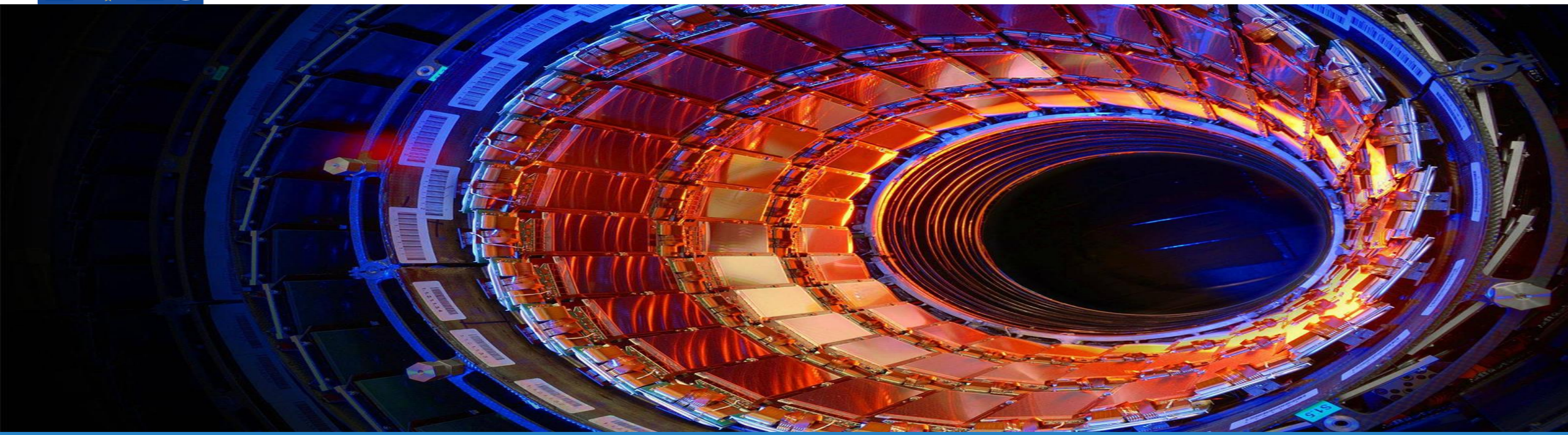


# JRA10:CryPTA
# Cryogenic Polarized Target Applications

Hartmut Dutz
Physikalisches Institut Universität Bonn

*This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 824093*

# JRA10:CryPTA
# Cryogenic Polarized Target Applications

## Cooperation of four partners

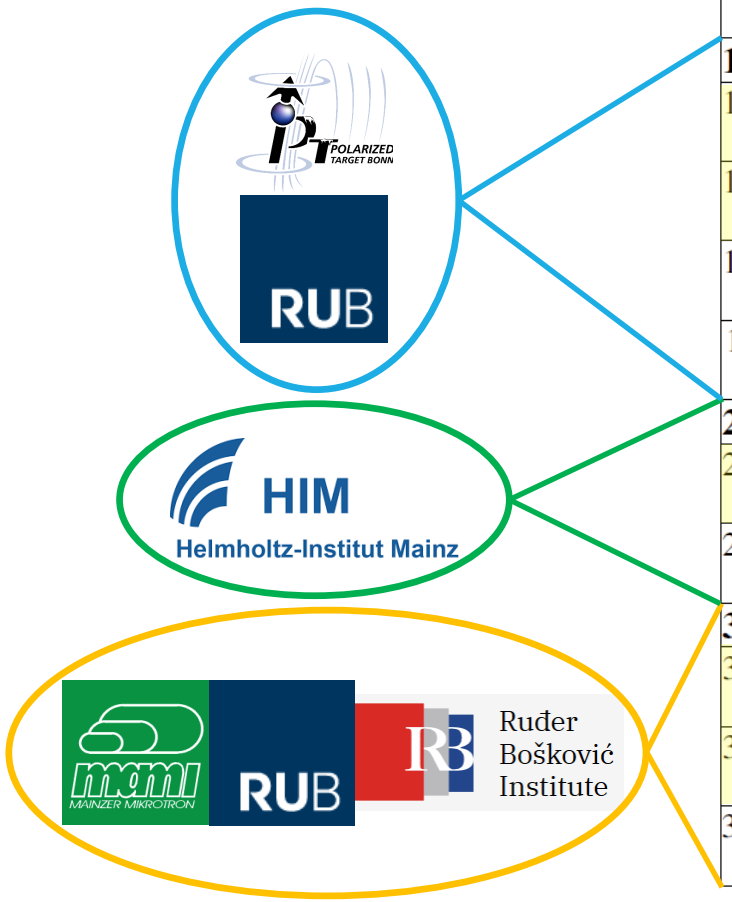
| Organization legal name | Short name | Activity leaders |
|---|---|---|
| Ruder Boskovic Institute | RBI | M. Korolija |
| Ruhr-Universität Bochum | RUB | G. Reicherz |
| Rheinische Friedrich-Wilhelms-Universität Bonn | UBO | H. Dutz |
| Johannes Gutenberg Universität Mainz | UMainz | A. Thomas |

