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Title of presentation:
Microfluidic geometries for precise manipulations on droplets

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Abstract:
In spite of the laminar character of the flow of liquids in the microchannels, the nonlinear effects are introduced by the presence of surface tension. In the case of droplets suspended in a continuous liquid (where the continuous phase wets walls of the microchannels) the channels confine the droplets. Drops larger than the largest sphere inscribed into the lumen of the channel are squeezed and the tightness of the channel sets the curvature of the interface and the pressure jump across the interface. Appropriate design of the geometry of the channel can be used to determine the pressure drop along the droplet. Here we present a concept of microfluidic modules (traps) that exploits this idea. They consist of geometrical elements like constrictions, barriers and bypasses in the form of slits. Appropriate use of these elements makes possible to create a variety of traps with different functions such as: i) metering prescribed volume of droplet; ii) immobilising a droplet of a predetermined length; iii) combining consecutive drops; iv) changing the drop speed and residual time. The precision of these operations is encrypted by the geometry of the device and by large mismatch of shear stresses and capillary forces what guaranties high level of repeatability. We demonstrate that these modules can be integrated into systems that perform complicated protocols with high level of accuracy while do not need to be precisely controlled.