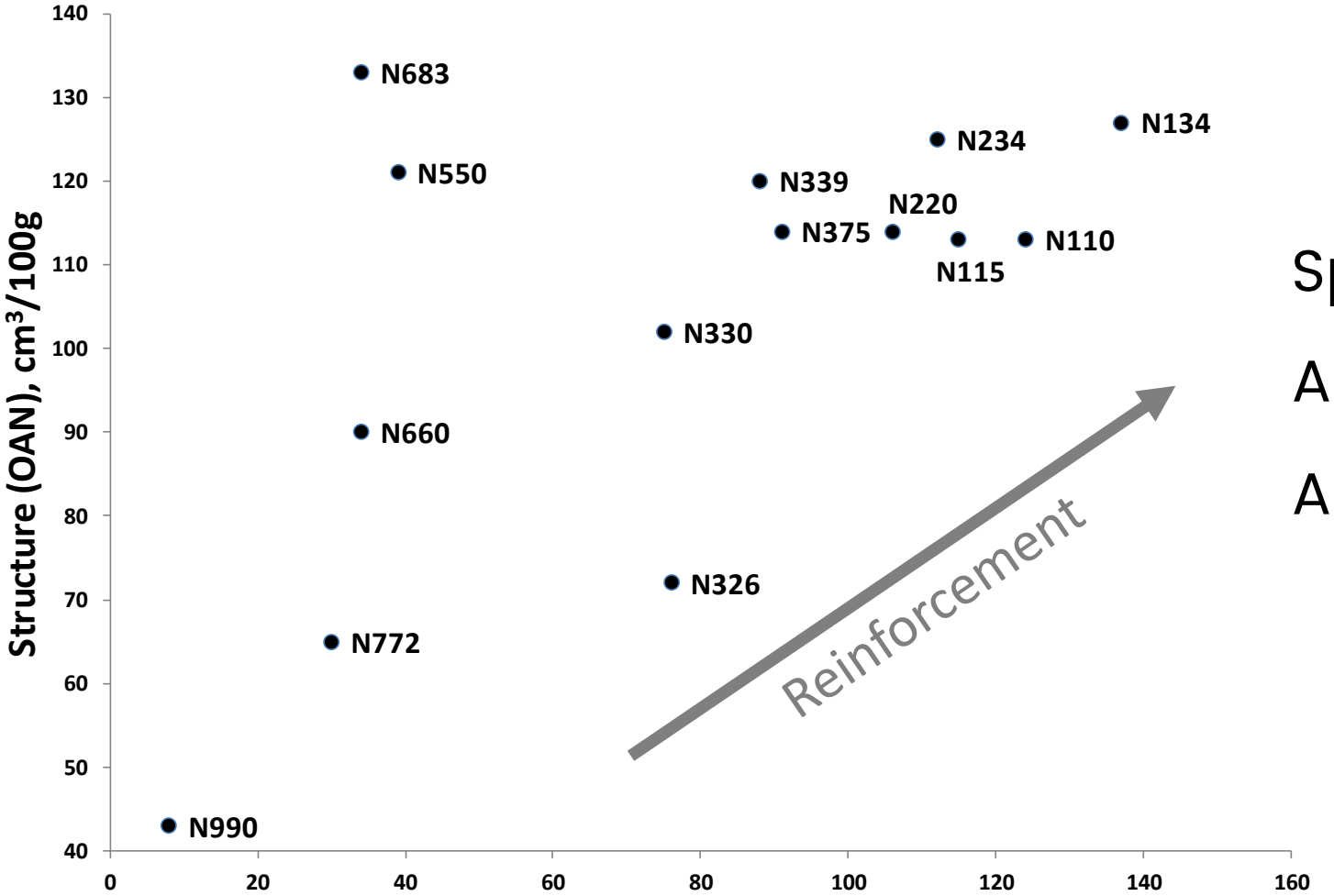
femtoG

Unveiling structure

femtoG.com
Jörg Wieder, Dr. sc. ETH Zürich
joerg.wieder@femtoG.com / +41 78 693 52 42

