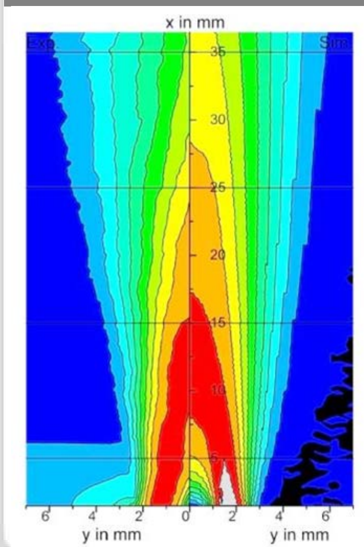
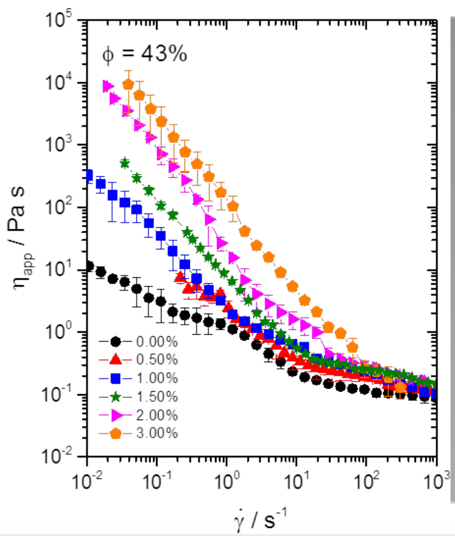
Zerstäubung von biosyncrude

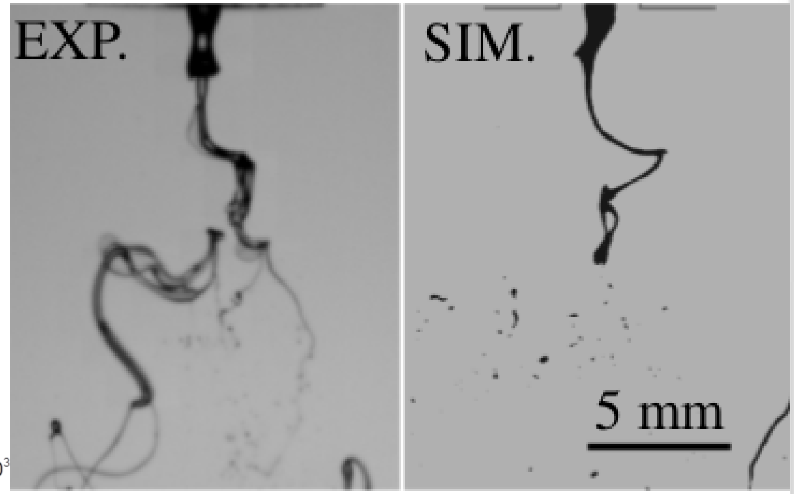
(Begleitforschung bioliq® 2)

KIT (ITC, EBI, ITS, MVM)

