# Tire Wear & Ambient Temperature
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Their Accelerating Effect on Neurodegenerative Diseases and Aging in the Animal Model *Caenorhabditis elegans*

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Traffic-related Air Pollution and Ambient Temperature
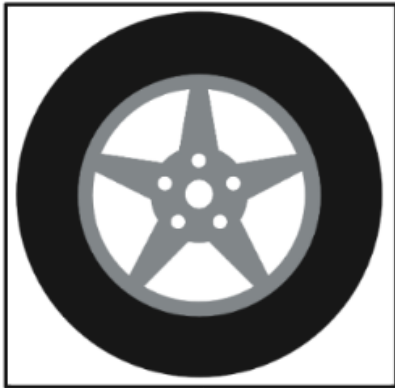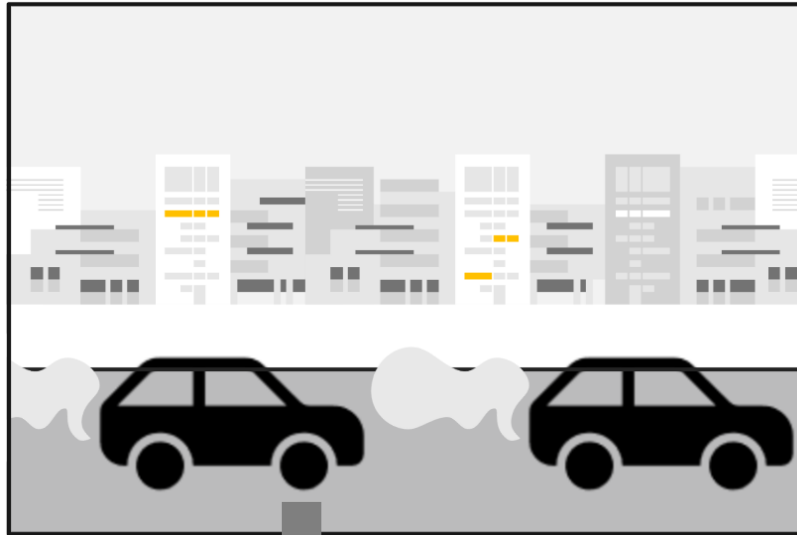
rubber, carbon black, **nano silica**

impact on human health

?

Caenorhabditis elegans As a Model Organism

- small, free-living soil nematode

- important model organism in the lab

- short life span of 2-3 weeks

- small size of about 1mm

- transparent body

- 302 neurons with high level of conservation

- ~ 22.000 coding genes (vs. 19.000 in humans)
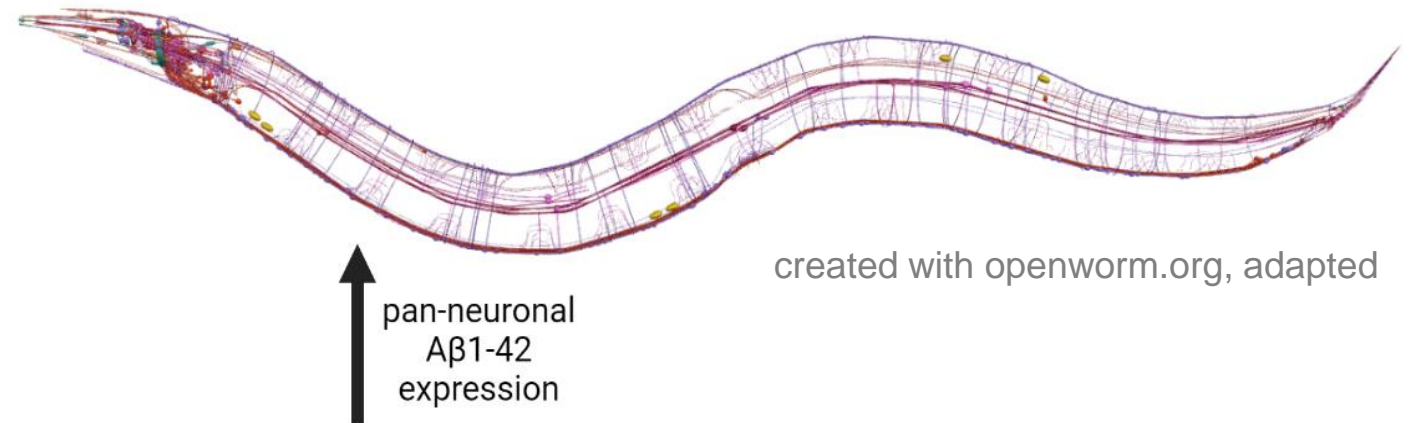
- ~ 60-80 % homology to disease related genes