Tire grade Carbon Blacks



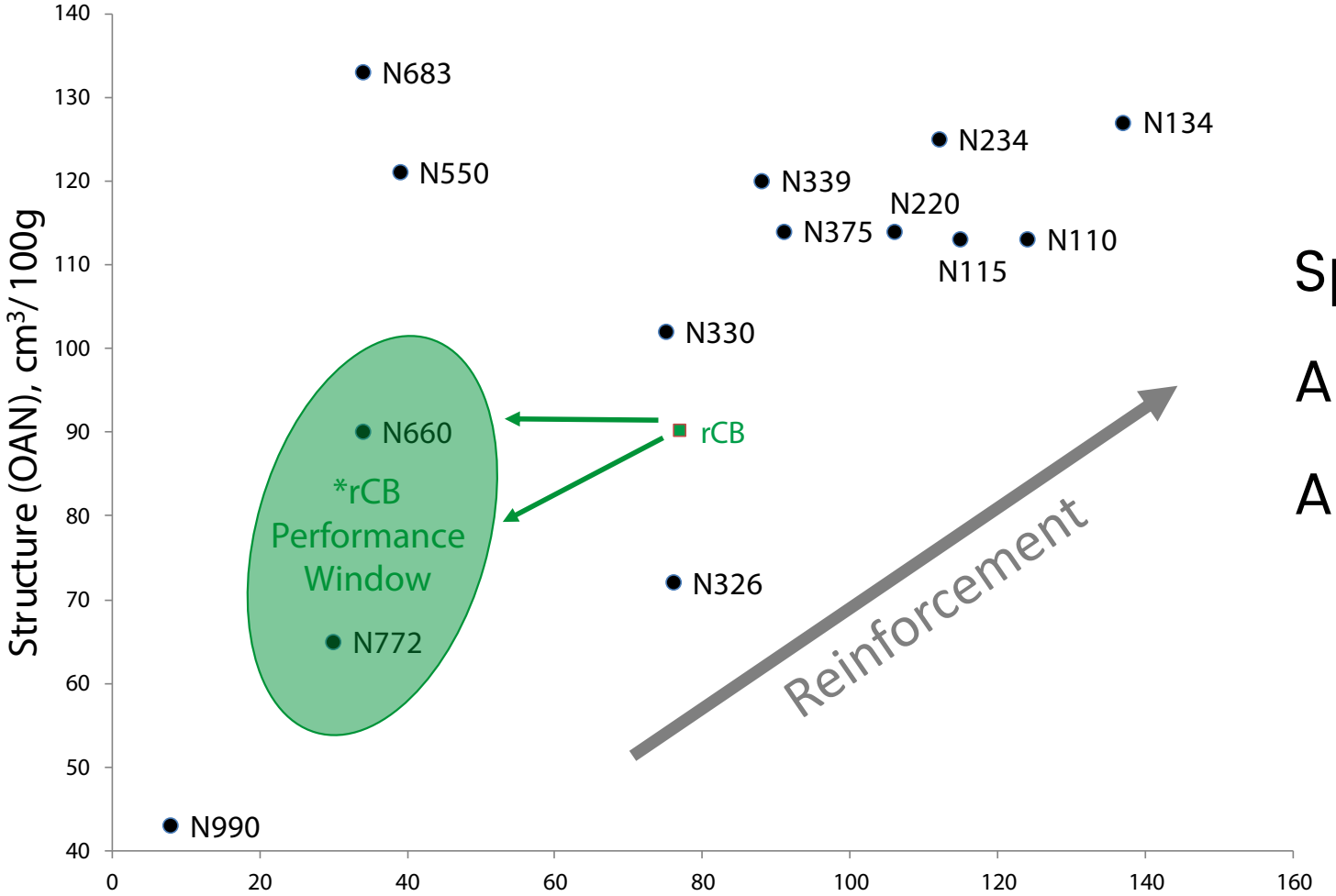
Spread, distribution?

Aggregate diameter?

Analysis time?

Figure kindly Provided by artis

Tire grade Carbon Blacks



Spread, distribution?

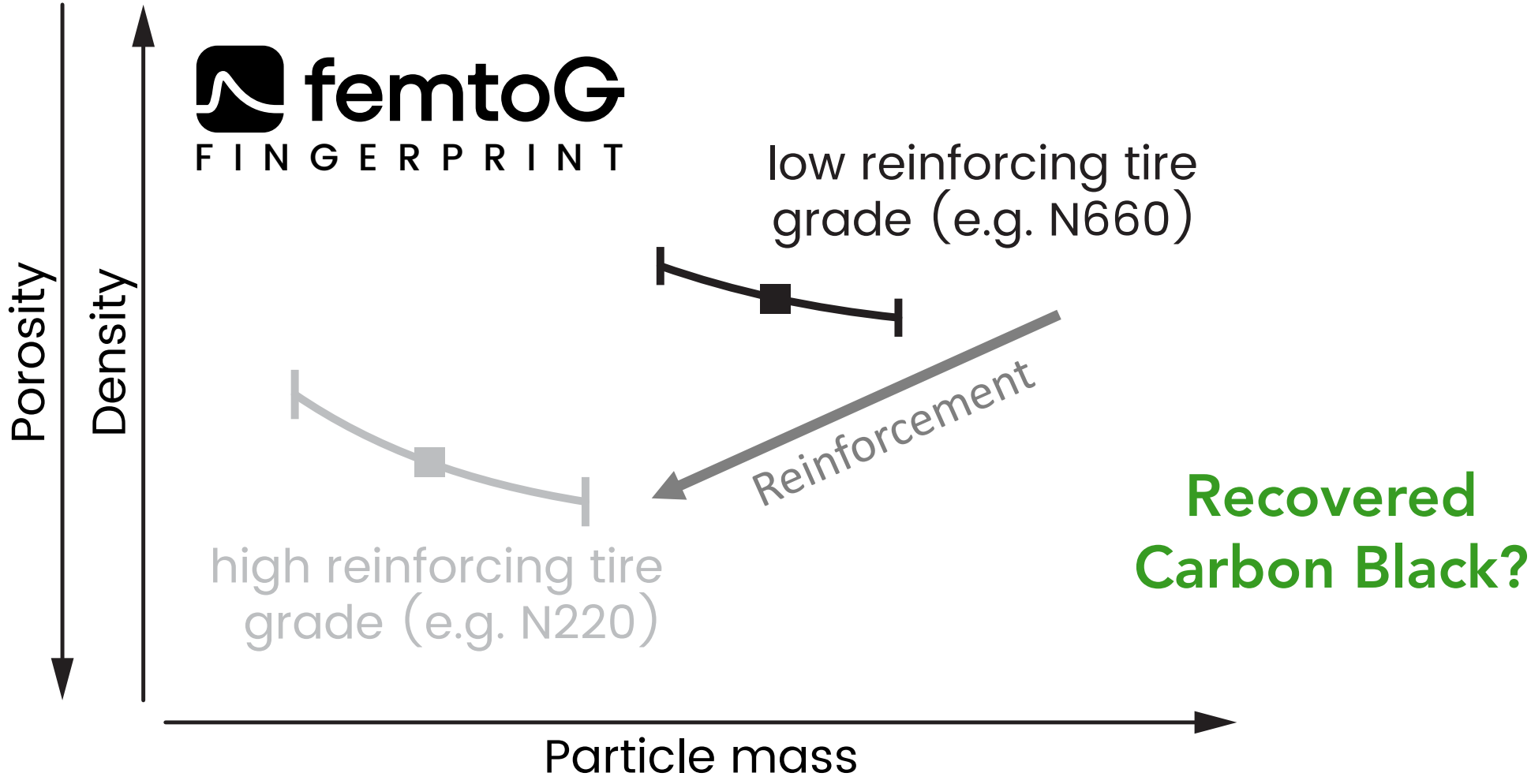
Aggregate diameter?

