# pyGIMLi

*Geophysical Inversion & Modelling Library*

## *Geophysical inversion and modeling beyond the standard*


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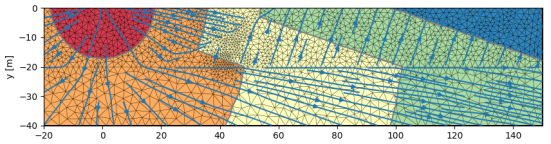
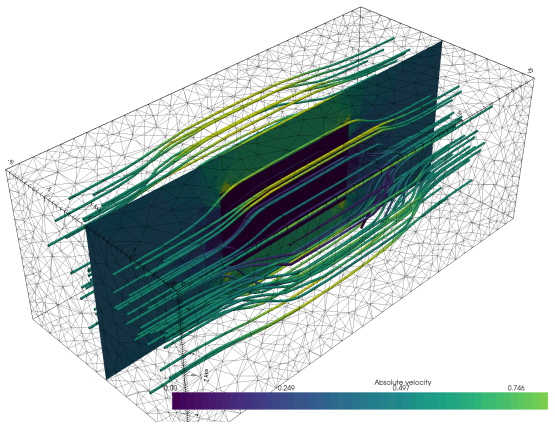
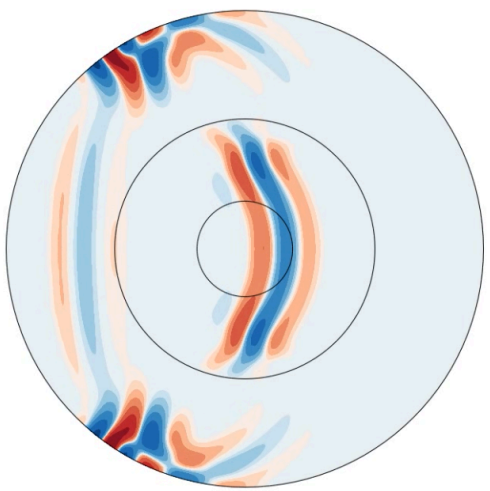
# pyGIMLi is a versatile open-source toolbox with:

- management tools for **structured and unstructured meshes** in 2D & 3D
- computationally efficient **finite-element and finite-volume solvers**
- **various geophysical forward operators**: ERT/IP, Traveltime, Gravimetry, Magnetics, SP, EM
- frameworks for **constrained, joint and process-based inversions** with **region-specific regularization**
- **open-source, platform compatible**, documented & tested code
- suitability for **teaching & reproducible research**
- 1.0 version published in 2017 in *Computers and Geosciences* (Rücker, Günther, and Wagner 2017) (and among the *Most Downloaded* papers since, > 330 citations, > 100 uses in peer-reviewed papers)



