BEST
Bioenergy and Sustainable Technologies

Reliability of TGA data for characterization of alternative biomass feedstocks

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Stefan Retschitzegger, Norbert Kienzl, Andrés Anca-Couce, Christos Tsekos, Scott Banks, Tzouliana Kraia, Francesco Zimbardi, Axel Funke, Paula Marques

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BRISK 2
BIOFUELS RESEARCH INFRASTRUCTURE

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  - TGA test
  - Data evaluation
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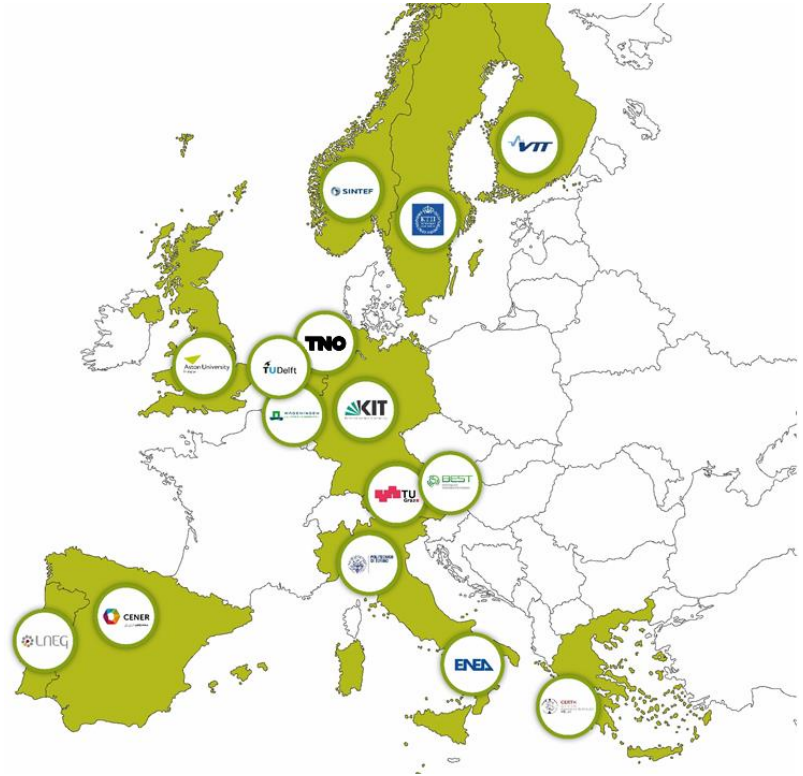
Introduction – BRISK 2

- 15 European partners
- Development of methods and research infrastructure
  - thermochemical and biochemical conversion
  - enhanced measurement techniques
  - new biorefining approaches
  - simulation tools



Introduction – TGA round robin

Potential for future

- Biomass can play a more relevant role in the production of power, liquid fuels or chemicals

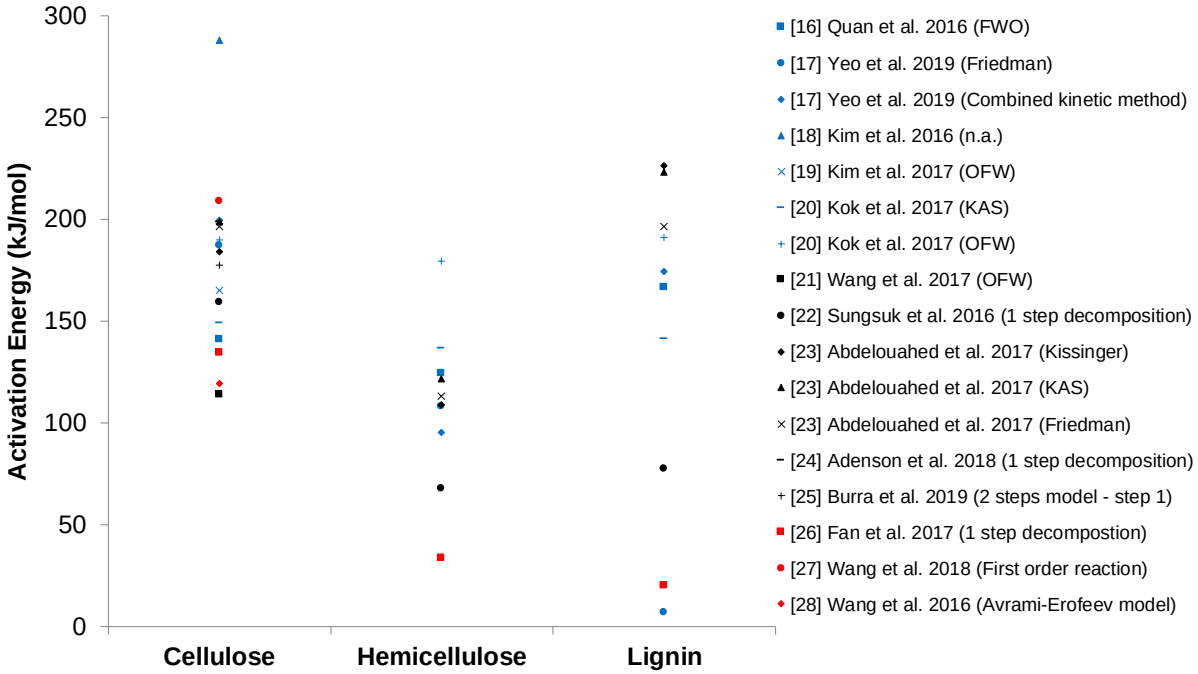
→ Thermo-chemical processes using ligno-cellulosic biomass

