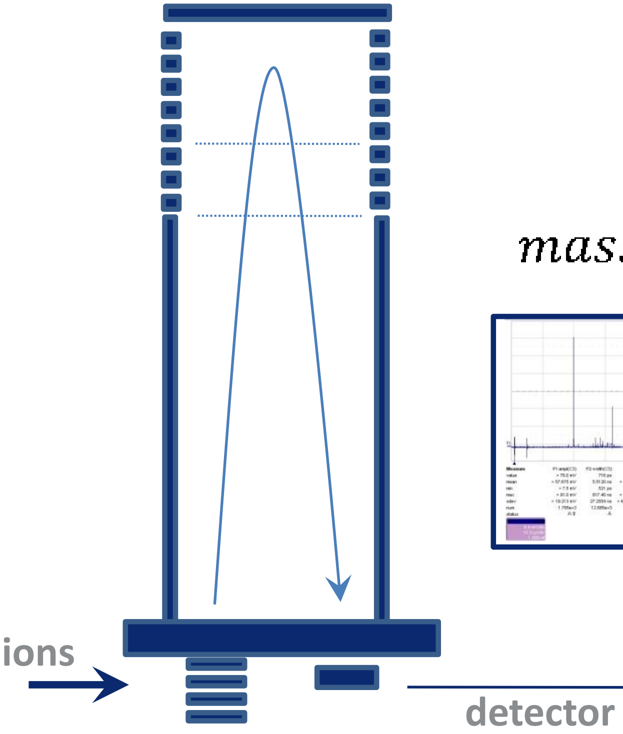
TruFlite™ Microchannel Plate

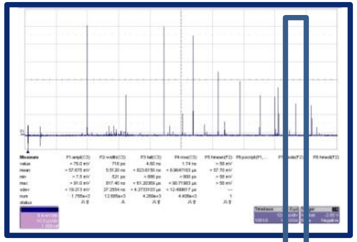
PHOTONIS
Scientific Detectors

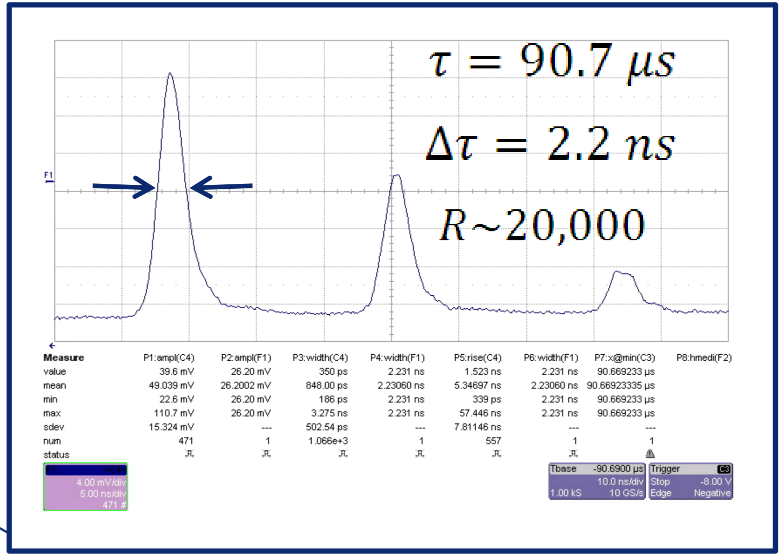
Time of Flight (TOF) Mass Resolution

$$R = \frac{m}{\Delta m} = \frac{\tau}{2\,\Delta\tau}$$



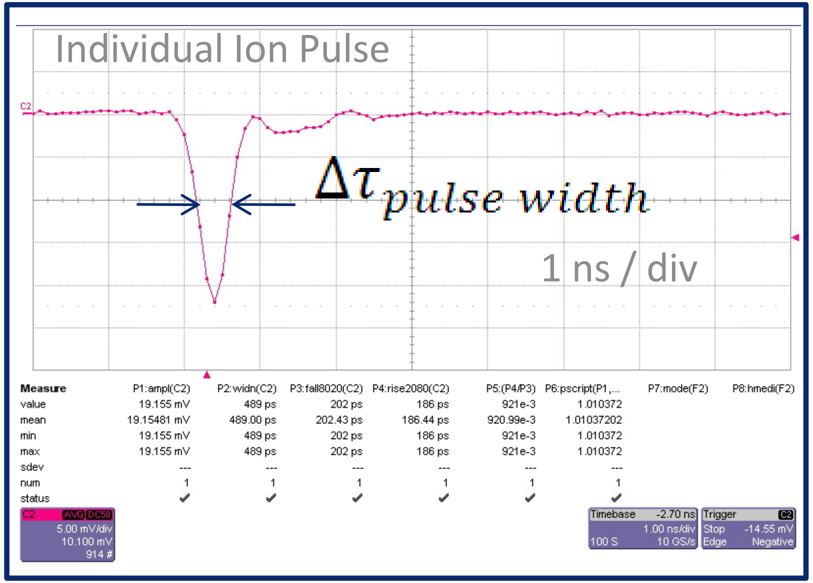
$$mass \sim \tau^2$$

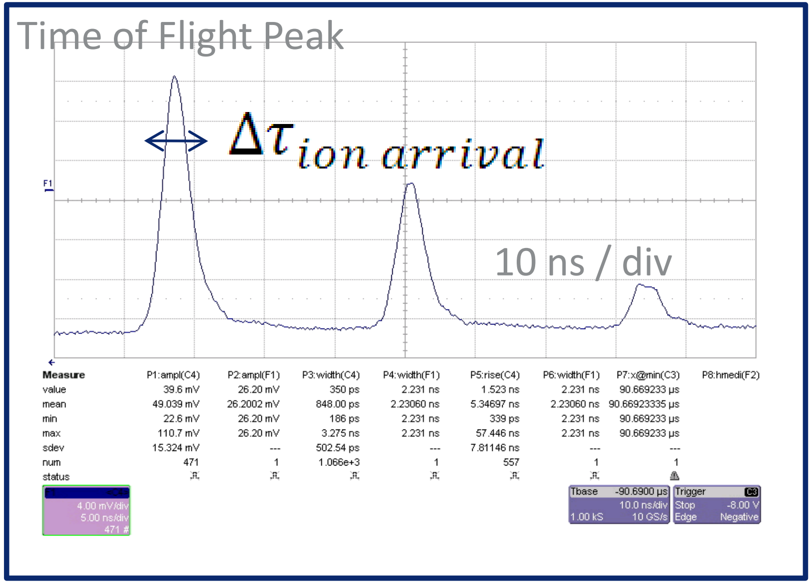




- Any travel-time difference for ions of the same mass in a TOF system reduces the mass resolution

Detector Time Jitter





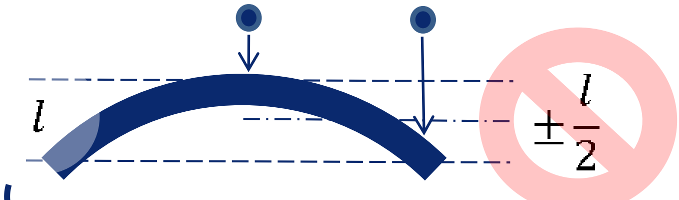
$$\Delta\tau_{detector}{}^{2} = \Delta\tau_{pulse\ width}{}^{2} + \Delta\tau^{*}_{ion\ arrival}{}^{2}$$