https://seg24.pygimli.org

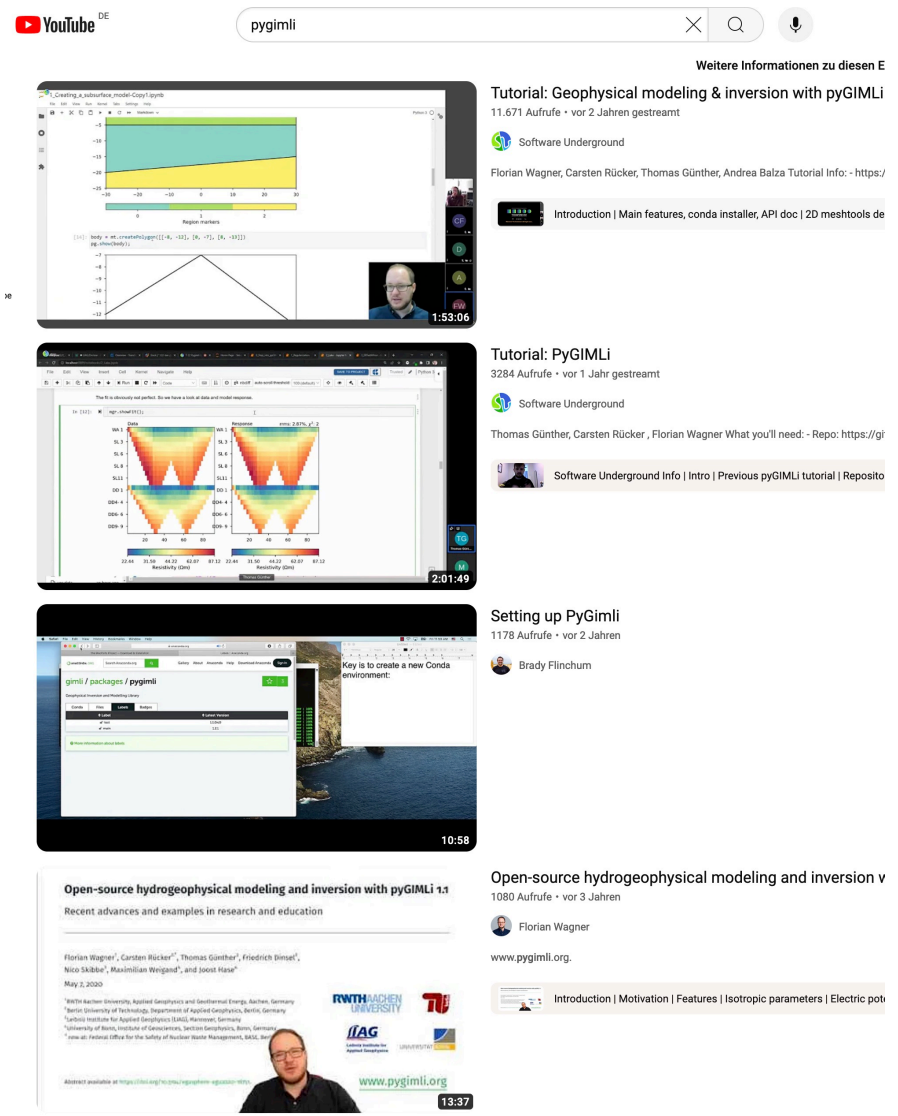
pyGIMLi
Geophysical Inversion & Modelling Library

# pyGIMLi aims to make:

- easy things easy
- hard things possible
- everything transparent and reproducible

# Existing tutorials

- Transform 2021: creating geometries & meshes, modeling PDEs, synthetic data creation, inversion (also with external forward operators).
- Transform 2022: fundamental `pyGIMLi` objects (`Mesh`, `DataContainer`, matrix types, etc.), geostatistical vs. smoothness regularization, treatment of subsurface regions, adding prior data.
- **Today** we will show you how to invert a **real-life 3D data** set (Hübner et al. 2017) with many ways to tweak your **inversion beyond the standard practice**.



# What is new since?

- Transform ’21 & ’22 notebooks available as tutorials or examples on pygimli.org
- **Improved 3D visualization** powered by pyvista (including filters, slices and interactiv notebook compatibility)
- **3D gravity and (full-tensor) magnetics** operators and managers
- **New matrices and matrix generators**, e.g. non-explicit (PDE-based) Jacobian matri
- `LSQRinversion` framework enabling additional parameter relations (from Wagner et a 2019)
- `MultiFrameModelling` framework for temporally/spectrally/spatially constrained inversion
- `TimelapseERT` class with different strategies, e.g. **4D inversion**
- **New examples** on ERT (2D/3D crosshole, 3D surface, timelapse), IP, 3D magnetics
- **Improved website**, i.e. fully upgraded to modern (pg>1.2) style and moved to the *pydata-sphinx-theme*
- Many **more convenience functions** to simplify the code
- Many **new papers using pyGIMLi** (https://pygimli.org/publist.html)

# Join the pyGIMLi user community!


> “In open source, we feel strongly that to really **do something well**, you have to get a lot of people involved.”
>
> – *Linus Torvalds*

1. **Join the `#pyGIMLi` chat** on Mattermost!
2. **Open a discussion** or **raise a issue** on GitHub.
3. **Contribute to the website** via the “Improve this page” button the right sidebar.
4. **Add your** pyGIMLi-powered **publication** to this database.
5. **Send your example** to mail@pygimli.org.
6. **Contribute to the code** as described in our contribution guidelines.