Analysis time?

Figure kindly Provided by artis

*typical rCB

rCB structural characterization



Recovered Carbon Black?

Comprehensive rCB characterization

- ✓ **Understand the structural impact of your upgrading process**
- ✓ **Monitor rCB structure online during production**
- ✓ **Measure the stability of your rCB agglomerates**
- ✓ **Product characteristics tailored to your needs**

Extensive

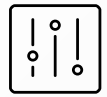
Multidimensional dataset

Fast

Only minutes for one scan

Robust

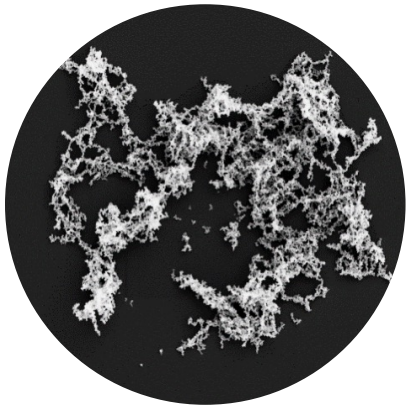
Millions of particles analyzed per scan



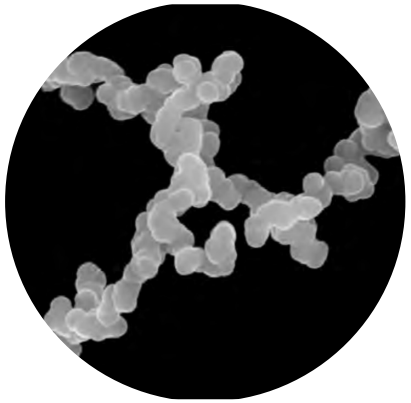
Adjustable

Variable scan range and resolution

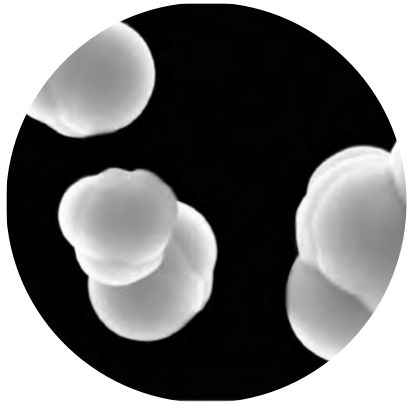
Powder



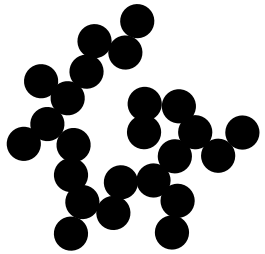
Agglomerates



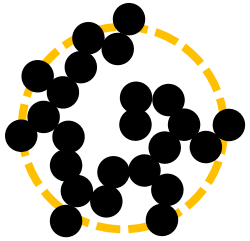
Aggregates



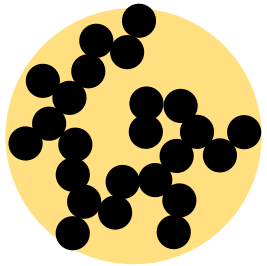
Primary particles



Aggregate **MASS**

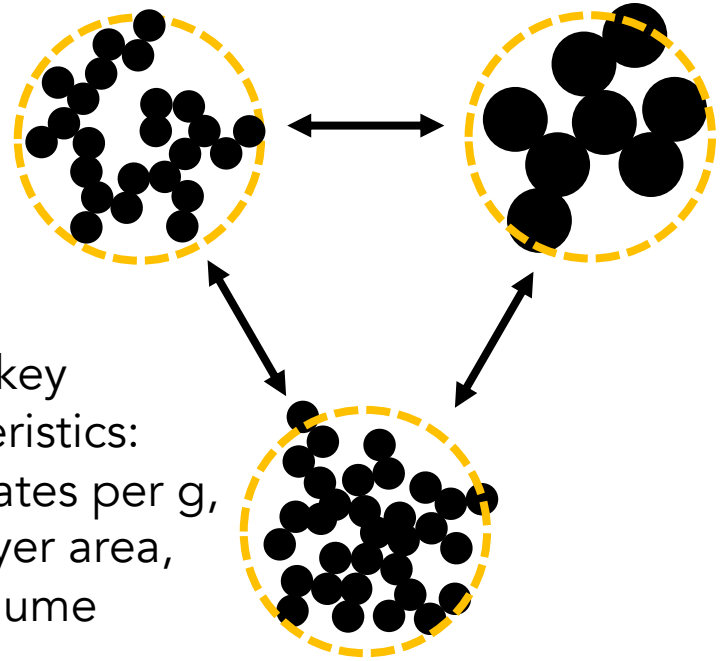


Aggregate **DIAMETER**



Volume, density, fractality

Further key characteristics: Aggregates per g, Monolayer area, pore volume



Measurement system

1. Sampling

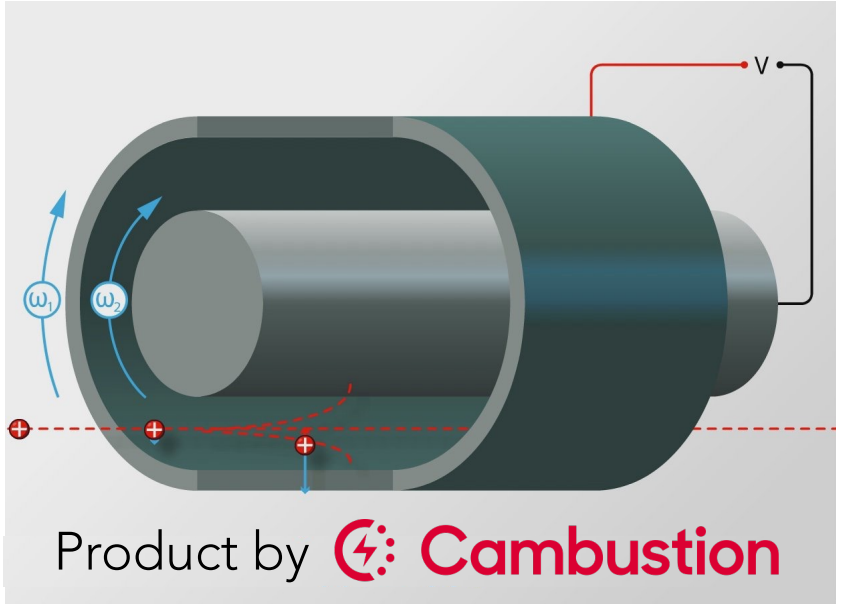
- Dry dispersion as powder
- Directly from reactor

2. Deagglomeration

- Venturi-nozzles
- Adjustable deagglomeration intensity
- Shear: 100-500 N/m2
- Force: $5 \cdot 10^{-10}$ N / particle