Biomass characterisation

- mass loss behaviour is commonly determined by TGA
- TGA results in literature have strong deviations
  - mainly attributed to biomass inhomogeneity
  - impact of institution, operator, equipment, … not known

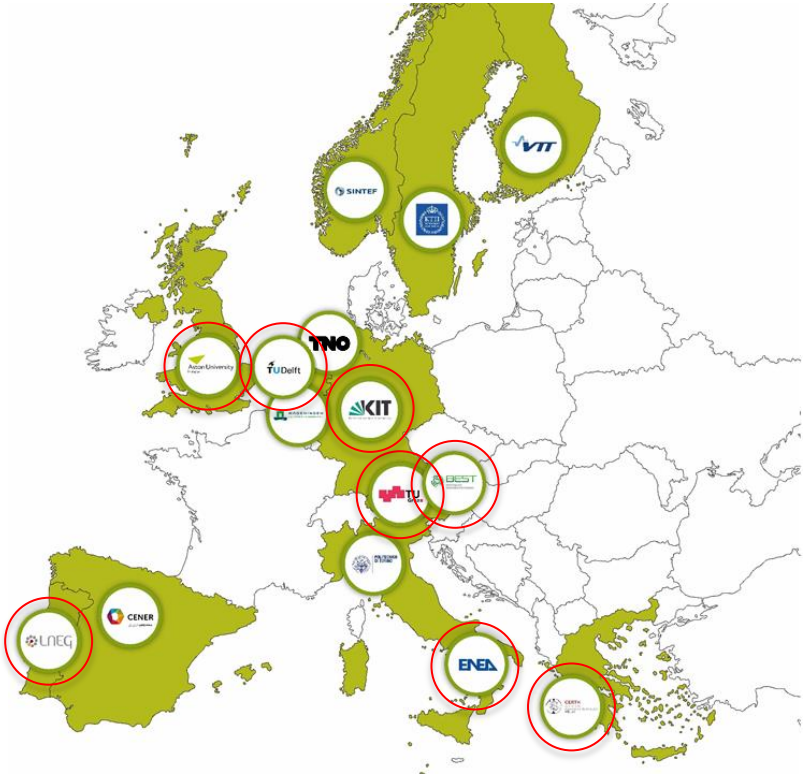
Introduction – TGA round robin

- Variation of data in literature



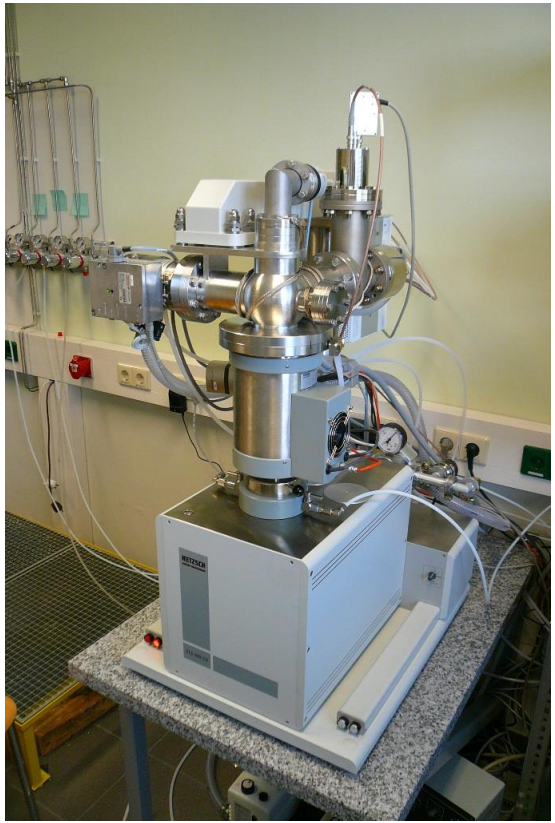
Scope – TGA round robin

- **Investigate the reproducibility of TGA biomass pyrolysis**
