Swansea System

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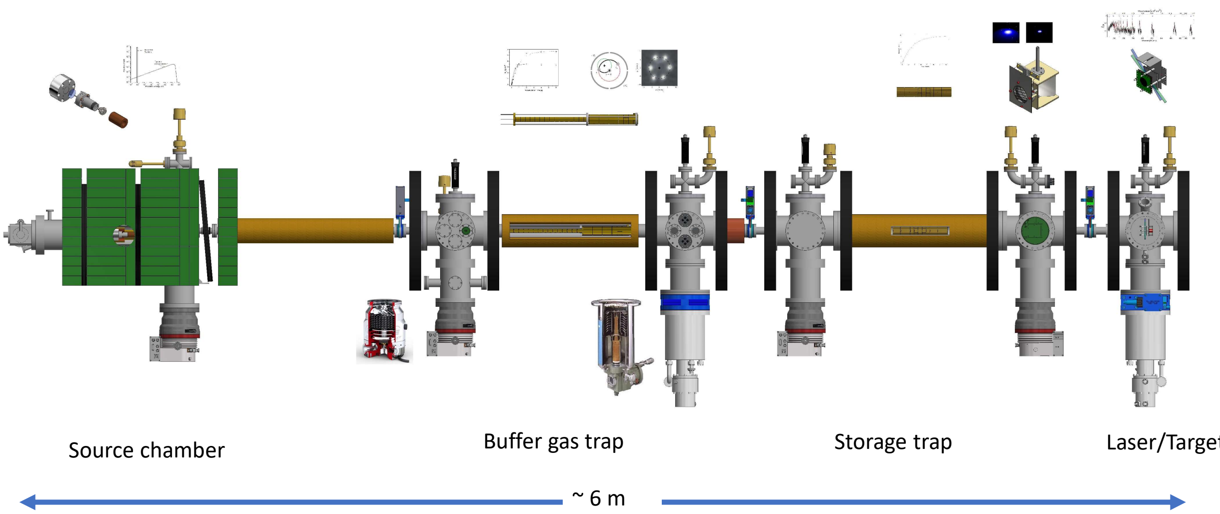
