JENSA - the main target for the Recoil Separator for Capture Reactions (SECAR)

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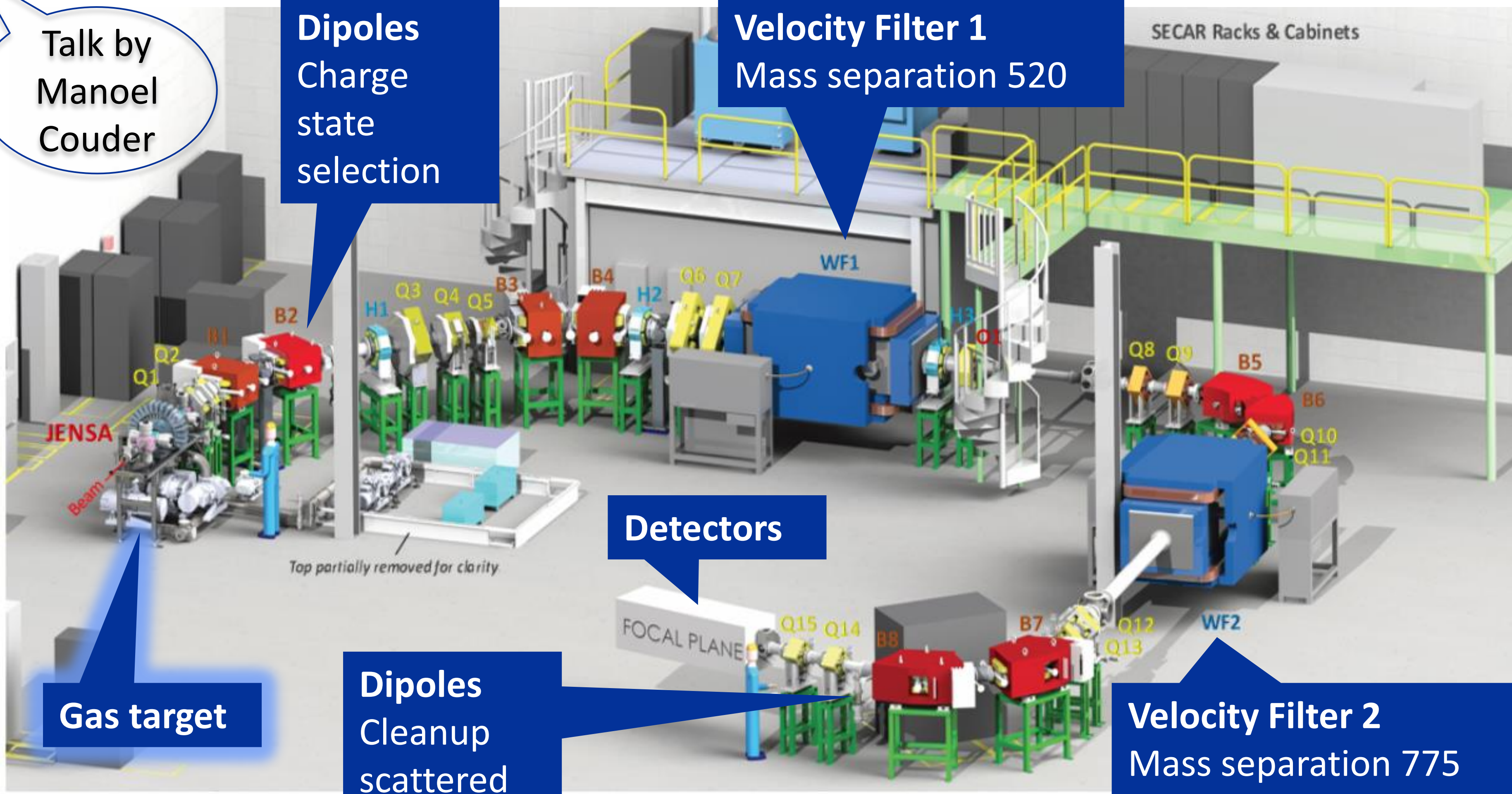
The Recoil Separator for Capture Reactions (SECAR)

Talk by Manoel Couder



Dipoles
Charge state selection

Velocity Filter 1
Mass separation 520

Detectors

Gas target

Dipoles
Cleanup scattered beam

Velocity Filter 2
Mass separation 775

fribastro.org/SECAR/

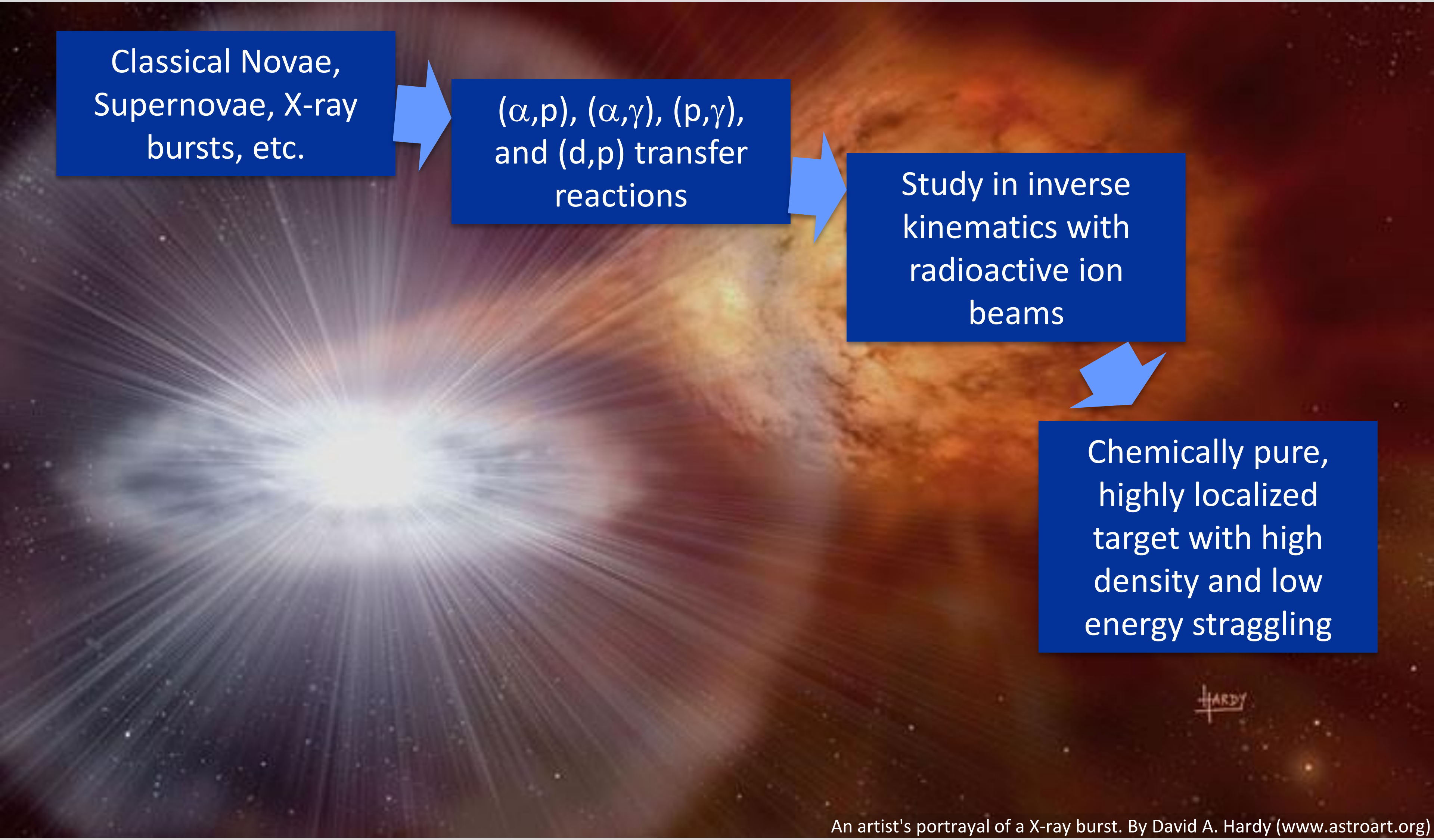
Why a gas jet target?

Classical Novae, Supernovae, X-ray bursts, etc.

