

# The Industrial Trajectory Generation and Python API of pilz\_industrial\_motion



[https://wiki.ros.org/pilz\\_robots](https://wiki.ros.org/pilz_robots)

Movelt Workshop 2019  
Macau, November 2nd 2019

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Advanced Development

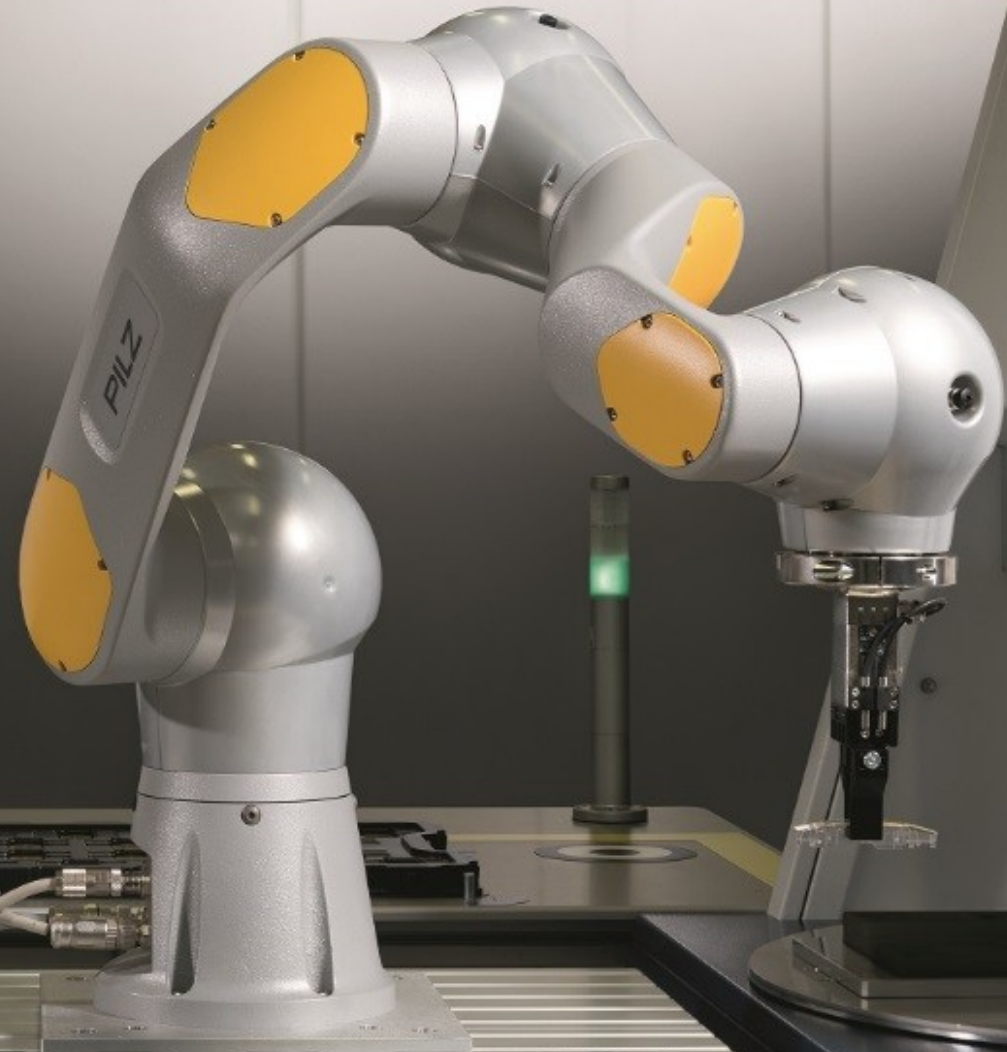