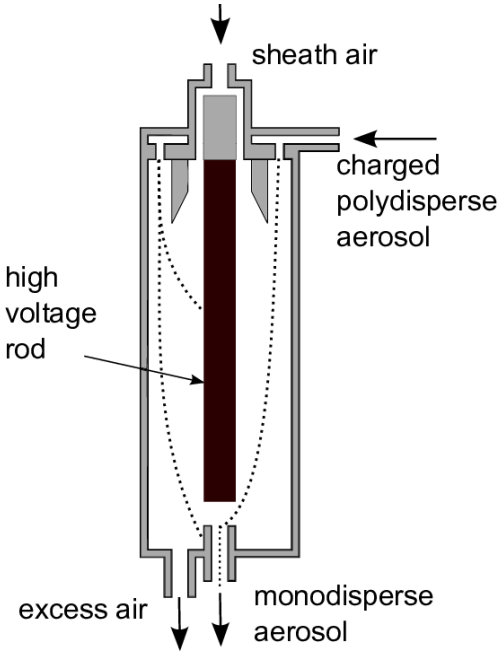
3. Mass

- Centrifugal particle mass analyzer
- selection by mass to charge ratio



4. Diameter

- Based on mobility to size ratio



Analyzed Samples

Recovered Carbon Blacks

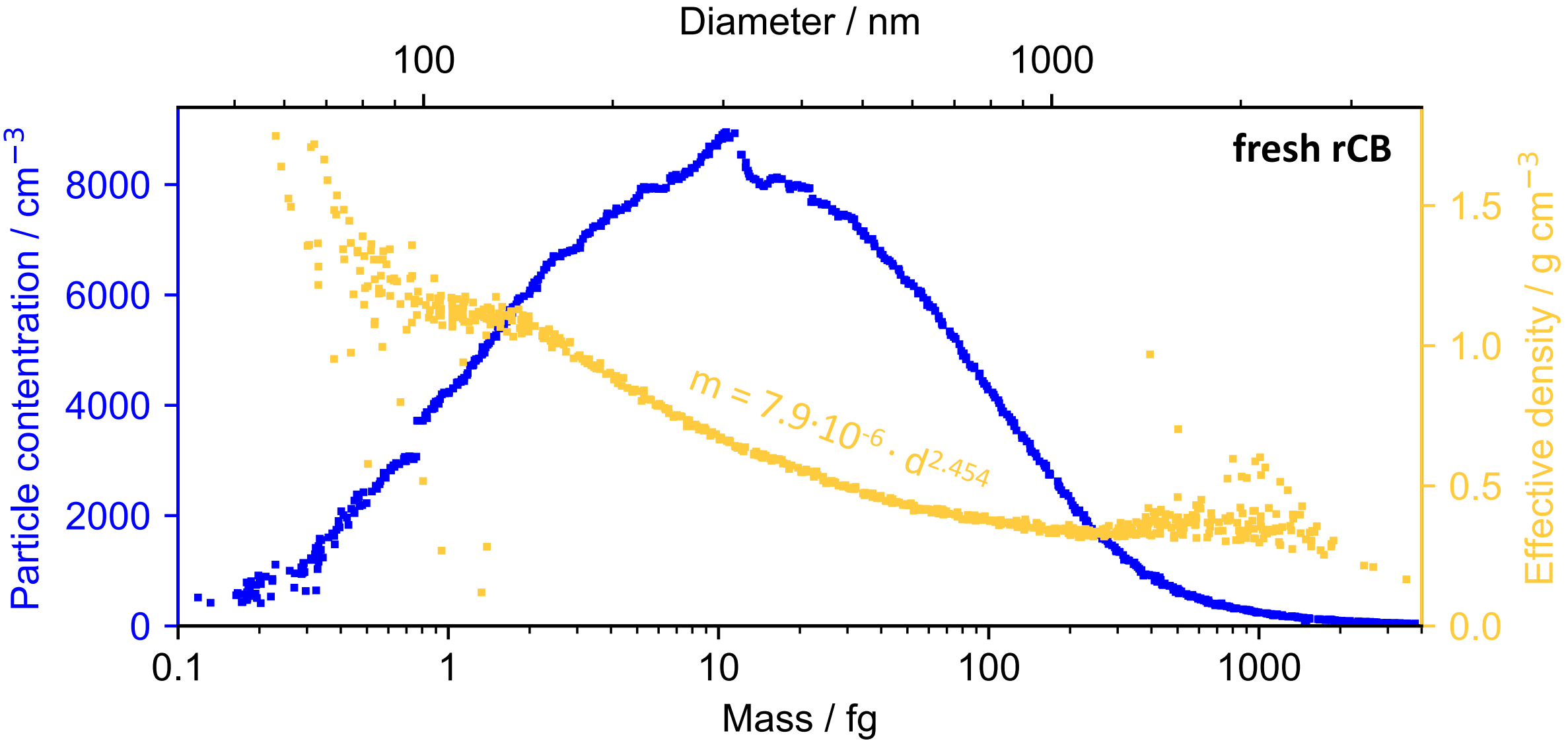
