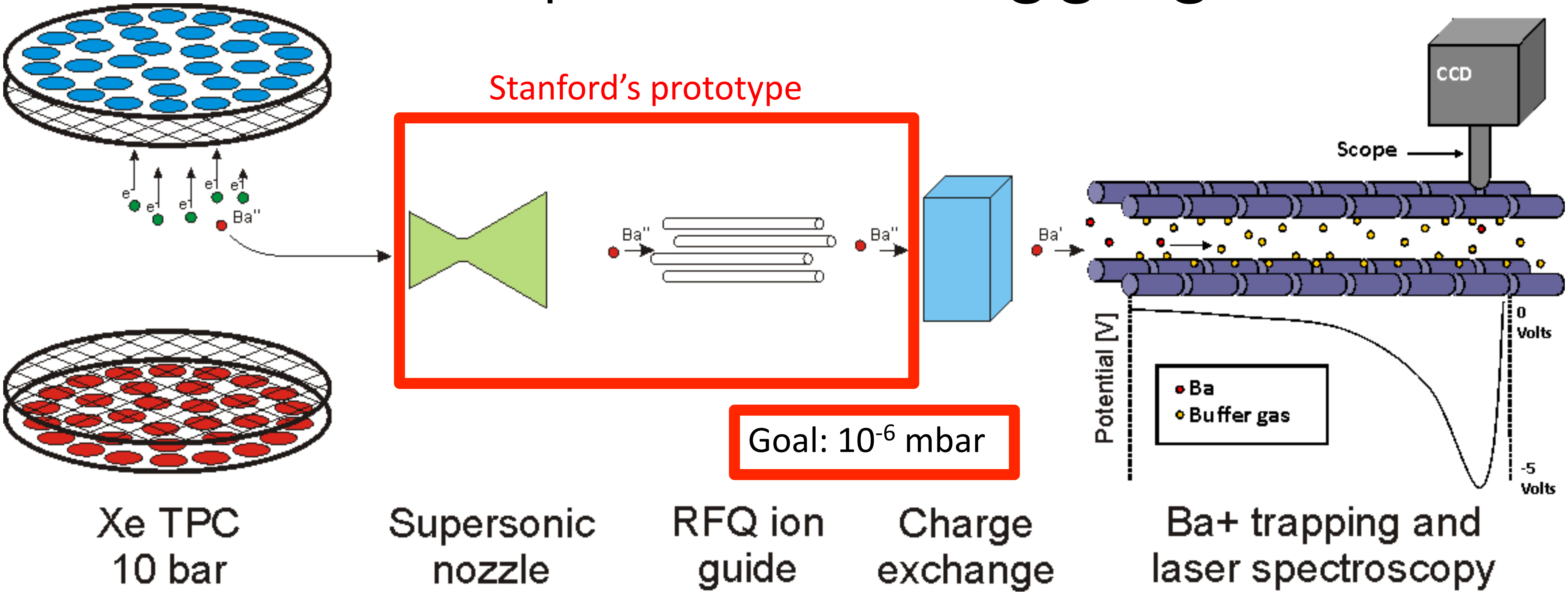
GXe Ba-ion Extraction

General Concept of Ba^{++} Tagging from Gas

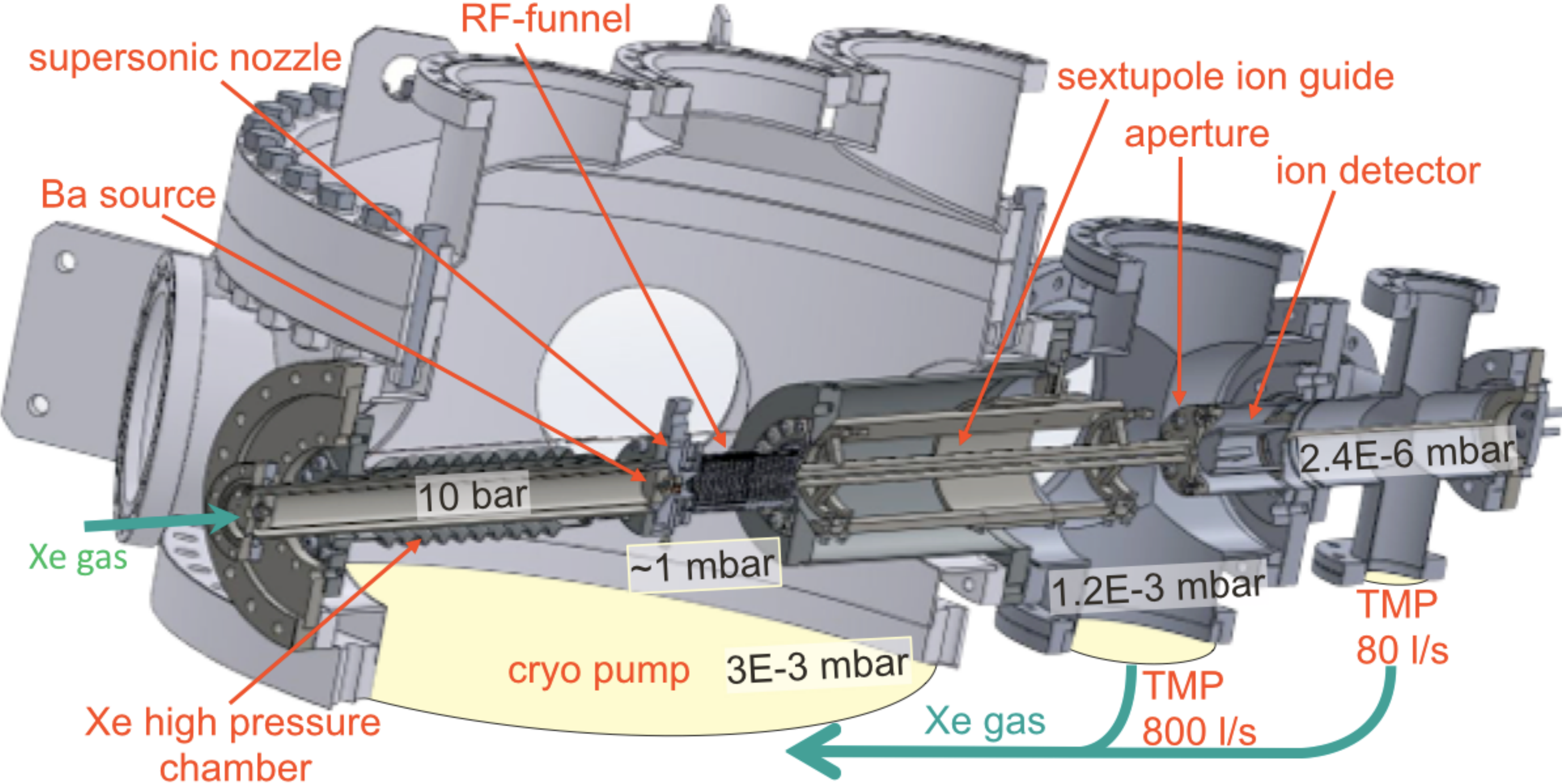


The Plan:

- Guide Ba^{++} in TPC (10 bar) by shaping E-field to a nozzle
- Extract Ba^{++} with gas jet to low pressure chamber then into vacuum
- Guide ions to indentification in vacuum chamber while recovering Xe
- One option for identification:
  - Convert Ba^{++} to Ba^{+} [1], Identify via laser spectroscopy [2]

[1] J. of Phys.: Conf. Ser. 309(2011)12005 [2] Phys. Rev. A 76, 023404 (2007)