### Research Objectives

The final goal of CryPTA is to develop groundbreaking s.c. magnet structures and low temperature detector techniques for new and innovative polarization experiments using polarized targets in 4π-detection systems for hadron physics experiments in Europe

# JRA10:CryPTA

## Tasks of WP28 (from Annex I)

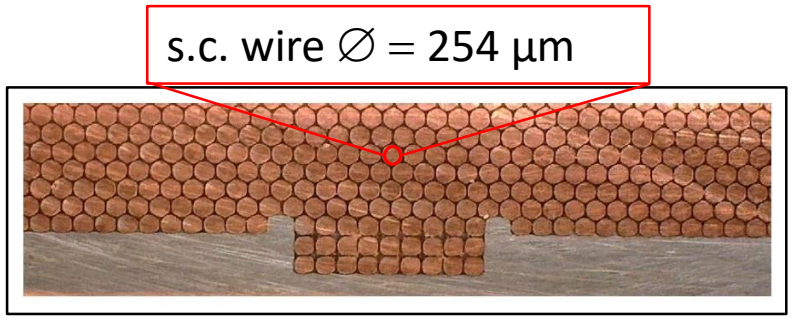


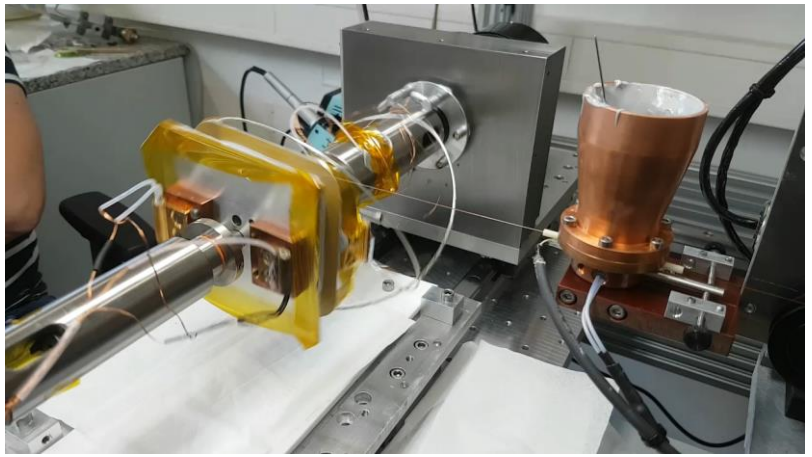

| TASKS/Subtasks | Year 1 | | | | |
|---|---|---|---|---|---|
| | Q1 | Q2 | Q3 | Q4 | Q1 |
| **1. Development of low mass superconducting high field magnets** | | | | | |
| 1.1 High precision winding machine for thin superconducting wires | | | 1 | | |
| 1.2 Manufacture and test of a small size low mass polarizing solenoid with high homogeneity | | | | | |
| 1.3 Design manufacture and cold test of a prototype low mass, combined field superconducting magnet system | | | | | |
| 1.4 Magnet field design studies for a low mass large sc. tracking solenoid | | | | | |
| **2. Development of low mass superconducting passive shielding** | | | | | |
| 2.1 Magnet field calculations for PANDA low mass superconducting passive shielding | | | | | |
| 2.2 Design and Manufacture of prototype HTSC shields and test at cryogenic temperatures | | | | | |
| **3. Detection of recoil particles in active polarized targets at cryogenic temperatures** | | | | | |
| 3.1 Design studies for polarized, scintillating target material | | | | | |
| 3.2 Prototypes of a scintillating target stacks with electronic readout | | | | | |
| 3.3 Prototype of a new cryogenic insert with active target material | | | | | |

