Comparison of different sampling methods in hot and diluted flue gas

- Preliminary results -

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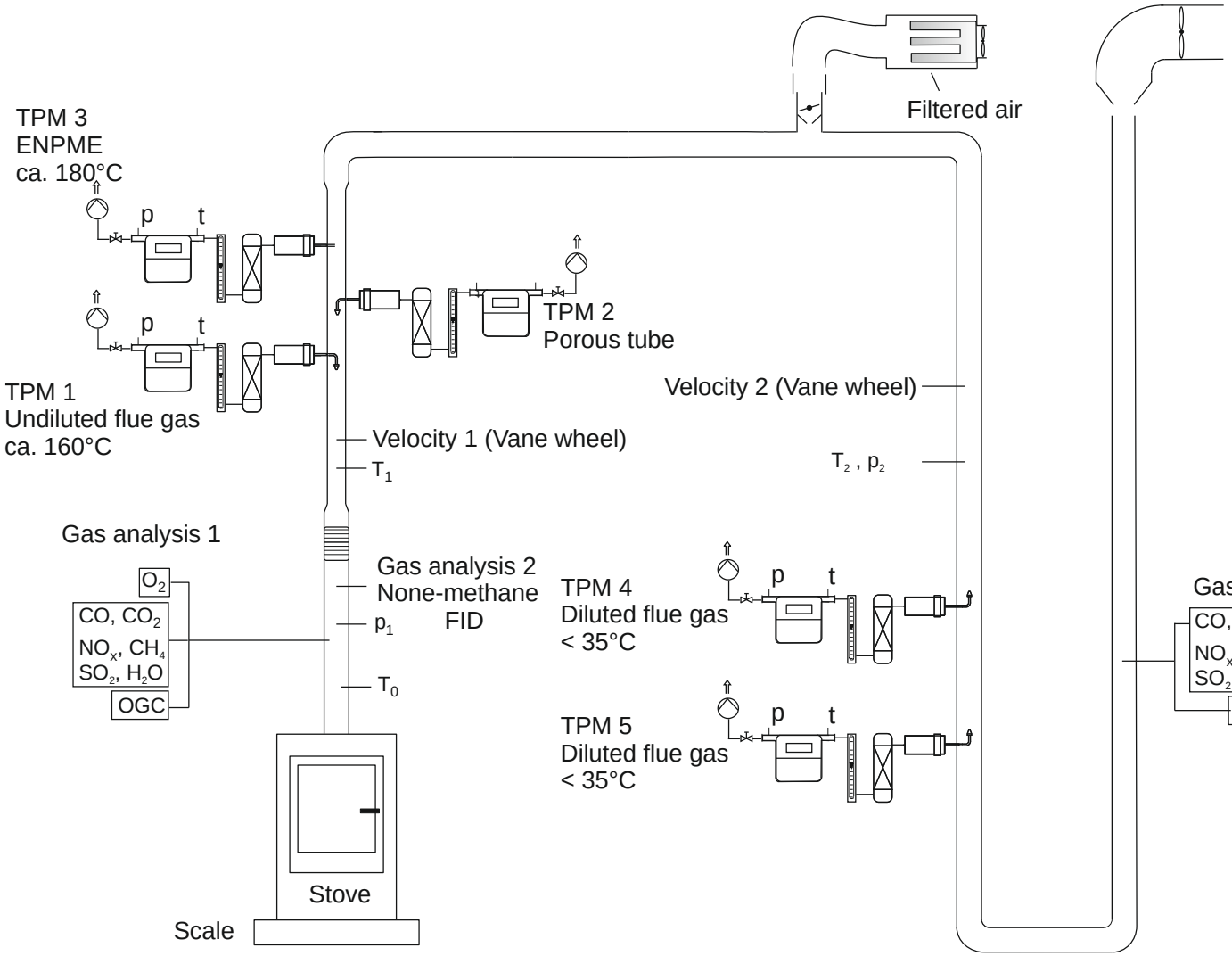
Experimental setup at TFZ



- Comparison of:
  - Heated filter
  - ENPME
  - Porous tube
  - Full flow dilution
- Investigation of:
  - TPM sampling methods
  - EC/OC/Salts and oxides on filter
- Same sampling duration

Only plane filters (45 mm), no stuffed cartridges

Log wood stove – Procedure

- All air inlets at log wood stove are open prior ignition
- 1st TPM measurement = ignition (from top or bottom)
- Intermediate batch at nominal load to change filters
- 2nd TPM measurement = nominal load (2.2 kg)
- Intermediate batch at nominal load to change filters (full load)
- 3rd TPM measurement = nominal load (2.2 kg)
- Intermediate batch at partial load to change filters (partial load)
- 4th TPM measurement = partial load (1.4 kg with 2 logs)
- Recharging of stove always at 4 % CO_2
- All results refer to 13 % O_2