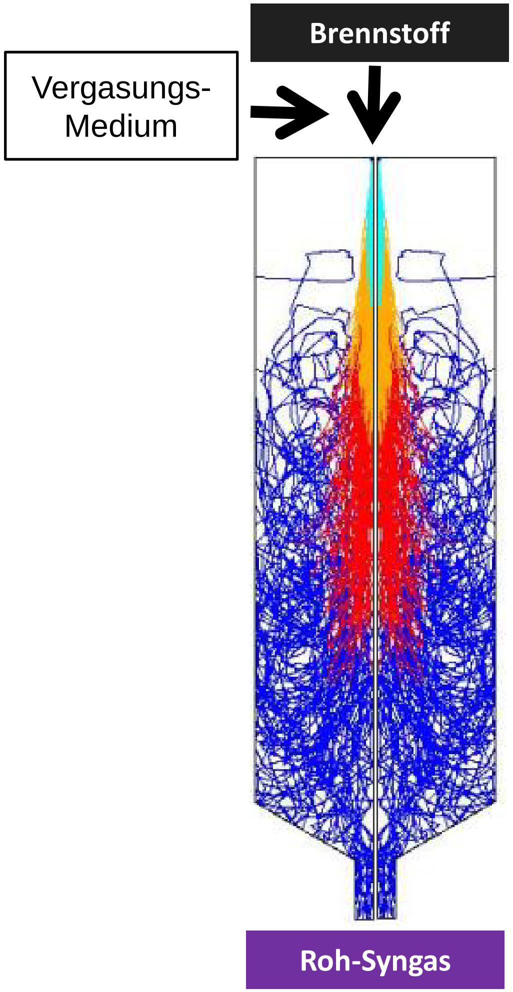
Tobias Jakobs





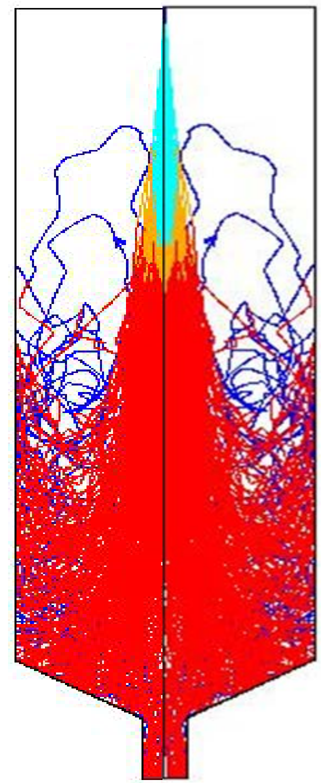


Prozessschritte der Flugstromvergasung

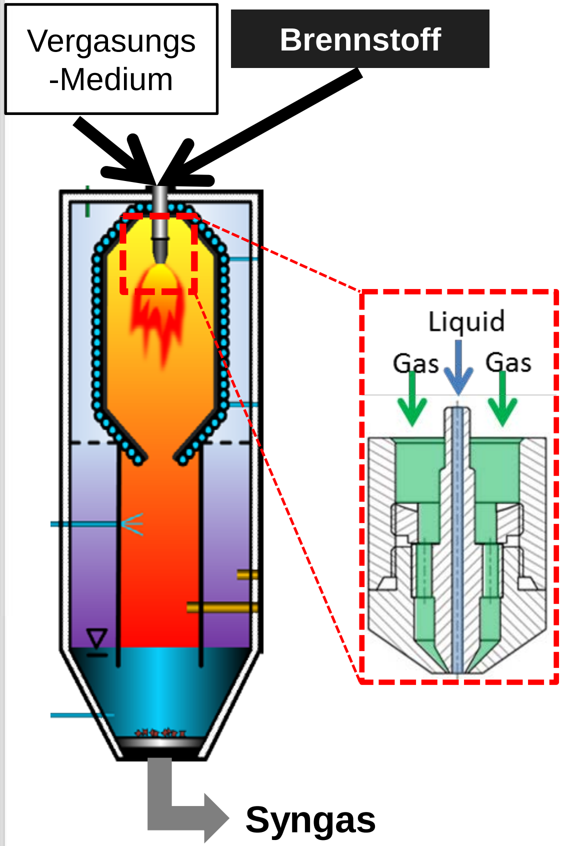


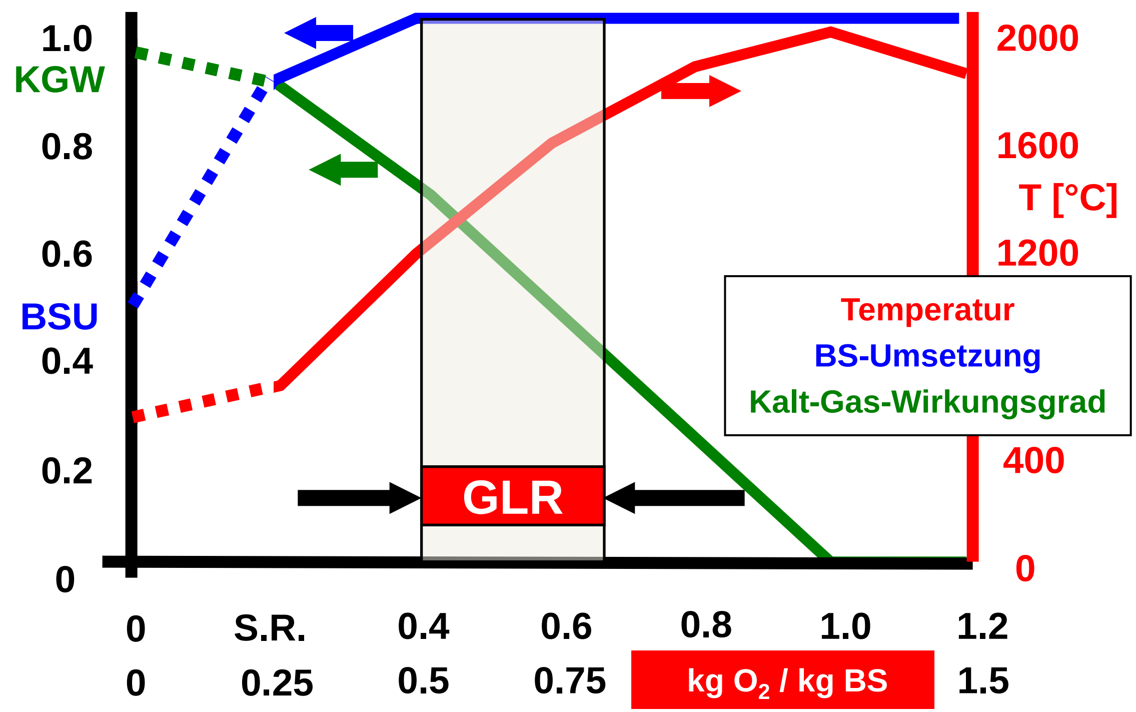
Prozessschritte:

- Zerstäubung
- Verdampfung
- Partikelaufheizung
- Vergasungsreaktionen
- Inertmaterial (Asche, Schlacke)



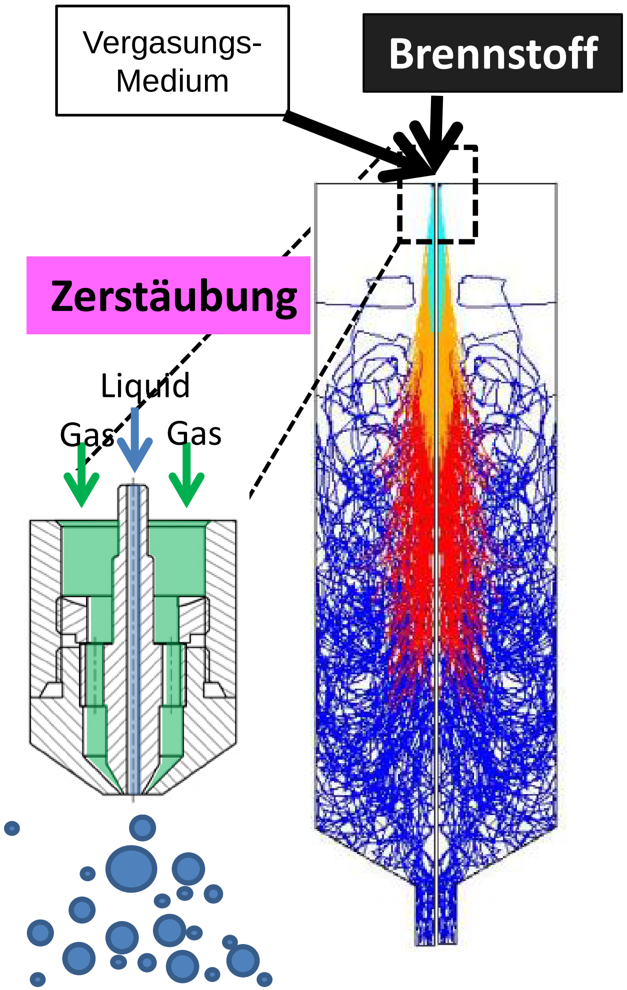
Zerstäubung ↔ Vergasung





$$GLR = \frac{\dot{M}_{Gas}}{\dot{M}_{Liq}} = \frac{\dot{M}_{Oxidizer}}{\dot{M}_{Fuel}} \propto S.R.$$