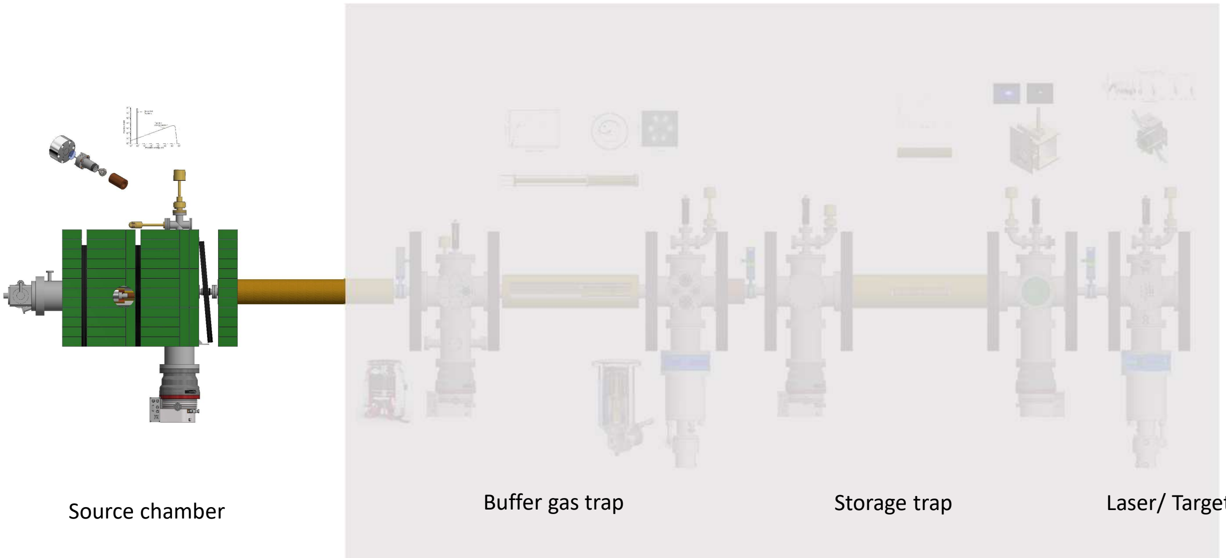
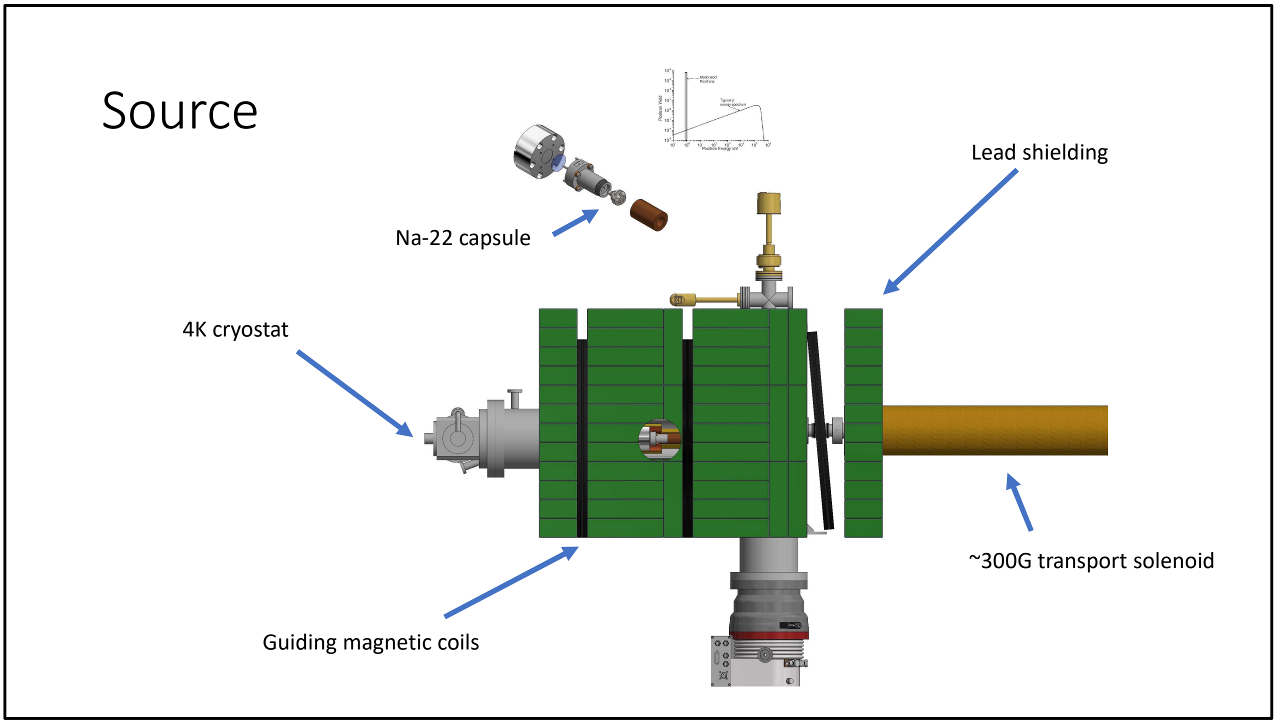
Positron beamline overview