- **7 European partners**
- **Eliminate influence of biomass inhomogeneity via homogenized feedstock**
- **Eliminate error from data evaluation → all results evaluated by one partner**



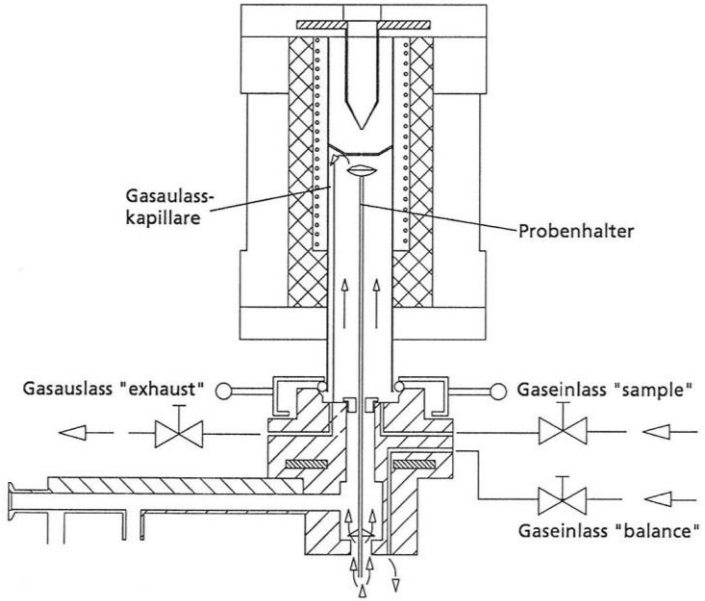
Methodology – TGA round robin

- **Fuels**
  - **Avicel® PH-101 cellulose**
  - **Beech wood**
- **low initial mass sample (ideally of 3 mg)**
- **Pyrolysis from 150 – 500 °C**
- **Detailed handling protocols**