- Fresh rCB
- G3C upgraded rCB

Tire-grade Blacks

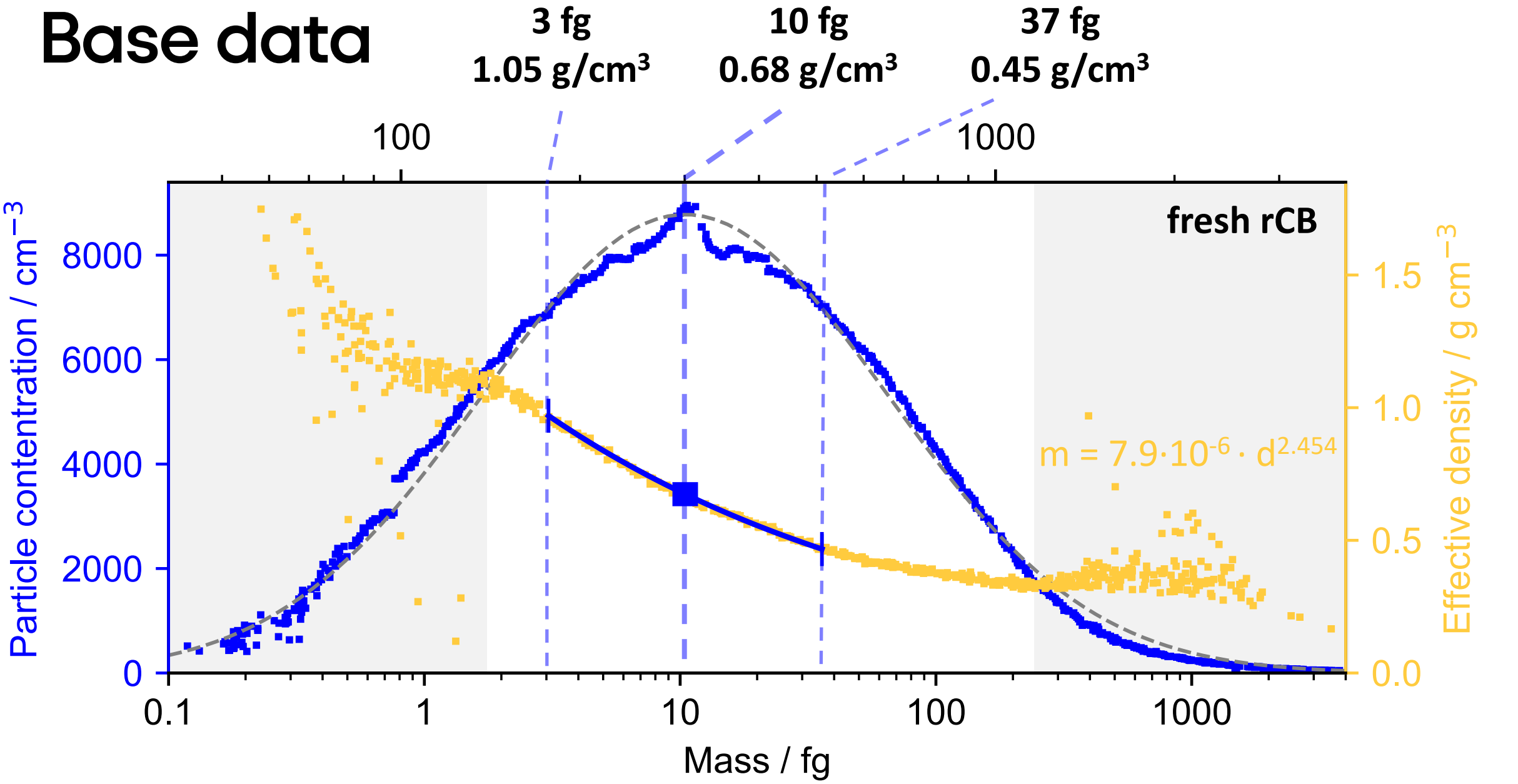
- N220
- N326
- N550
- N660

G3C upgraded rCB was provided by Vitaly Khusidman of G3C Technologies Corporation