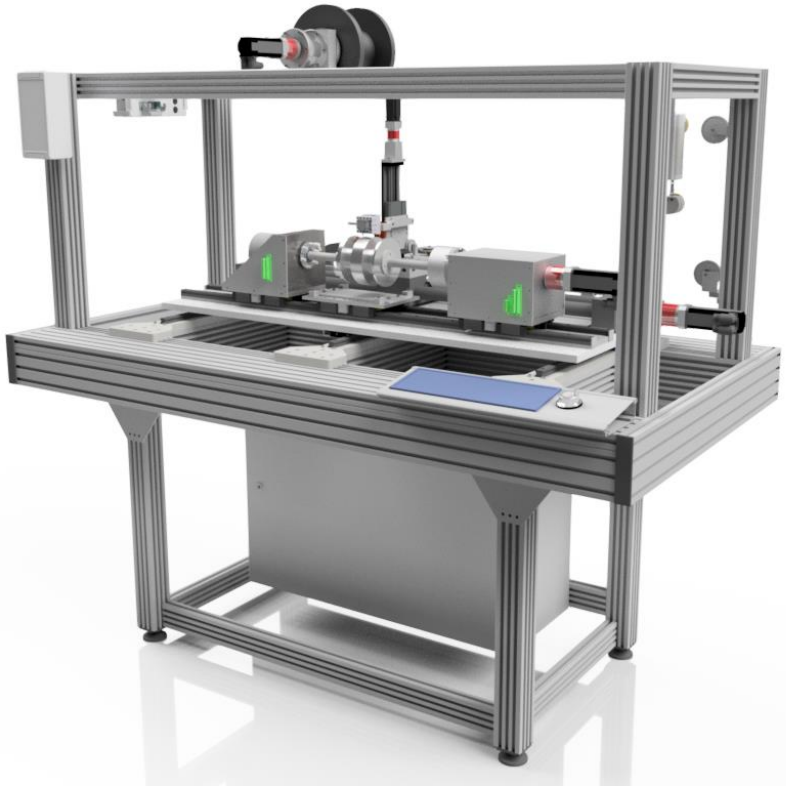
# JRA10:CryPTA:Task 1

## 1.1 High precision winding machine for thin superconducting wires

- → Small superconducting magnet (solenoid 150 mm x ⌀45 mm x WT 1.8 mm) high field (B=2.5T) and high homogeneity ($\Delta B/B \leq 10^{-4}$, 20 x ⌀20 mm)
- → Wrap thin s.c. wire (⌀254µm) with high precision (orthocyclic, wet winding)
- → Displacement ≤ 2.5µm





- → Not commercially available
- → Custom made high precision winding machine fulfill the requirements (MS63)
- → Co financed by a collaborative SME research project (BMWI, ZIM) with CryoVac (Germany) and Physics Institute University Bonn

MS63: High precision winding machine for thin superconducting wires: https://www.polarisiertes-target.physik.uni-bonn.de/files/internalreportmilestonewindingmaschine.pdf

