

# Interval Measurement Software for Measuring Aging Parameters

Student Project (5. Semester)

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Examiner: Prof. Wolfram Haupt

Student: Don Winter

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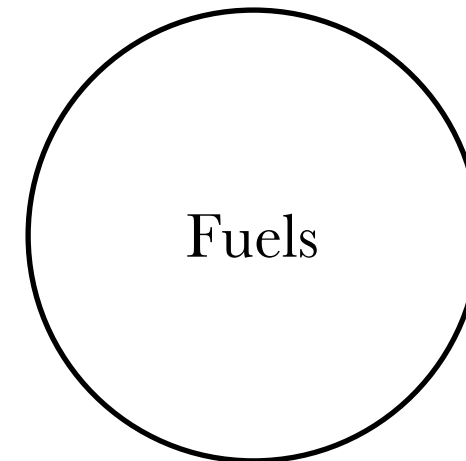
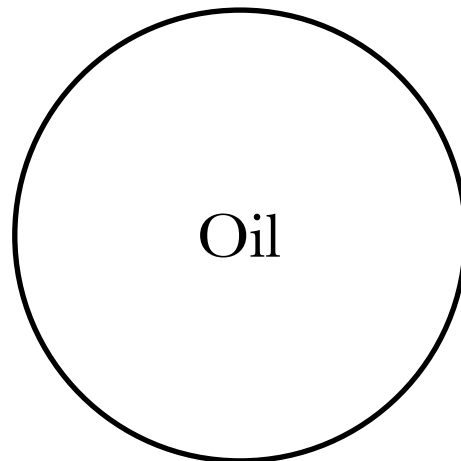
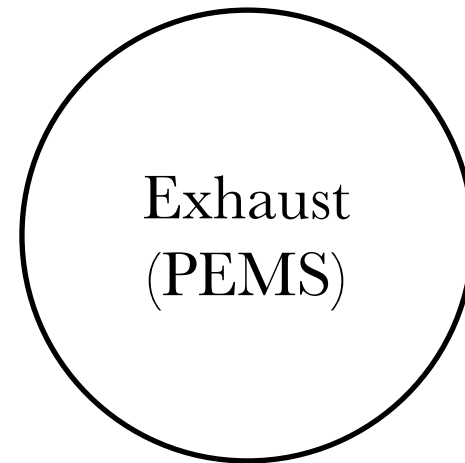
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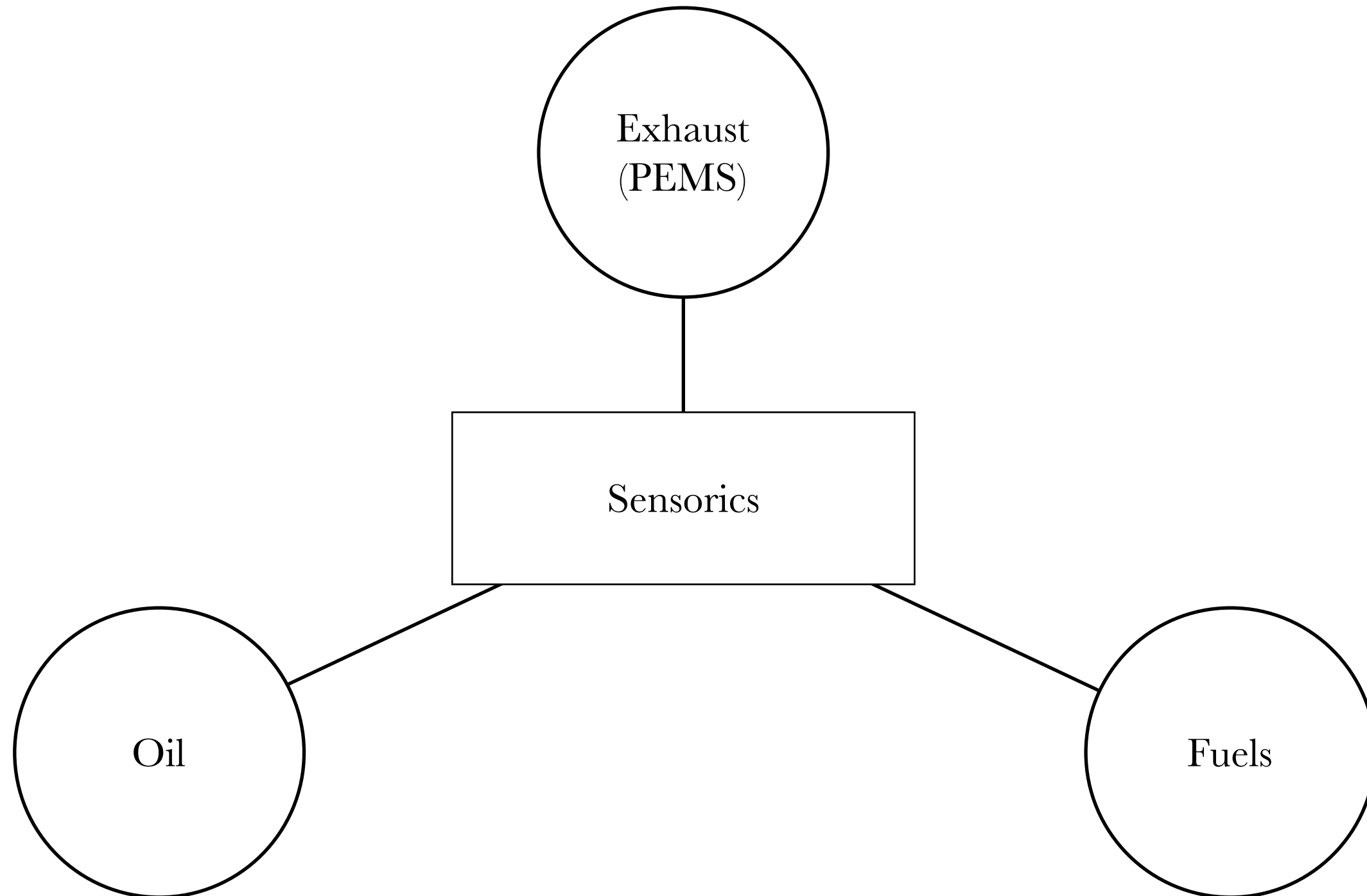
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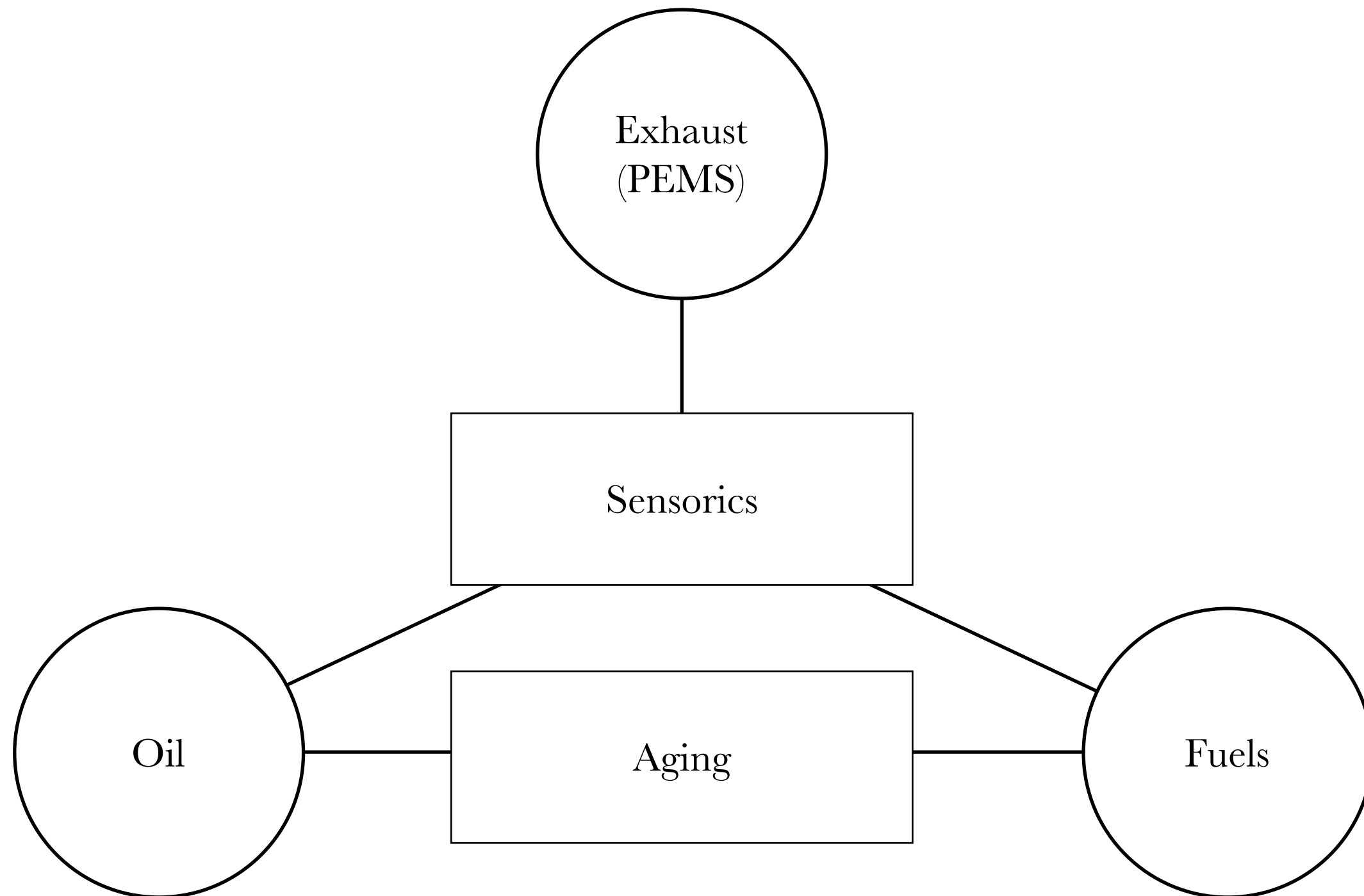
# Research at Hochschule Coburg



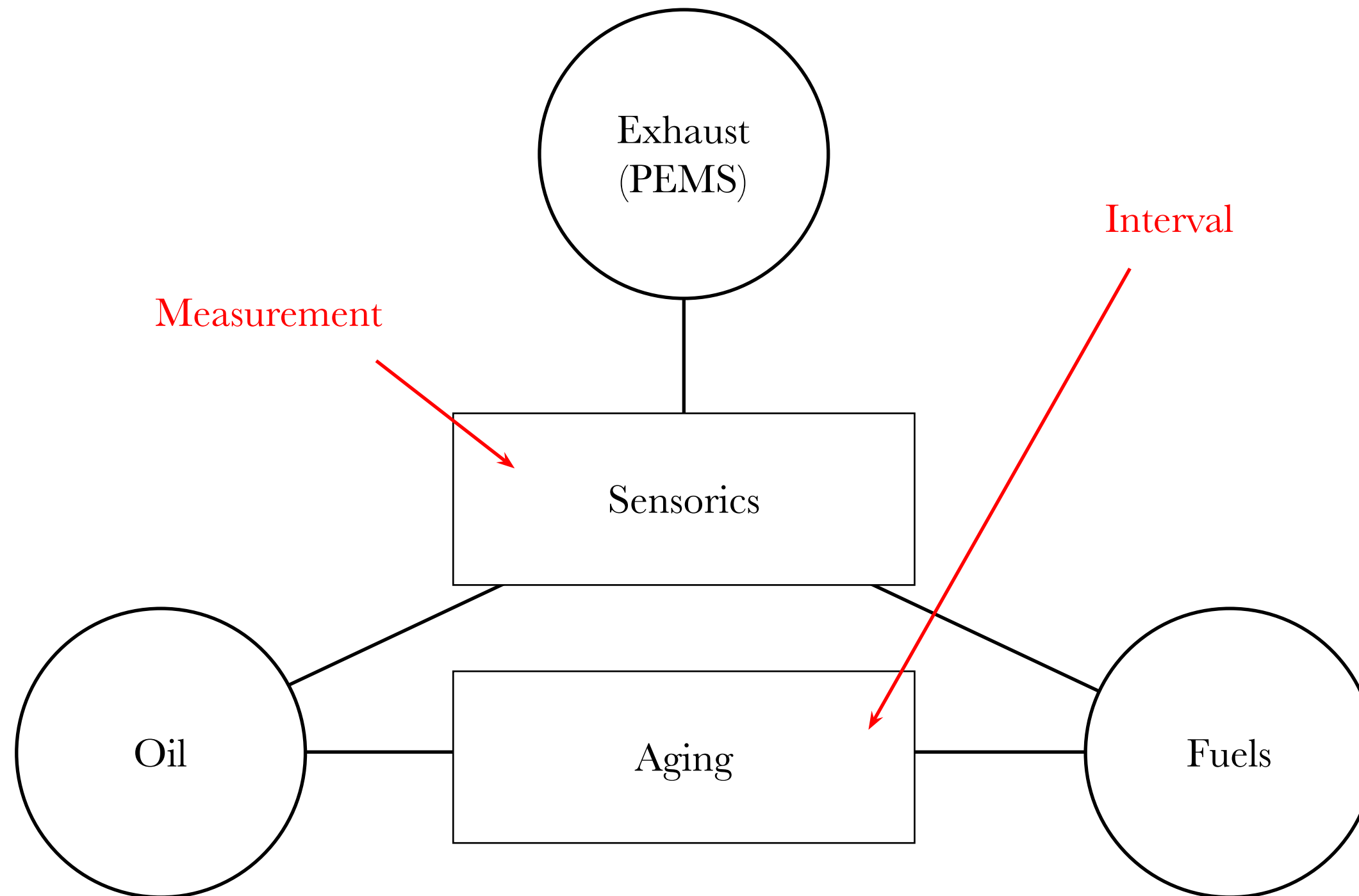
# Research at Hochschule Coburg



# Research at Hochschule Coburg



# Research at Hochschule Coburg

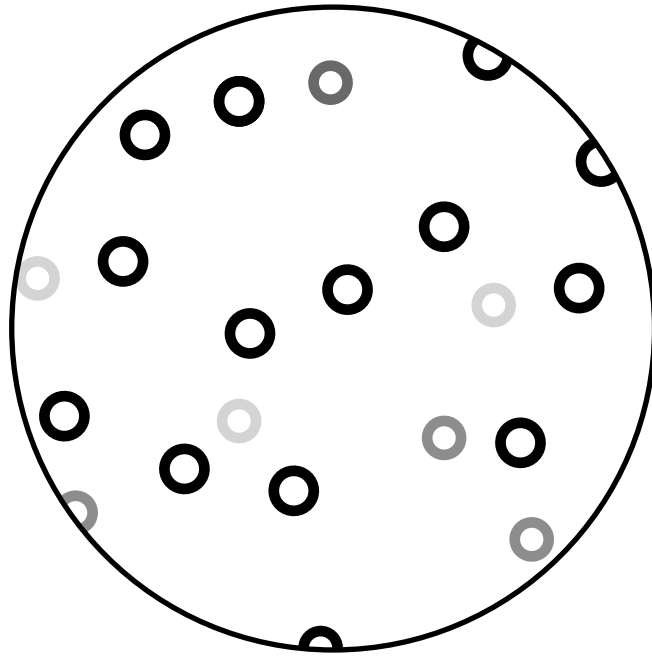


# Aging

Process of adverse physical or chemical changes due to long-term storage of fuel/oil in a system.

