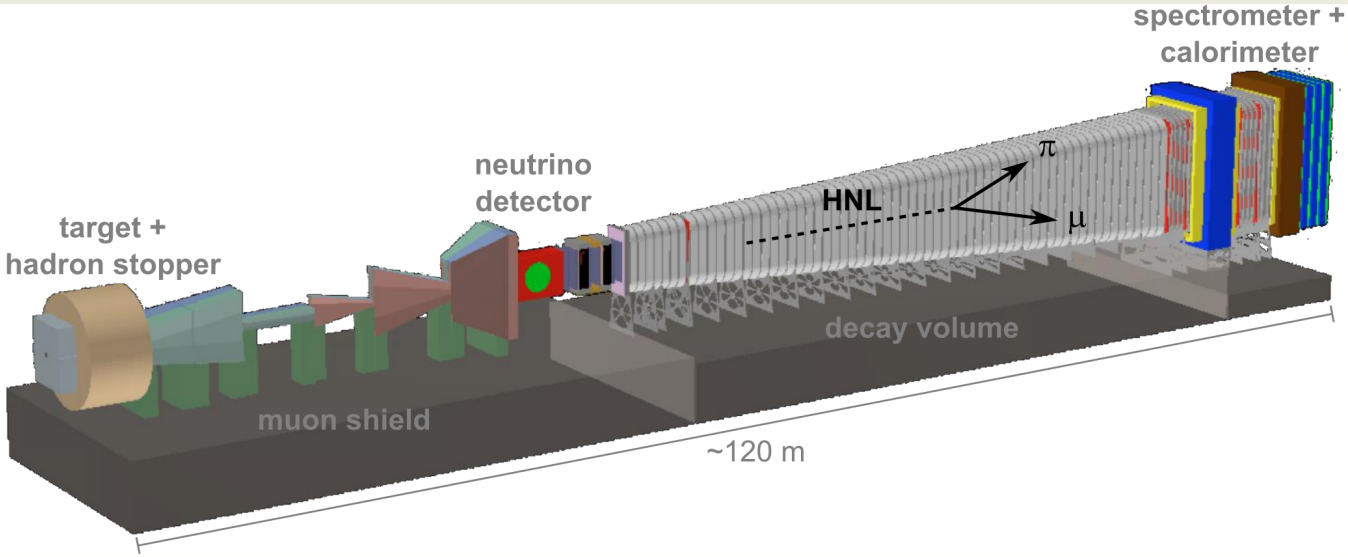
Filling & Emptying the SBT

Annika Hollnagel
annika.hollnagel@uni-mainz.de

Johannes Gutenberg-Universität Mainz, ETAP
WG Michael Wurm

SHiP Joint Physics & Detector Meeting
- Vacuum Vessel Workshop -

The SHiP LS-SBT

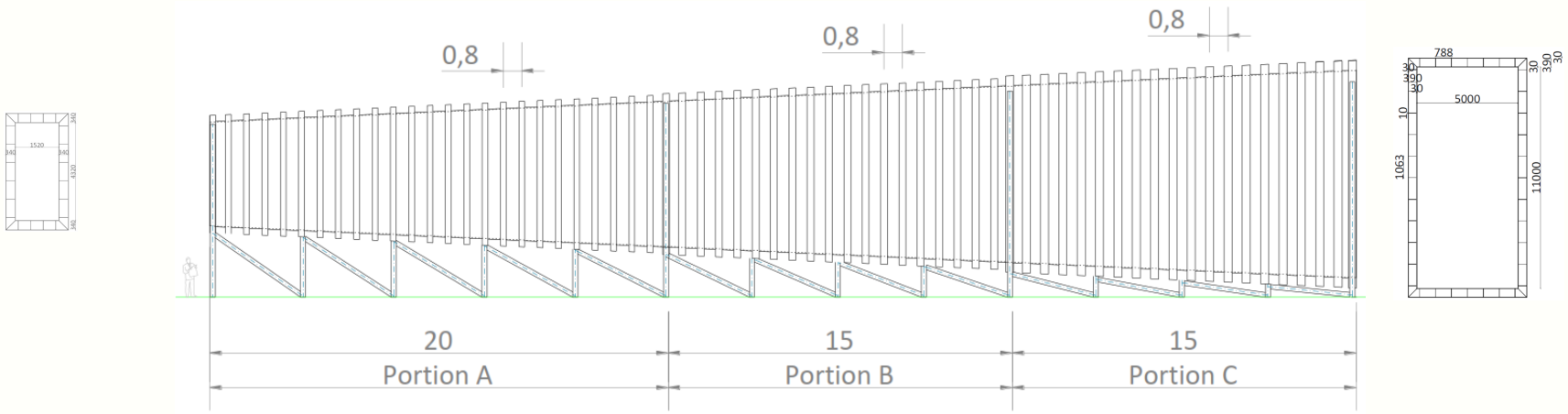


Liquid Scintillator-Surround Background Tagger:

