Cl update

Hao, Amir and Narrender
Nozzle disk we use (For CI nozzle designs)

Gas flow direction

<table>
<thead>
<tr>
<th>Tolerances</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Disc diameter</td>
<td>±0/-0.02mm</td>
</tr>
<tr>
<td>Thickness</td>
<td>±0/-0.02mm</td>
</tr>
<tr>
<td>Hole size</td>
<td>5 - 10μm: ±1μm</td>
</tr>
<tr>
<td></td>
<td>11 - 70μm: ±2μm</td>
</tr>
<tr>
<td></td>
<td>71 - 300μm: ±5μm</td>
</tr>
<tr>
<td></td>
<td>301 - 1000μm: ±10μm</td>
</tr>
<tr>
<td>Capillary length</td>
<td>1/2 hole diameter for 10 - 200μm</td>
</tr>
<tr>
<td></td>
<td>&lt;100μm for larger holes</td>
</tr>
<tr>
<td>Roundness of hole</td>
<td>0.1μm for holes 5 - 10μm</td>
</tr>
<tr>
<td>Centring of hole</td>
<td>0.02mm for diameter up to 7mm</td>
</tr>
<tr>
<td></td>
<td>0.03mm for diameter 7 - 30mm</td>
</tr>
</tbody>
</table>
1\textsuperscript{st} CI nozzle design

• The cap add 3mm nozzle-skimmer distance
• O-ring is used between cap and nozzle to seal.
• Disadvantage: nozzle disk is very tight on the adaptor, not easy to remove. Removing the disk will damage or destroy the disk.
Early experiment with 1st CI nozzle design (30um and 50 um)

- The 30 um nozzle data shows a similar result but ~1/3 less photon.
- The 50 um nozzle data shows a 6~7 time lower gas jet density. It also suffers with a high pressure in the nozzle chamber (higher load). (See meeting 20190524)
Further development

• Installation of a flow sensor.
  • We could measure the flow rate, which matches with the theory value.
  • Before pumping down, we could check whether the nozzle is blocked or not sealed properly. For 30um nozzle, 3bar inlet pressure will cause a flow rate of ~0.027 bar L/min and for 20 um, the number is around 0.009 bar L/min.
20 um nozzle using 1st Cl nozzle design

• Initial tests (see meeting 20190816)
  • The third skimmer was placed at various locations but a gas jet was not observed for any of them.

• The skimmer assembly was removed and realigned several times and the third skimmer location was changed but no gas jet was observed.

• The nozzle was removed and cleaned and the skimmer assembly was realigned again - no gas jet was observed.
Issues

One screw is broken inside the threads and cannot remove, currently only using three screw to tighten the nozzle disk.

Other consideration for another design: We also want to avoid the damage of nozzle disk by changing it, we have our new nozzle design.
2\textsuperscript{nd} nozzle design

- Currently we have 3 set of nozzle head to host 3 nozzle disk.
- Easier to interchange from one nozzle size to another.
Initial test with 2\textsuperscript{rd} design (20um)

Without 3\textsuperscript{rd} skimmer and scan e-beam vertically

From Y=-300 to 300,
Possibly out of camera range?

- Redo a test with CERN nozzle without 3\textsuperscript{rd} skimmer
- We see gas jet in a range of y position.
- Then we did change the pressure and nozzle skimmer distance to confirm the gas jet is in the view range of Camera.

From data20190911
2\textsuperscript{nd} Cl design with 30 um test

- Again no gas jet has been seen.
Issues

• The nozzle pieces is not done carefully with large errors. Some tolerances are not as expected.

• When fasten the cap with O-ring, it is possible that there is a tilt of the nozzle disk. (This can be seen from the alignment, when rotate the nozzle in the nozzle hold, the alignment is lost).
Next step

• Put a stop on 20 um nozzle
  • Need to rethink the nozzle design
    • Either do it more accurately with careful mechanical shop
    • Weld the nozzle disk to the nozzle holder (Suggested by a book*)

• CD nozzle?

• Measure the gas jet density in the skimmer chamber (Shorten the nozzle to interaction distance is a way for increasing the gas jet density. This need to be tested.)

*G. Scoles, Atomic and Molecular Beam Methods: