TNO innovation for life

level acoustics & vibration

rivas & CargoVibes

# fysische werking en betrouwbaarheid van trillingsmaatregelen

Chris Geurts (TNO)

Arnold Koopman (Level)

# Inhoud

- RIVAS en CargoVibes
- Fysische principes van trillingsmaatregelen
- Wat is er zo lastig aan spoortrillingen?
- Betrouwbaarheid

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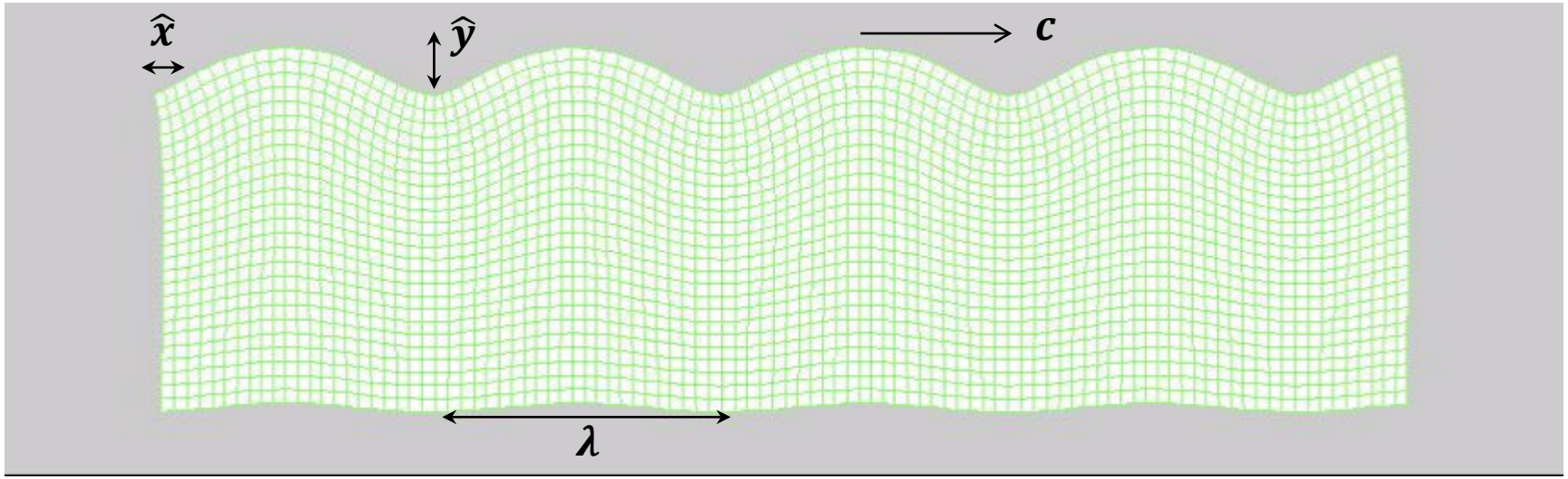
European Commission | Horizon 2020 European Union funding for Research & Innovation

rivas

# Ontwikkelen van beoordelingsmethoden van maatregelen

# Ontwikkelen van maatregelen




| | | |
|---|---|---|
| $c$ | golfsnelheid [m/s] | $c = \mathrm{f}\,\lambda$ |
| $\lambda$ | golflengte [m] | $\mathrm{y} = \hat{y}\sin 2\pi f t$ |
| $f$ | frequentie [1/s, Hz] | $\mathrm{T} = {}^{1}/_{f}$ |

$$\lambda = {}^{c}/_{f}$$

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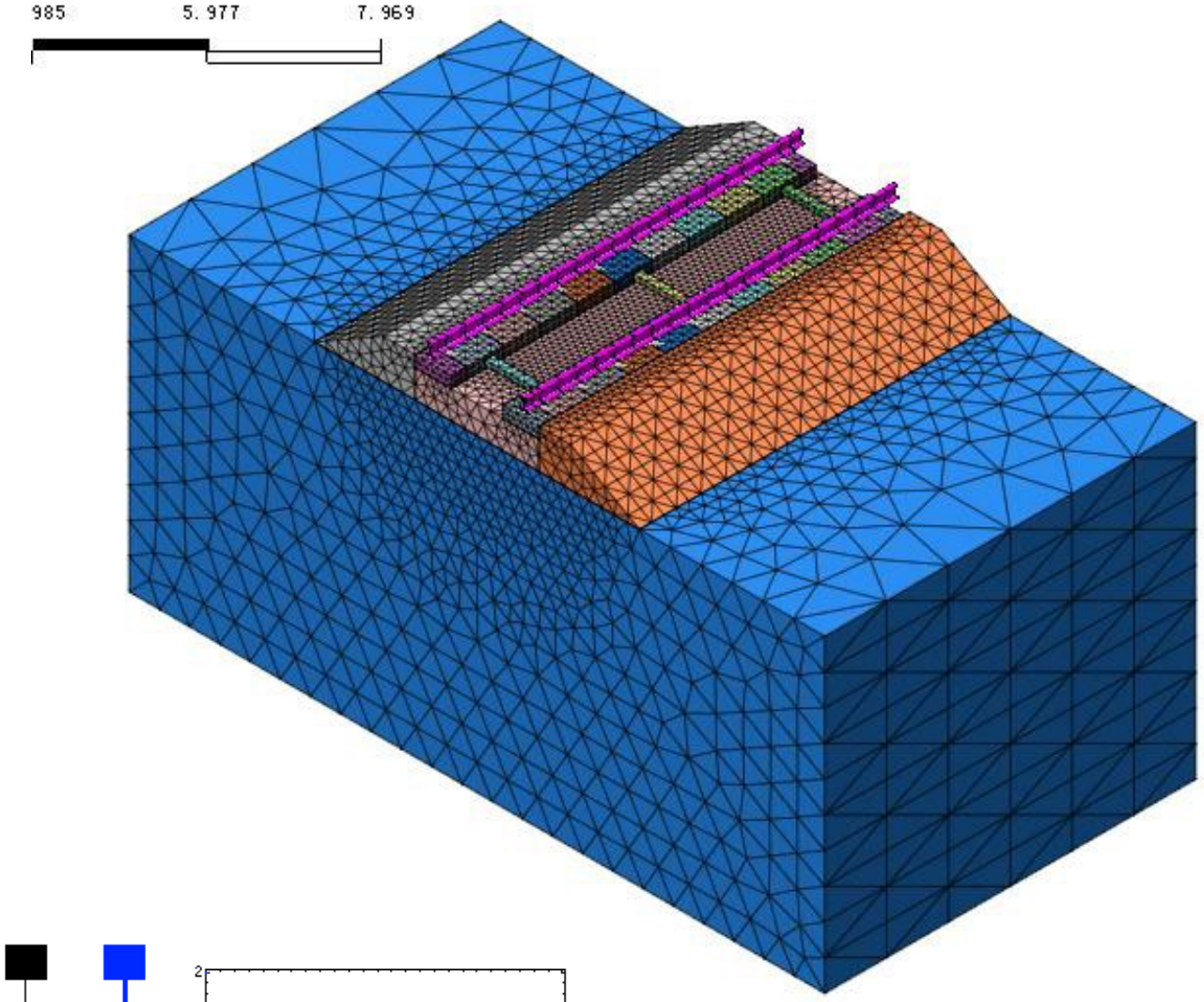
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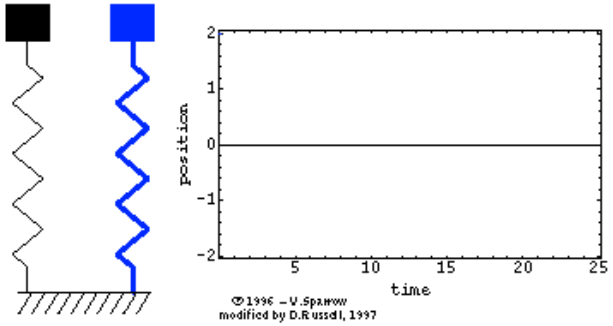
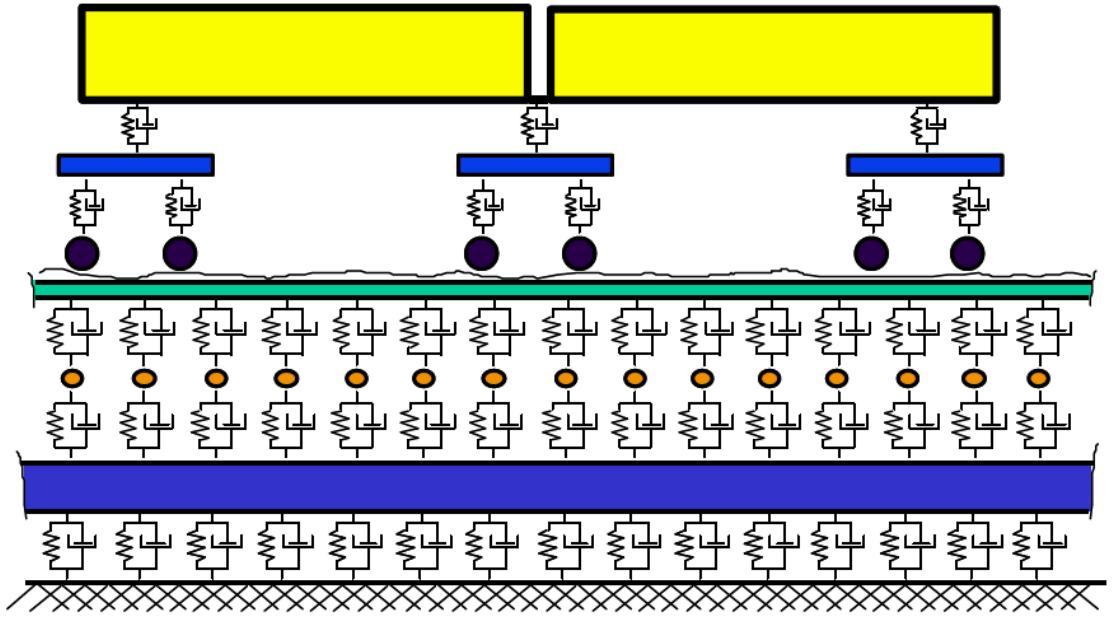
7.969