► Two talks

`pilz_robots`  
Drivers  
Hardware Support

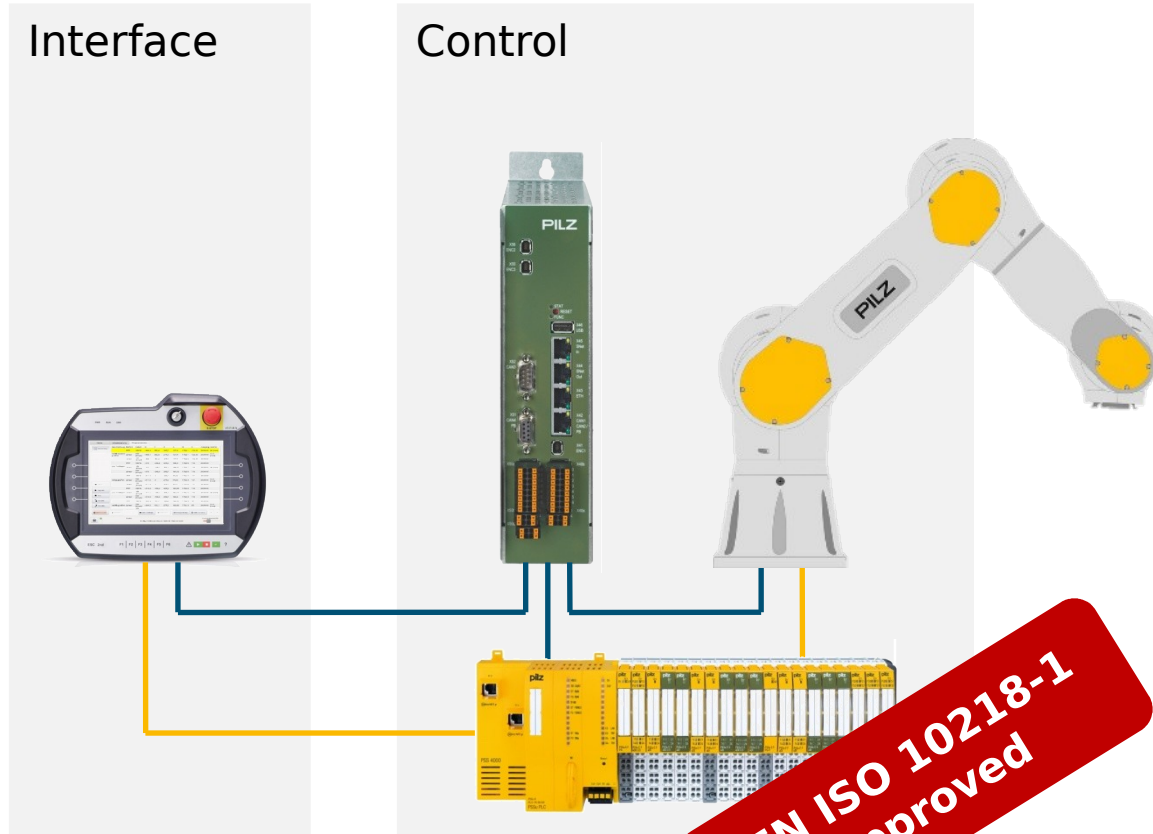
→ ROScon

`pilz_industrial_motion`  
Planner  
API

→ **NOW**

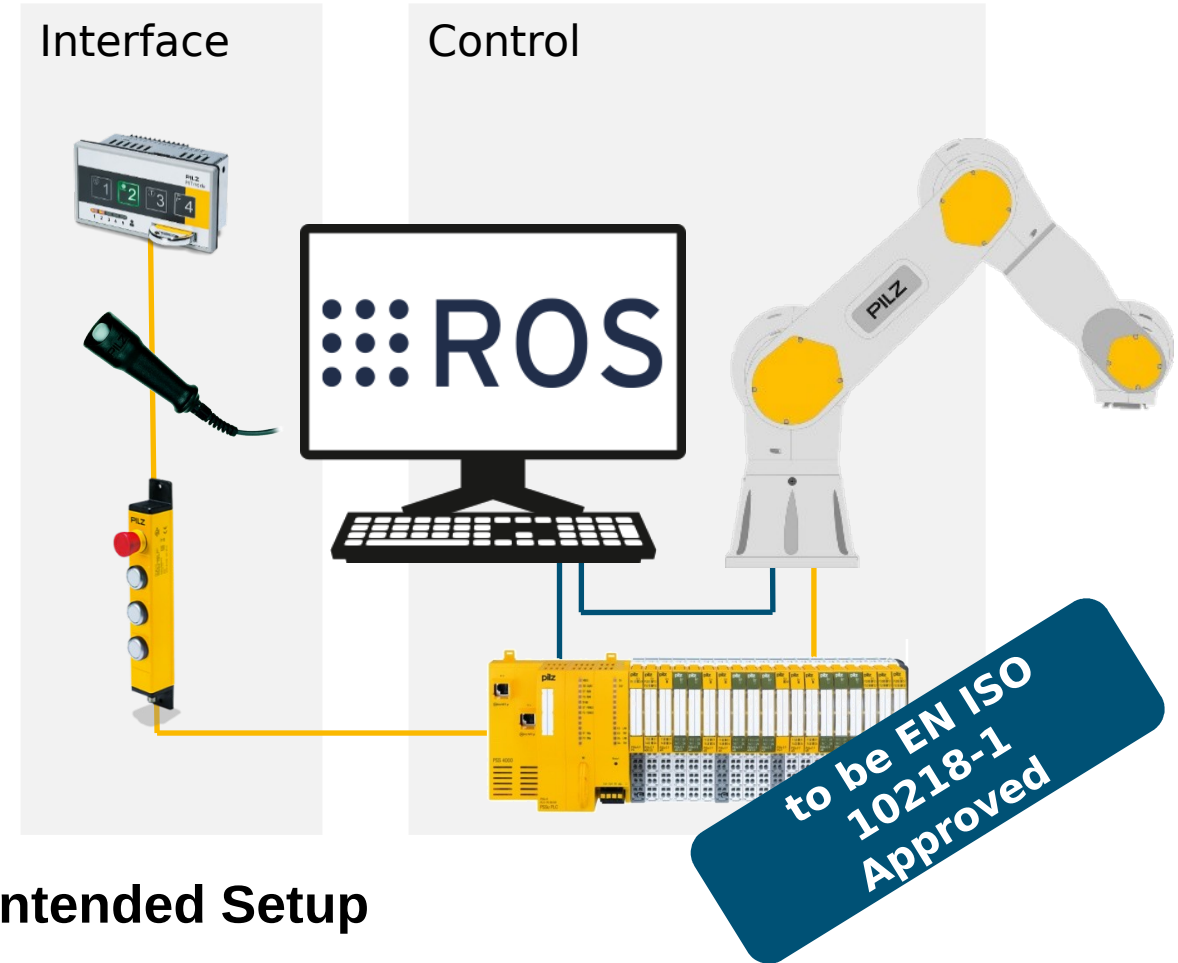


# Recap of „Safety Certified ROS-native Industrial Manipulator“ @ ROSCon



**Traditional