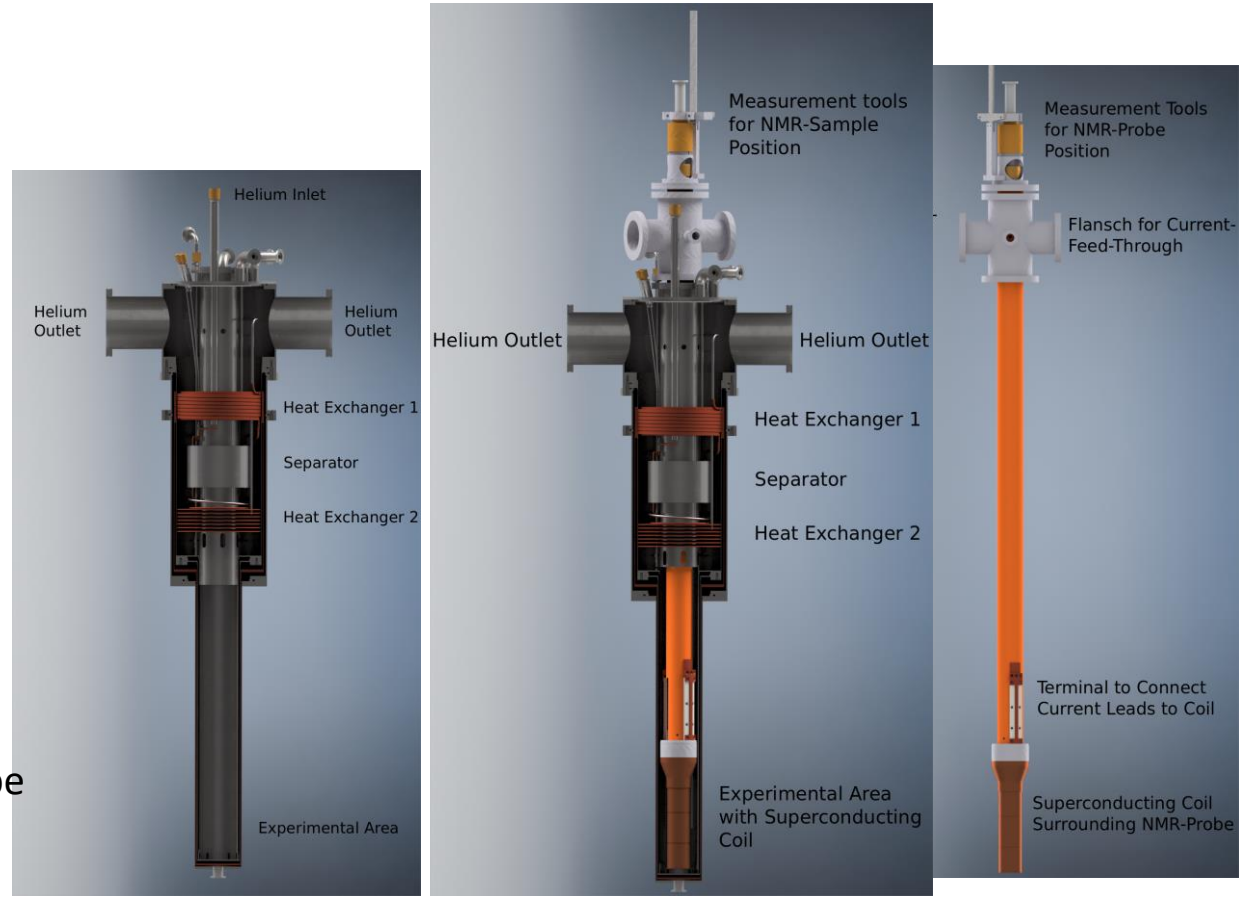
# JRA10:CryPTA:Task 1

## 1.2 Manufacture and test of a small size low mass polarizing solenoid with high homogeneity

- → Small superconducting magnet designed and build for DNP in a dilution refrigerator (magnet operating parameters: 90A @ 1K)
- → For test measurements (performance tests) of the magnets a simple 1K test facility is required

- → New $^4$He evaporation refrigerator is under construction
  - → Fits into the external high field DNP-magnet ($B_{max}$ = 6.5T)
  - → Variable temperature range (1K – 70K)
  - → Large low temperature volume (500 mm x ∅75 mm, 2.2l)
  - → Flexible and open access via insert tube

- → (already) available magnet test insert
  - → Current leads ($I_{max}$ =100A)
  - → Field measurement (mapping) by pulsed-, cw-NMR, Hall-probe
  - → Equipped for DNP (50 – 140 GHz)



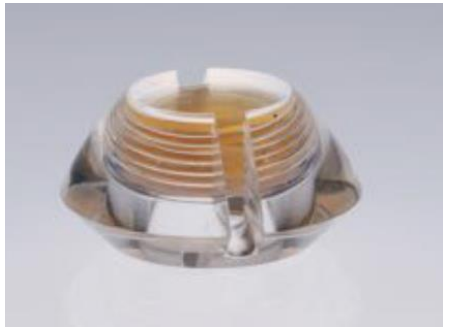

$^4$He evaporation refrigerator for magnet tests: https://www.polarisiertes-target.physik.uni-bonn.de/files/InternalReportEinNeuer4HeKryostat_translated.pdf