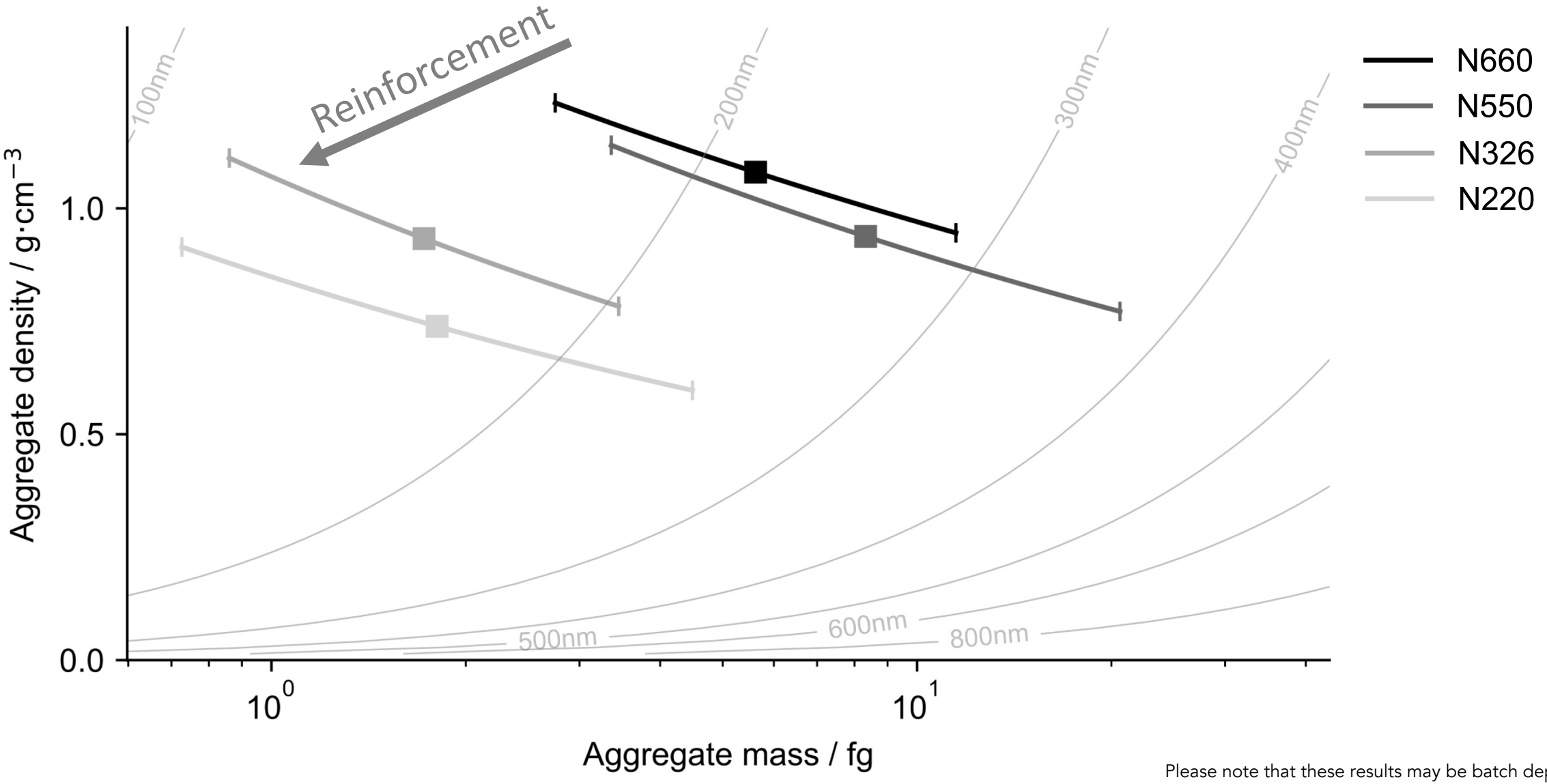
Base data


Diameter / nm
100
1000
fresh rCB
Particle contentration / cm^{-3}
8000
6000
4000
2000
0
$m = 7.9 \cdot 10^{-6} \cdot d^{2.454}$
Effective density / g cm^{-3}
1.5
1.0
0.5
0.0
0.1
1
10
100
1000
Mass / fg