Main system we have in Swansea is a positron beamline ~6m long. Comprising the source chamber (left), buffer gas accumulator (middle), storage trap (middle right), and laser/target/sample cross.

Positron beamline overview





The source chamber comprises a 4K cold finger, onto which a positron emitting radioactive source (Na-22) is thermally connected, but electrically isolated, via a sapphire disk (see exploded inset). Neon is condensed onto the source to moderate the positrons (see plot, for instance), such that ~1% of positrons are emitted with a few eV K.E., and accelerated downstream by biasing the source to e.g. 50V. Radial confinement is provided by Helmholtz-like guiding coil arrangement of up to ~100 gauss.

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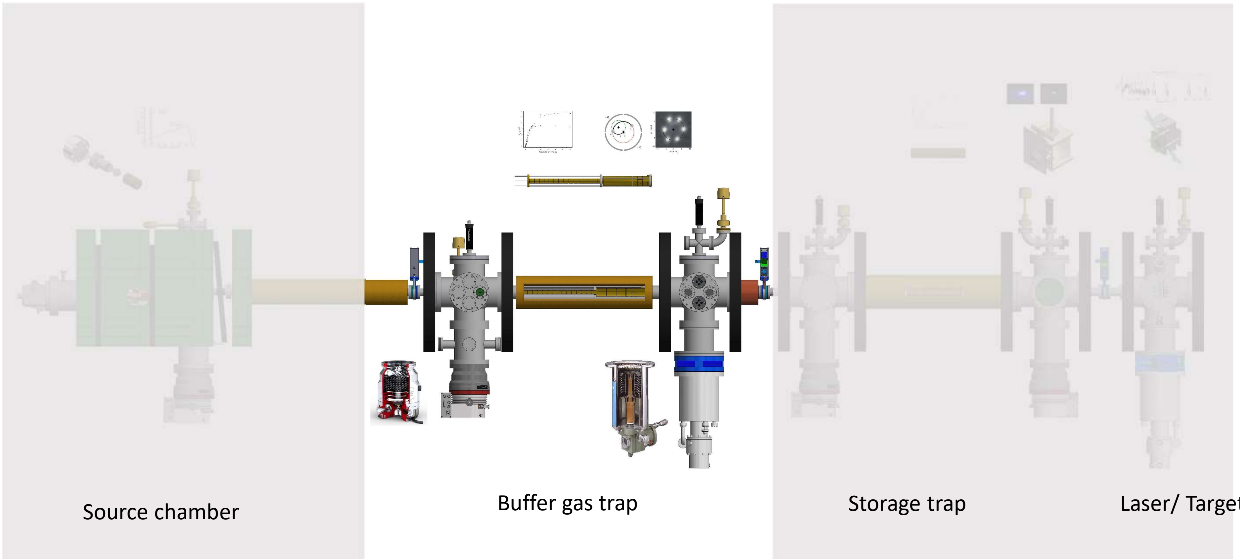
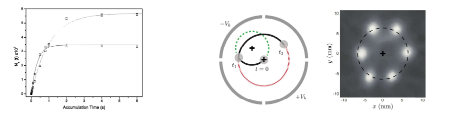
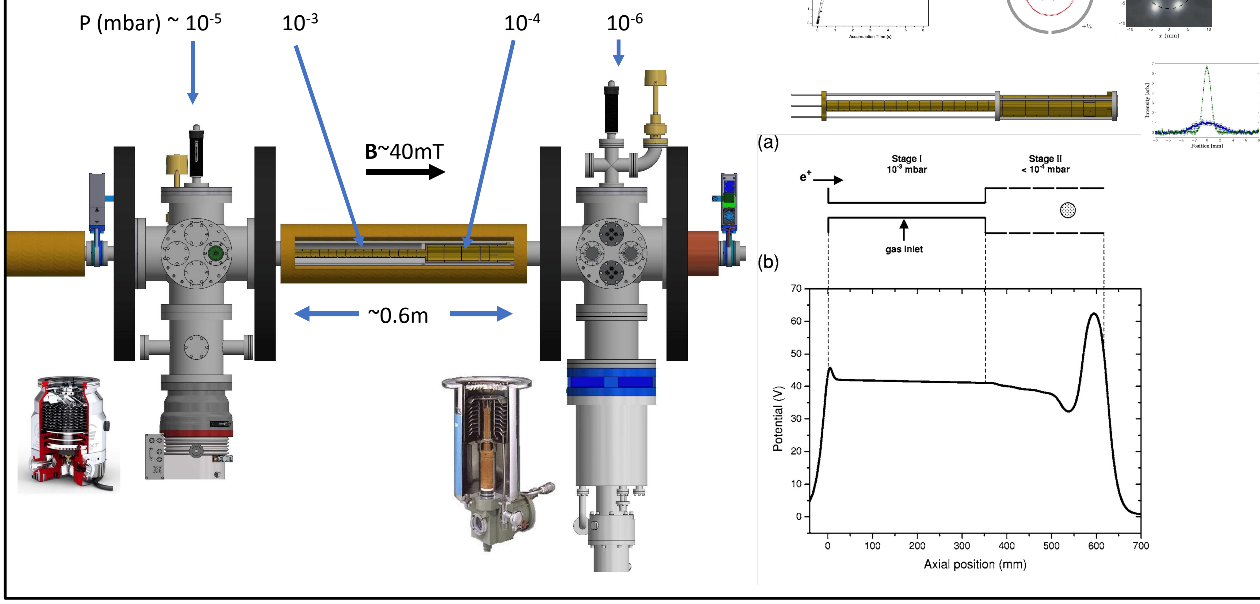