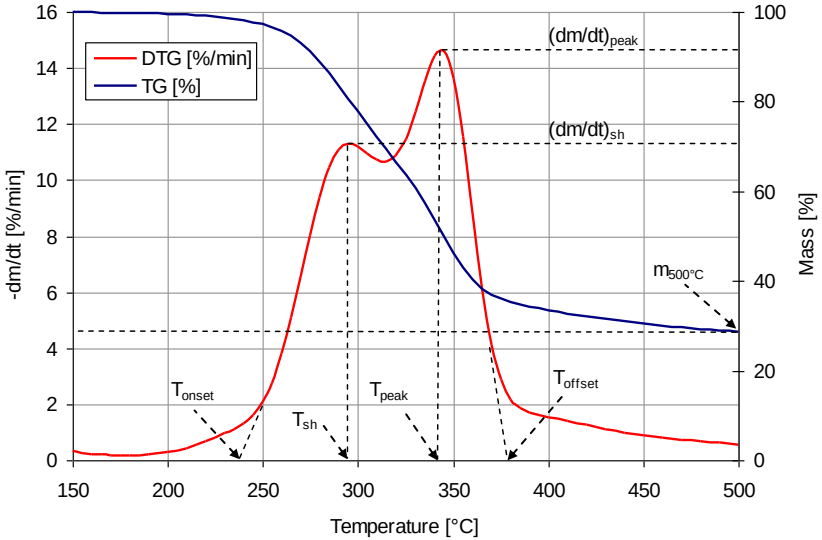


Methodology – TGA

- Scheme of TGA

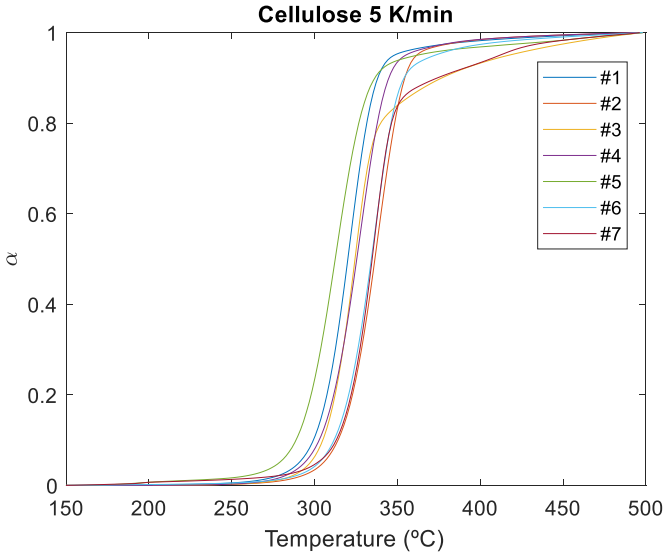


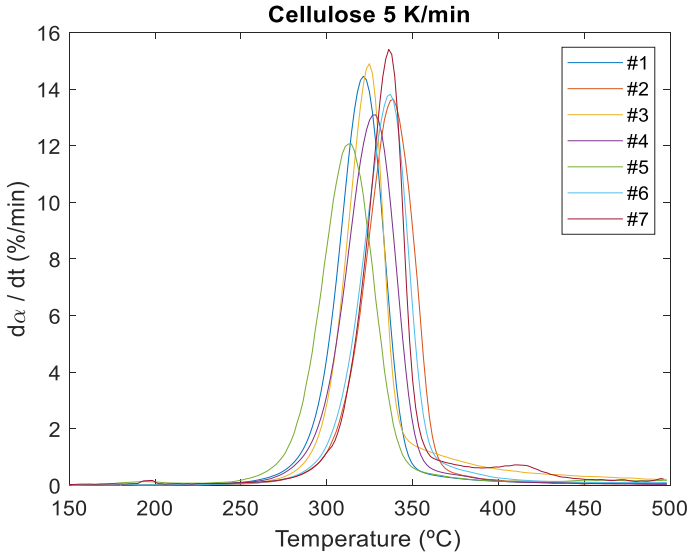
- m vs. t and dm/dt vs. t



Source: Quelle: Netzsch-Gerätebau GmbH

Cellulose pyrolysis – Conversion α

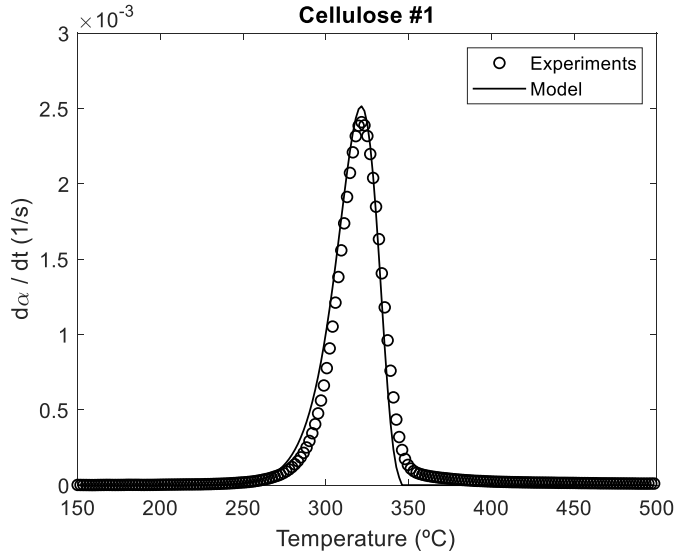


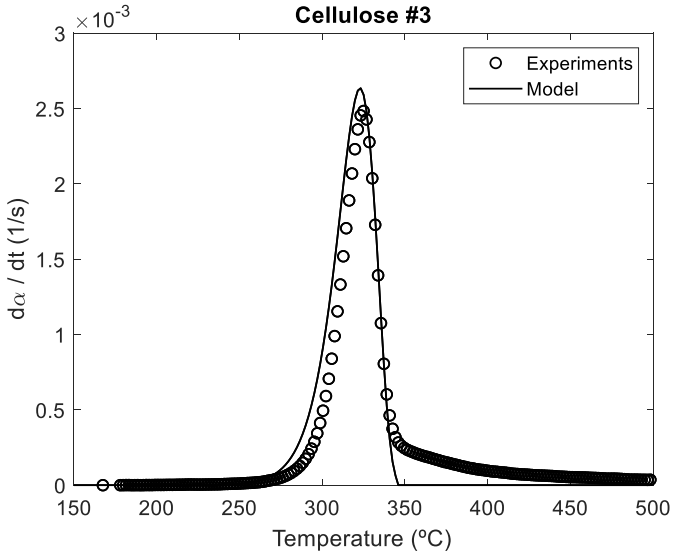


- shape of the curves almost similar for all cases
