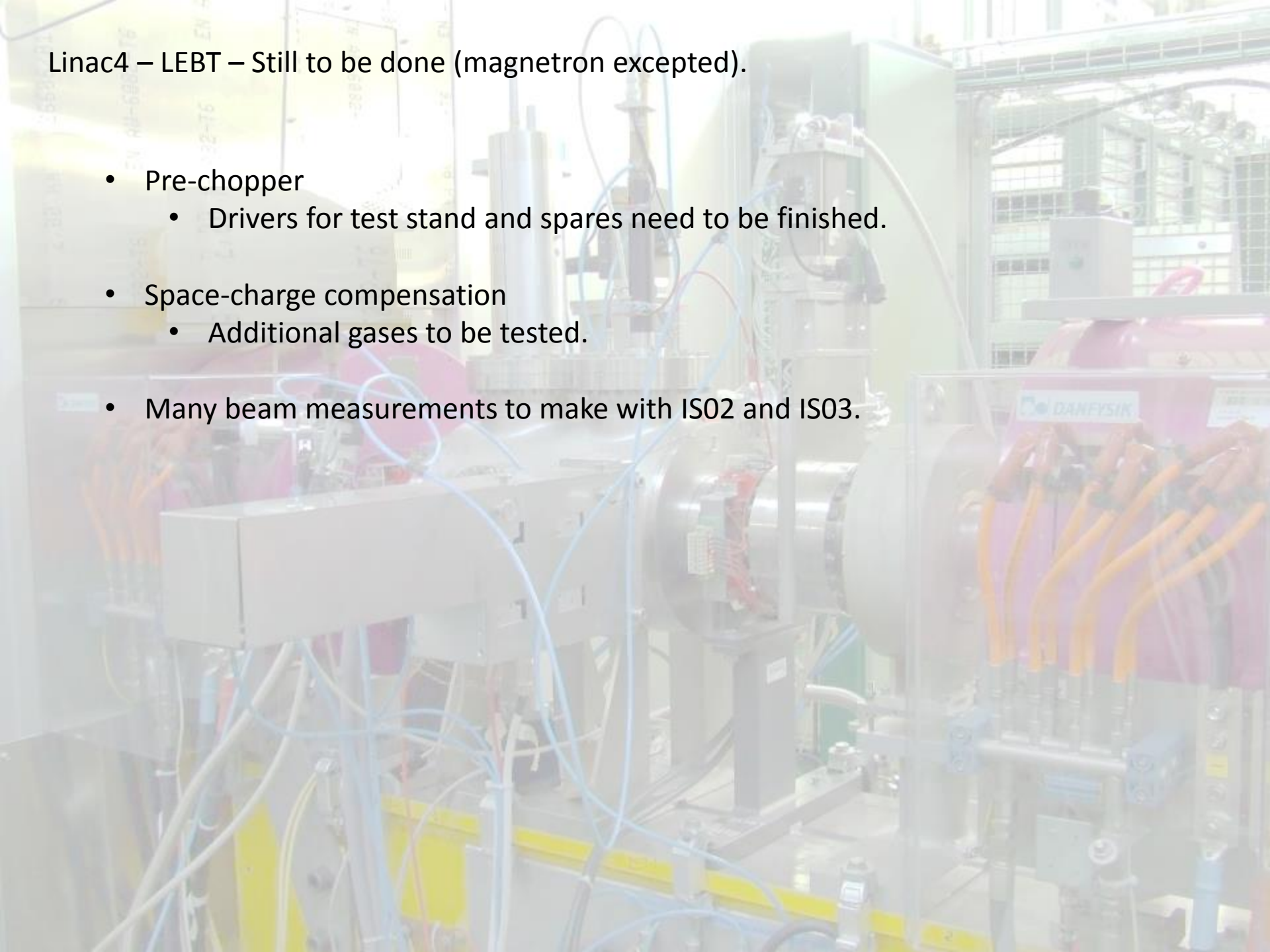


- Space-charge compensation of the beam is clearly visible.
- Establish stable conditions faster at higher pressure.
- We do not know why the emittance is increasing with compensation (but a 10% effect).
- Best RFQ transmission was at  $1 \times 10^{-6}$  mbar (based on limited study)

