

# Cavity Ringdown Spectroscopy of Molecular Ions in a Fast Ion Beam

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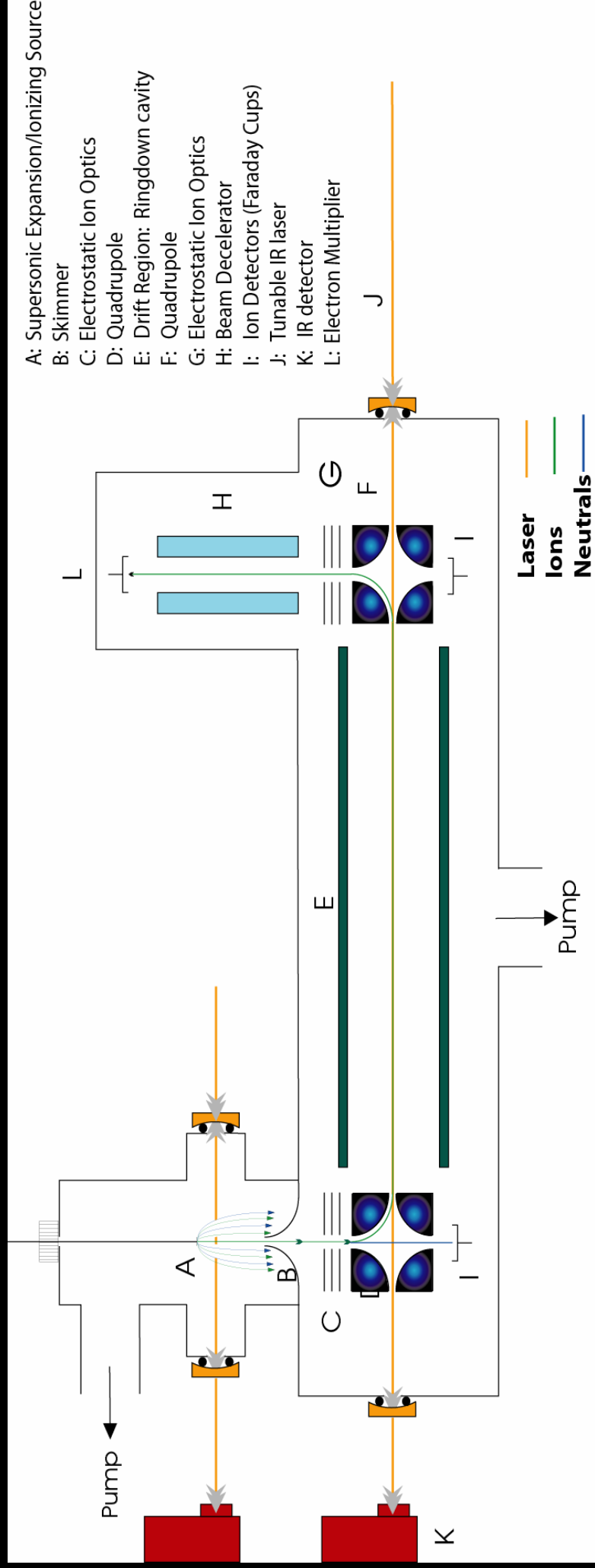


# The SCRIBES Instrument

SCRIBES = Sensitive, Cooled, Resolved Ion Beam  
Spectroscopy

- Sensitive:** IR cw cavity ringdown spectroscopy with minimum detectable absorption  $\sim 10^{-9} \text{ cm}^{-1}$
- Cooled:** cw supersonic expansion discharge source which leads to adiabatic cooling of ions
- Resolved:** high resolution with sub-Doppler linewidths
- Ion Beam:** ion optics used to steer a collimated beam of ions into the drift region, where it can be probed by cw ringdown techniques