The Setup

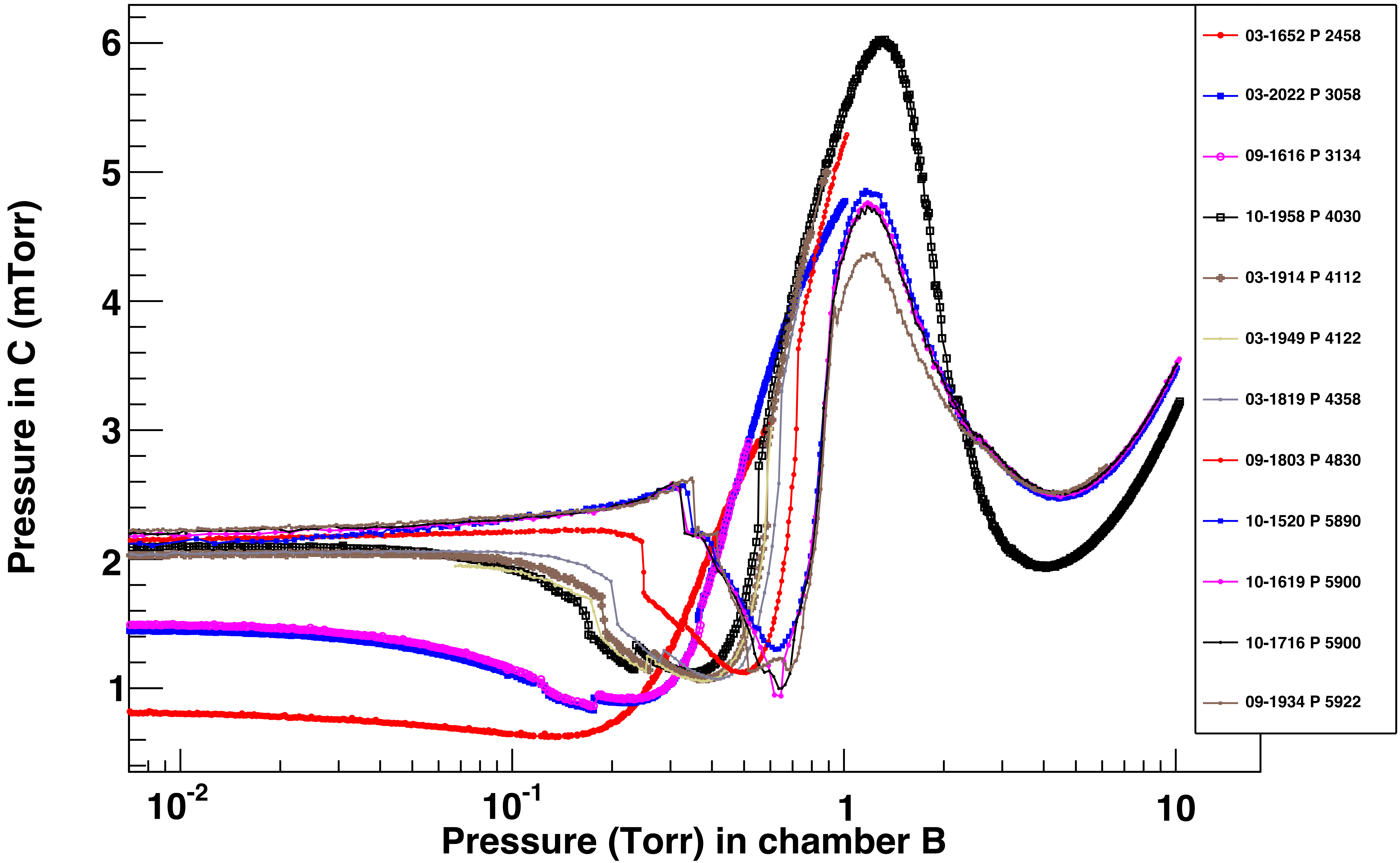


Differential Pumping Stages during a Xe run

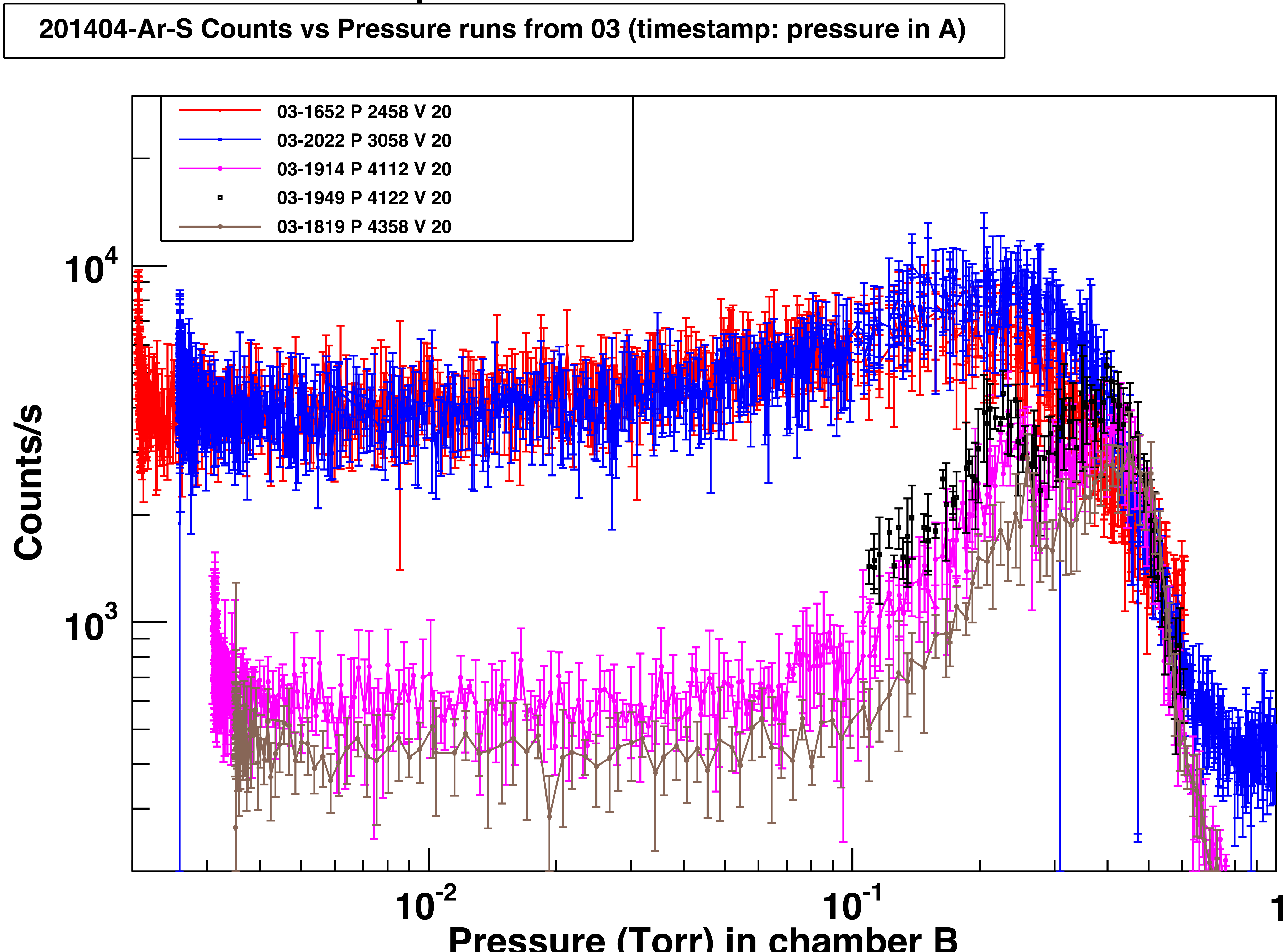
Chamber A	Funnel Interior	Chamber B	Chamber C	Chamber D
High pressure Xe gas	Funnel	Cryopump chamber	SPIG chamber	Detection chamber
10 bar	~1 mbar	3E-3 mbar	1.2E-3 mbar	2.4E-6 mbar

Downstream Pressure Dependance on Pressure in B

201404-Ar-S Pressure response in C. var. runs (timestamp: pressure in A)



