

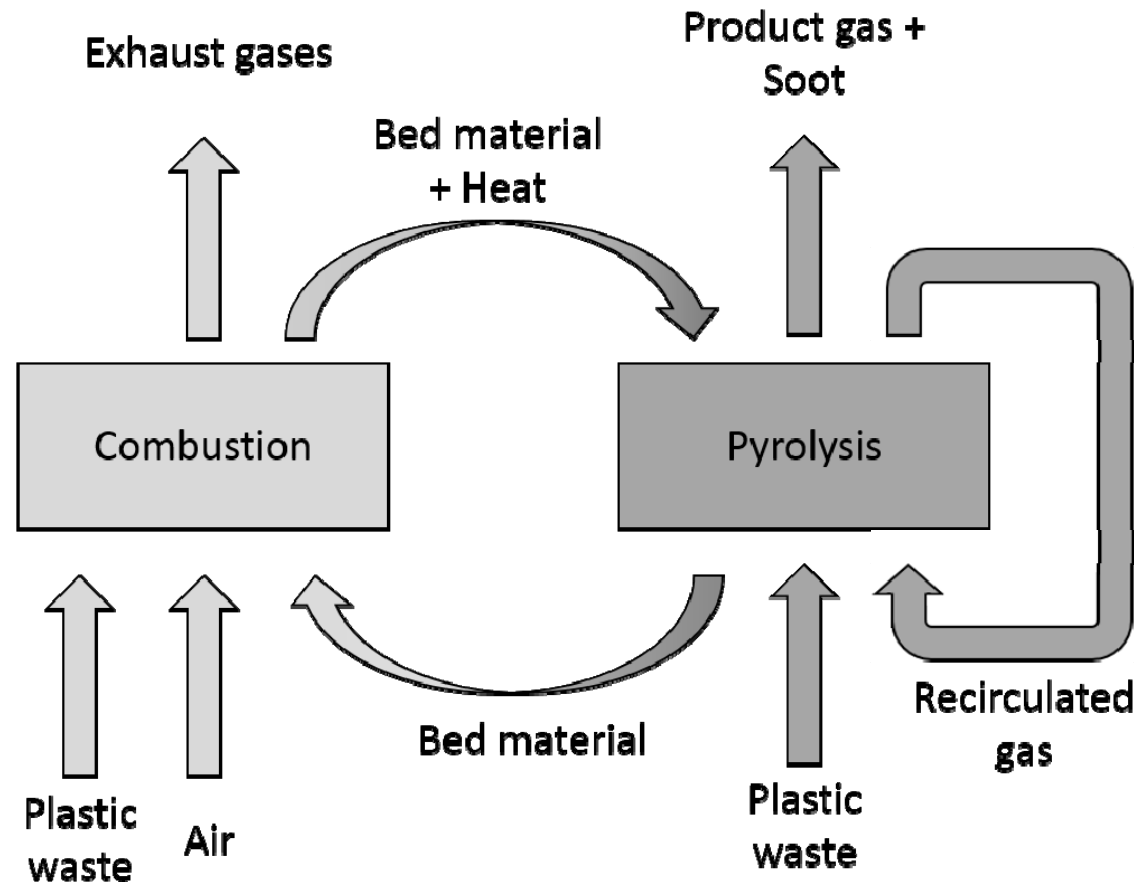
Universität für Bodenkultur Wien
**University of Natural Resources and
Life Sciences, Vienna**