# The SCRIBES Instrument

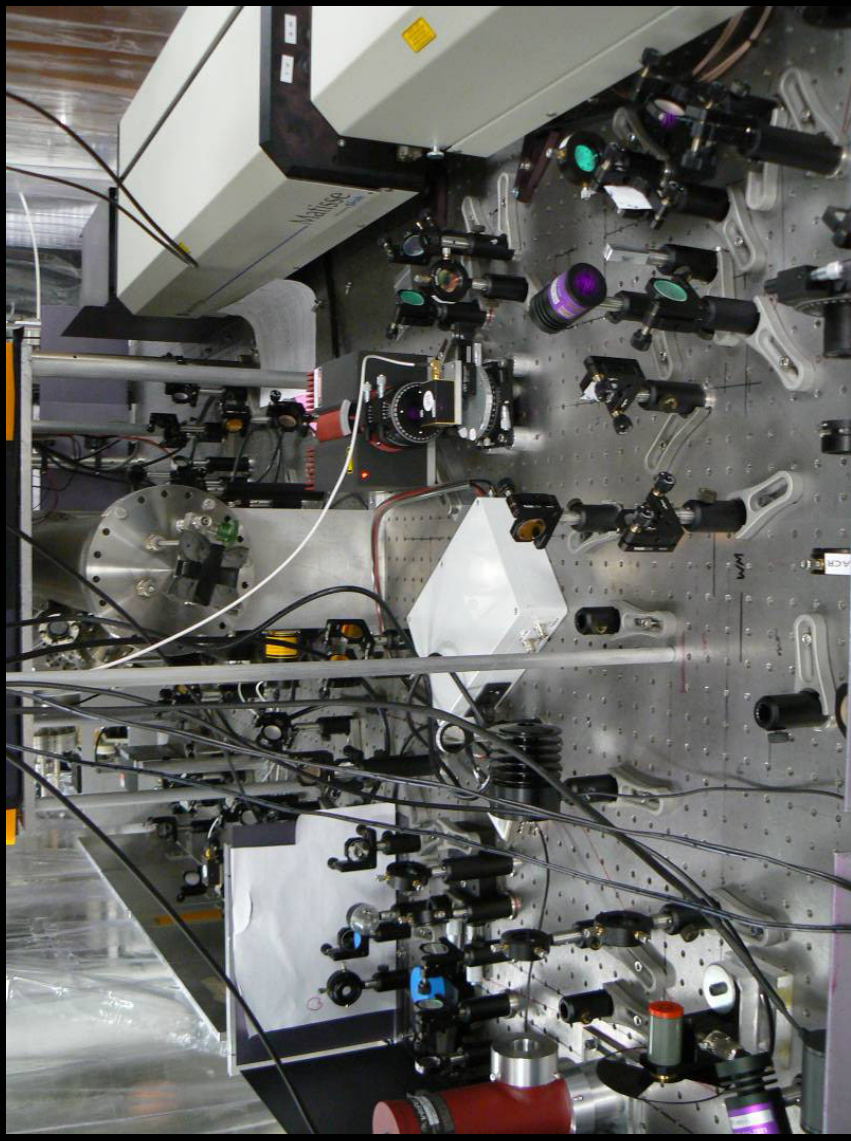
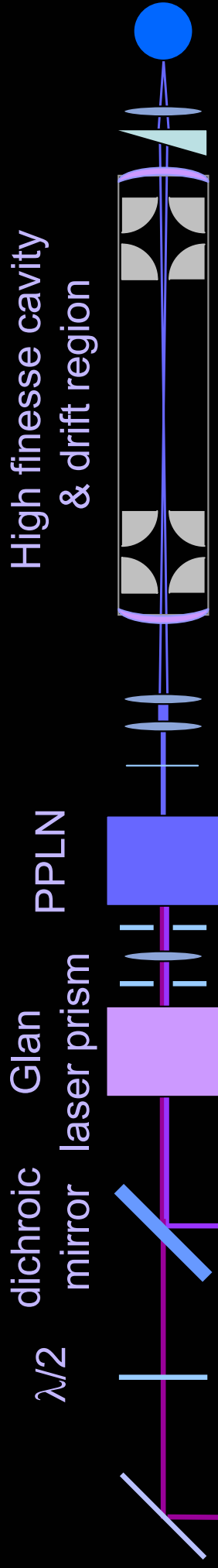


# Outline

- cw-CRDS systems
- Ion sources
- Progress on SCRIBES development
- Upcoming SCRIBES projects

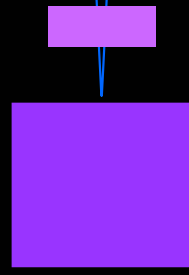
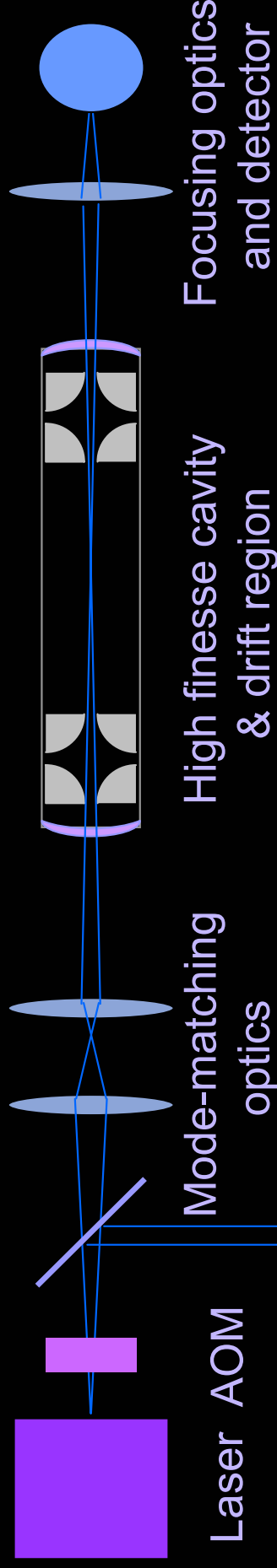
# SCRIBES cw-CRDS Options