Base data

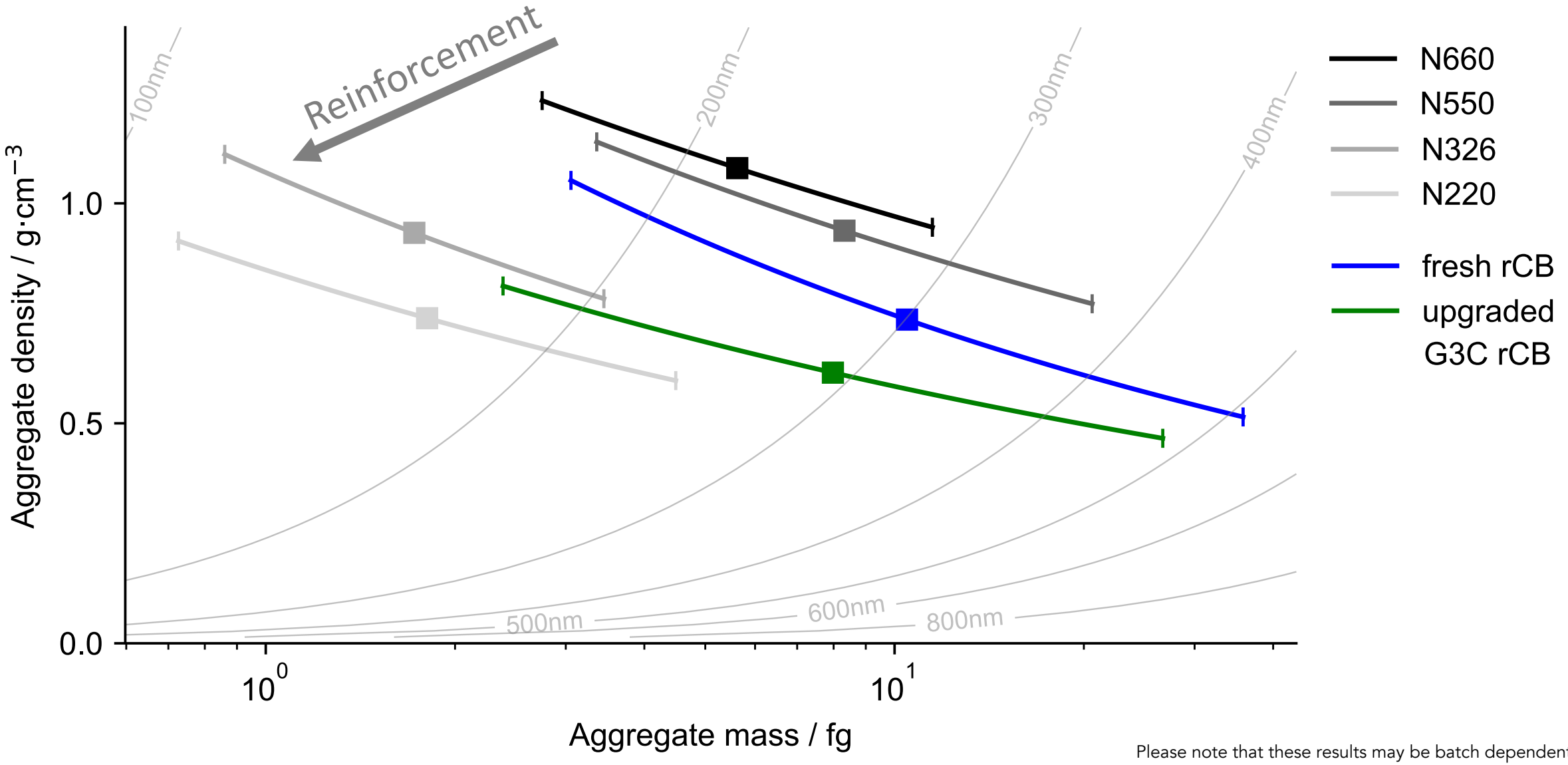

3 fg
1.05 g/cm³
10 fg
0.68 g/cm³
37 fg
0.45 g/cm³
fresh rCB
m = 7.9·10⁻⁶ · d^2.454
Particle contentration / cm⁻³
Effective density / g cm⁻³
Mass / fg
0
2000
4000
6000
8000
0.0
0.5
1.0
1.5
0.1
1
10
100
1000