Log wood stove – Fuels

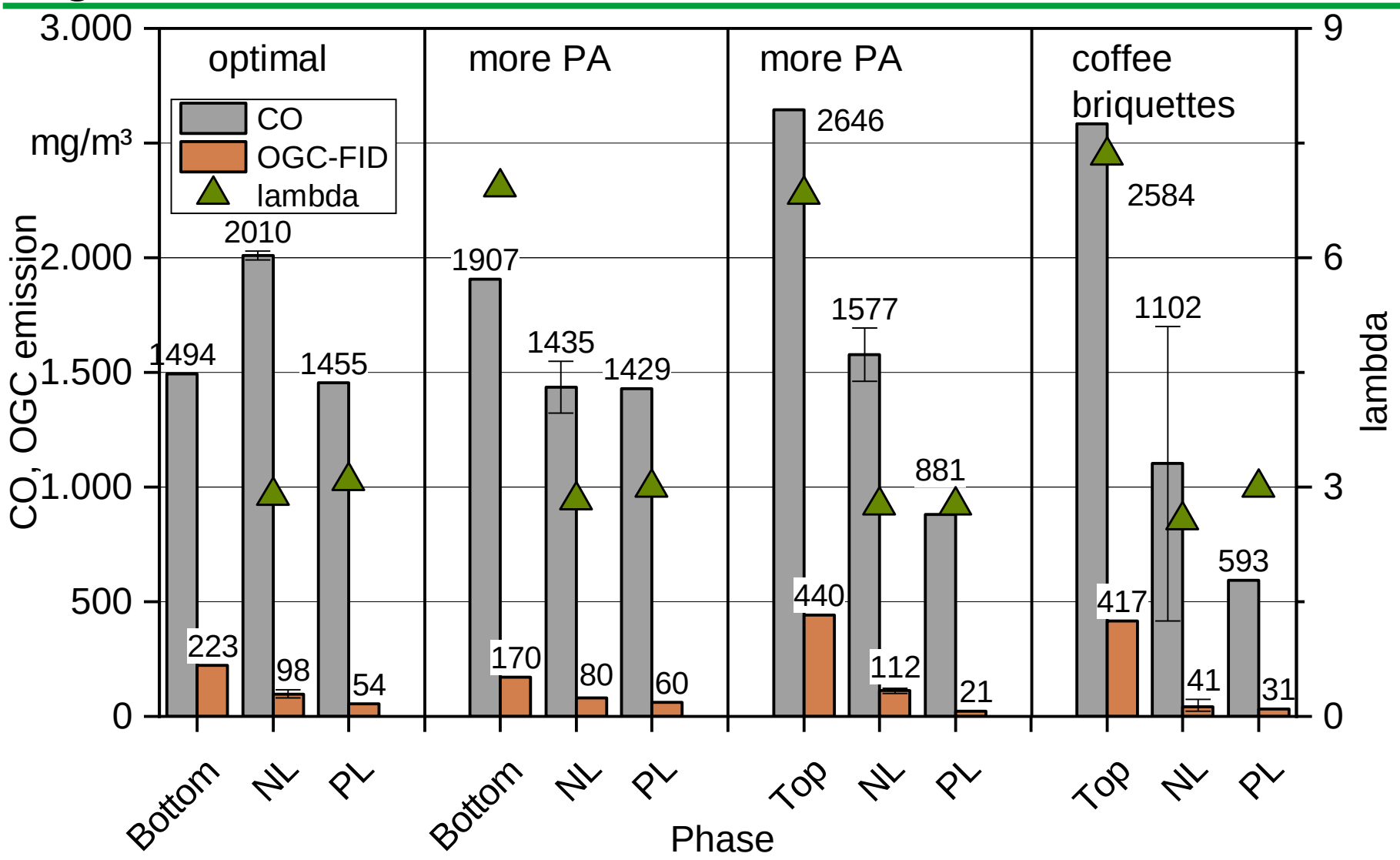
- Beech log wood (3 pieces)

- Ignition with beech logs and small spruce pieces (always)
- Ignition aid: wax-wood wool blocks

Coffee briquettes (4 pieces)