- Surrounding the SHiP decay volume
- Structure defined by decay vessel support elements
- $\mathcal{O}(2000)$ detector cells of $\sim 120 \times 80 \times 30\,\mathrm{cm}^3$
- $\mathcal{O}(300\,000\,\mathrm{l})$ of liquid scintillator

▷ **Subdivision into rings of connected cells**

The SHiP LS-SBT



Liquid Scintillator-Surrounding Background Tagger:

- Surrounding the SHiP decay volume
- Structure defined by decay vessel support elements
- $\mathcal{O}(2000)$ detector cells of $\sim 120 \times 80 \times 30\,\mathrm{cm}^3$
- $\mathcal{O}(300\,000\,\mathrm{l})$ of liquid scintillator

▷ **Subdivision into rings of connected cells**

Cell Filling Scheme

Inter-Cell LS & N_2 Flow:

- 'Cut' corners of segment walls for inter-cell connection
  - ▷ Quarter-circle holes with $3\,\mathrm{cm}$ radius

Per Ring of Cells:

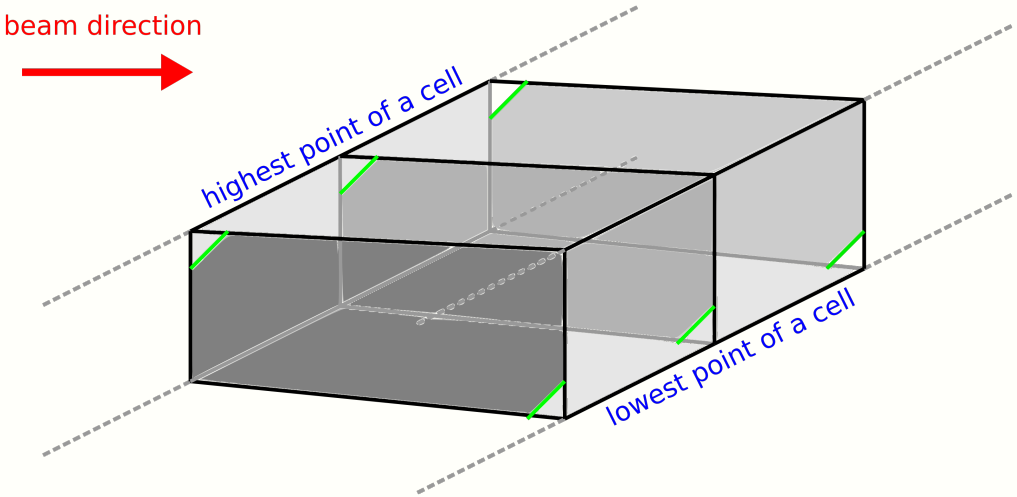
- 1 opening center bottom for LS filling / emptying
- 1 opening center bottom for N_2 filling & flushing
- 1 opening center top for N_2 release

Discussion:

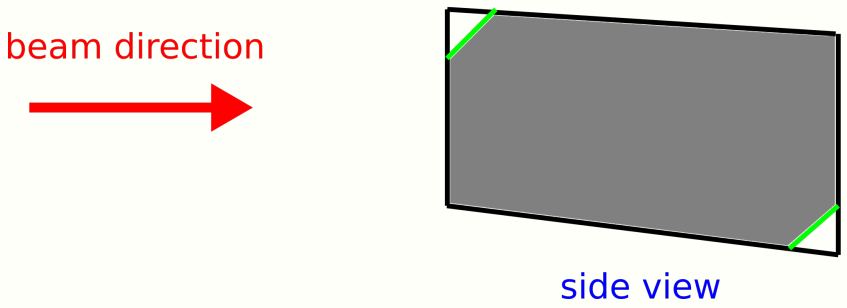
- Vertical division of rings into two halves?
- Diameter & placement of openings & connections?
  - ▷ **Acrylic mock-up to study liquid & gas flow**

Cell Filling Scheme

Lower Horizontal Section of a Ring:

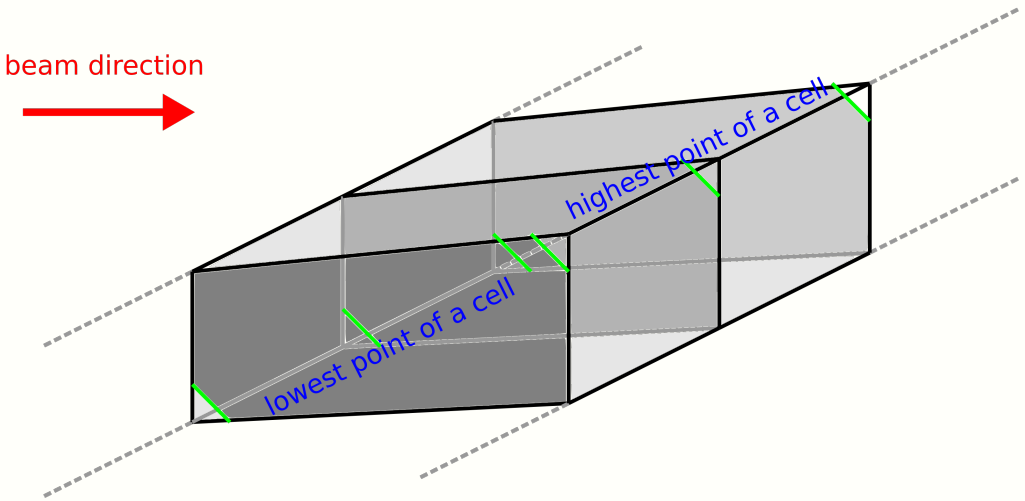


- 'Cut' (at least) 2 corners of **vertical** segment walls to allow inter-cell gas / liquid flow to neighbouring cells at **highest** / **lowest** points:

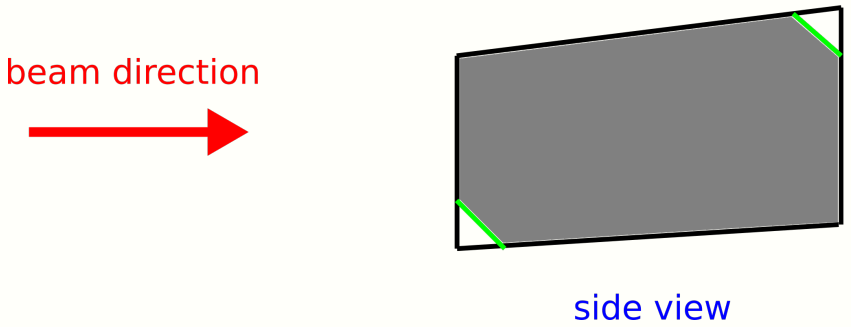


Cell Filling Scheme

Upper Horizontal Section of a Ring:

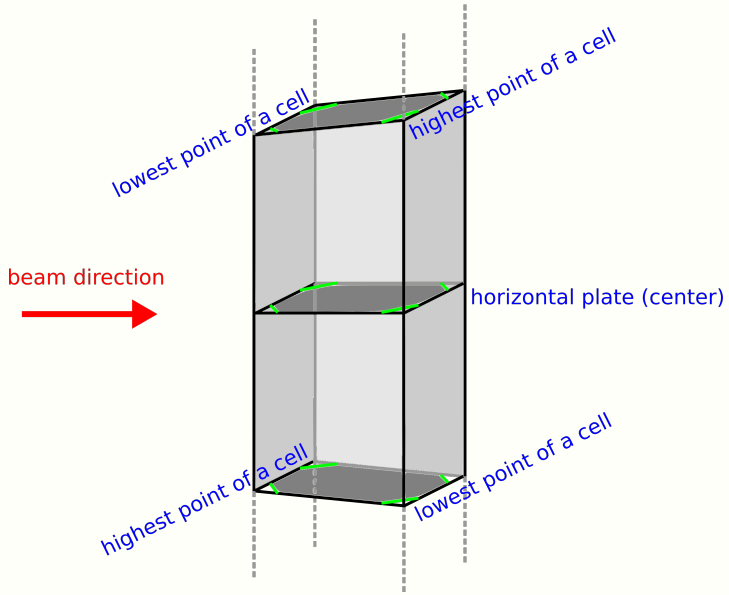


- 'Cut' (at least) 2 corners of **vertical** segment walls to allow inter-cell gas / liquid flow to neighbouring cells at **highest** / **lowest** points:

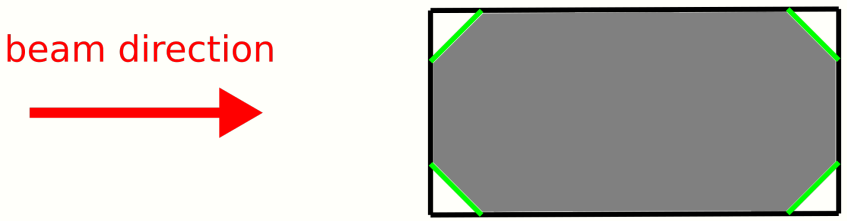


Cell Filling Scheme

Vertical Section of a Ring:



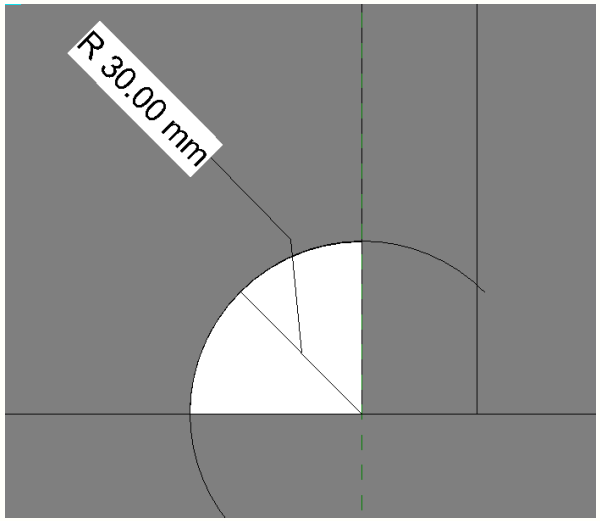
- 'Cut' **all** 4 corners of **horizontal** segment walls to allow inter-cell gas / liquid flow to neighbouring cells at **highest** / **lowest** points:



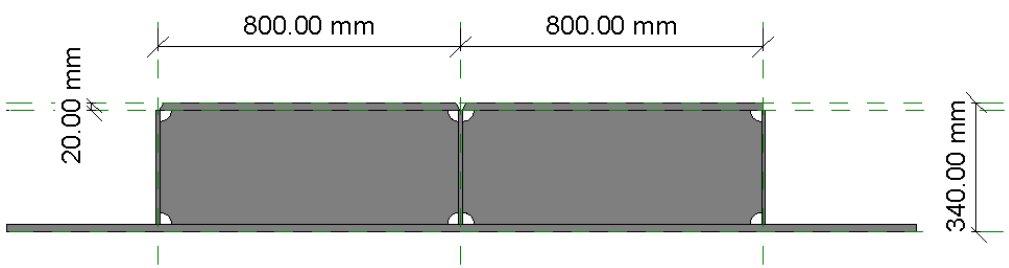
top view

Cell Filling Scheme

'Cut' Corners:



- Quarter-circles of 3 cm radius
  - ▷ Ensuring safe flow of liquid also in case of welding seams

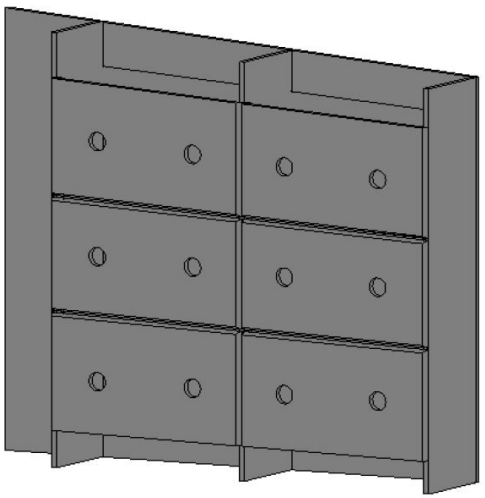


Backup

WOM Placement

WOM Openings:

- 2 WOM openings per (standard) cell
- 7 cm diameter
- placed along cell center line
- $\sim$ 30 cm distance to cell wall
- $\lesssim$ 60 cm distance between each other



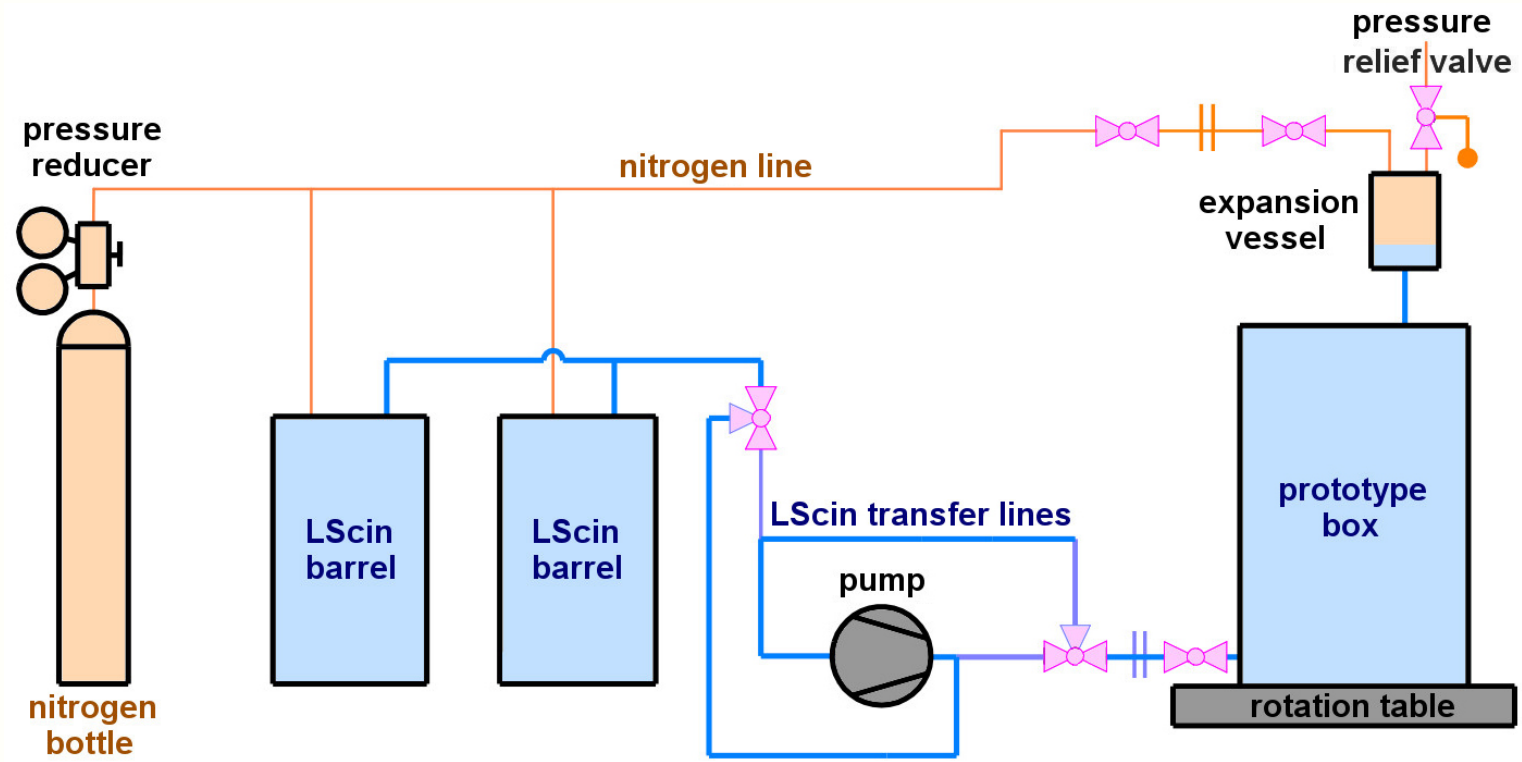
(top / bottom)

(side)

▷ **Ideal placement to be determined by simulations**
(taking into account scintillator absorbance, wall reflectivity...)

Filling System Small-Scale Prototype

Test Beam Operation (CERN 2018 / DESY 2019):



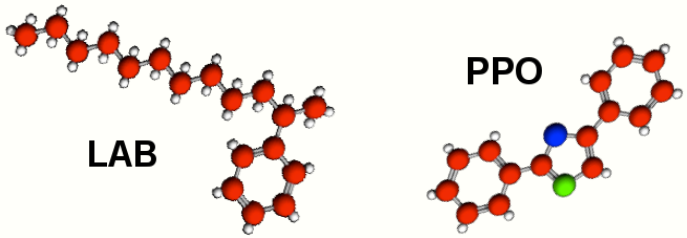
Filling System Small-Scale Prototype

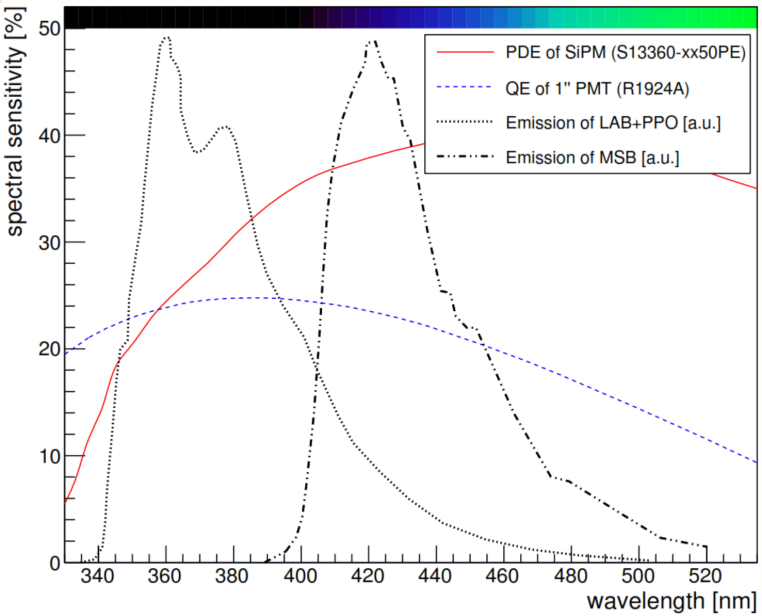
Test Beam Operation (CERN 2018 / DESY 2019):

LS Development

Liquid Scintillator for SHiP: LAB & PPO

- **Solvent:** Linear alkylbenzene (**LAB**)
- **Fluor:** 2,5-diphenyl-oxazole (**PPO**)