(α,p), (α,γ), (p,γ), and (d,p) transfer reactions

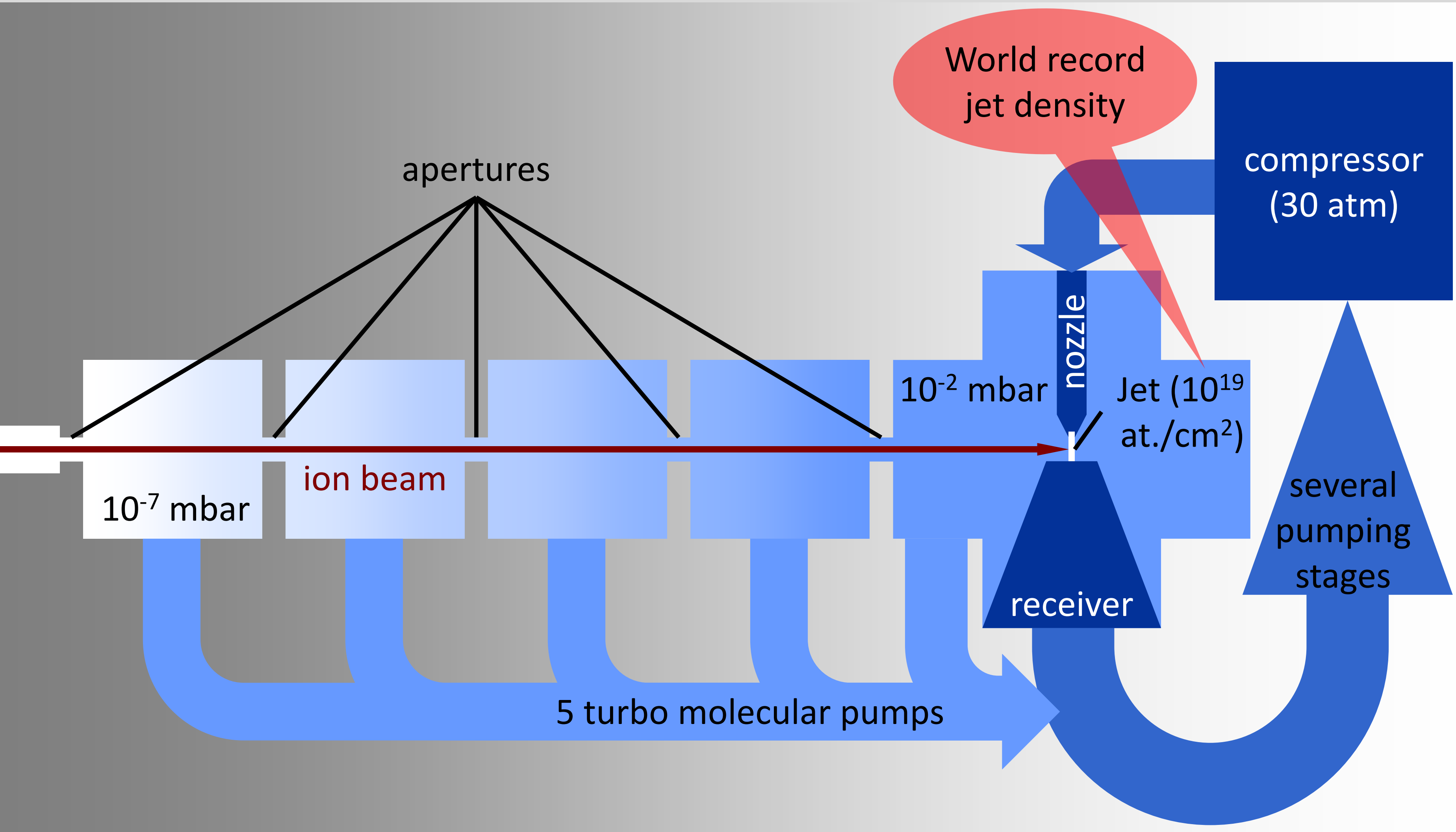
Study in inverse kinematics with radioactive ion beams

Chemically pure, highly localized target with high density and low energy straggling



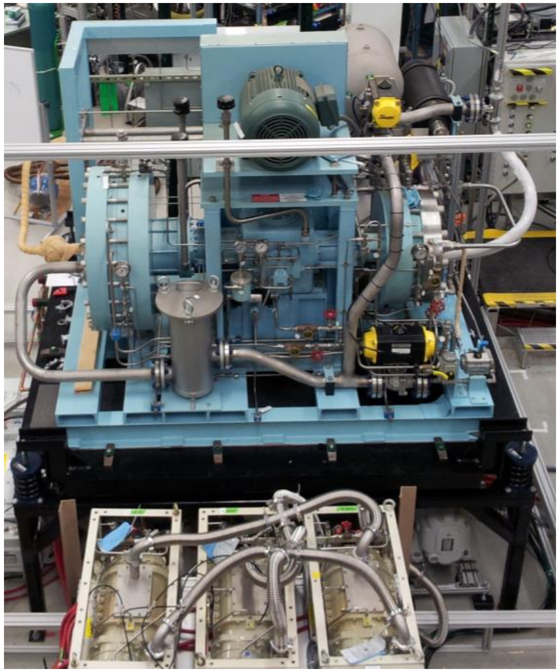
An artist's portrayal of a X-ray burst. By David A. Hardy (www.astroart.org)