Forschungsgruppe Zerstäubung



Experiment

Rheologie

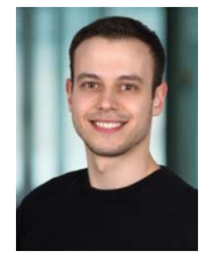
Simulation

ITC

T. Jakobs

A. Sänger

MVM



L. Jampolski

EBI

T. Müller

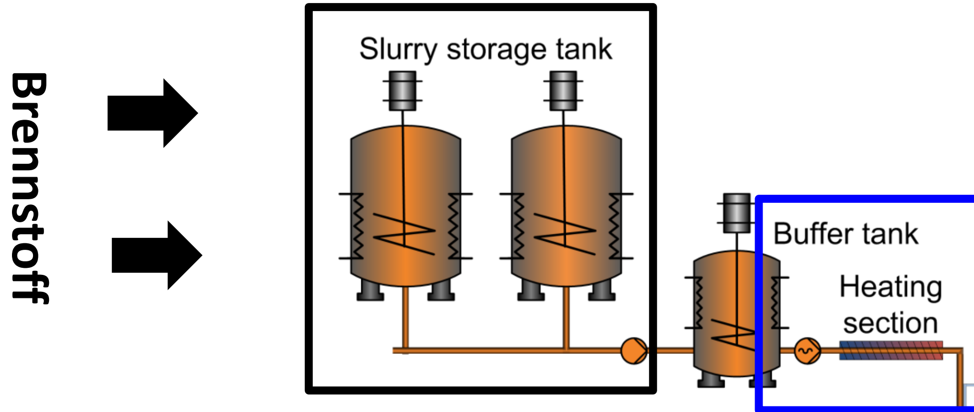
ITS

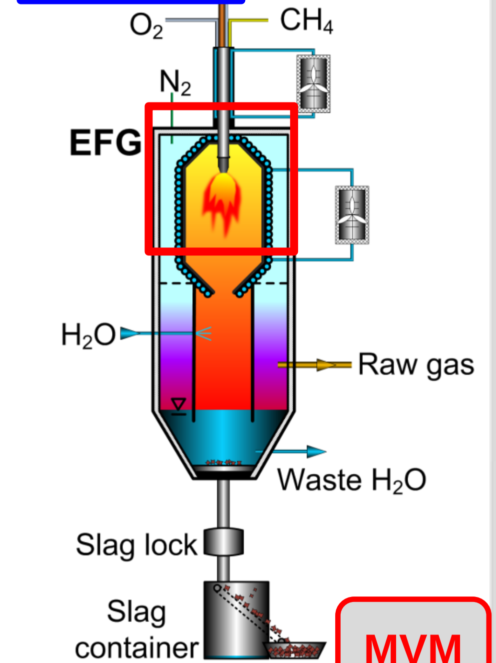
G. Chaussonnet

→ Brennerentwicklung & Modellierung der Zerstäubung

Rheologische Untersuchung biosyncrude

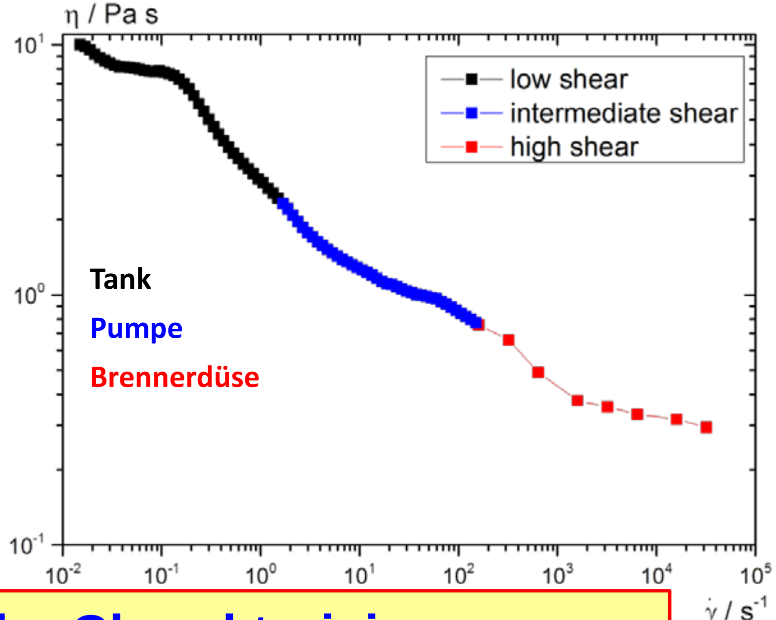
biosyncrude:





Rheologische Eigenschaften:

- Fließverhalten
- Viskosität (bis zu 10 Pa·s)



➔ Rheologische Charakterisierung

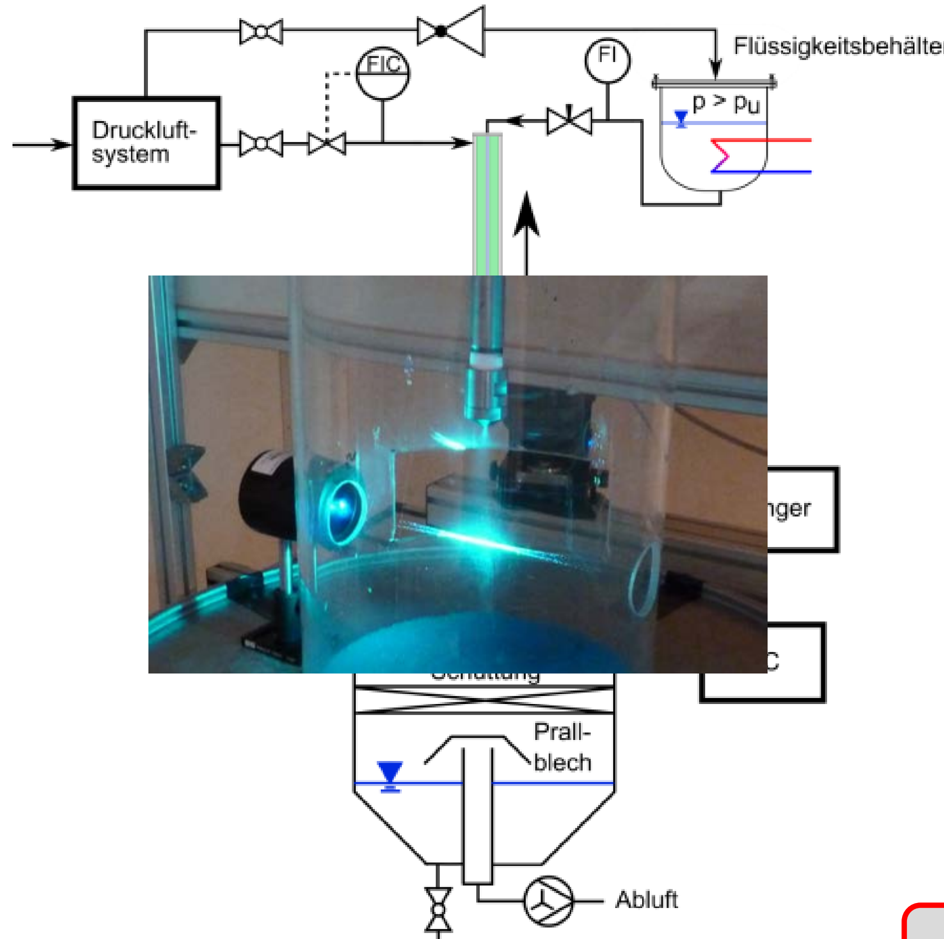
MVM

Versuchsanlage – ATMO

Technische Daten:

- **$p = 1\ bar_{abs}$**
- **$\eta_{liq,max} = 1000\ mPa\ s$**
- $T_{liq} = 10 – 50\ °C$
- $\dot{m}_{gas} = 1 – 20\ kg\ h^{-1}$
- $\dot{m}_{liq} = 1 – 20\ kg\ h^{-1}$

- geeignet für Suspensionen
- Verschiedene Düsen



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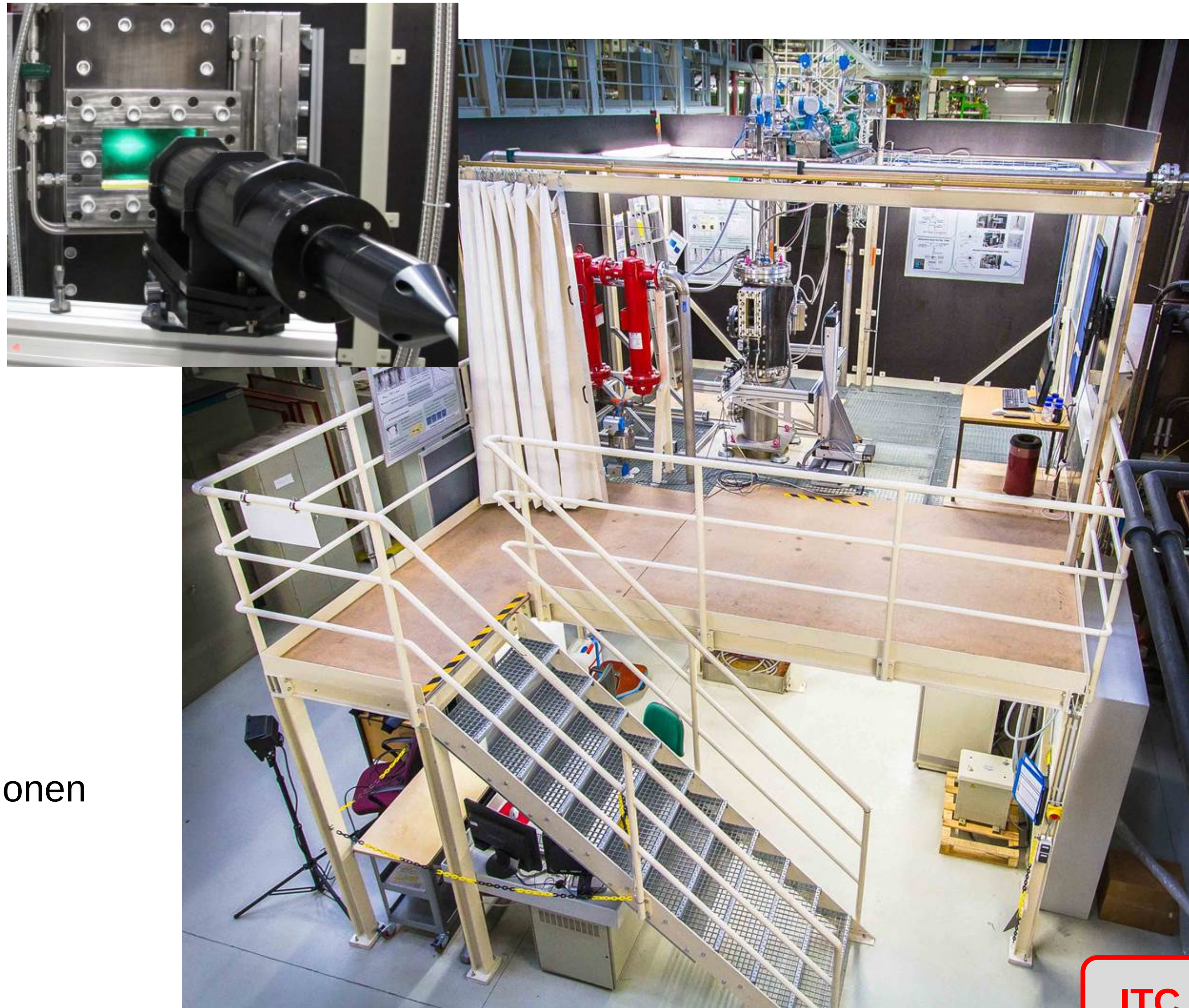
Versuchsanlage – PAT