Counts Dependance on Pressure in B



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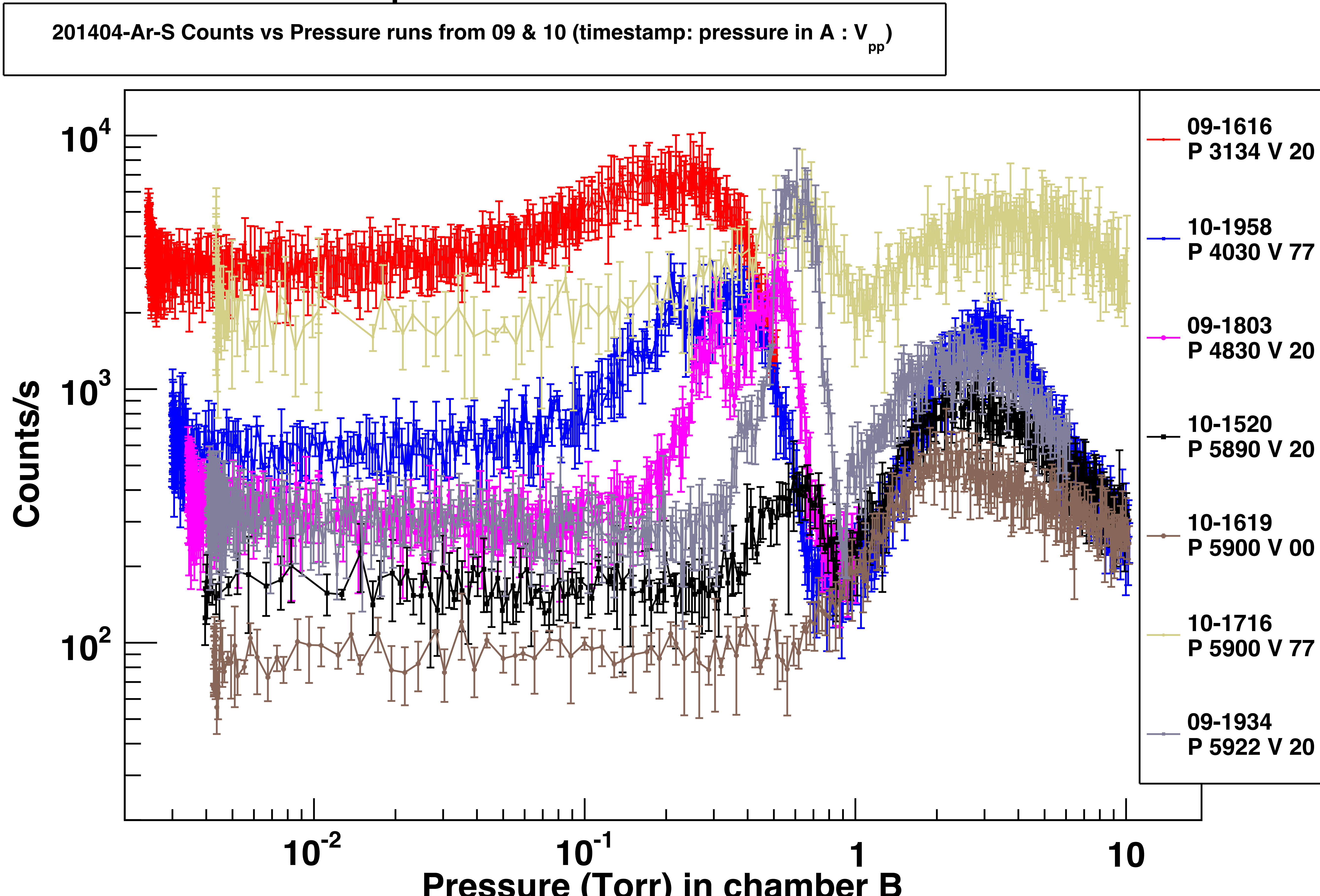
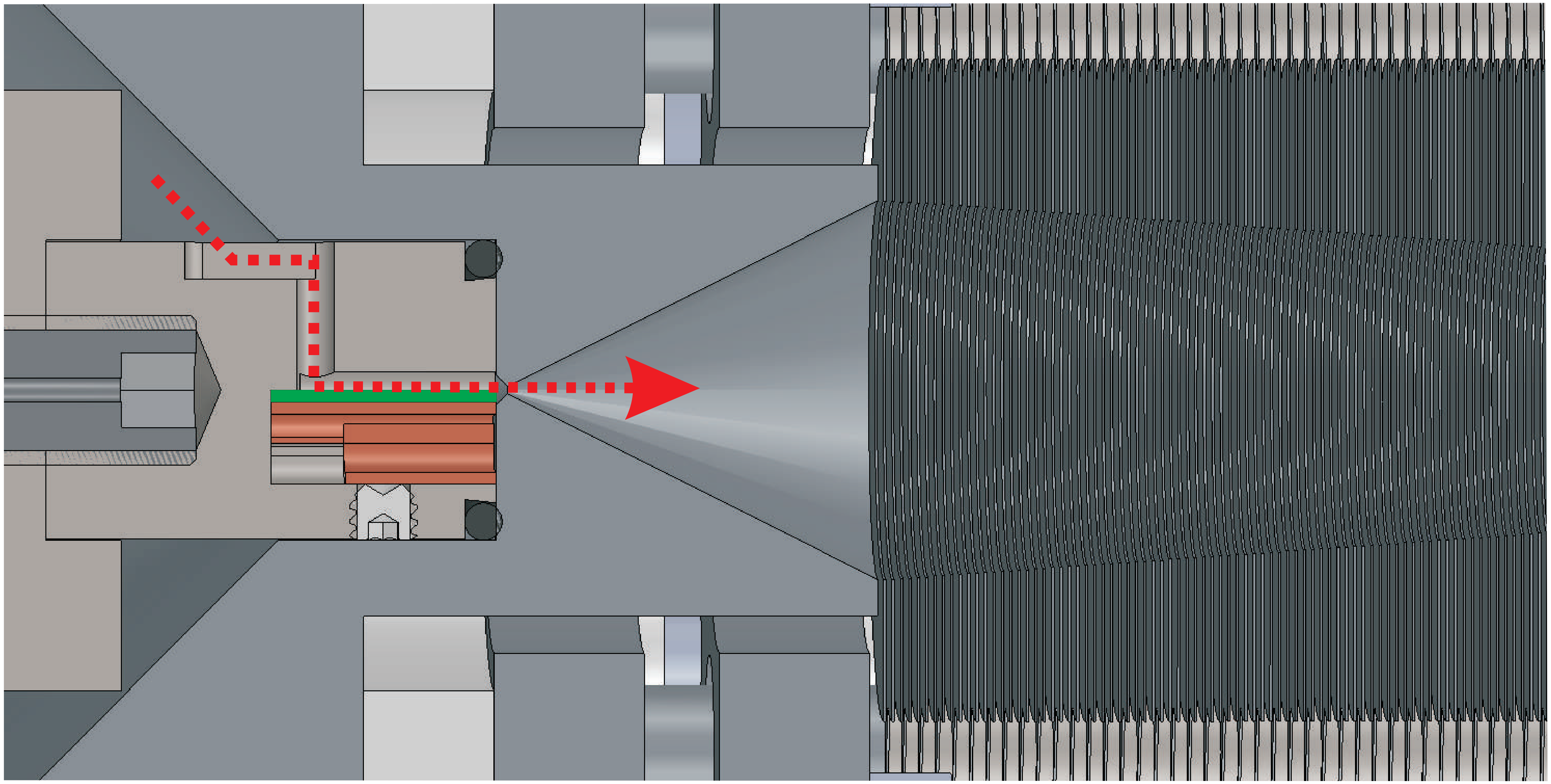


Future Directions

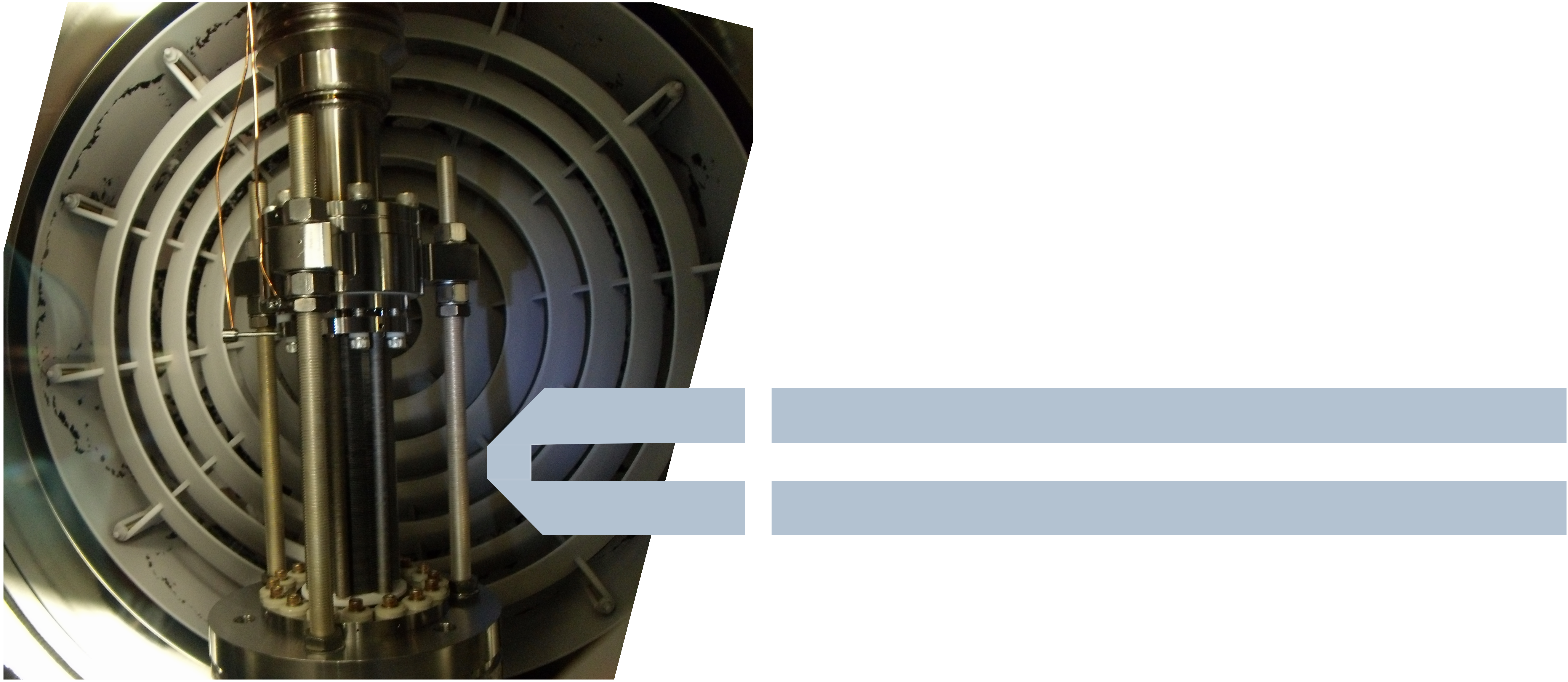
Ion Source

- After first m/q identification
- Replace the current ion source with a rotationally symmetric source
- Schematic of current source:



Pressure Measurement

- Building a Pitot tube to measure the pressure in the immediate vicinity of the funnel
- Relation to the temperature of the first stage of the cryopump



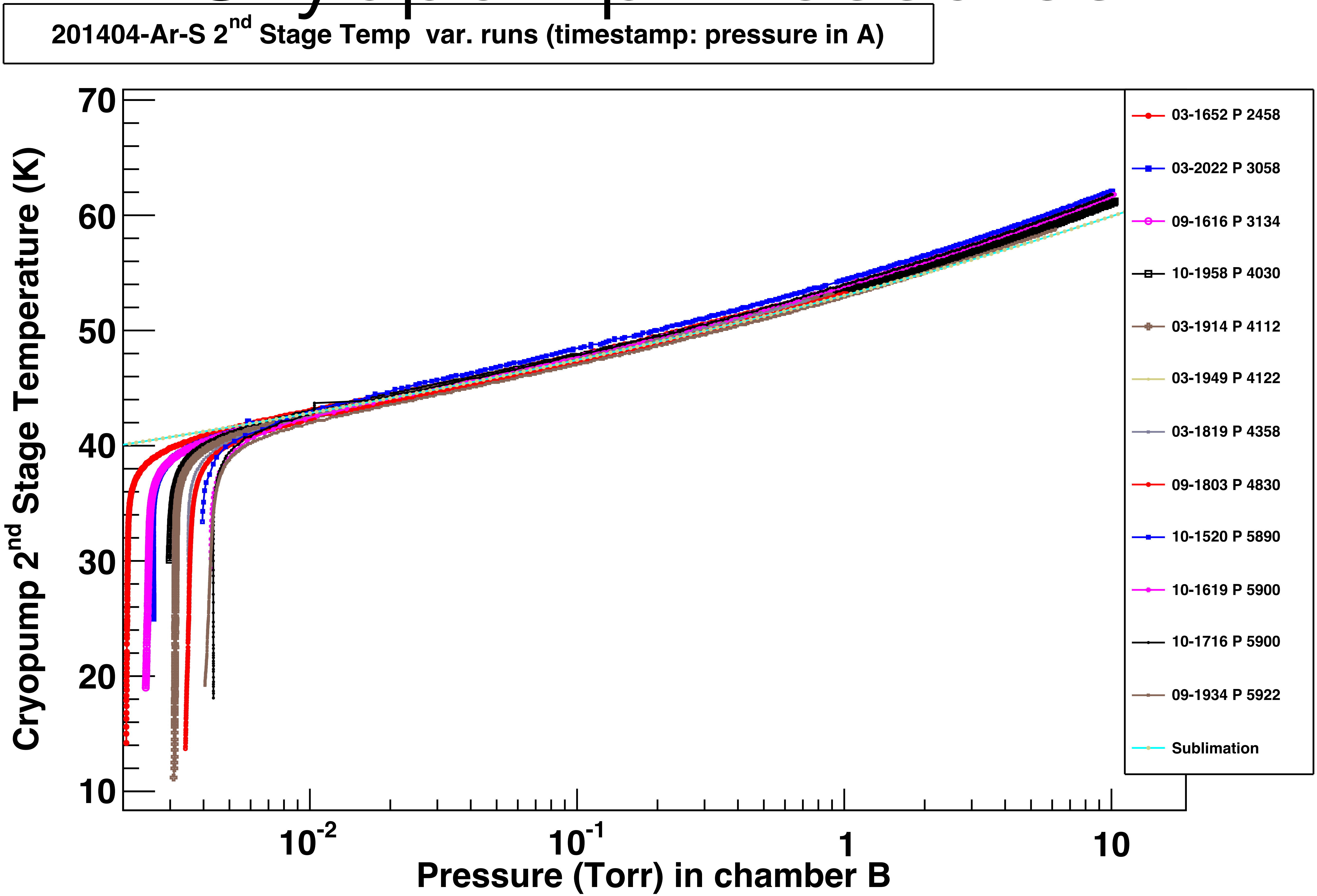
m/q Identification

- We have tried to inject the ion beam into an RGA with no success to date
  - Disassembled RGA ion source
  - Floated entire RGA
- Looking into MR-TOF for mass identification
  - Simple TOF: $R = t / (2T + t\,\Delta\delta)$
  - Duty cycle = 1 : 1364 for $\Delta\delta$= 2E-4 & R = 600
  - Unable to extract quickly from SPIG
  - Multiplexing incompatible with MR-TOF
  - For 5m TOF, T=0.2us, $\Delta\delta$=2E-4, E=1keV : R=311 at 136
  - We want a separate trapping and cooling stage

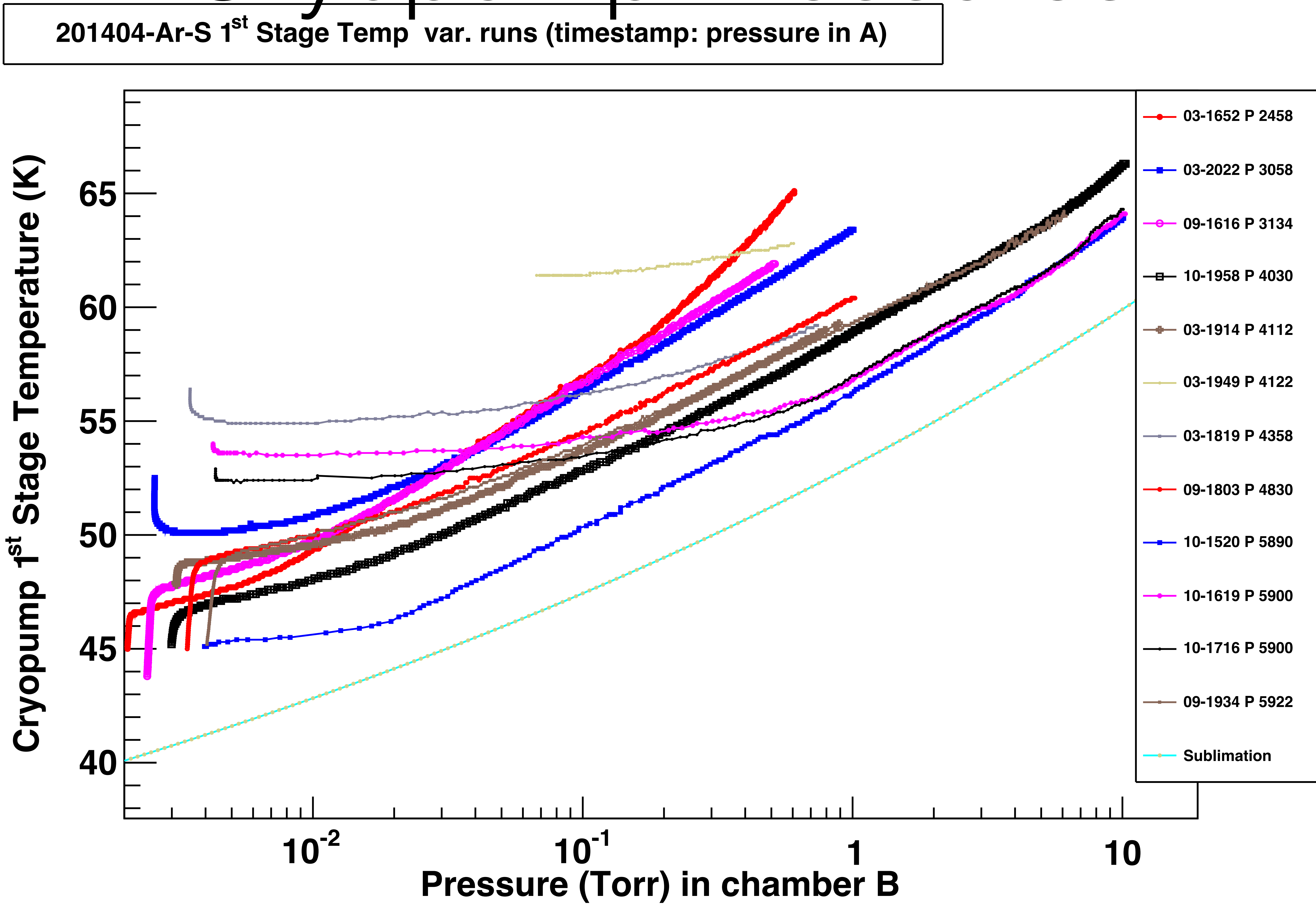
t is the time of flight of the reference
T is the initial time spread
$\Delta\delta$ is the relative energy spread
DOI: 10.1016/S1076-5670(09)01608-5

