

# Extending the Golay Equation for Coupling a Gas Chromatograph to a Drift Tube IMS

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## Introduction

Due to chemical cross sensitivities and limits in resolving power of ion mobility spectrometers (IMS), a pre-separation of complex mixtures is required. In most cases, gas chromatographic (GC) pre-separation is used [1-3]. In contrast to typical detectors, an IMS adds a significant dead volume to the system which leads to peak broadening. In the traditional Golay equation [4], the plate heights  $H$  are described by the longitudinal diffusion  $B$  and the radial diffusion  $C$  inside the column. Therefore, we extended this equation by adding a new term  $V$  to incorporate the influence of the IMS volume.

$$H = V + \frac{B}{\bar{u}} + C\bar{u}$$

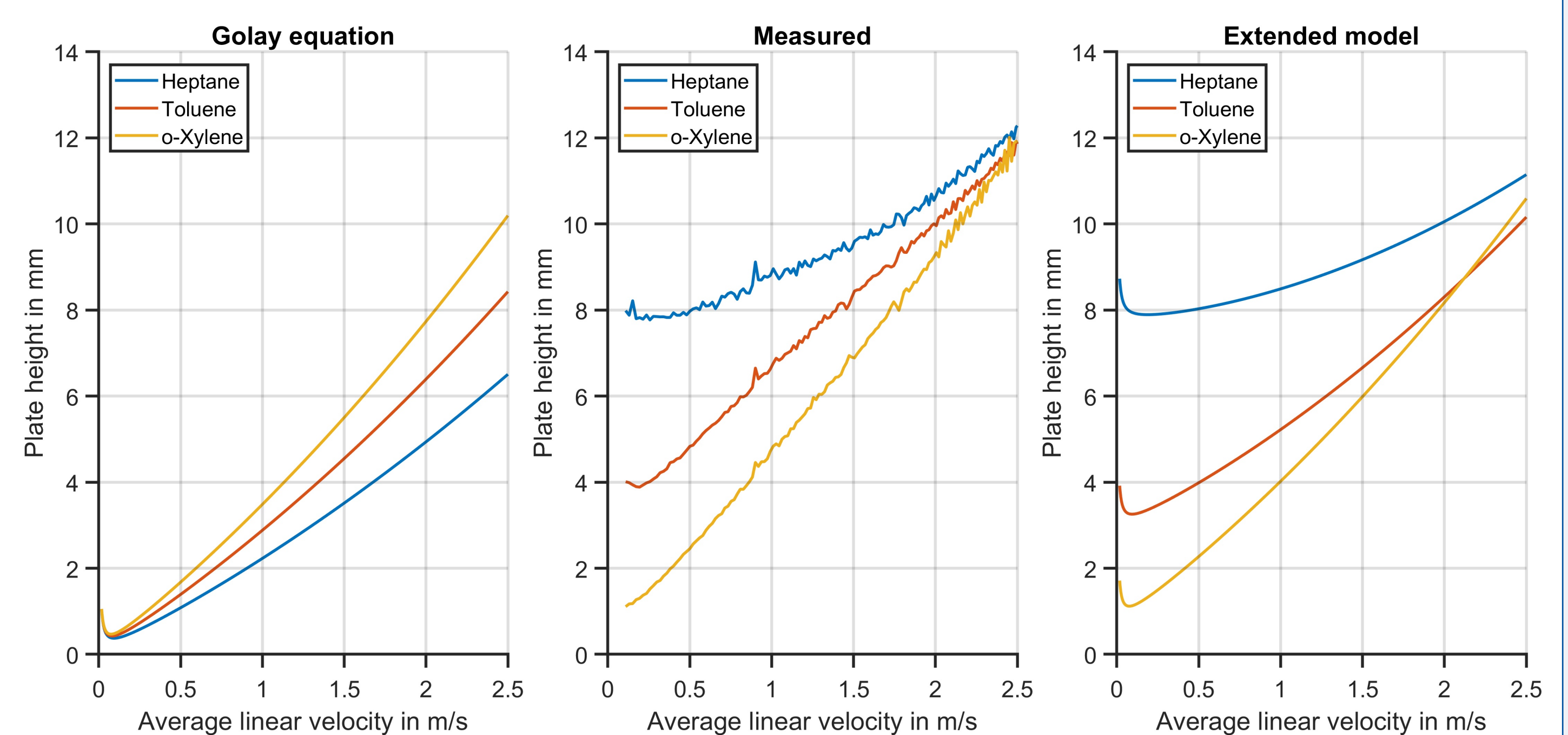
Our model has been experimentally verified using an ultra-high sensitive IMS detector in combination with capillary columns of different lengths and diameters.