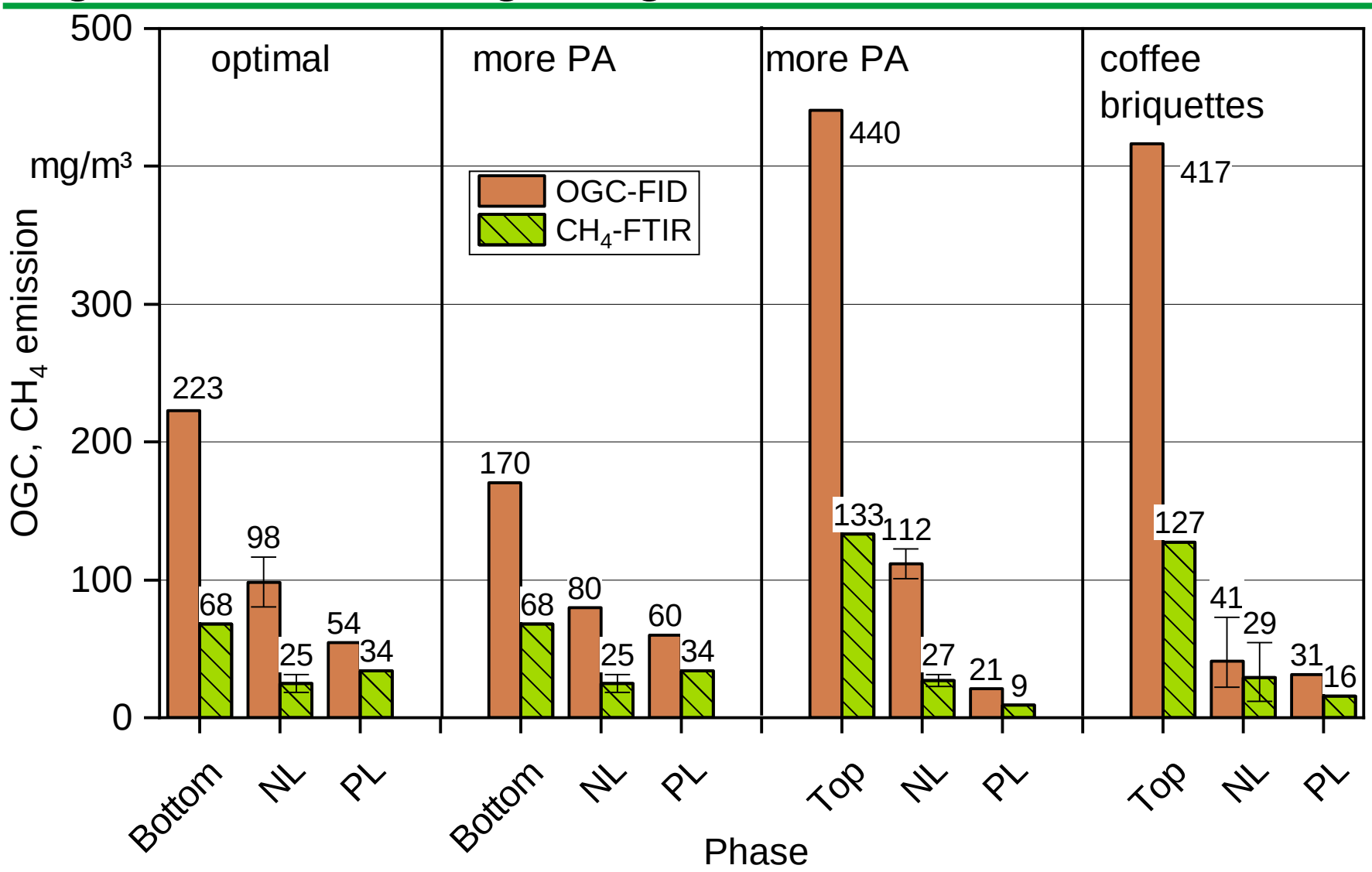
Parameter	Coffee briquette
Ash content	1.47 w-%
C	53.8 w-%
N	1.81 w-%
K	4140 mg/kg
Si	950 mg/kg
Ca	1430 mg/kg

Log wood stove – Gaseous emission



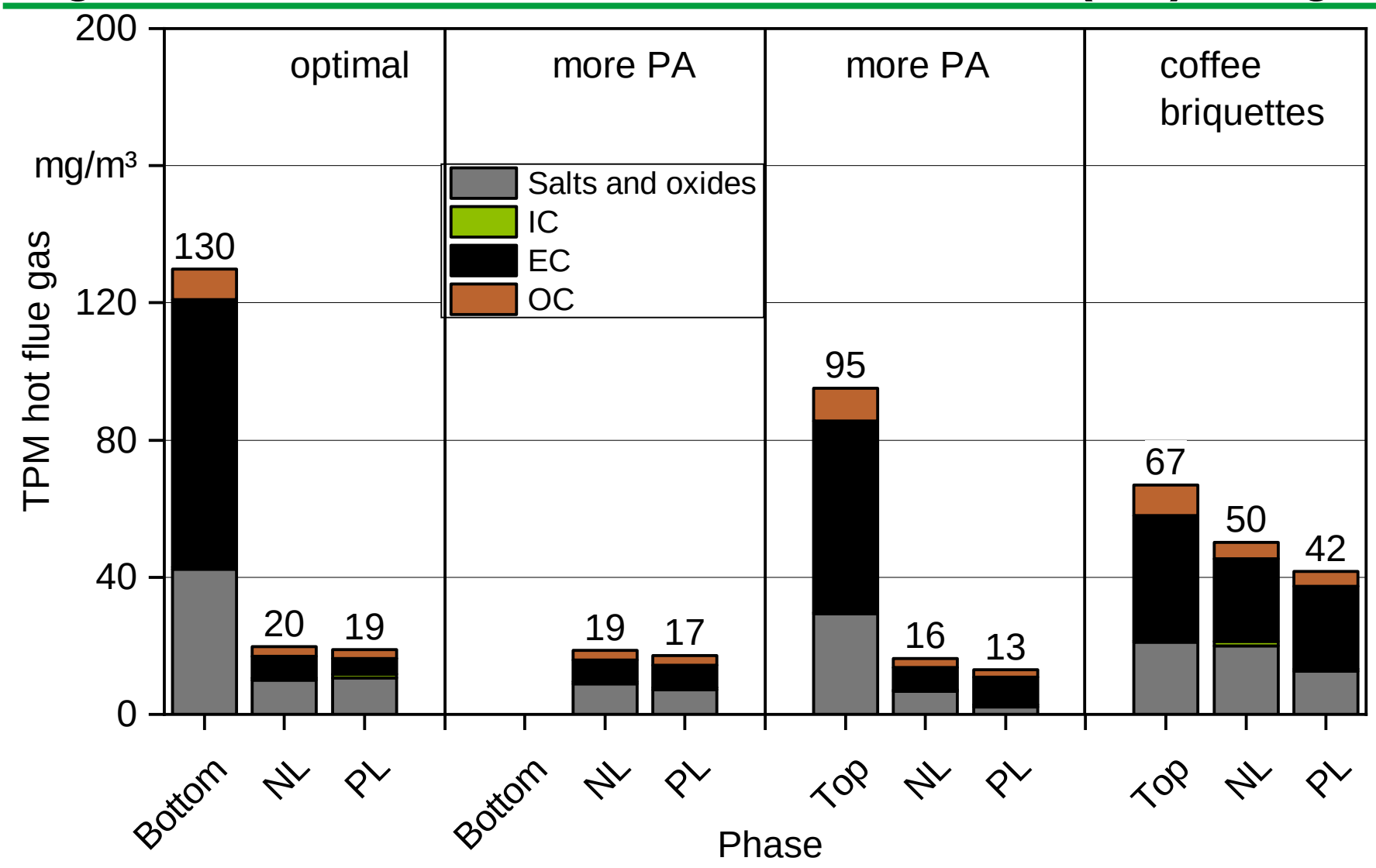
PA – primary air, bottom – ignition from bottom, top – ignition from top,
NL – nominal load, PL – partial load