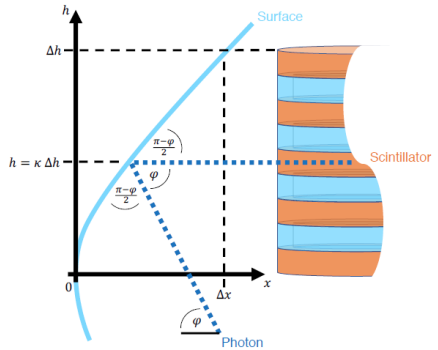
# JRA10:CryPTA:Task 3

## 3.1 Design studies for polarized, scintillating target material

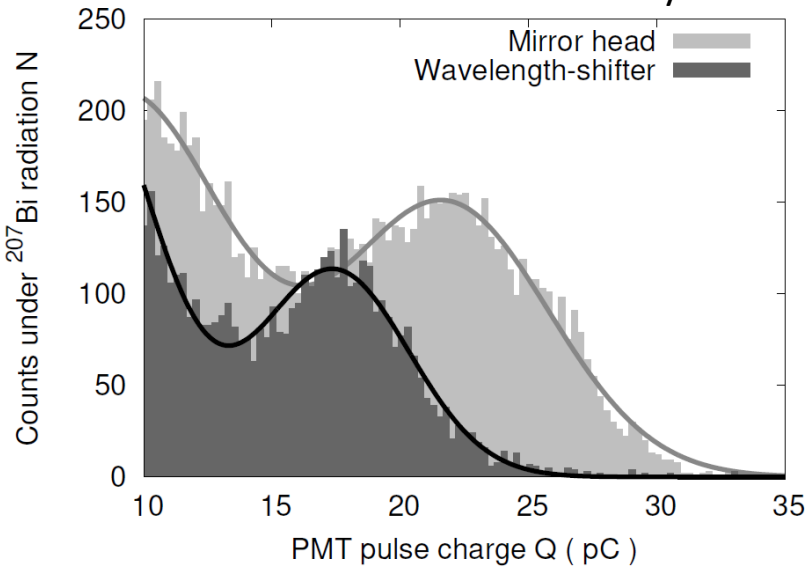
Detailed analysis, calculations and comparison of concepts for target heads for better light collection

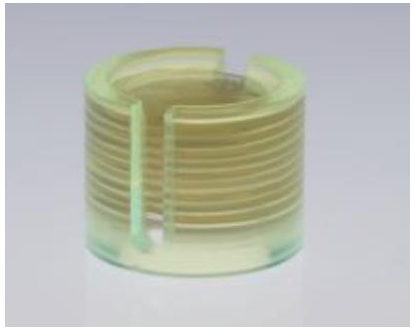
eg. mirror head target ⟷ vs. ⟷ wave length shifter concept

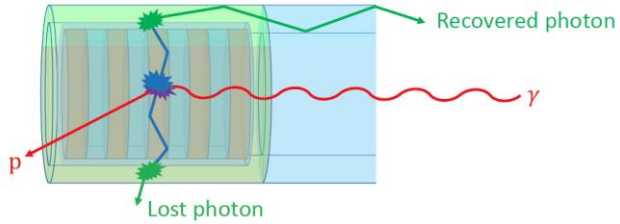





The mirror head shows a superior light collection efficiency.
Problem: Mechanical stability.

