GISMO Gasdynamic ECR Ion Source Status: Towards High-Intensity Ion Beams of Superior Quality

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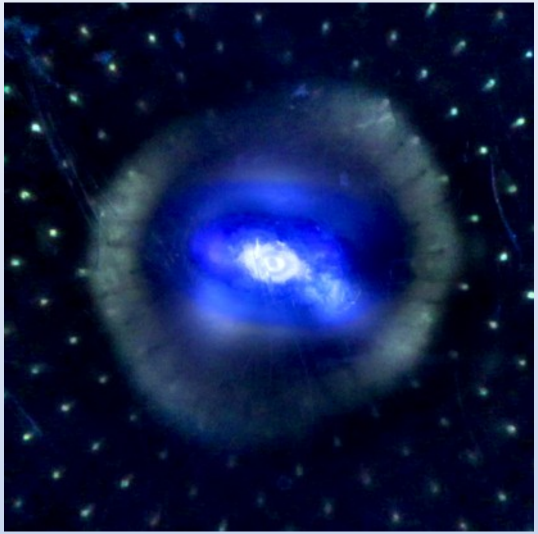

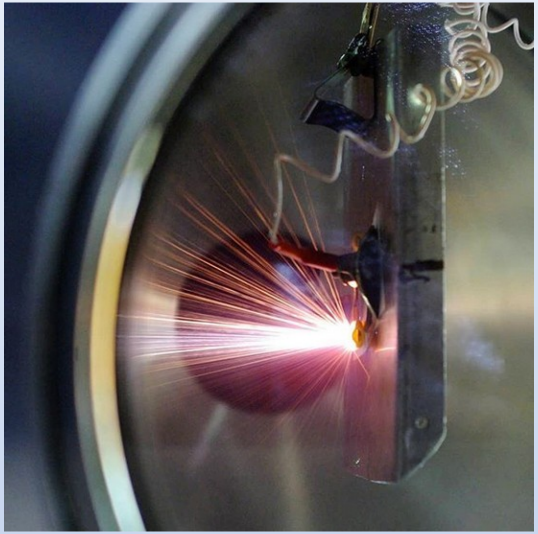

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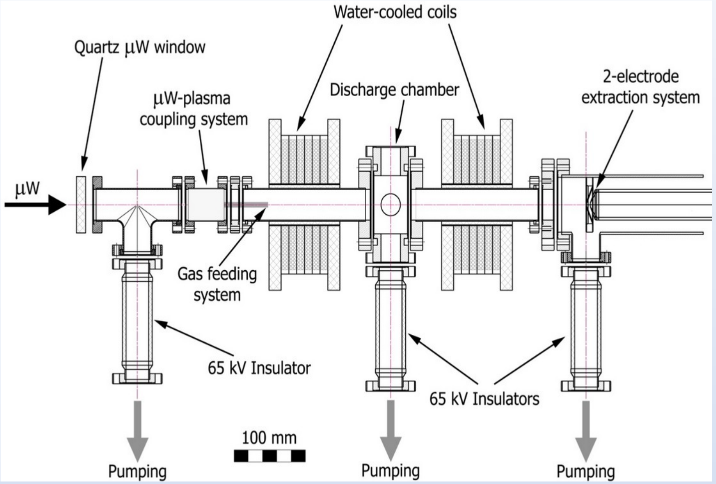
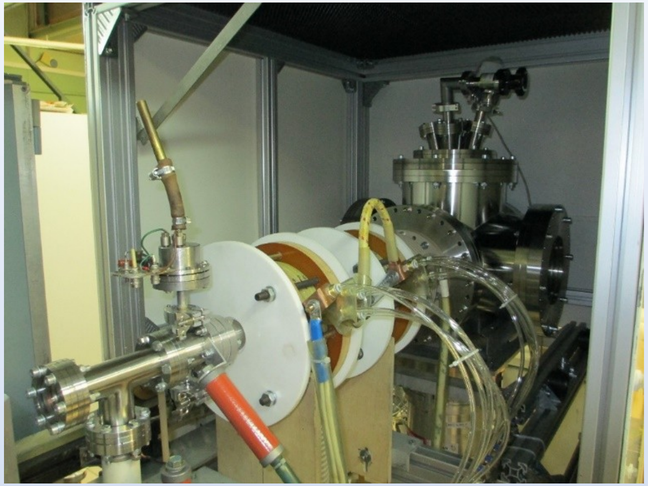
The first gasdynamic ECRIS: SMIS37





Frequency 37.5 or 75 GHz
Power up to 100 kW
Pulse duration 1 ms
Trap magnetic field up to 5 T

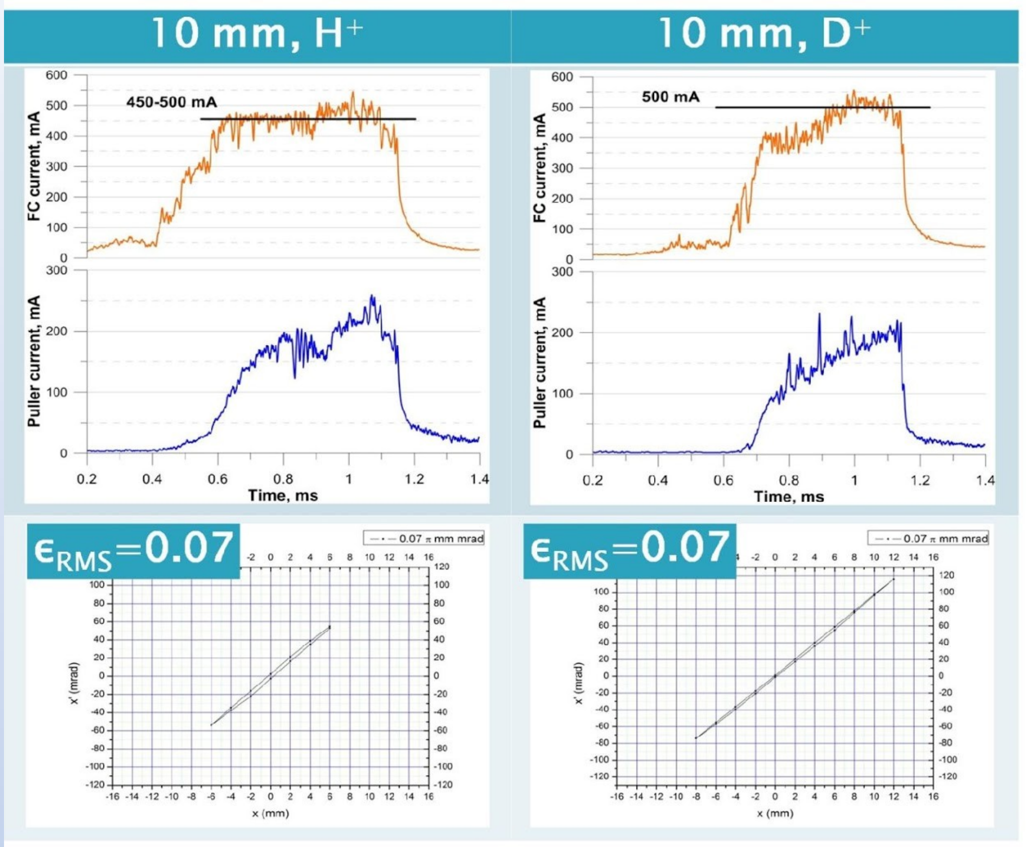
Low temperature high density collisional plasma