Setup**

ROS would be merely an afterthought



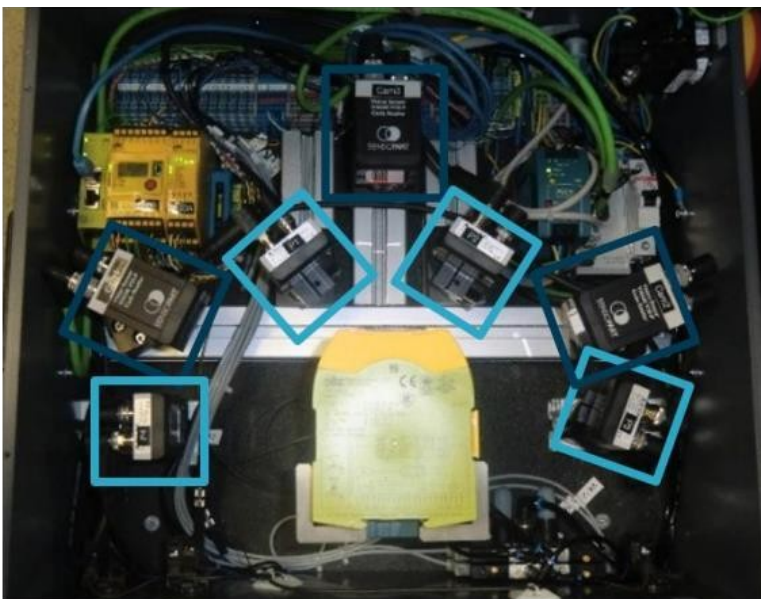
**Intended Setup**

*ROS as core component*

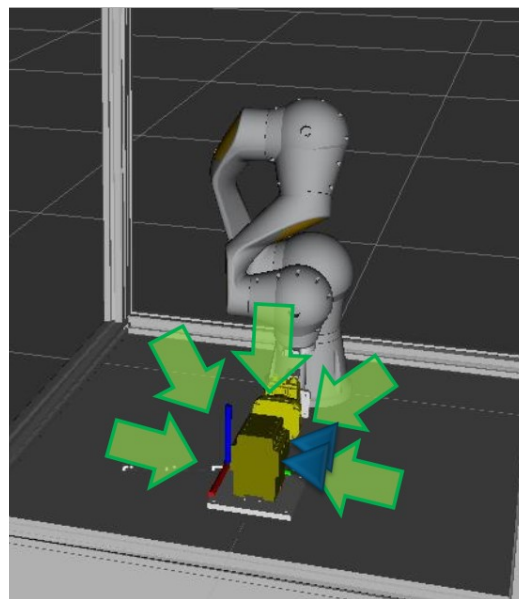
## ► Example Application: Visual Inspection

- *Task:* Inspect part features for large number of product variants
- *Approach:* Robot on-board camera supported on database to lookup poses and save results
- Strengths of ROS:
  - High-level control based on the adaption of State-Machine packages
  - Interface with other software components
  - Use of workspace based (OMPL) and deterministic (pilz\_industrial\_motion) motion planners