Technische Daten:

- **p_{reac} = 1 – 21 bar_{abs}**
- **$\eta_{liq,max}$ = 1000 mPa s**
- T_{liq} = 10 – 50 °C
- $\dot{m}_{gas}$ = 1 – 500 kg h^{-1}
- $\dot{m}_{liq}$ = 10 – 200 kg h^{-1}

- 3 optische Zugänge
- Scheibenreinigung
- geeignet für Suspensionen
- Verschiedene Düsen

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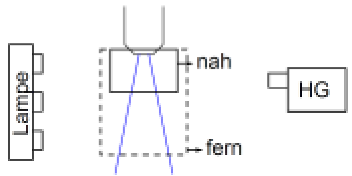
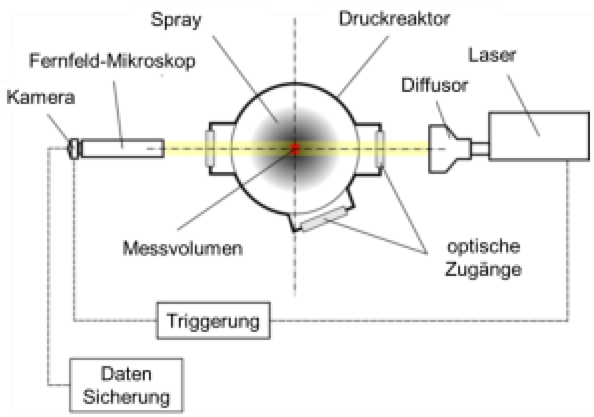
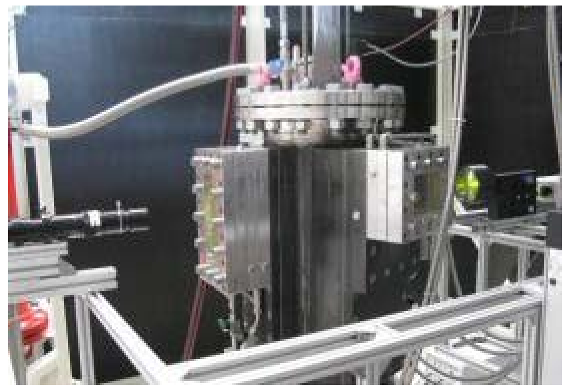
Eingesetzte Messtechnik

High Speed Camera

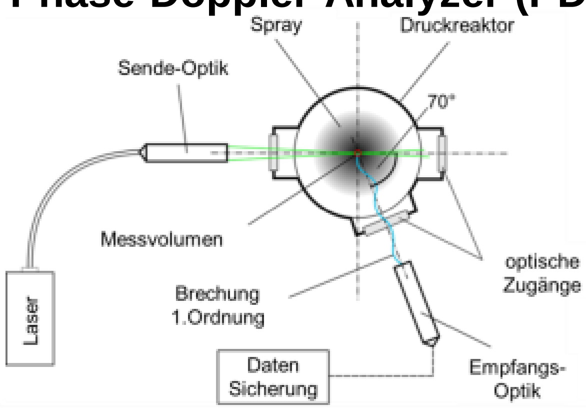


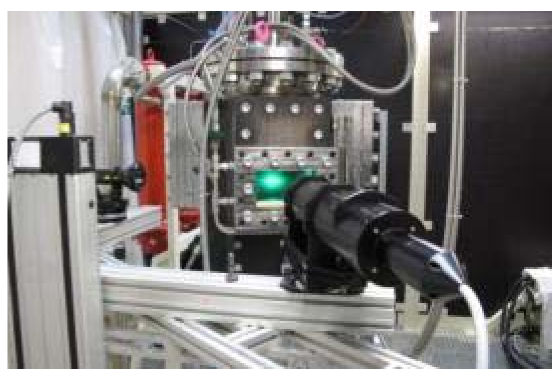
Shadow-Sizer

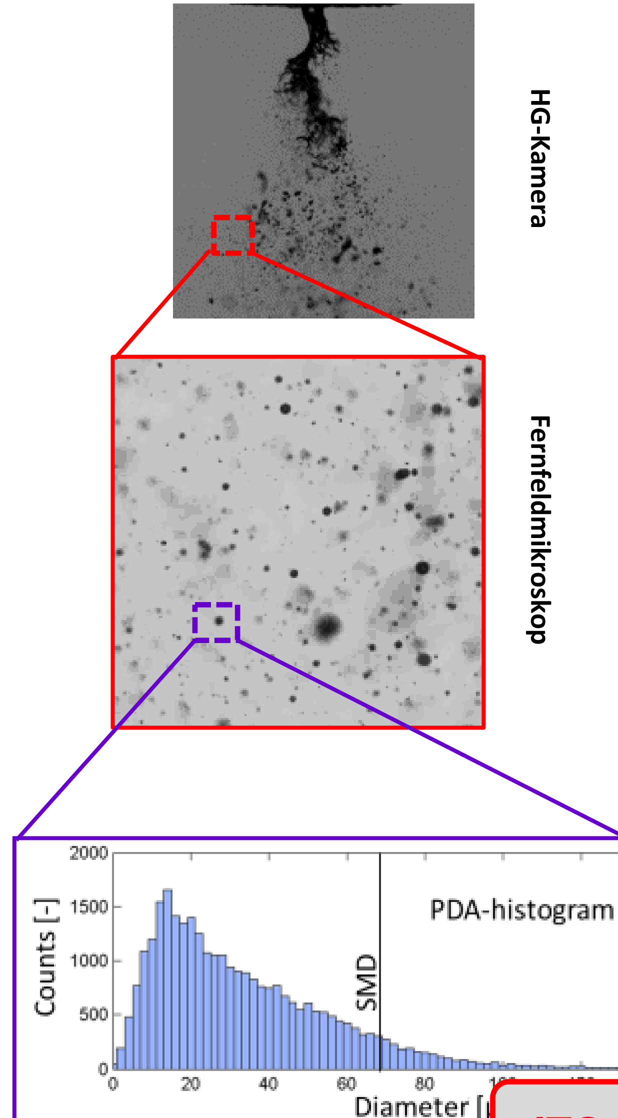




Phase-Doppler-Analyzer (PDA / LDA)