- max reaction rate at 328.3 ± 9.2 °C; literature[1]: 327 ± 5 °C

[1] Gronli et al. A round-robin study of cellulose pyrolysis kinetics by thermogravimetry. 1999

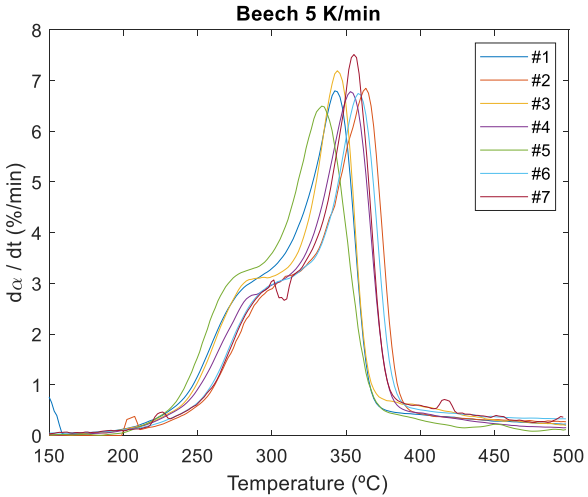
Cellulose pyrolysis – Modelling (single reaction)

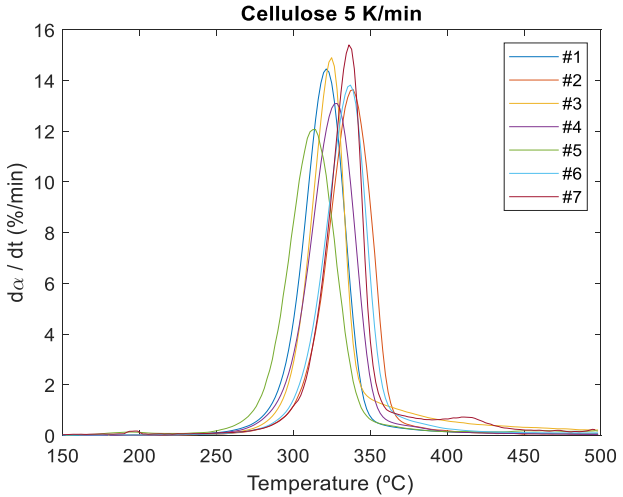




- averaged error in the fitting: 2.9 ± 1.2 % → low error
- Error: mainly at temperatures around 350°C due to the tail of the DTG curve → especially pronounced in case #3