Current Setup



Inspection Poses



Demo Setup



Machine setup

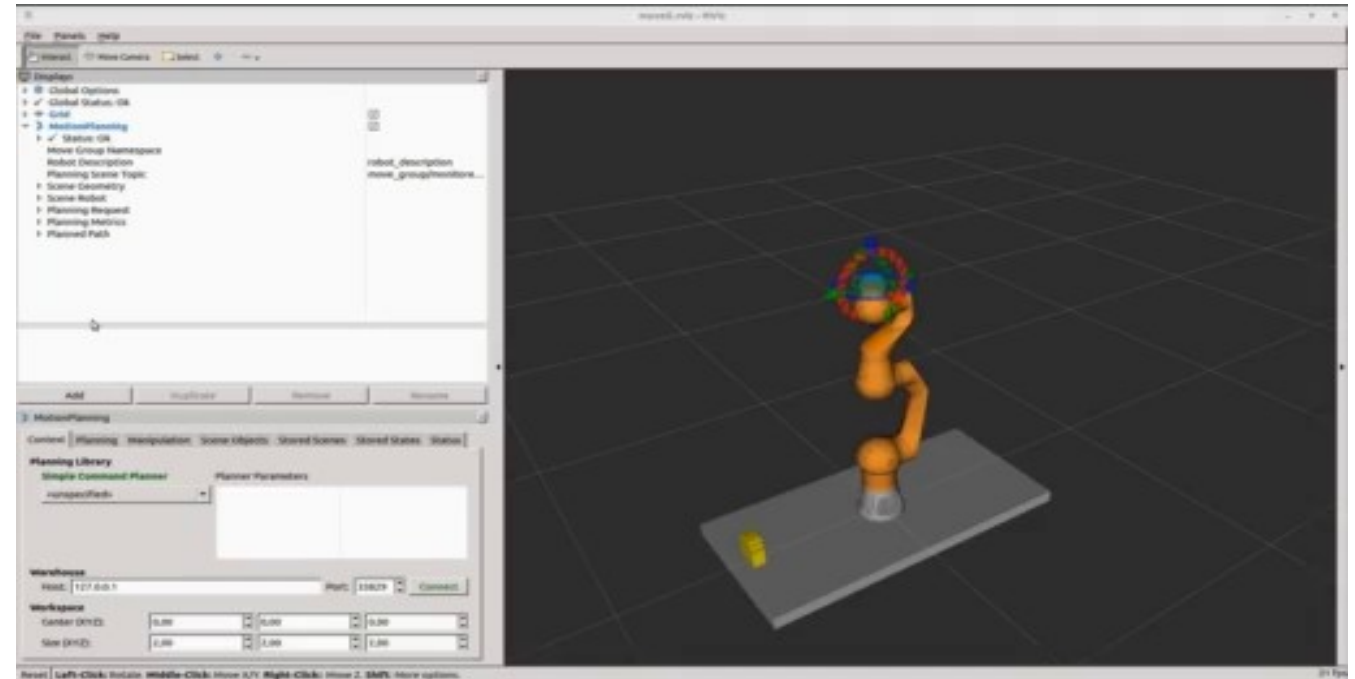


# ► FTP Industrial Trajectory Generation for MoveIt!

## Goal:

- Reproducible trajectories (PTP, LIN, CIRC)
- Fast computation
- Easy-to-use interface
  - Motion from RViz
  - Programming with Python API
