# High Throughput Methods in Photovoltaics - addressing the terawatt challenge

## HI ERN – ZAE Cooperation



HI ERN Helmholtz Institute Erlangen-Nürnberg

part of JÜLICH Forschungszentrum

in cooperation with FAU Friedrich-Alexander Universität Erlangen-Nürnberg, HZB Helmholtz Zentrum Berlin

# Where do we come in?

~30 People
~2,5Mio. € Budget
~3500qm Facilities

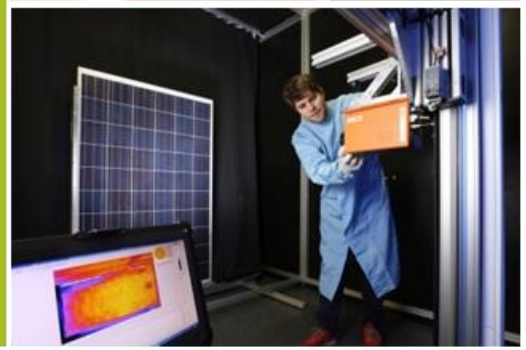
Basic Research

FAU FRIEDRICH-ALEXANDER UNIVERSITÄT ERLANGEN-NÜRNBERG

Chair:

I-MEET

Applied Research: **High Throughput Methods in Photovoltaics**

High Throughput **Materials and Devices for PV**

High Throughput **Processing for PV**

ZAE BAYERN

High Throughput **Characterization and Modelling for PV**

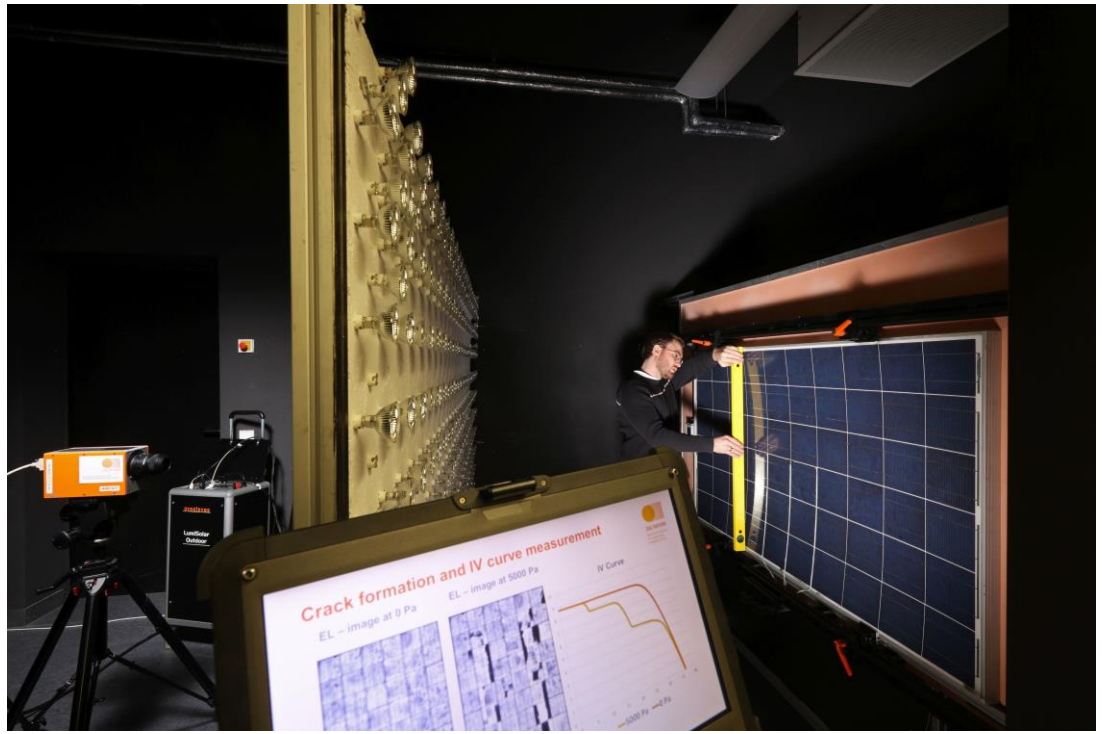
# High Throughput Characterization and Modelling

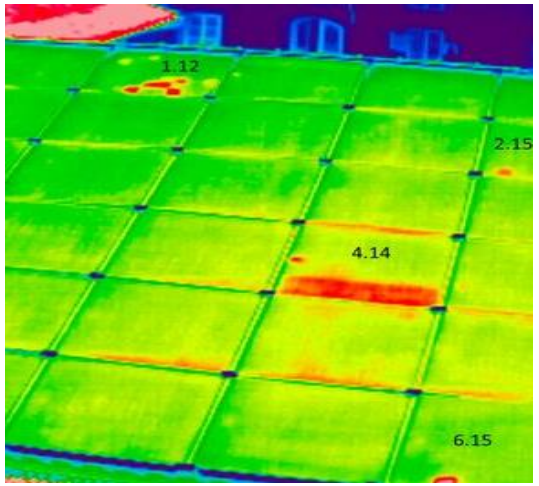
## Goals

- Full characterization and yield prediction for PV-systems
- Development of new methods for the characterization of PV-modules and installations
- Coupling AI and large data methods with PV-Systems know-how

## Main Capabilities/Infrastructure

- Reliability lab and outdoor weathering
- IR-characterization of PV installations with UAV/Drones
- Si/CIGS Cell technology
- Failure analysis (Raman/Thermography/ EL/Spectroscopy/X-ray…)



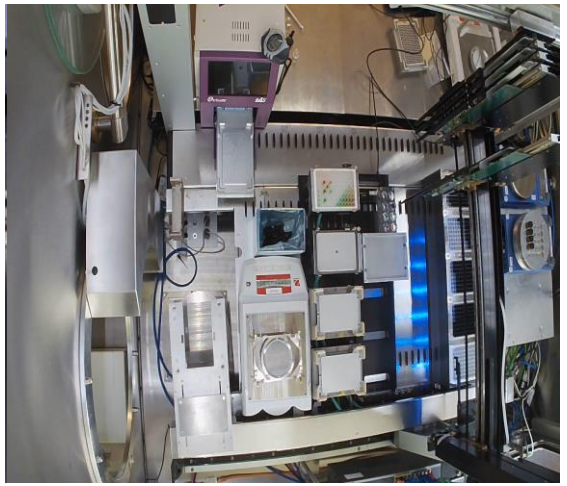
# Team: High Throughput Materials and Devices for Photovoltaics

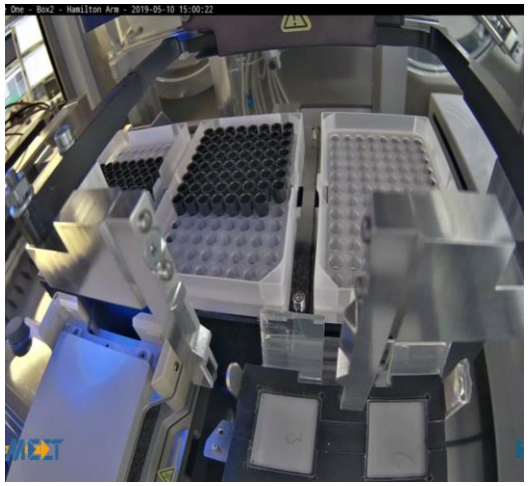
## Goals

- Development of high throughput methods for materials research
- Acceleration of materials development through automation, large data techniques, machine learning and intelligent sampling
- Create autonomous research machines
- Coupling of AI with automated equipment

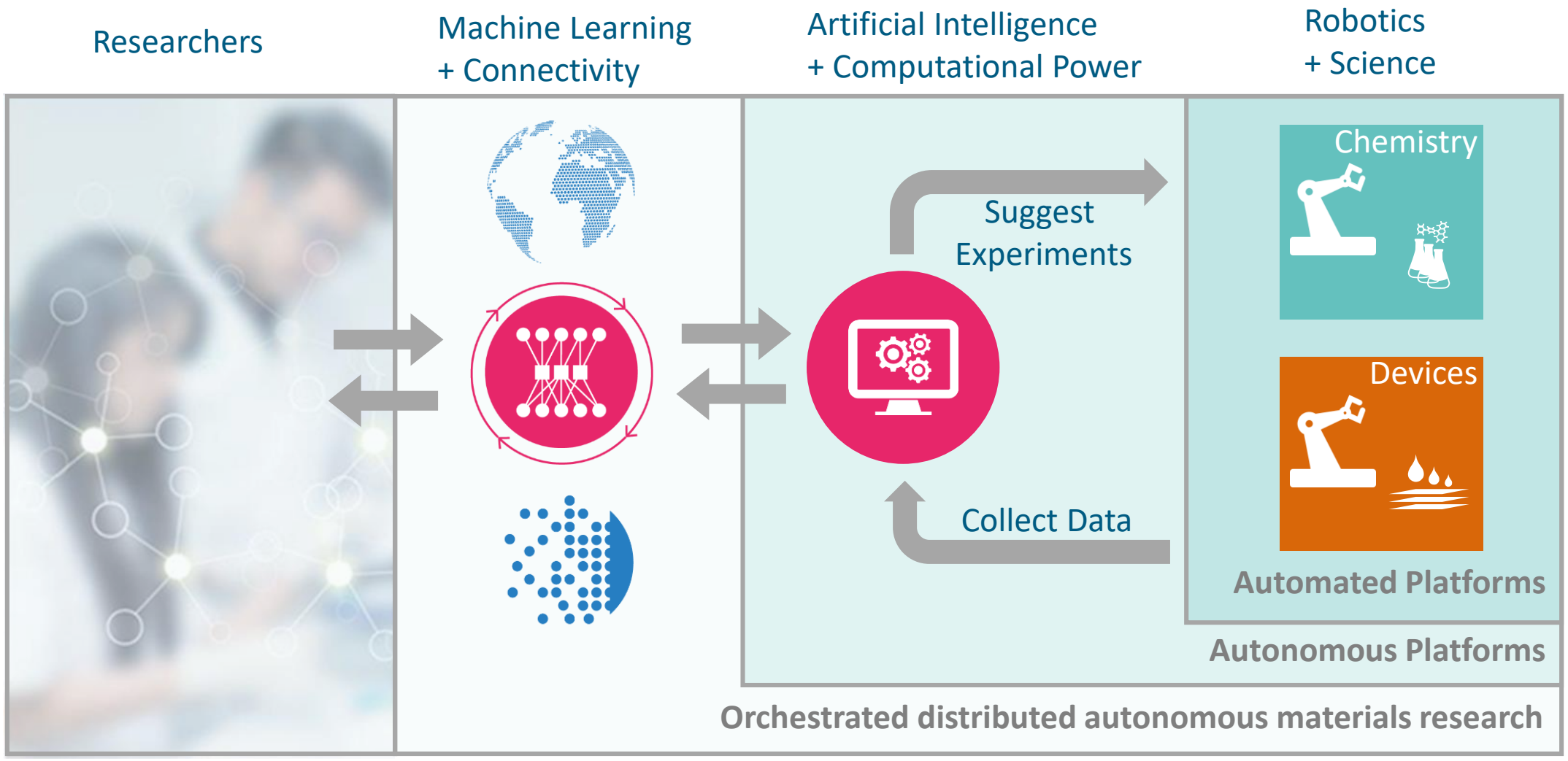
## Main Capabilities/Infrastructure

- High throughput techniques for materials screening
- Implementation of experiments in automated, robotic based materials handling equipment
- Machine development
- IT infrastructure