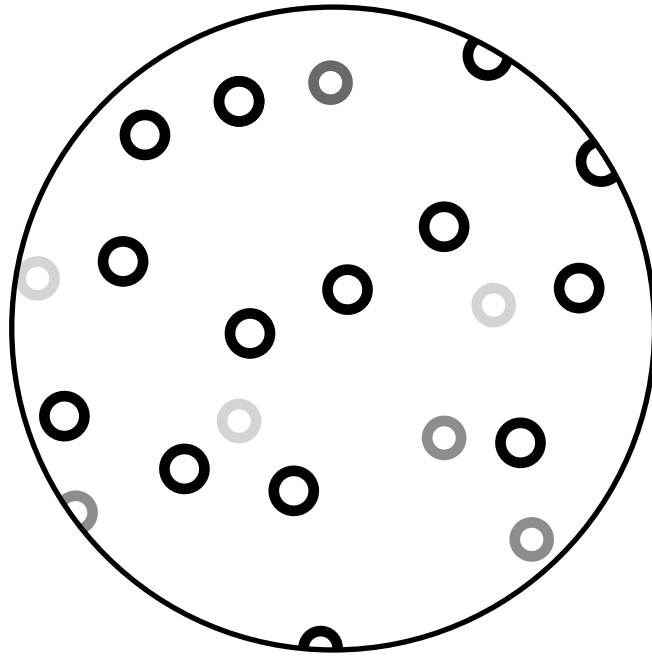


# Aging Parameters



Additive consumption

# Aging Parameters

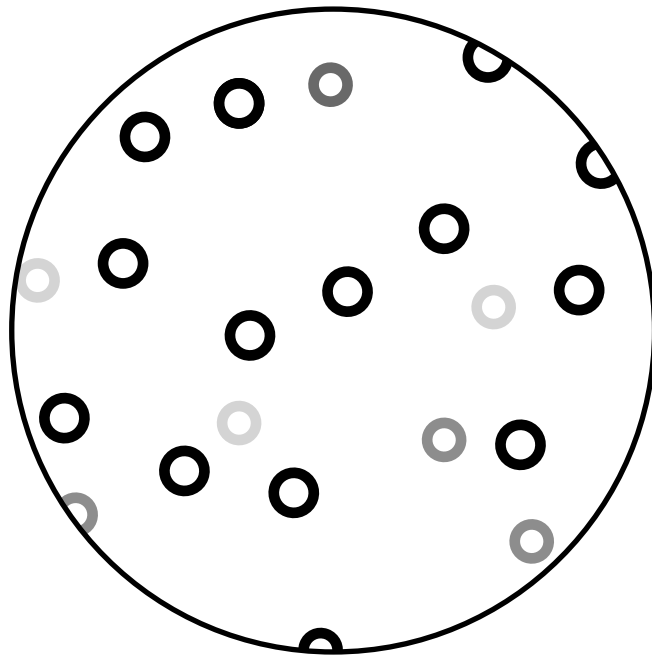


Additive consumption



Creation of Oligomers

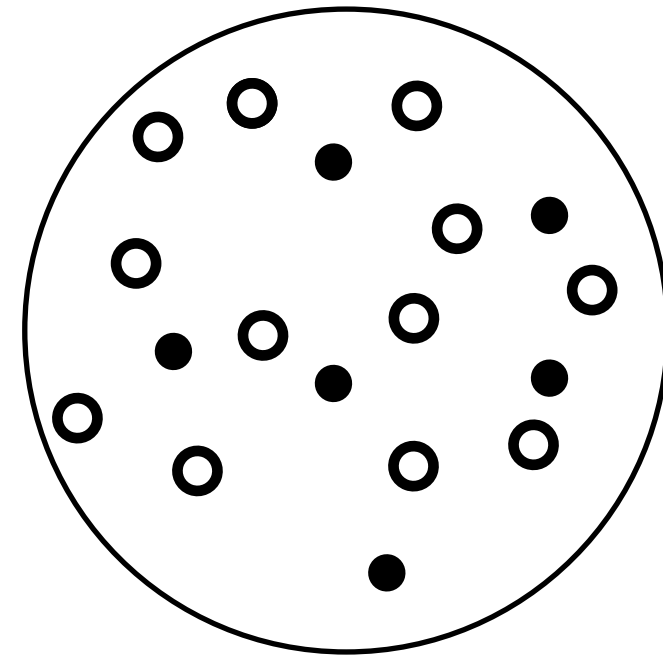
# Aging Parameters



Additive consumption

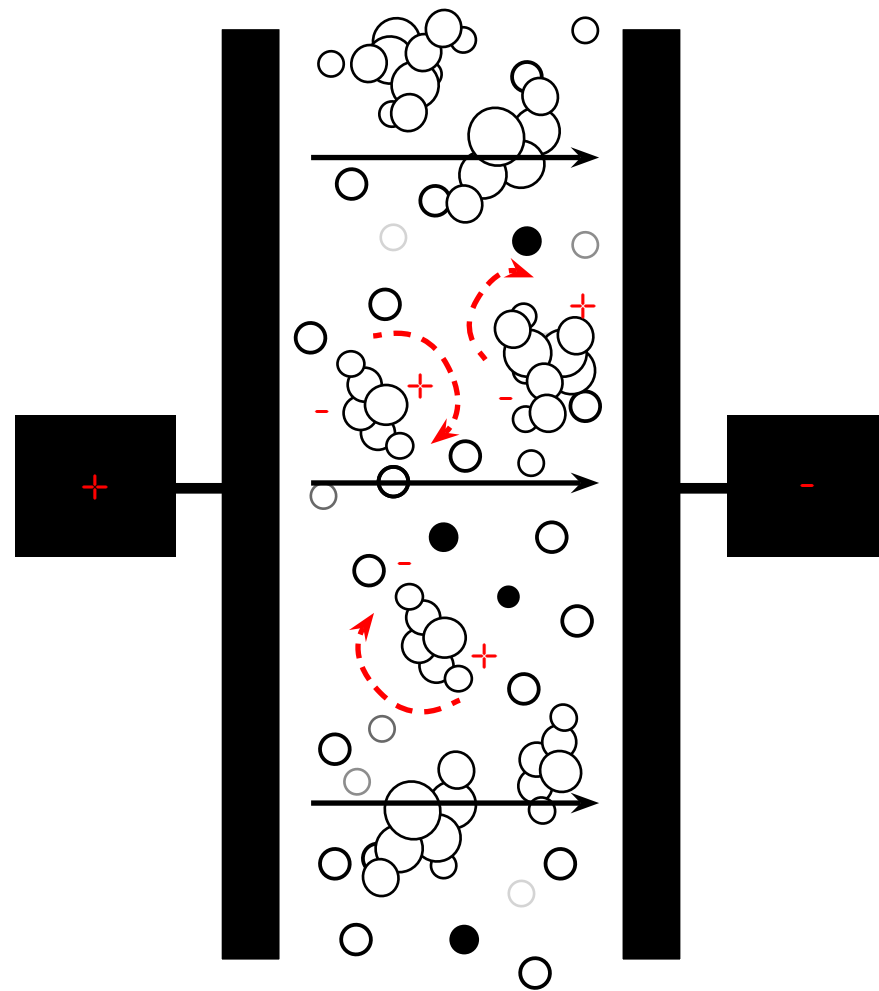


Creation of Oligomers



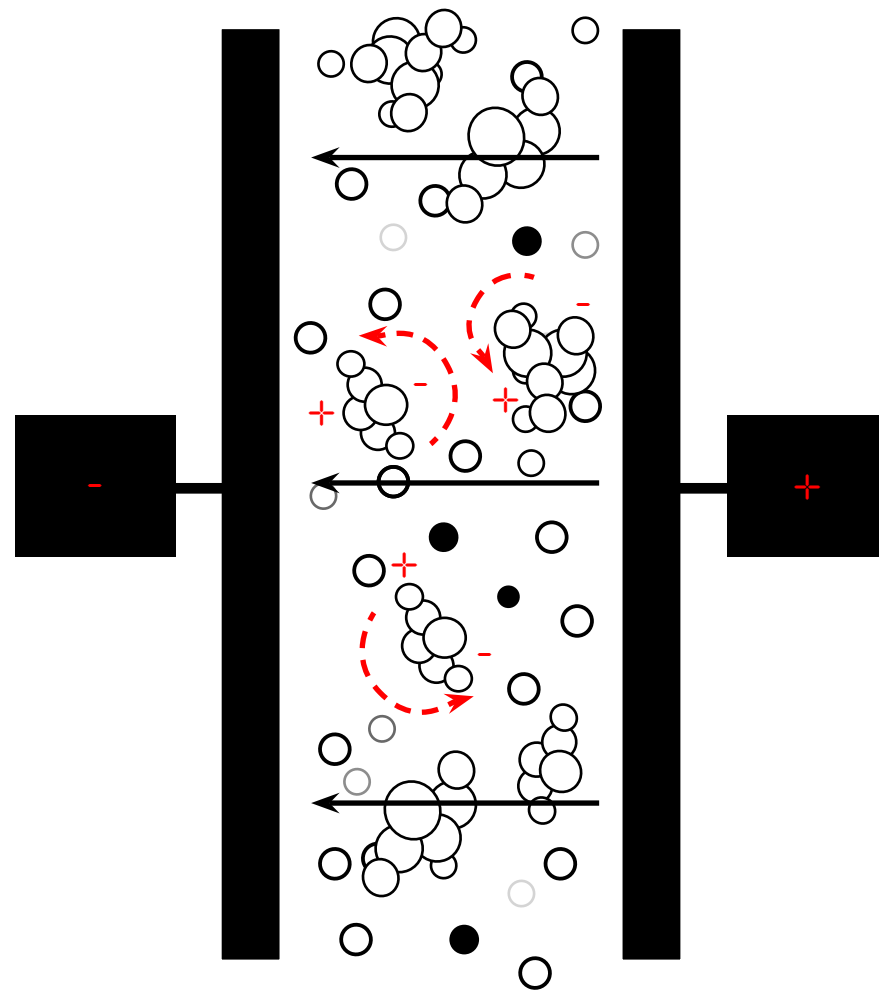
Particle contamination

# Aging Measurement



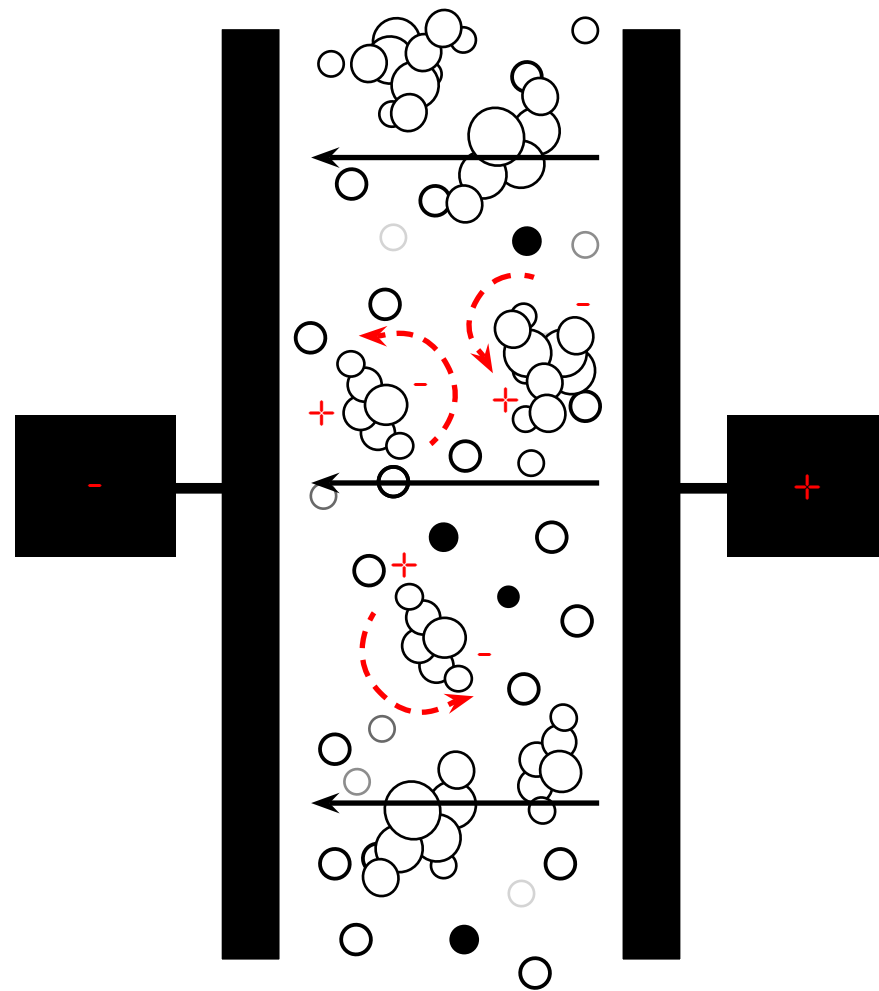
Dielectric Permittivity  
*Capacitive Sensor + Keysight E4990A*

# Aging Measurement



Dielectric Permittivity  
*Capacitive Sensor + Keysight E4990A*

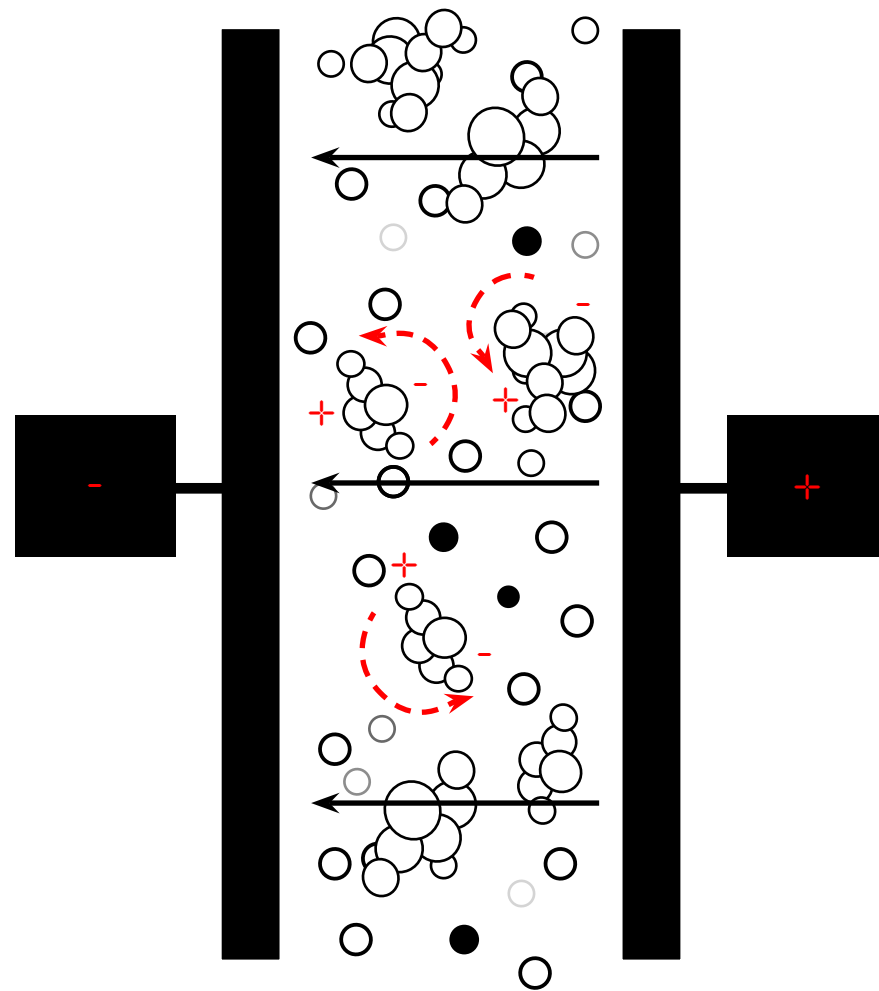
# Aging Measurement



Impedance  $Z = (\text{DC}) \text{ Resistance } Z' + (\text{AC}) \text{ Reactance } jZ''$   
Reactance = Capacitance  $R_C$  + Inductance  $R_L$

Dielectric Permittivity  
*Capacitive Sensor + Keysight E4990A*

# Aging Measurement



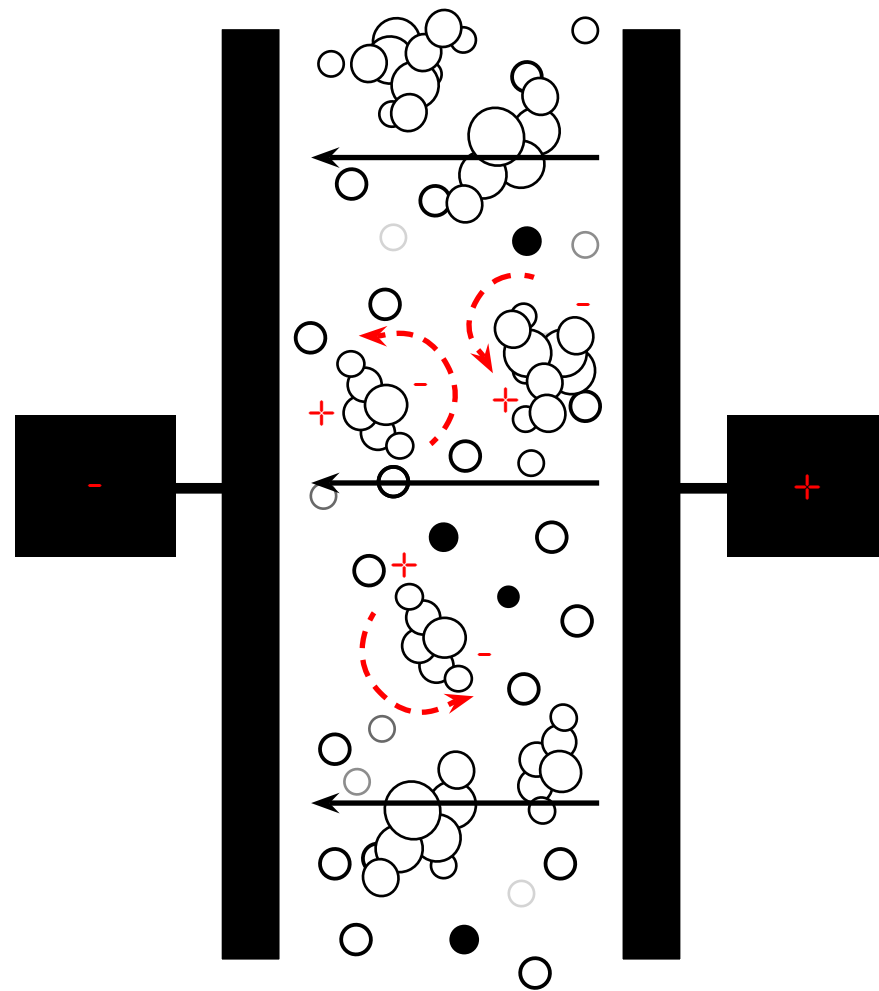
Impedance  $Z = (\text{DC}) \text{ Resistance } Z' + (\text{AC}) \text{ Reactance } jZ''$   
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... by measuring the impedance  $Z$  at an AC frequency  $\omega$  we can apply following transformation:

$$\varepsilon' = \frac{-Z}{\omega c_o (Z'^2 + Z''^2)}, \varepsilon'' = \frac{Z'}{\omega c_o (Z'^2 + Z''^2)}$$

Dielectric Permittivity  
*Capacitive Sensor + Keysight E4990A*

# Aging Measurement



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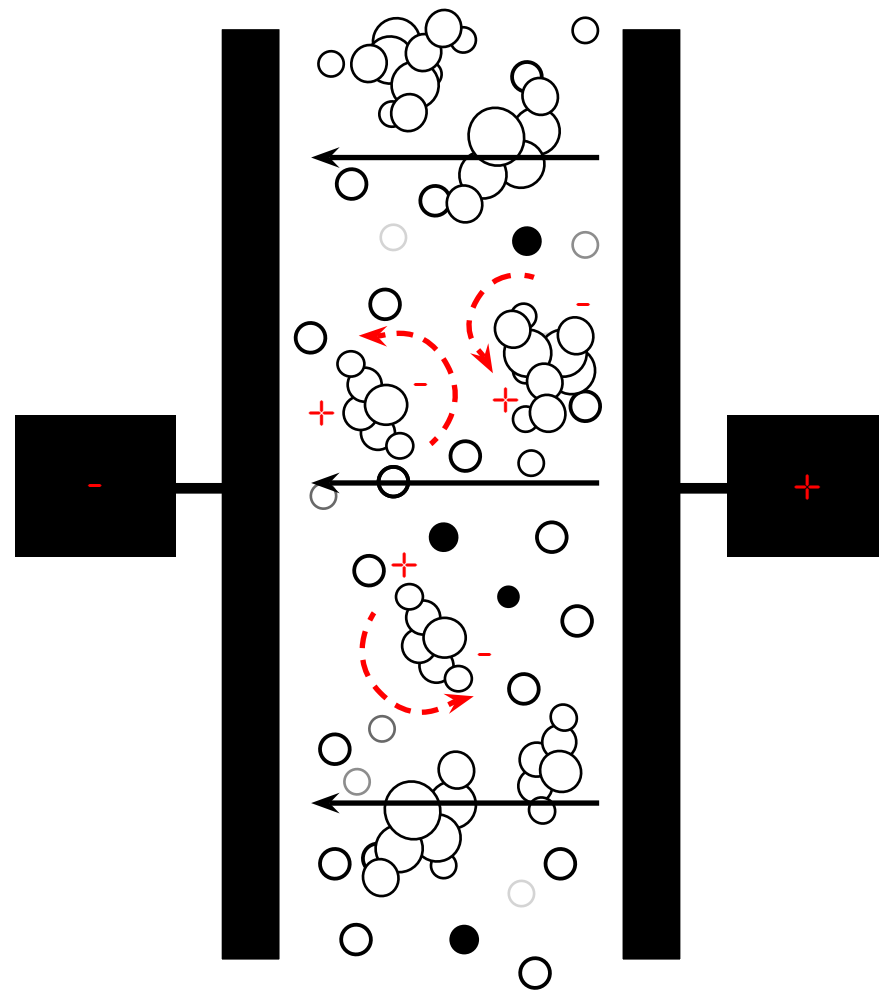
and get the complex permittivity  $\varepsilon^*$  with its loss factor:

$$\varepsilon^* = \varepsilon' - j\varepsilon'' \quad \tan \delta = \frac{\varepsilon''}{\varepsilon'}$$

Dielectric Permittivity  
*Capacitive Sensor + Keysight E4990A*



# Aging Measurement



Dielectric Permittivity  
Capacitive Sensor + Keysight E4990A

Impedance  $Z = (\text{DC}) \text{ Resistance } Z' + (\text{AC}) \text{ Reactance } jZ''$   
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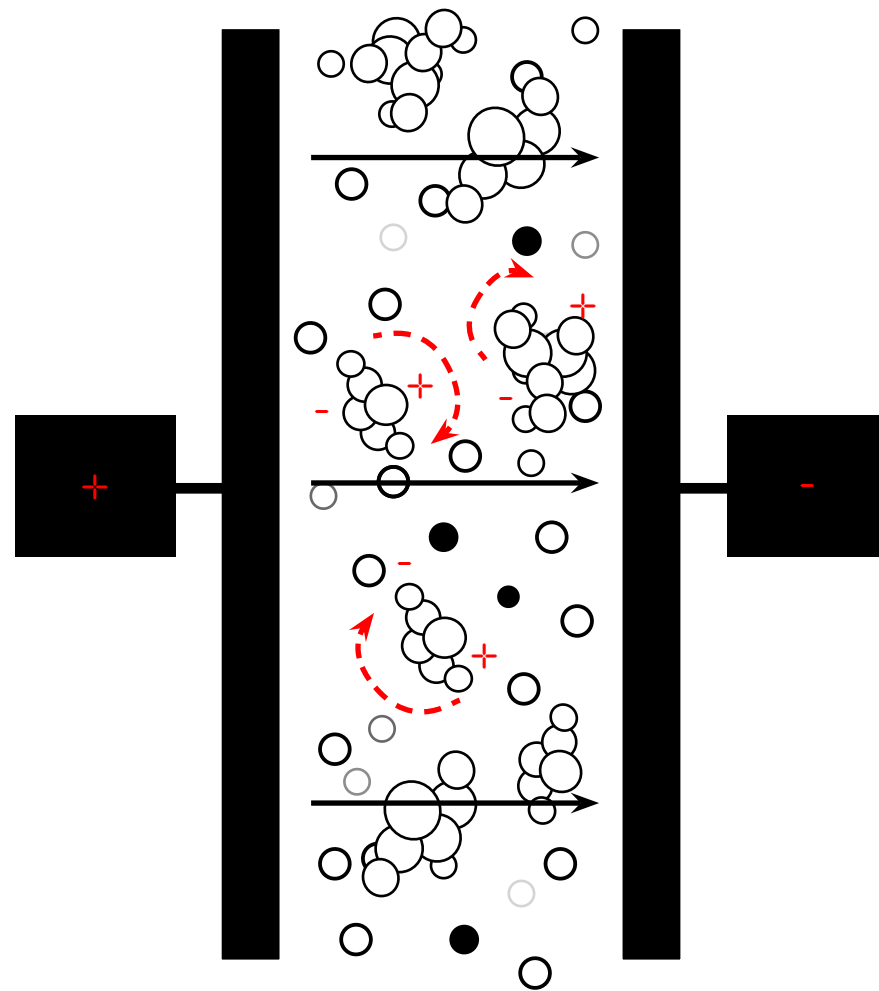
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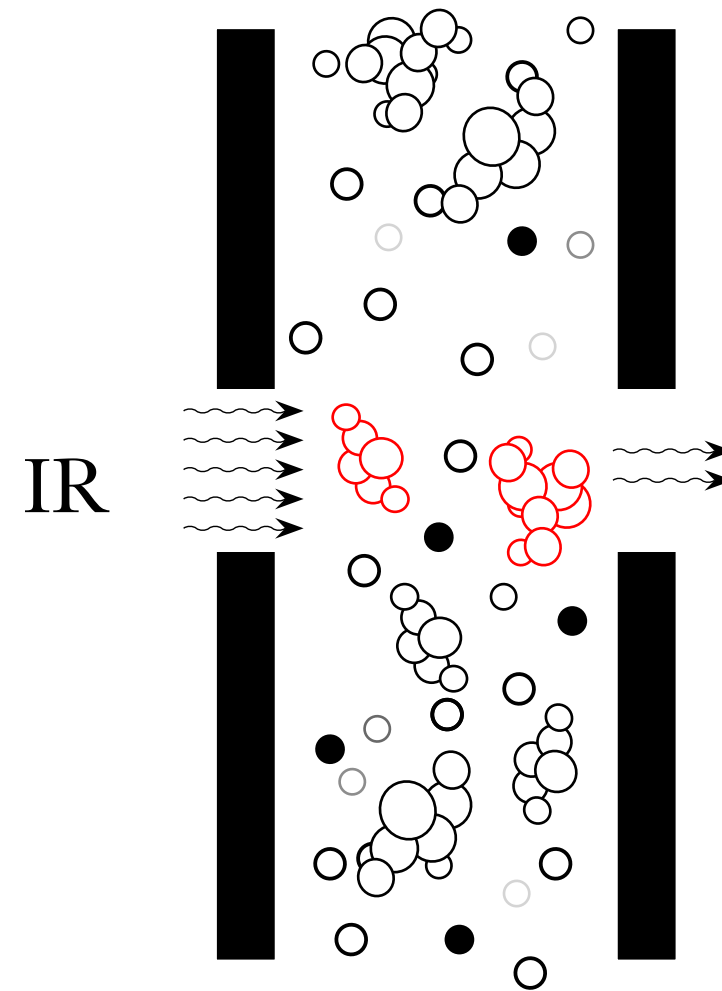
$$\varepsilon^* = \varepsilon' - j\varepsilon'' \quad \tan \delta = \frac{\varepsilon''}{\varepsilon'}$$

... the permittivity is a measure of a combination of chemical and physical effects due to aging (for example length of molecules)

# Aging Measurement

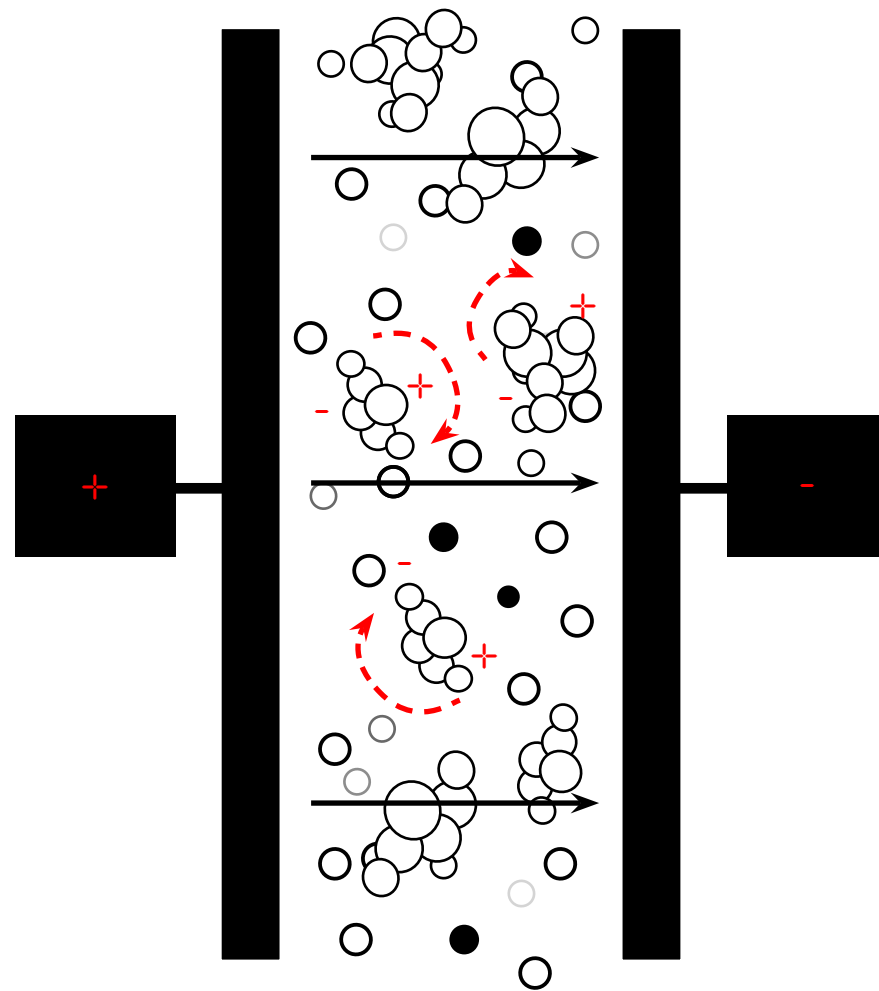


Dielectric Permittivity  
*Capacitive Sensor + Keysight E4990A*

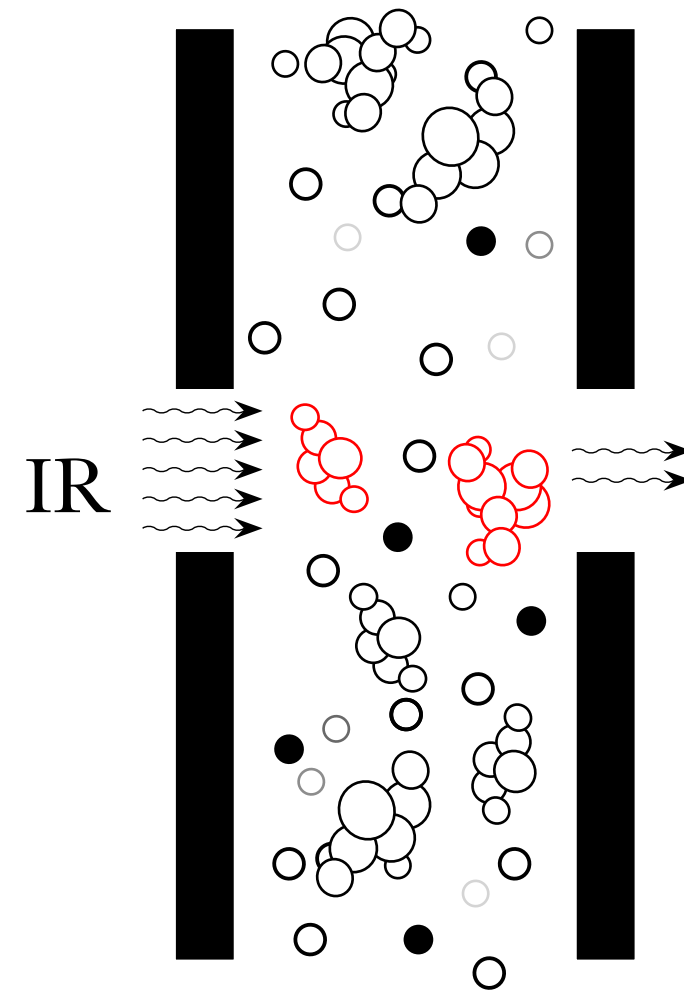


Near Infrared Spectroscopy  
*not implemented yet.*

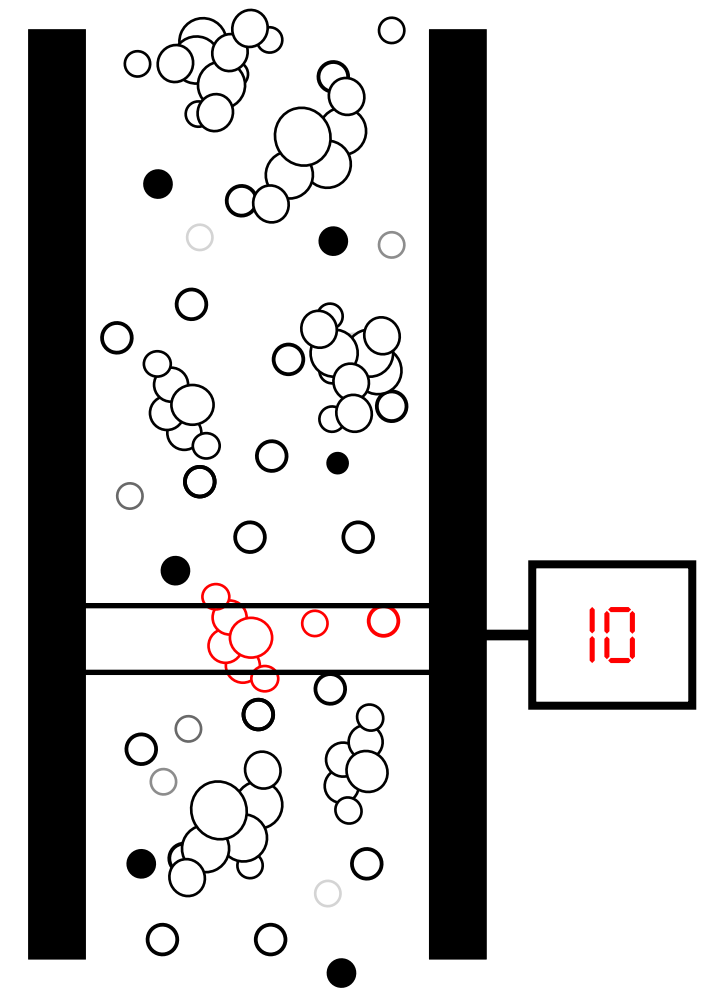
# Aging Measurement



Dielectric Permittivity  
*Capacitive Sensor + Keysight E4990A*

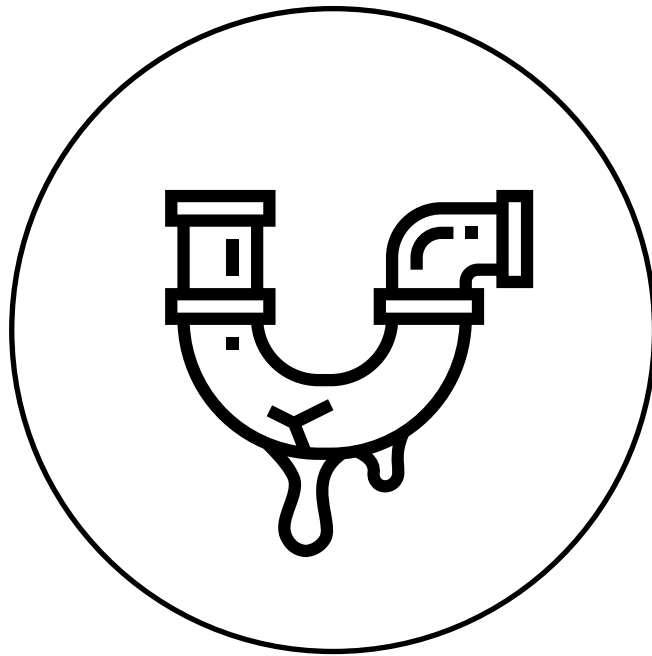


Near Infrared Spectroscopy  
*not implemented yet.*



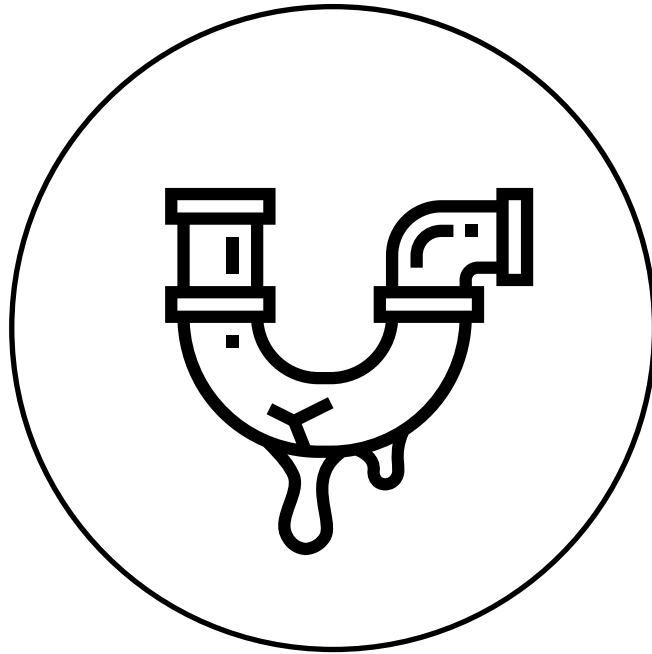
Particle Counter  
*will not be implemented.*

# Performance Indicators

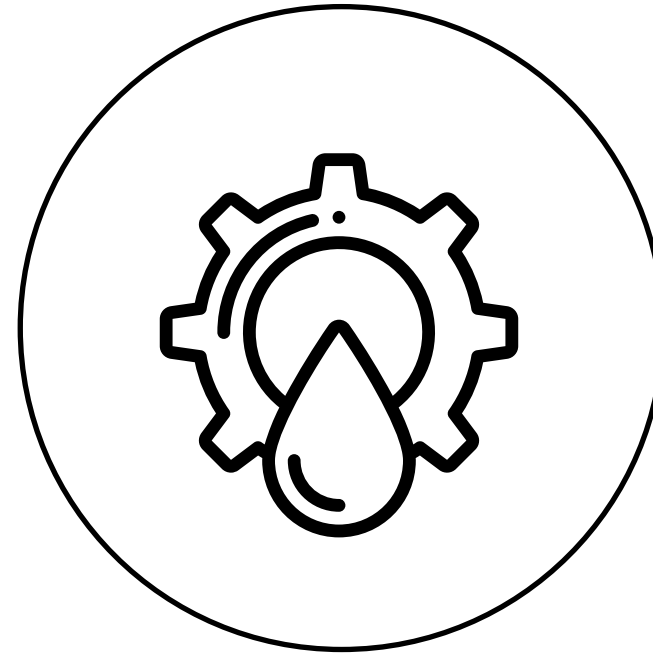


Damage

# Performance Indicators

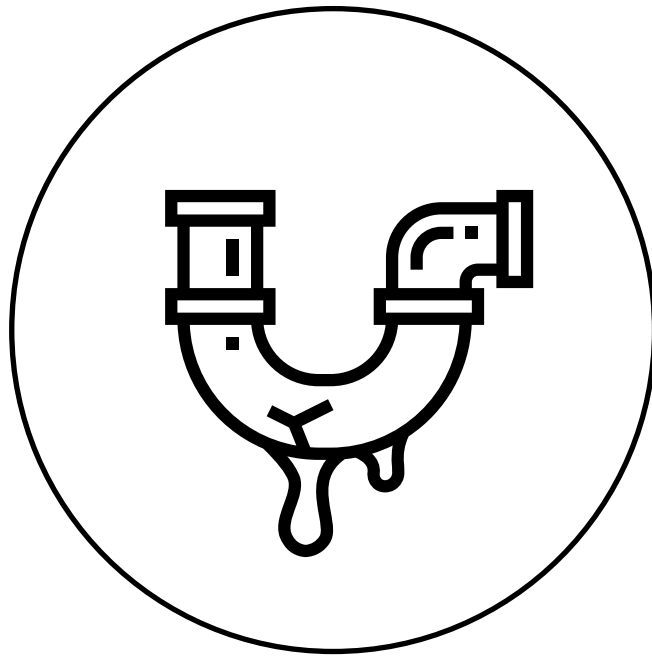


Damage

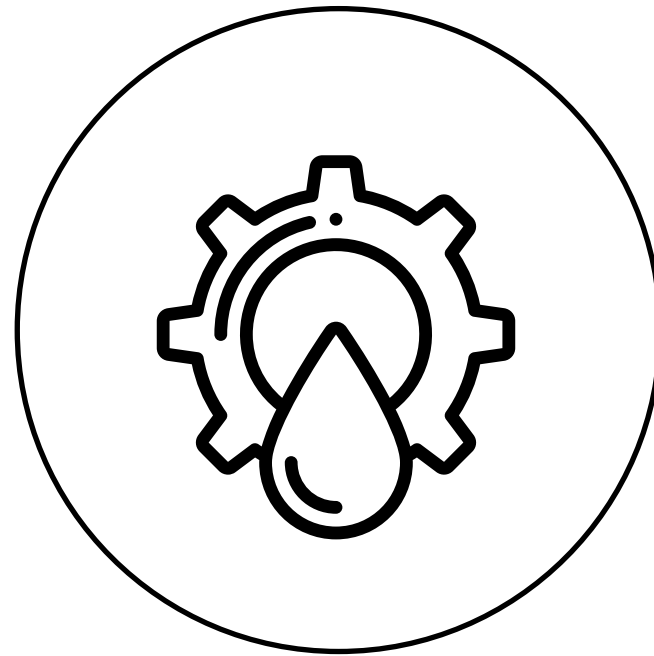


Maintenance

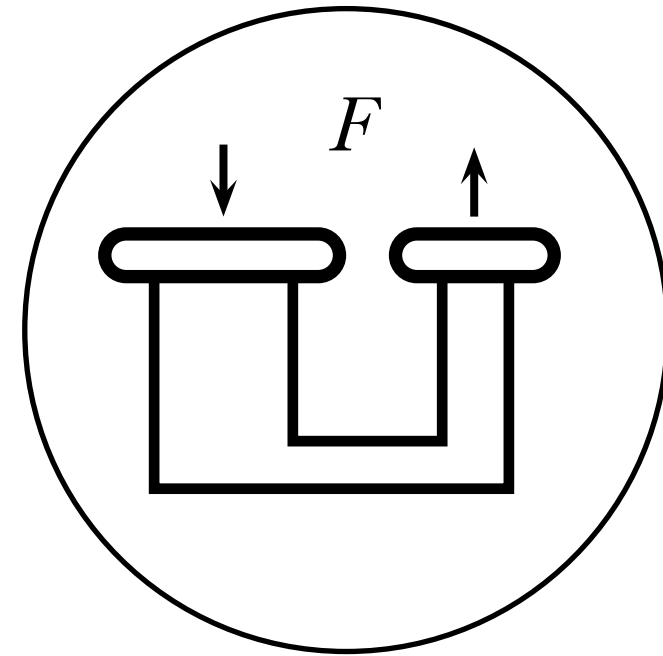
# Performance Indicators



Damage

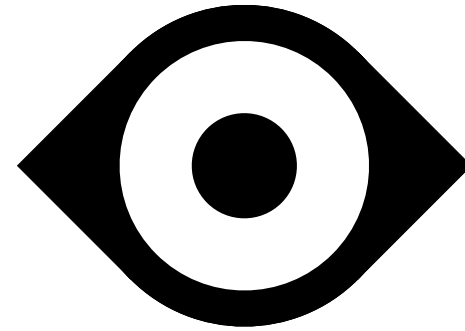


Maintenance



Efficiency

Researching the influence of aging parameters on performance indicators allows development of countermeasures.



# Observer



# Purpose of the Program

**Continuously measure** aging parameters.


**Store** data efficiently for later evaluation and comparison.

# Program Overview



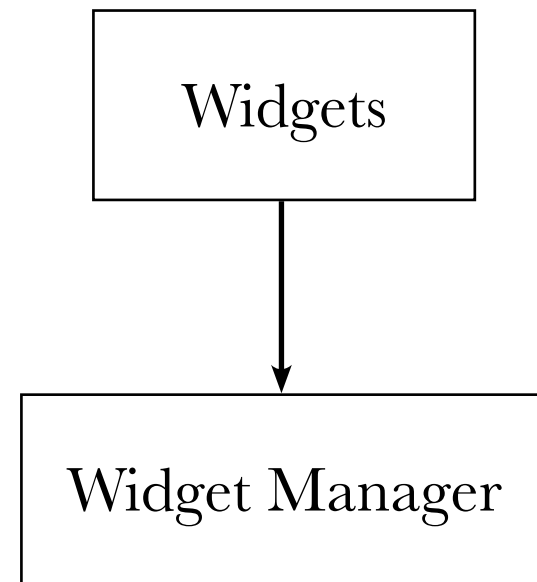
Widgets

Buttons, Lists, .. used in GUI



Class

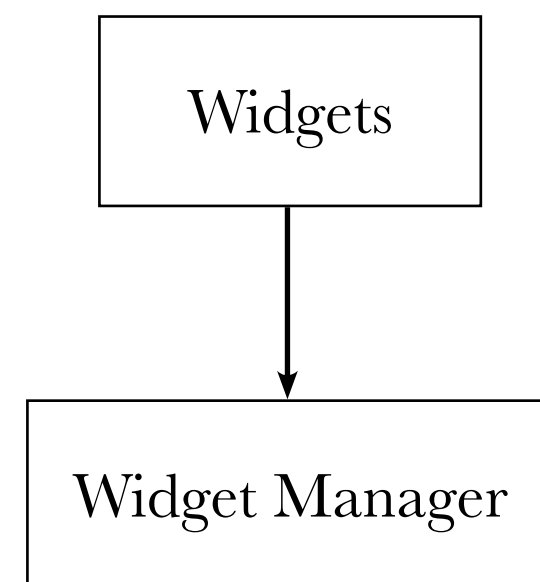
# Program Overview



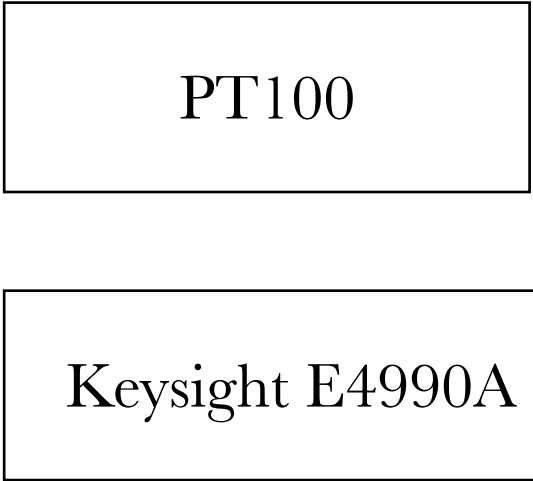
Renders the front end  
Allows for simple assembly of GUI



# Program Overview

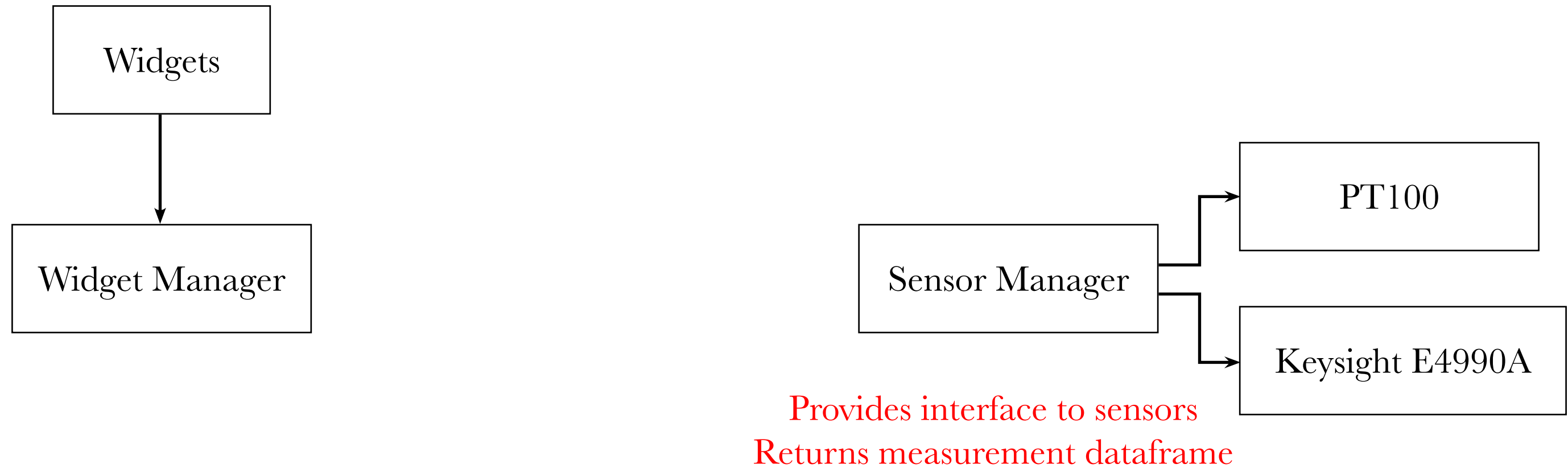


Implemented Sensors  
inherit from base class Sensor

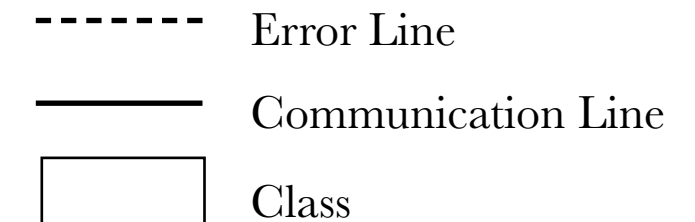
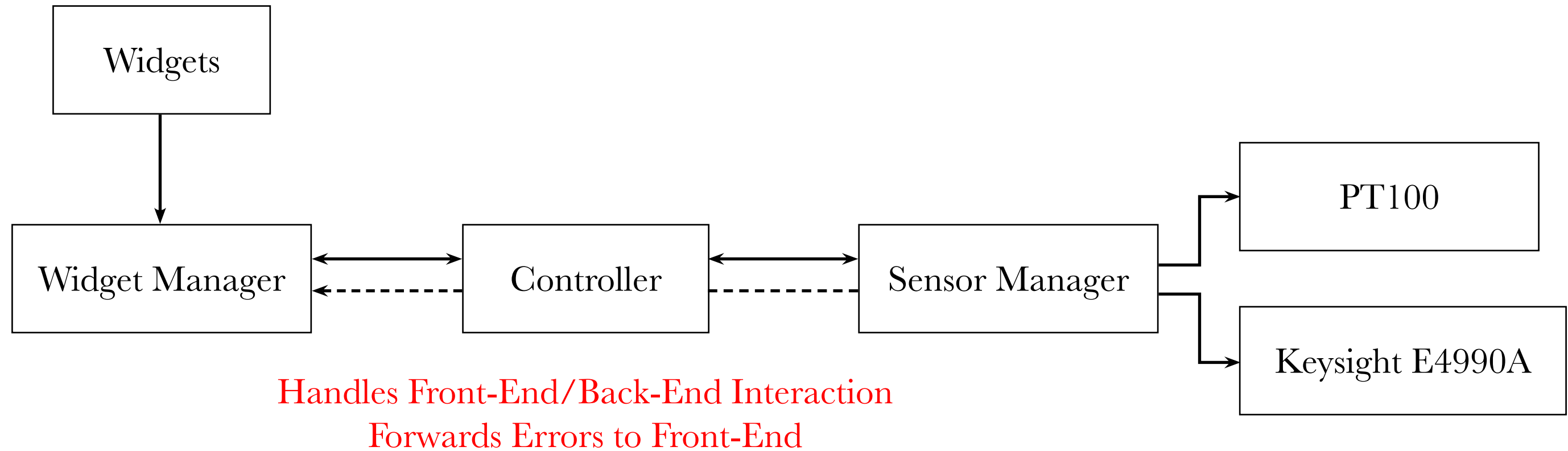


— Communication Line  
□ Class

# Program Overview

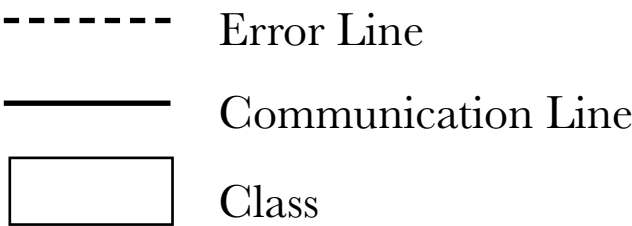
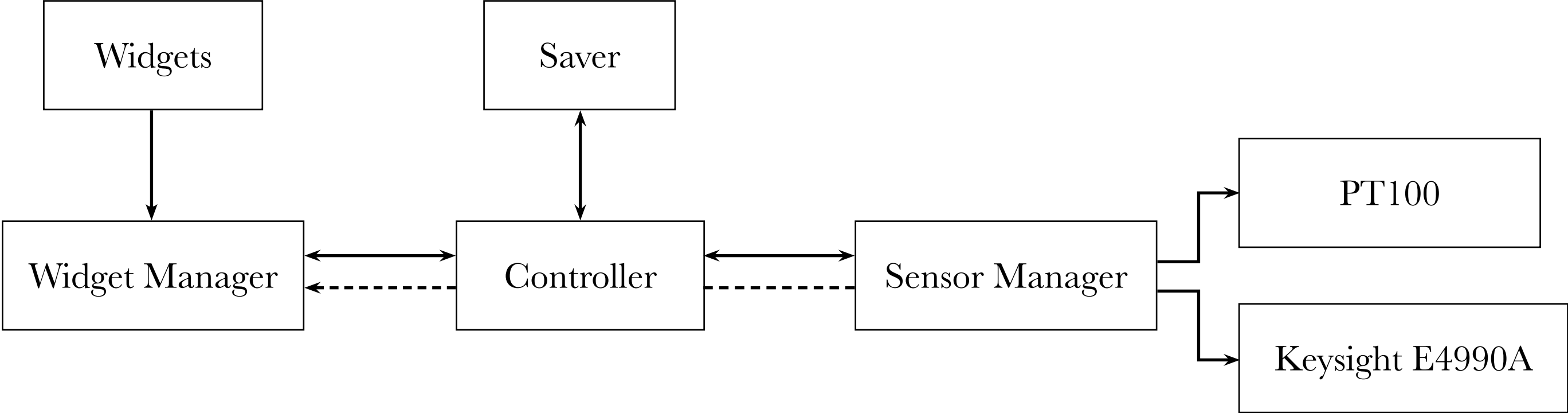


# Program Overview

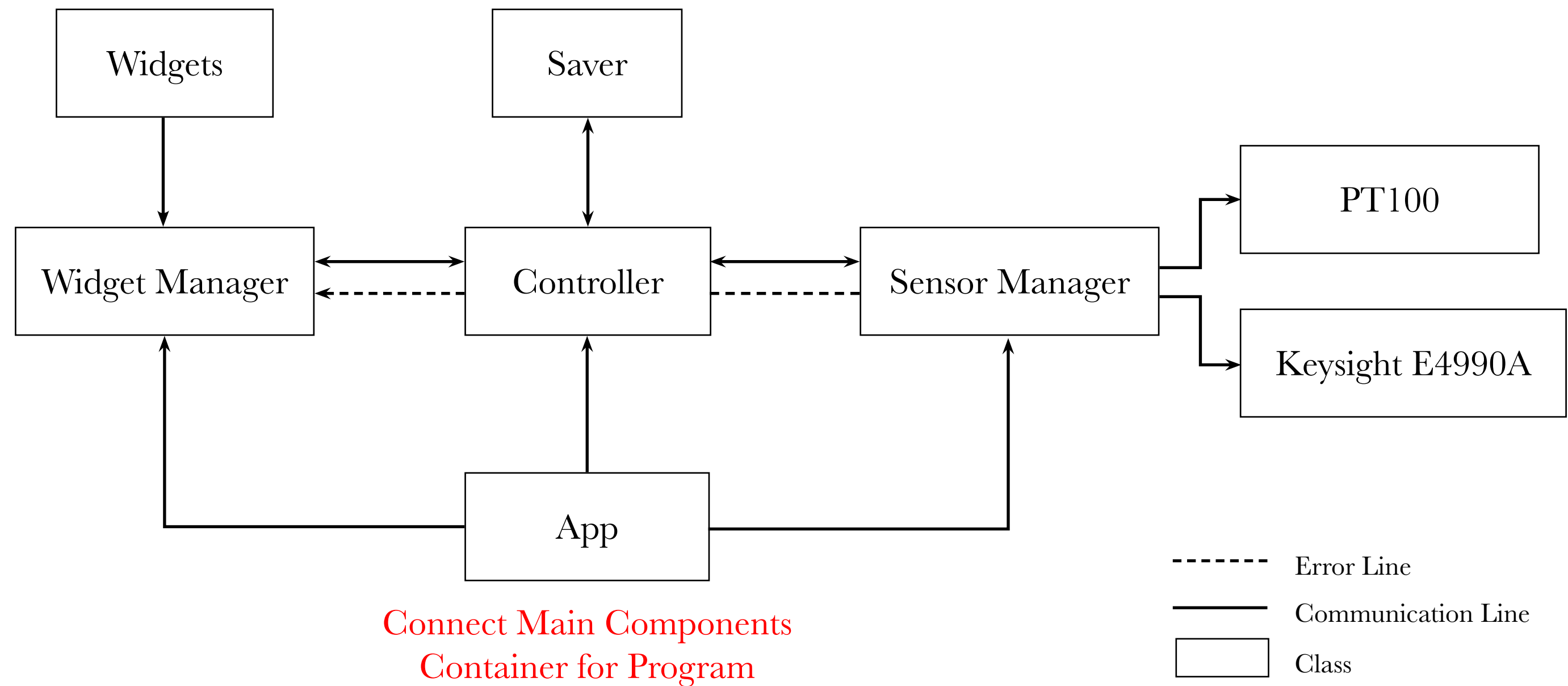


# Program Overview

PostgreSQL Database Interface

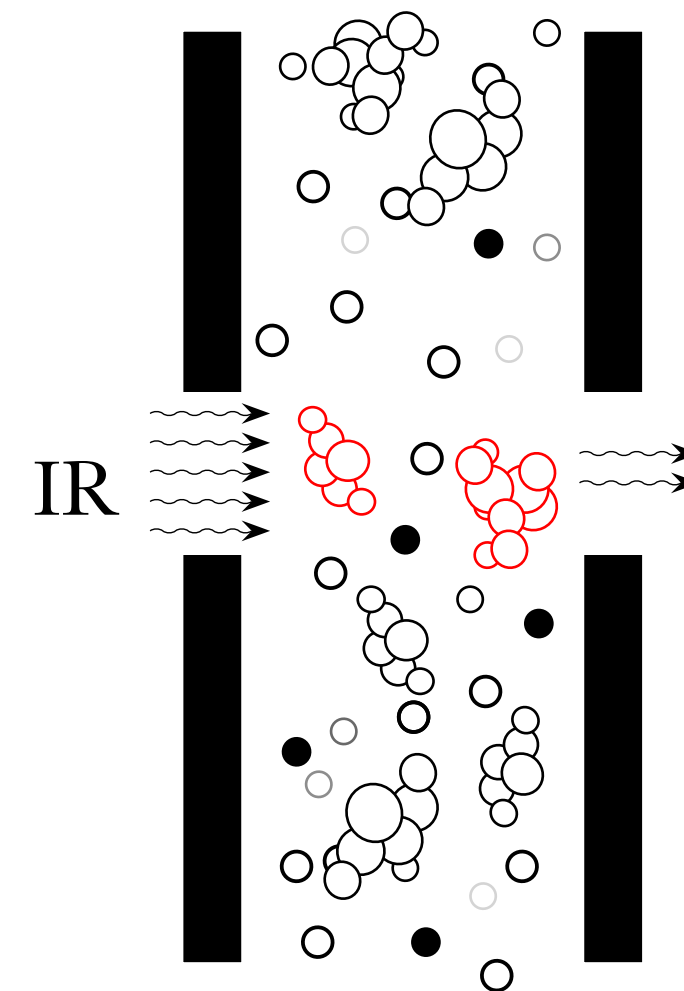
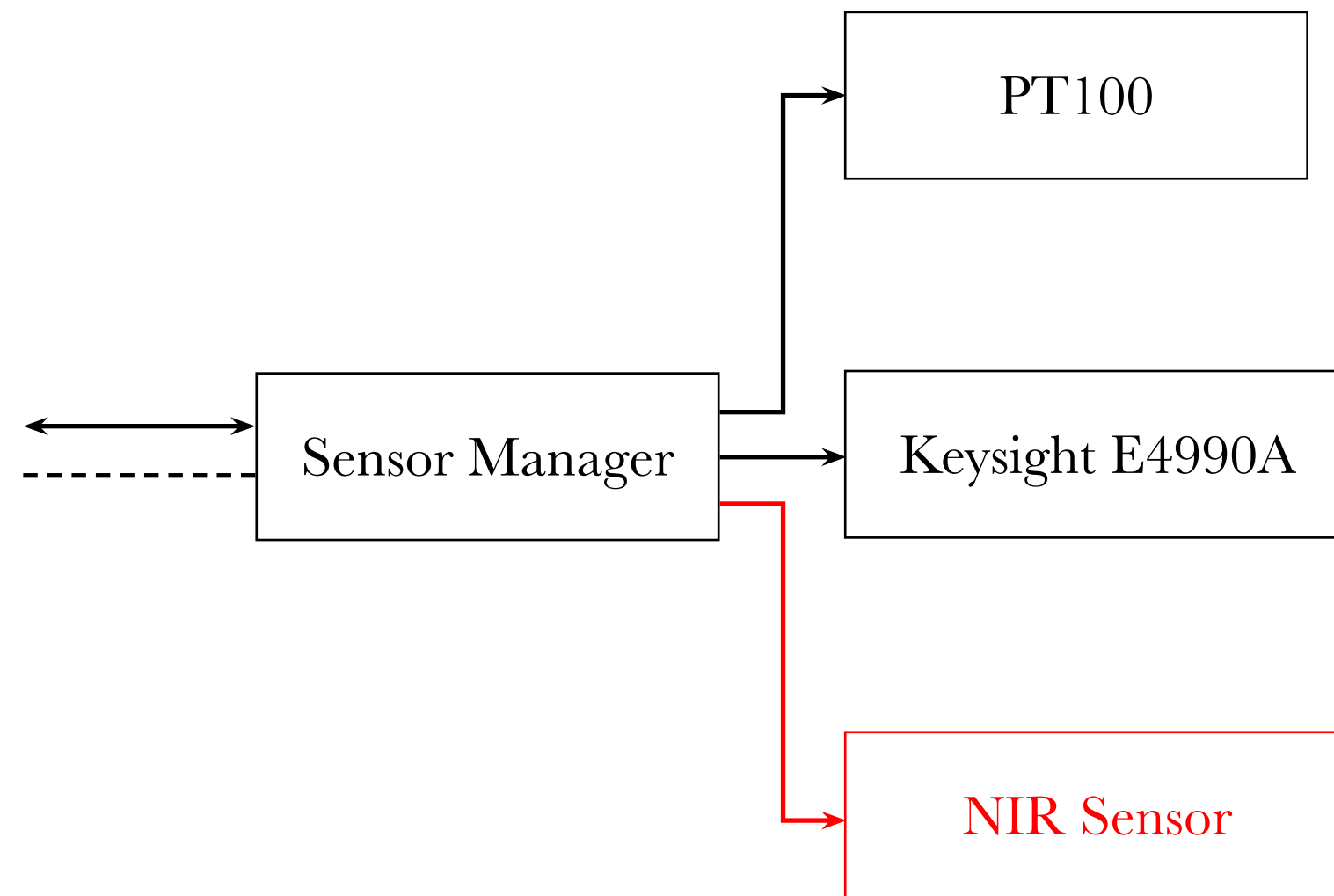


# Program Overview





# Exemplary extension of NIR Sensors

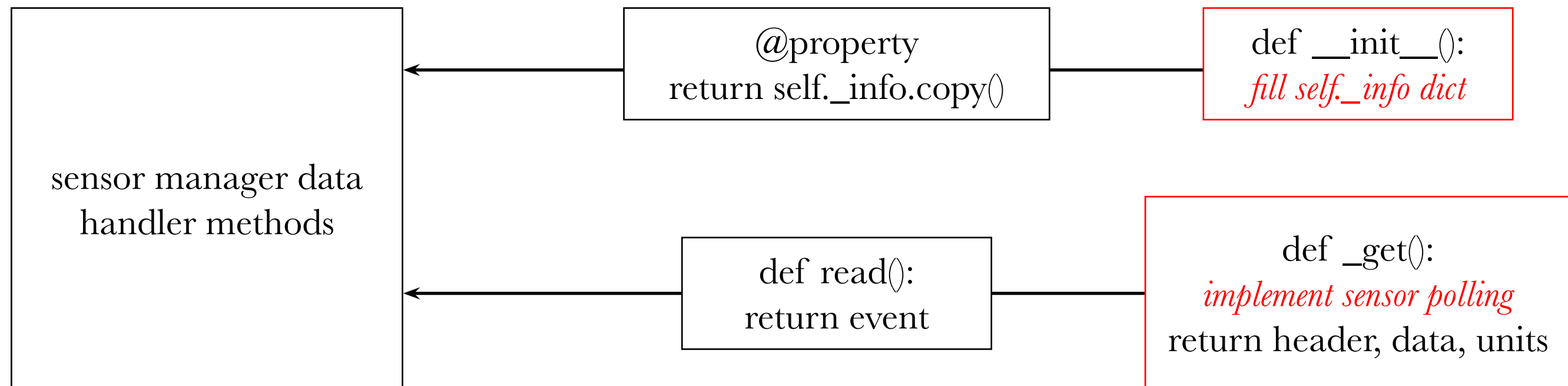


# Exemplary extension of NIR Sensors

Sensor Manager

Sensor (Parent)

NIR Sensor

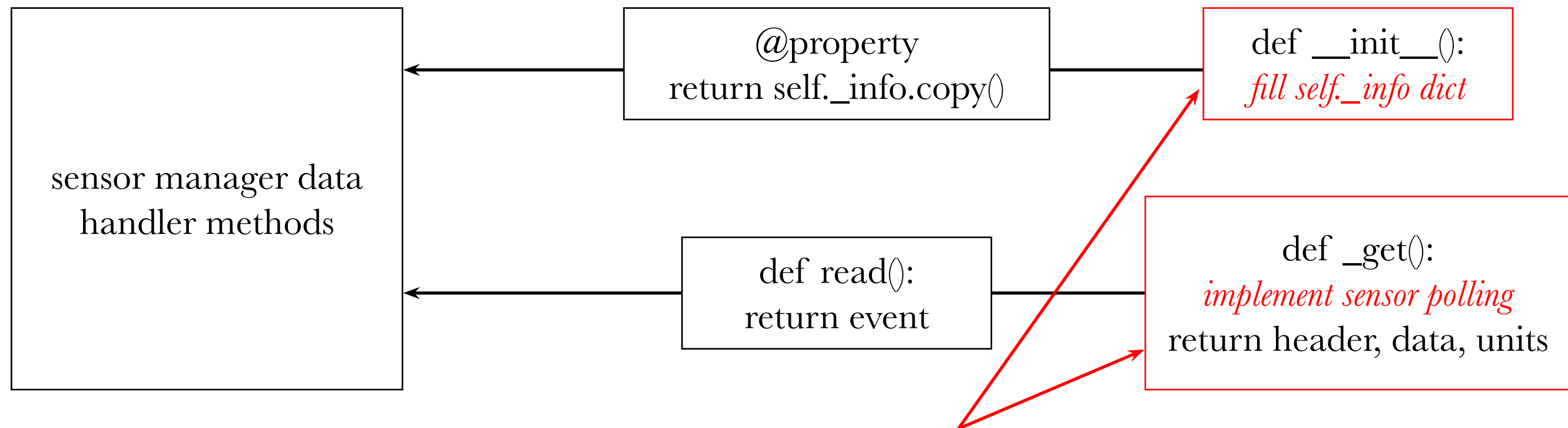


# Exemplary extension of NIR Sensors

Sensor Manager

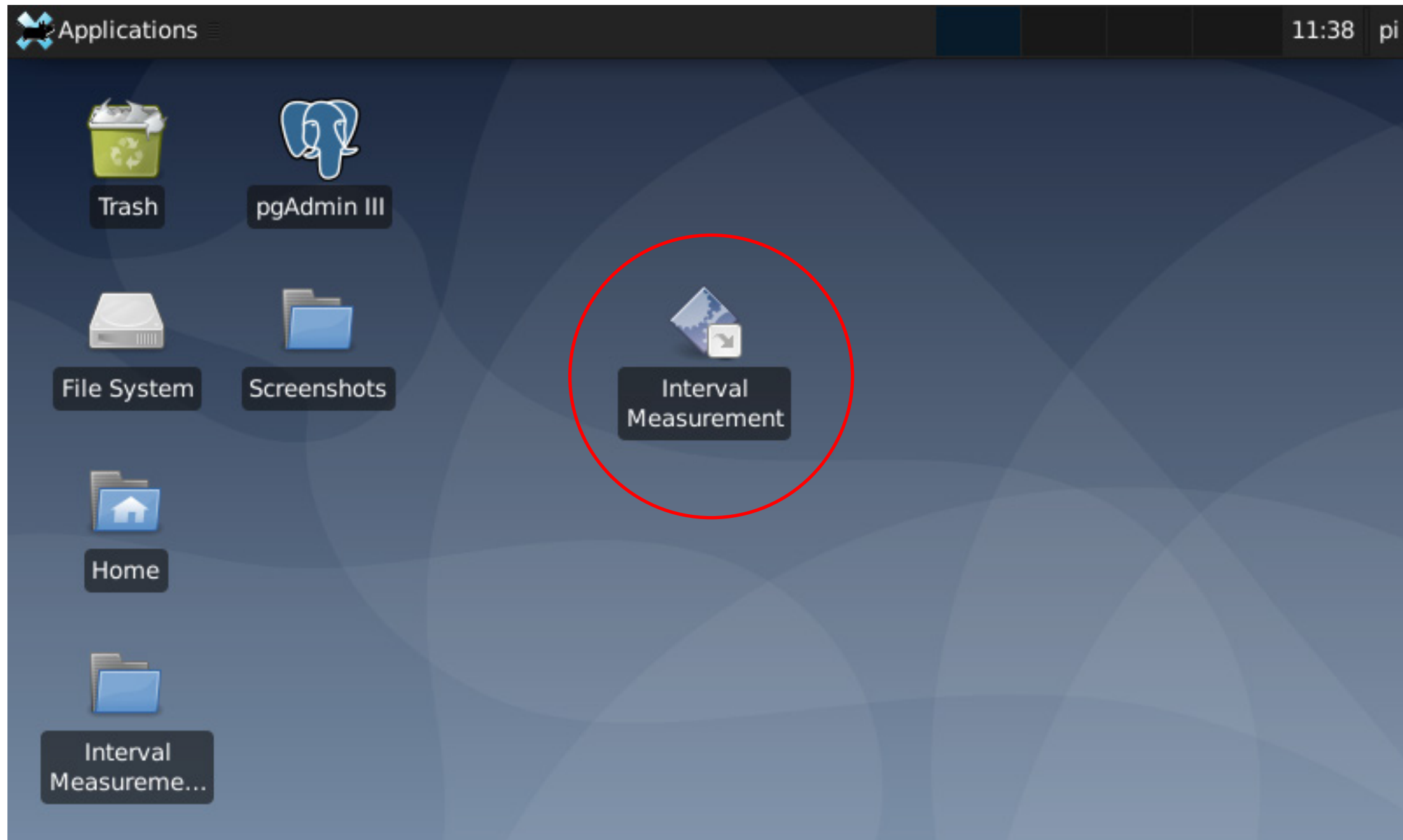
Sensor (Parent)

NIR Sensor

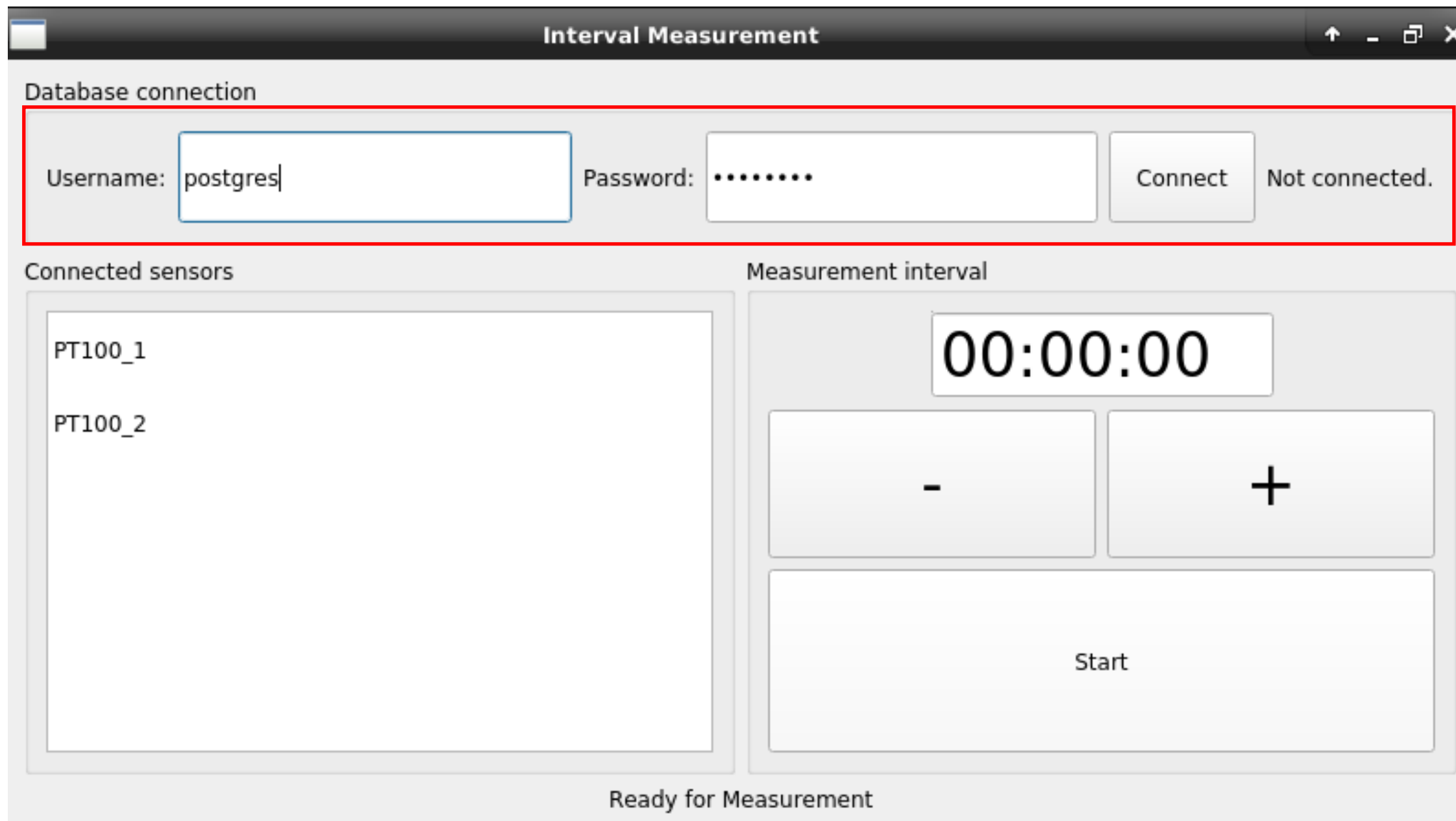


These methods must be  
implemented by new sensor class

# Observer Interface Tour



# Observer Interface Tour



The screenshot shows a software window titled "Interval Measurement" with standard window controls (maximize, minimize, close) in the top right corner. The interface is divided into several sections:

- Database connection:** A section at the top, outlined with a red border, containing a "Username:" label with a text input field containing "postgres", a "Password:" label with a masked text input field containing ".....", a "Connect" button, and the text "Not connected.".
- Connected sensors:** A section on the left containing a list of sensors: "PT100\_1" and "PT100\_2".
- Measurement interval:** A section on the right containing a large digital display showing "00:00:00", two buttons labeled "-" and "+", and a large "Start" button.