Recirculating gas system

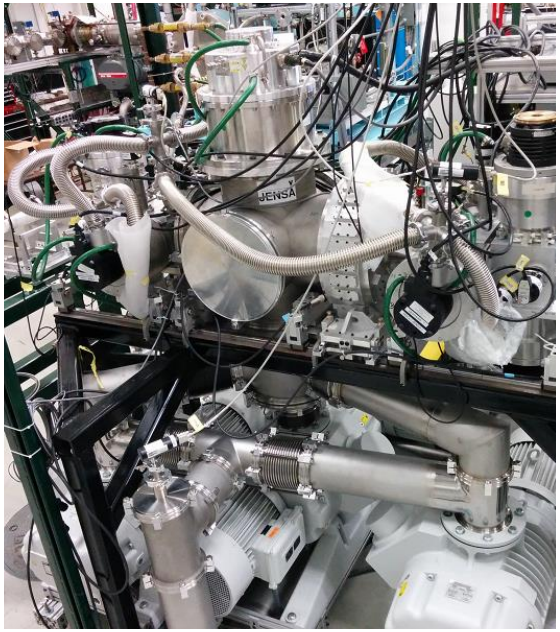


The JENSA gas jet target at NSCL

Jet **E**xperiments in **N**uclear **S**tructure and **A**strophysics



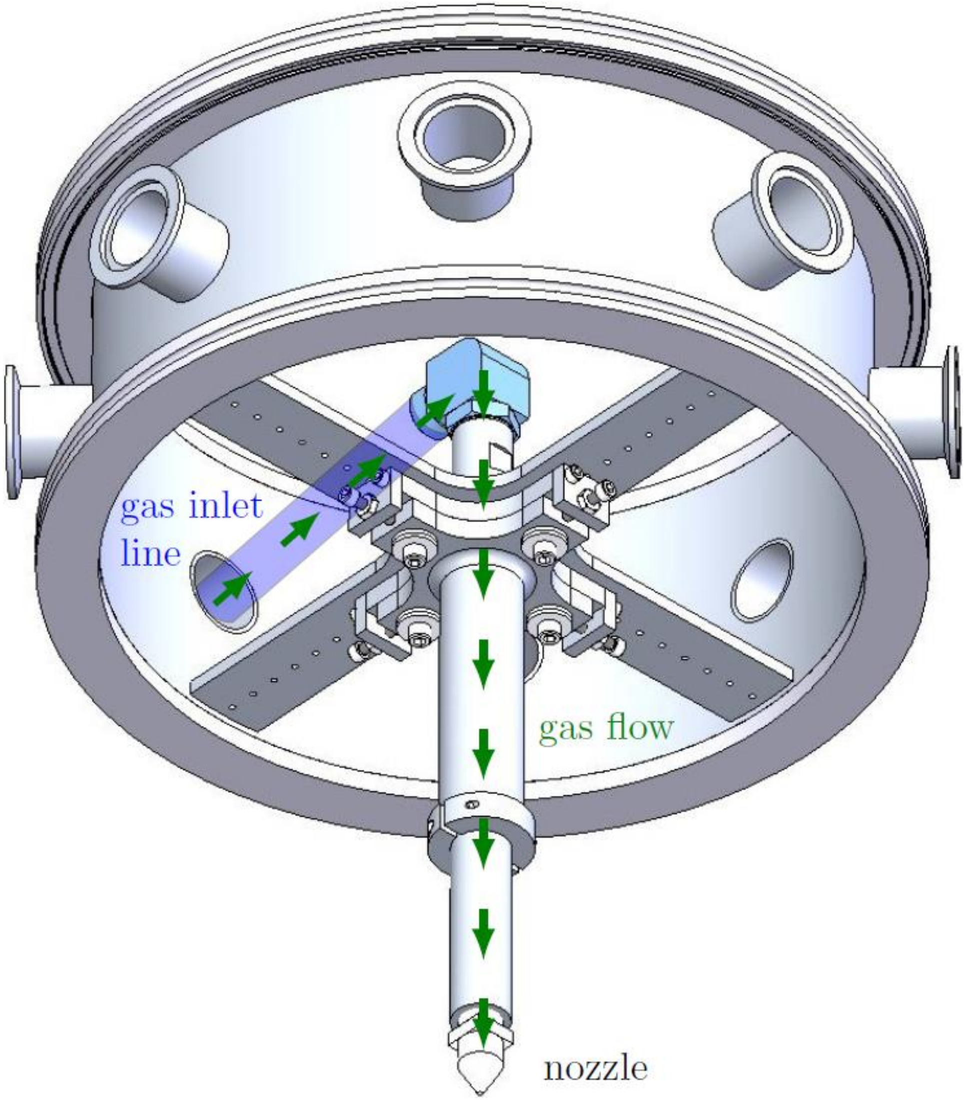
Diaphragm compressor

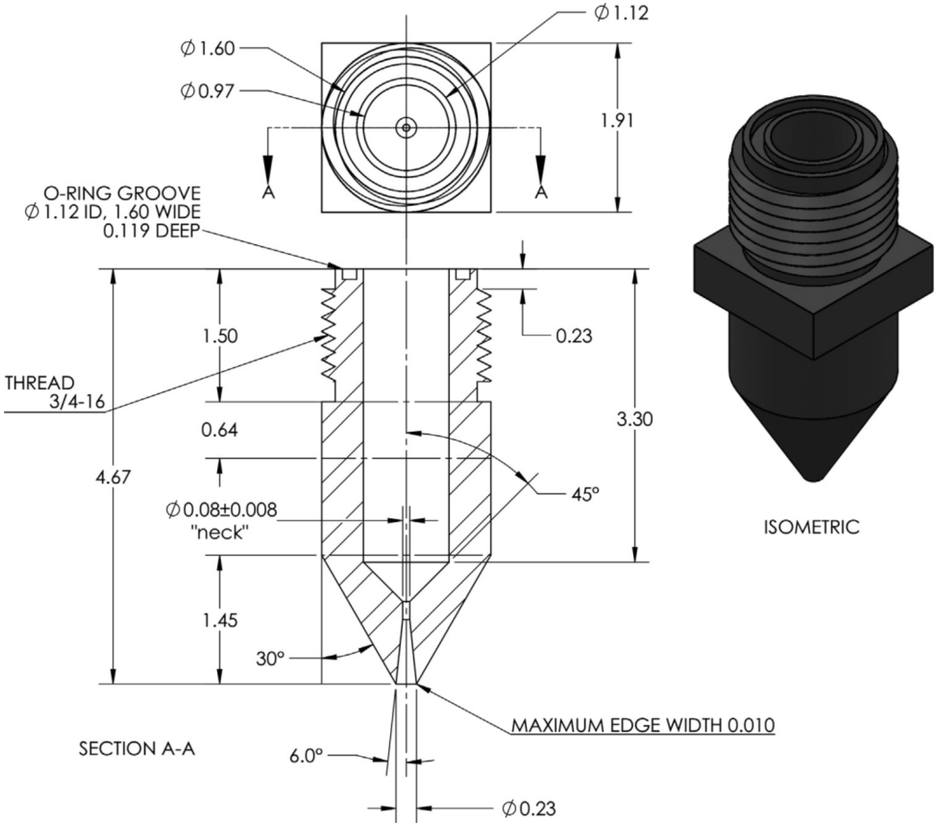


Target chamber and pumps

Nozzle, receiver and Si detectors

Precise alignment of the nozzle

