

**clean green  
hydrogen**



**Gen<sub>2</sub> Energy**

# NV NTNU – laboratory work in practice

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- 1 Experiments – crap in crap out
- 2 HSE and PPE
- 3 Steps involved in a good analysis
- 4 Summary

# Experiments – crap in crap out

- If you don't do the right thing right, you better not do it at all
- Laboratory work involves much more than just analysing



# HSE and PPE

- **HES**

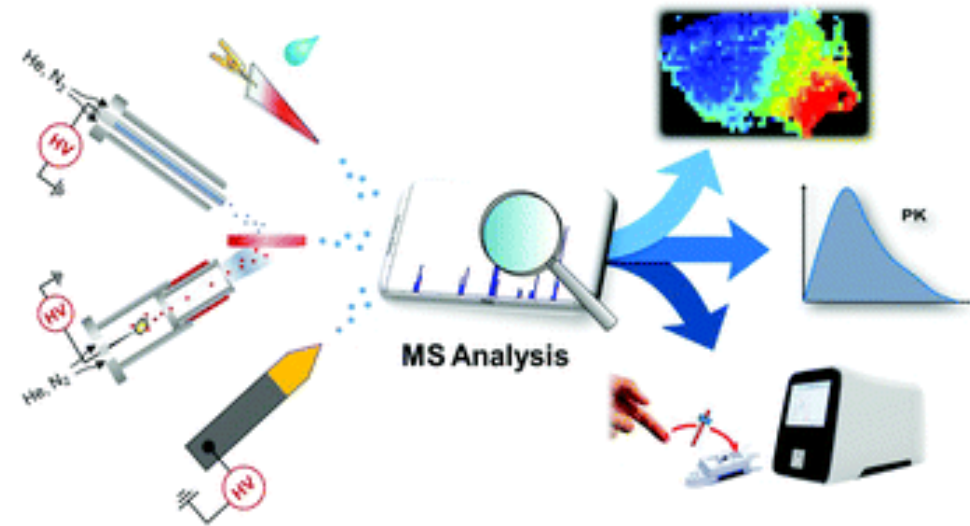
- *Health*
  - it starts in the lab
- *Environment*
  - people, equipment and surroundings
- *Safety*
  - you are your own safety manager

- **PPE**

- Personal Protection Equipment
  - Think before you act!