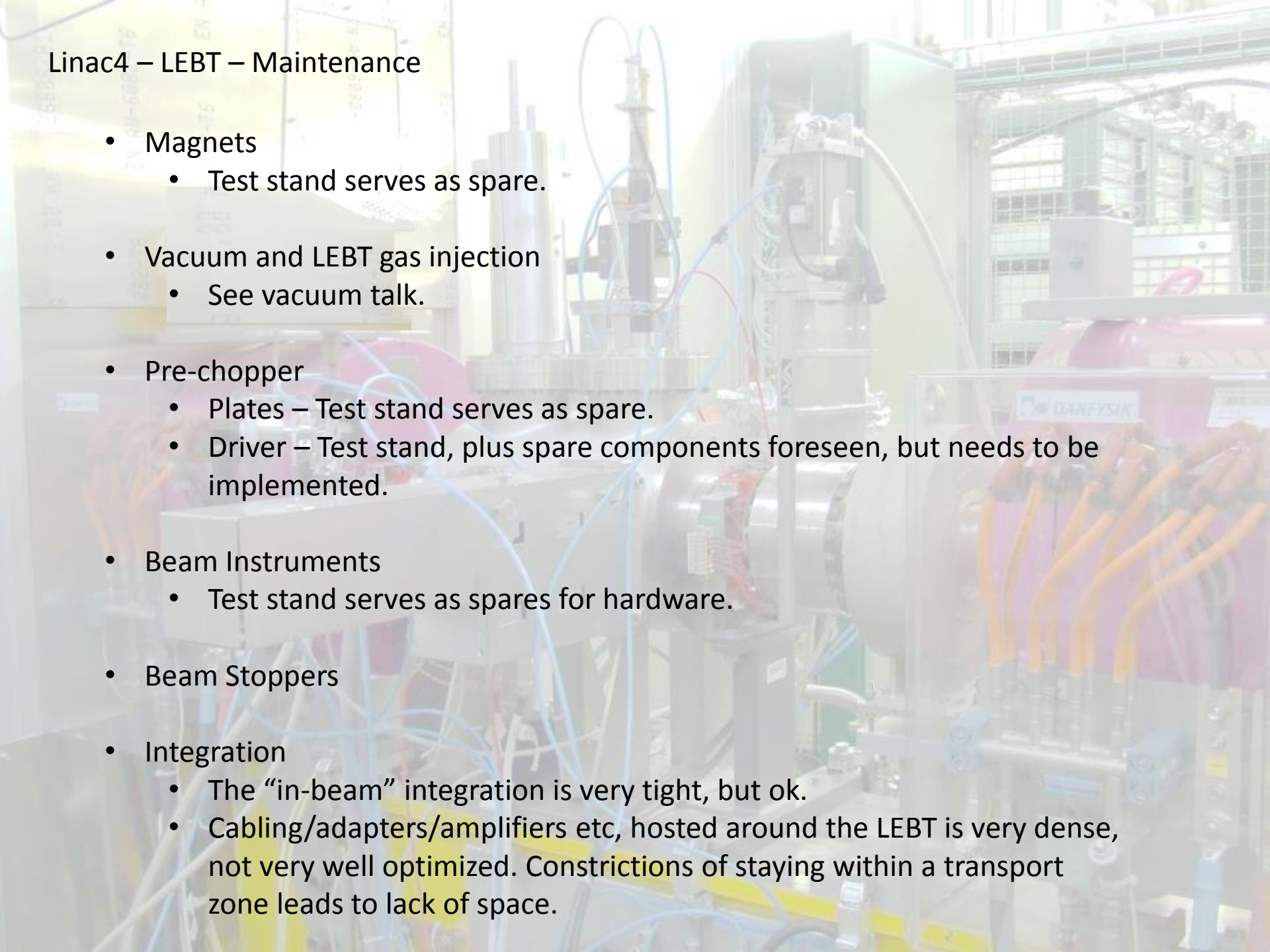


## Linac4 – LEBT – Still to be done (magnetron excepted).

- Pre-chopper
  - Drivers for test stand and spares need to be finished.
- Space-charge compensation
  - Additional gases to be tested.
- Many beam measurements to make with IS02 and IS03.