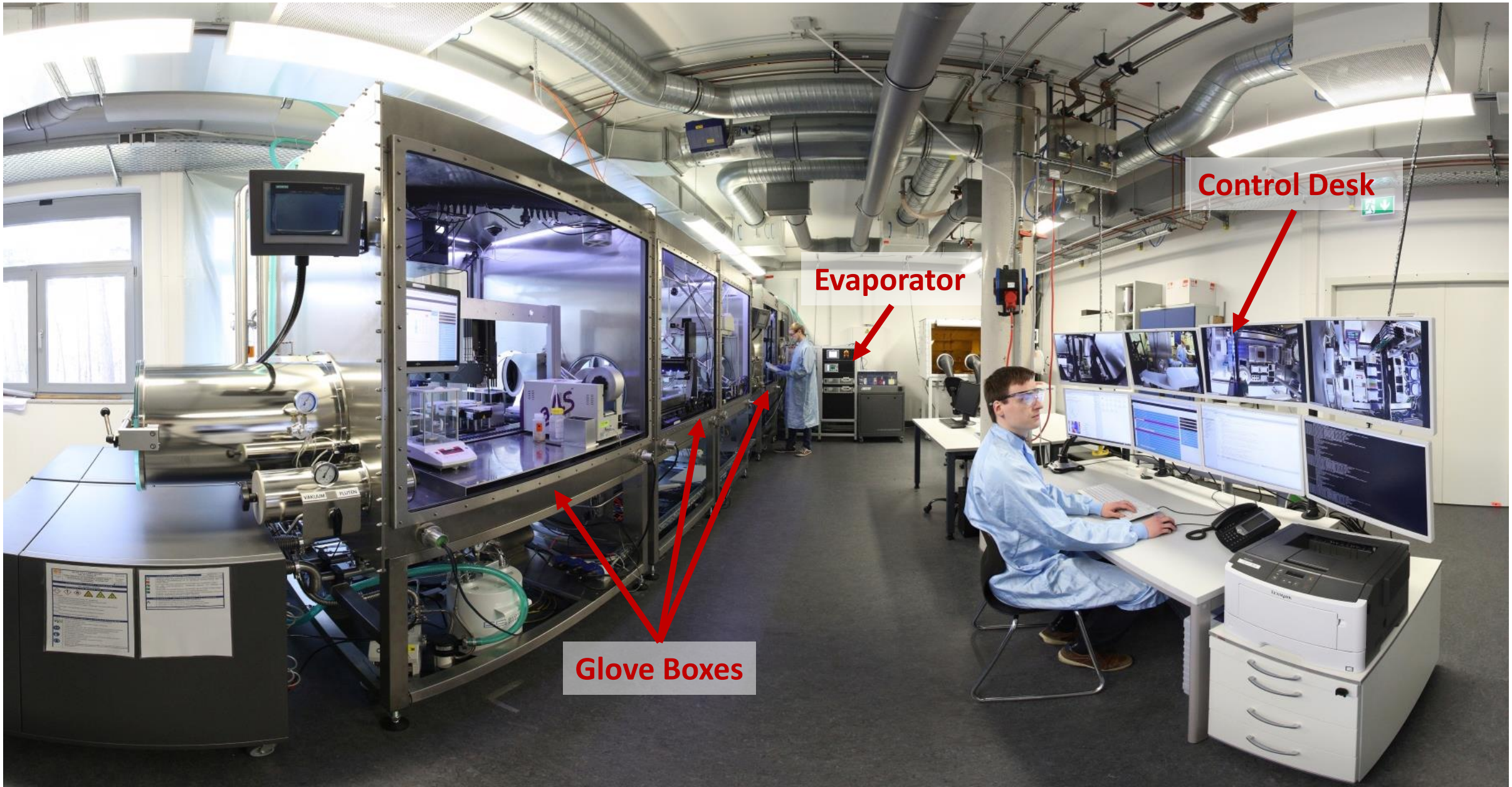


# Towards autonomous Materials Discovery

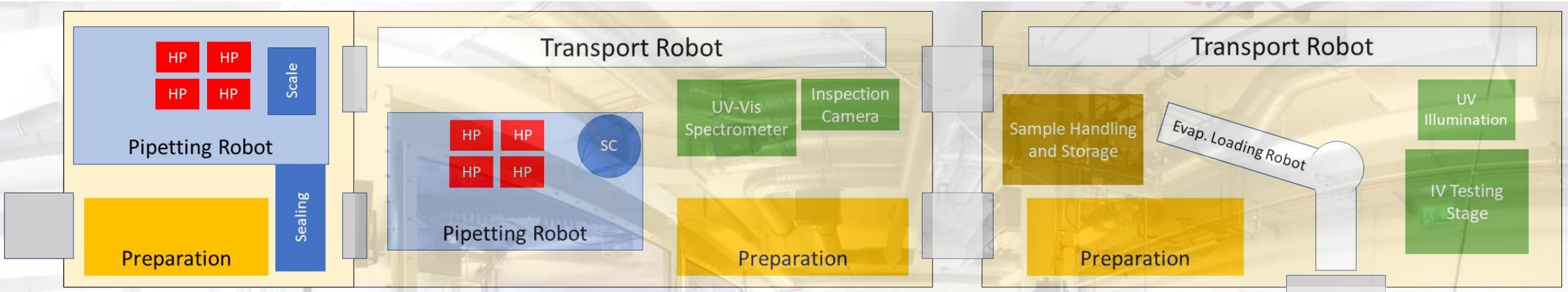



**Accelerating the discovery of complex functional materials**

# AMANDA – Autonomous Materials and Device Application Platform



# AMANDA – Schematic View




**Box 1**
**Solution preparation**

- Weighing of powders
- Mixing & diluting of solutions into well plates
- Stirring & heating of solutions ➔ chemical reactions possible
- Sealing of well plates

**Box 2**
**Film Preparation**

- Automatic sample transport
- Spin coating
  - On-the-fly (static)
  - Dynamic
- Drop Casting
- Post treatment of layers
- UV-Vis Spectrometer
  - Absorbance
  - Photoluminescence
- Layer quality control

**Box 3**
**Sample Finishing**

- Automatic sample transport
- Thermal evaporation
- Light dependent electrical characterization
  ➔ Solar simulator
- Sample storage

# AMANDA - Workflow


## Database

- Logging of process sequence, parameters and atmospheric information
- Saving measurement results
- Capturing video footage

## Control Logic

- Control of every single device
- Calculating machine state
- Resource management (parallelization)

## User Interface

- Web based
- Drag and drop
- Predefined experiment plans
- User based projects and permissions
- Direct output of measurement results

## Calculating Logic

- Compute measurement results
- Provides different machine learning modules
  - Predict promising experiments
- Image analysis
  - Edge detection
  - Evaluate layer quality

# High Throughput Methods are the driving force for accelerating Materials Discovery!

**What we offer:**

- automation/robotics for laboratory environments
- Materials Science & Photovoltaics Expertise
- Optoelectronic Characterization and Analytical Techniques

**What we are looking for**

- Self learning robotic systems
- Artificial Intelligence/Machine learning
- Development of Materials Acceleration Platforms
- Utilizing AI to create autonomous laboratories