position
time
2
1
0
-1
-2
5
10
15
20
25
©1996 - V.Spanow
modified by D.Russell, 1997



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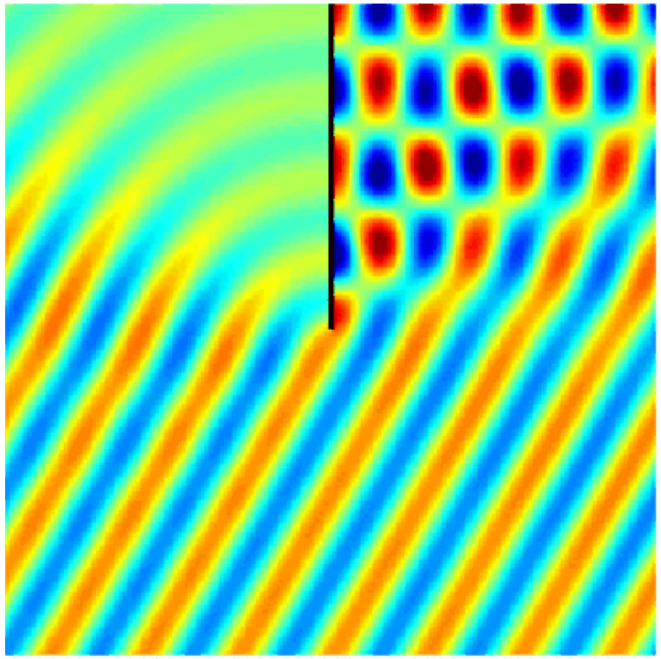
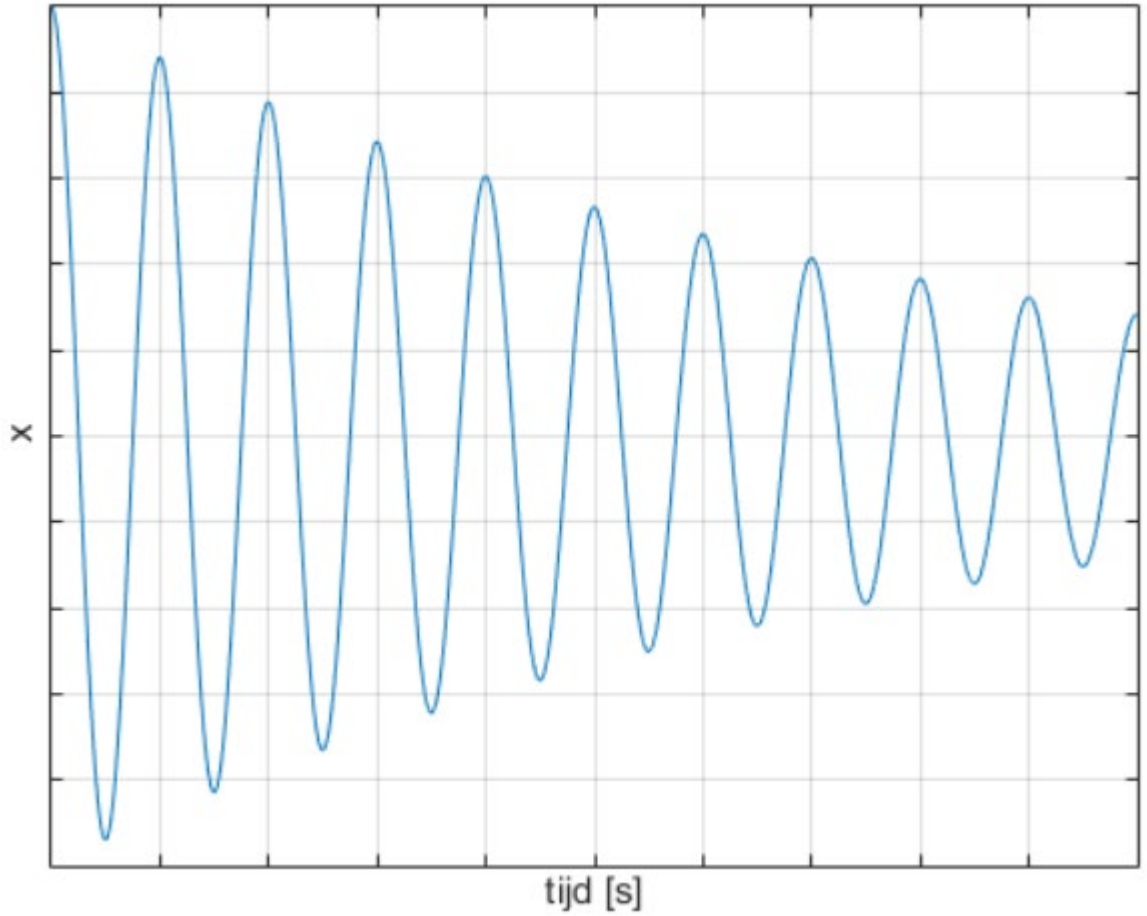
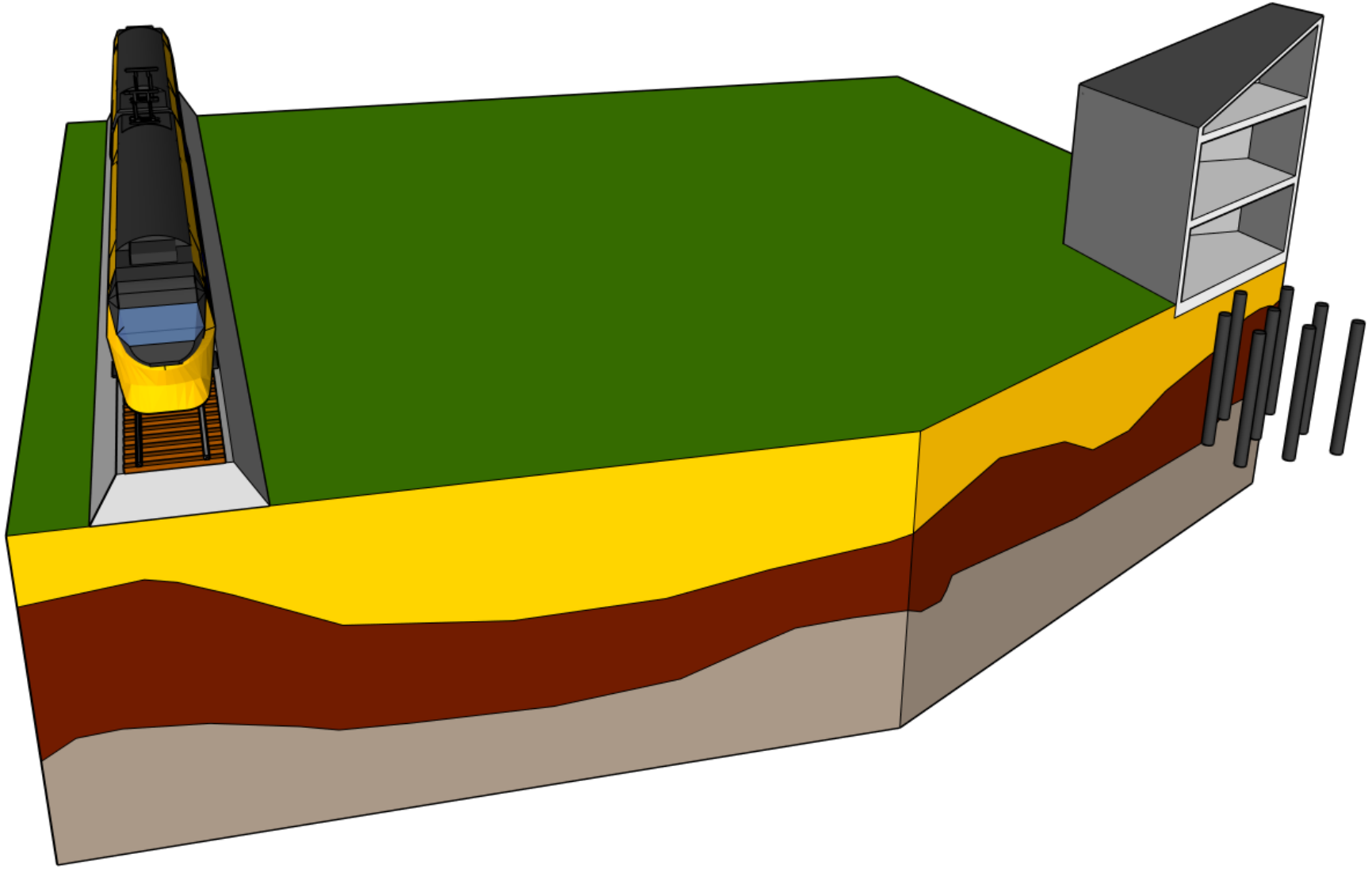