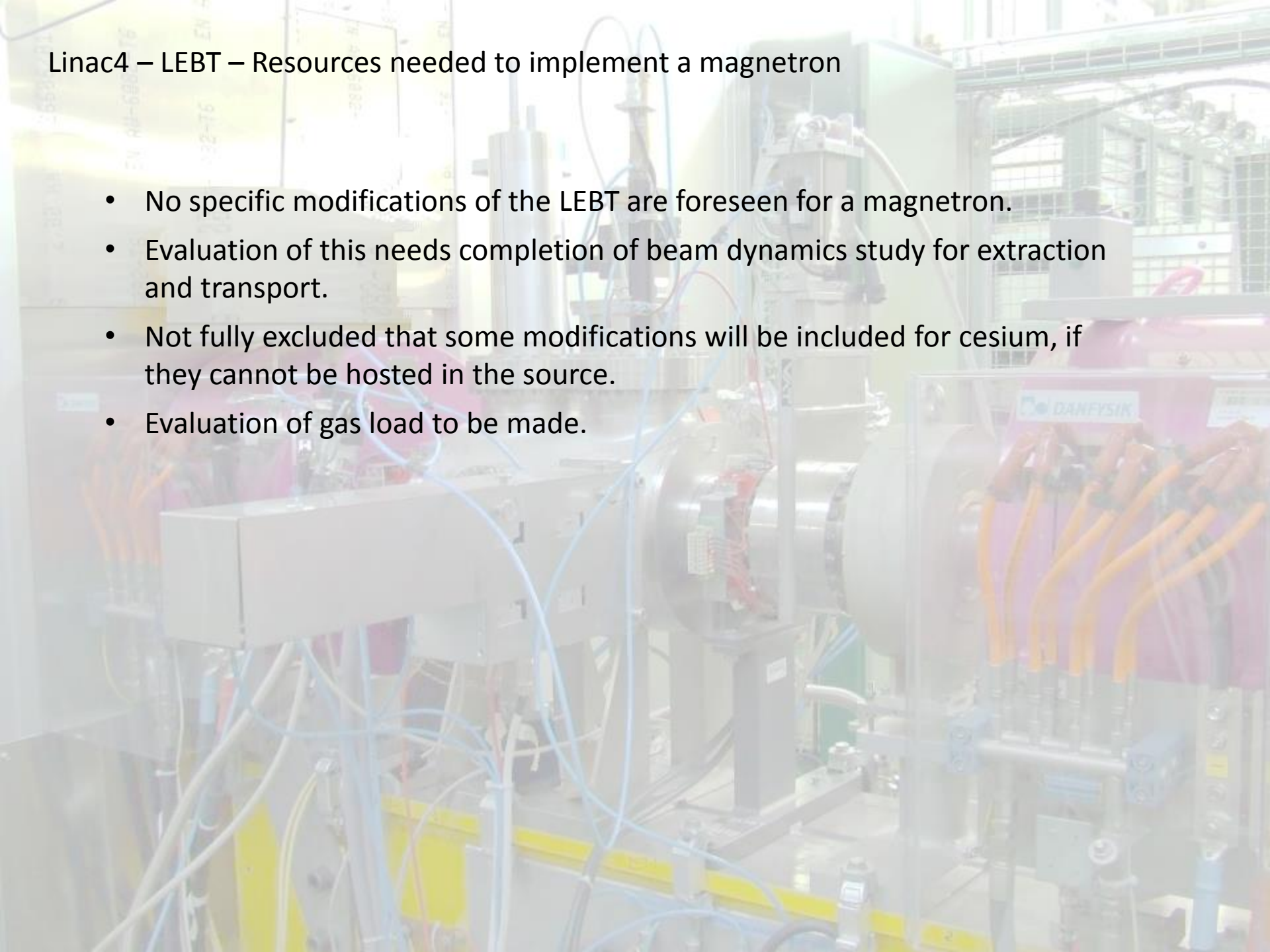
## Linac4 – LEBT – Maintenance

- Magnets
    - Test stand serves as spare.
  - Vacuum and LEBT gas injection
    - See vacuum talk.
  - Pre-chopper
    - Plates – Test stand serves as spare.
    - Driver – Test stand, plus spare components foreseen, but needs to be implemented.
  - Beam Instruments
    - Test stand serves as spares for hardware.
  - Beam Stoppers
  - Integration
    - The “in-beam” integration is very tight, but ok.
    - Cabling/adapters/amplifiers etc, hosted around the LEBT is very dense, not very well optimized. Constrictions of staying within a transport zone leads to lack of space.
- 