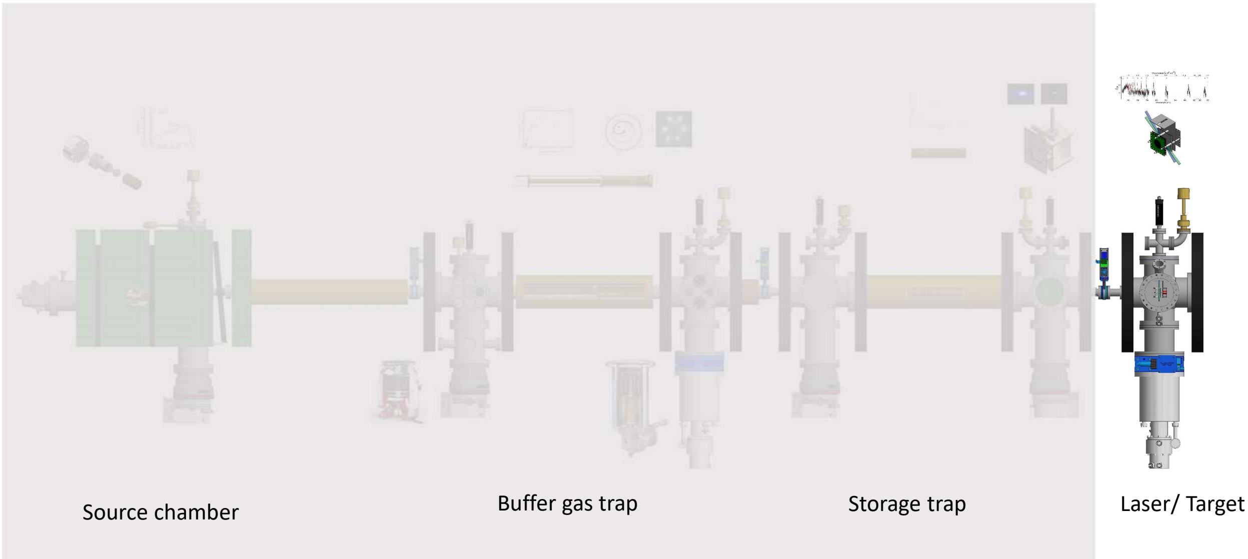
Positron buffer gas trap (accumulator)



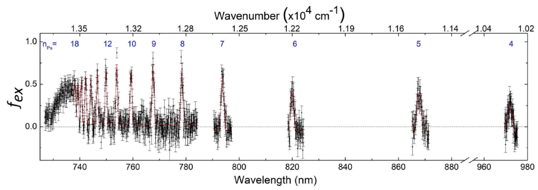


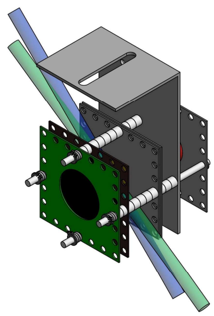
The buffer gas trap comprises ~20 independently bias-able cylindrical electrodes immersed in a ~400gauss solenoidal magnetic field (Penning Malmberg trap). The electrodes are biased to provide an axial trapping profile (see right hand plot). Nitrogen gas is injected and due to the differential pumping and varying electrode conductances, a static pressure profile is established. Carefully choosing the pressure & potentials allows positrons to be accumulated. This accumulation is studied, and the positrons manipulated as necessary to increase their number, or density, or control radial positioning.