Unique plasma parameters
$N_e > 10^{13}$ cm^{-3}, $\tau = 5 \div 50$ us,
T_e: $50 \div 300$ eV

High current density
J ~ 100 - 800 mA/cm^2

Low emittance values

The first gasdynamic ECRIS: SMIS37

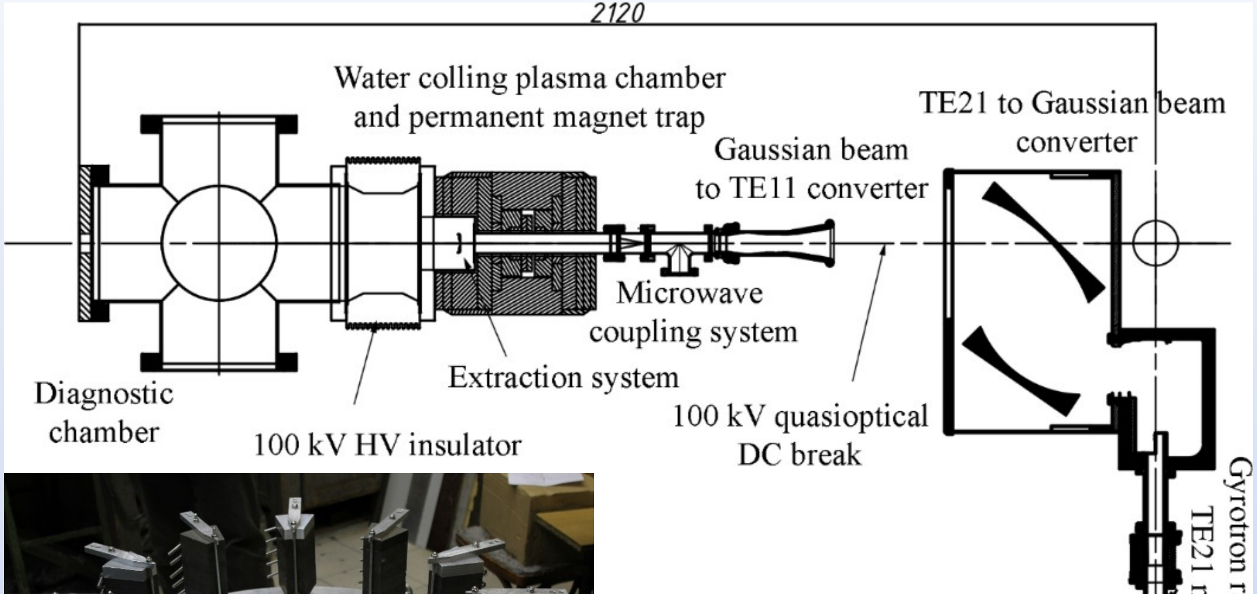


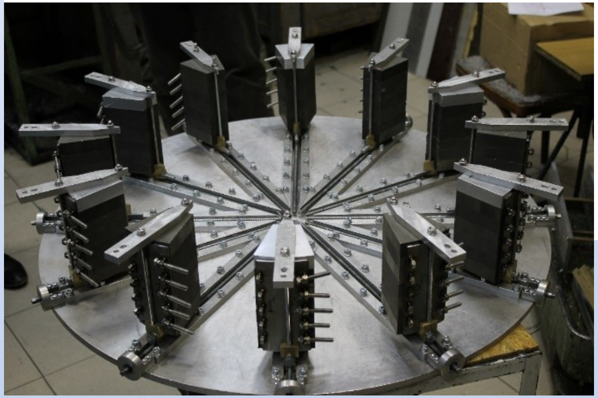
H+, D+ Ions current density
> 600 mA/cm^2

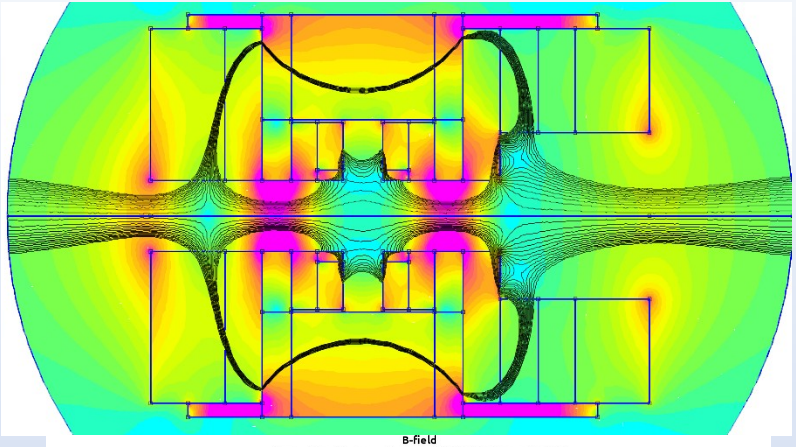
Emittance:
<0.07 pi*mm*mrad
might be even less, low measurement accuracy

