‘The strong interaction at the frontier of knowledge: fundamental research and applications’

WP31

Eric Voutier for the P3E team

CNRS/IN2P3/IPNO, Université Paris-Sud, Université Paris-Saclay

STRONG-2020 Kick-off meeting

October 23-25, 2019

P3E
Polarized Electrons, Positrons and Polarimetry

Pushing further
the **intensity frontier** of polarized electron sources,
the **intensity frontier** of low energy polarized positron sources,
and the **precision frontier** of electron polarimetry.

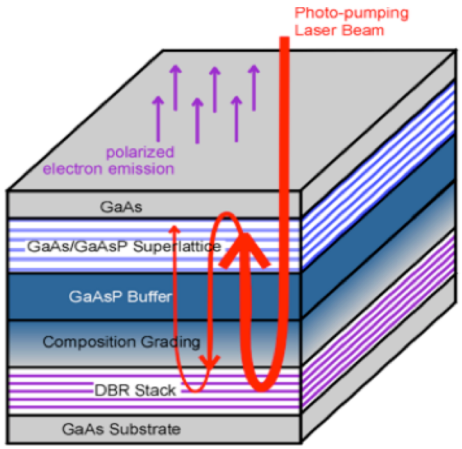
- P3E-1: High Intensity Polarized Electron Source
- P3E-2: High Intensity Polarized Positron Source
- P3E-3: High Precision Electron Polarimetry

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

P3E

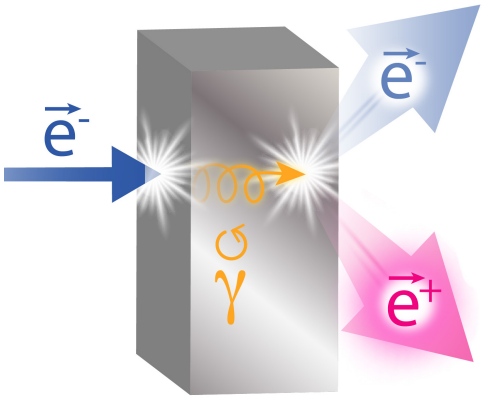
Polarized Electrons, Positrons and Polarimetry

Photocathode R&D



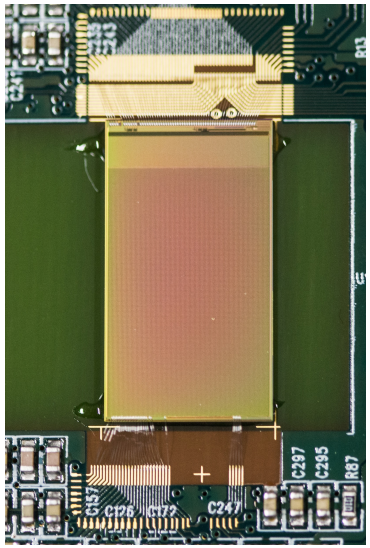
Development of high quantum effciency and long live-time photocathodes

Polarized Positron R&D



Application of the newly demonstrated PEPPo technique to hadronic physics accelerators

Sensors R&D



Development and applications of HV-MAPS sensors

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P3E
Polarized Electrons, Positrons and Polarimetry

Work package number	WP31/JRA13															
Work package acronym	P3E															
Work package title	Polarized Electrons, Positrons and Polarimetry															
TASKS/Subtasks	**Year 1**				**Year 2**				**Year 3**				**Year 4**			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
P3E-1. High Intensity Polarized Electron Source																
1.1 Modelling of photocathode quantum efficiency								1								
1.2 Proof-of-concept experimentation												2				
P3E-2. High Intensity Polarized Positron Source																
2.1 Simulation of positron production, collection, deceleration				3				3						3		
2.2 Target stress simulation and experimental analysis				4						4			4			
P3E-3. High Precision Electron Polarimetry																
3.1 Simulation of the polarimeter detector						5										
3.2 Technical design of the polarimeter detector																

- P3E-1: JLab (Newport News), TUD (Darmstadt)
- P3E-2: DESY (Zeuthen), IPNO (Orsay), LAL (Orsay), UH (Hamburg)
- P3E-3: JGU (Mainz)

Leading institution *Partner institution* *Funded institution*

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Polarized Electrons, Positrons and Polarimetry

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- P3E-3: JGU (Mainz)