Log wood stove – Organic gaseous carbon emission



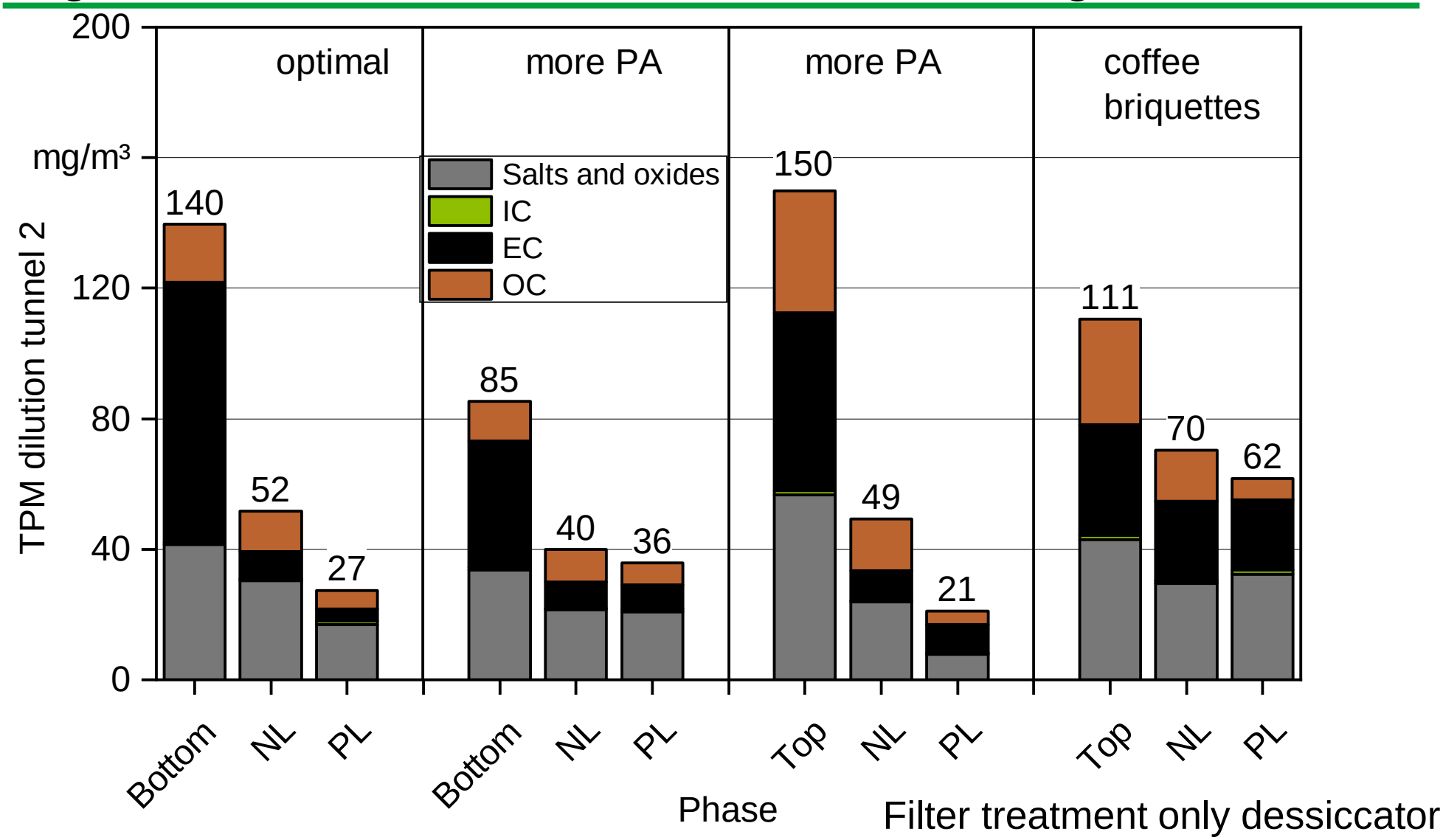
PA – primary air, bottom – ignition from bottom, top – ignition from top,
NL – nominal load, PL – partial load

Log wood stove – TPM emission in undiluted (hot) flue gas



PA – primary air, bottom – ignition from bottom, top – ignition from top,
NL – nominal load, PL – partial load
IC – inorganic carbon, EC – elemental carbon, OC – organic carbon

