capacitance to that of known MEMS devices using similar RF waveform parameters, such as FAIMS microchips. The capacitance of a planar electrode stack is proportional to its total area and inverse gap width, however, as the exemplary funnel embodiment and the microchips have equal g values, one can simply compare the areas. In the version featuring 47 channels of 2.5 mm lateral span and 0.3 mm length, the gap area of the microchips is 35 mm^2. While the FAIMS electrode length depends on the ion residence time required for the desired separation quality, the funnel electrodes need to be deep enough for the RF field near the edges to stay unaffected by the underlying substrate. For that, the electrode depth should be at least about 2 g or 0.07 mm (with g=35 μm). That is much less than 0.3 mm, allowing a greater face area by 0.3/0.07=4.3 times, or 35 mm^2. With the lateral span of 15 mm, each side of the "wedge" can be 1.2 mm long. Many applications would be better suited by a funnel of smaller lateral span and proportionately greater length for same surface area, e.g., 5 mm and 3.6 mm, respectively. Such funnels can create a proportionately lower gas outflow, reducing the pressure and/or needed pumping capacity in the subsequent chamber(s).

To capture and focus ion beams wider than the opening of a single funnel limited by capacitance constraints, multiple funnel panels can be assembled in various arrangements including, e.g., laterally, consecutively, or in a 2-D matrix. For example, FIGS. **5*a*-5*c*** show composite wedge ion funnels of lateral **200**, consecutive **300**, and 2-D arrangements **400**, respectively. A person of ordinary skill in the art will recognize that other arrangements can be made, thus no limitations are intended. In particular, five funnels can be laterally disposed such that the "wedge" sides have the span of 10 mm and length of 9 mm. With θ=45°, the composite funnel **200** would have a rectangular opening of 9 mm×8 mm. More powerful waveform supplies would allow larger composite funnels with fewer individual elements.

Ions driven through a gas by an electric field experience collisional or "field" heating that may induce their isomerization or dissociation. The magnitude of heating scales as $(KA)^2$, where K is the ion mobility. As K is proportional to 1/P and A should be scaled linearly with P for consistent ion funnel performance as discussed above, the quantity KA and thus the extent of ion heating in atmospheric-pressure funnels would equal that in existing funnels, despite much stronger fields. This heating may cause isomerization of fragile ions, such as proteins that have been observed to unfold in funnels known in the art. Hence ambient-pressure ion funnels, like the current low-pressure ones, may be unsuitable for handling of fragile ions when conformational characterization is intended (e.g., at the entrance to IMS drift tube). However, no dissociation of ions that would interfere with MS analyses has been observed in known funnels and none should occur in the atmospheric-pressure ones of the invention.

FIG. **6** compares circular ion beams **14** delivered by conventional funnels with belt-shaped beams **14** produced in accordance with different embodiments of the invention. In the figure, the belt-shaped beam **14** and circular 14 beam have the same cross-sectional areas (120 mm^2), but the circular beam **14** is over three times thicker than the belt-shaped beam **14** in the minimum dimension. Belt-shaped beams output by a wedge funnel may be focused into circular beams as discussed above. However, rectangular cross-sectional shapes are preferred in some arrangements because Coulomb repulsion scales as the ion density squared, and belt-shaped beams (focused in 1D) have a much smaller density than circular beams of the same minimum size focused in 2-D, e.g., by nearly tenfold compared to the circular beam **14** with the 4 mm diameter. While circular beams may have the same cross-sectional area and thus ion density as rectangular beams, they would be much thicker as exemplified above.

FIG. **7** shows one system **500** for beneficial use of belt-shaped ion beams, according to an embodiment of the invention. In the figure, a belt-shaped beam **14**, produced by wedge funnel **100** of the invention, is introduced into a o-ToF MS instrument **15**. The thickness of incoming beam **14** defines the spread of initial ion coordinates along the flight path that limits the resolving power and decreases it for stronger ion currents. As space-charge phenomena depend on the total ion density, MS peaks for non-abundant species in a mixture also broaden when the total flux is large. Depending on the ion detection scheme, the recorded peak position and thus the mass measurement accuracy (mma) may be affected as well. Here, the losses of MS resolution and mma due to peak broadening are ameliorated by processing a rectangular beam **14** delivered by funnel **100** with the exit slit **12**—and thus the beam plane—oriented parallel to the o-ToF pusher plate **16**, ion mirror **17** (in a reflection ToF), and ion detector **18**. In this "waterfall" configuration, the initial spread of ions perpendicular to pusher plate **16** is minimized, while their lateral spread parallel to pusher plate **16** does not affect the measured MS spectra.

The utility of belt-shaped ion beams is not limited to ToF MS. FIG. **8** shows another system **600** of the invention, in which a wedge funnel **100** introduces a rectangular beam **14** through a slit **12** into a wedge ion funnel trap (IFT) **25** defined by a second and a third wedge funnel **100** positioned as shown Cuboid packets delivered by IFT **25** are injected into an IMS drift tube **30** and mobility-separated therein while maintaining a laterally elongated shape. In this configuration, the electrodes **32** in tube **30** preferably have internal apertures with shape approaching that of beam **14** exiting IFT **25**. As rectangular beams have a lower ion density, the Coulomb expansion that decreases the IMS resolving power is reduced, while lateral packet expansion does not affect the IMS resolution.

DTIMS/ToF MS is emerging as a powerful and versatile platform for complex mixture analyses, and various arrangements employing "wedge" funnels can be envisioned. One example is an embodiment where rectangular packets separated in DTIMS are refocused in 1D at the terminus by another "wedge" funnel and injected into the ToF MS. In this way, the whole IMS/MS analysis is performed on (chopped) belt-shaped ion beams. In another embodiment, a wedge funnel focuses spherical packets exiting the drift tubes known in the art into cuboid packets for ToF analyses. Openings of single "wedge" funnels (e.g., 15 mm×1.2 mm or 5 mm×3.6 mm) are smaller than the circles of 1-2 in. diameter in the funnels within or at the end of present IMS drift tubes. However, the ion beam expansion (through either diffusion or Coulomb repulsion) is much slower at higher and particularly ambient pressure. For example, a 15-cm long tube at atmospheric pressure that provides a resolving power of ~150, ions would spread to only ~1 mm width at half-maximum intensity, or ~2 mm near the peak baseline. This is within the 5×3.6 mm opening and well within the openings of larger funnel arrays exemplified above. Hence practical "wedge" funnels can be large enough to focus ions at IMS/MS interfaces and within IMS stages.

Planar rather than circular ion beams are also advantageous for analyses involving a tight beam of light (typically laser) or particles crossing the ion beam, such as in photoelectron spectroscopy (PES). In this scenario, the overlap of two beams and thus the ion utilization efficiency and sensitivity are maximized when the ion beam is no thicker than the laser