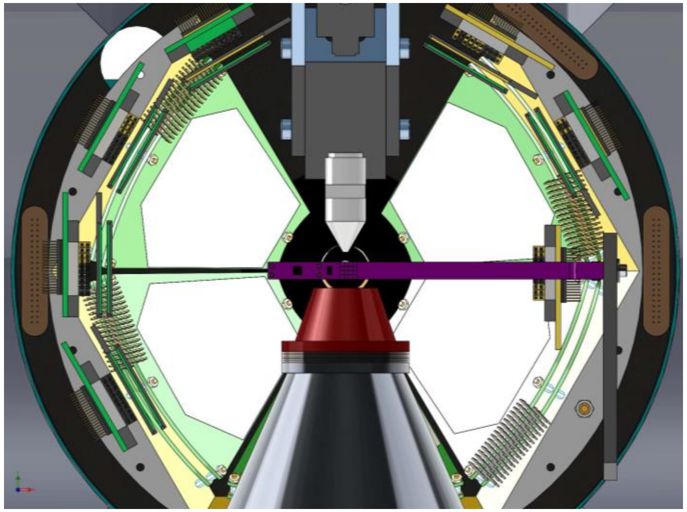


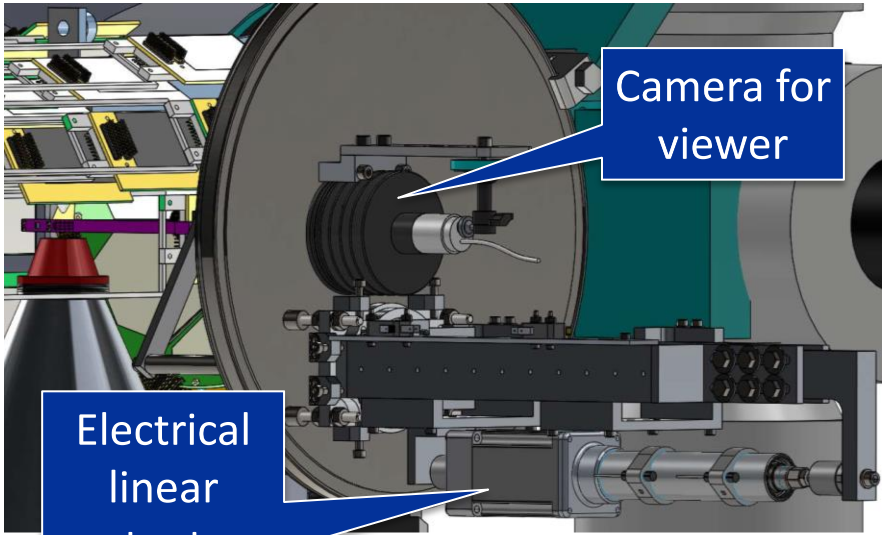


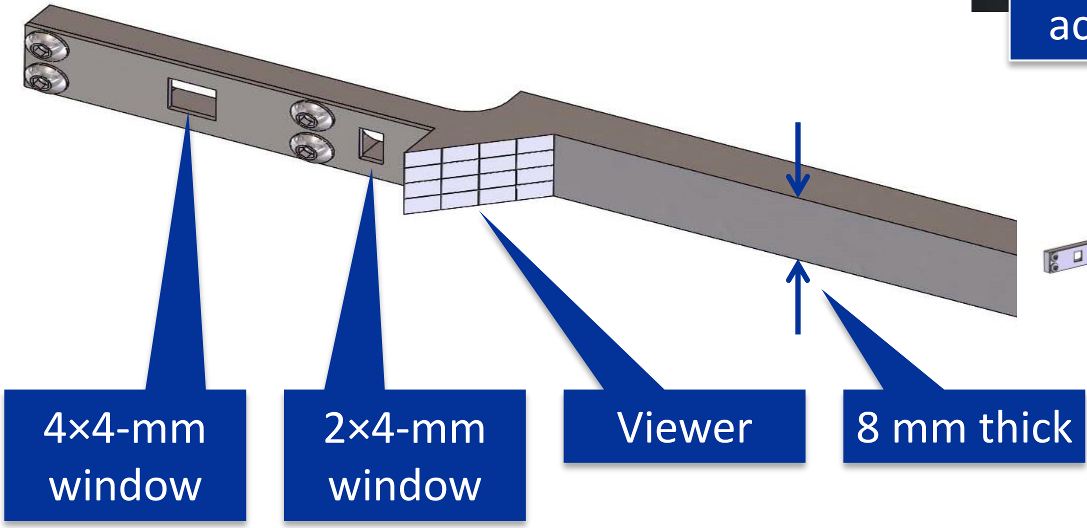
Nozzle for a supersonic jet

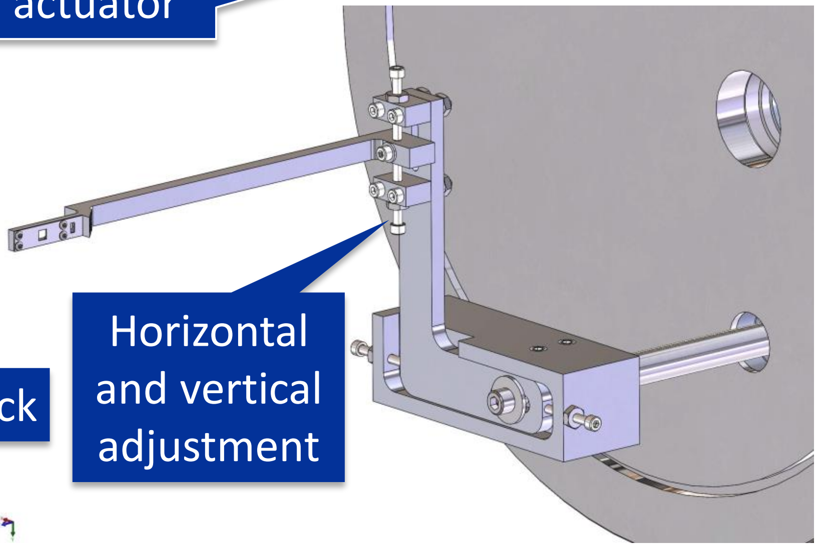
Minimum inner diameter	0.8 mm

Beam viewer for transmission check



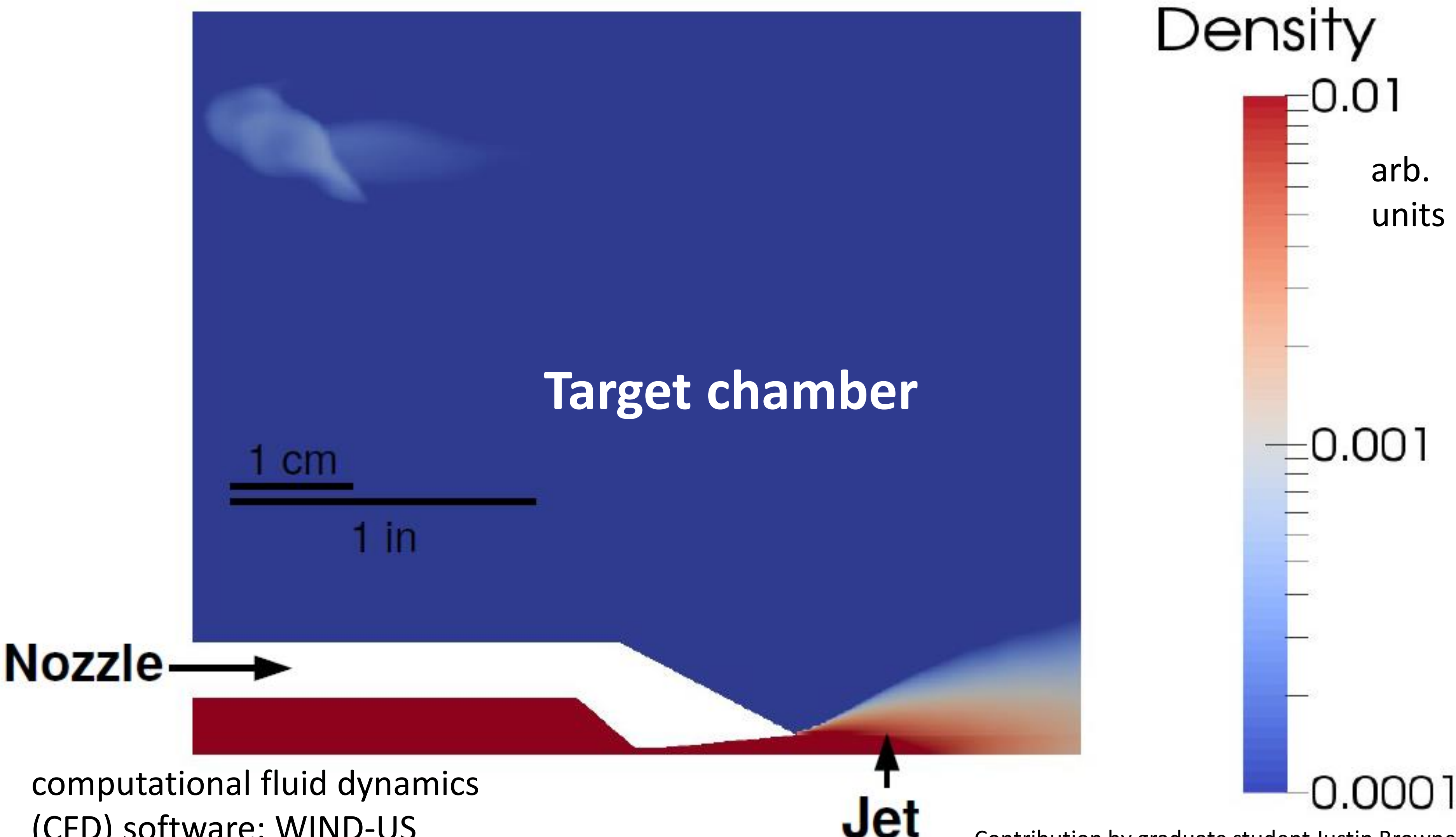






Jet thickness studies

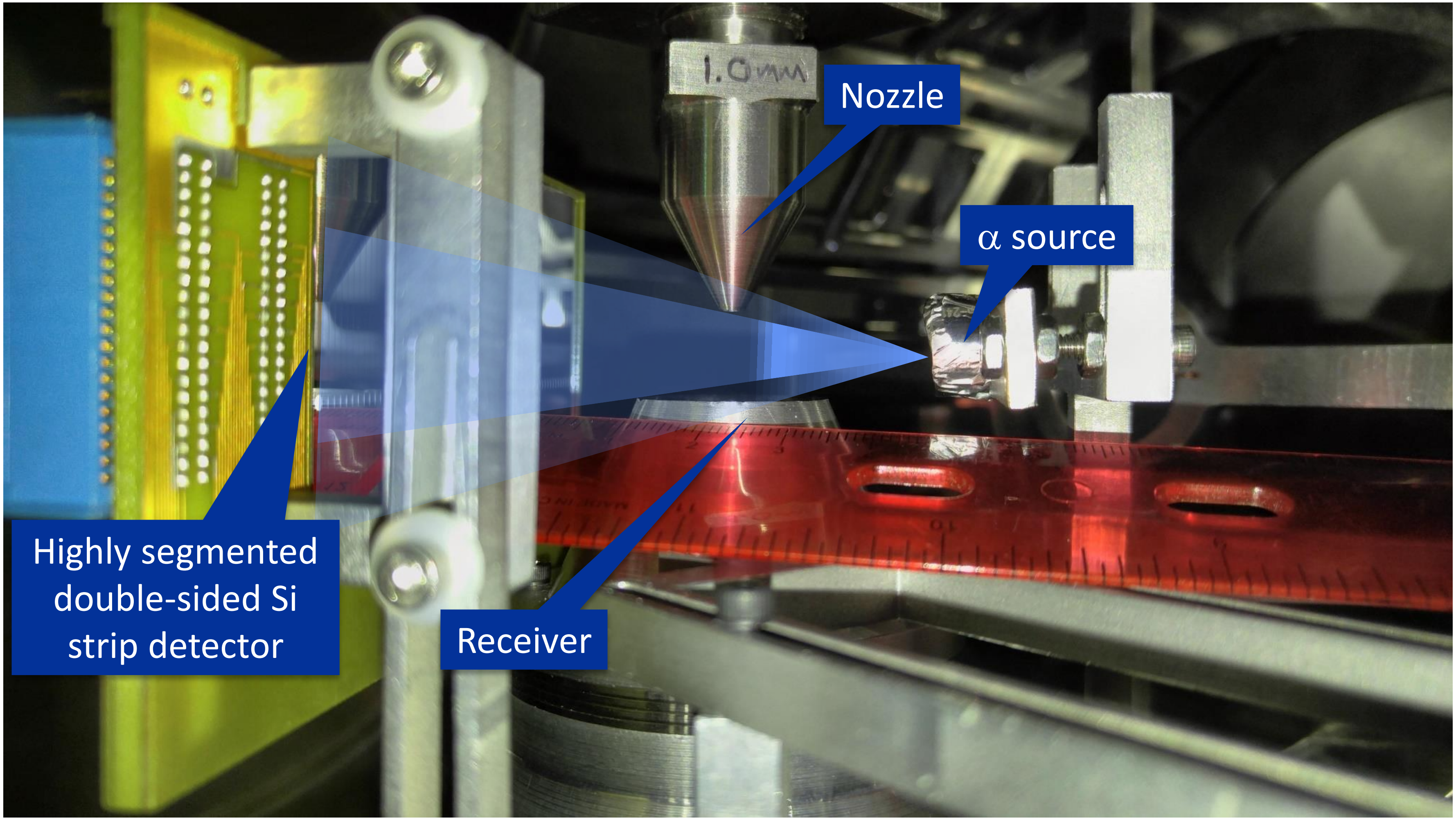