Log wood stove – TPM emission in diluted flue gas



PA – primary air, bottom – ignition from bottom, top – ignition from top,
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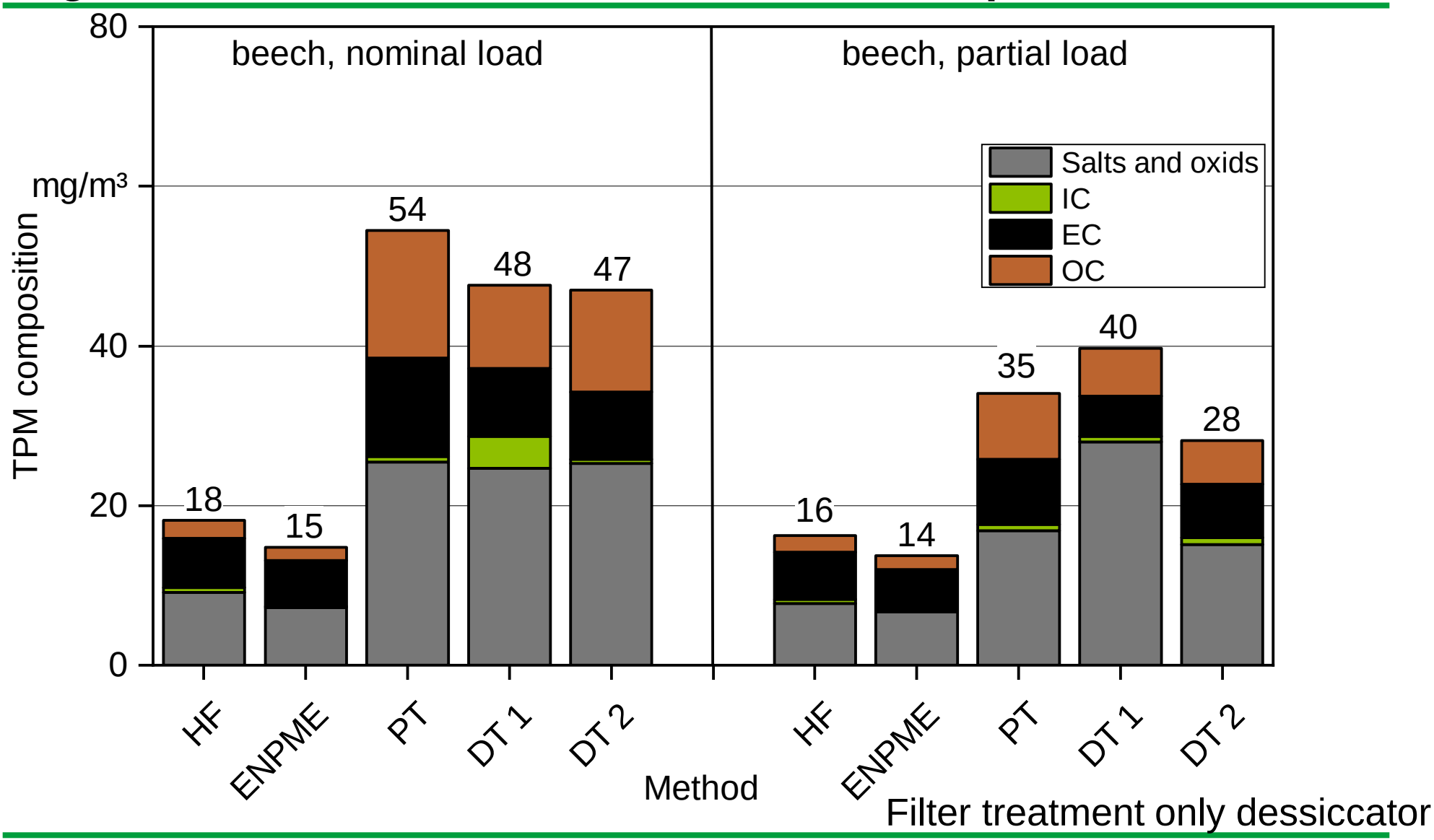
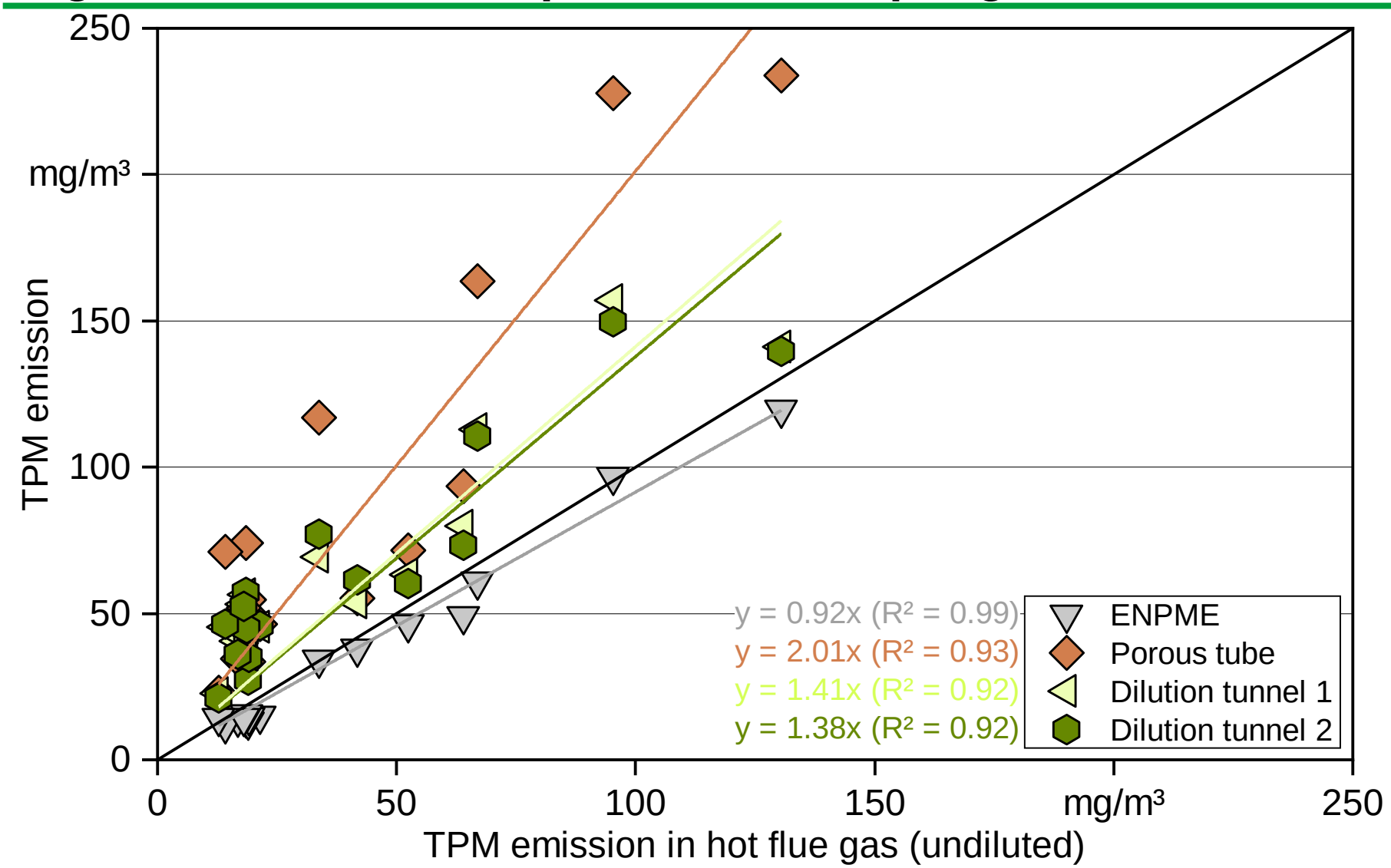
Log wood stove – TPM emission and its composition – Beech