## 2 – 5 $\mu\text{m}$ Difference Frequency Generation (DFG) System

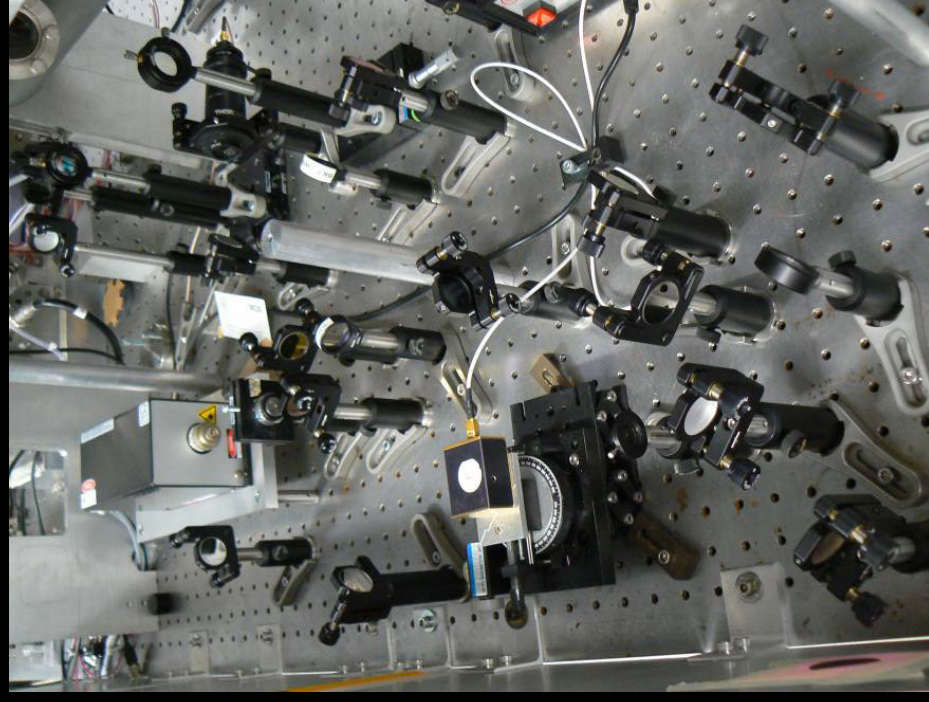
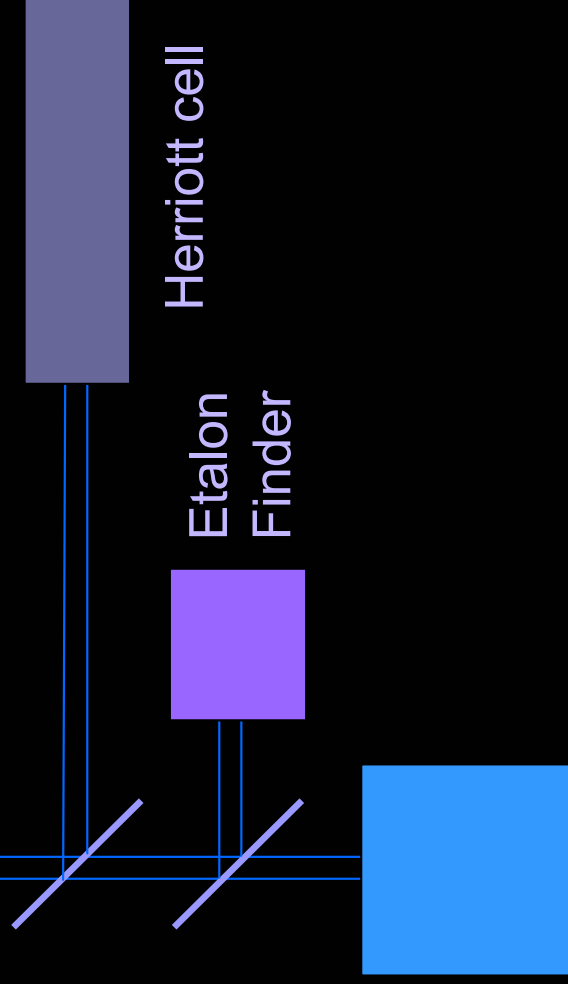