- Ion arrival jitter is partially due to the TOF instrument
- We are separating out the jitter that is due to the detector

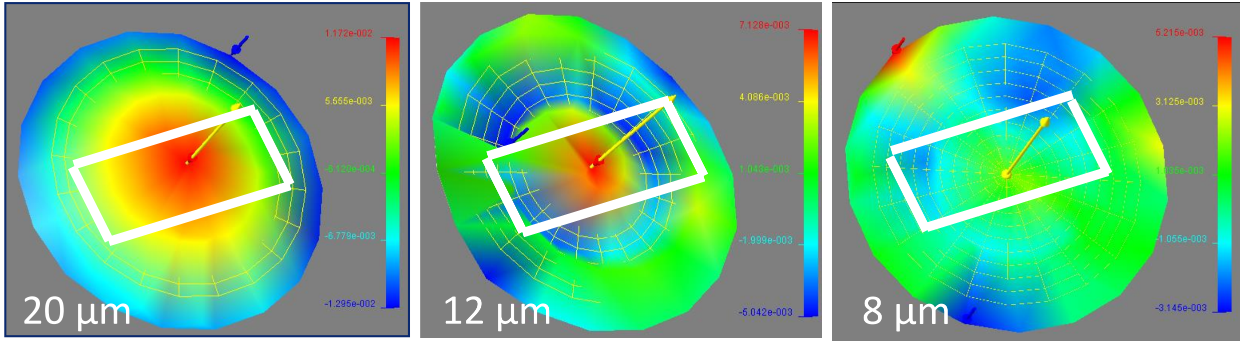
Reducing Detector Time Jitter

- Pulse Width
  - Fast internal transit times
  - Ideally, all of the electrons resulting from the ion impact should reach the anode at the same time.
- Ion Arrival
  - The electromagnetic environment created by the detector should not disturb the motion of the approaching ions. (no electric or magnetic fields in front of the detector)
  - **The detector surface should be planar and parallel to the arriving ion packet.**