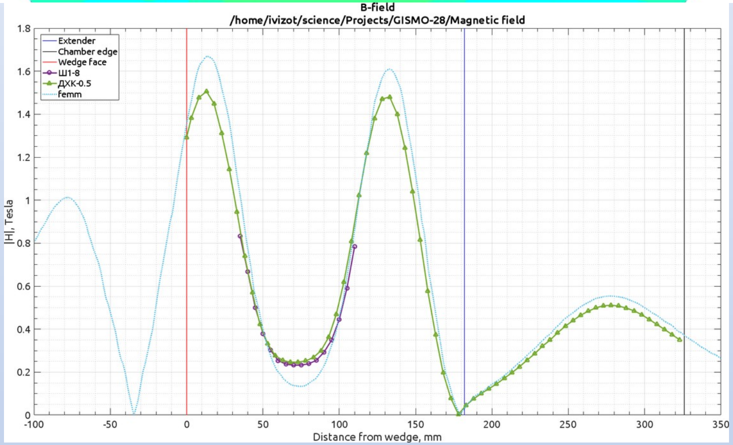
Molecular ions:
<6% of the beam

GISMO ECR ion source



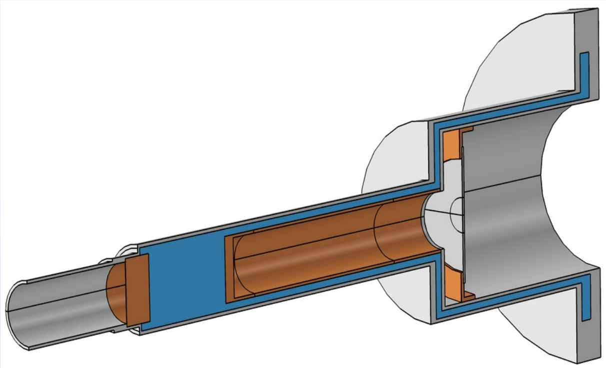


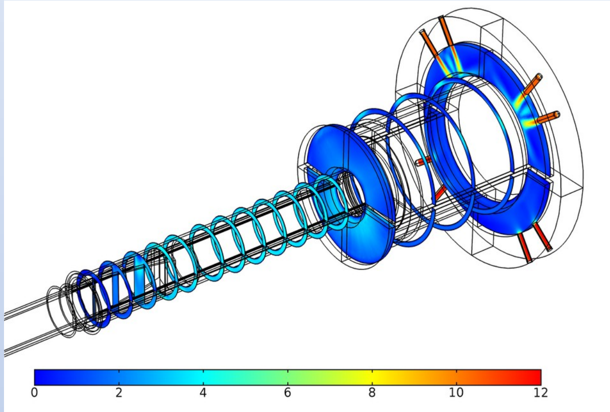


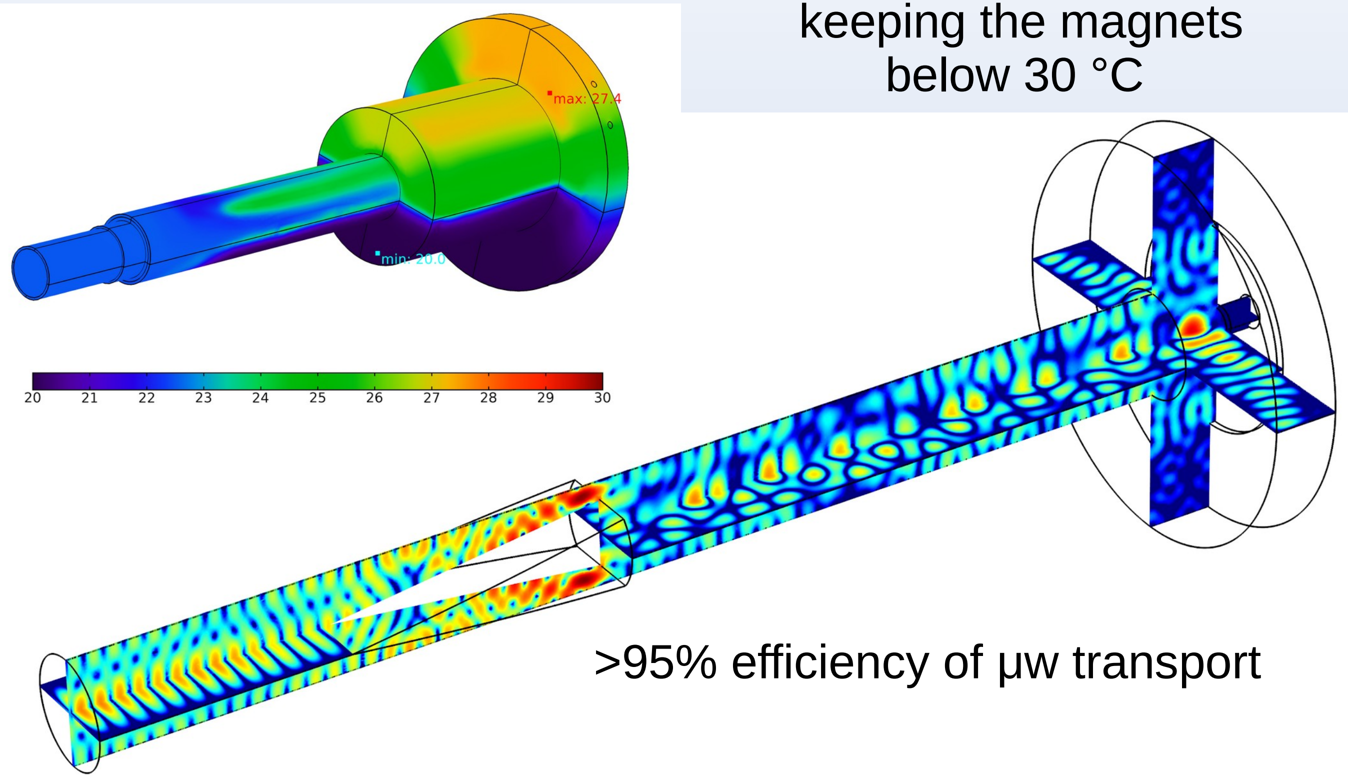


GISMO plasma chamber

Handles 10 kW of CW power keeping the magnets below 30 °C