Lokale TGV

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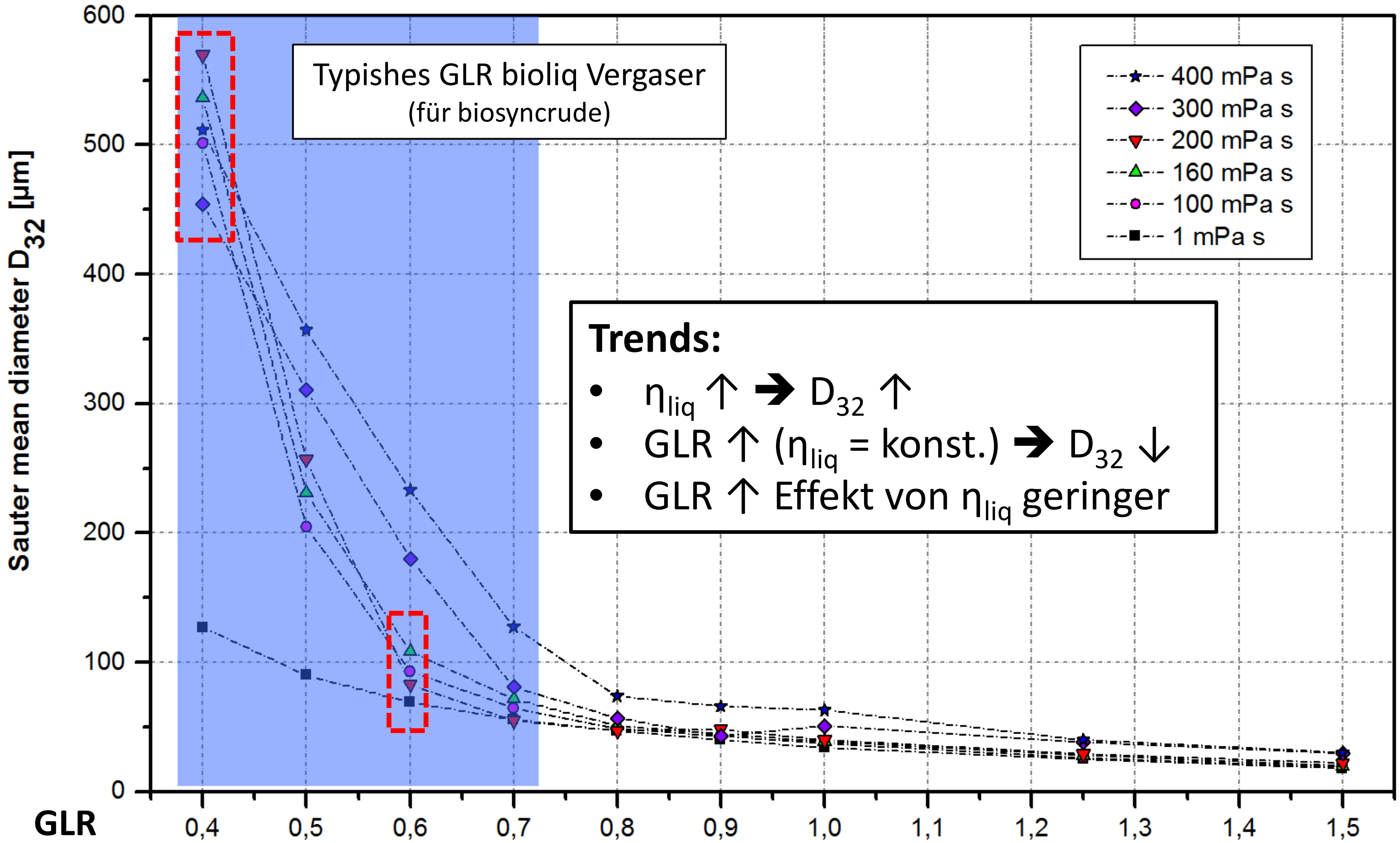
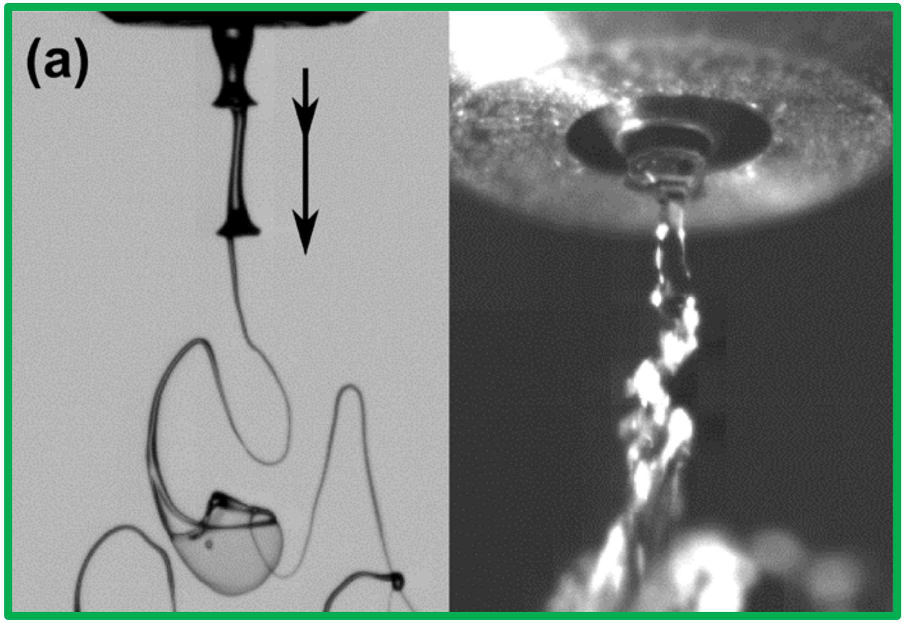
Tropfengröße als Fkt. der Viskosität

