Abstract Submitted
for the DFD16 Meeting of
The American Physical Society

A heat transfer model for slug flow boiling within microchannels MIRCO MAGNINI, JOHN THOME, Ecole Polytech Fed de Lausanne — We propose a novel physics-based model for the fluid mechanics and heat transfer associated with slug flow boiling in horizontal circular microchannels, to update the widely used three-zone model for the design of multi-microchannel evaporators. The flow is modelled as the cyclic passage of a liquid slug, an elongated bubble which traps a thin liquid film against the channel wall, and a dry vapor plug. The capillary flow theory, extended to incorporate evaporation effects, is applied to estimate the bubble velocity along the channel. A liquid film thickness prediction method considering bubble proximity effects, which may limit the radial extension of the film, is included. Theoretical heat transfer models accounting for the thermal inertia of the liquid film and for the recirculating flow within the liquid slug are utilized. The heat transfer model is compared to experimental data taken from three independent studies: 833 slug flow boiling data points covering R134a, R245fa and R236fa and channel diameters from 0.4 mm to 1 mm. The new model predicts more than 80% of the database to within ±30% and it represents an important step toward a complete physics-based modelling of bubble dynamics and heat transfer within microchannels under evaporating flow conditions.

Mirco Magnini
Ecole Polytech Fed de Lausanne

Date submitted: 26 Jul 2016 Electronic form version 1.4