HF – heated filter, PT – porous tube, DT1 – dilution tunnel 1, DT2 – dilution tunnel 2
IC – inorganic carbon, EC – elemental carbon, OC – organic carbon

Log wood stove – Comparison of sampling methods



Log wood stove – Summary

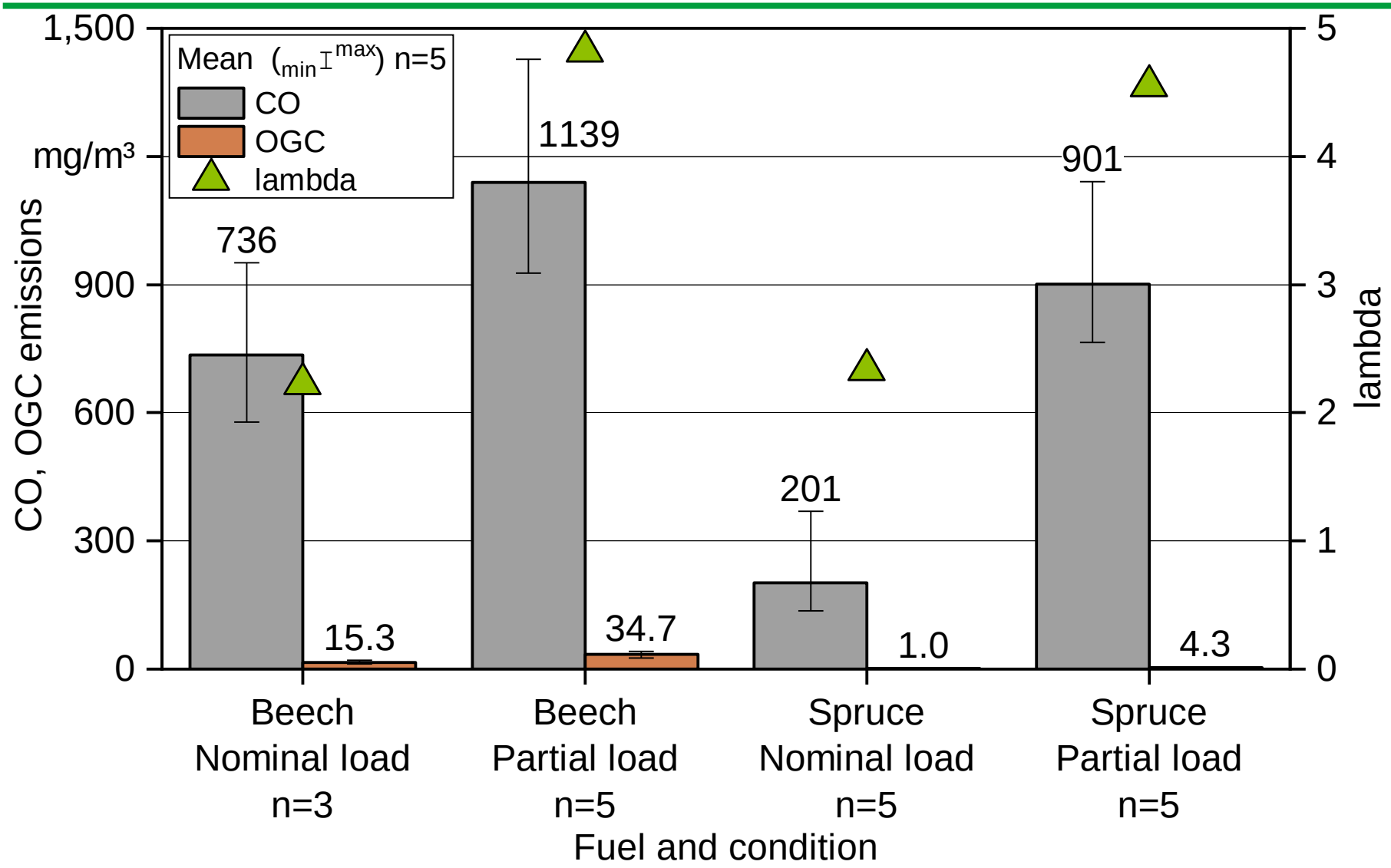
- Highest emissions during ignition batch
- ENPME underestimates TPM emission slightly by 8 % compared to heated filter method (same sampling duration!)
- Clear increase in TPM emission if flue gas is diluted:
  - Porous tube by factor of 2
  - Dilution tunnel by factor of 1.4