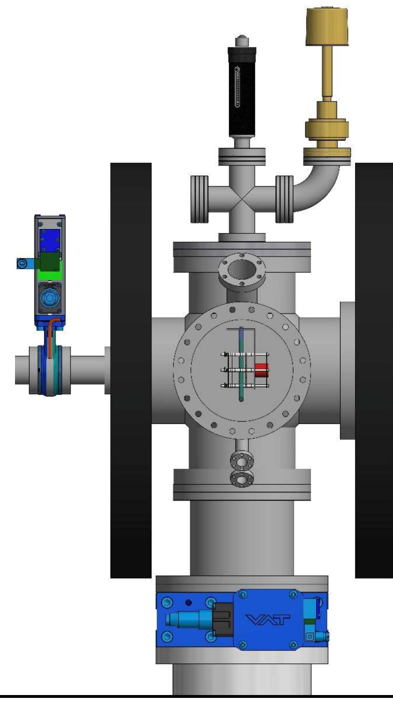
Positron beamline overview



Positronium formation (Ps)

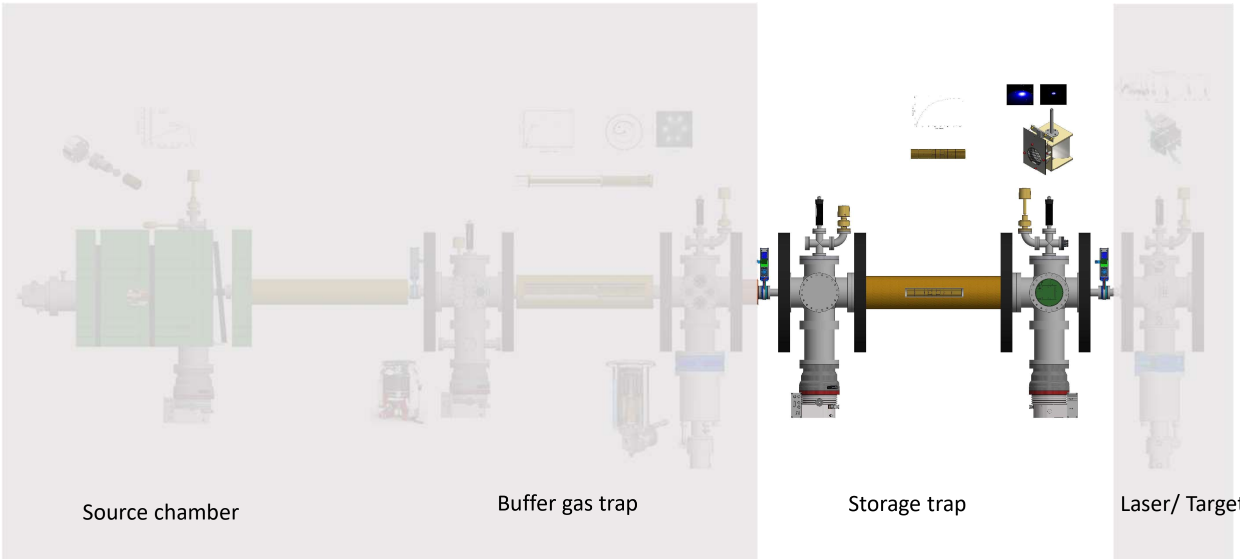


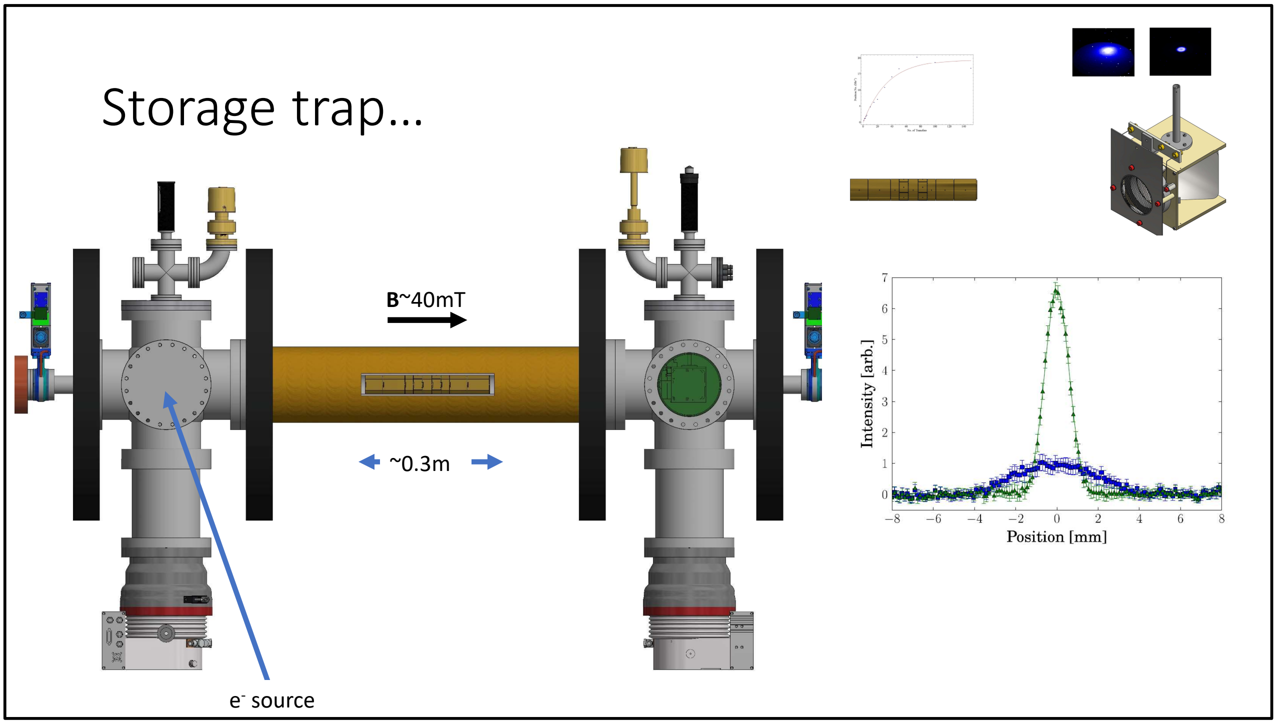




We can use these accumulated positrons, alongside the manipulation techniques, to produce positronium atoms for spectroscopic study via laser illumination. For instance, Ps atoms can be excited from their ground state to Rydberg levels (see inset figure).