# SCRIBES cw-CRDS Options

920 – 985 nm External Cavity Diode Laser



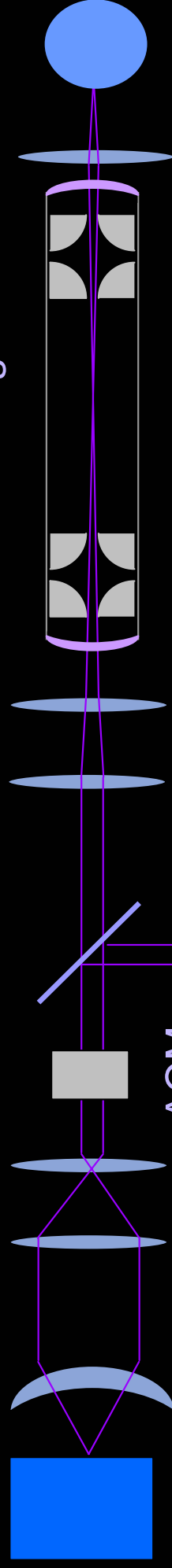
Laser AOM



# SCRIBES cw-CRDS Options

## 8.5 $\mu\text{m}$ Quantum Cascade Laser

Cryostat  
with QCL



High finesse cavity  
& drift region  
& detector

Aspheric  
lens

Mode-matching  
optics

AOM

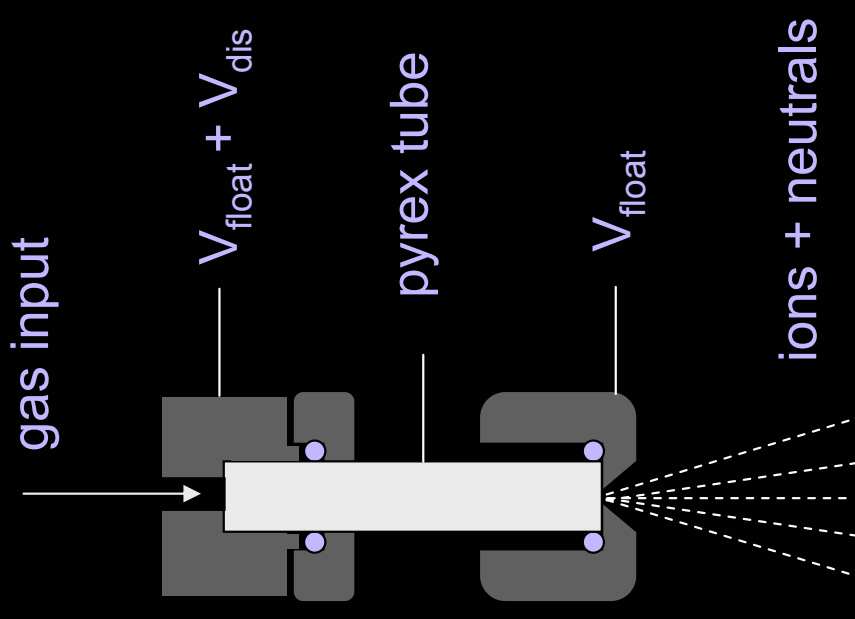
Reference  
cell



See talks RB08 & RD08

# SCRIBES Ion Sources

DC Cold Cathode Source



$$V_{\text{float}} = 4 \text{ kV}$$

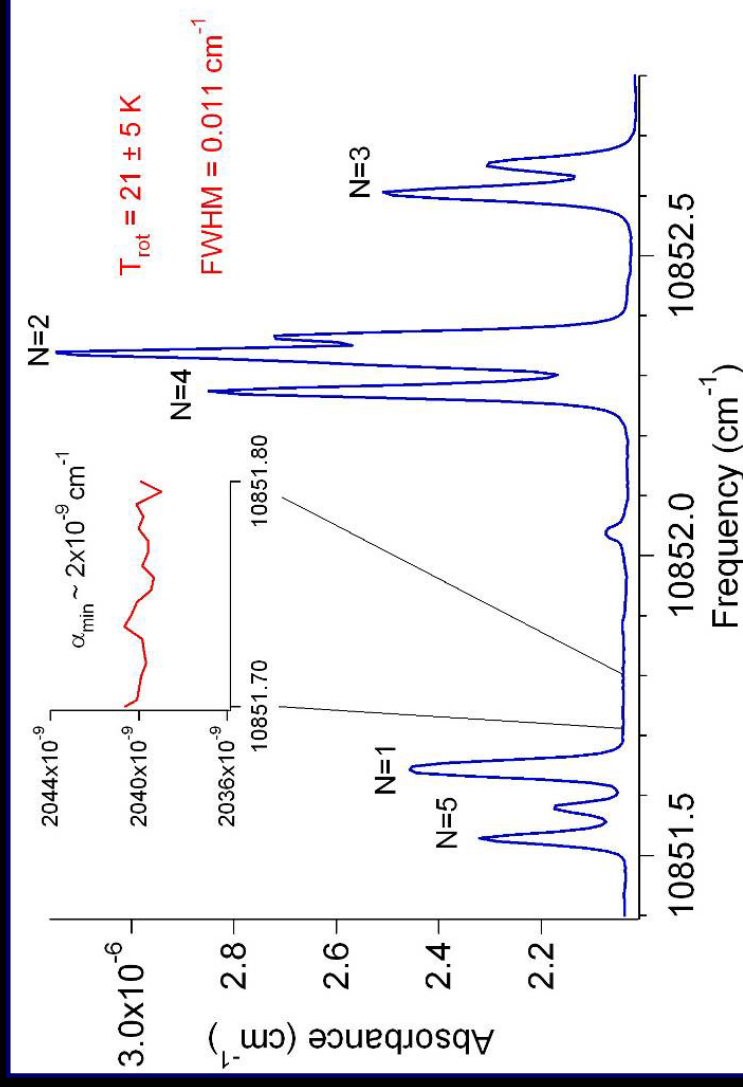
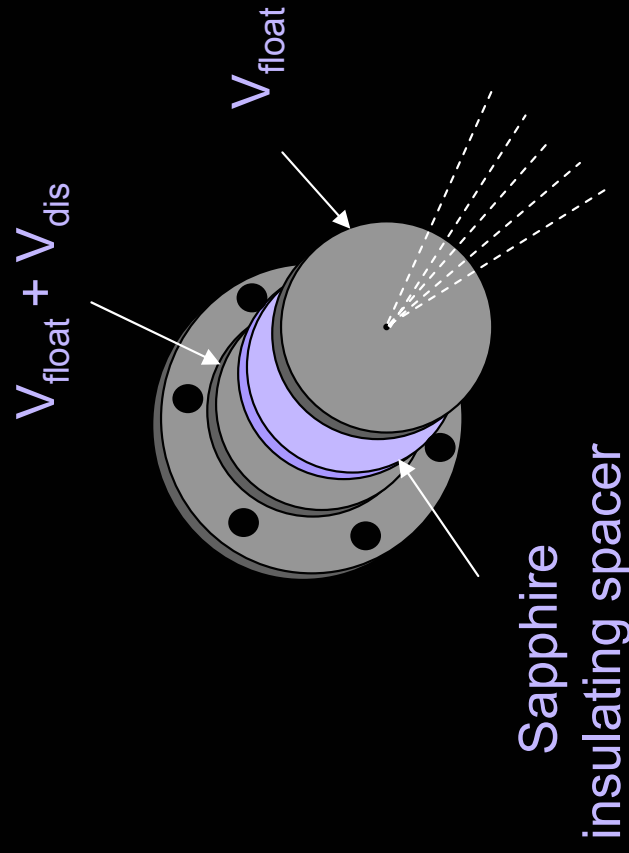
$$V_{\text{dis}} = 3 \text{ kV}$$