Particle Residence Time Measurement in a Dual Fluidized Bed Pyrolysis Unit

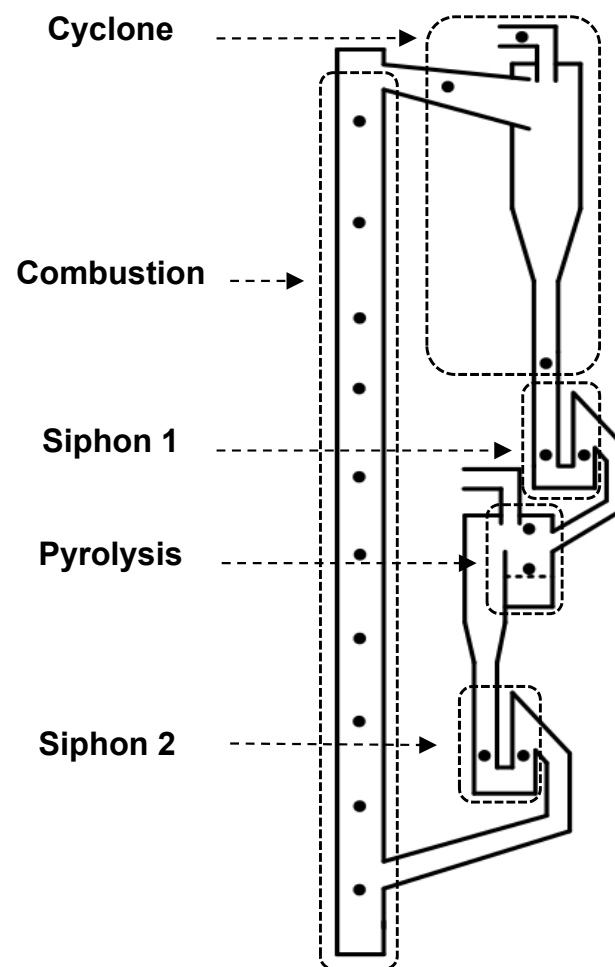
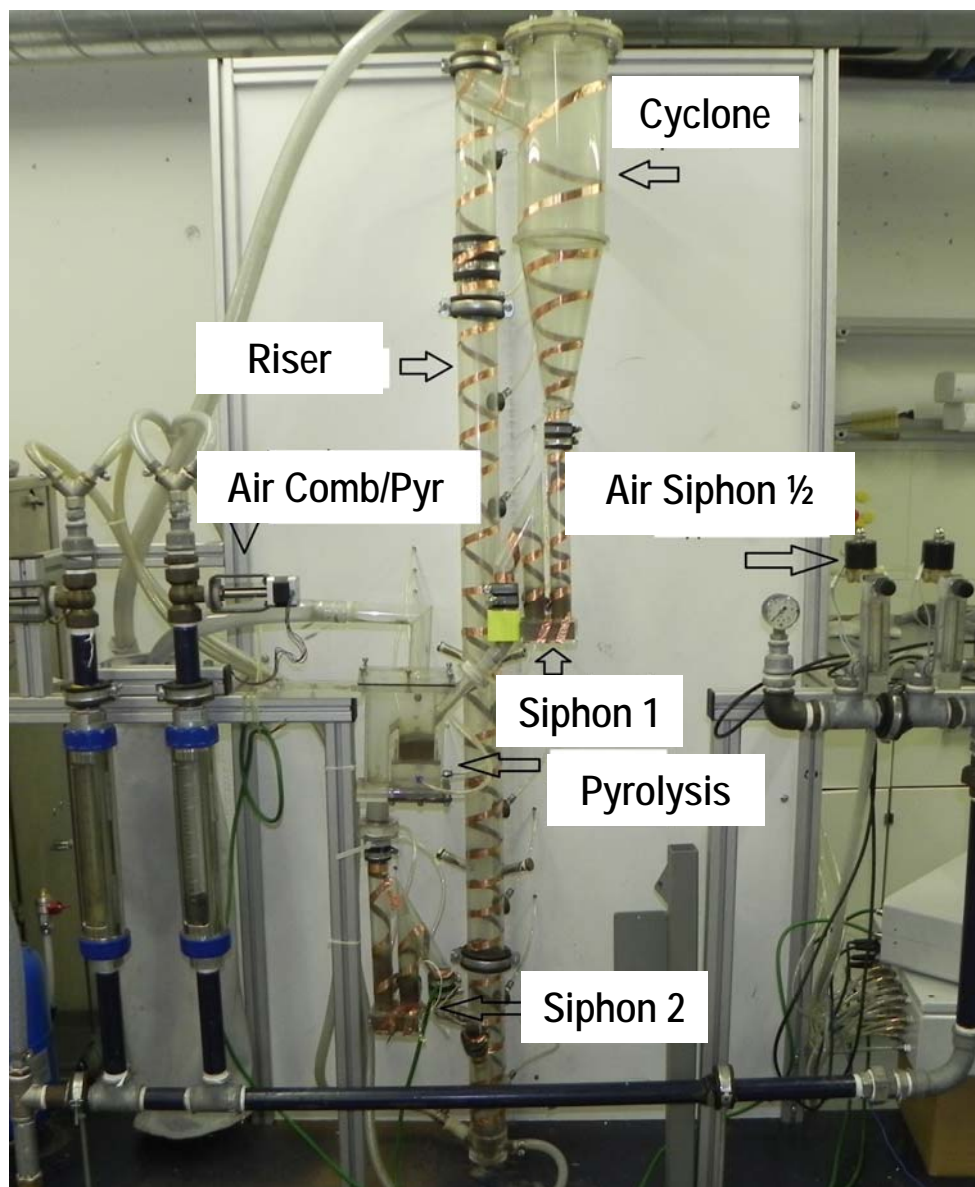
Christoph Pfeifer