  - Tutorials

Working for every robot which has a `moveit_config`.



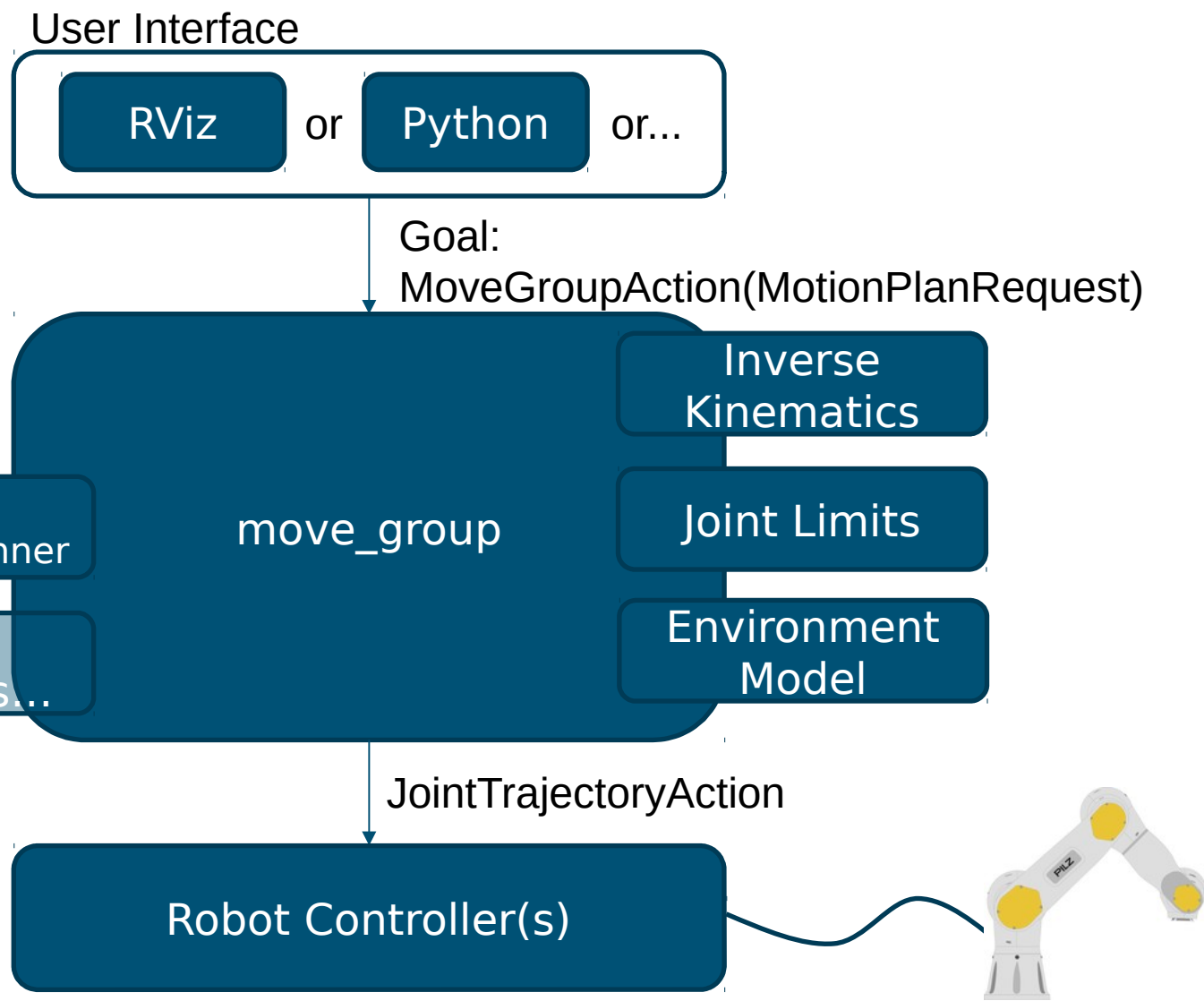
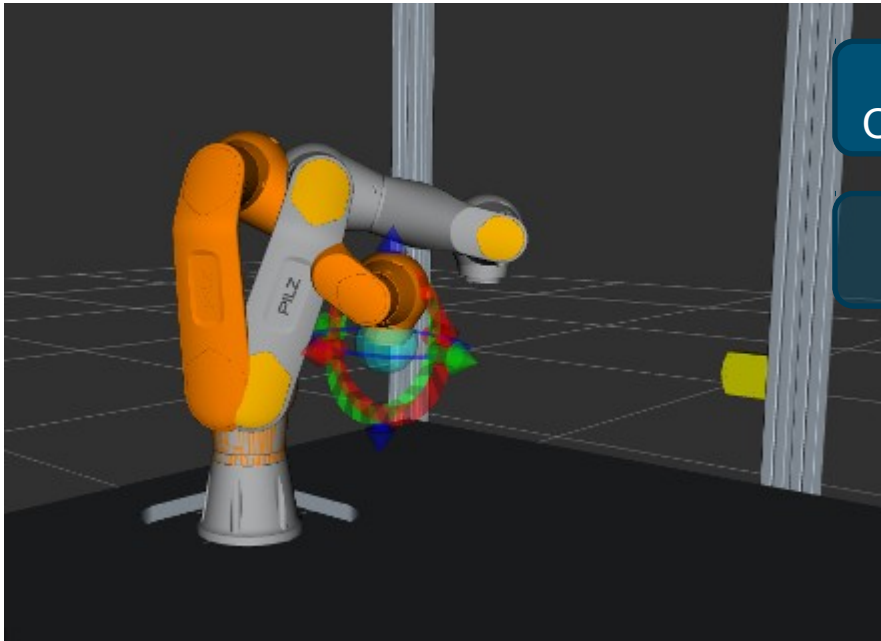
Supported by ROSIN - ROS-Industrial Quality-Assured Robot Software Components. More information: [rosin-project.eu](http://rosin-project.eu)