At the bottom center of the window, the text "Ready for Measurement" is displayed.

# Observer Interface Tour

The screenshot displays the 'Interval Measurement' application window. It features a 'Database connection' section with fields for 'Username' (postgres) and 'Password' (masked with dots), a 'Connect' button, and a 'connected.' status indicator highlighted with a red box. Below this is the 'Connected sensors' list containing 'PT100\_1' and 'PT100\_2'. To the right is the 'Measurement interval' section with a digital display showing '00:00:00', minus and plus buttons, and a 'Start' button. The status 'Ready for Measurement' is shown at the bottom.

Interval Measurement

Database connection

Username: postgres Password: ..... Connect connected.

Connected sensors

PT100\_1  
PT100\_2

Measurement interval

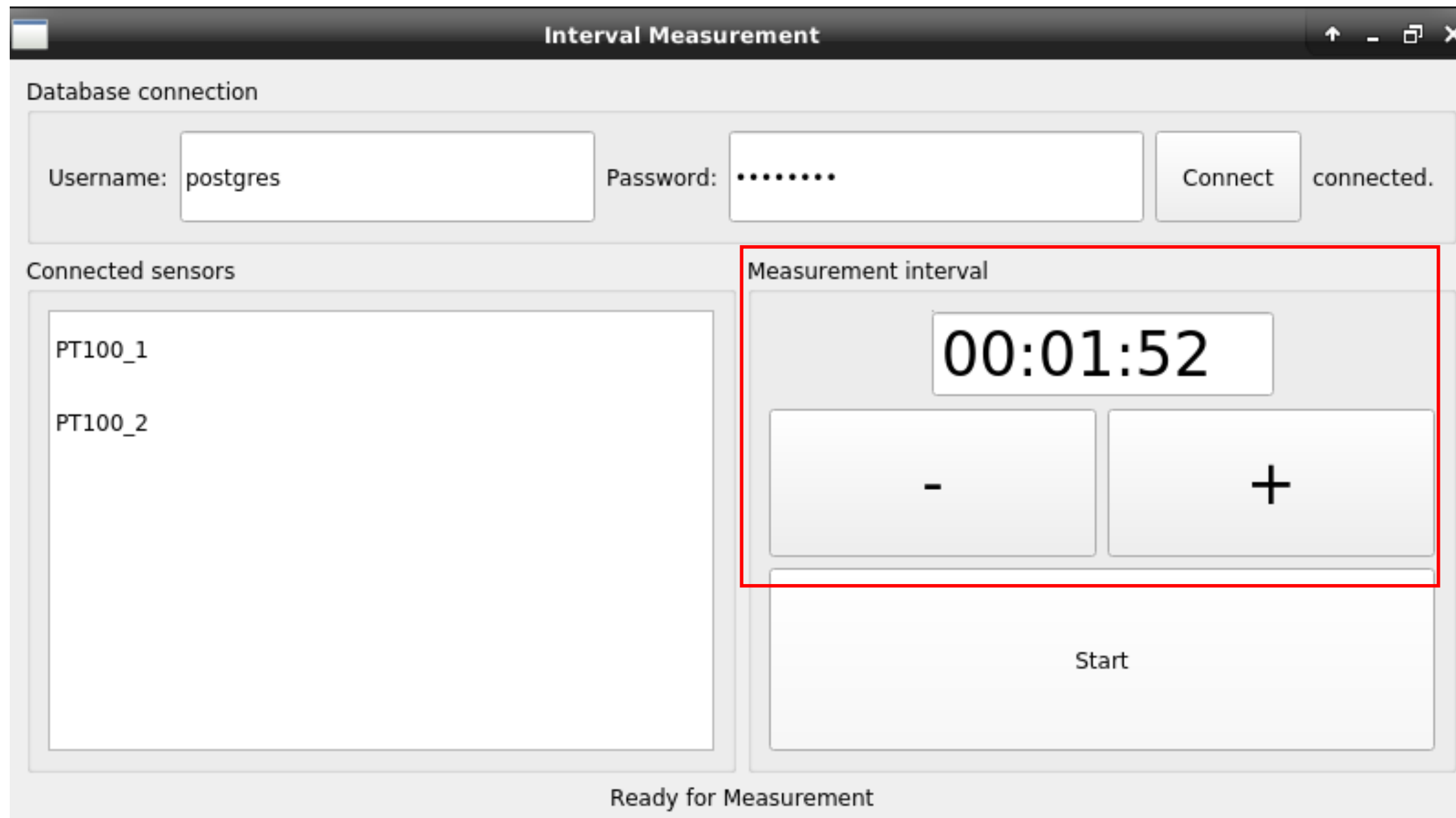
00:00:00

- +

Start

Ready for Measurement

# Observer Interface Tour

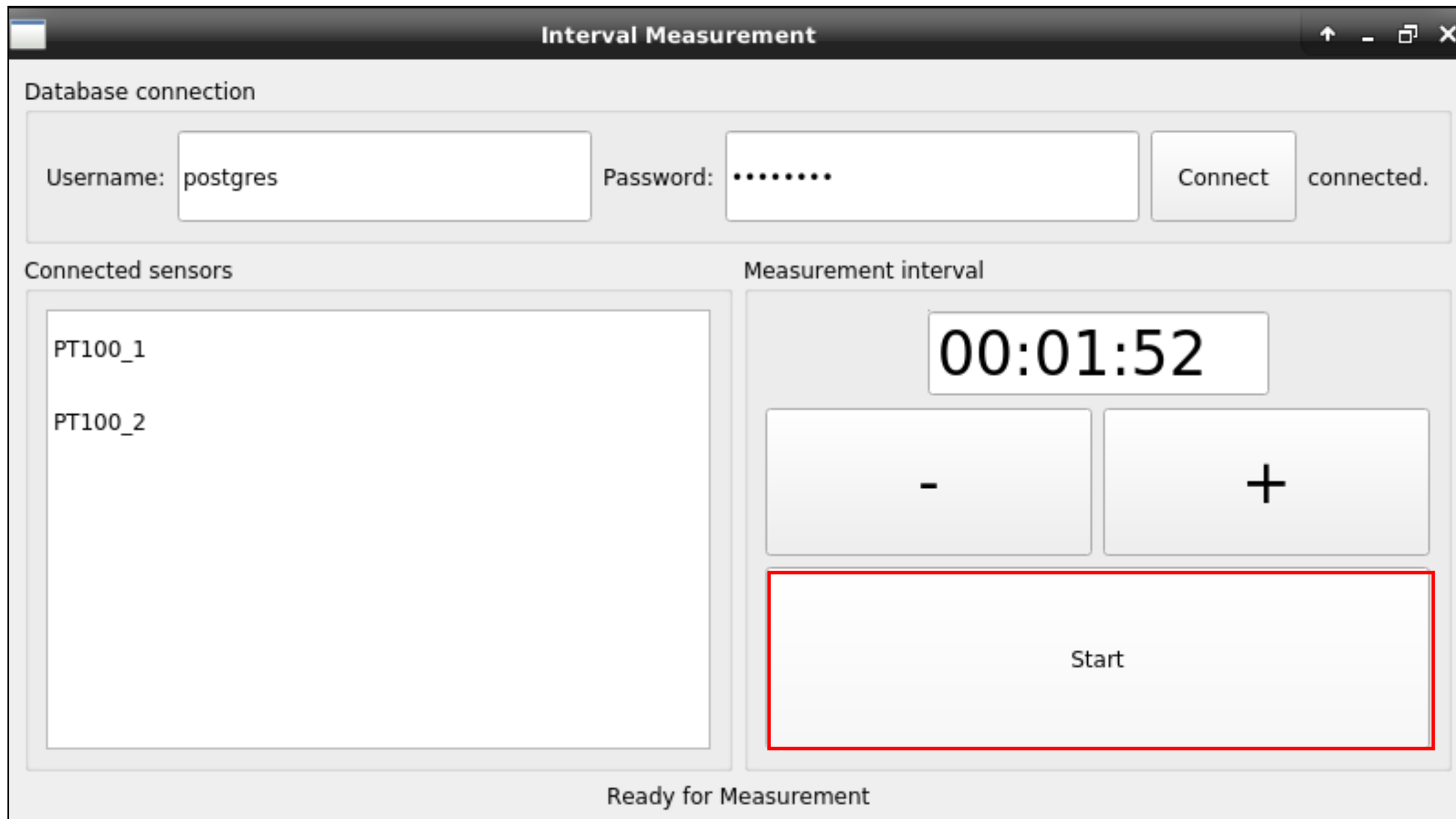


The screenshot shows a software window titled "Interval Measurement" with standard window controls (maximize, minimize, close) in the top right corner. The interface is divided into several sections:

- Database connection:** This section contains a "Username:" label followed by a text input field containing "postgres", a "Password:" label followed by a masked input field with seven dots, a "Connect" button, and a status indicator that says "connected."
- Connected sensors:** A large rectangular area on the left containing two sensor identifiers: "PT100\_1" and "PT100\_2".
- Measurement interval:** This section is highlighted with a red rectangular border. It contains a large digital display showing "00:01:52", two buttons labeled "-" and "+" for adjusting the interval, and a "Start" button at the bottom.

At the bottom center of the window, the text "Ready for Measurement" is displayed.

# Observer Interface Tour



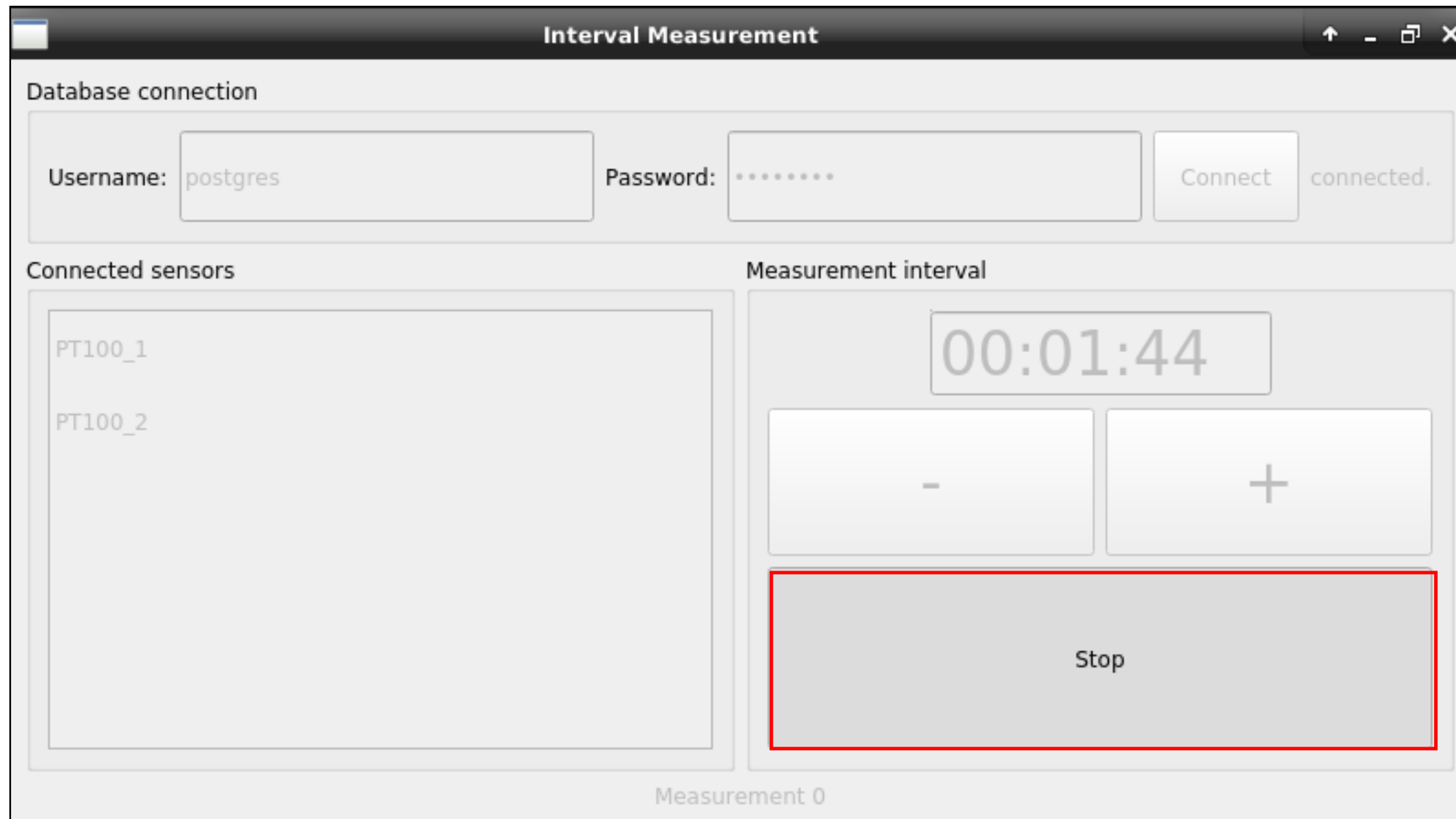
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- Database connection:** This section contains a "Username:" label followed by a text input field containing "postgres", a "Password:" label followed by a masked input field with seven dots, a "Connect" button, and a status indicator that says "connected."
- Connected sensors:** A large rectangular area on the left containing two sensor identifiers: "PT100\_1" and "PT100\_2".
- Measurement interval:** A section on the right containing a large digital display showing "00:01:52". Below the display are two buttons, one with a minus sign "-" and one with a plus sign "+". At the bottom of this section is a large button labeled "Start", which is highlighted with a red rectangular border.

At the bottom center of the window, the text "Ready for Measurement" is displayed.



# Observer Interface Tour



The screenshot shows a software window titled "Interval Measurement" with standard window controls (maximize, minimize, close) in the top right corner. The interface is divided into several sections:

- Database connection:** This section contains a "Username:" label followed by a text input field containing "postgres", a "Password:" label followed by a masked input field with seven dots, a "Connect" button, and a status indicator that says "connected.".
- Connected sensors:** A large rectangular area on the left side of the window. It contains two labels, "PT100\_1" and "PT100\_2", positioned at the top left of the area.
- Measurement interval:** A section on the right side of the window. It features a digital display showing "00:01:44". Below the display are two buttons: a minus sign "-" on the left and a plus sign "+" on the right. At the bottom of this section is a large, light gray button labeled "Stop", which is highlighted with a red rectangular border.

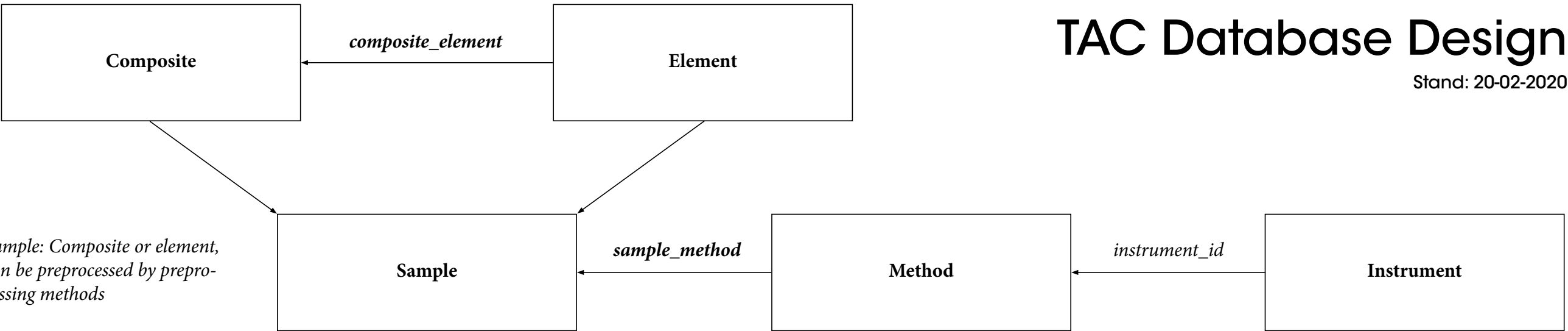
At the bottom center of the window, the text "Measurement 0" is displayed.

# Database

# TAC Database Design

Stand: 20-02-2020

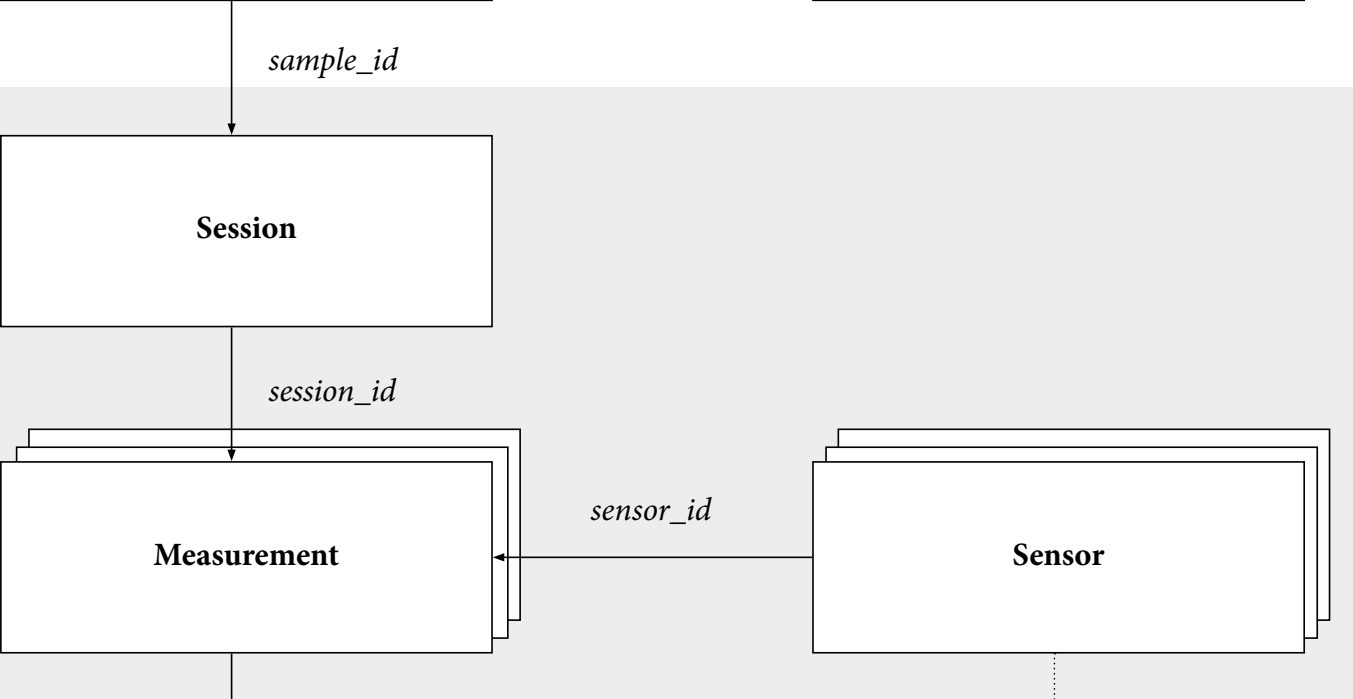
1. Sample Management



2. Measurement

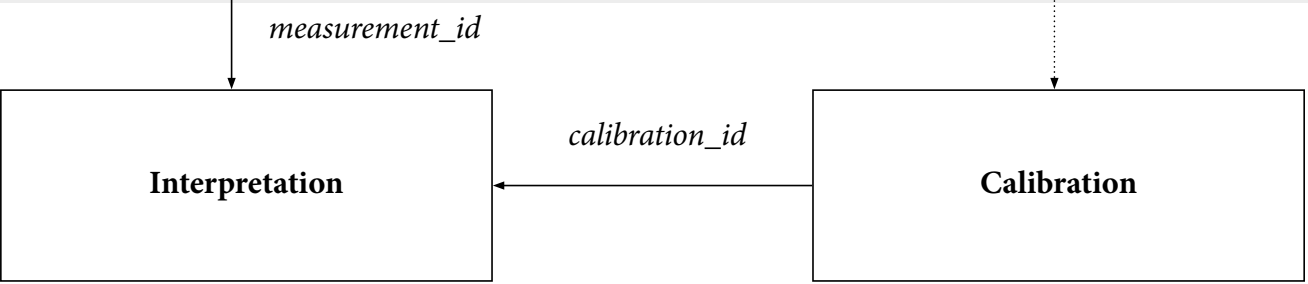
Session: Set of Measurements from different sensors. Measurement of same set is repeated periodically in same Session.