CFD simulation of the jet



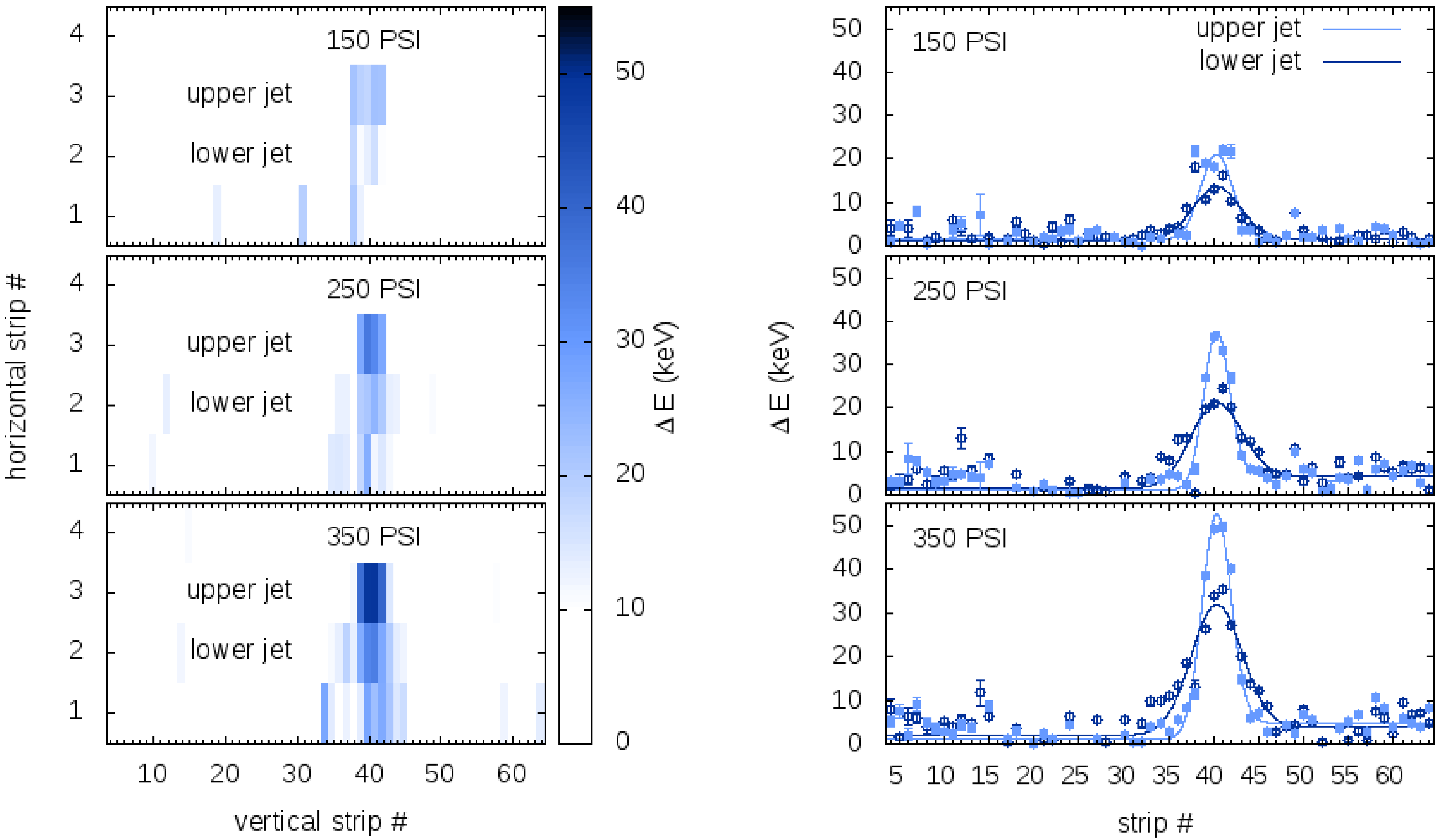
computational fluid dynamics (CFD) software: WIND-US

Contribution by graduate student Justin Browne

Setup for jet thickness study

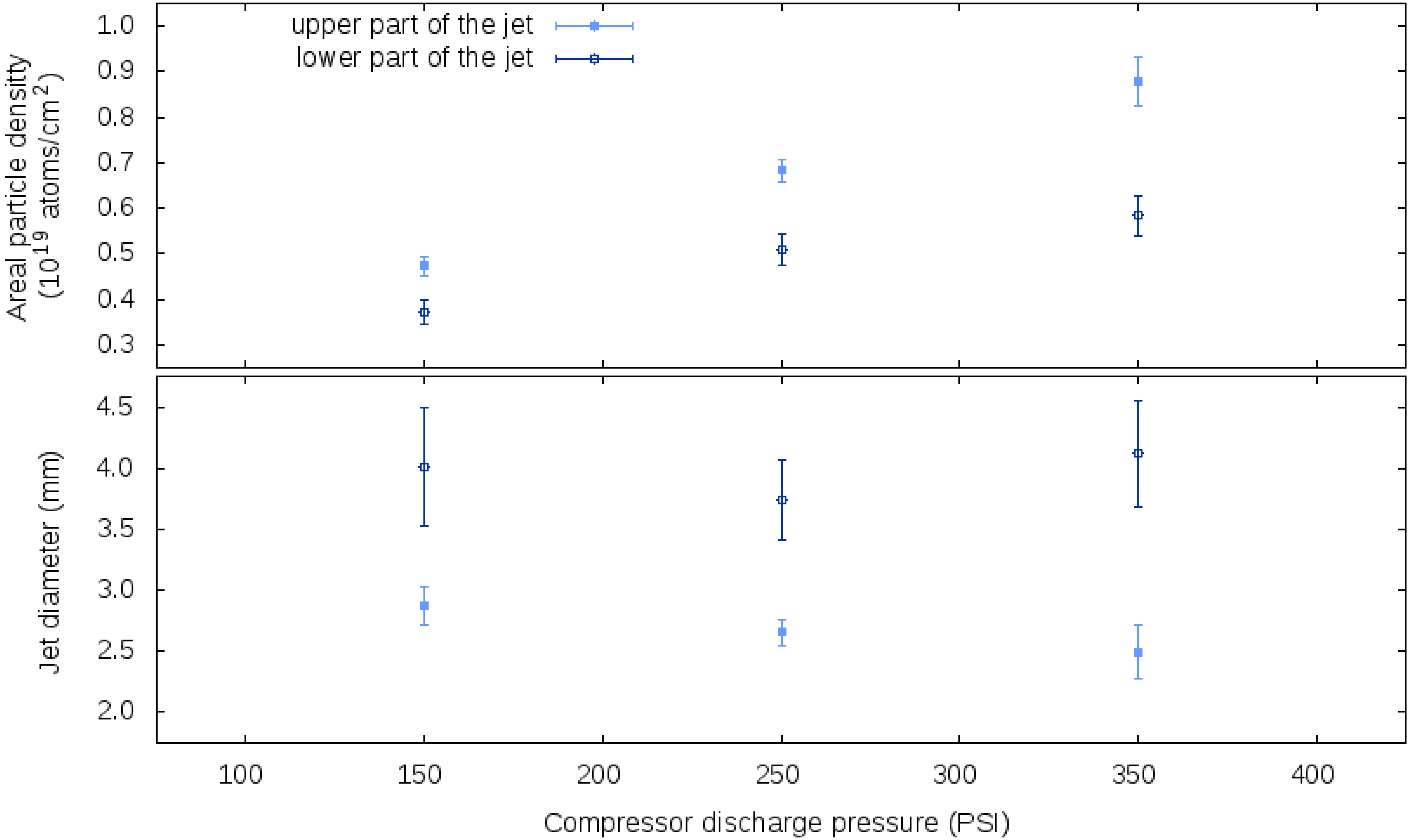


Energy loss profiles



10^{19} atoms/cm^2 in less than 4 mm He jet

Density from measured energy loss and stopping power [1]