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no. 732287.

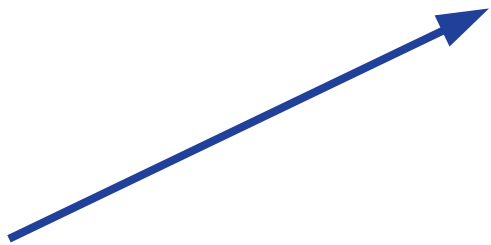
The framework combines

- Kinematics module(s)
- Collision checking with the environment model
- Trajectory execution



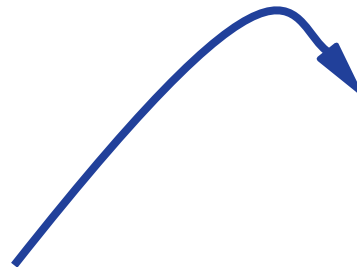
**LIN**

Linear intrapolation  
in cartesian space



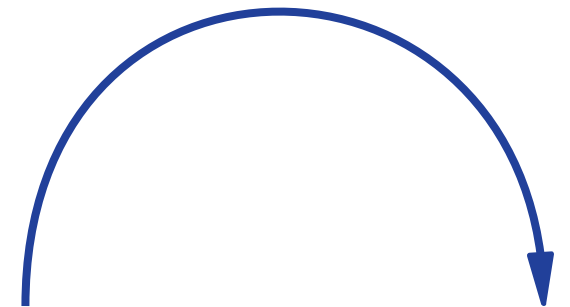
**PTP**

Linear intrapolation  
in joint space



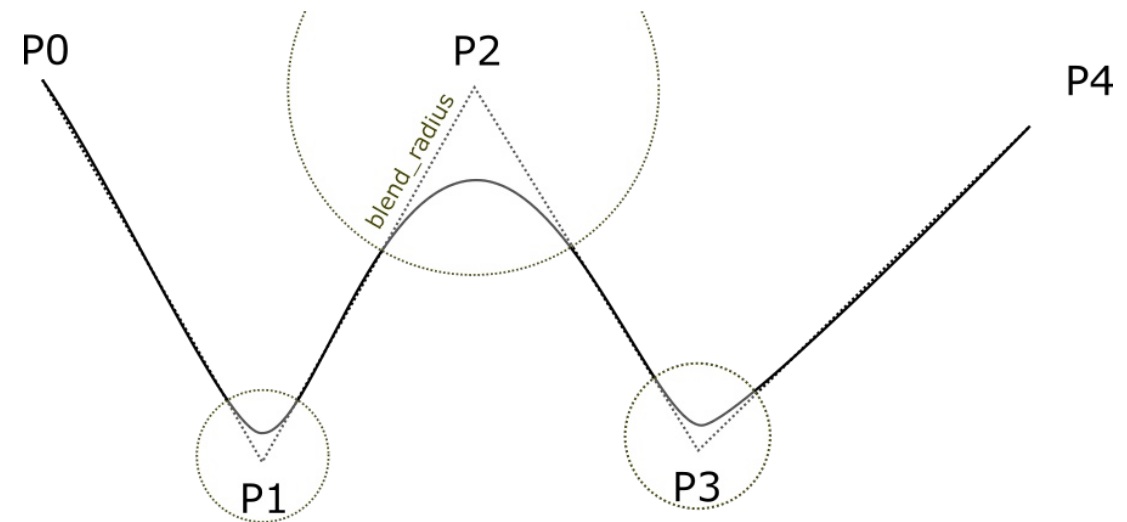
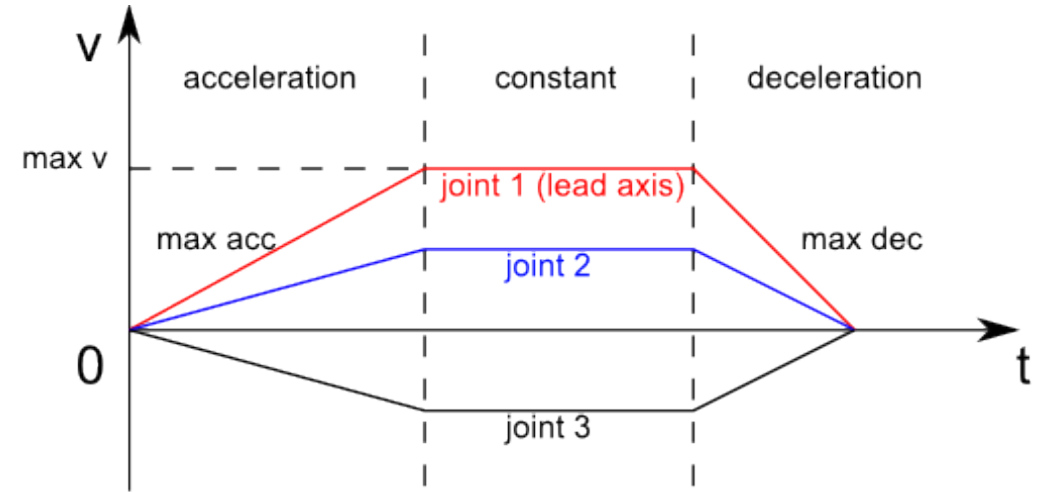
**CIRC**

Circular intrapolation  
in cartesian space



## ► Pilz CommandPlanner

- Trapezoidal velocity profiles
- Collision checking (no avoidance)
- Blend combines a sequence of commands:  
e.g. LIN-LIN