## New Model

$$V = L \frac{V_{ims}^2}{V_{col}^2} \frac{1}{(k+1)^2} \frac{f^2}{\left(1 + \frac{\Delta T}{T_0}\right)^2}$$

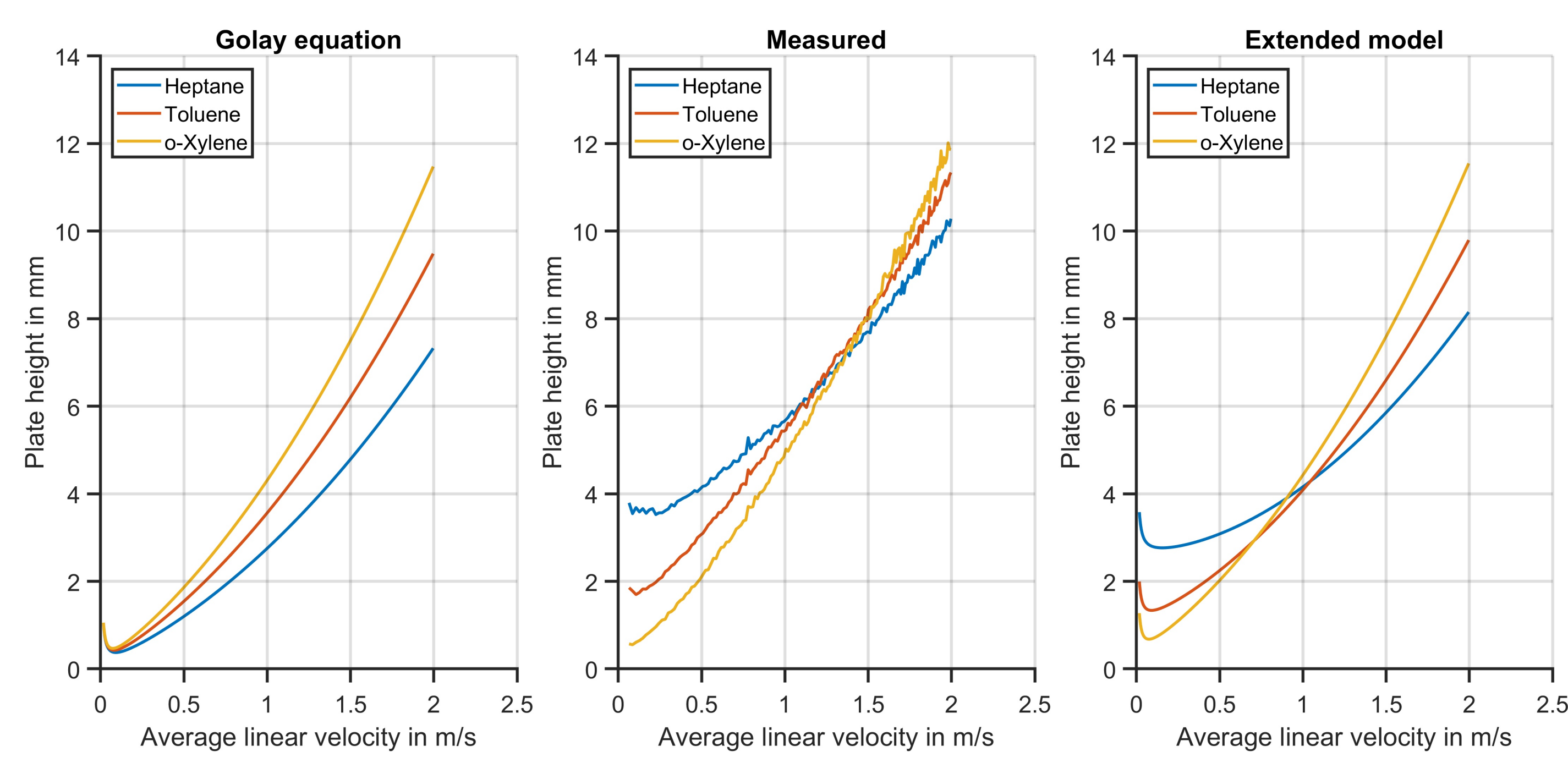
- » Adds a new term  $V$  to the plate height  $H$
- » New term can be divided into three parts:
  - » 1: Relation between IMS volume  $V_{ims}$  and column volume  $V_{col}$
  - » 2: The retention coefficient  $k$  of the observed substance
  - » 3: Gas expansion due to thermal expansion caused by the temperature difference  $\Delta T$  between IMS and GC and the pressure correction  $f$  [5]