# Absorptie

•



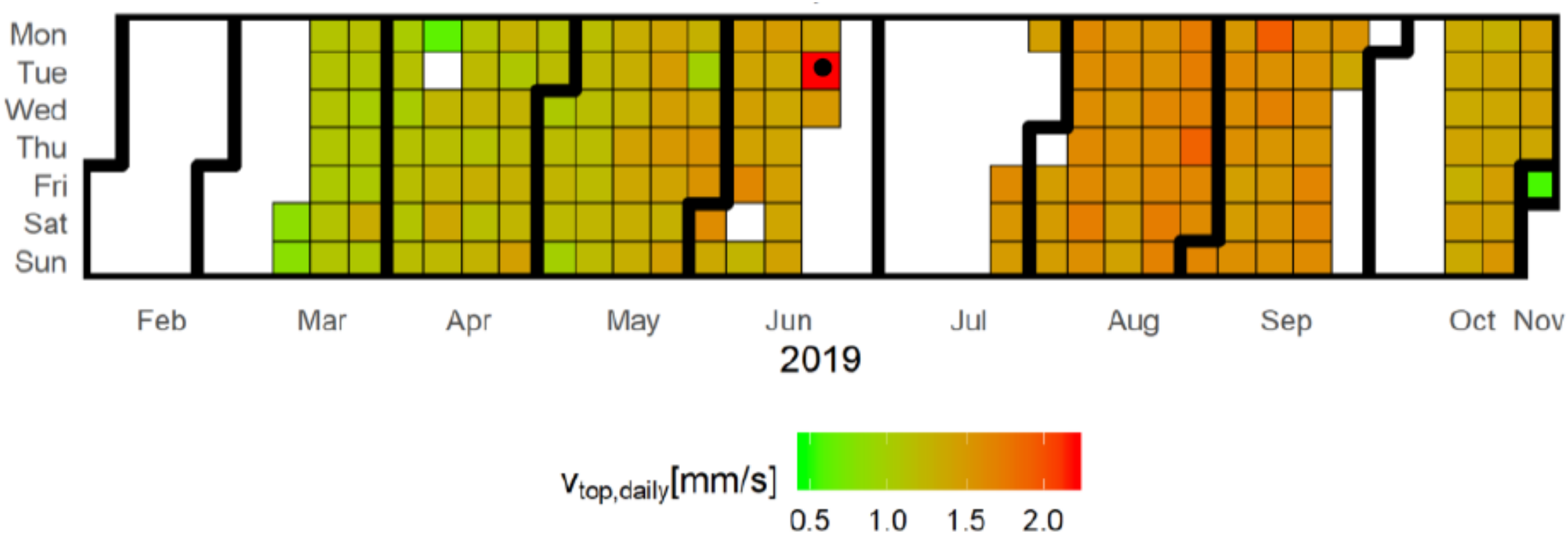
# Wat is er zo lastig aan spoortrillingen?