More Plots

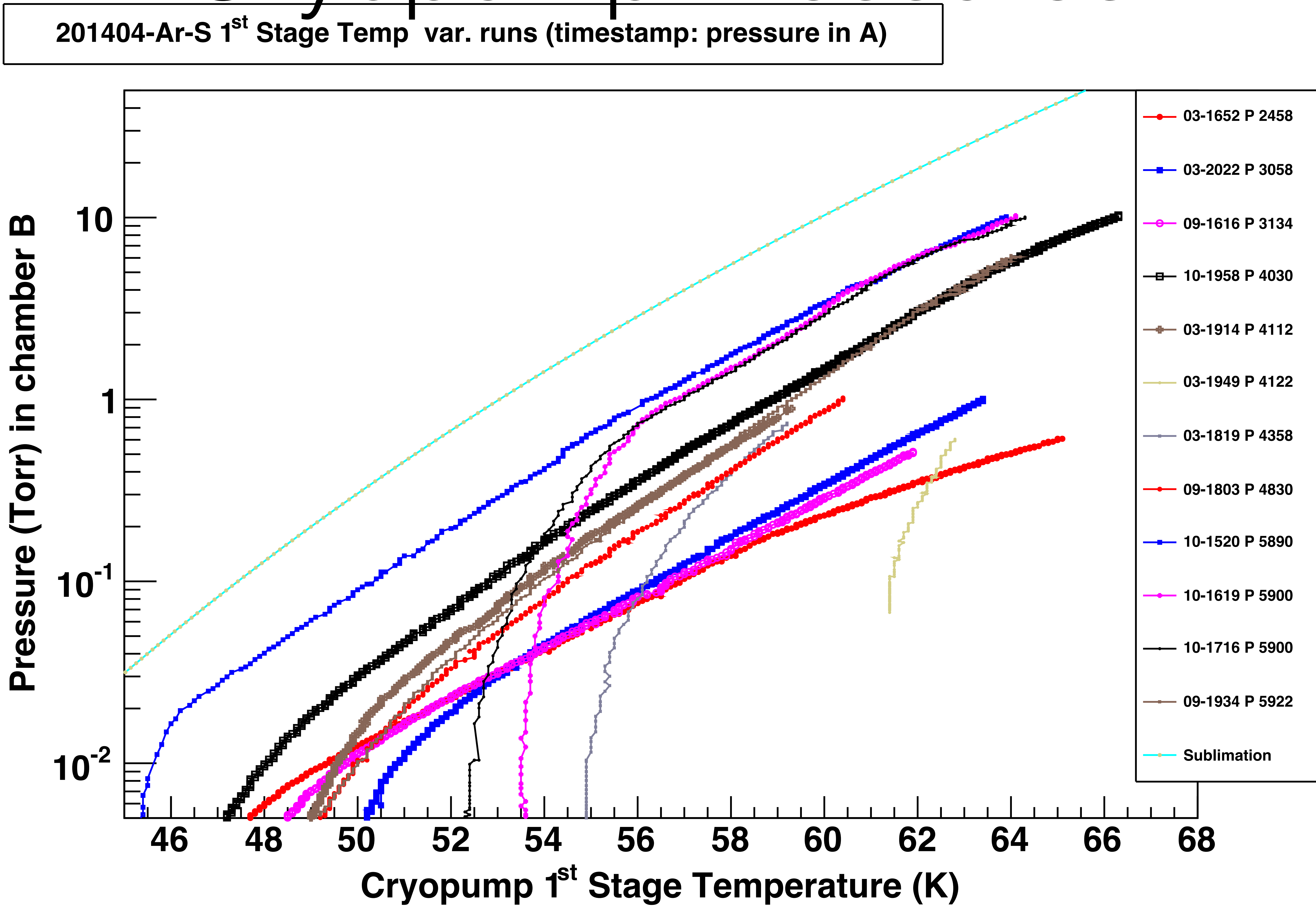
Cryopump Pressures



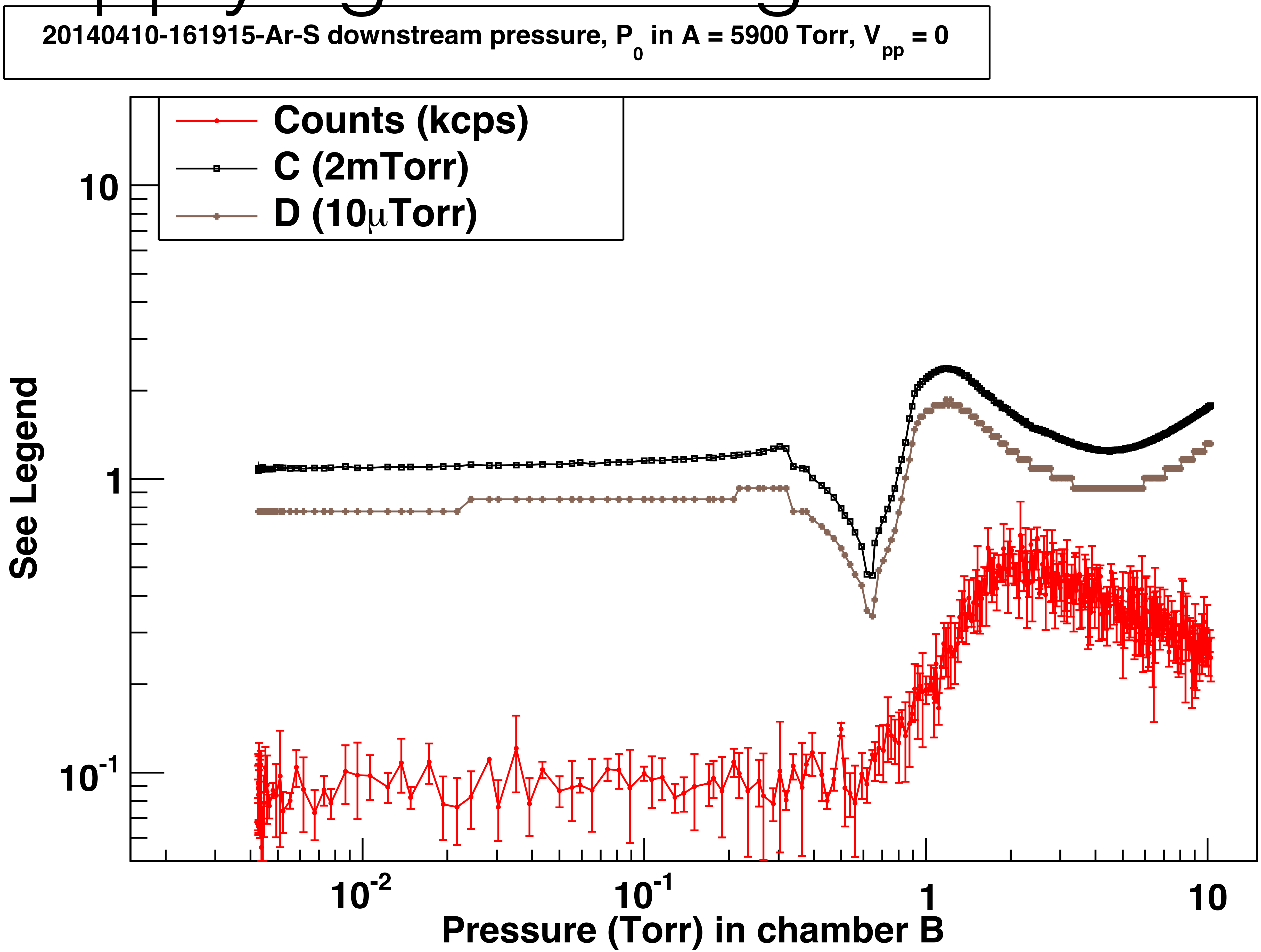
Cryopump Pressures



Cryopump Pressures



Applying RF-Voltage at 5900 Torr