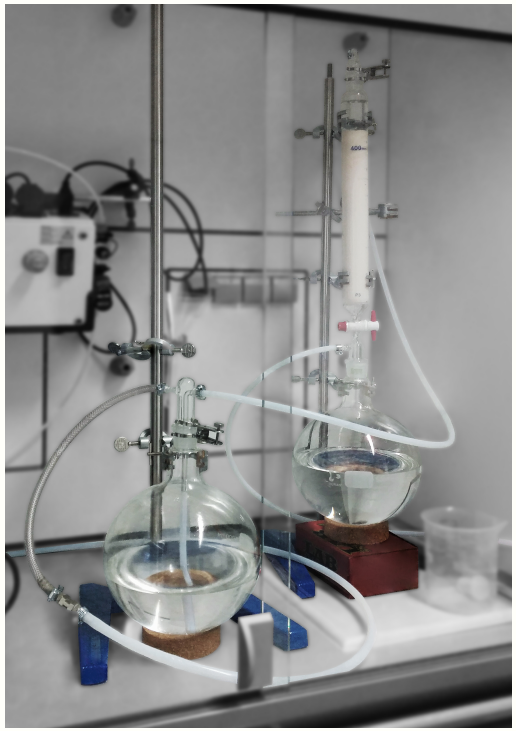


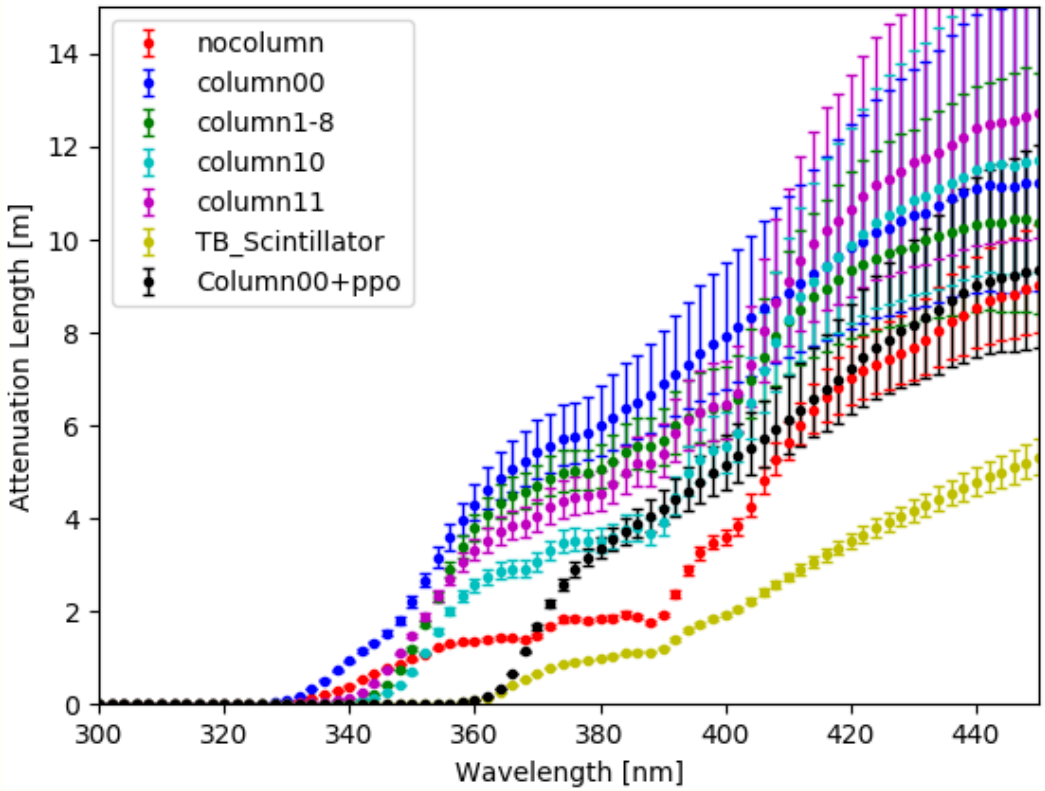


- **Emission spectrum:**
  - ▷ **LS:** LAB + 1.5 g/l PPO
  - ▷ **WLS paint:** bis-MSB
- **Photodetector quantum efficiency (QE):**
  - ▷ **PMT:** R1924A
  - ▷ **SiPM:** S13360-xx50

LAB Purification (MZ)

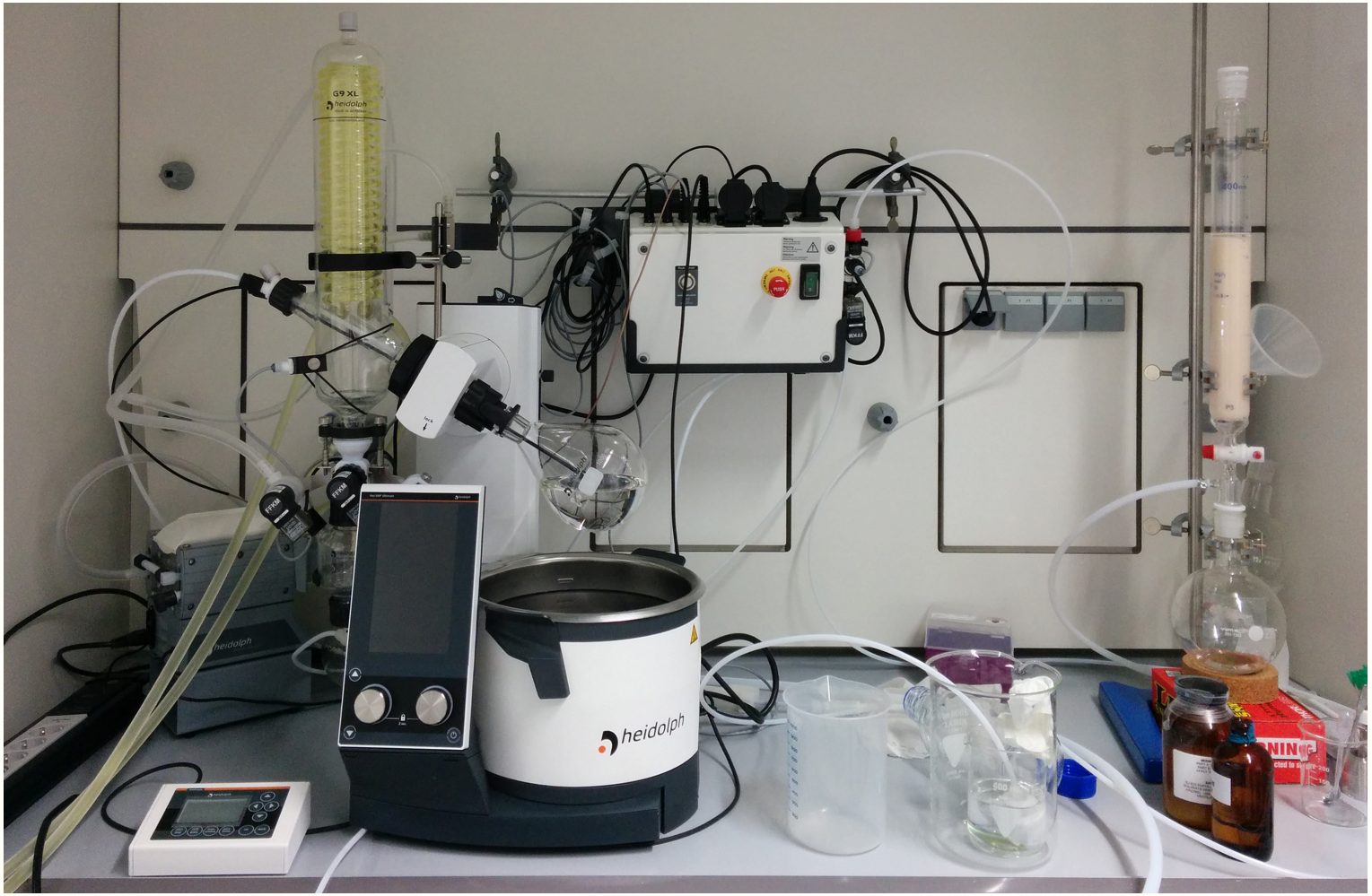
Al_2O_3 Column:





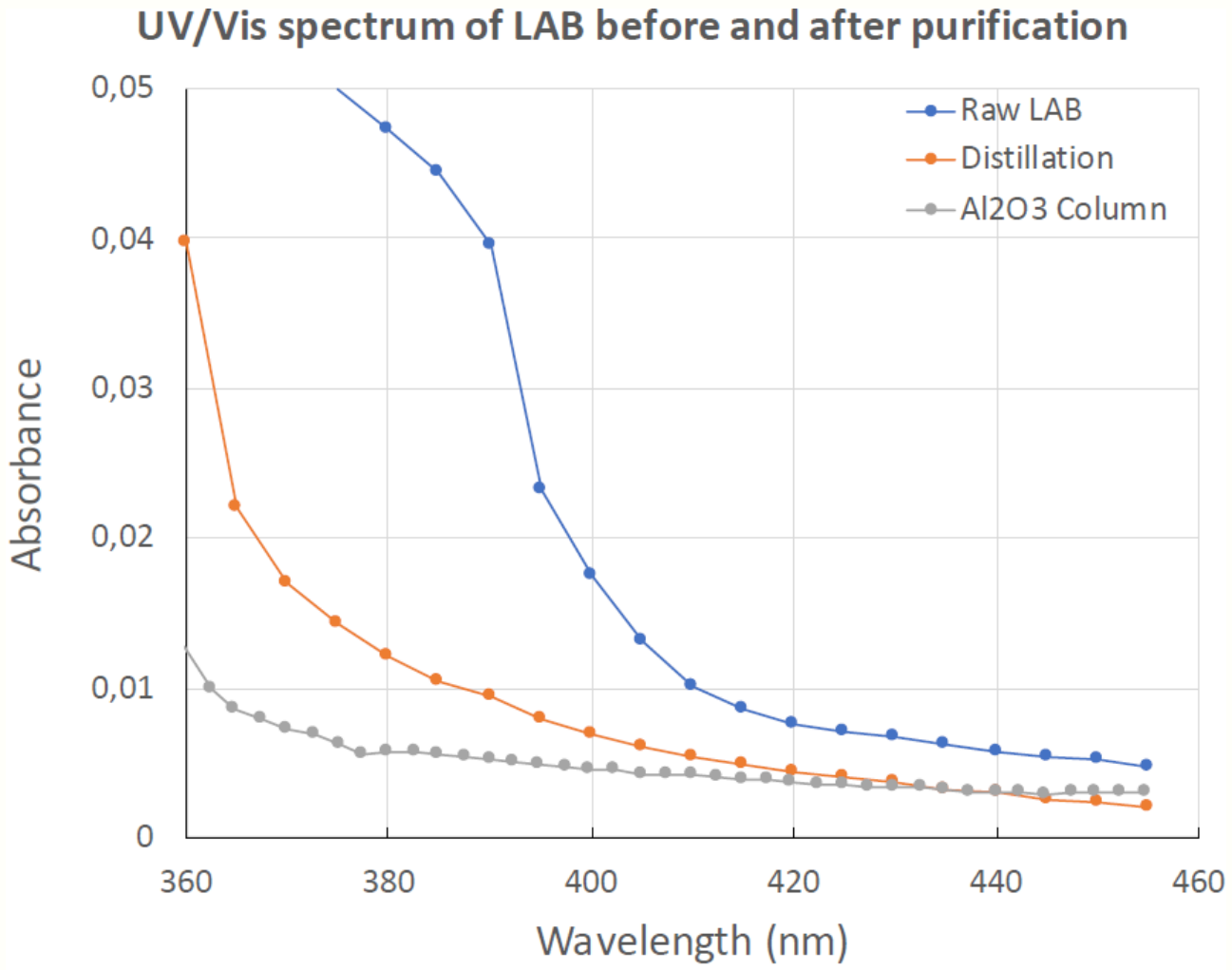
LAB Purification (MZ)

Vacuum Distillation Plant:



LAB Purification (MZ)

Comparison (Al_2O_3 Column vs. Distillation Plant):



LAB Purification (MZ)

Comparison (Al_2O_3 Column vs. Distillation Plant):