$$I_{\text{beam}} = 30 \mu\text{A}$$



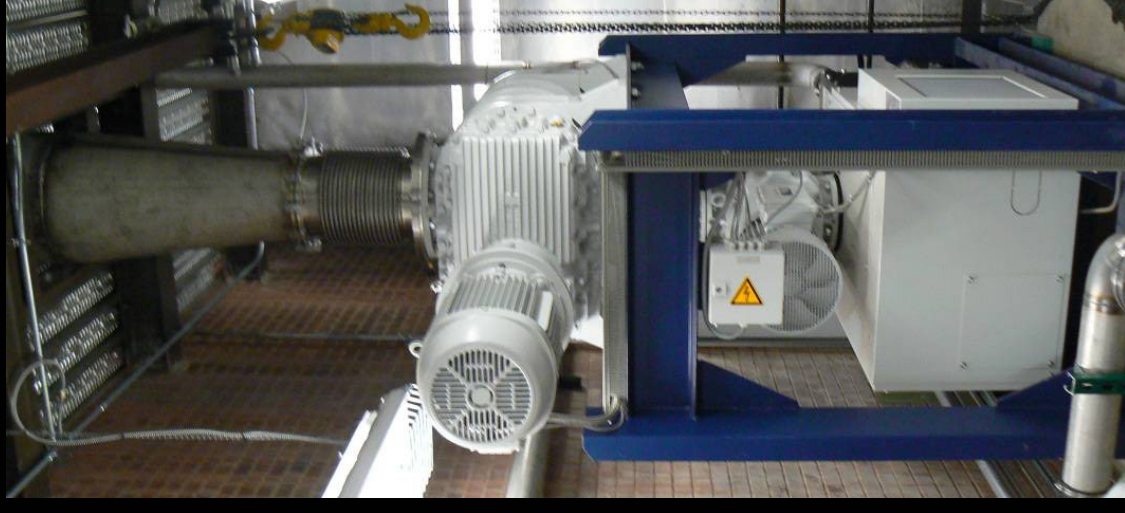
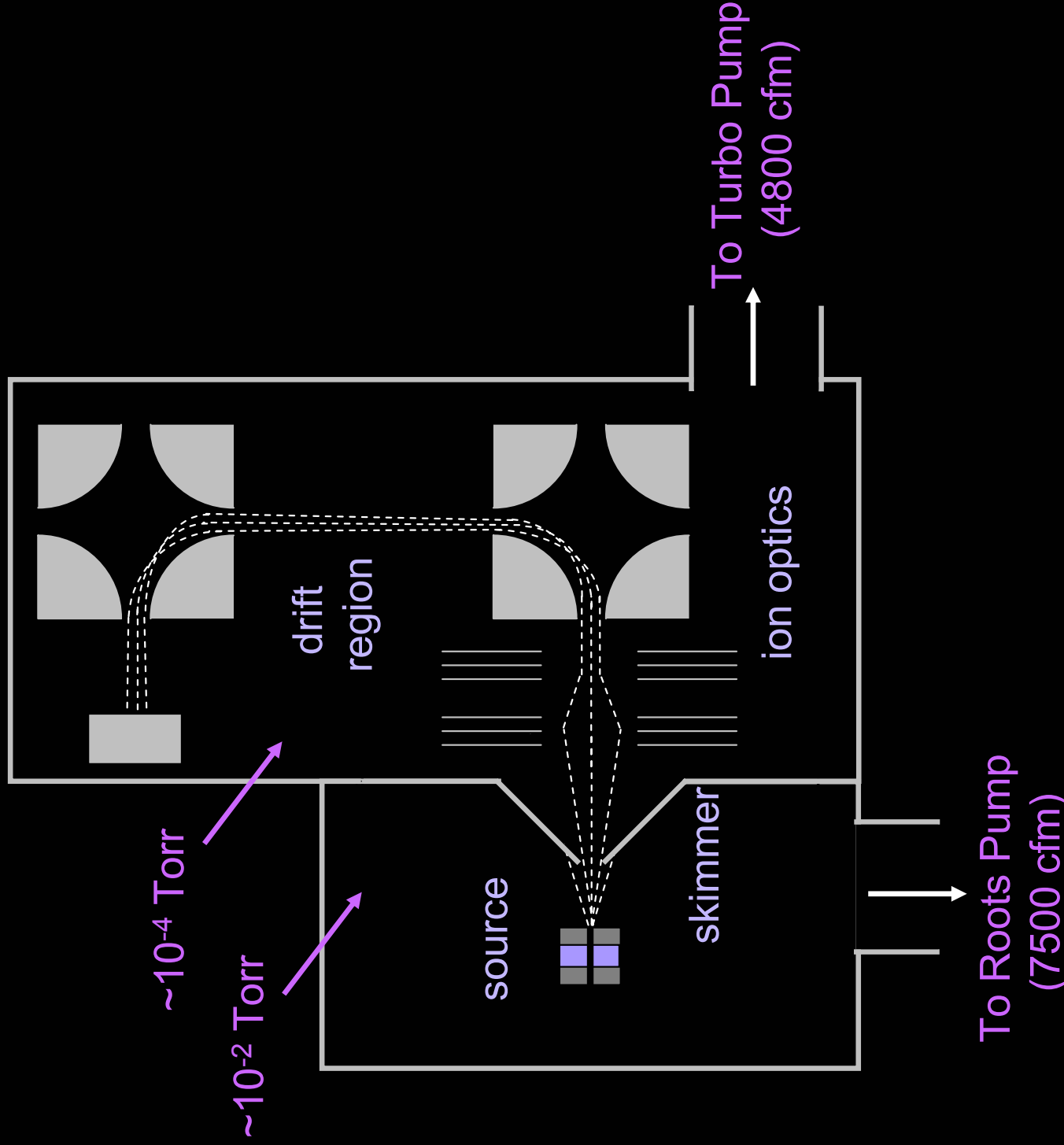
# SCRIBES Ion Sources