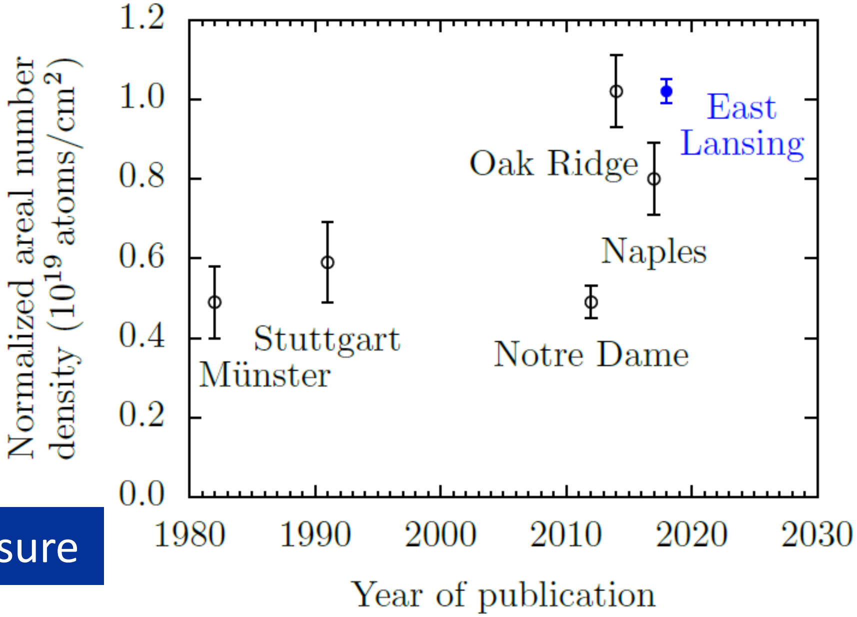


[1] C. Hanke and J. Laursen, Nuclear Instruments and Methods **151**, 253 (1978)

Comparison of different He jets

Location	Year	Input pressure (kPa)	^{4}He jet density (10^{18} at./cm^2)	^{4}He jet FWHM (mm)
Münster	1982	200	0.34 ± 0.06	2.5 ± 0.2
Stuttgart	1991	38	0.078 ± 0.013	2.6 ± 0.2
Notre Dame	2012	150	0.259 ± 0.021	2.2 ± 0.2
Oak Ridge	2014	2859	10.2 ± 0.9	5.1 ± 0.3
Naples	2017	700	1.97 ± 0.21	not reported
East Lansing	2018	2515	9.0 ± 0.3	2.03 ± 0.09