Global Flatness



25 mm diameter MCPs



- Reporting maximum absolute focal plane deviation
- Values reported as “±” need to be doubled for comparison

Increased Bias Angle

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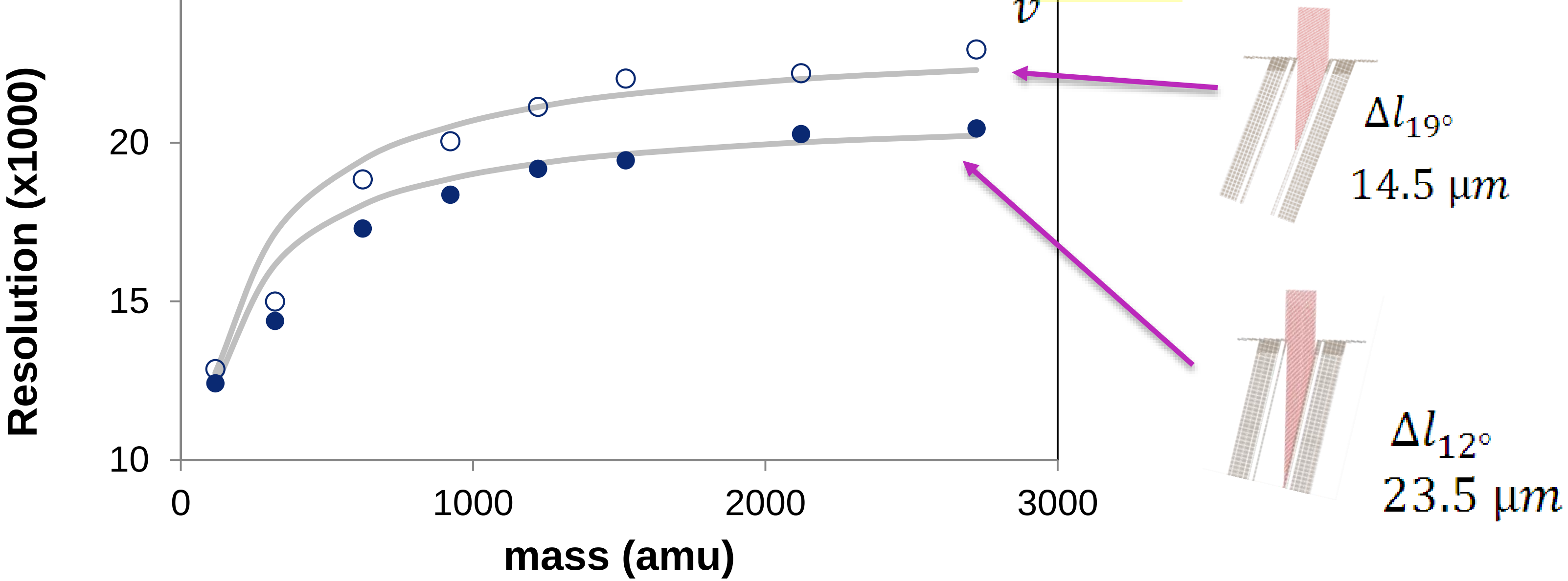
$$\Delta\tau = \frac{d}{v}\tan\theta$$



Bias angle change improved resolution ~ 10% at high mass

Reduced Pore Size

$$\Delta\tau = \frac{d}{v}\tan\theta$$

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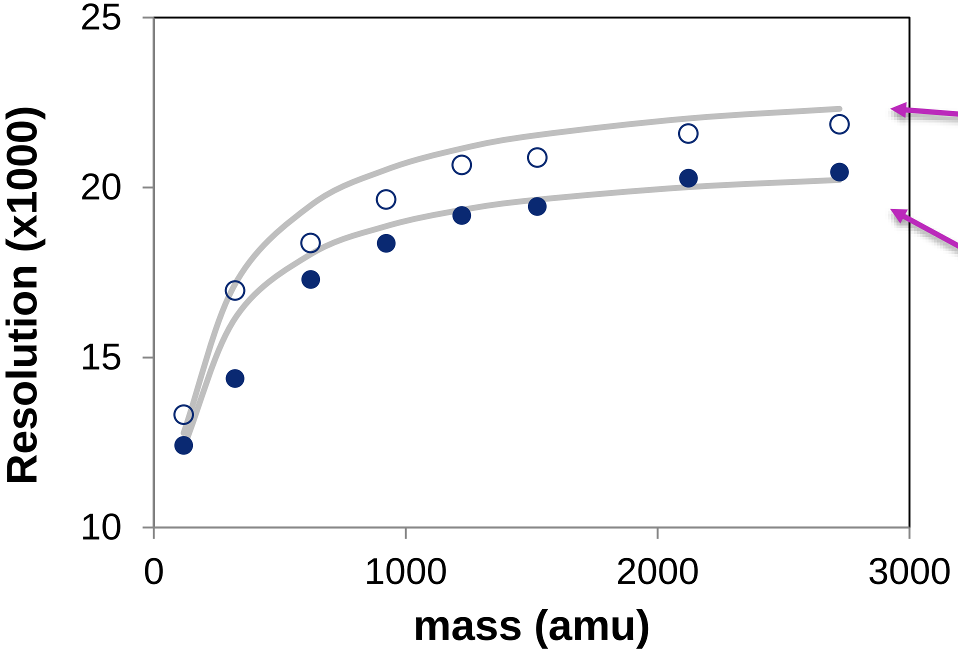