## Supersonic Ion Source



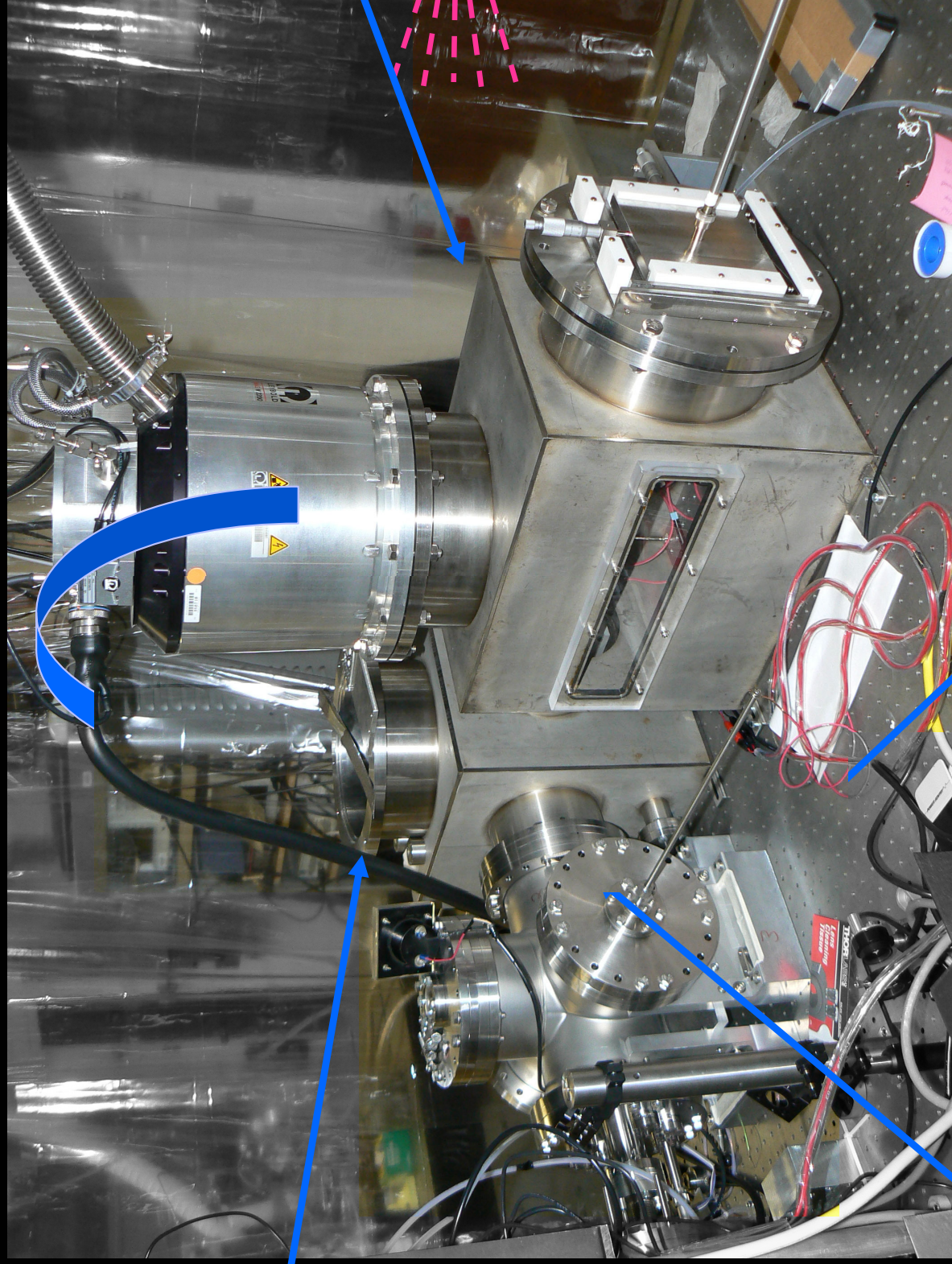
0.7 mm pinhole

# Going Supersonic with SCRIBES

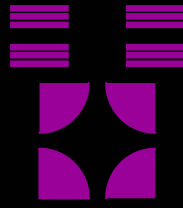


Roots pump

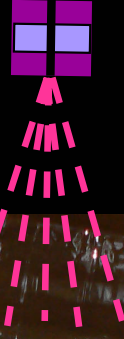