Corsi et al., Wormbook (2015), Kuwabara and O'Neil, J Inherit Metab Dis (2001), Spieth and Lawson, Wormbook (2005)

Alzheimer's Disease

in humans:

- disease characterized by presence of amyloid plaques and neurofibrillary tangles in the brain

- $A\beta_{1-42}$ and Tau protein predominant peptides in amyloid deposits or neurofibrillary tangles

- causes loss of neuron functionality

***C. elegans* model for AD:**

- expression of $A\beta_{1-42}$ in all neurons

- age-related increase of amyloid deposits

- causes neuromuscular defects

created with openworm.org, adapted

pan-neuronal
Aβ1-42
expression

Roher et al., Proc Natl Acad Sci U S A (1993); Fong et al., Scientific reports (2016)

Parkinson's Disease

H$_2$O

Pollutant

α-synuclein aggregates

in humans:

- disease characterized by accumulation of α-synuclein protein

- causes loss of dopamine-producing neurons
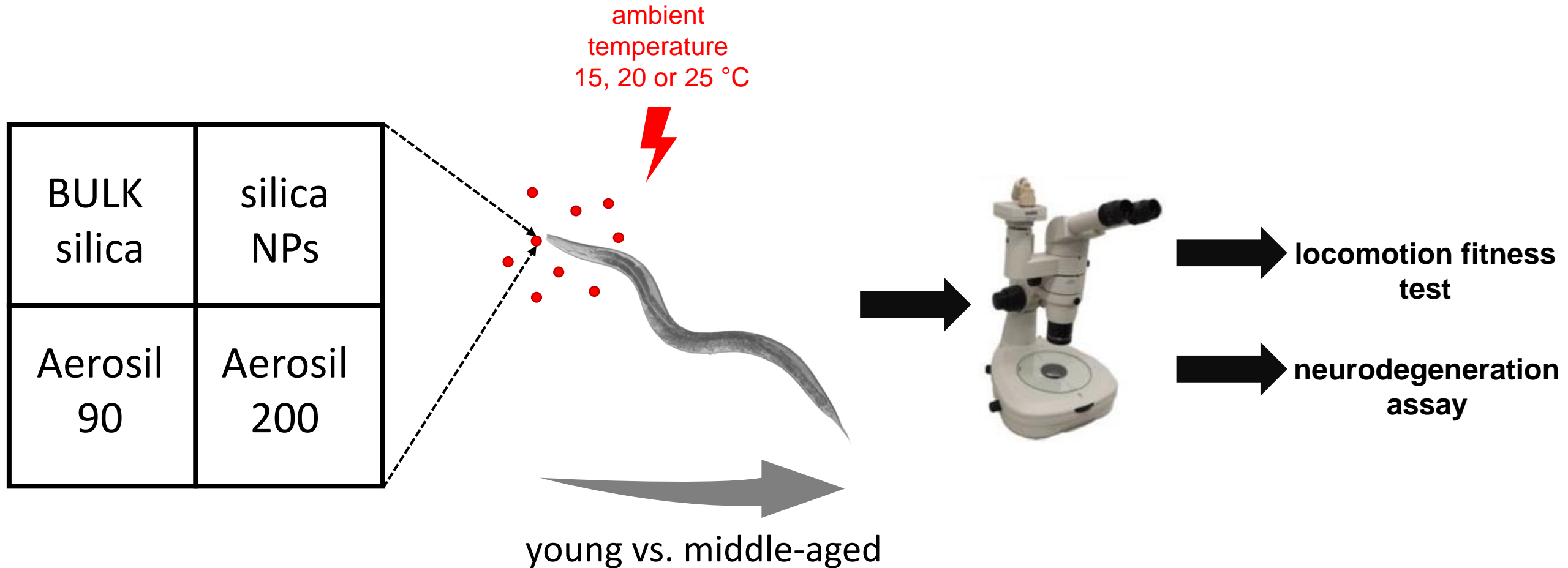
- most cases idiopathic (~85%)
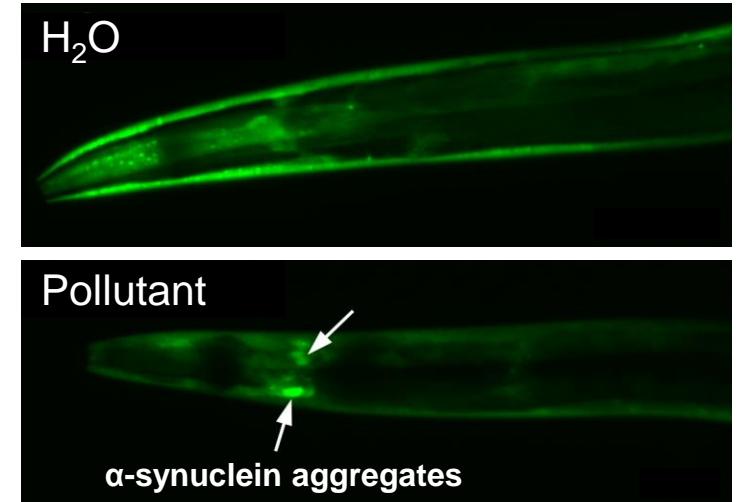
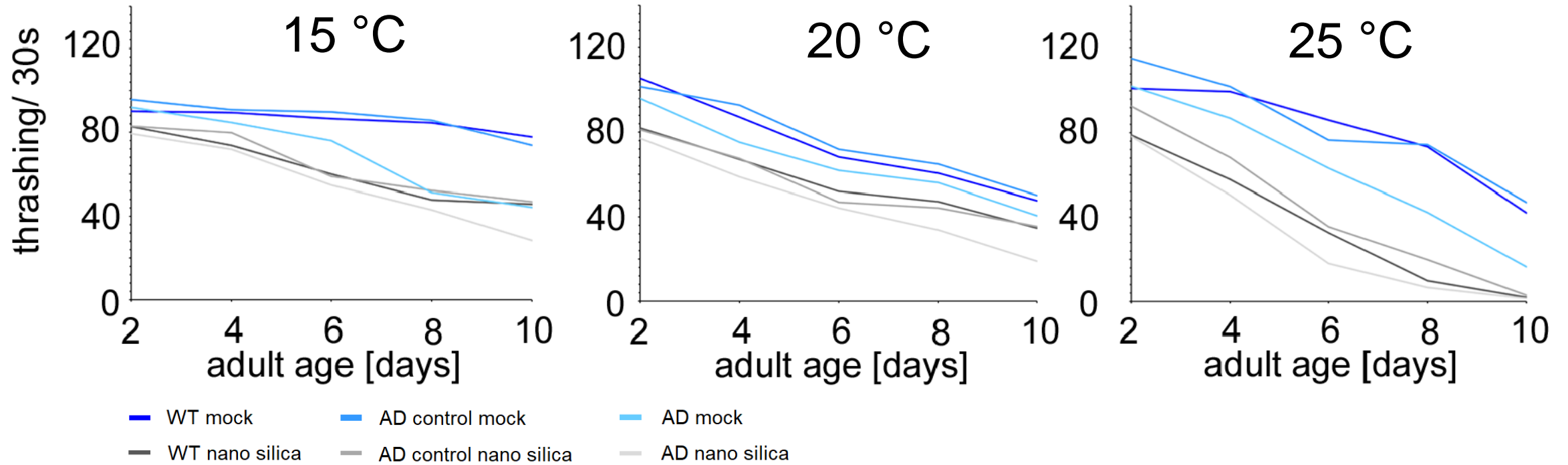adapted from: Limke et al., Environ Pollut (2023)

C. elegans **models for PD:**

- α-synuclein reporter

- reporter for dopaminergic neurons

- enables observation of neurodegeneration

dat-1p::GFP

Nass et al., Proc Natl Acad Sci U S A (2002); Cooper and Raamsdonk, J Parkinsons Dis (2018)