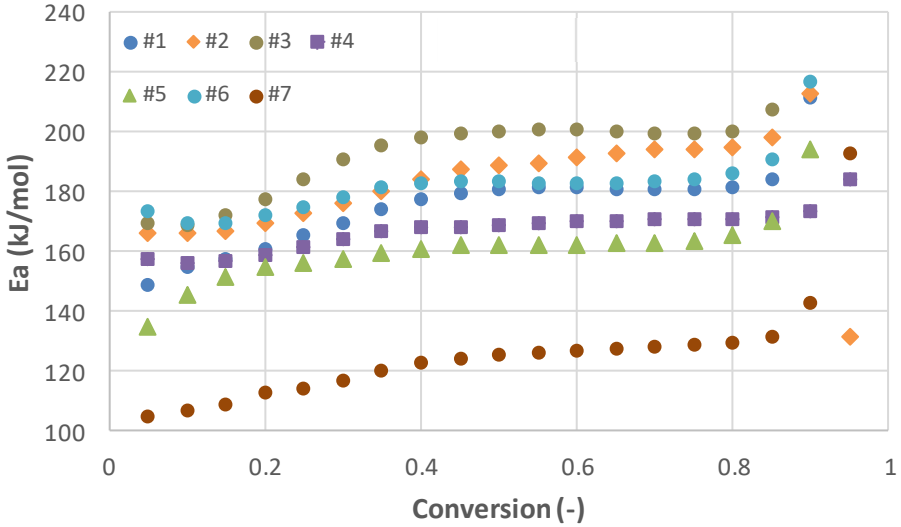
Beech wood pyrolysis
Conversion α





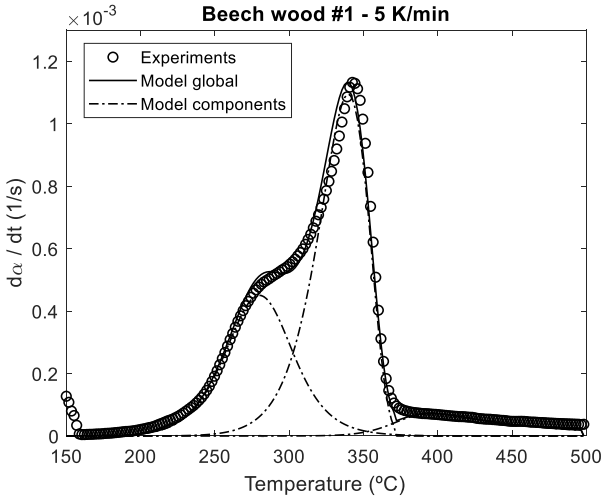
- Beech wood: 1 peak, 1 shoulder Cellulose: one peak only
  → results from hemicellulose
- obtained deviations between participants are of a similar order as for cellulose

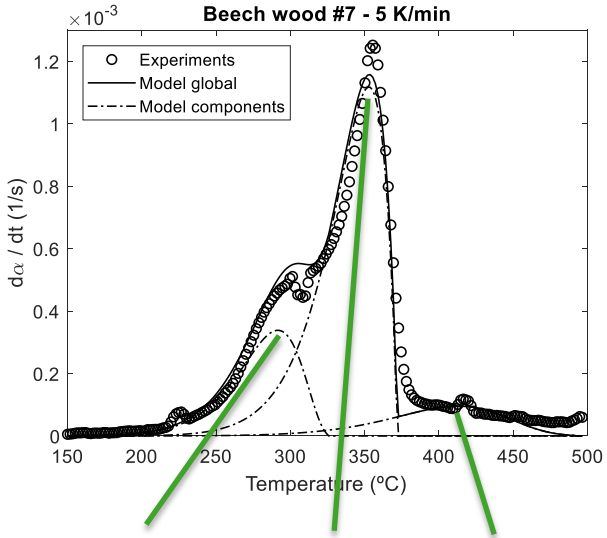
Beech wood pyrolysis
Comparison of activation energies



- Activation energy E_a calculated by *Isoconversional KAS method*
- Standard deviations 20 – 25 kJ/mol - within acceptable range
- One case significantly lower

Beech wood pyrolysis – modelling





hemi-cellulose cellulose lignin

- Beech is modelled simulating 3 components:
  - hemi-cellulose, cellulose, lignin
- Fluctuations in signals of some partners (e.g. #7)

Summary and Outlook

- TGA is widely used, but mass loss kinetics for biomass pyrolysis is still a non resolved topic.
- Round robin of TGA pyrolysis experiments with 7 partners
  - Pure Cellulose: satisfactory reproduction of pyrolysis experiments from literature (Gronli et al. 1999)
  - Beech Wood: deviations with different devices are of a similar order as for cellulose
  - BUT certain deviations are obtained in DTG curves for all cases
  - Detailed documentation of protocols necessary
  - Evaluation of protocols for elucidation of remaining variation

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Thank you for your attention!

Norbert Kienzl
norbert.kienzl@best-research.eu

www.best-research.eu