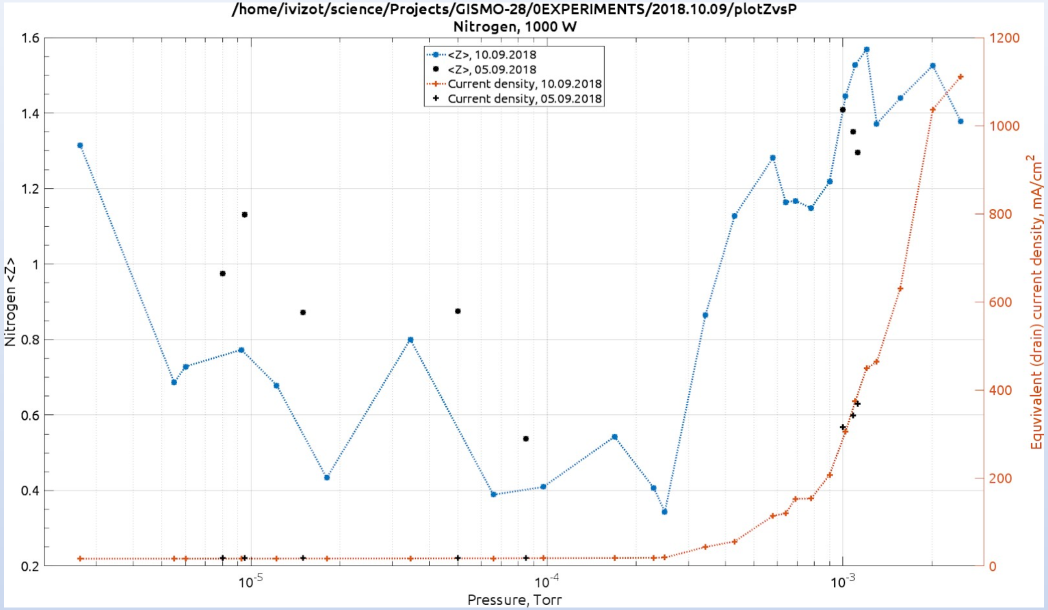


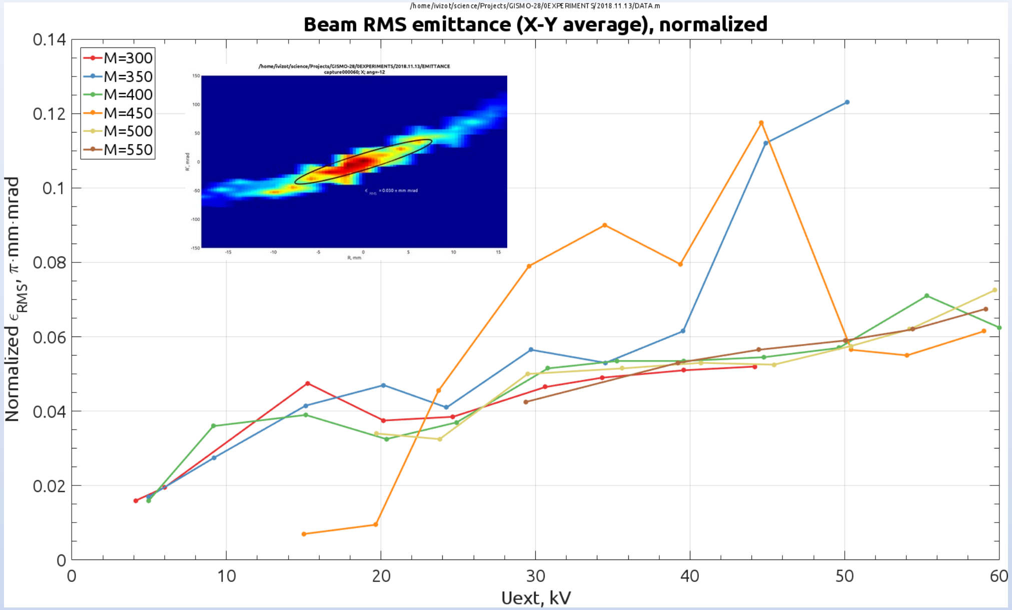




>95% efficiency of μw transport

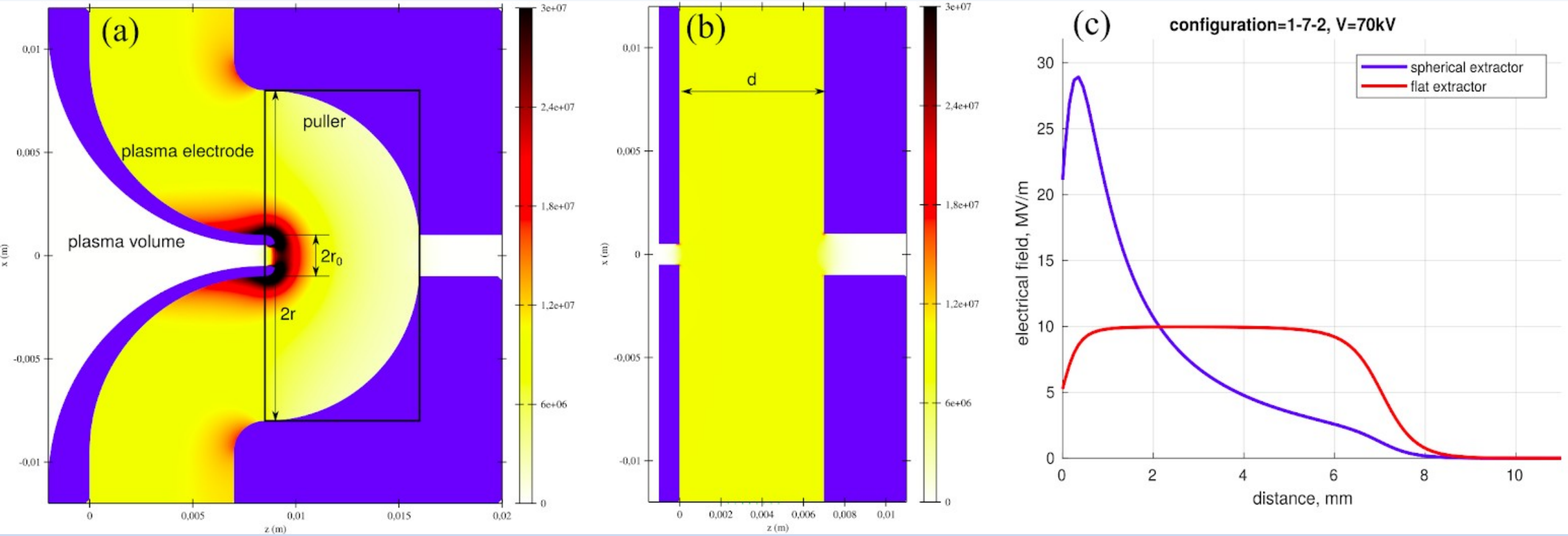
$J \sim 1000\ mA/cm^2$ [drain]
$E_{rms,norm} < 0.2\ \pi \cdot mm \cdot mrad$





We need a sophisticated extraction system!