Experimental Flow:
Behavioral Phenotyping and Neurodegeneration

BULK silica	silica NPs
Aerosil 90	Aerosil 200

ambient temperature 15, 20 or 25 °C

young vs. middle-aged

locomotion fitness test

neurodegeneration assay

Silica NPs Accelerated Neuromuscular Defects in a *C. elegans* **AD Model**

- nano silica accelerated locomotion fitness decline in a AD model

- middle-aged AD model worms most vulnerable

- ambient temperature critically determines susceptibility to pollutants

# Silica NPs Accelerated Neuromuscular Defects in a *C. elegans* **PD Model**

15 °C
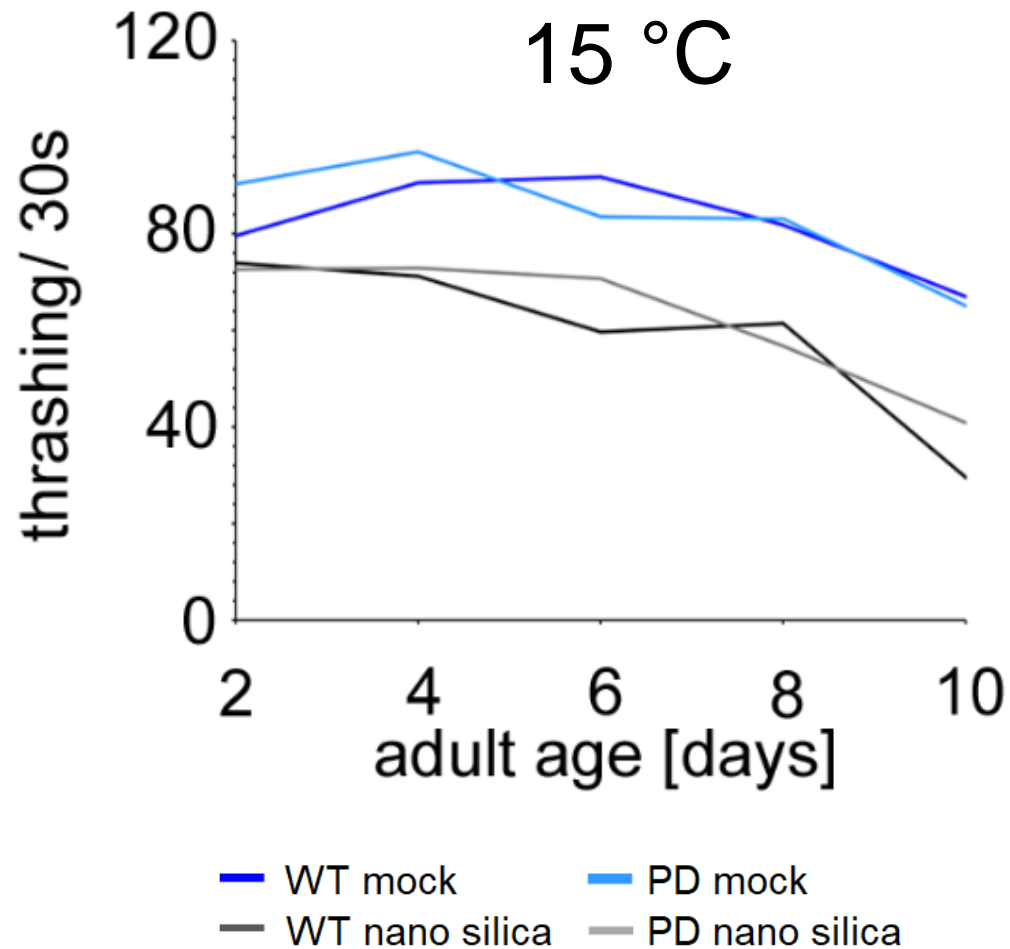
- nano silica accelerated locomotion fitness decline in a PD model

- WT and PD model same vulnerability against nano silica

Limke et al., Environ Pollut (2023)