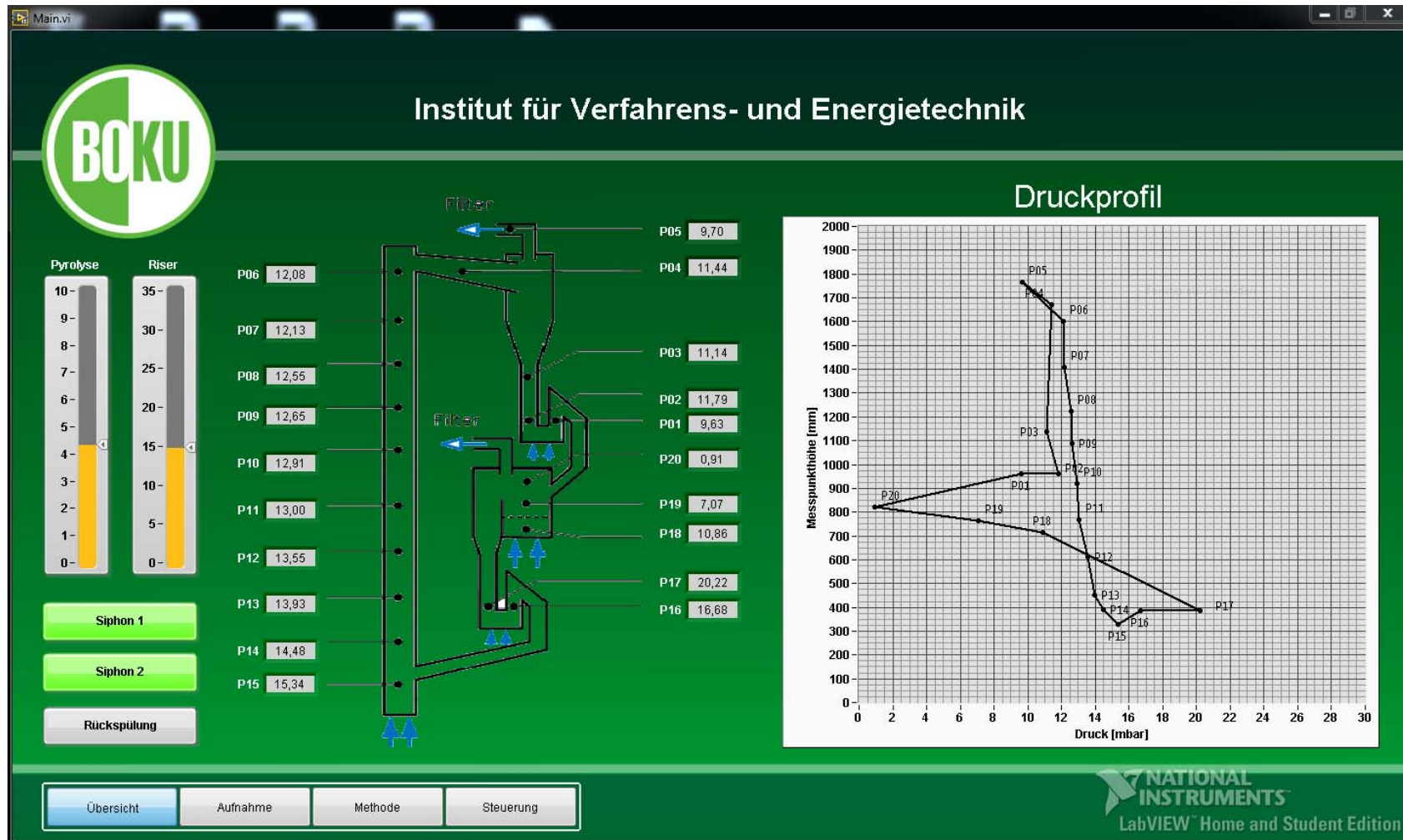
Dual fluidized pyrolysis process