## $L = 10 \text{ m } C_d = 530 \mu\text{m}$

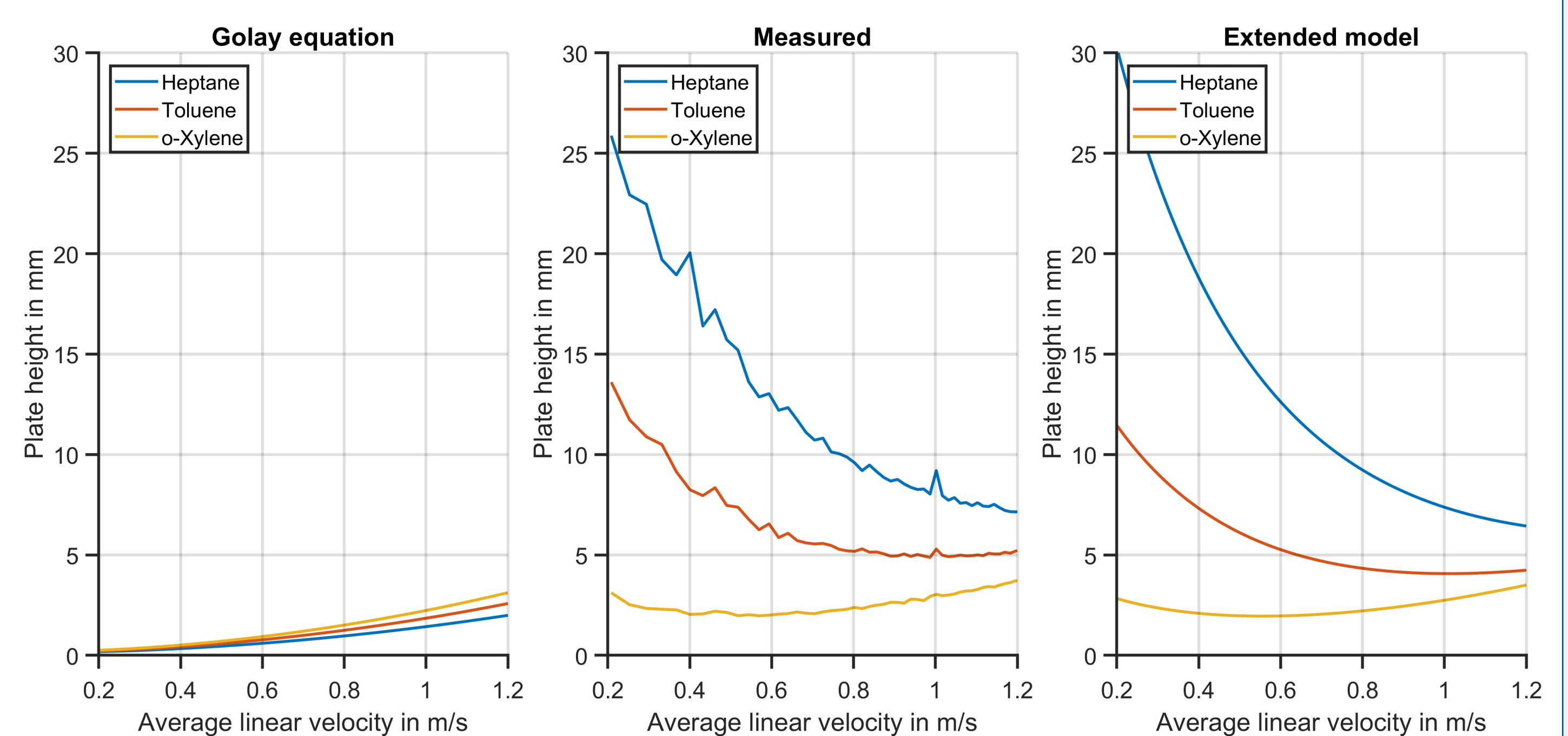


- » Left: expected plate heights from the pressure corrected [5] Golay equation
- » Middle: measurement with an actual GC-column at isotherm 70°C and the IMS as detector
- » Right: expected plate heights from the extended Golay equation including the new term  $V$