Measurement: Reading of a single sensor at one point in time.



3. Interpretation

Interpretation: corrected data from Measurement by Calibration and formula



- 1. Sample Management**  
A Composite is assembled from multiple elements. One sample contains one composite or element. Each method is associated with one instrument.
- 2. Measurement**  
A Measurement is a single Sensor reading. A Session contains multiple Measurements of the same set of Sensors in between Start/Stop.
- 3. Interpretation**  
An interpretation is associated with one measurement. An interpretation is associated with one or no calibration, e.g. when sensor need no calibration. The calibration should be used for a whole session.

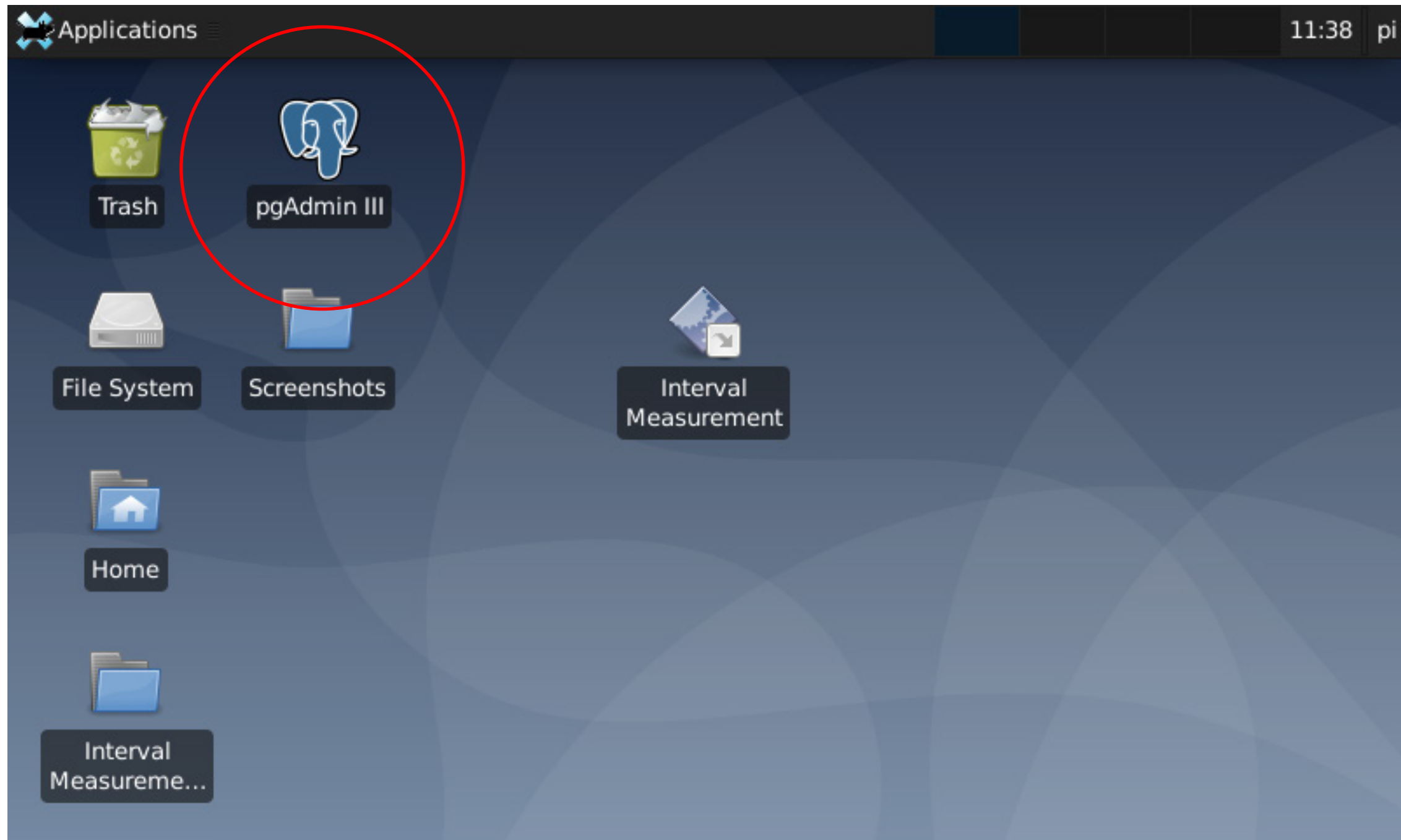
M-M table      entity table      foreign key

don@wintr.de

contact me for further information.

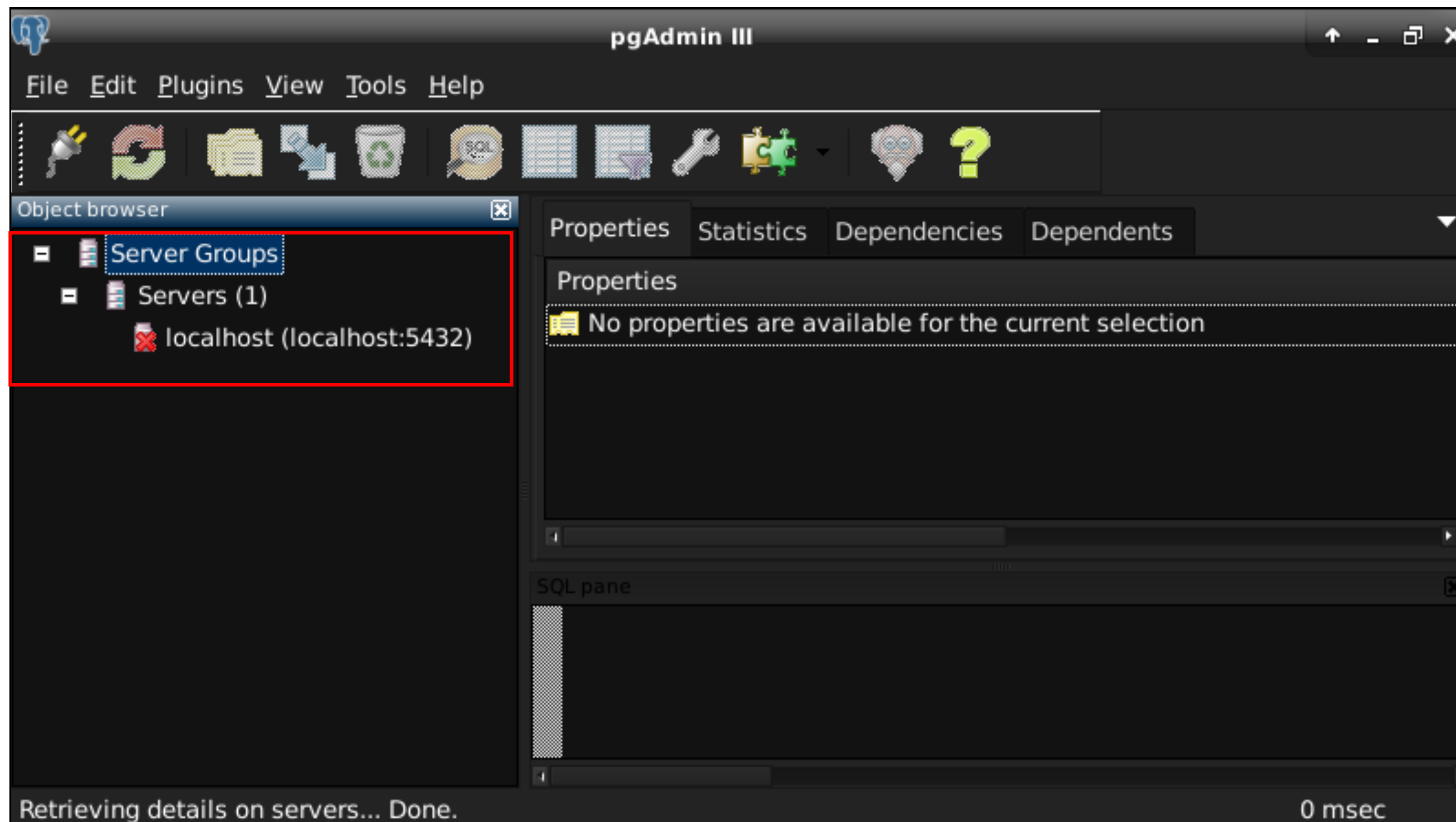
# Appendix

# pgAdmin Interface Tour



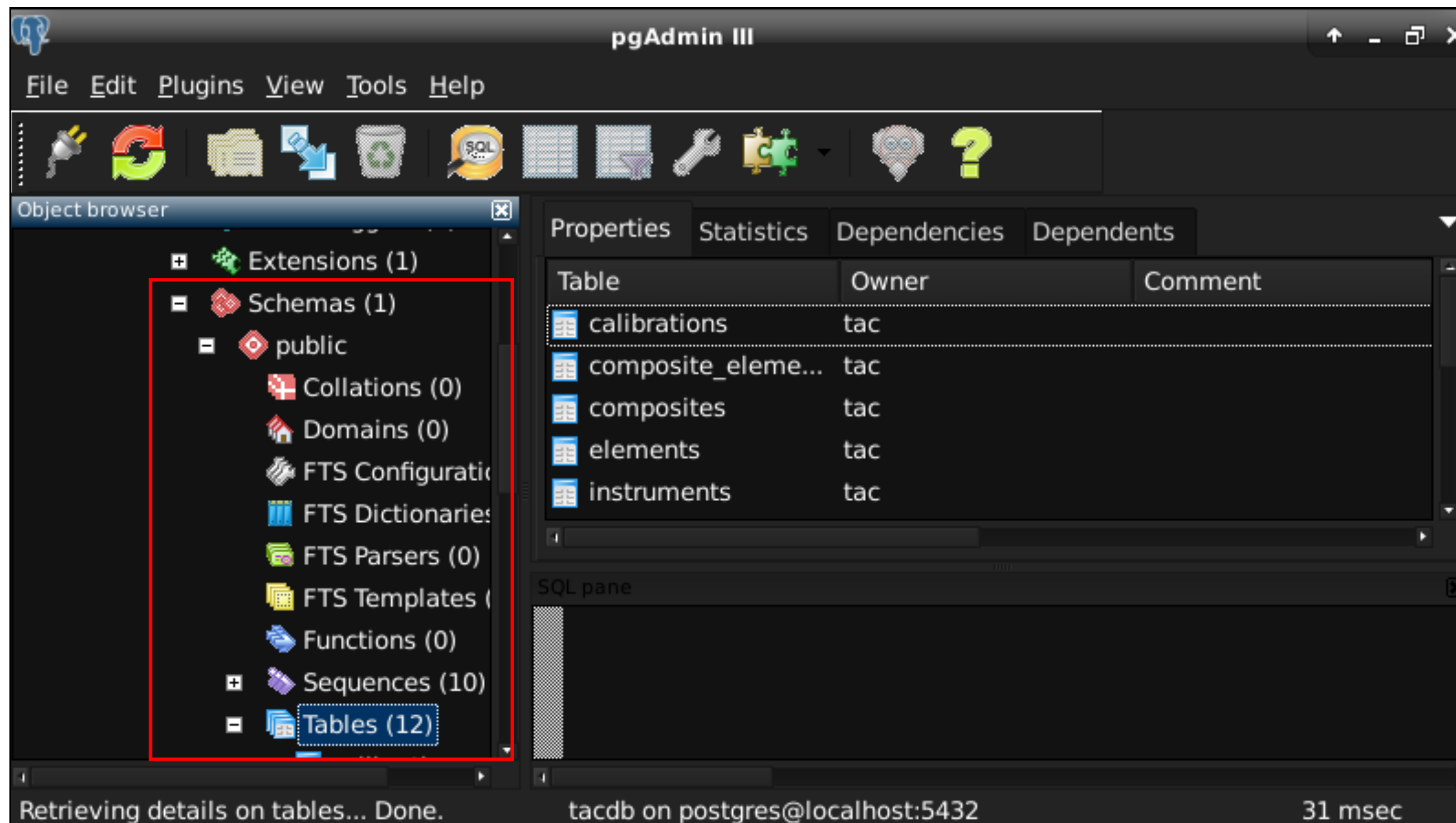
# pgAdmin Interface Tour

Connect to local psql Server on port 5432 (localhost:5432)



# pgAdmin Interface Tour

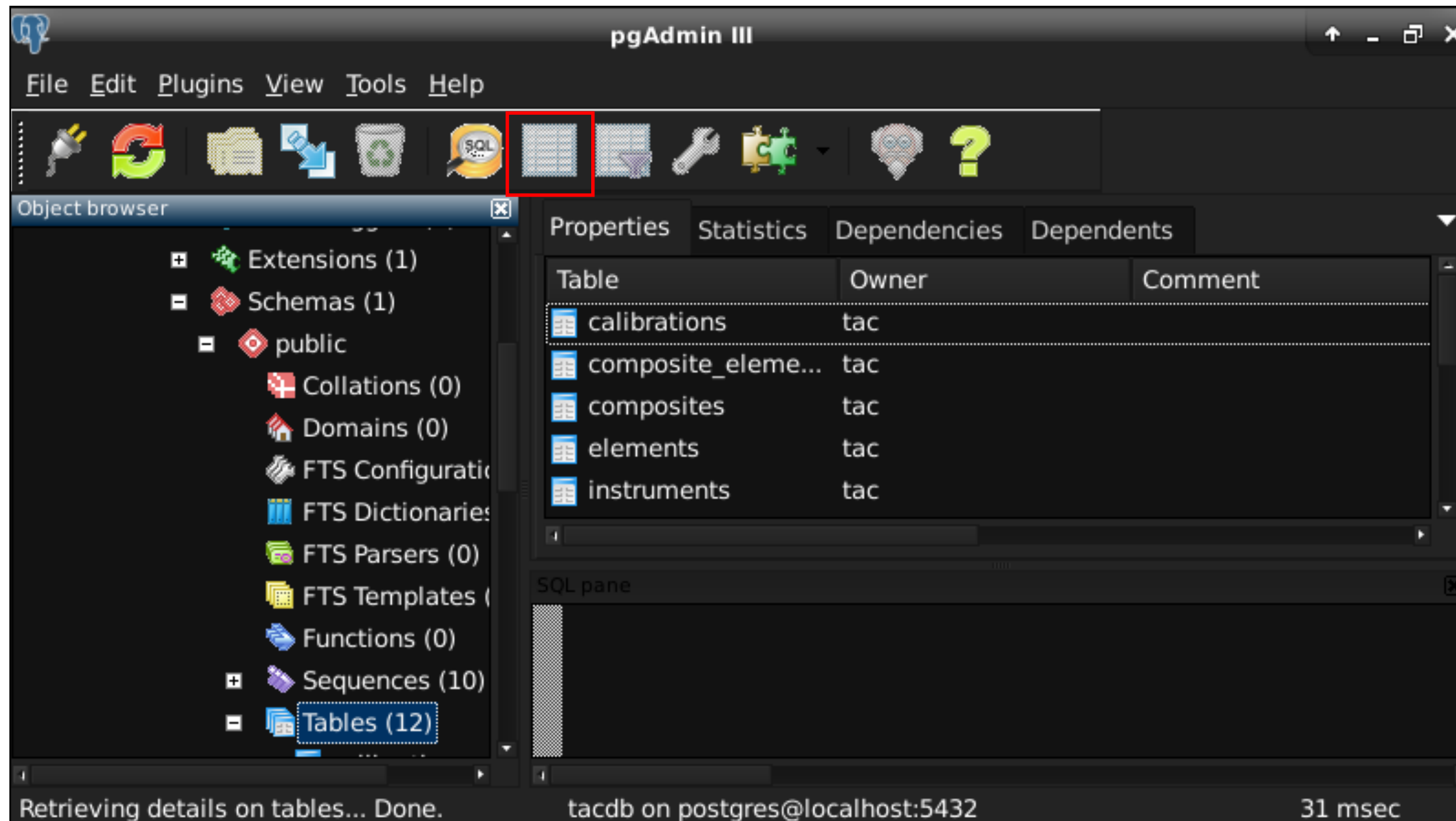
Tables can be found under Schemas > public > Tables