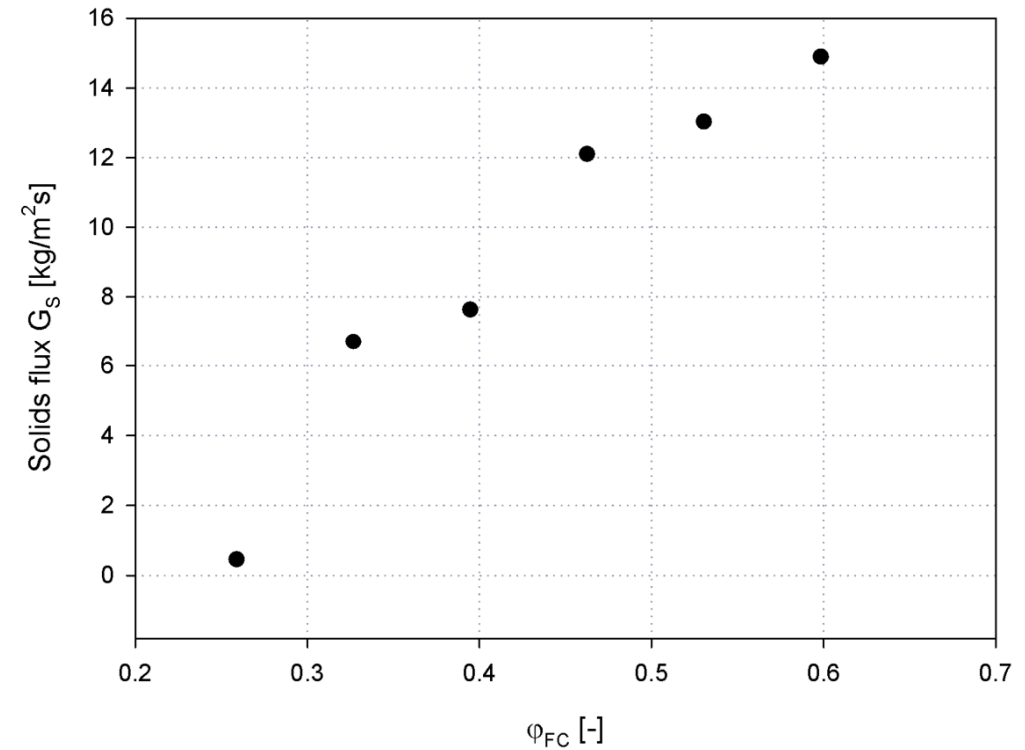
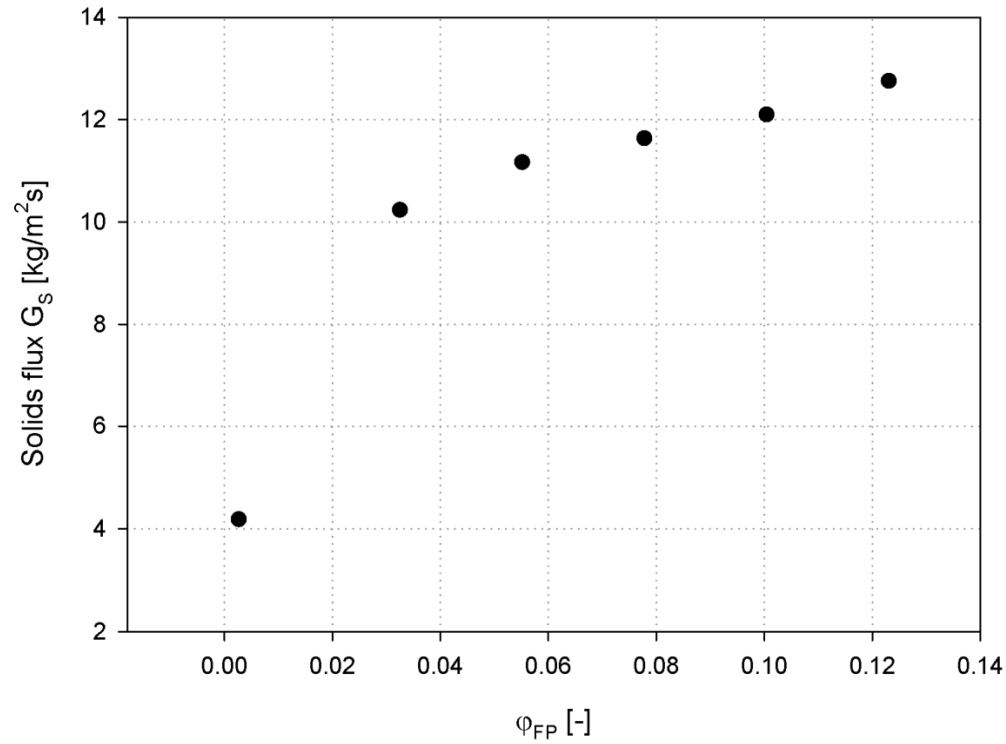
The cold flow model I