# Onzekerheden in voorspellingen

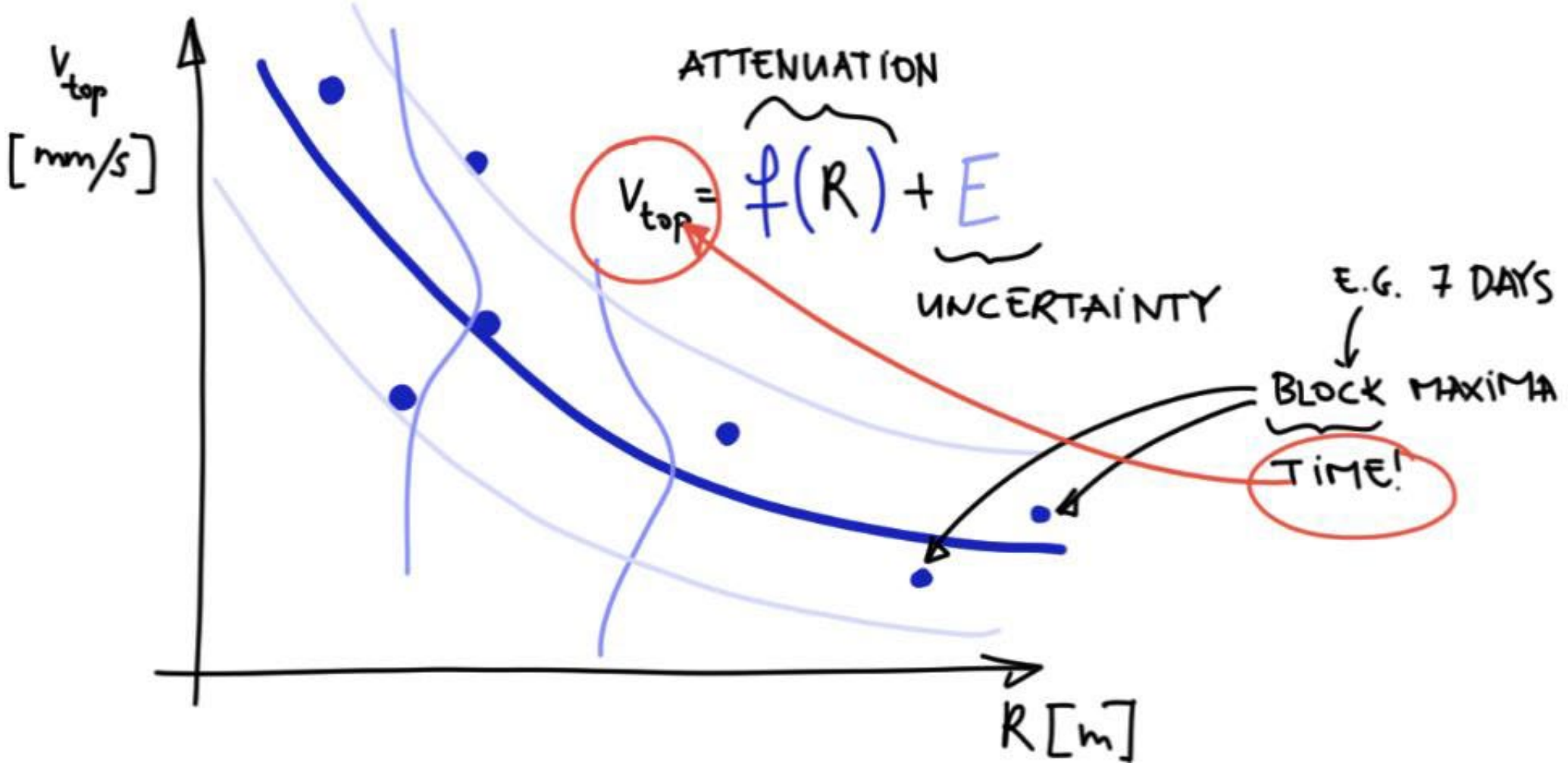
- Keuze meetperiode
- Representatieve meetduur
- Modelonzekerheid