Tire grades vs. rCBs



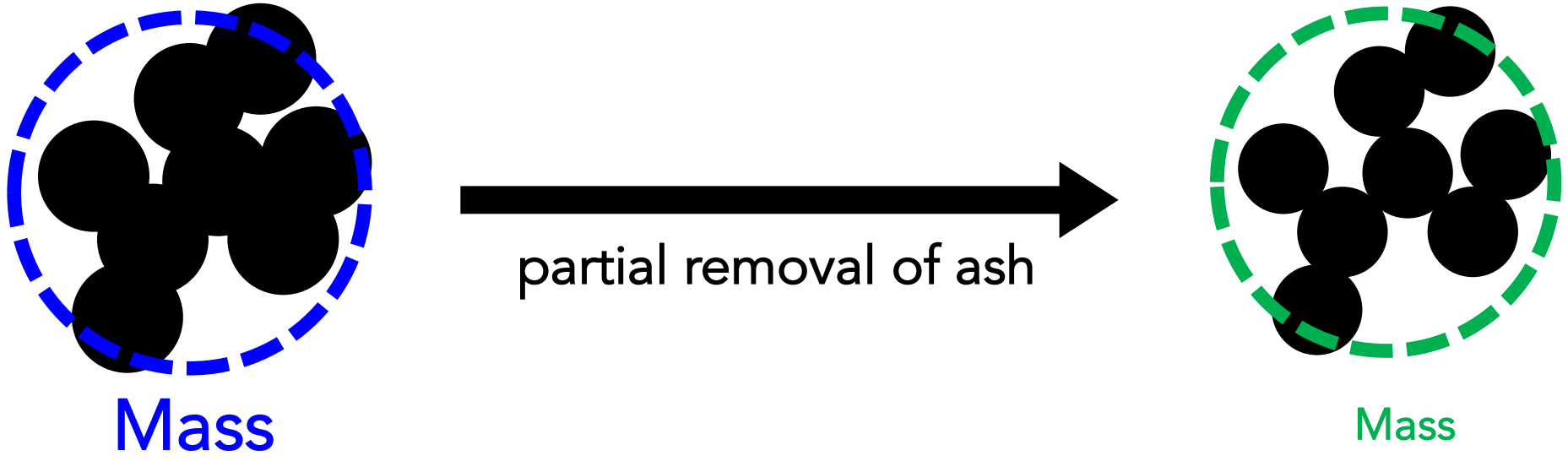
Please note that these results may be batch dependent.

Tire grades vs. rCBs



Please note that these results may be batch dependent.

G3C rCB upgrading: effect on mass distribution



- Upgraded rCB has increased structural level
  - OAN: 91 → 134 ml/100g
  - STSA: 76 → 310 m^2/g
- Reduced ash content: 17.8% → 13.7%

Other derived products

	N220	N326	N550	N660	Fresh rCB	upgraded G3C rCB
m_{50} / fg	1.81	1.72	8.32	5.62	10.5	9.78
D_{50} / nm	167	152	257	215	301	292

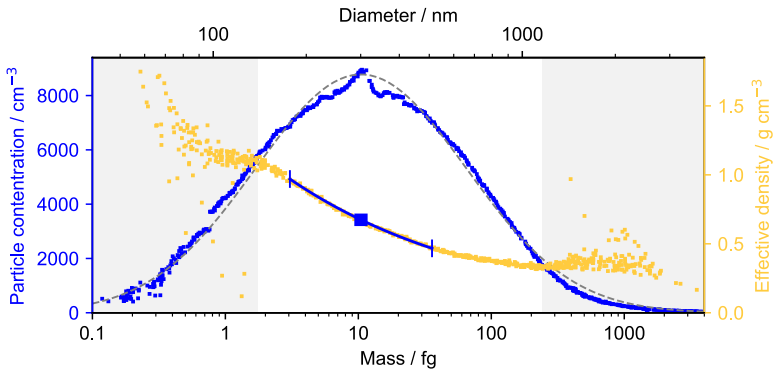
Fractality, density, distribution spread, …

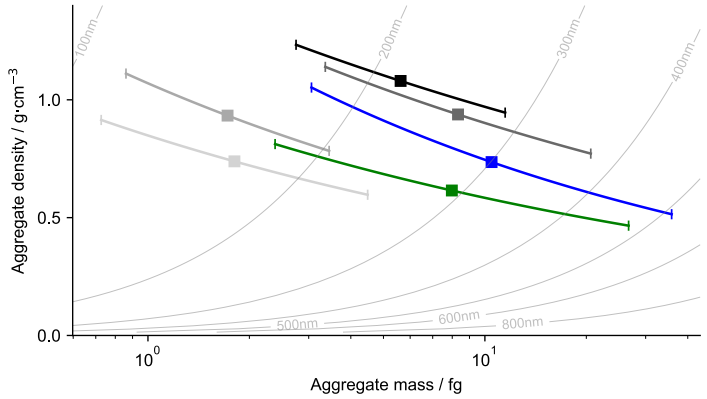
N° aggregates / g^{-1}	$2.23 \cdot 10^{14}$	$3.42 \cdot 10^{14}$	$4.87 \cdot 10^{13}$	$1.02 \cdot 10^{14}$	$1.81 \cdot 10^{13}$	$1.70 \cdot 10^{13}$
Aggregate monolayer area / m^2	9.31	9.23	6.61	7.09	6.52	6.66

Conversion to other diameters, e.g., aerodynamic diameter (health)

Please note that these results may be batch dependent.

Summary





	N660	Fresh rCB	G3C up-graded rCB
$Spread_{mass}$	0.621	1.07	1.05
N° aggregates / g^{-1}	$1.02 \cdot 10^{14}$	$1.81 \cdot 10^{13}$	$1.70 \cdot 10^{13}$
Aggregate monolayer area / m^2	7.09	6.52	6.66

Measuring structure of rCB via mass and diameter

G3C-rCB: significant differences compared to tire-grade CBs

Custom products for assessment

femtoG

Unveiling structure

Fast and comprehensive rCB characterization

- Lab analysis
- Research projects
- Process monitoring
- Consulting

femtoG.com
Jörg Wieder, Dr. sc. ETH Zürich
joerg.wieder@femtoG.com / +41 78 693 52 42