## $L = 30 \text{ m } C_d = 530 \mu\text{m}$

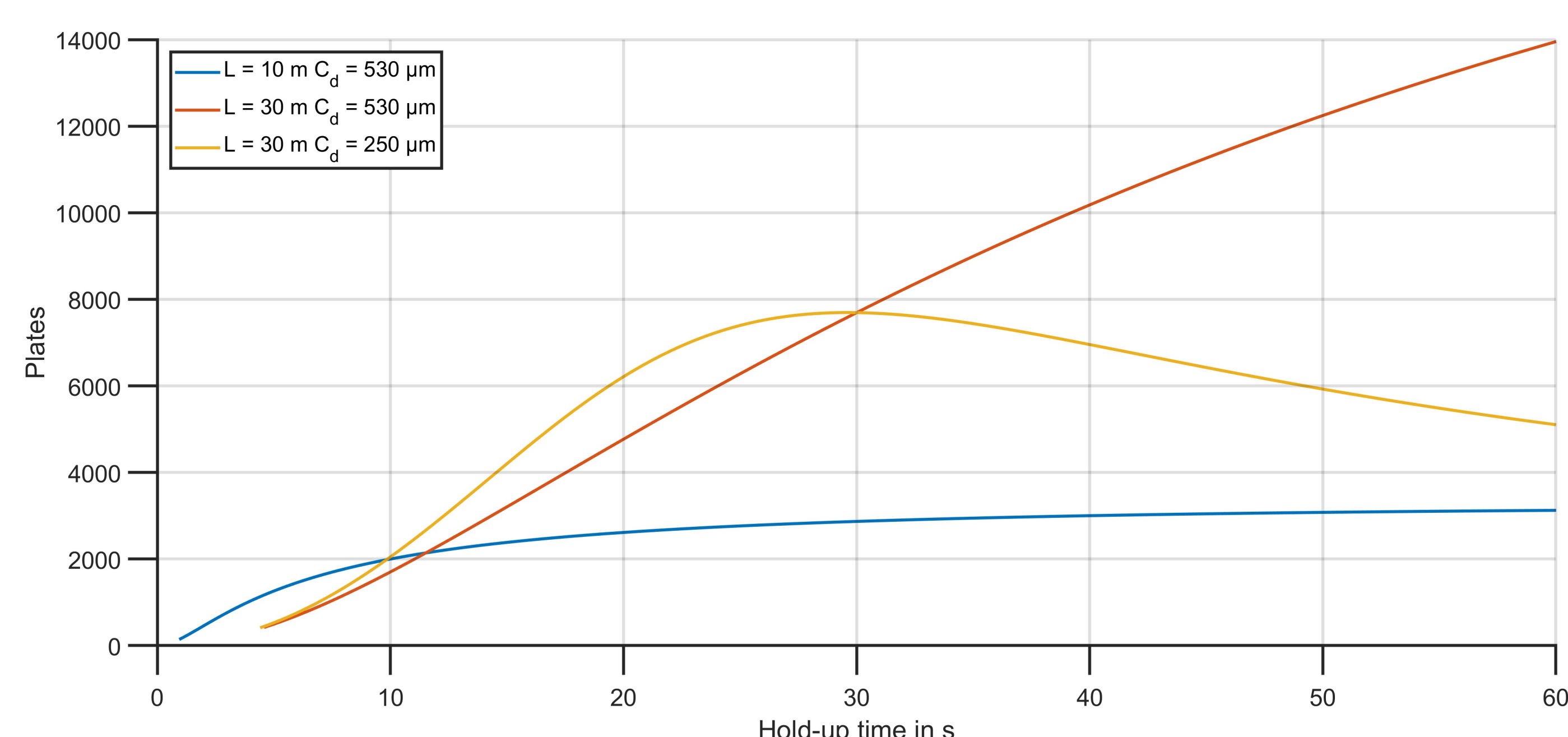


## $L = 30 \text{ m } C_d = 250 \mu\text{m}$



- » For a small column volume, plate heights are dominated by the influence of the new term  $V$

## Direct Comparison of the Three Columns



- » Greater column lengths  $L$  add significant plates at higher hold-up times
- » Smaller column diameters  $C_d$  result only in small improvements

## Acknowledgments & References

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