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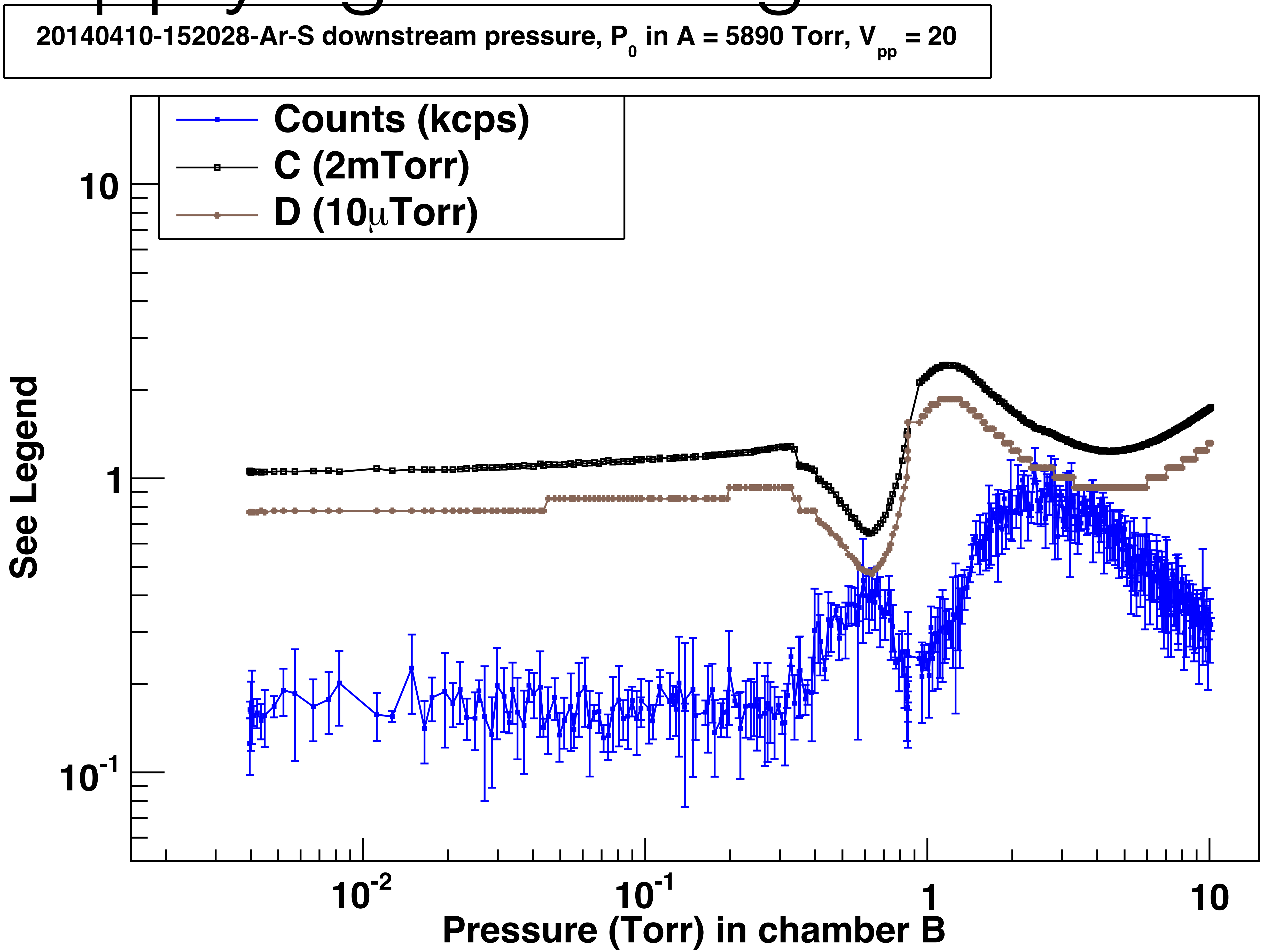

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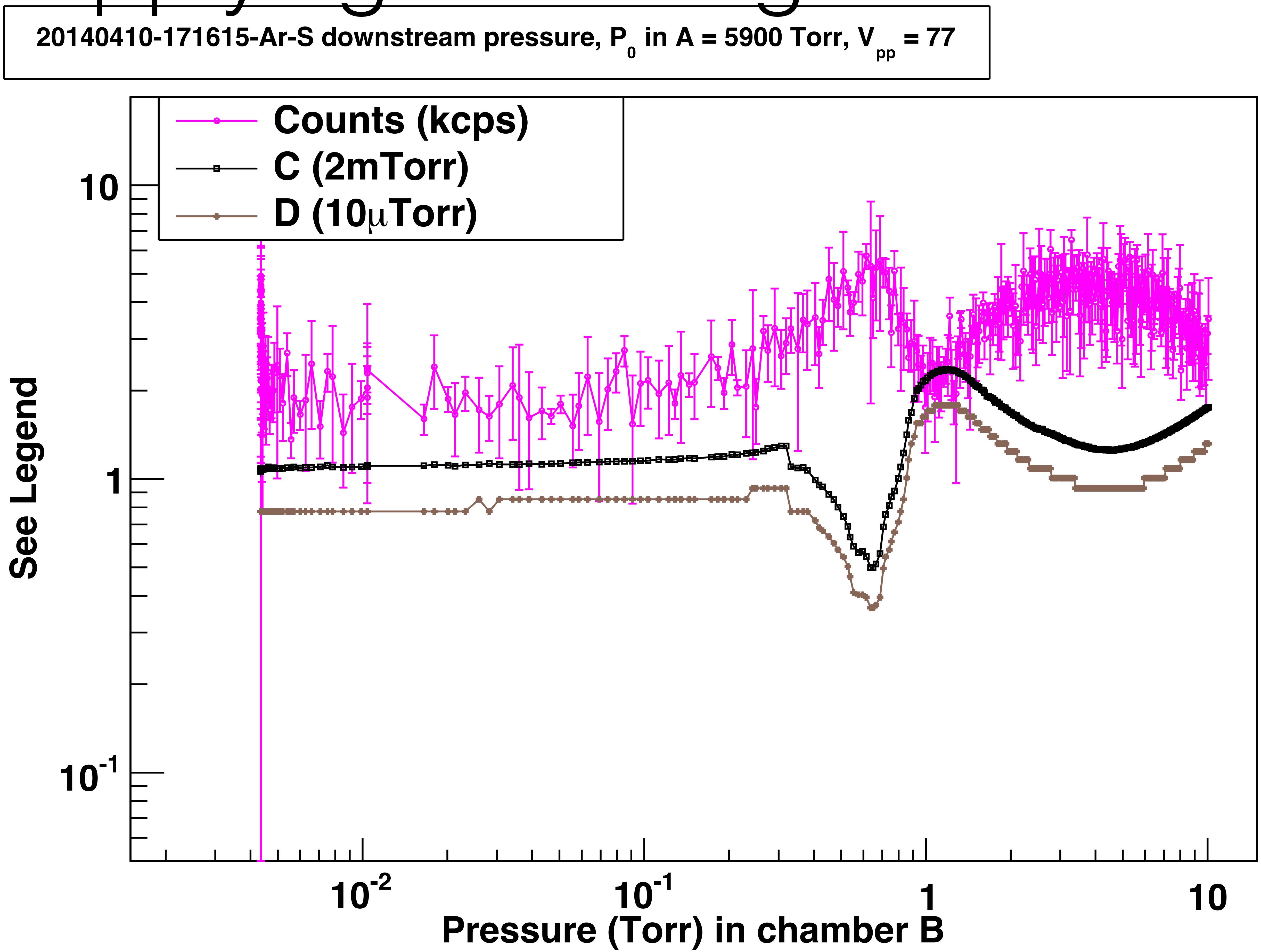