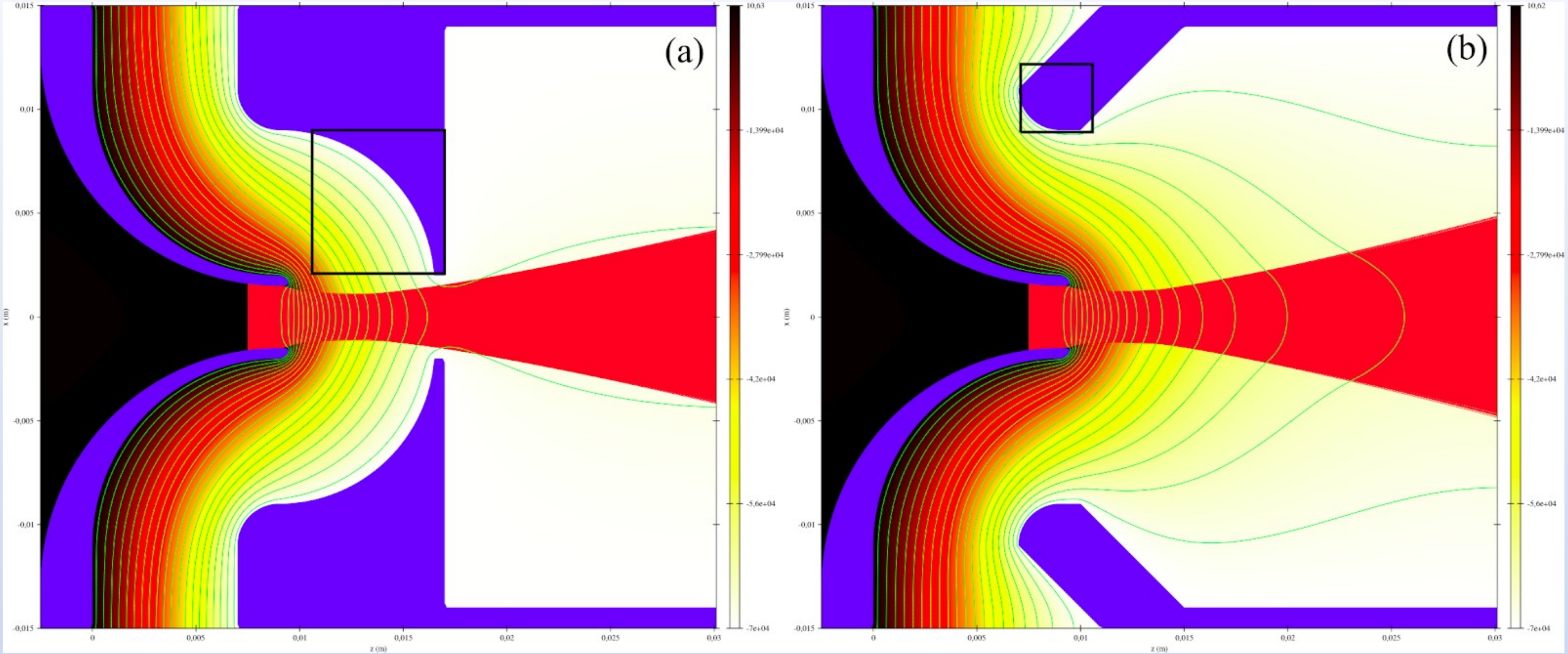
New extraction system: spherical



https://arxiv.org/abs/2009.02757
PSST: under review

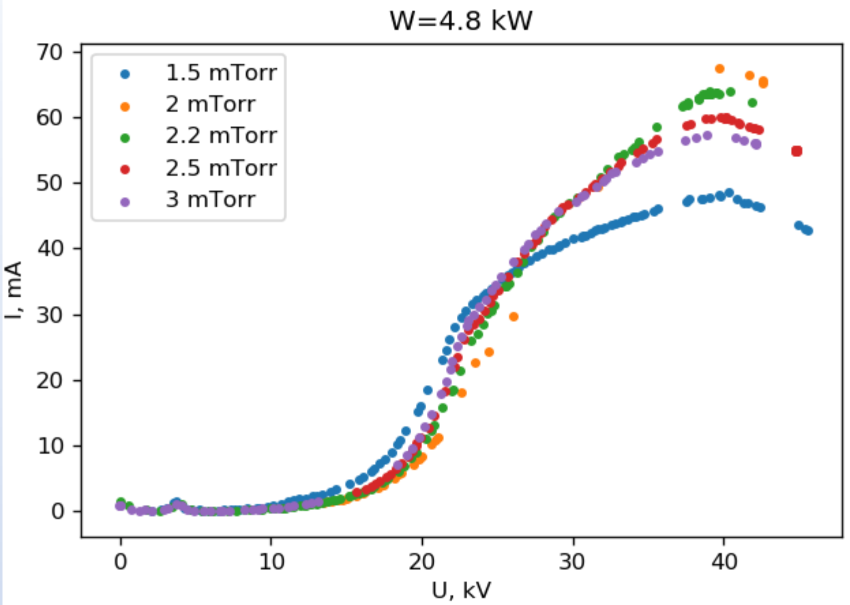
Patent #2726143 (Russian Federation)

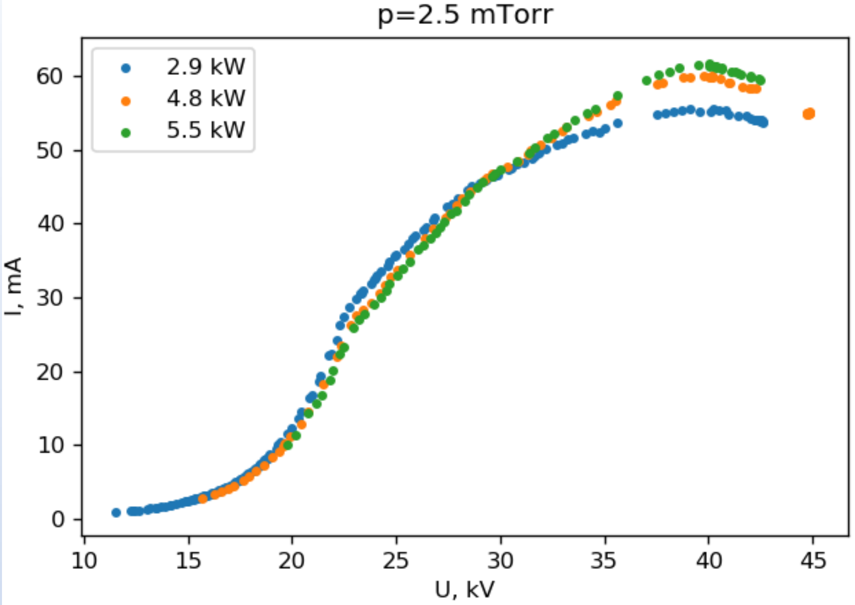
Large puller aperture barely affects the beam



Despite the native transverse E-field, the spherical extractor may enhance the beam divergence due to lower influence of the space charge.