# Effecten in de tijd

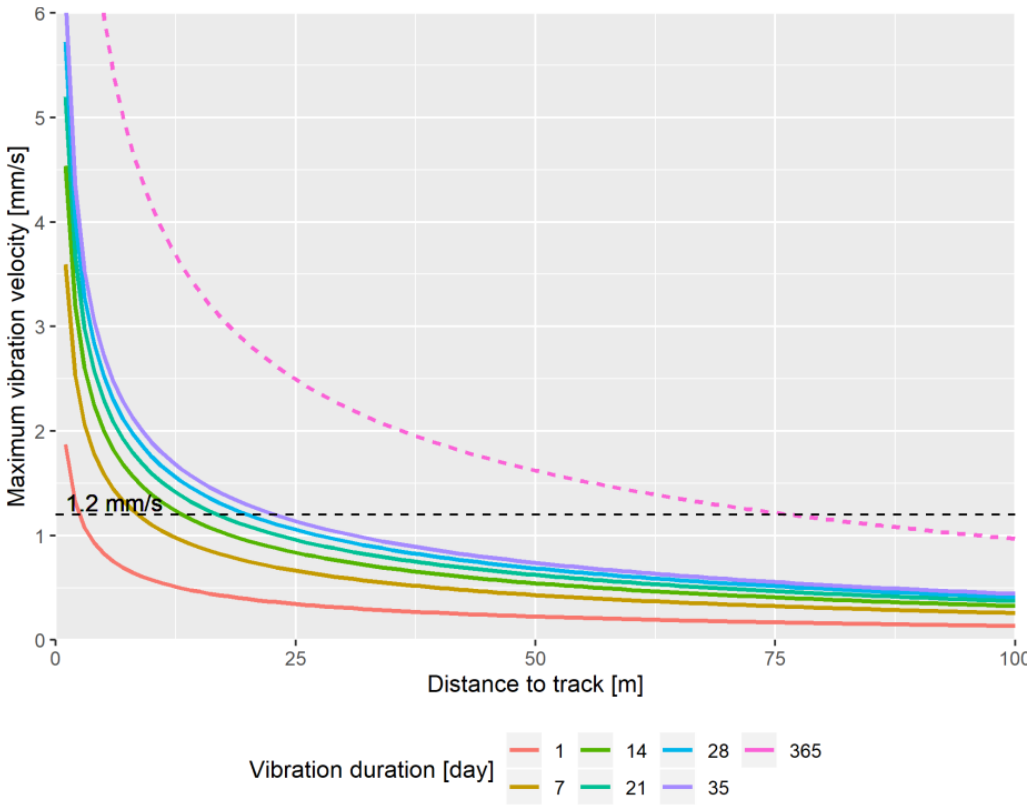


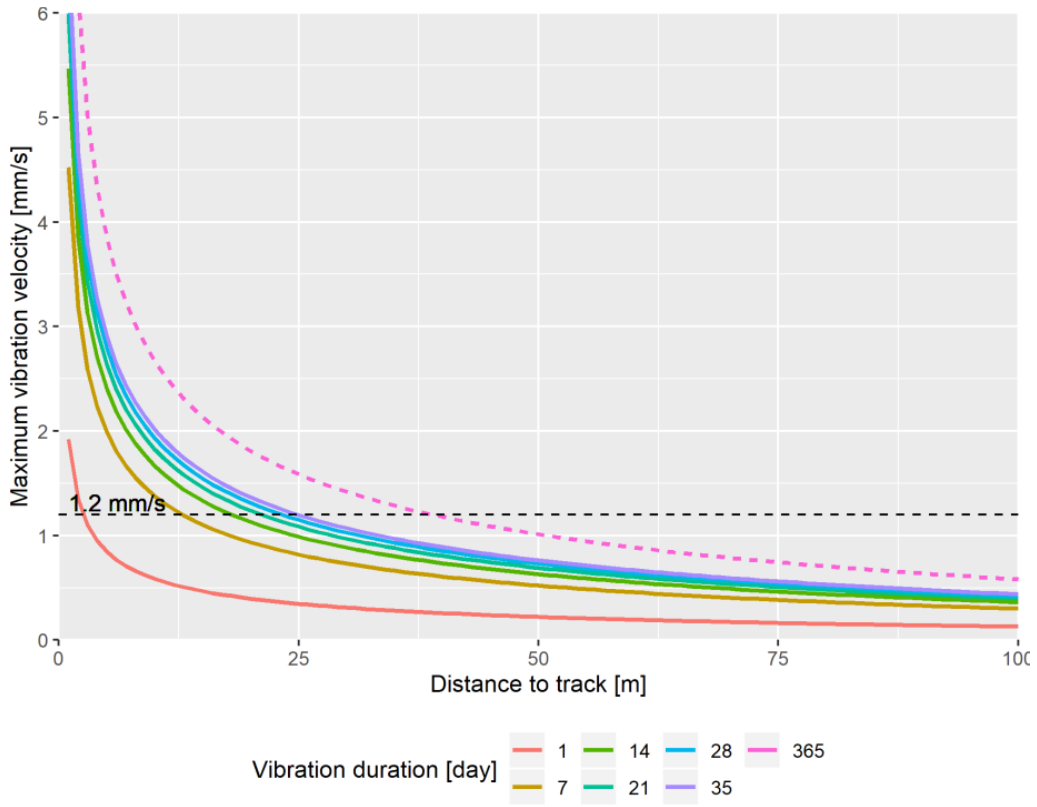

Uit: TNO Rapport 2020 R10620: Achtergronden bij Prorail Schadeprotocol

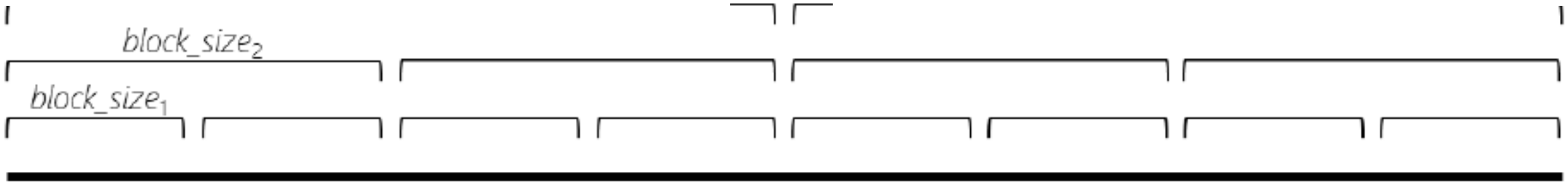
# Relatie afstand tot spoor en $v_{top}$