Silica NPs Induced Premature Neurodegeneration of Dopaminergic Neurons
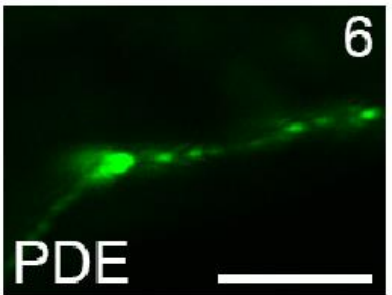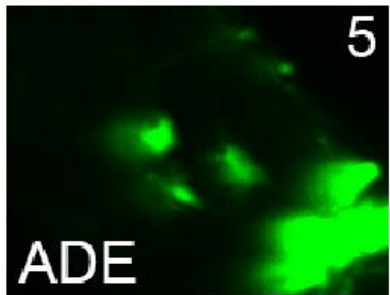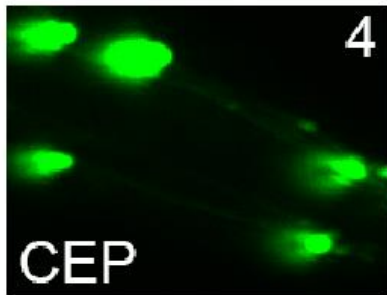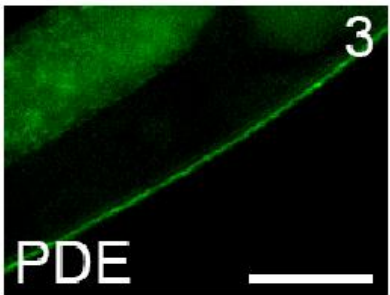