# SCRIBES Progress



ion optics  
chamber



source  
chamber



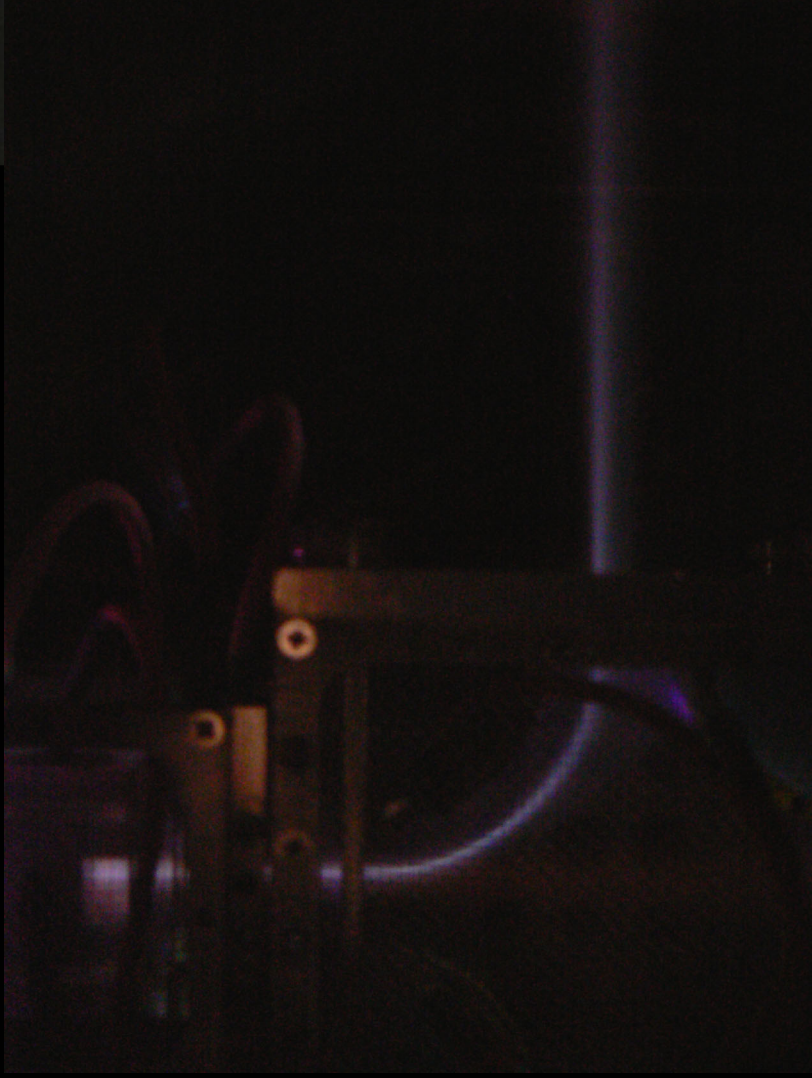
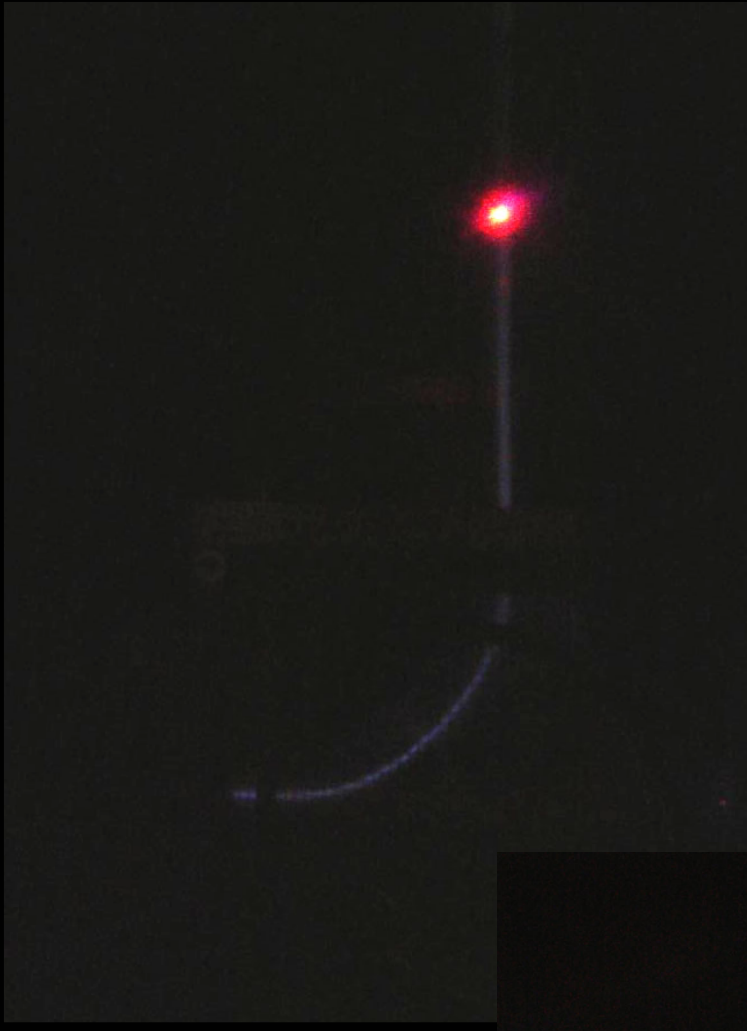
ringdown cavity  
& drift region