Pellet stove

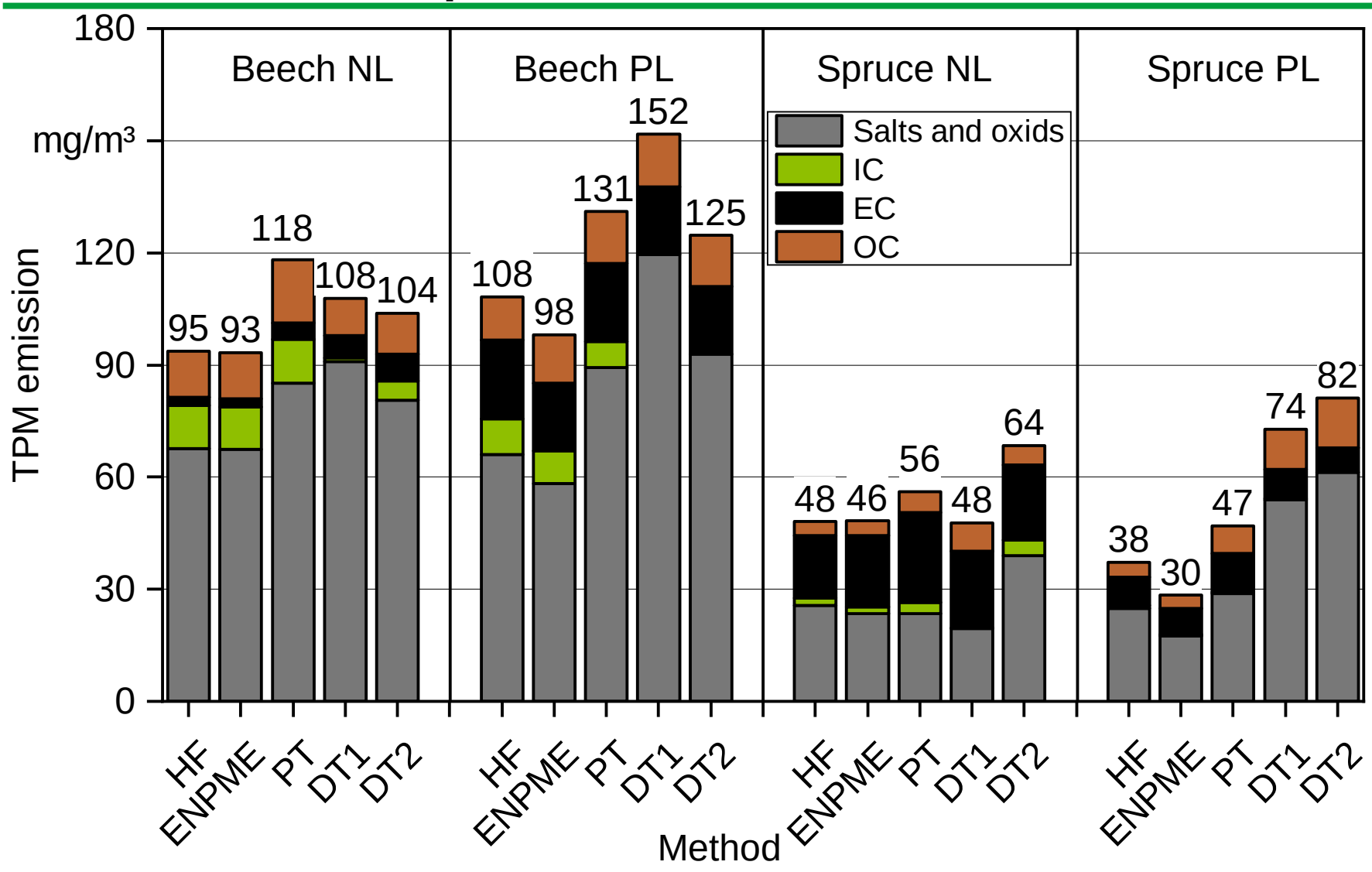
- 6 kW drop down pellet stove
- Automatic cleaning every hour (not measured)
- 30 minutes measurement (5 replications)
- Nominal load and partial load