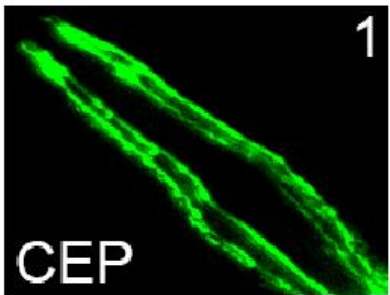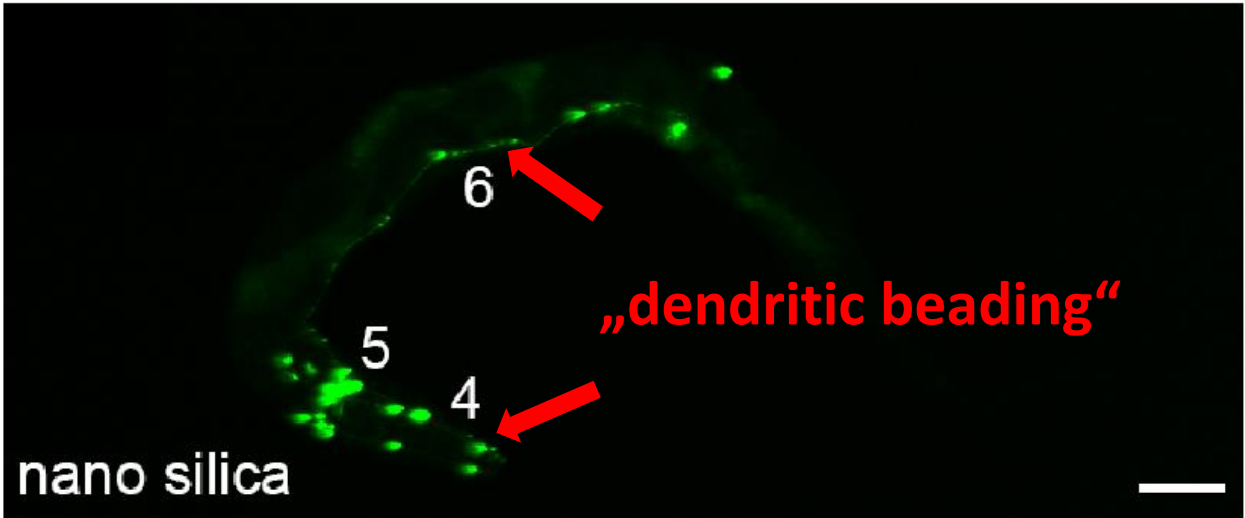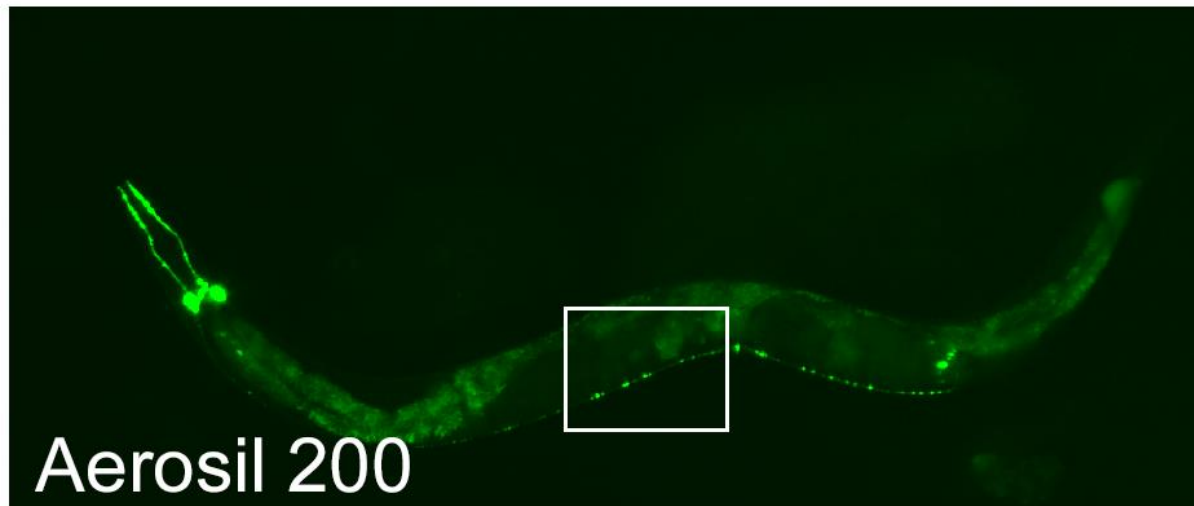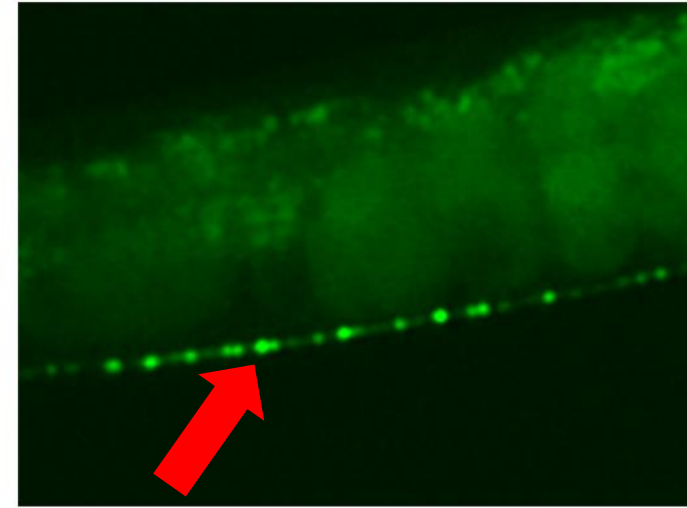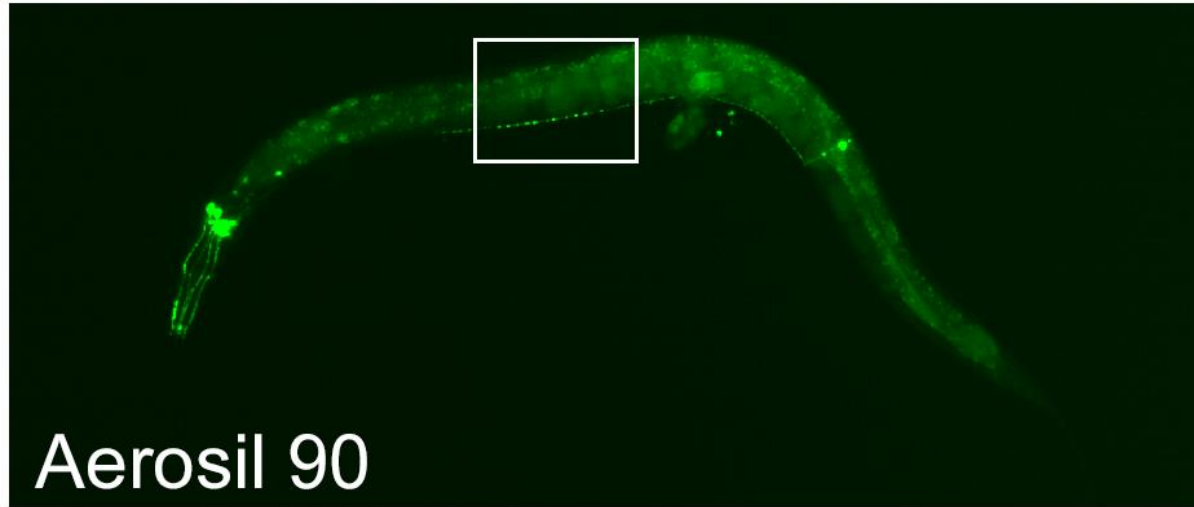