Automation System II



Solid flux vs. fluidization rate



$$\phi_F = \frac{U - U_{mf}}{U_{se} - U_{mf}}$$

Residence time distribution

■ Magnetic tracers

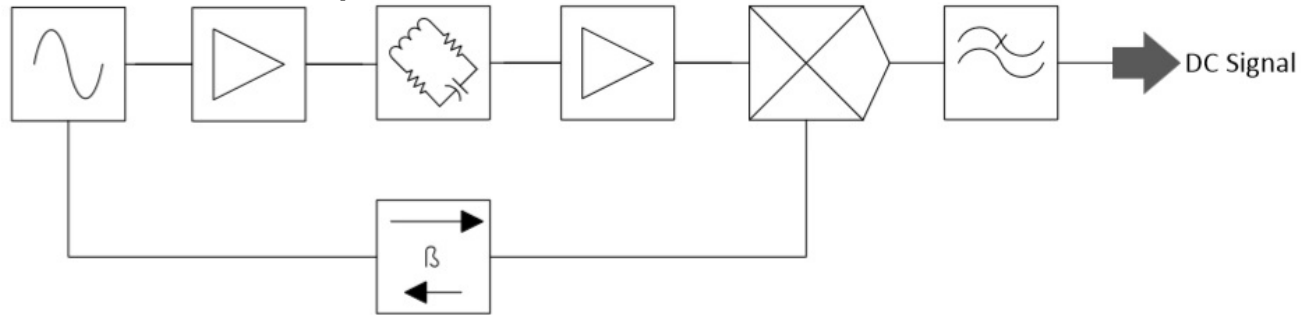
- Ferromagnetic particles do not require special handling, nor are they toxic
- The density and size can be modified
- Temperature has only a slight influence
- The magnetic properties do not change
- The particles can be easily separated from the bed material by means of magnets

Guio-Perez, DC; Proll, T; Wassermann, J; Hofbauer, H. Design of an Inductance Measurement System for Determination of Particle Residence Time in a Dual Circulating Fluidized Bed Cold Flow Model. *Ind.Eng.Chem.Res.* 2013; 52(31): 10732-10740