Parameter	Unit	Spruce	Beech
Moisture content	w-%, d	7.7	6.2
Ash content	w-%, d	0.37	0.63
Bulk density	kg/m³, ar	703	691
K content	mg/kg, d	402	1130
Si content	mg/kg, d	677	1260

Pellet stove – Gaseous emission



Pellet stove – Composition of TPM emission



HF – heated filter, PT – porous tube, DT1 – dilution tunnel 1, DT2 – dilution tunnel 2
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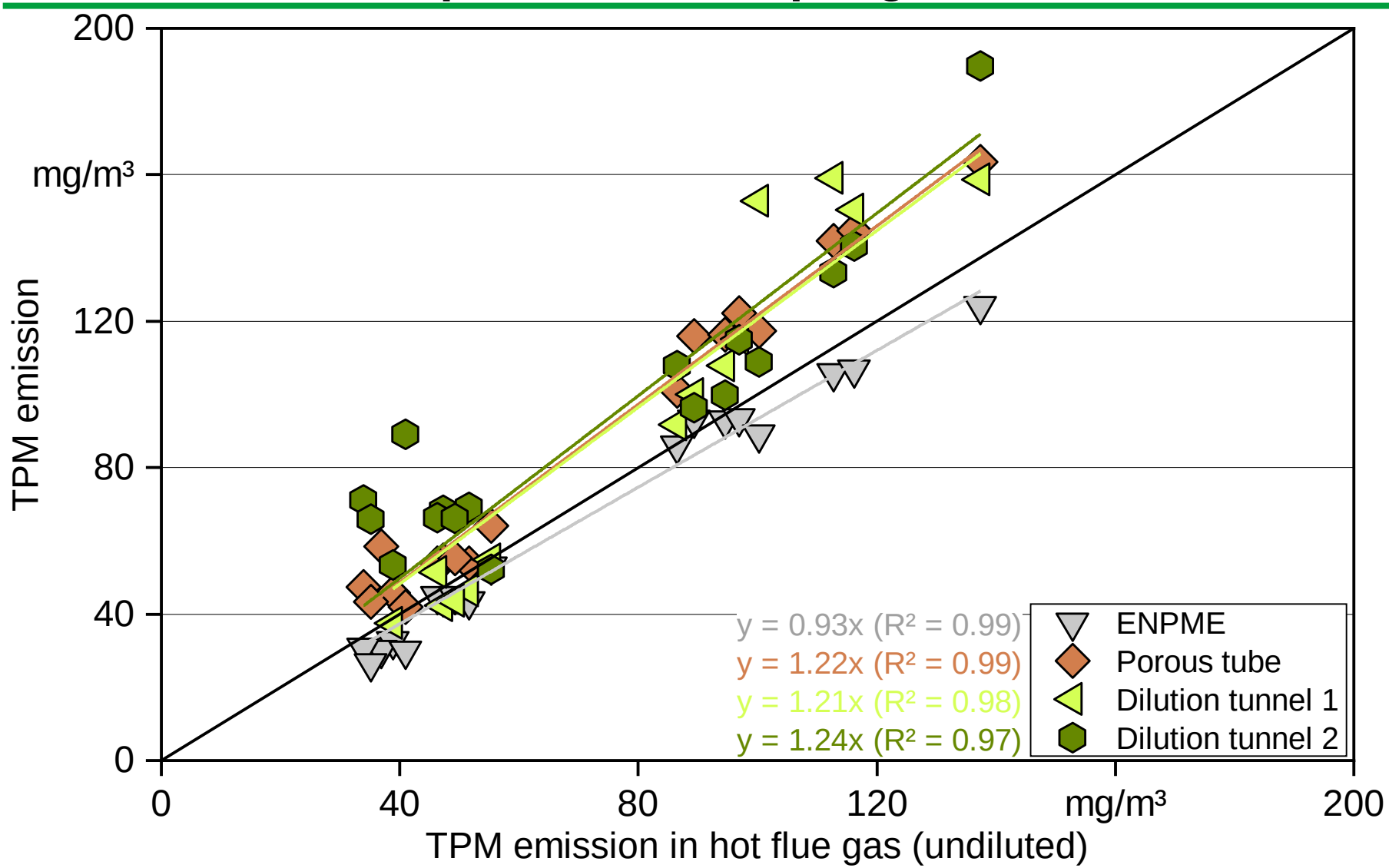
Pellet stove – Comparison of sampling methods



Pellet stove – Summary

- Beech wood pellet combustion caused higher emissions compared to spruce
- ENPME detected slightly lower TPM emission by 7 % → in agreement with log wood stove trials
- Clear increase in TPM emission if flue gas is diluted:
  - Porous tube and full flow dilution tunnel by the factor of 1.2 to 1.25
  - → lower TPM increase during pellet combustion compared to log wood stove

Thank you for your Attention!

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Log wood stove – Influence of filter treatment