future home of the mass spec

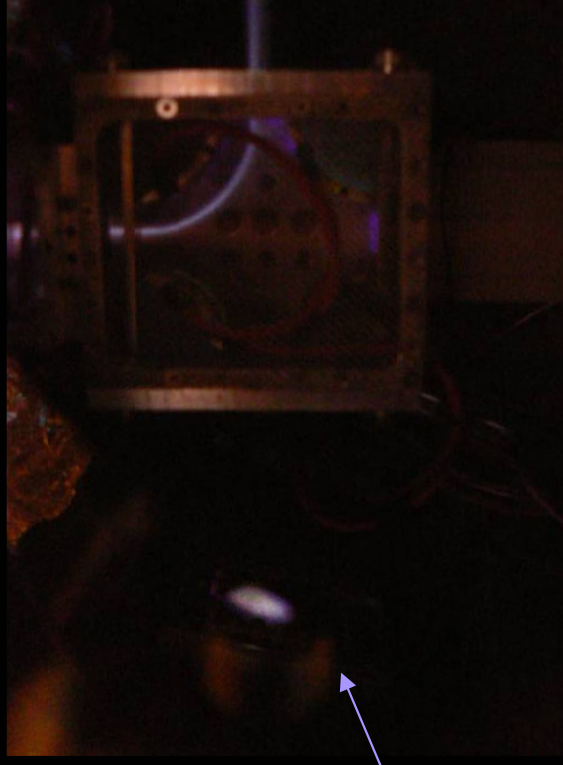
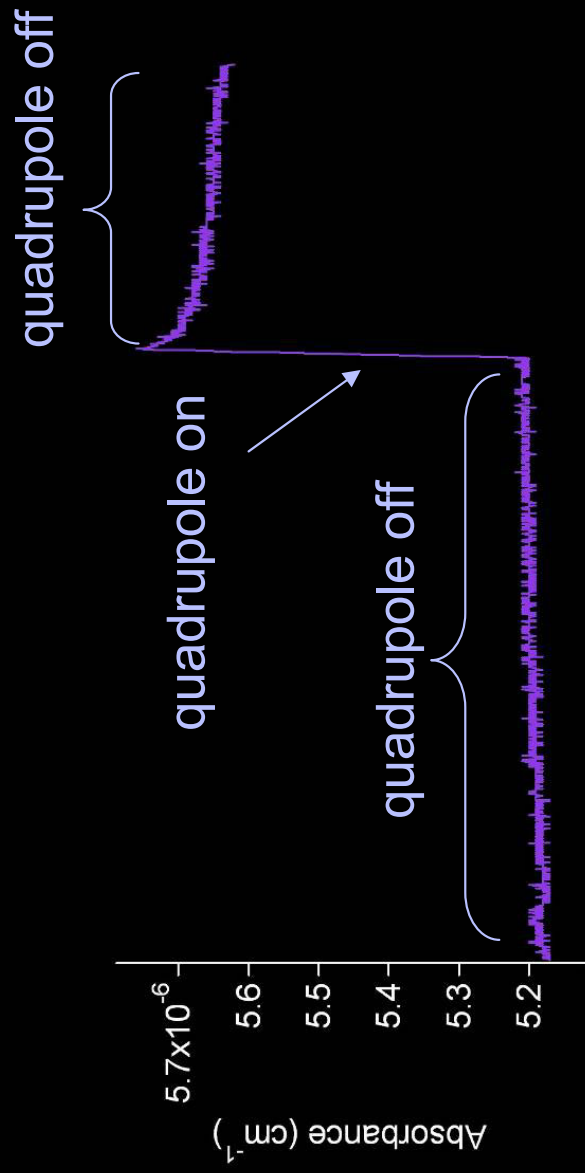
# SCRIBES Progress

- 30  $\mu\text{A}$  from DC cold cathode discharge source
- Ion beam through ion optics, turned by quadrupole



- Ion beam, ringdown cavity colinear
- Ready to scan!

# What not to do to your mirrors!



$e^-$  and/or negative ions are hitting the RD mirror!

# The Next Steps with SCRIBES ...

## Development

- Deflector plate to divert negative ions & e<sup>-</sup> from mirror
- Supersonic source & skimmer
- Second quadrupole
- Mass spec

## Spectroscopy

- N<sub>2</sub><sup>+</sup>: A<sup>2</sup>Π<sub>u</sub>-X<sup>2</sup>Σ<sub>g</sub><sup>+</sup> @ 950 nm
- H<sub>3</sub><sup>+</sup>: ν<sub>2</sub> ← 0 @ 3.67 μm
- other ions ...

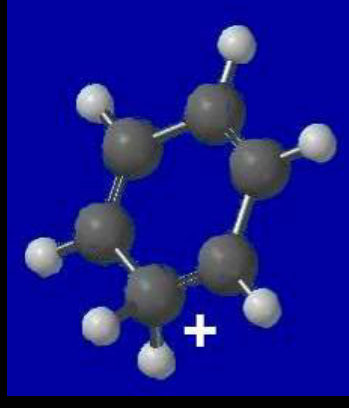
# Planned SCRIBES Spectroscopy



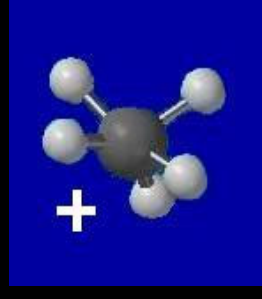
Important to gas phase interstellar chemistry;  
internal rotation & inversion  
see T109 & T110



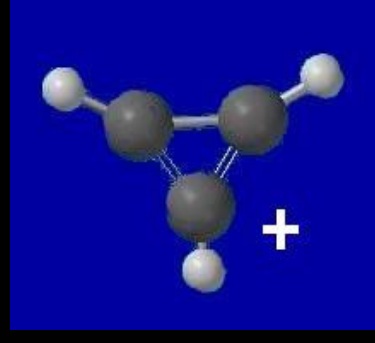
Precursor to interstellar  $\text{C}_6\text{H}_6$ ; proton “walks”  
around ring



Precursor to interstellar  $\text{CH}_4$ , other  
hydrocarbons; highly fluxional molecule



Precursor to interstellar c- $\text{C}_3\text{H}_2$ ; simplest  
Hückel aromatic  $4n+2$



# Acknowledgements



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<http://astrochemistry.uiuc.edu>