JENSA is the most dense He gas-jet target

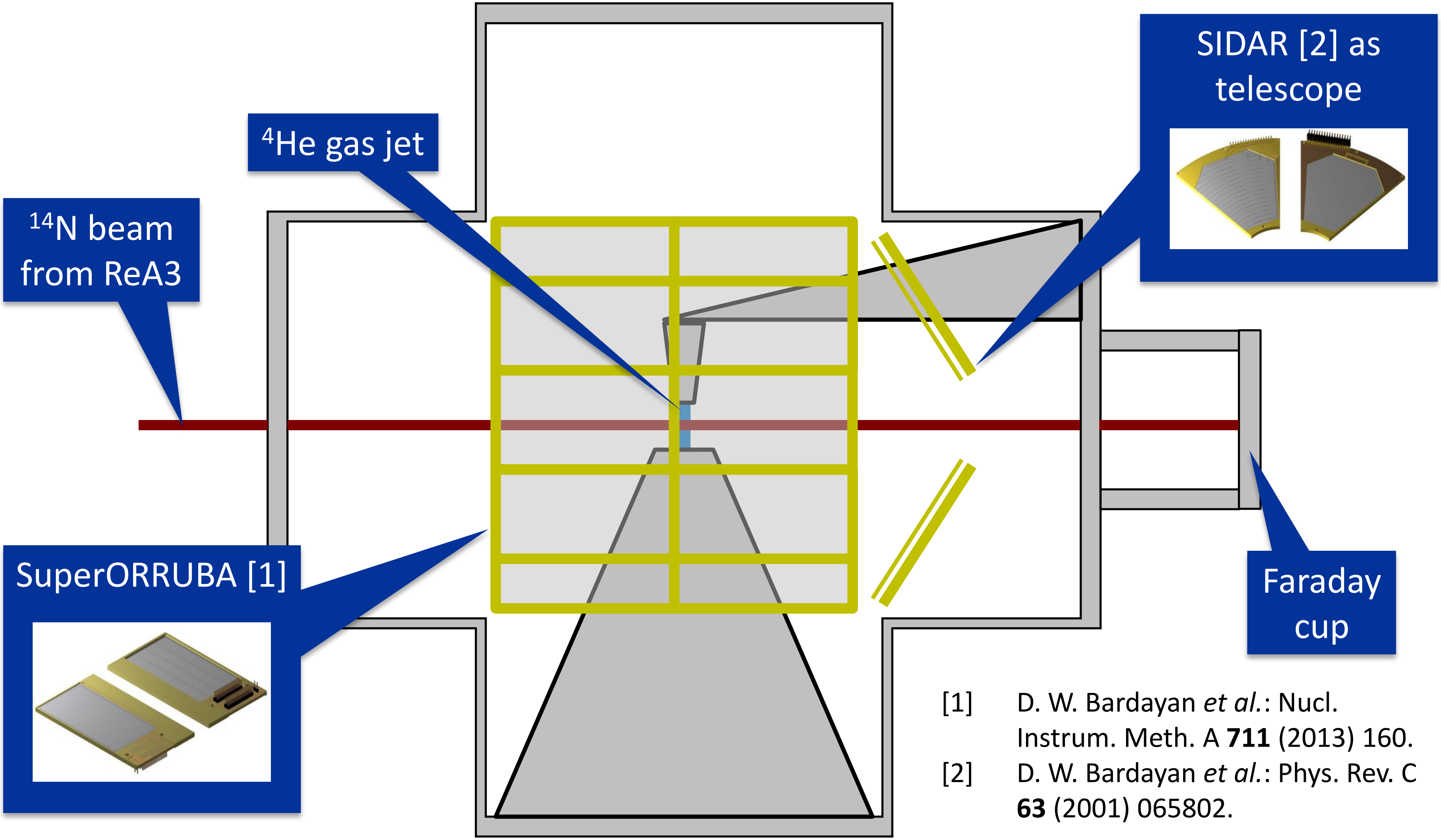


Normalized to 2.859 MPa input pressure

Commissioning experiment at NSCL

$^{4}He(^{14}N,p)^{17}O$

Setup for $^{4}He(^{14}N,p)^{17}O$ study

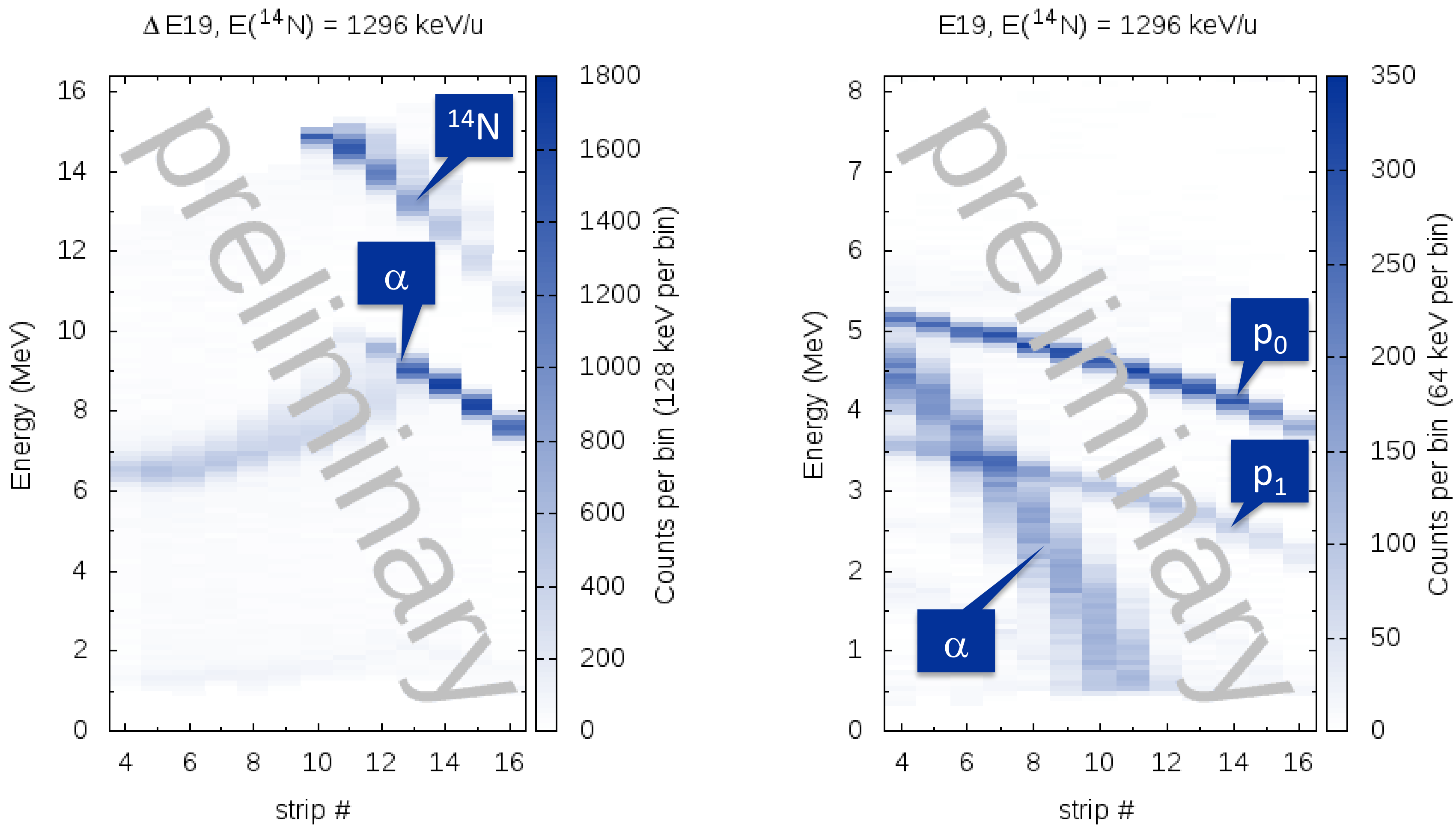


[1] D. W. Bardayan *et al.*: Nucl. Instrum. Meth. A **711** (2013) 160.

[2] D. W. Bardayan *et al.*: Phys. Rev. C **63** (2001) 065802.

$^{4}He(^{14}N,p)^{17}O$ – preliminary results

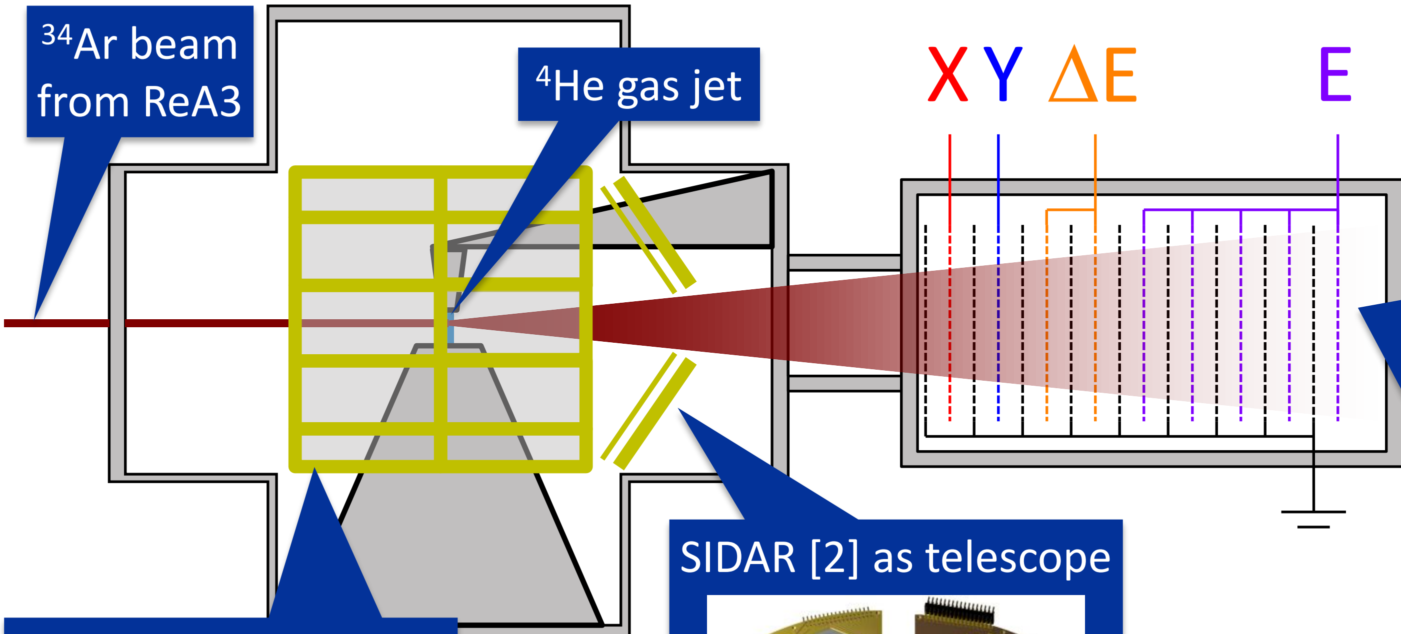
Segmented Si detector telescope



First radioactive beam experiment

$^{4}He(^{34}Ar,p)^{37}K$

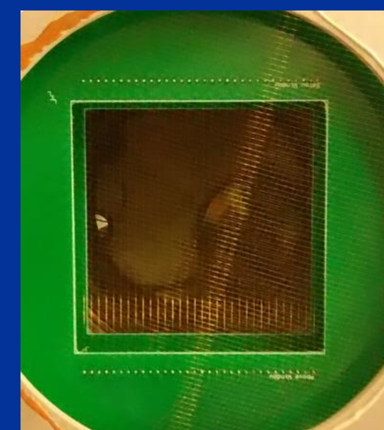
Setup for $^{4}He(^{34}Ar,p)^{37}K$ study



^{34}Ar beam from ReA3

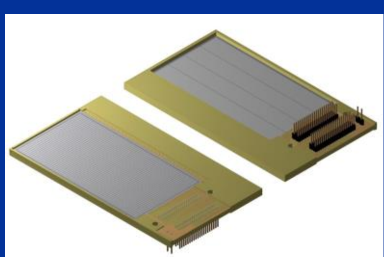
^{4}He gas jet

Position sensitive ionization chamber (PSIC)