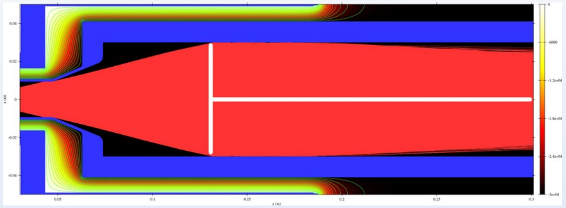
H^+ beam current

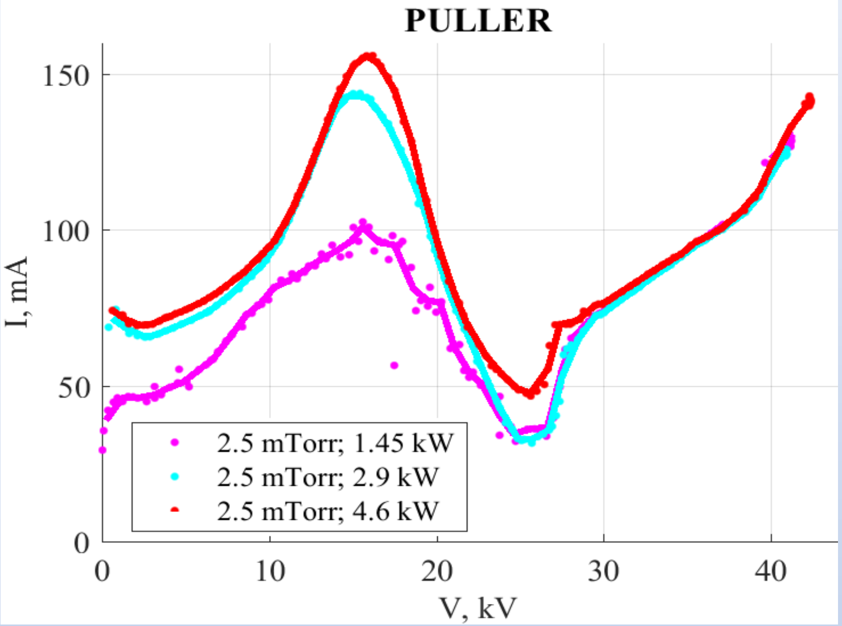


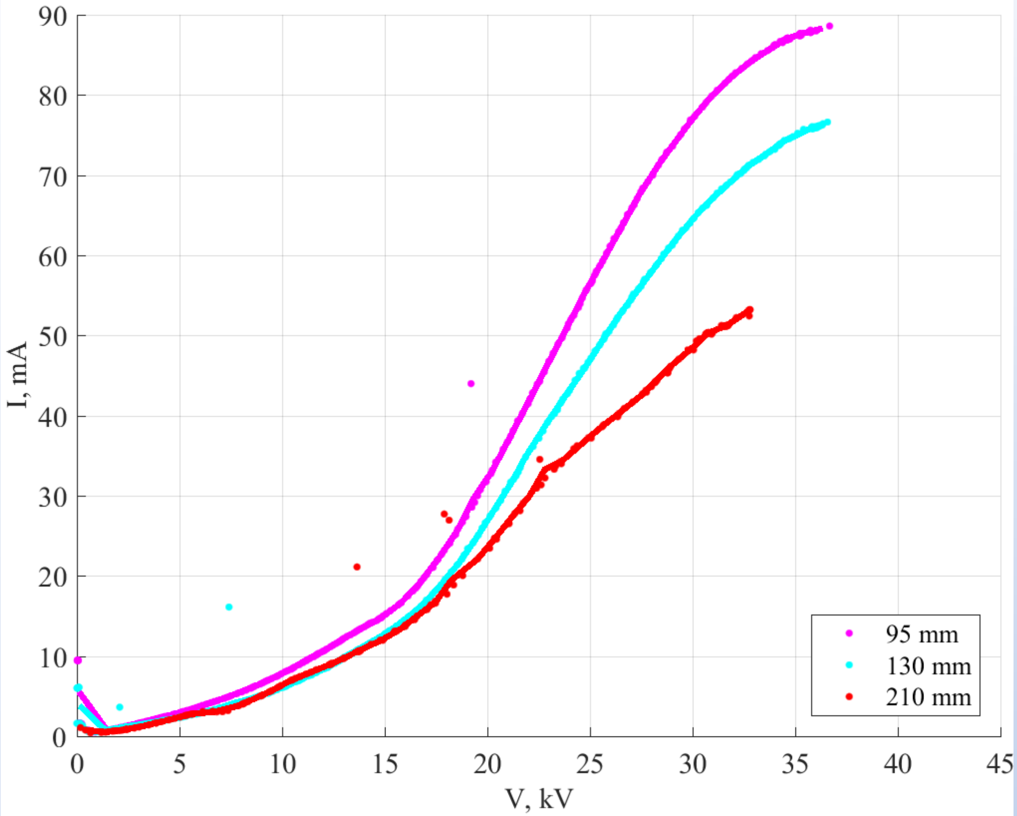


In combination with intrinsic magnetic lenses, the spherical extractor allowed us to achieve >60 mA of H+ beam at 40 keV. Beam size (>99%) is 50 mm at 70 cm from the extraction system. Yet >100 mA are lost in the beam line (puller) and may be delivered with the enhanced multi-electrode beam forming configuration.