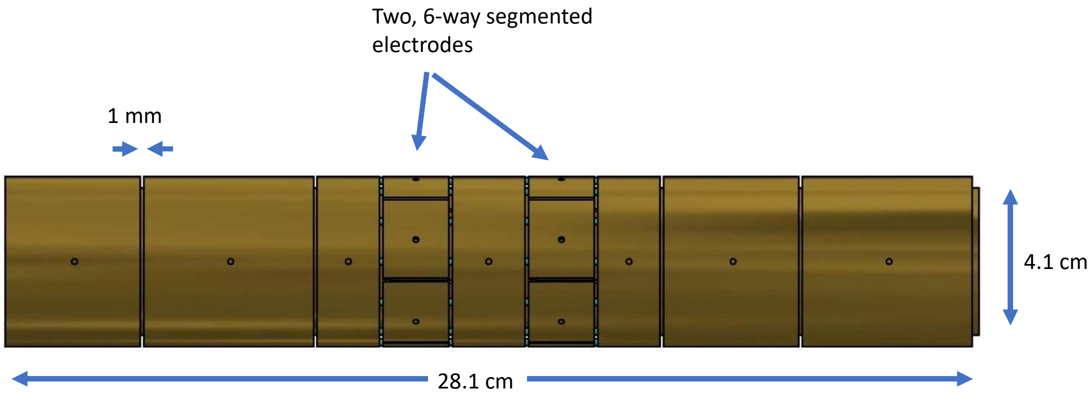
Positron beamline overview



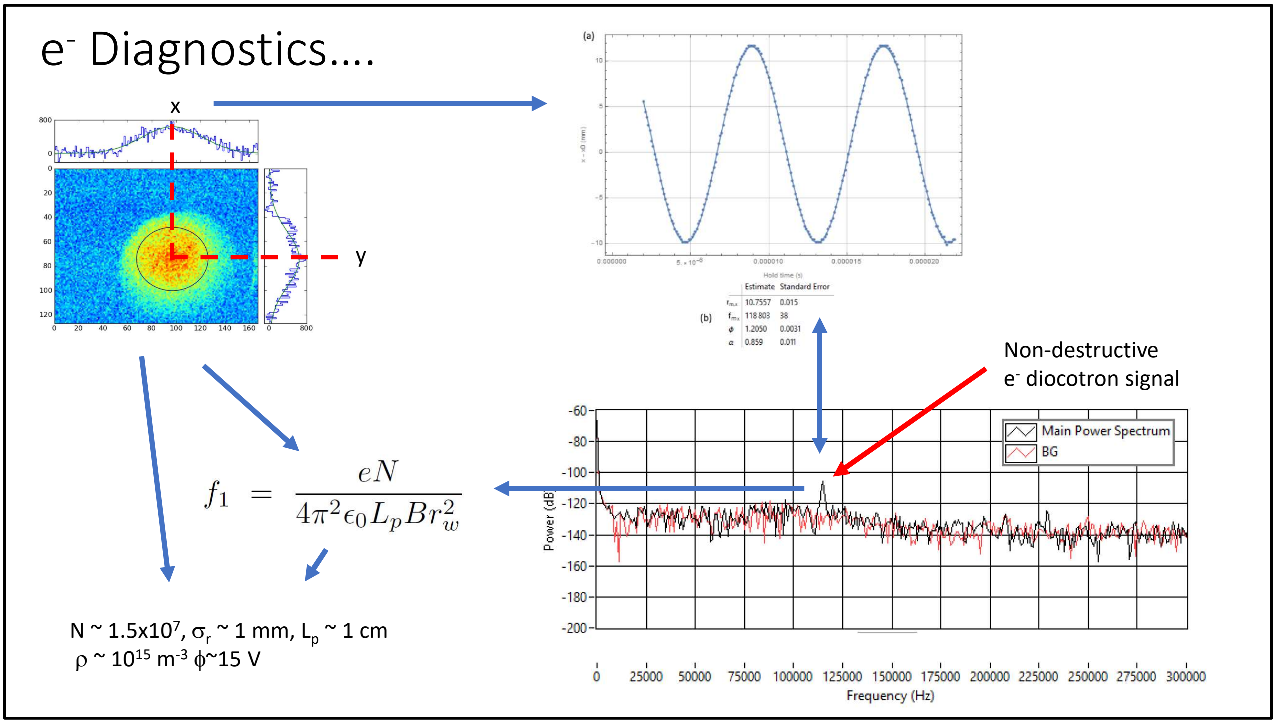


The storage trap is similar in design to the lower pressure stage of the accumulator. See next slide for trap details. It can be used for e.g. positron stacking (see inset figure) and has an MCP/P-screen assembly located at the exit for imaging the radial position & line integrated density of positrons. An electron source is also installed on a linear manipulator upstream of the storage trap.

Trap detail - current



As currently installed the electrode configurations is as shown.



The storage trap has also been used for electron studies. Destructive studies (ejecting particles towards the MCP) allows the plasma size, position, number, and temperature to be determined. Non-destructive measurements have also been performed and allow e.g. the diocotron frequency to be determined from induced image charges. Some typical plasma parameters can be determined from these measurements. Typically a ‘beam catching’ technique is employed to load the trap as opposed to e.g. collision, or stream instability, scattering accumulation techniques for convenience.