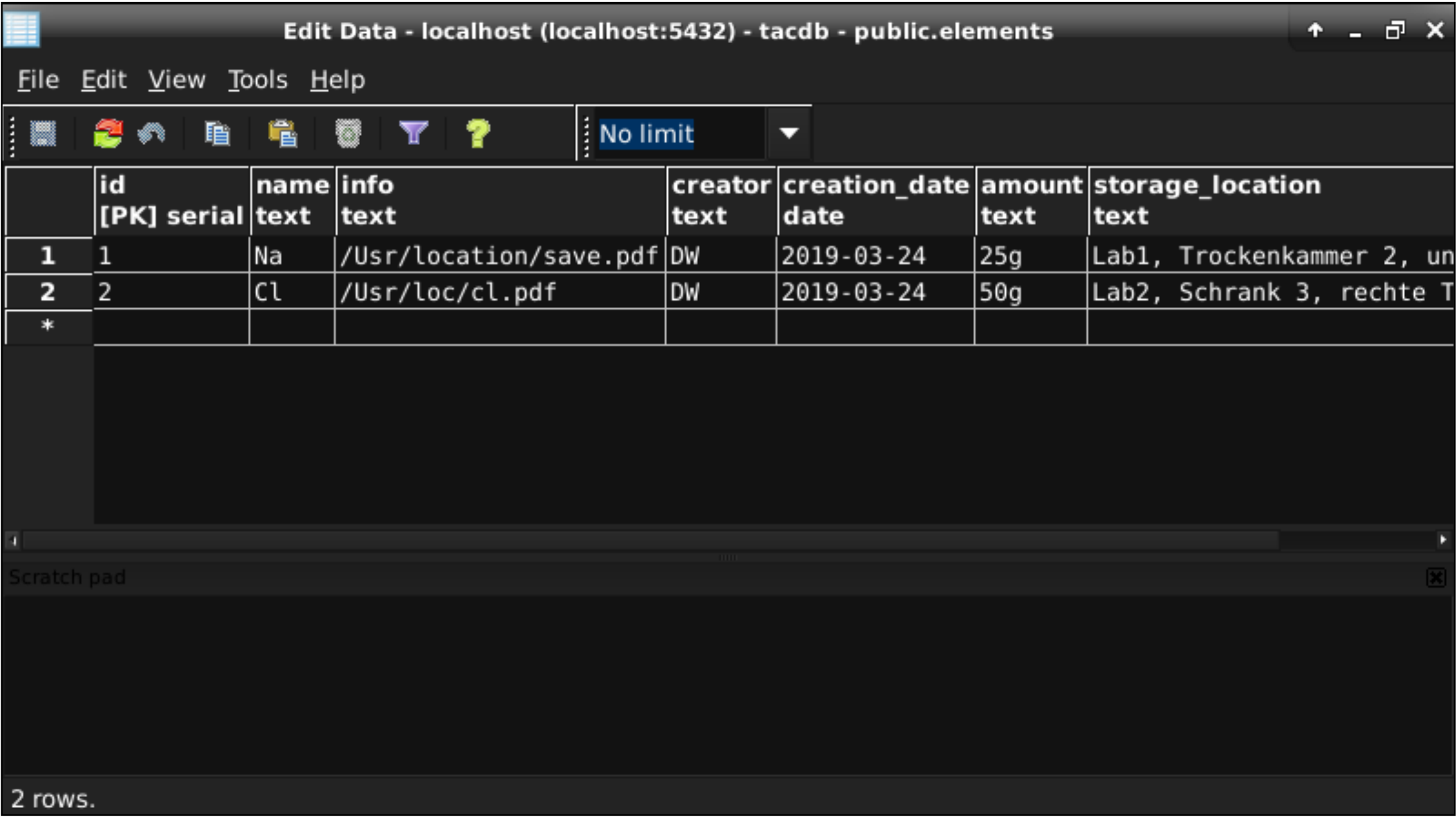
# pgAdmin Interface Tour

List the content of a Table



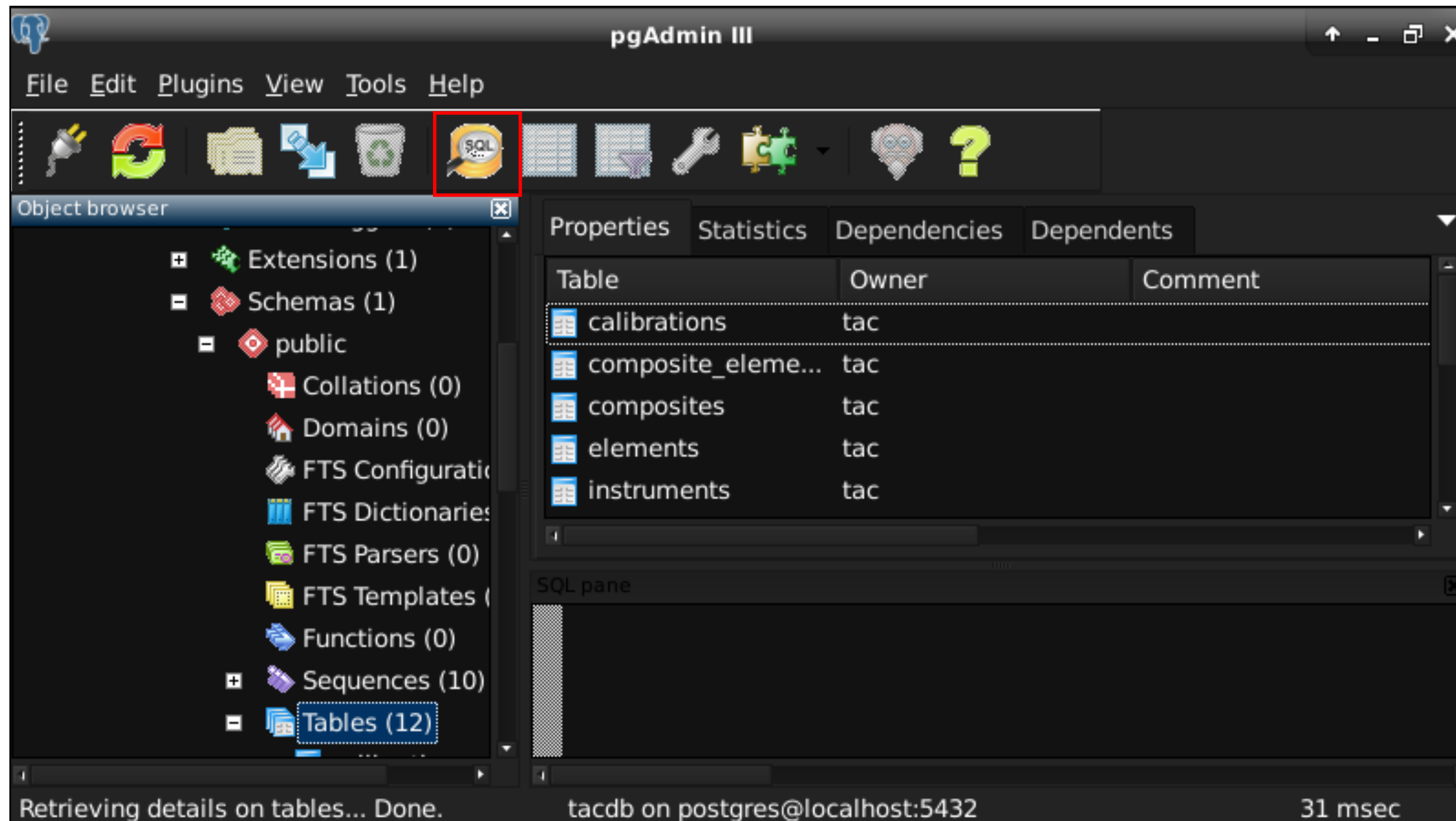
# pgAdmin Interface Tour

The list view allows for manipulation and export of Table data

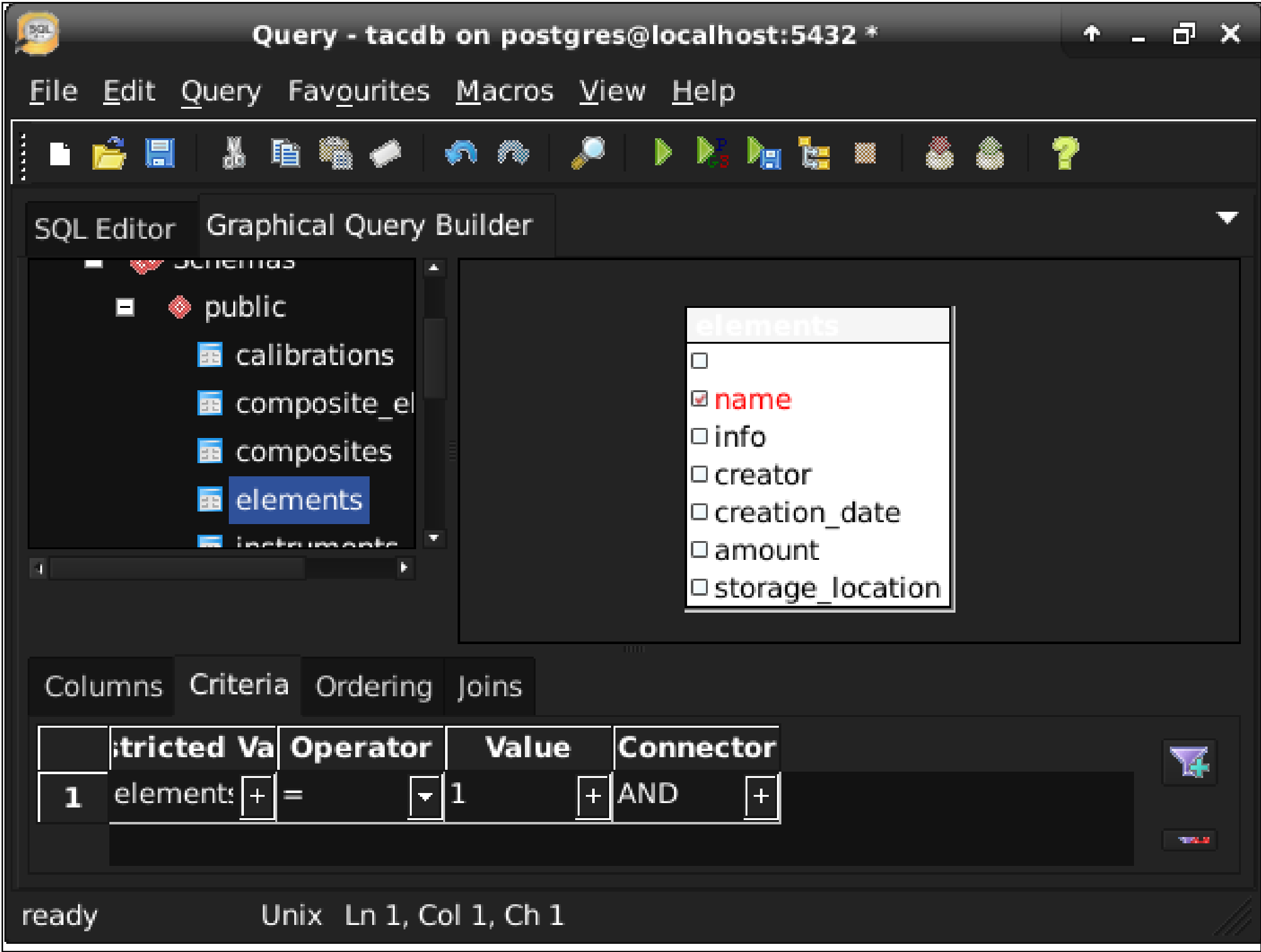


# pgAdmin Interface Tour

The Query Tool allows for Searching inside the database or single tables

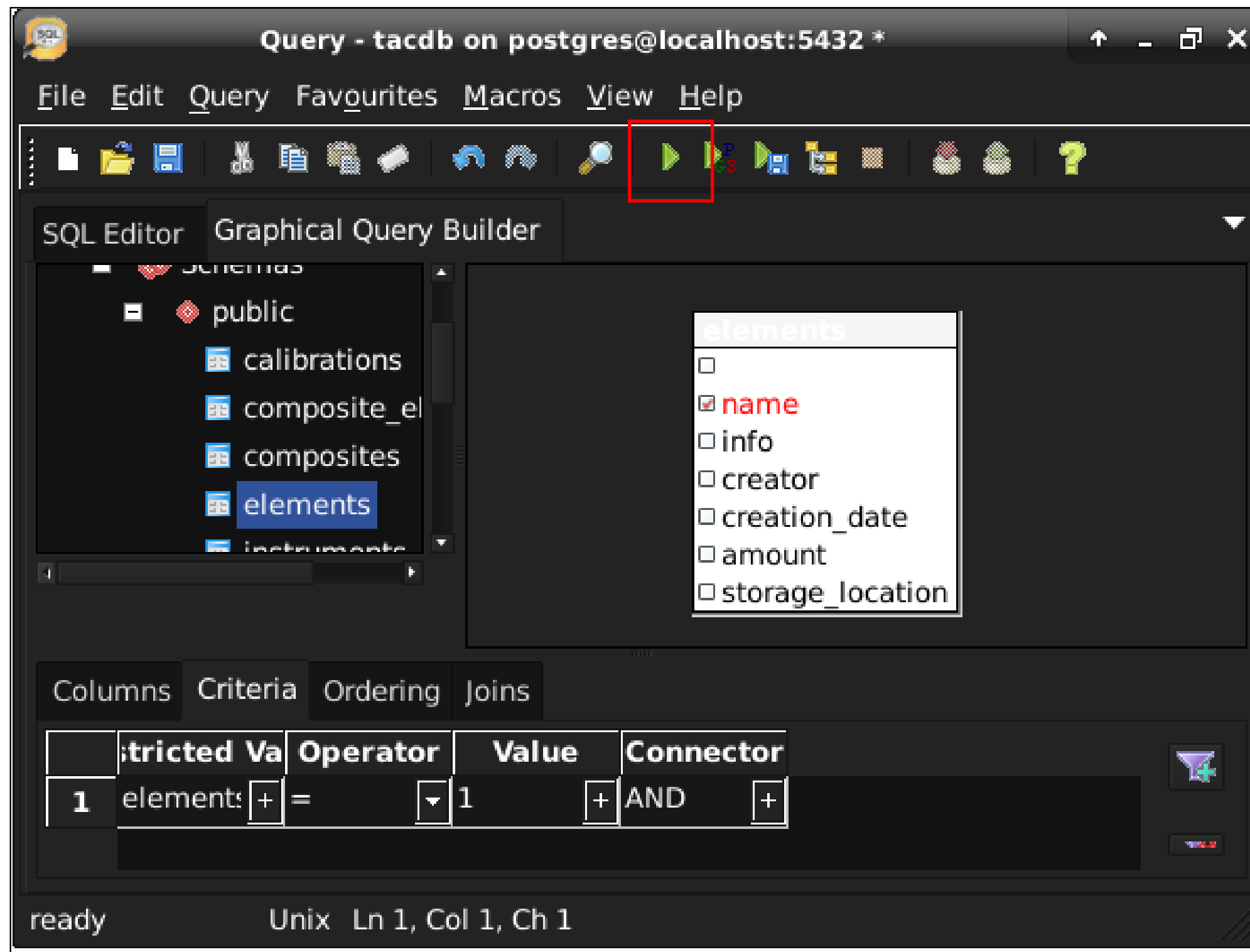


# pgAdmin Interface Tour



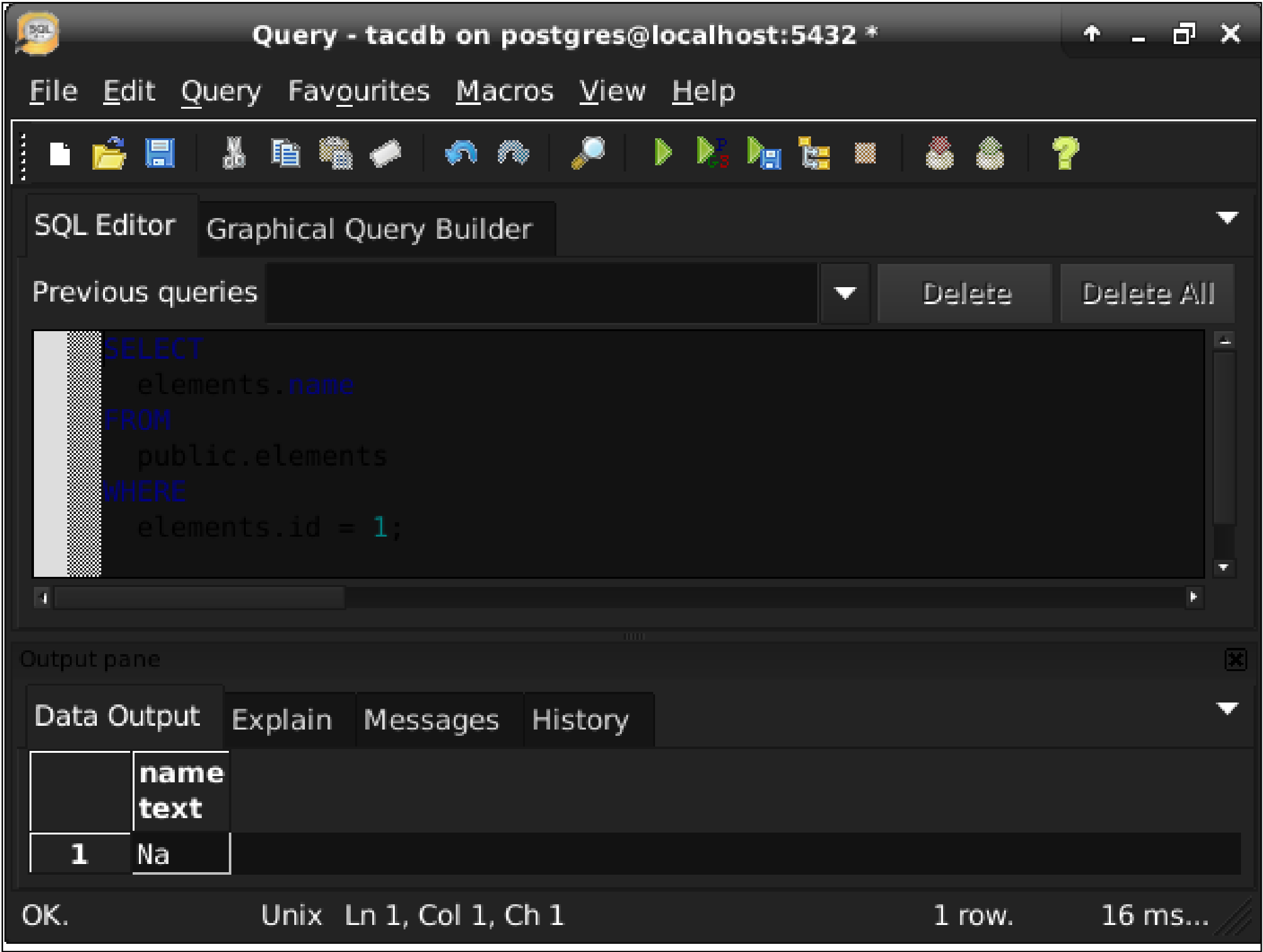
Build Query  
with Graphical  
Query Builder

# pgAdmin Interface Tour



Run Query

# pgAdmin Interface Tour



Extract  
Query  
Results