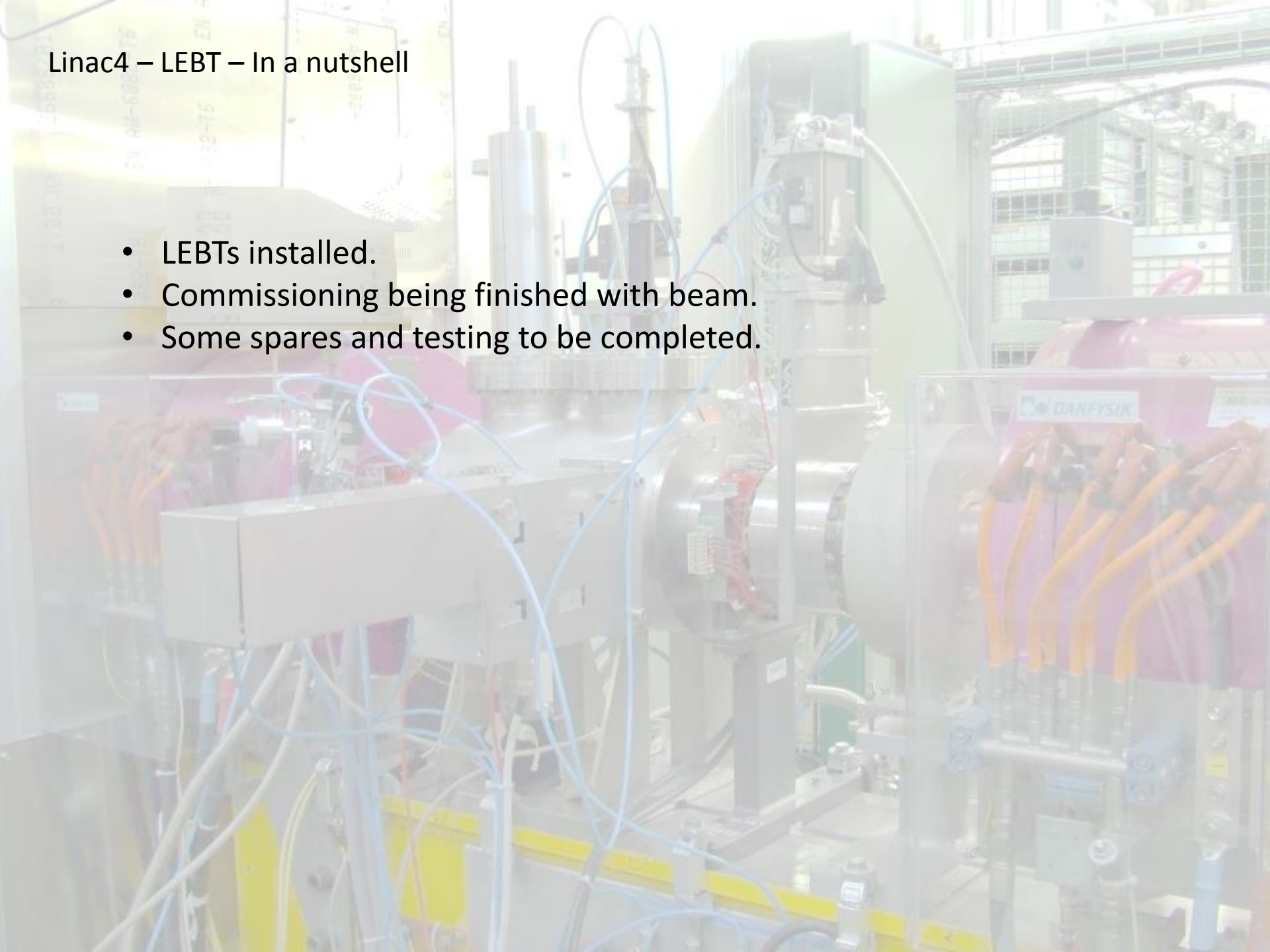
## Linac4 – LEBT – Resources needed to implement a magnetron

- No specific modifications of the LEBT are foreseen for a magnetron.
- Evaluation of this needs completion of beam dynamics study for extraction and transport.
- Not fully excluded that some modifications will be included for cesium, if they cannot be hosted in the source.
- Evaluation of gas load to be made.



## Linac4 – LEBT – In a nutshell

- LEBTs installed.
- Commissioning being finished with beam.
- Some spares and testing to be completed.



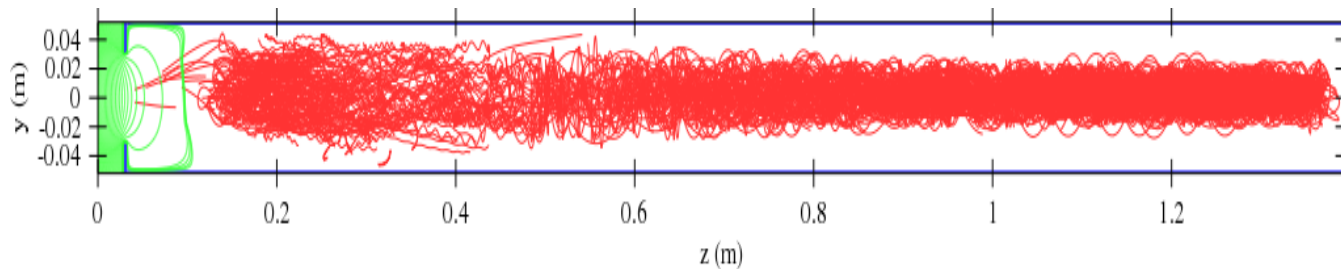
# Linac4 – LEBT – Backups

Simulation with IBSimu, taking into account secondary ions causing spec charge compensation.  
Evolution of the beam in time can be seen.



Particle trajectory from a simulation of the experimental setup and part of the Extraction system at  $20\mu\text{s}$  and  $200\mu\text{s}$ .  $\text{H}^-$  beam [red] and the potential lines [green].

Phase space rotation



Trajectories of secondary ions.