2 µm 12° bias

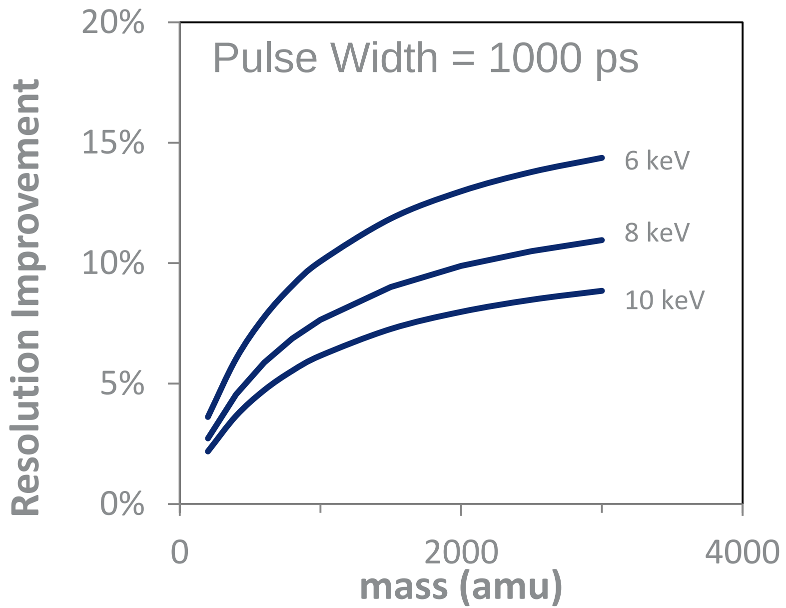
$$\Delta l_{2\ \mu m} = 9.4\ \mu m$$

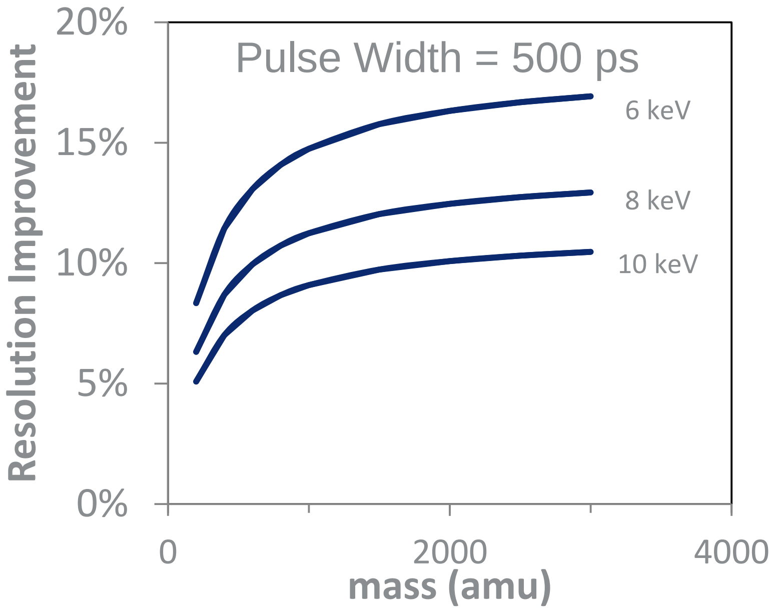
5 µm 12° bias

$$\Delta l_{5\ \mu m} = 23.5\ \mu m$$

2 µm pore improves resolution ~ 10% at high mass

Ion Arrival: Limit of Resolution Improvement





Showing the expected improvement in resolution if time spread due to the entrance geometry could be eliminated.

Conclusions

- With no changes to the instrument, TOF mass resolution can be improved by:
  - Controlling MCP global flatness
  - Increasing MCP bias angle
  - Reducing MCP pore size
- MountingPad MCP global flatness can be controlled in hardware to under 10 µm for a 25 mm diameter active area.
  - Control of hardware and assembly are critical
- 25 mm diameter 2 µm pore 19° bias angle MCPs reduce the pore penetration depth from 23.5 to 5.4 µm.
- The use of True Flight MCPs can improve resolution by 15% over standard configuration

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