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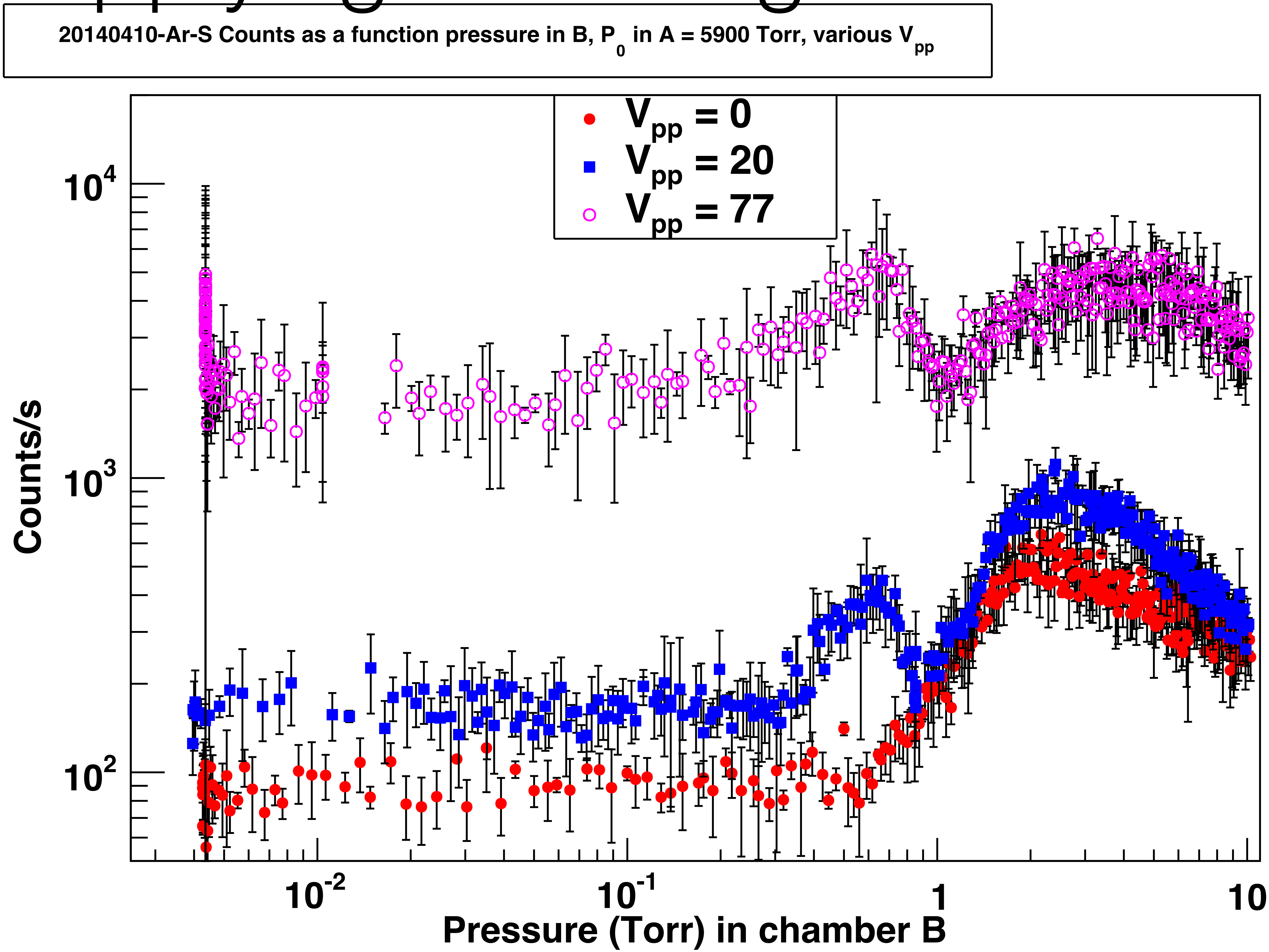
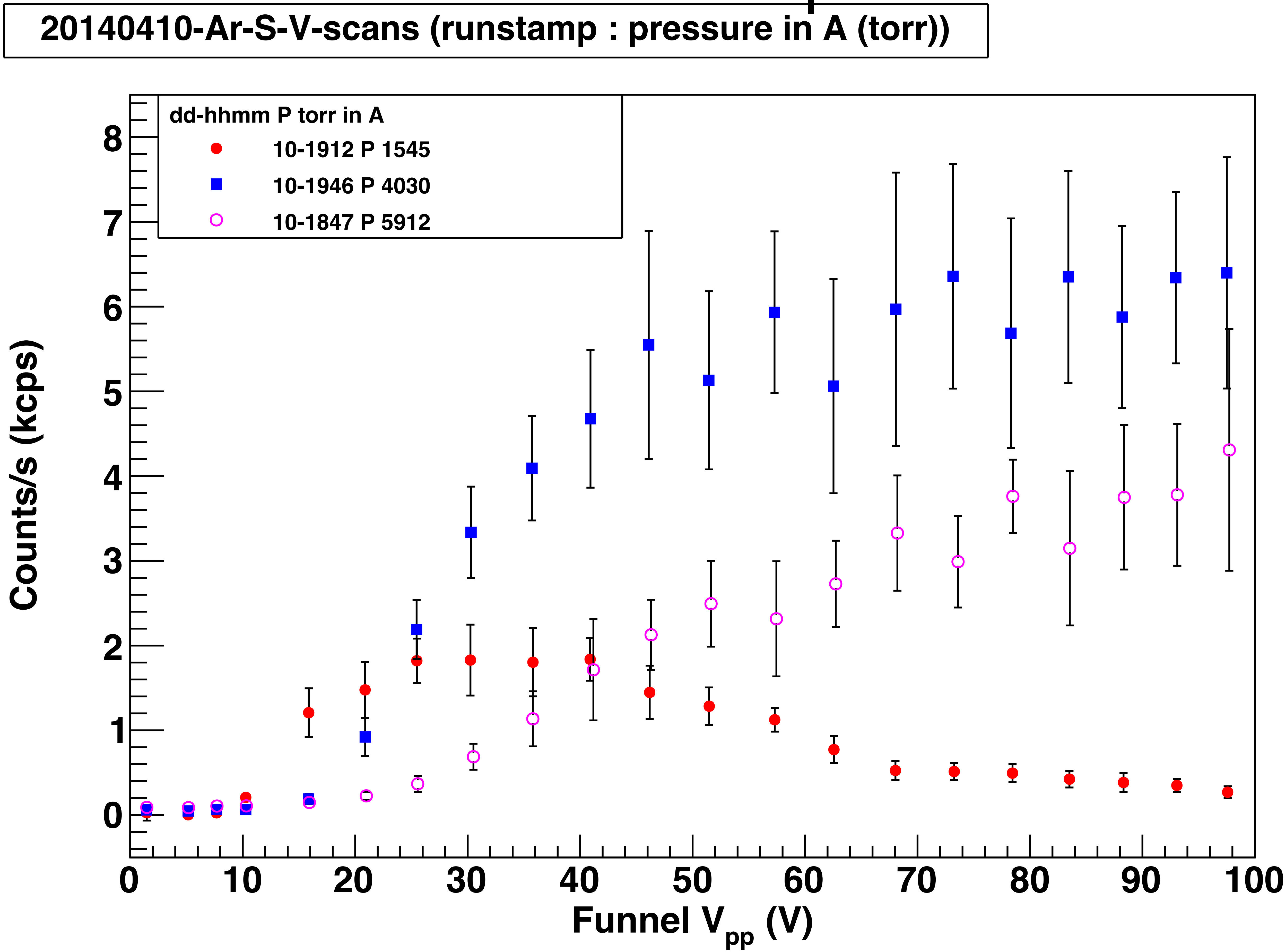
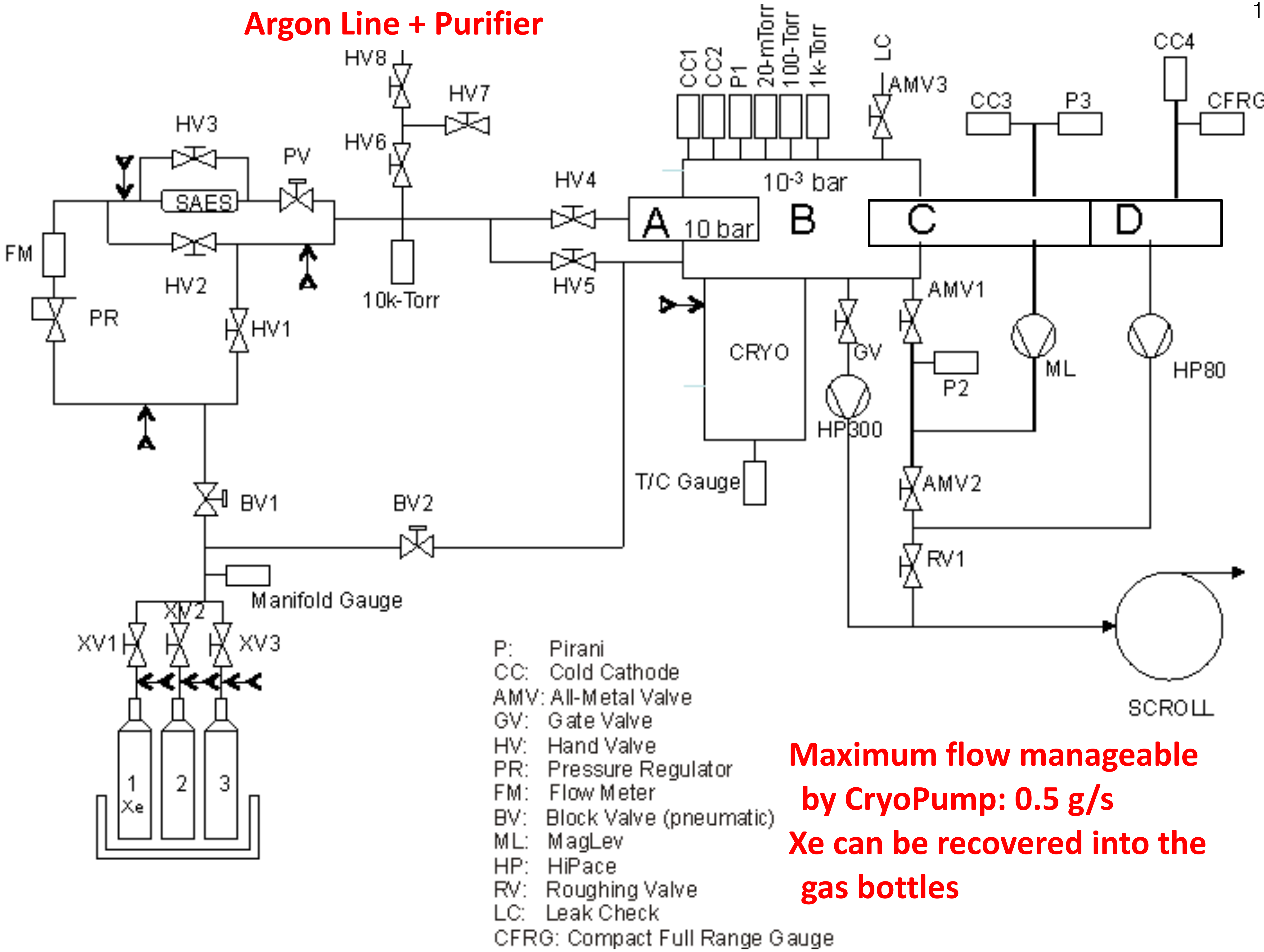