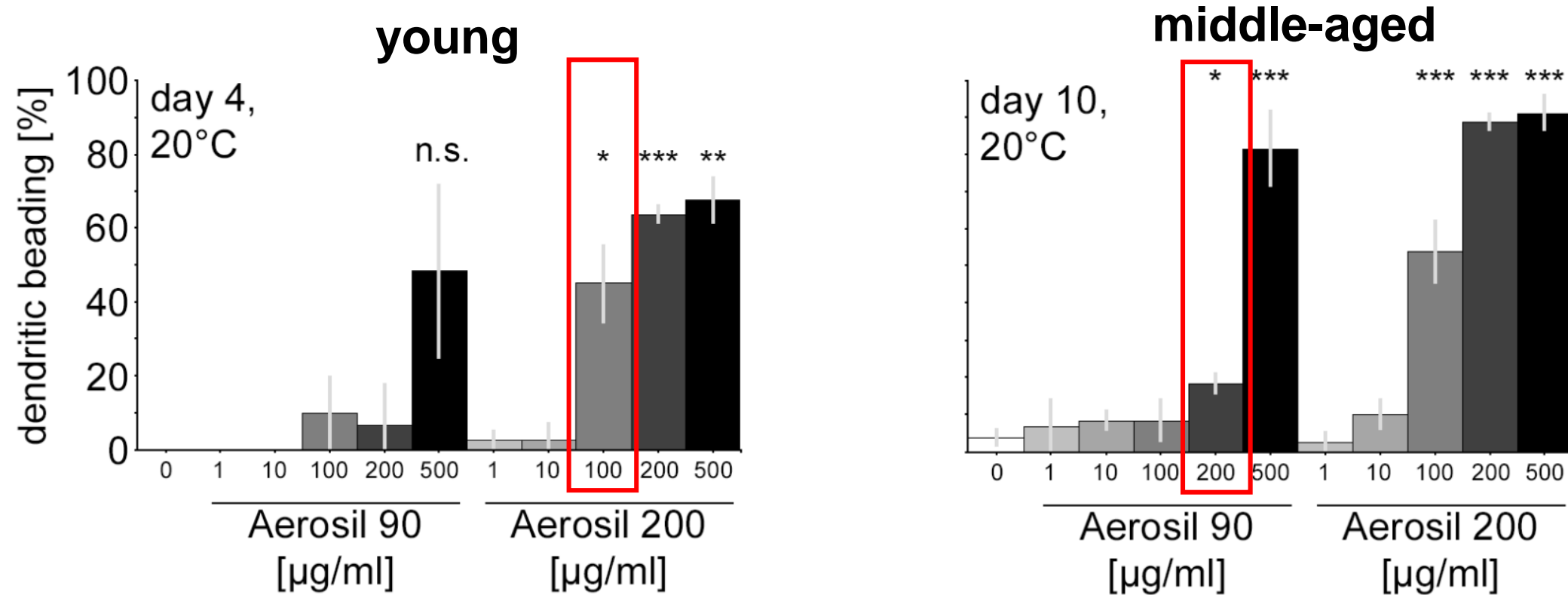# Silica NPs Induced Premature Neurodegeneration of Dopaminergic Neurons
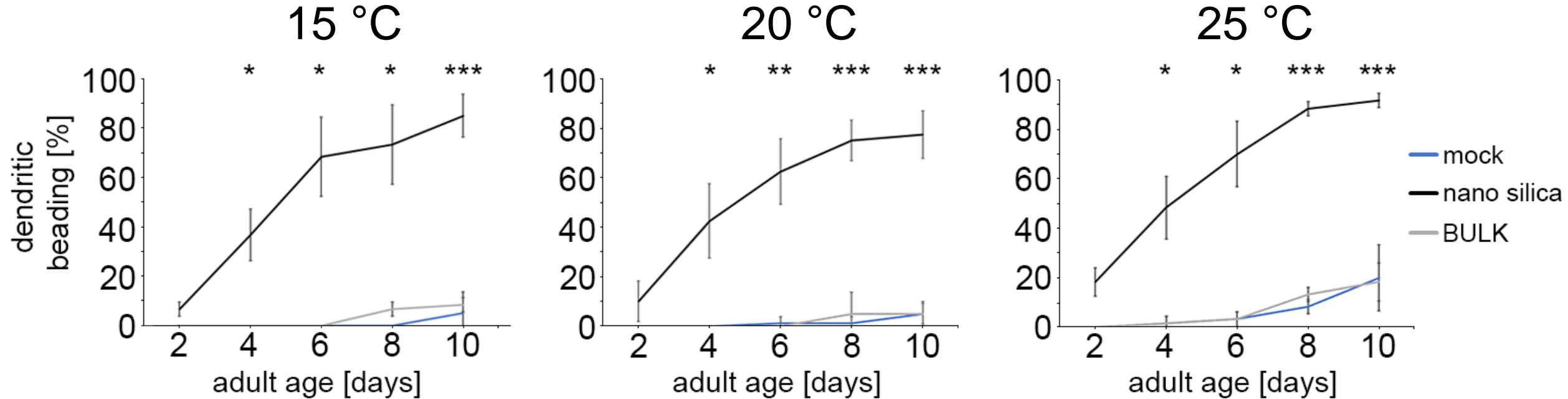
- silica NPs induced premature degeneration of dopaminergic neurons

