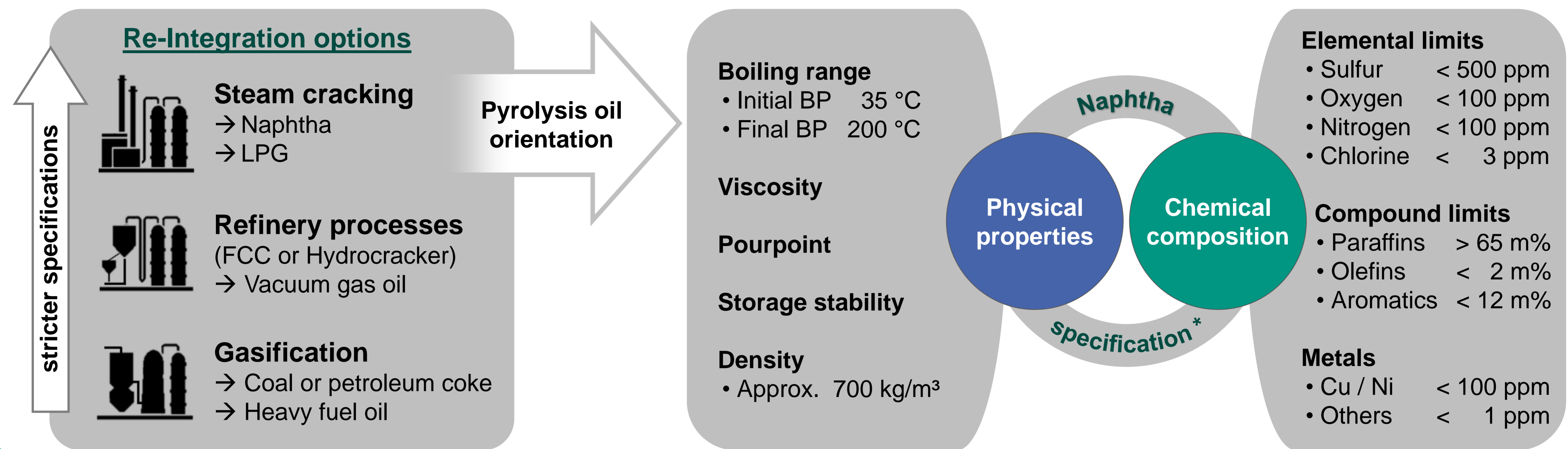


# Advanced analytical methods for characterization of condensable pyrolysis products from plastic waste

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## Pyrolytic plastic waste recycling

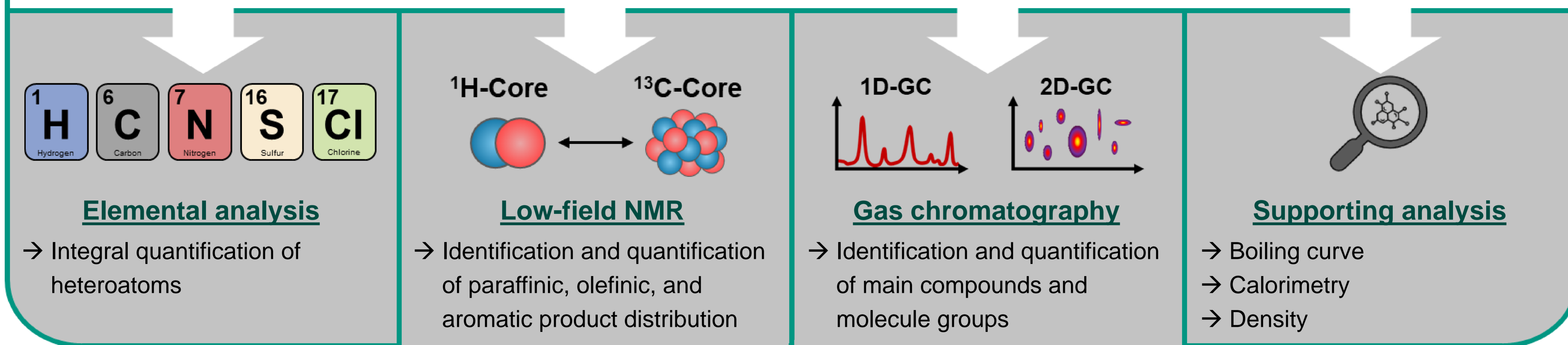
Complex chemical composition of pyrolysis oil derived from plastic waste requires advanced analytical methods to evaluate the re-integration into chemical value chains



\* Kusenberg et al. 2022. Waste Management

## Analytical solution

Combination of multiple analytical techniques enables detailed characterization of pyrolysis condensates