# How to get started

1. Open the Anaconda Prompt (Windows) or a Terminal (macOS/Linux).
2. Clone the `SEGwebinar` repository.

```
git clone https://github.com/gimli-org/SEGwebinar.git
cd SEGwebinar
```

3. Install the `pg` environment with the required dependencies (in particular `pygimli=1.5.0`).

```
conda env create
```

4. Activate the environment and start a Jupyter Notebook.

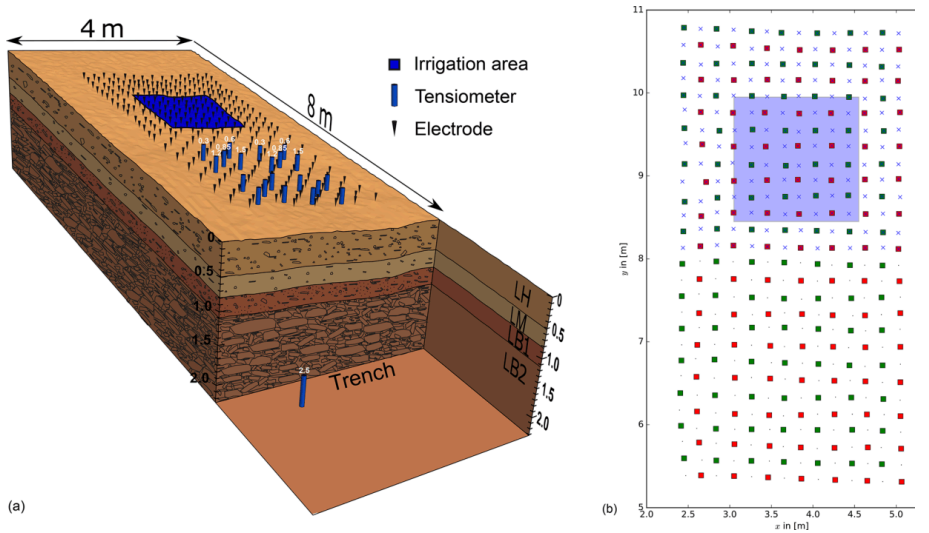
```
conda activate pg
jupyter notebook
```

**Follow without a local installation**

You can also visit https://colab.research.google.com, open an empty notebook and type `!pip install pygimli`.

# Let's go!

1. A single story with timelapse ERT data
2. Load, process and visualize data
3. Work on different meshes
4. Use different regularization approaches
5. Add prior information and petrophysics
6. Visualize results in 2D and 3D
7. Time-lapse inversion




*Source:* Hübner et al. (2017)


Hübner, R., T. Günther, K. Heller, U. Noell, and A. Kleber. 2017. "Impacts of a Capillary Barrier on Infiltration and Subsurface Stormflow in Layered Slope Deposits Monitored with 3-d ERT and Hydrometric Measurements." *Hydrology and Earth System Sciences* 21 (10): 5181–99. https://doi.org/10.5194/hess-21-5181-2017.

Rücker, C., T. Günther, and F. M. Wagner. 2017. "pyGIMLi: An Open-Source Library for Modelling and Inversion in Geophysic *Computers and Geosciences* 109: 106–23. https://doi.org/10.1016/j.cageo.2017.07.011.

Wagner, F. M., C. Mollaret, T. Günther, A. Kemna, and C. Hauck. 2019. "Quantitative Imaging of Water, Ice, and Air in Permafrost Systems Through Petrophysical Joint Inversion of Seismic Refraction and Electrical Resistivity Data." *Geophysical Journal International* 219 (3): 1866–75. https://doi.org/10.1093/gji/ggz402.