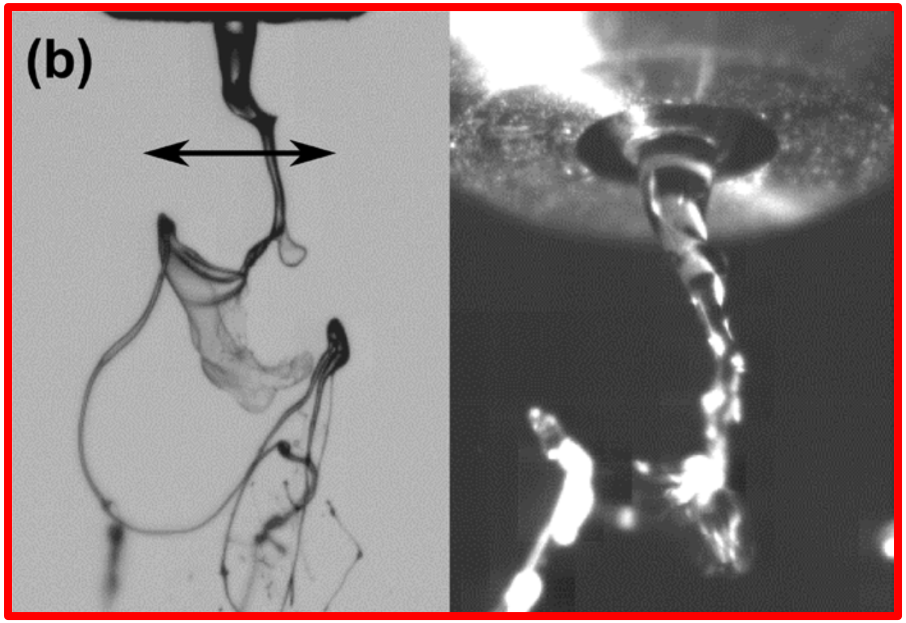


➔ Unerwartetes Verhalten der Tropfengröße

ITC

Primärinstabilitäten „Pulsating / Flapping“



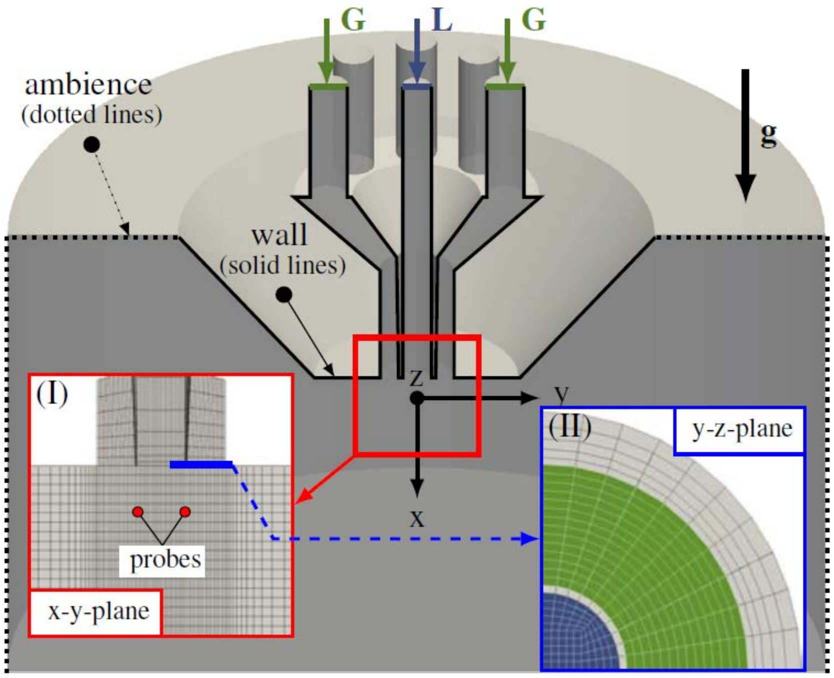


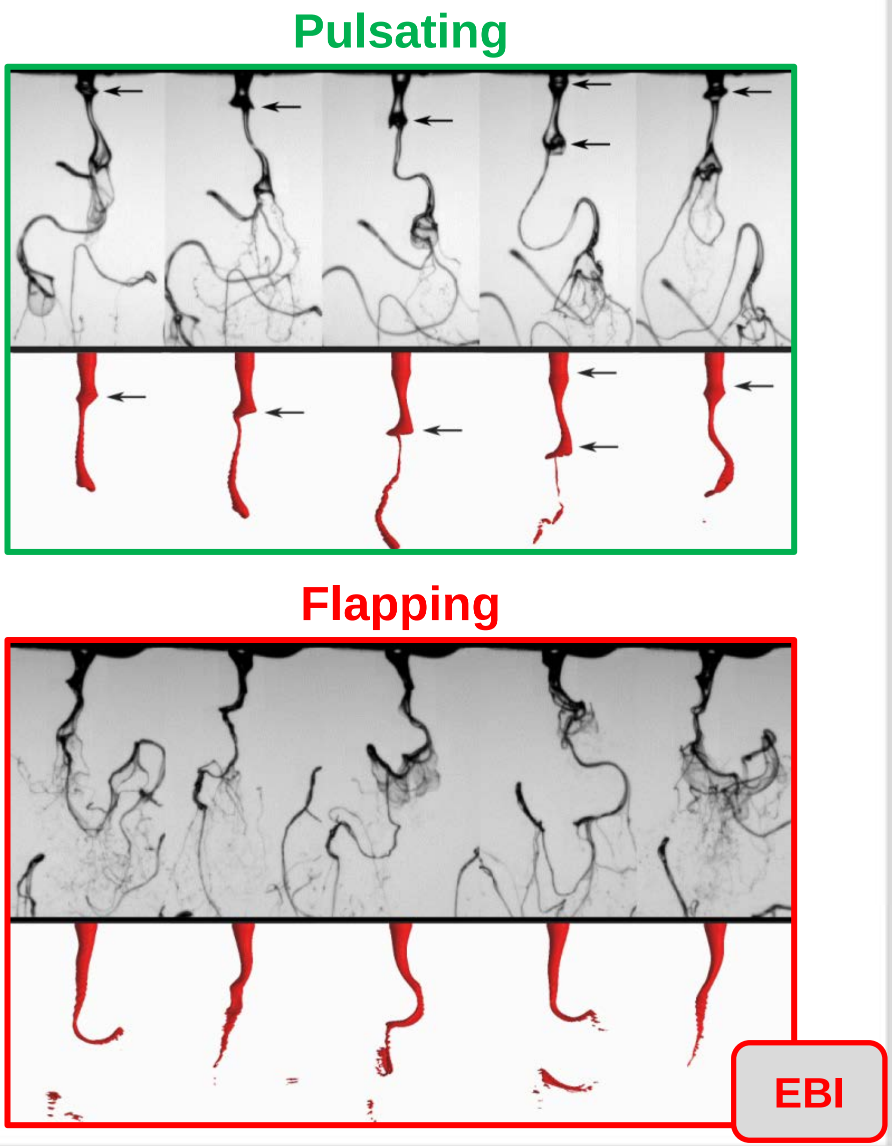
- Hohe aerodynamische Kräfte (GLR > 1.0) → ***Pulsating mode***
- Geringere aerodynamische Kräfte (GLR < 1.0) und η_{liq} < 200 mPa·s → ***Pulsating mode***
- Geringere aerodynamische Kräfte (GLR < 1.0) und η_{liq} > 200 mPa·s → ***Flapping mode***

→ Flapping effektiver als Pulsating

ITC

VoF Modell – Gitter





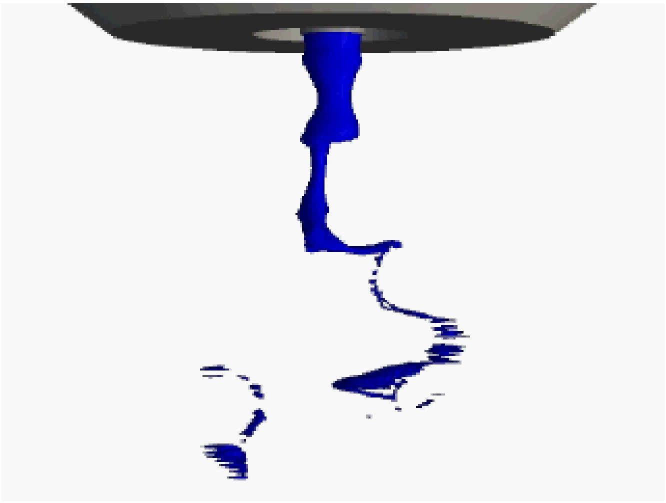
Gitter:

6.6 Millionen Zellen

50 x 50 x 50 µm³

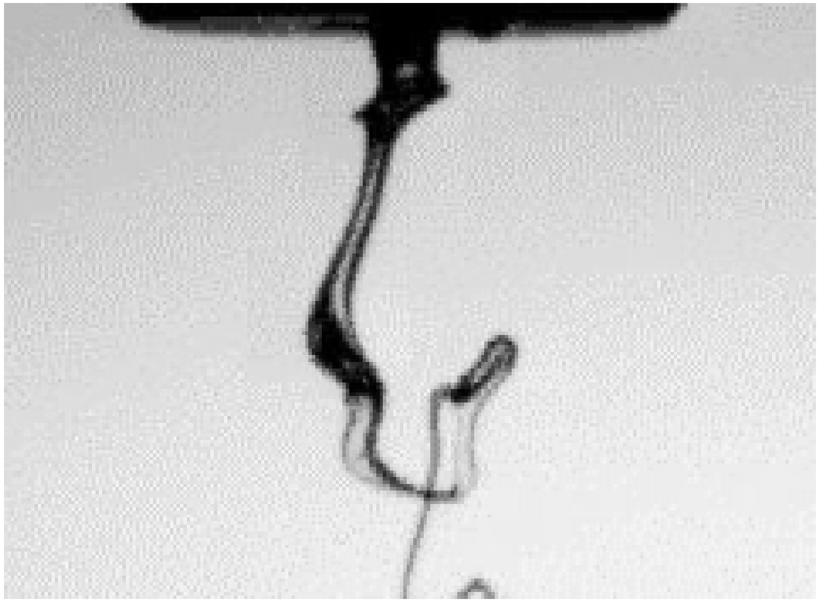
Strahlzerfall VoF / Experiment

Simulation



$f_{primär} = 429\ Hz$

Experiment



$f_{primär} = 426\ Hz$

➔ Gute Übereinstimmung für alle Betriebspunkte

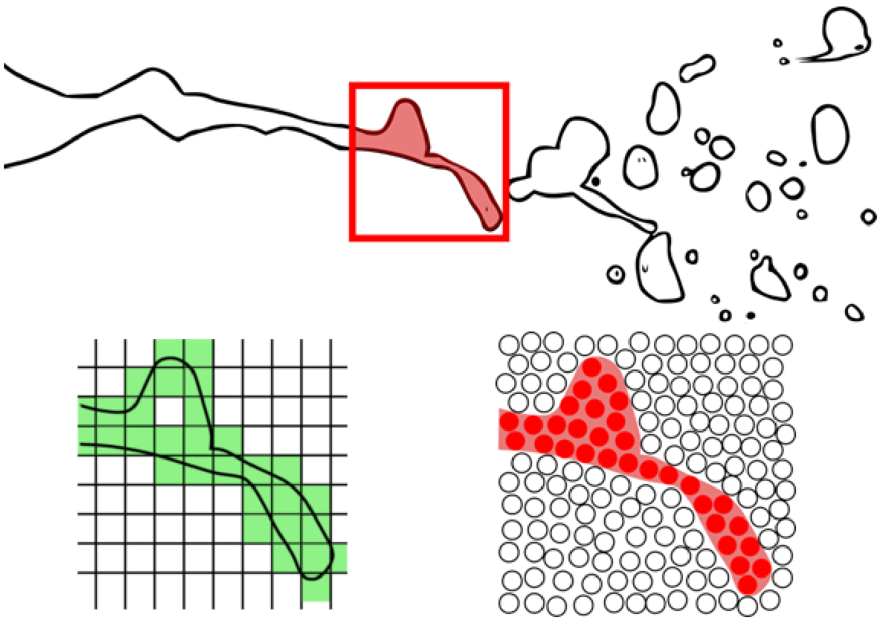
EBI

SPH Methode

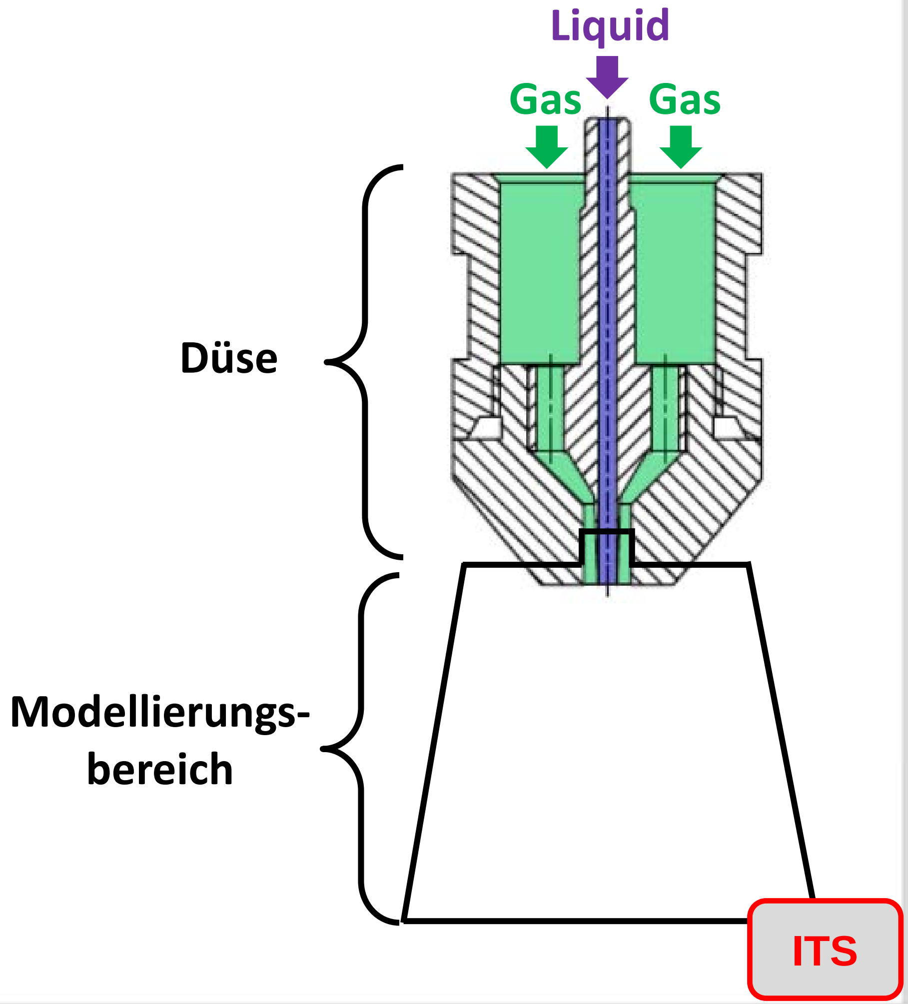
Vorteil: Mehrphasen / Grenzflächen Handling:

➔ Kein Gitter nötig

➔ Grenzfläche automatisch gegeben

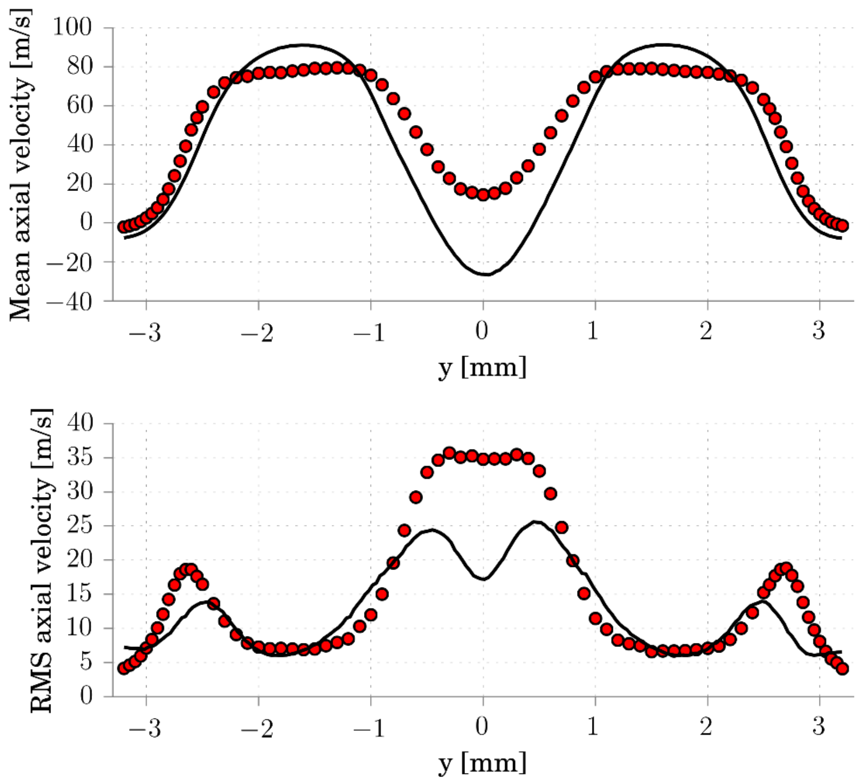


Numerisches Setup



SPH – Ergebnisse

Simulation Gasströmung



➔ Gute Übereinstimmung der Axialgeschwindigkeit

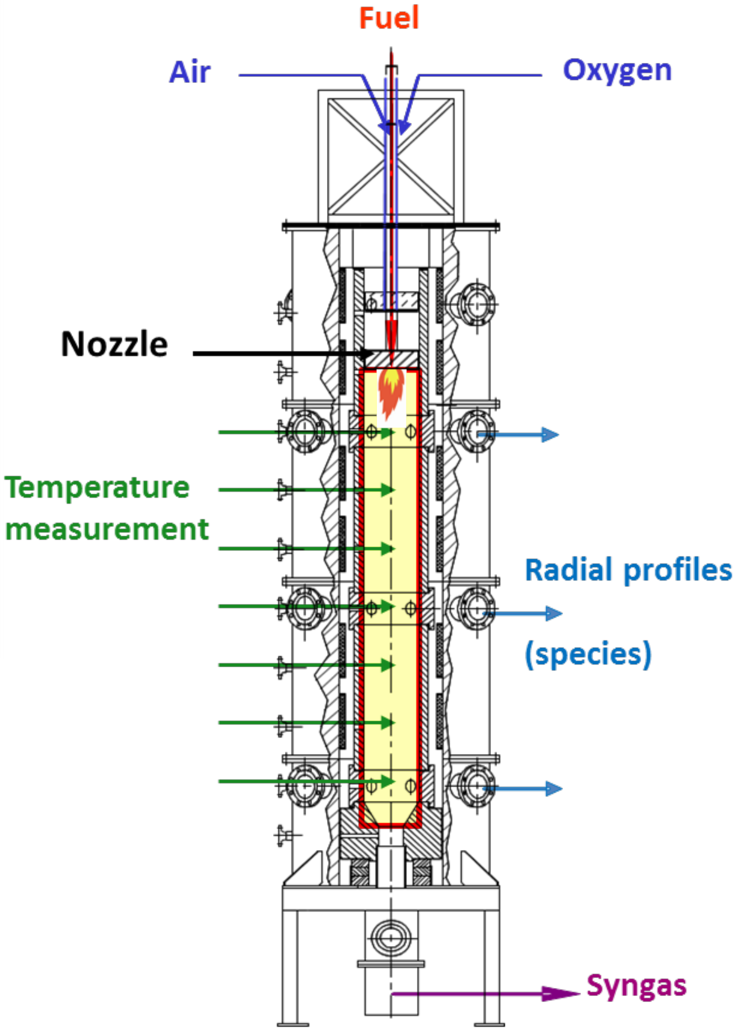
ITS

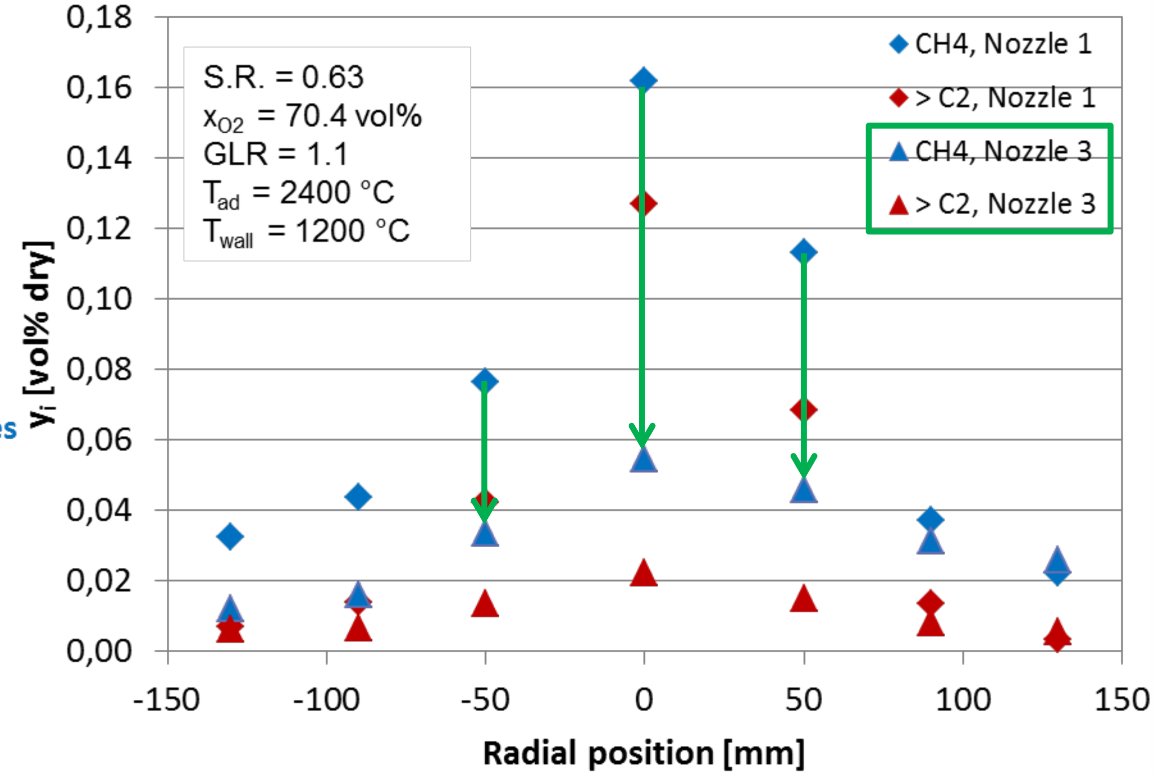
Einfluss Druck – Zerstäubung hochviskos

Karlsruher Institut für Technologie

ITC

Einsatz neuer Brennerdüsen im Vergaser





➔ Verbesserung der Syngas Qualität durch neue Düse

ITC

Zusammenfassung und Ausblick

Zusammenfassung

- Rhelogische Charakterisierung biosyncrude
- Zerstäubung hochviskoser Brennstoffe bei 1 – 21 bar_{abs}
- Numerische Simulation des Strahlzerfalls (VoF / SPH)
- Einsatz Brennerdüsen im Vergaser ➔ Syngas-Qualität gesteigert

Ausblick

- Optimale Sprayqualität für ein breites Brennstoffspektrum

Danke!