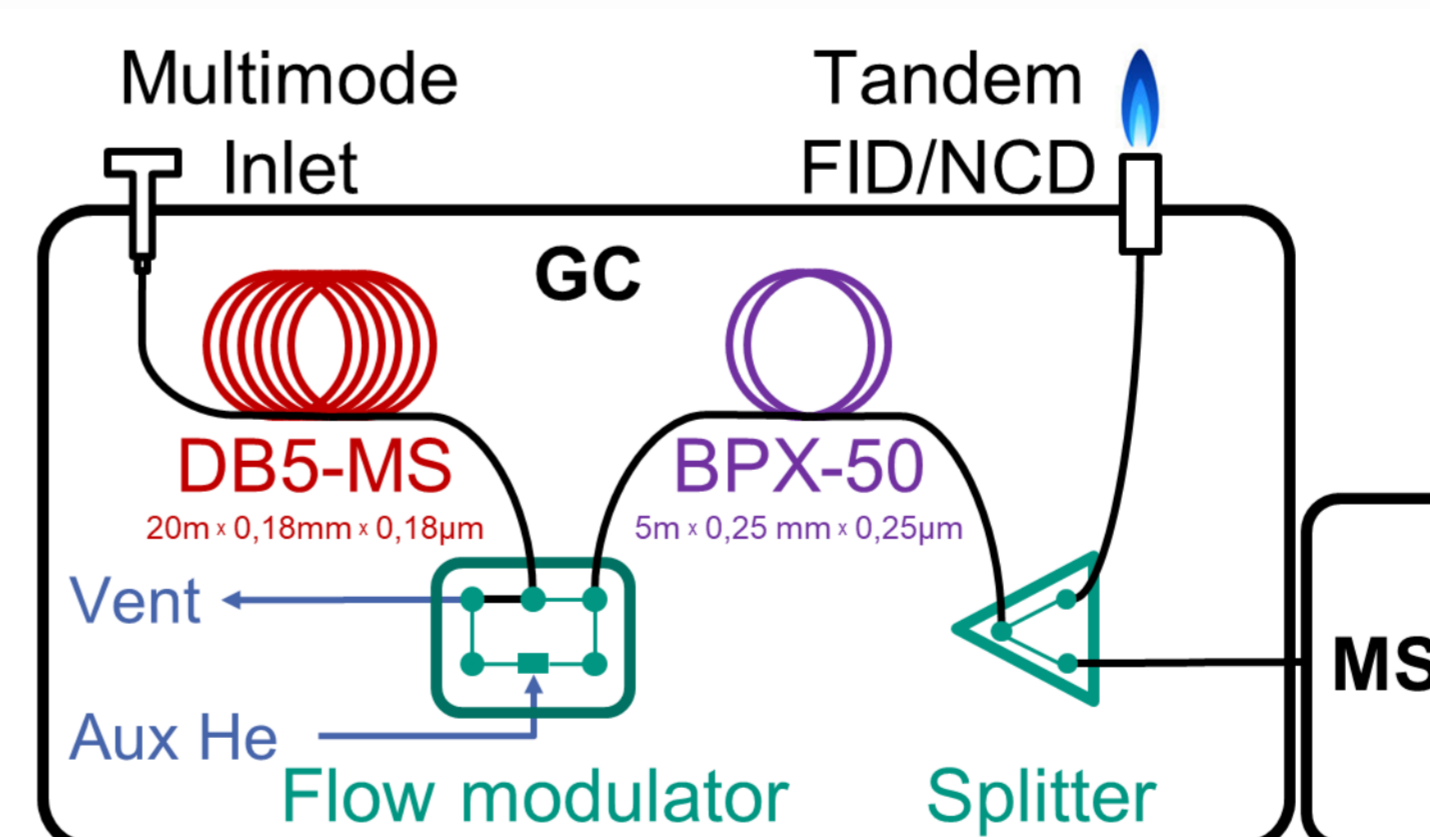


### <sup>1</sup>H-NMR Quantification

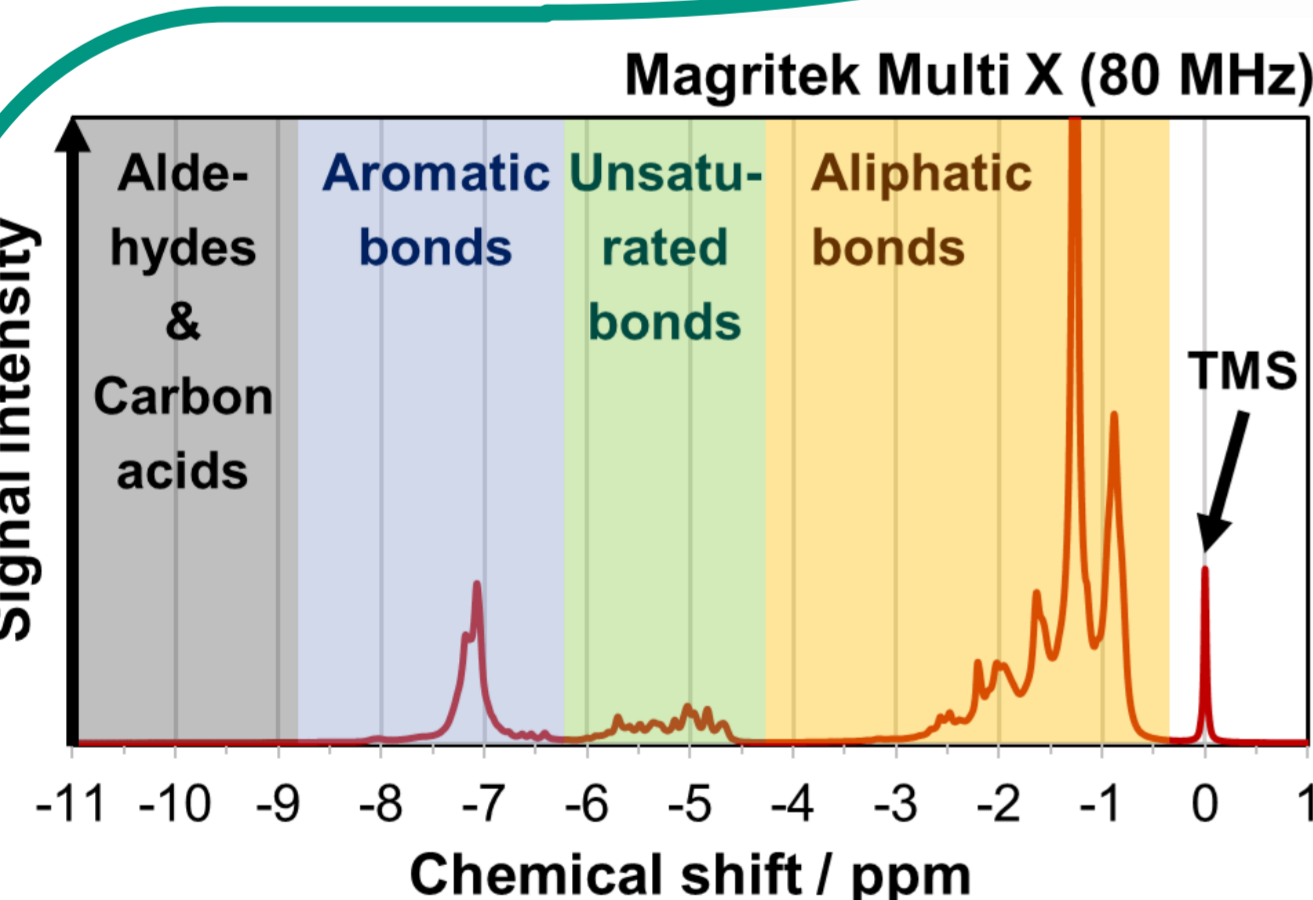
→ Molar distribution of <sup>1</sup>H atoms in molecule groups by integrating spectral regions

- ⊕ Fast and cost-efficient
- ⊕ Other modes available (e.g. <sup>13</sup>C)

### Setup of 2D-GC



- ⊕ High peak resolution
- ⊕ Molecule class specific peak separation
- ⊕ Analysis flexibility by parallel detector configuration



### NMR result: Mixed thermoplastics

Molecule group	Chemical shift in ppm	<sup>1</sup> H-distribution in mol%	Runtime 4min
Aliphatics	0.4 – 4.3	76.9	Scans 16
→ R-CH <sub>3</sub>	0.4 – 1.1	→ 17.8	Pulse angle 90°
→ R-CH <sub>2</sub> -R	1.1 – 1.5	→ 38.0	<sup>13</sup> C decoupling
→ R-CH-R <sub>2</sub>	1.5 – 1.8	→ 8.3	Neat sample
→ Other aliphatics	1.8 – 4.3	→ 12.8	TMS referenced
Unsaturated bonds	4.3 – 6.3	8.1	Automated data analysis
Aromatics	6.3 – 8.7	14.8	
Aldehydes / Carbon acids	8.7 – 13.0	0.2	

### 2D-GC result: Mixed thermoplastics