V-RF scans at low pressure in B



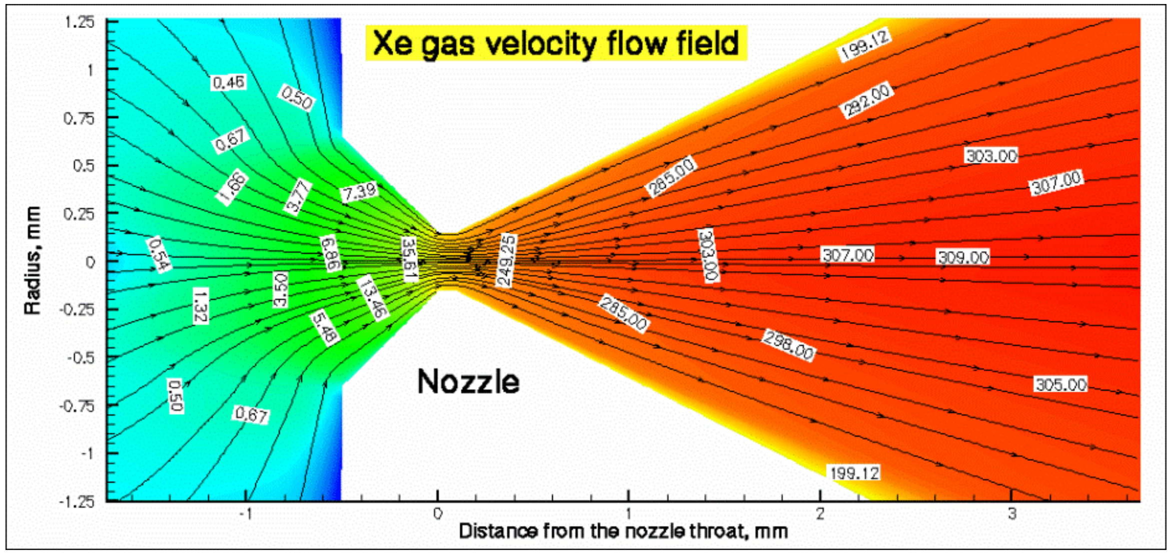
More

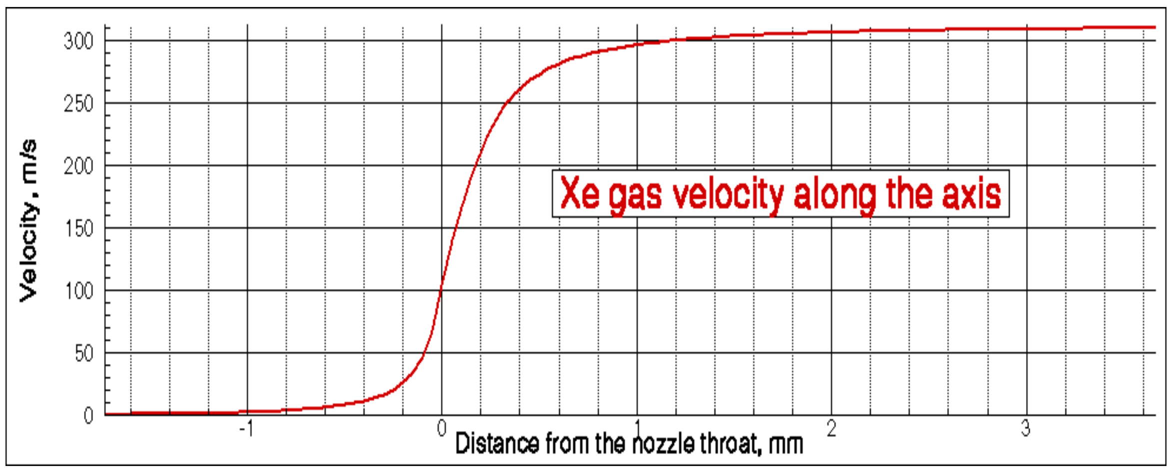
Argon Line + Purifier

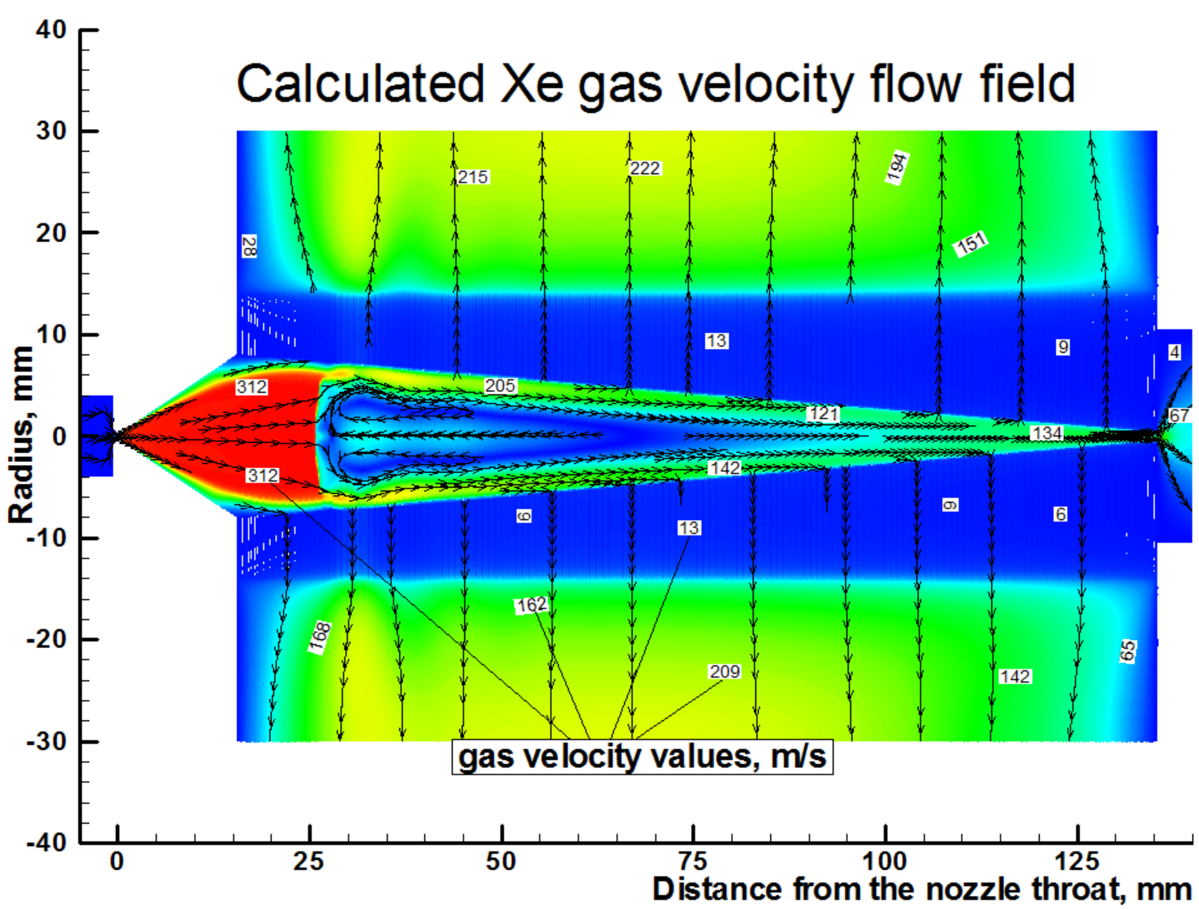


Maximum flow manageable by CryoPump: 0.5 g/s

Xe can be recovered into the gas bottles







Funnel Parameters

<u>Converging-diverging nozzle</u>	
Half-angle of subsonic cone	45^o
Half-angle of supersonic cone	26.6^o
Throat diameter	0.28 mm
Mass Flow	0.33 g/s
Exit diameter	16.0 mm
Subsonic part length	0.5 mm
Supersonic part length	15.5 mm
<u>RF-funnel electrodes</u>	CU
Entrance aperture diameter	0.6299”
Exit aperture diameter	0.0394”
Ring electrode diameter	1.1024”
Change in aperture diam./el.	0.0020”
Ring electrode thickness	0.0040”
(design)	0.0001”
Gap between electrodes	
Total number of electrodes	301