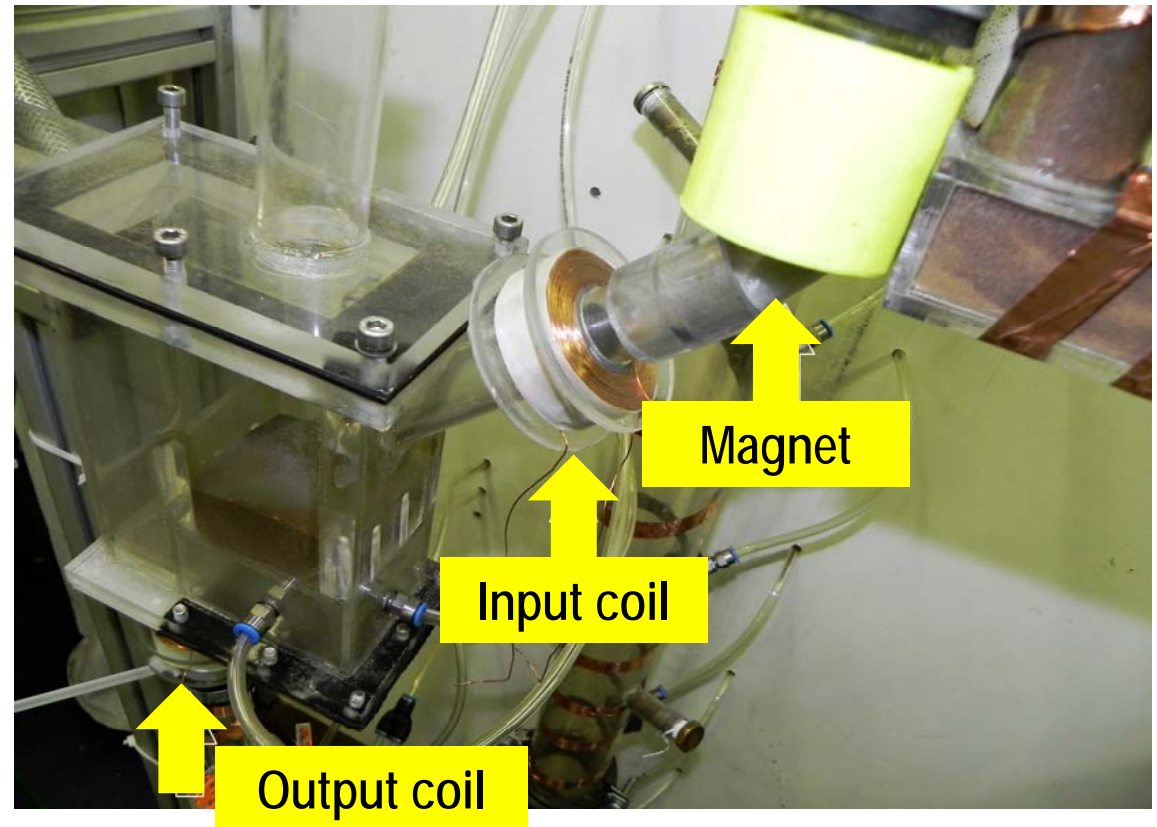
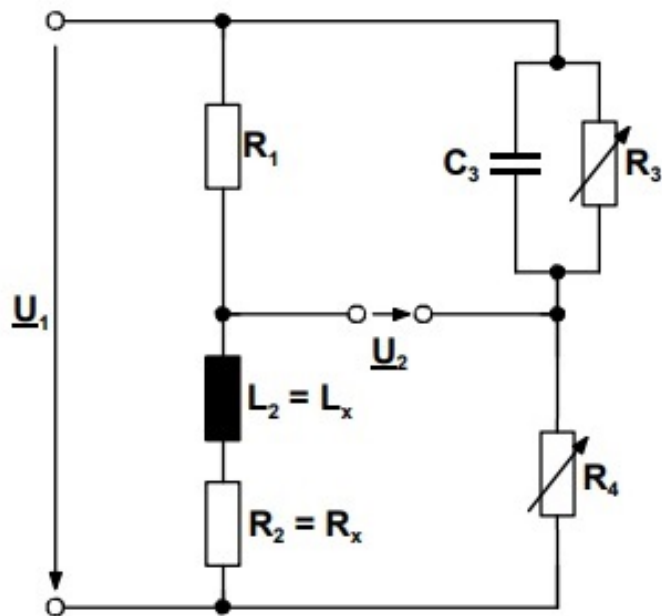
Hofer, G; Marzinger, T; Eder, C; Proll, F; Proll, T. Particle mixing in bubbling fluidized bed reactors with continuous particle exchange. *Chem.Eng.Sci.* 2019; 195: 585-597