SIDAR [2] as telescope

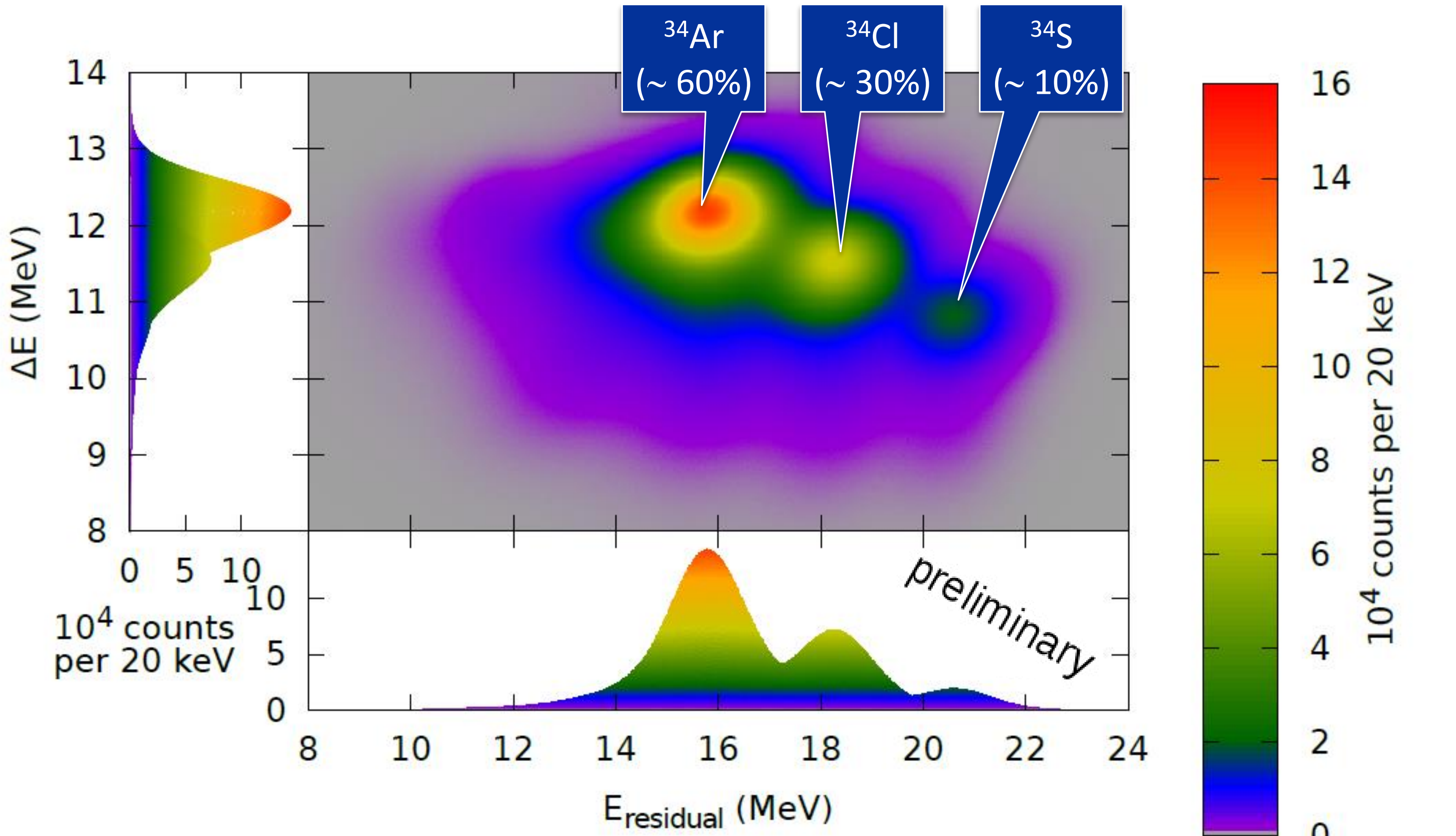
SuperORRUBA [1] in part as telescope



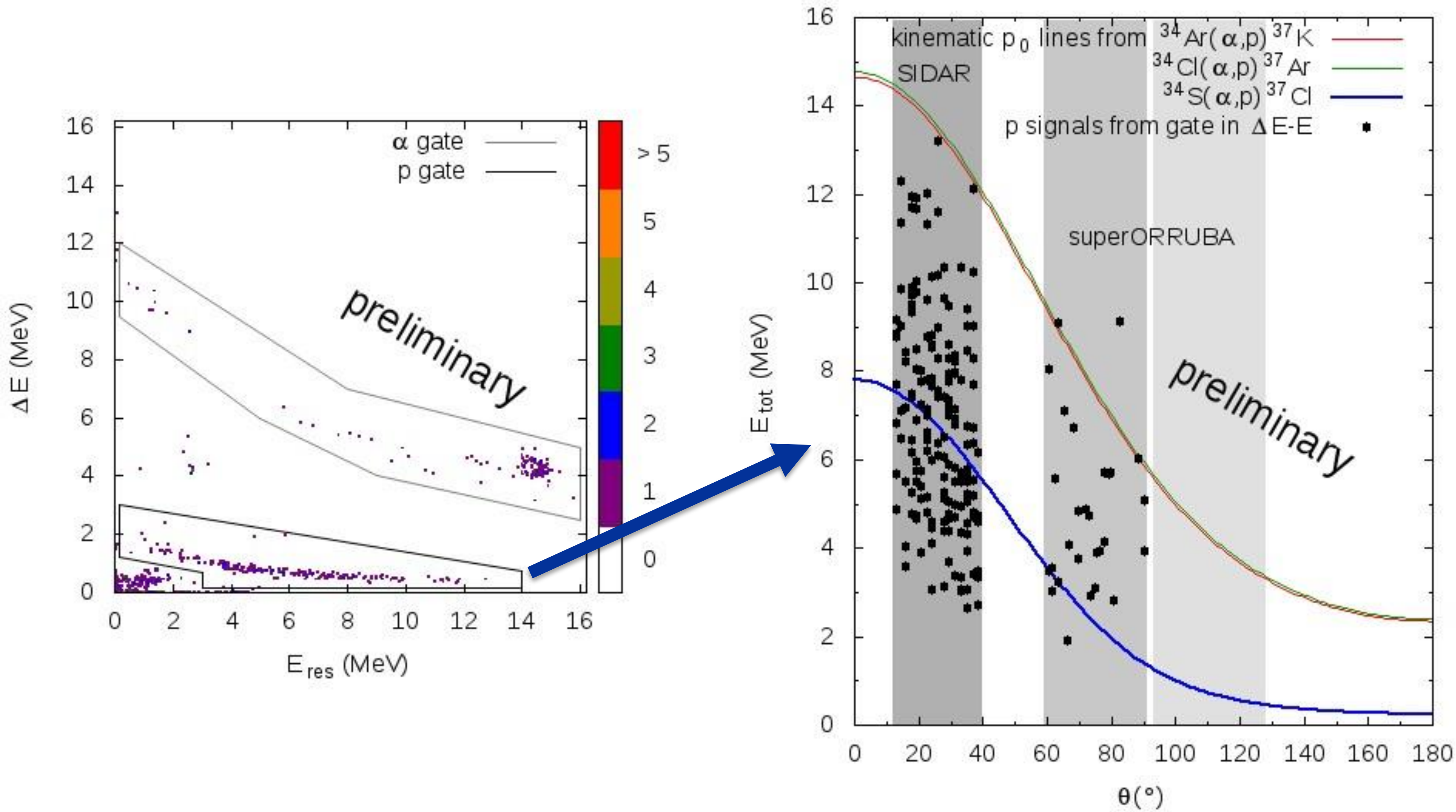
[1] D. W. Bardayan *et al.*: Nucl. Instrum. Meth. A **711**, 160 (2013).

[2] D. W. Bardayan *et al.*: Phys. Rev. C **63**, 065802 (2001).

~3000 pps at 1.625 MeV/u for 108 hours



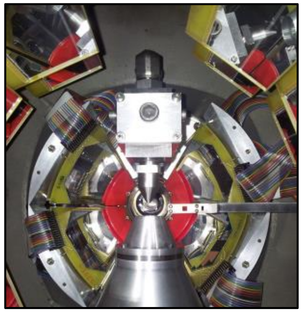
Proton signals in Si detectors



Summary

JENSA successfully commissioned at ReA3/NSCL

He densities up to 10^{19} atoms/cm^2 demonstrated



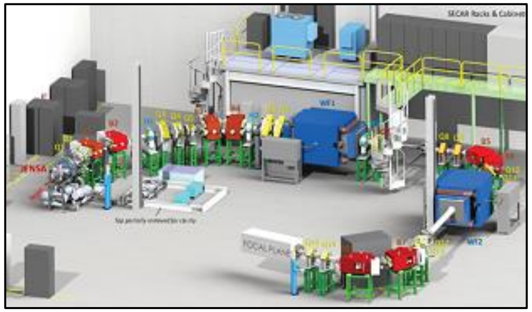
Stand-alone operation

(α,p), (p,α), (d,p), (^{3}He,d),…

First direct ^{34}Ar(α,p)^{37}K study

Target for SECAR

(α,γ), (p,γ)



JENSA collaboration

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