- ▶ Easy-to-use
- ▶ Versioning
- ▶ Move Command
- ▶ Reference Poses or Joint Values
- ▶ Relative Motions
- ▶ Sequences with Blending

```
r = Robot(__REQUIRED_API_VERSION__)

# Simple ptp movement
r.move(Ptp(goal=[0, 0.5, 0.5, 0, 0, 0], vel_scale=0.4))

start_joint_values = r.get_current_joint_states()

# Relative ptp movement
r.move(Ptp(goal=[0.1, 0, 0, 0, 0, 0], relative=True, vel_scale=0.2))
r.move(Ptp(goal=Pose(position=Point(0, 0, -0.1)), relative=True))
r.move(Ptp(goal=[-0.2, 0, 0, 0, 0, 0], relative=True, acc_scale=0.2))
```

```
sequence = Sequence()
sequence.append(Lin(goal=Pose(position=Point(0.2, 0, 0.8)), vel_scale=0.1, acc_scale=0.1))
sequence.append(Circ(goal=Pose(position=Point(0.2, -0.2, 0.8)), center=Point(0.1, -0.1, 0.8), acc_scale=0.4))
sequence.append(Ptp(goal=pose_after_relative, vel_scale=0.2))
```

[https://github.com/PilzDE/pilz\\_industrial\\_motion/blob/melodic-devel/pilz\\_robot\\_programming/examples/demo\\_program.py](https://github.com/PilzDE/pilz_industrial_motion/blob/melodic-devel/pilz_robot_programming/examples/demo_program.py)

# ► With a focus on quality

## Documentation

- Overview on [wiki.ros.org/pilz\\_robots](http://wiki.ros.org/pilz_robots)
- Tutorials
- API-Documentation

## Tests

- Unit- and Integration tests (Travis-CI-Integration)
- ~100% code coverage

The screenshot shows the ROS.org website for the `pilz_robots` package. It features a navigation bar with 'Documentation', 'Browse Software', and 'News'. The package name 'pilz\_robots' is displayed with version selectors for 'kinetic' and 'melodic'. A 'Documentation Status' section lists sub-packages: `prbt_ikfast_manipulator_plugin`, `prbt_moveit_config`, and `prbt_support`. A 'Package Summary' section includes status indicators for 'Released', 'Continuous Integration: 6 / 6', and 'Documented'. A 'Package Links' sidebar contains links for Tutorials, FAQ, Changelog, Change List, and Reviews. Below, it shows 'Dependencies (4)' and 'Jenkins jobs (9)'. The maintainer information lists 'Pilz GmbH and Co. KG'.

The screenshot shows a ROS.org tutorial page titled 'ModelYourApplicationWithPRBT'. It features a 3D visualization of a robotic arm (PNOZ) positioned over a table. The tutorial is part of the 'pilz\_robots' package. Below the visualization, the '2. Prerequisites' section is visible, listing requirements such as a workstation or virtual machine with Linux Ubuntu 16.04 LTS and ROS kinetic installed.

The image displays a Travis-CI test result card. At the top, it shows a progress bar and the word 'coverage'. Below this, '100%' is displayed in large green text with a green checkmark icon. The text 'All checks have passed' and '1 successful check' is shown. At the bottom, there is a green checkmark icon, the Travis-CI logo, and the text 'continuous-integration/travis-ci'.

## ► Summary / Outlook

- Industrial Trajectory Generation
  - LIN, PTP, CIRC
  - Blending
- Python API
  - Easy to use
  - Versatile
- Example using two planners
  - ompl + Pilz
  - LIN to approach
  - ompl in free space
- MoveIt 2.0 !
- World MoveIt Day



## Automatisierungs- technik

COMPONENTS  
SYSTEMS  
SERVICES

innovativ    ökologisch  
sicher        wirtschaftlich

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Please visit  
[https://github.com/pilzde/pilz\\_robots](https://github.com/pilzde/pilz_robots)  
[https://github.com/pilzde/pilz\\_industrial\\_motion](https://github.com/pilzde/pilz_industrial_motion)



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**PILZ**  
THE SPIRIT OF SAFETY