# Meetduur en statistisch model

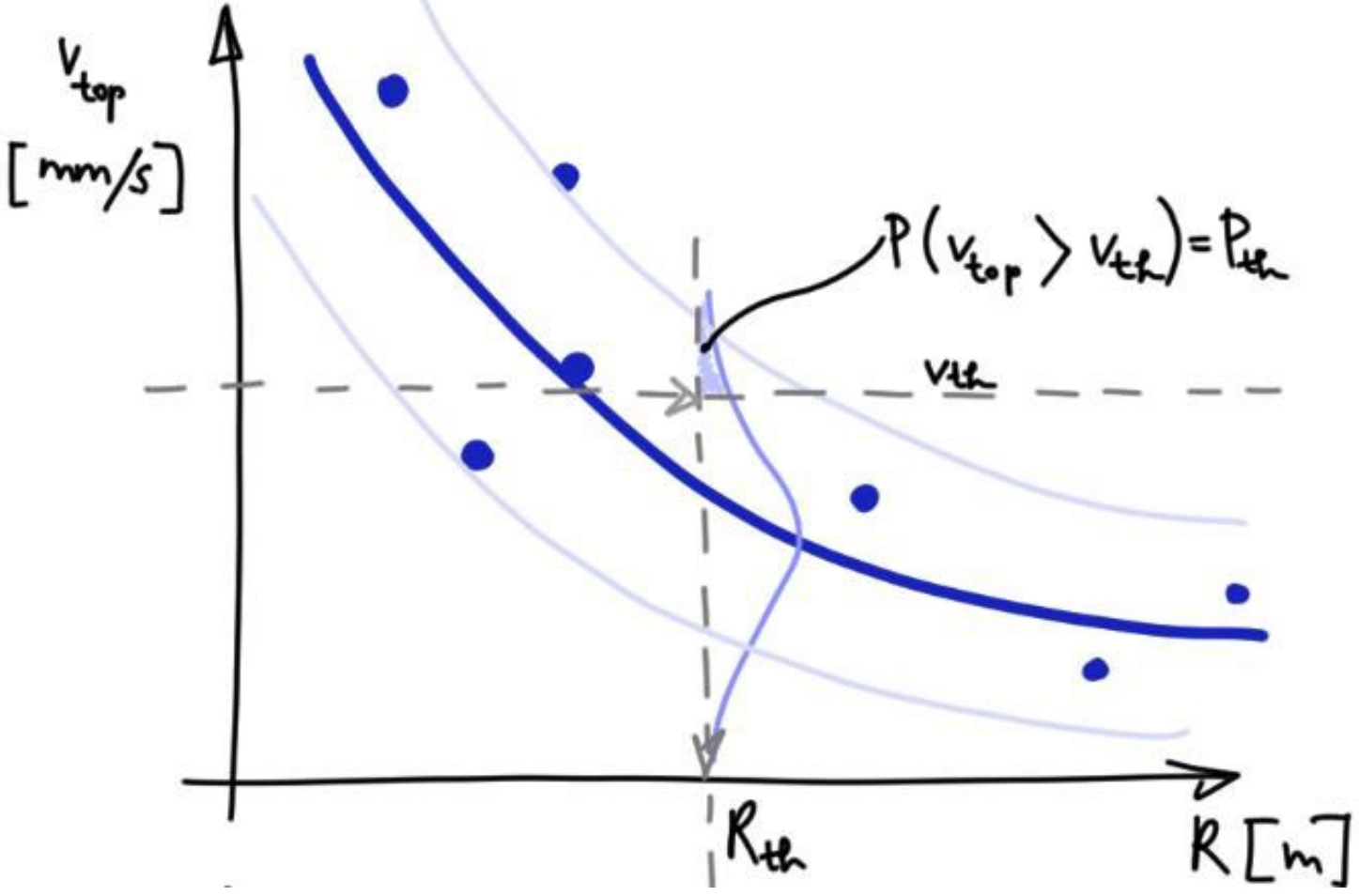


# Onzekerheden in voorspellingen

**Voorbeeld: Bepaal afstand waarbinnen Schadekans > 1**




**Bekend**:
Schadekans 1% bij $v_{grens}$

$v_{top}$ als functie van afstand R

# Onzekerheden in voorspellingen

- Spreiding in belasting én in weerstand, via criteria
  - Belasting: trillingsniveaus [$v_{top}$, $v_{max}$, $v_{per}$, etc]
    - Metingen: deterministisch – representatieve meetperiode
    - Modellen: probabilistisch (model- en natuurlijke onzekerheden)
  - Weerstand
    - Bij sterkte: kwetsbaarheidskrommen (fragility curves)
    - Bij hinder: Dose-Response relaties

# Dank u voor uw aandacht!

Chris Geurts

Arnold Koopman