- nanoparticle-specific effect

- simultaneous occurence of fitness reduction and neurodegeneration

Tire Components Induced Neurodegeneration in Dopaminergic Neurons of Young Worms
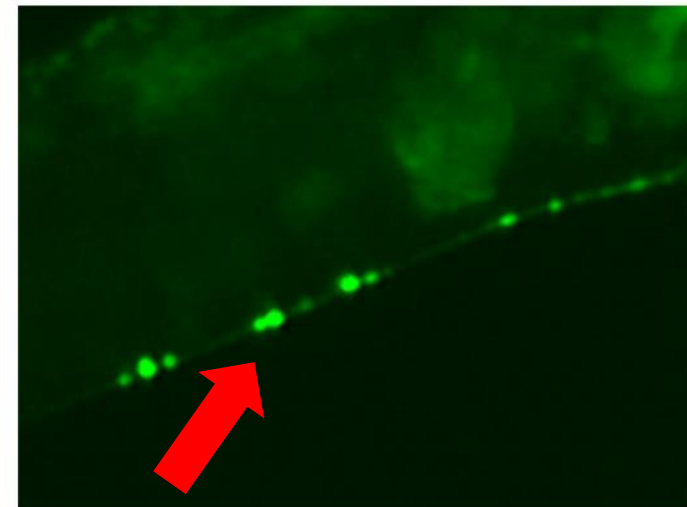
„dendritic beading" in PDE neurons

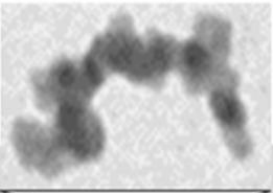# Tire Components Induced Neurodegeneration in Dopaminergic Neurons of Young Worms

- tire components induced neurodegeneration in dopaminergic neurons in young worms

- LOAEL of Aerosil 200 - **100 µg/mL** and Aerosil 90 - **200 µg/mL**

- silica NPs from different sources & synthesis methods induced neurodegeneration
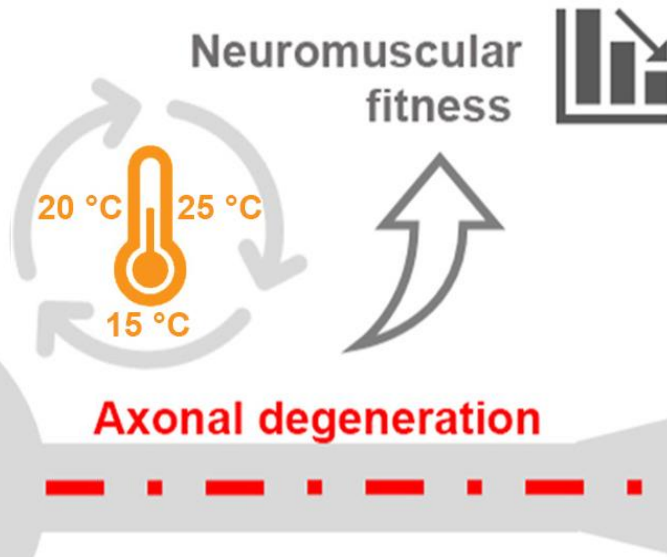
Conclusions

- tire component nano silica induced neurodegeneration in *C. elegans*

- most vulnerable to nano silica was a *C. elegans* Alzheimer's disease model

- a Parkinson's Disease model showed degeneration of dopaminergic neurons

- combined exposome factors accelerated neurodegeneration in *C. elegans*

- tire components, old age, $A\beta_{1-42}$ expression and 25 °C all increased neural decline

Acknowledgements