Residence Time Measurement

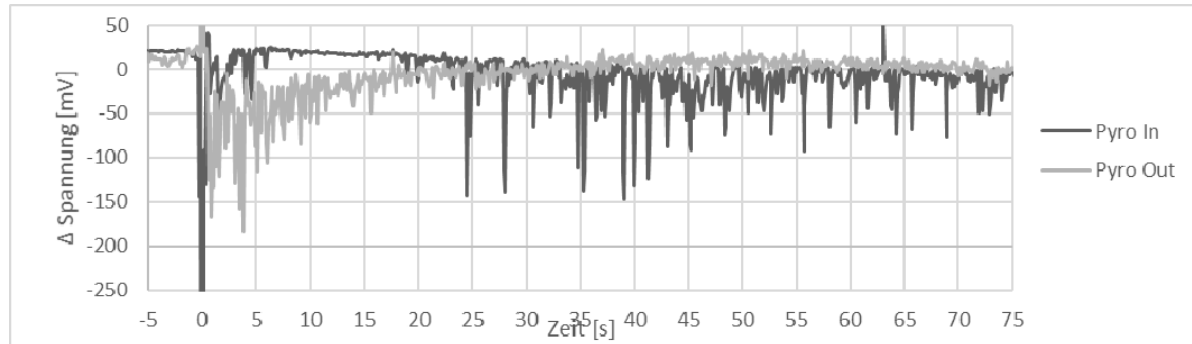
Measurement setup



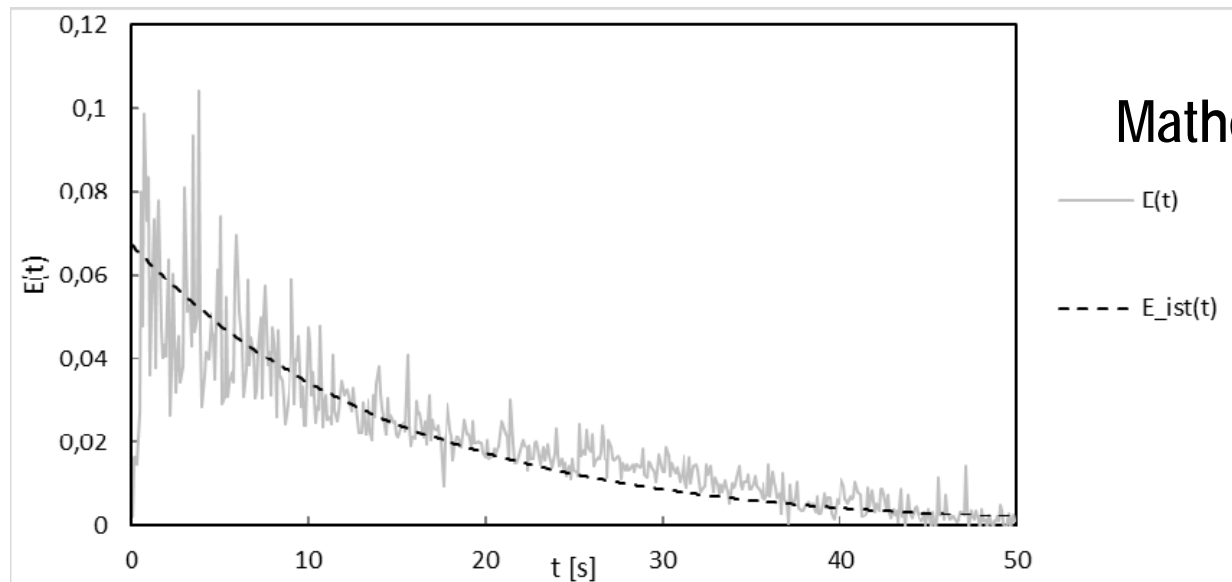
Measuring bridge



Residence Time Distribution



Measurement signal



Mathematical model

plug flow:

$$E(t) = \delta(t - \tau)$$

ideally mixed stirred tank:

$$E(t) = \frac{1}{\tau} e^{-t/\tau}$$

Residence time in the pyrolysis unit

Bed material: bronze powder $d_{sv} = 0.129$ mm
 Tracer material: Fe-powder $d_{sv} = 0.107$ mm

Volume flow pyrolysis (BFB)	Volume flow combustion (CFB)	Solid flux	Residence time measured
[Nm ³ /h]	[Nm ³ /h]	[kg/m ² s]	[s]
3	22	70.1	14.7
4	22	75.9	12.7
5	22	79.9	10.2

Conclusions

- All devices are installed externally – no change of the geometry of the cold flow model
- The system is relatively sensitive – further optimization needed
- Investigations to use it for hot modules as next step

Questions?

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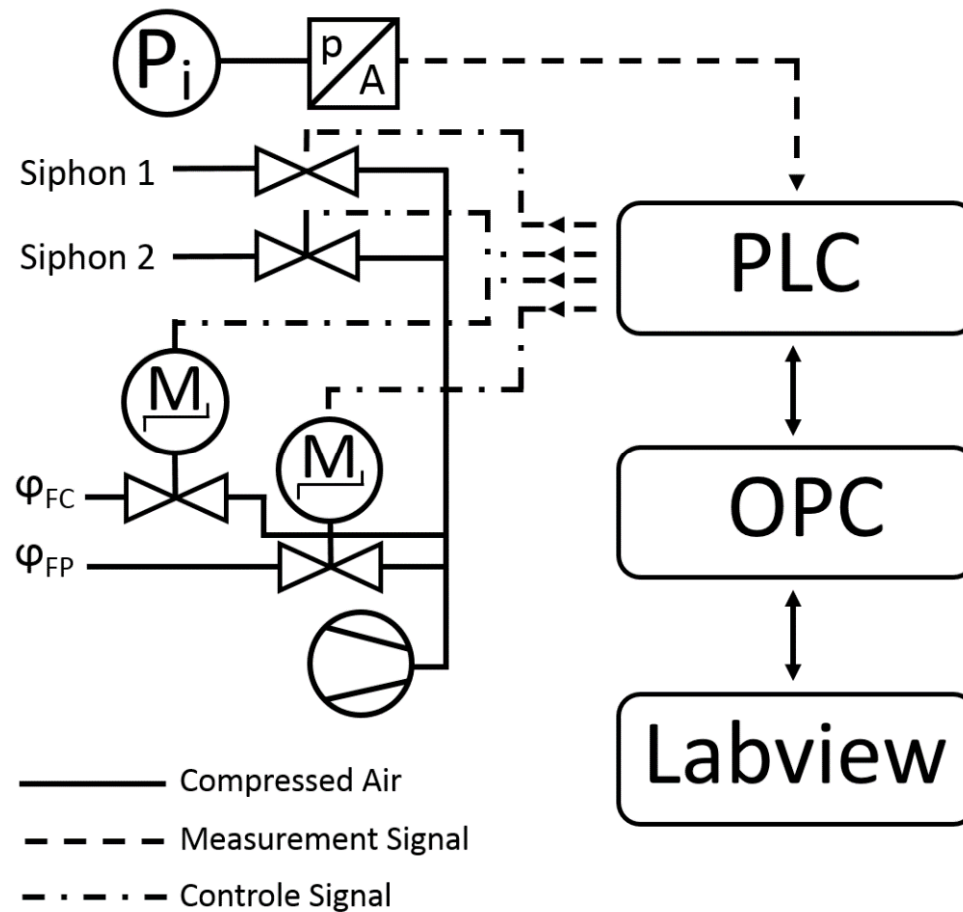
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Automation System I



Pressure profile in the system