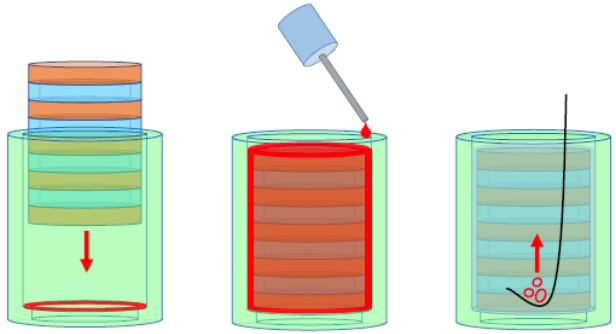


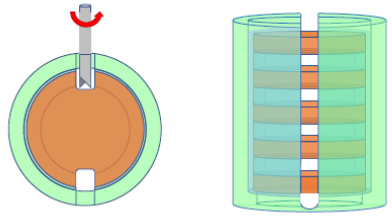


# JRA10:CryPTA:Task 3

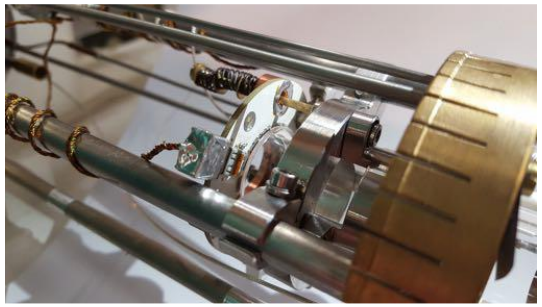
## 3.2 Prototypes of a scintillating target stack with electronic readout

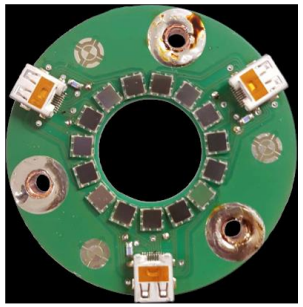


The production process of the
active polarized target stacks has been optimized.

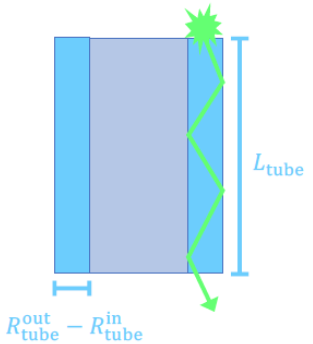


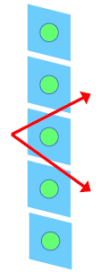
The machining procedure for post production
for NMR and cryogenic cooling slits was further developed.

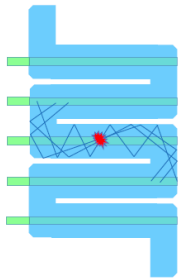




The coupling of the electronic readout to the light guide components is well under control and documented.





# JRA10:CryPTA

## List Milestones and human resoures

List of Milestones in the reporting period

| Milestone number | Milestone name | Lead beneficiary | Delivery month from Annex I | Delivered (yes/no) | Actual delivery month | Comments |
|---|---|---|---|---|---|---|
| MS63 | High precision winding machine for thin superconducting wires | 10 - UBO | 9 | yes | 8 | A detailed description of the winding machine is given in: https://www.polarisiertes-target.physik.uni-bonn.de/files/internalreportmilestonewindingmaschine.pdf |

Use of human resources in the reporting period

| Beneficiary number | Organization legal name (in italics the Research Units) | Short name | Human effort from Annex I (person-months for 18 months) | Actual human effort in the reporting period (person-months) |
|---|---|---|---|---|
| 9 | Johannes Gutenberg-Universitat Mainz | JGU MAINZ | 3,40 | 0,00 |
| 10 | Rheinische Friedrich-Wilhelms-Universitat Bonn | UBO | 7,50 | 0,00 |
| 25 | Ruder Boskovic Institute | RBI | 1,10 | 0,00 |

Use of financial resources in the reporting period: ~ 11K€ for instrumentation at UBO

No Deliverables in the reporting period

# JRA10:CryPTA
## Conclusions

### Research Objectives

The final goal of CryPTA is to develop groundbreaking s.c. magnet structures and low temperature detector techniques for new and innovative polarization experiments using polarized targets in 4π-detection systems for hadron physics experiments in Europe

Despite the currently unfavorable circumstances: the 3 Tasks are on the right track

Task 1: → completing the magnet test refrigerator.
→ preparing the manufacture and test of a small size low mass polarizing solenoid with high homogeneity.
Task 2: → Magnet field calculations for PANDA low mass superconducting passive shielding still ongoing.
Task 3: → development of low temperature polarized active targets is on the way.
→ next step is the preparation of an improved target insert implementing the knowledge we have collected in the last years.

But: Corona also seems to slow down (thwart?) JRA10
So: lets hope the best