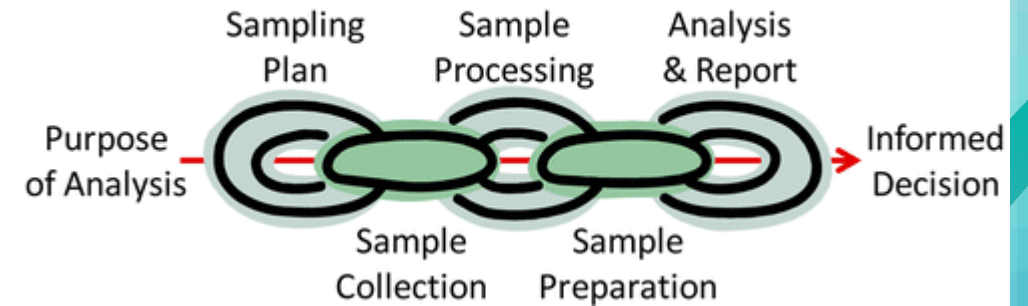
# Hunting the truth is complex



# Steps in a properly done analysis

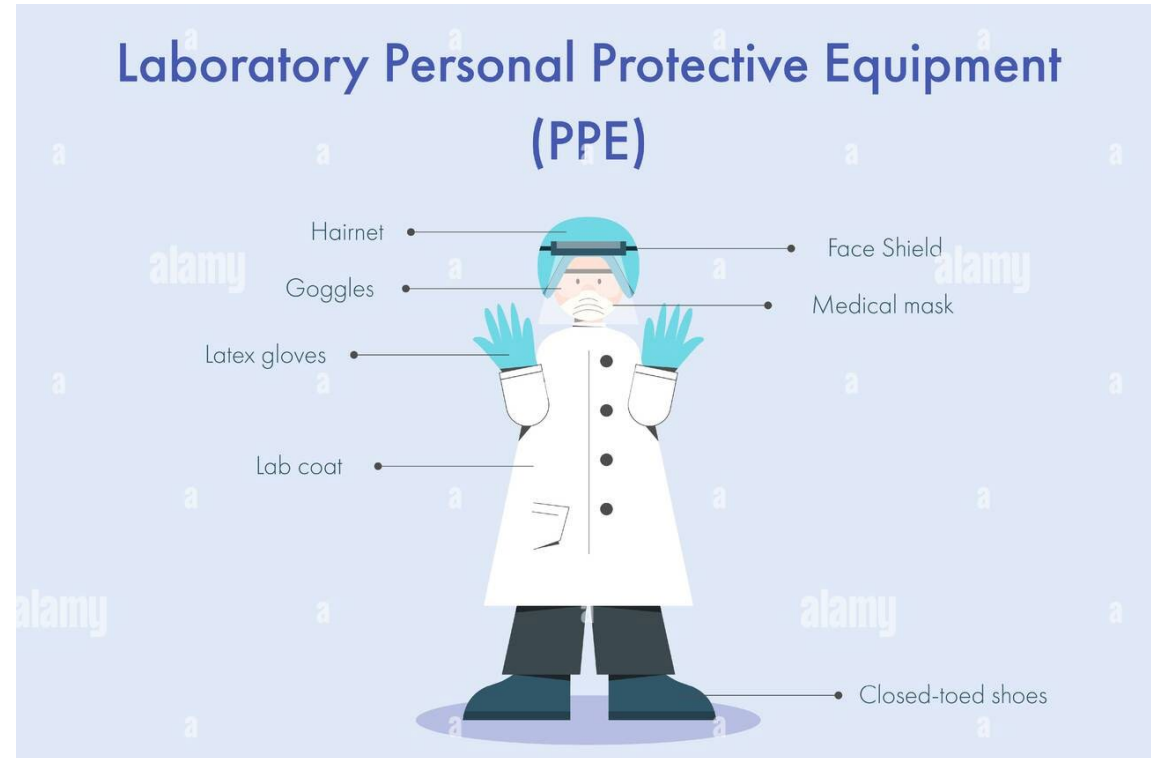
1. Select the right measuring method
  - What to measure, concentration range etc.
2. Sampling
  - Where, how, when, how many samples etc.
3. Know your instrument and do it right
4. Data quenching
  - Interpretations
5. Actions!

## The Analytical Process is Only as Strong as its Weakest Link



# Lab skills you need, part 1

- HSE – PPE
- Be thorough
- Be tidy
- Know your instrument
  - Calibration
  - Maintenance
  - Procedure
- Understand your results
  - Cause and effect





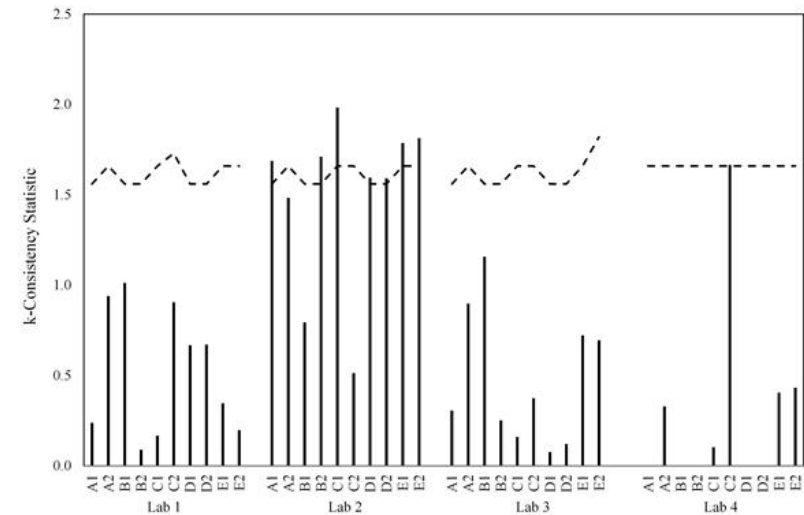
# Lab skills you need, part 2

- Understand cause and effect
- Present you results properly
  - Acknowledge inaccuracy and uncertainty
- IoT gives unlimited possibilities
  - Data overflow?
  - Quality?
  - Accuracy?

\*IoT = Internet of Things

## Z Test Statistics Formula

$$\text{Z Test} = \frac{\bar{x} - \mu}{\frac{\sigma}{\sqrt{n}}}$$






# Future lab skills

- Is classical wet chemistry out of date?
  - Micro sensors are everywhere
  - How to use nano materials
    - Surface chemistry rather than bulk
    - RRI – Responsible Research and Innovation
- How to measure “climate”?
  - Air
  - Soil
  - Indirect “markers”



# Summary

- Experiments don't start at the instrument
  - It starts by analysing the fundamentals of the issue you try to solve
- If you don't identify the key parameter to measure, you risk measuring perfectly the wrong thing
- Sampling is key to a good result
- Being precise and accurate is a must to get a reliable result
- Statistical analysis make you understand the results
- **ALWAYS** use proper Personal Protective Equipment (PPE)



# Herøya industrial site

## *Complexity*

- Many companies
- Different materials and products
- Complex cause and effect
- Many potential risks – safety is key!