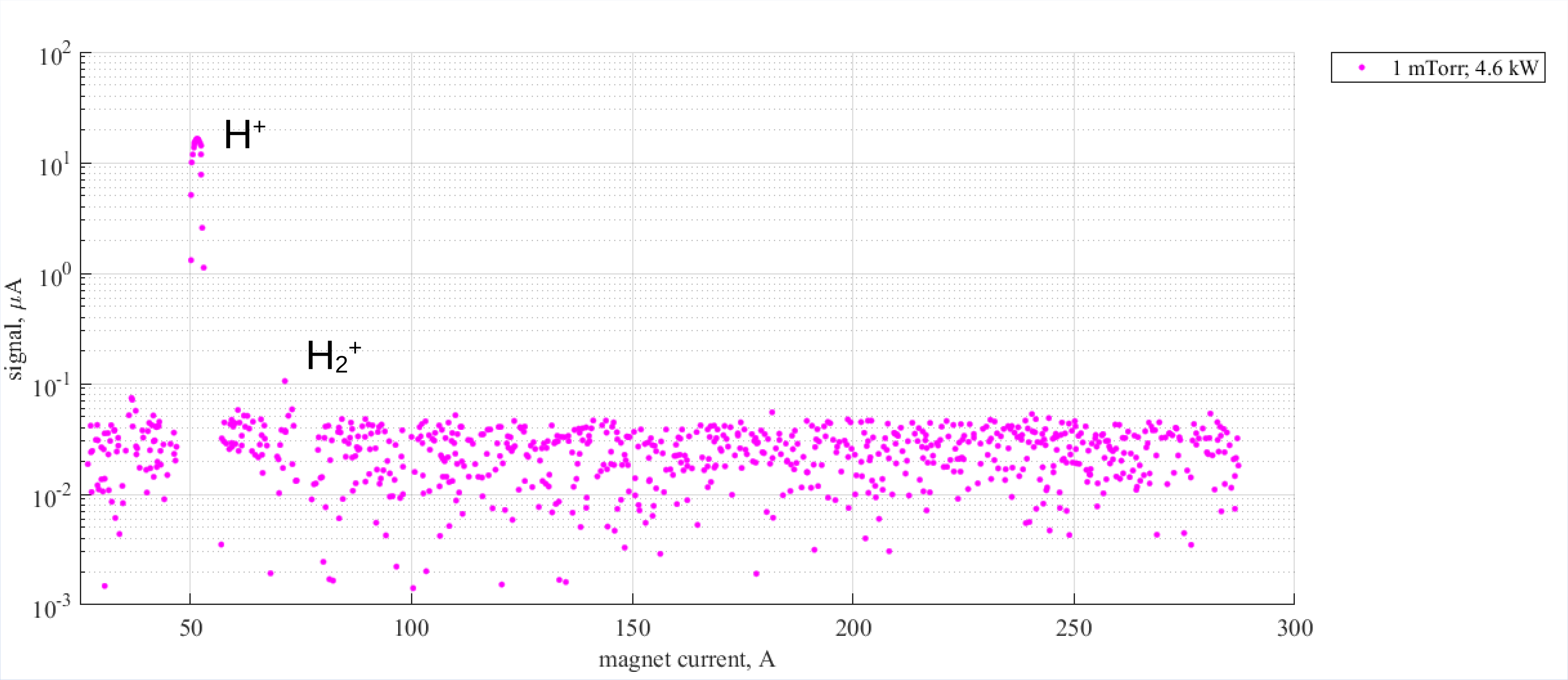
Beam losses



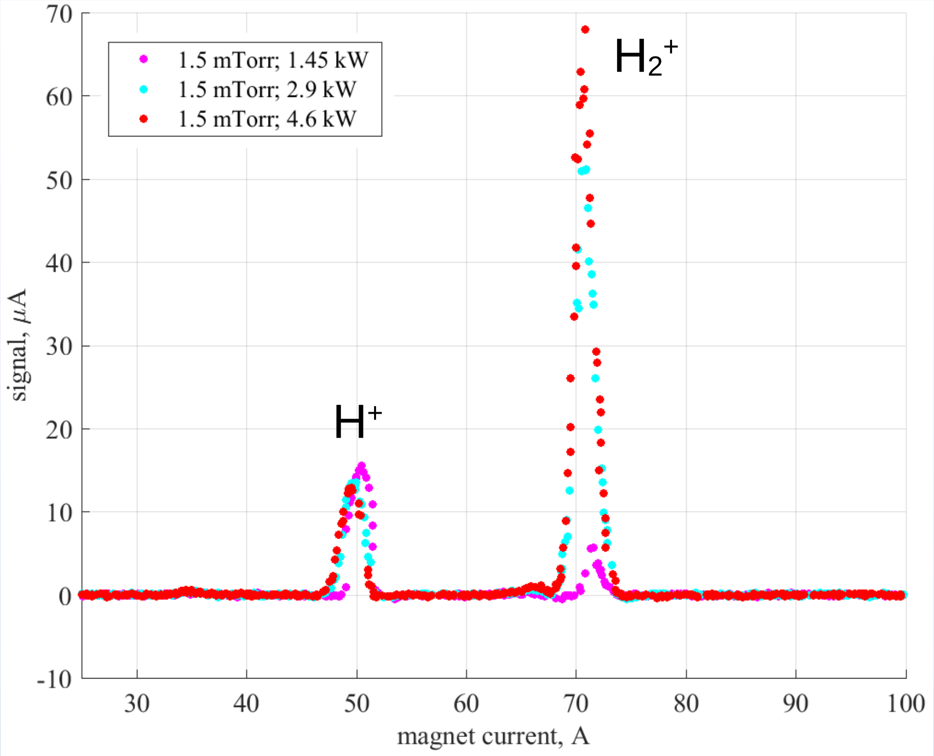

PULLER
I, mA
V, kV
2.5 mTorr; 1.45 kW
2.5 mTorr; 2.9 kW
2.5 mTorr; 4.6 kW

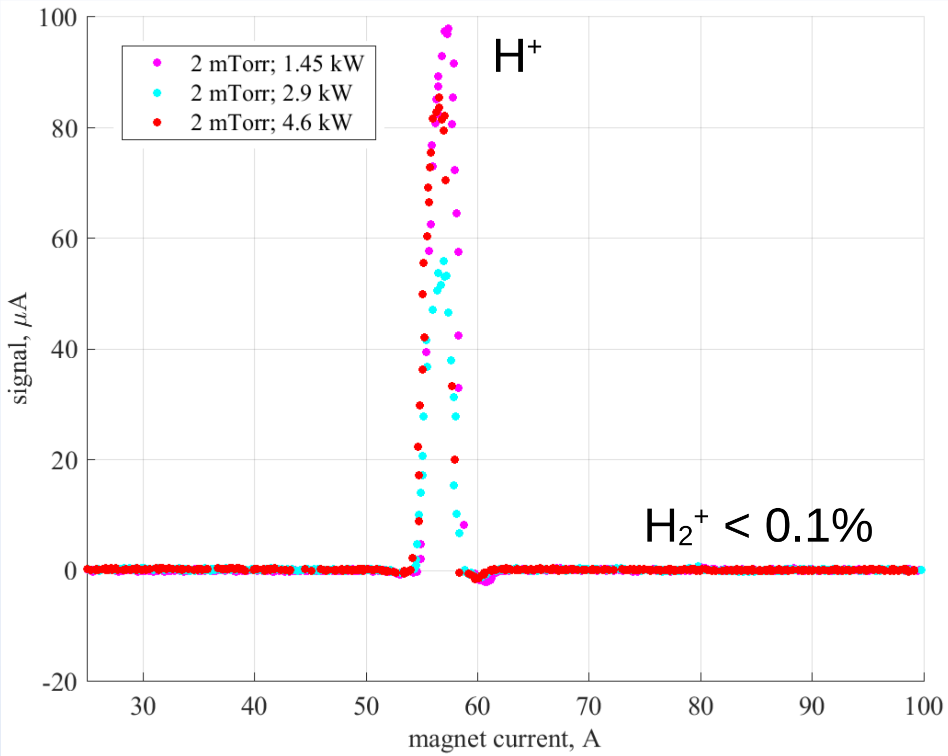

I, mA
V, kV
95 mm
130 mm
210 mm

Ion beam composition: impurities



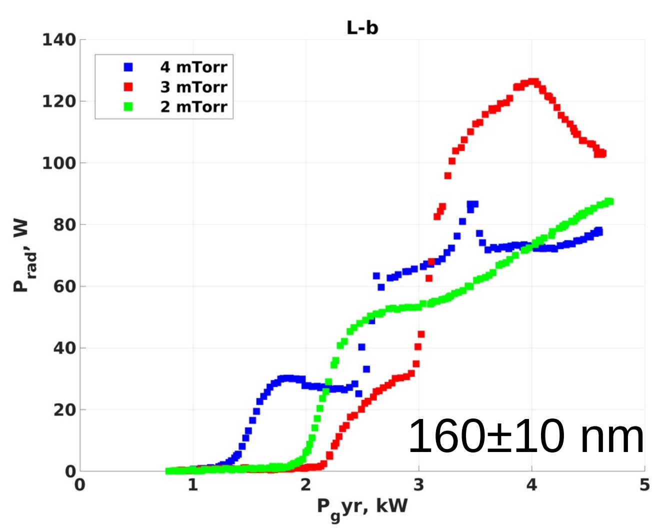
Ion beam composition: H^+/H_2^+ ratio

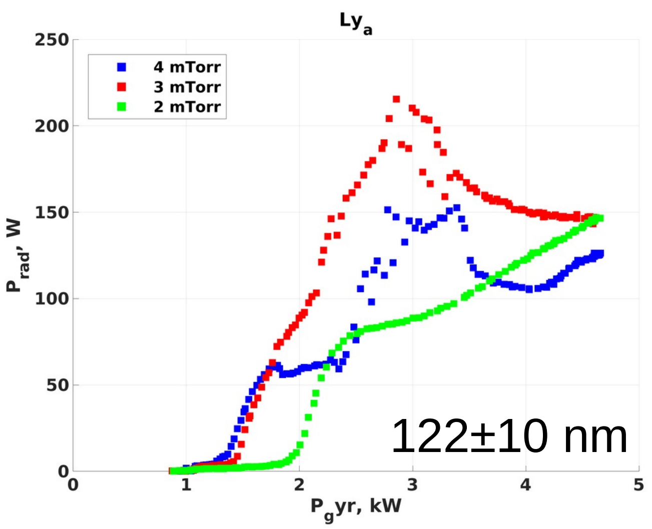


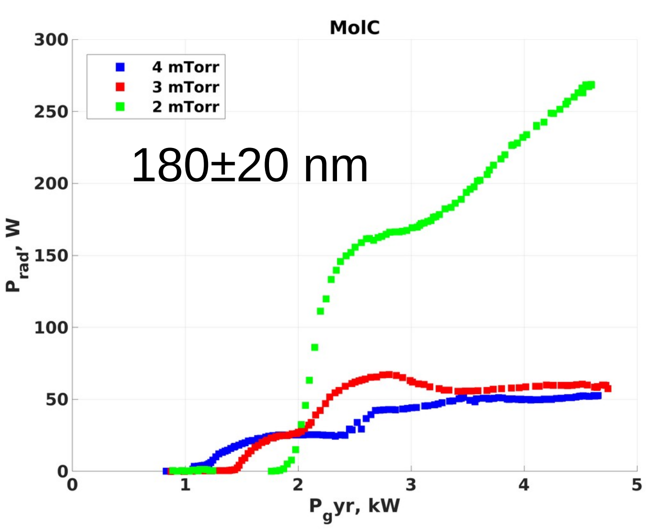


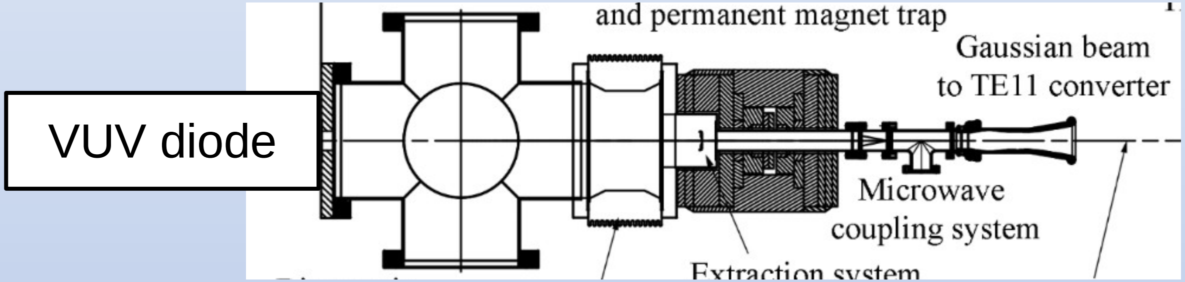
Pure proton beam with no need to separate

VUV emission





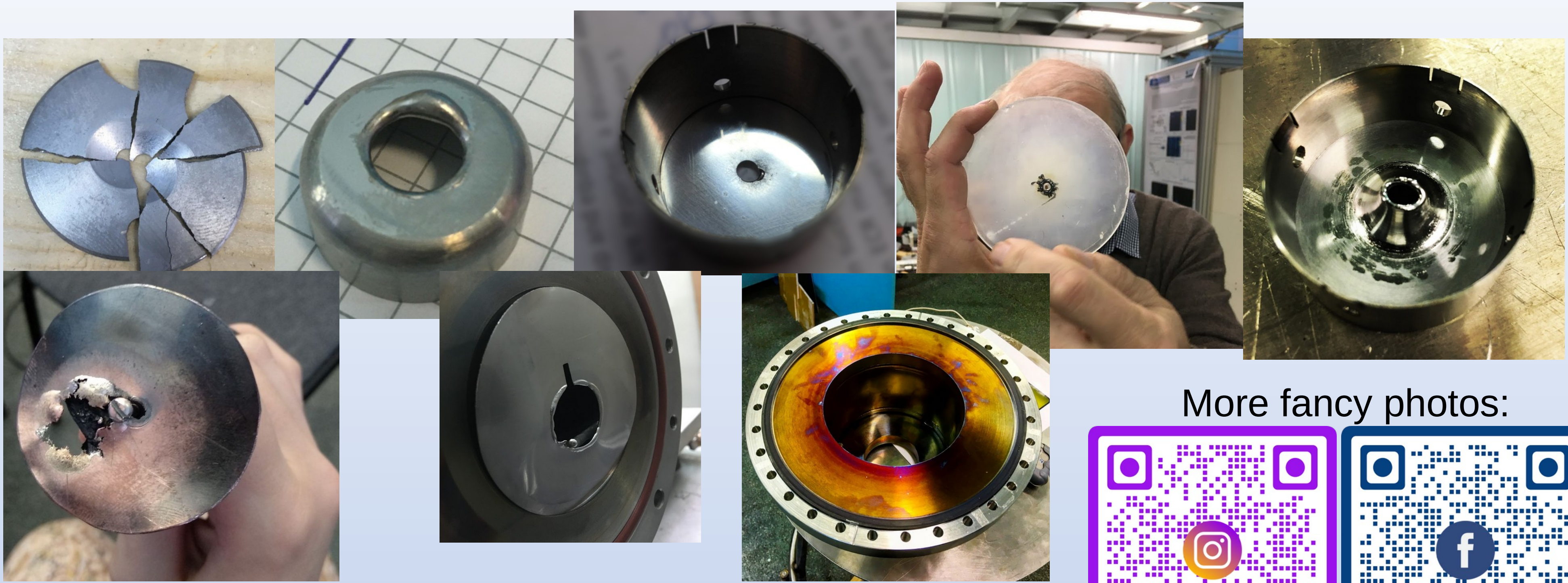




Conclusion and possible applications

- Plasma emissivity >1000 mA/cm^2
- Emittance: precise measurements are in progress, preliminary results showed $E_{rms,norm}$ < 0.2 π·mm·mrad
- With proper extraction system it may be possible to fulfill requirements of such projects as ISIS-II (250 mA, Erms<0.1) and DARIA (100 mA. Erms<0.2). New extractor is in production.
- GISMO may be an intense source of VUV
- D+ beams may be successfully used to produce wide neutron fluxes for BNCT and to implement a point-like neutron source for fast neutron imaging

Dozens of kW in a CW beam: challenging :)



More fancy photos:

@122lab

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Thank you for your attention!