Leading institution *Partner institution* *Funded institution*

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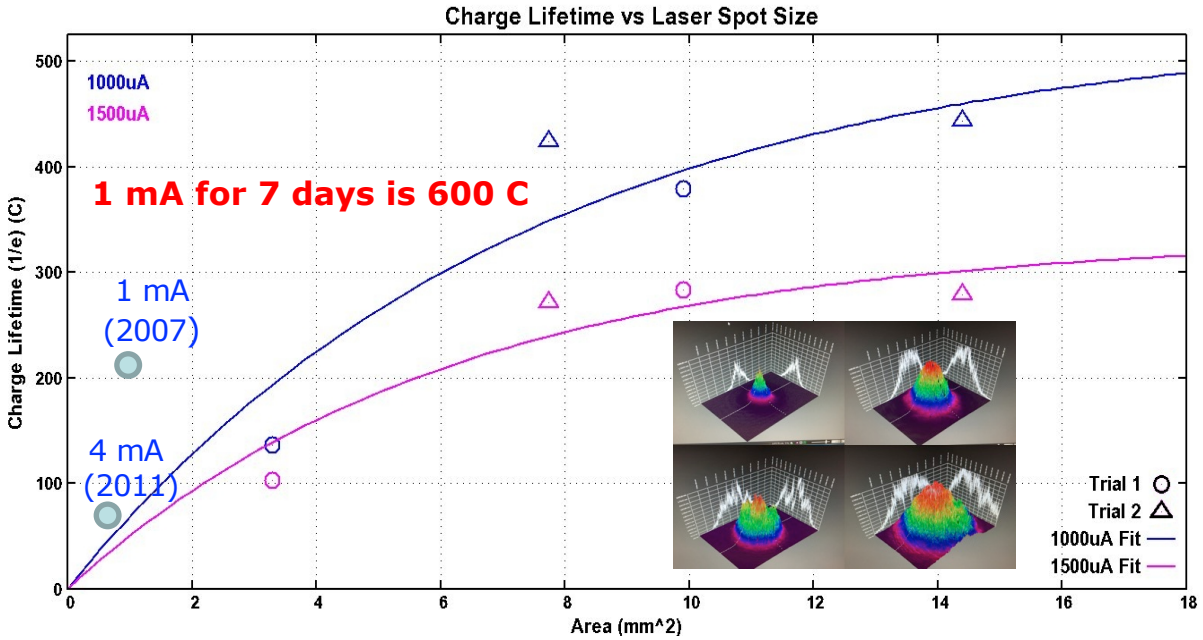
JRA13 : Update on progress (P3E-1)

J. Grames et al. at *LHeC, FCC-eh and PERLE Workshop*, Orsay, June 27-29, 2018

- Polarized positrons for **CEBAF** and high current operation at **eRHIC** prompted experiments at CEBAF to characterize the influence of the laser spot size on the lifetime of high-polarization photocathodes



- As expected, larger spot size improves lifetime
- Diffracted Brag Reflection photocathode is an excellent candidate for improving quantum efficiency
- On-going work to build a HV > 300 kV polarized electron gun

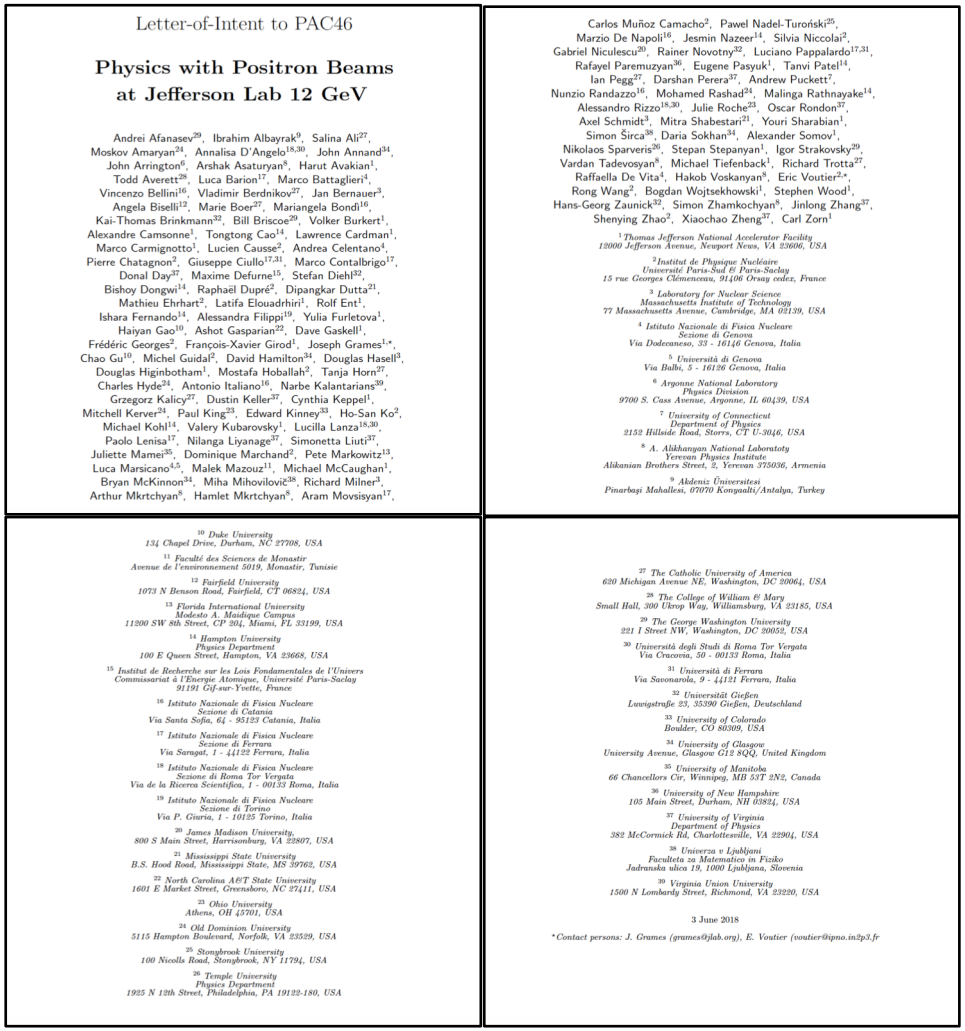
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 824093.

JRA13 : Update on progress (P3E-2)

Publication of the JPos17 proceedings (free access at https://aip.scitation.org) describing the science of **polarized positron beams and physics** for JLab 12 GeV and JLEIC, and their applications for fundamental research in Atomic Physics and Material Science

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

JRA13 : Update on progress (P3E-2)



Letter-of-Intent to PAC46

Physics with Positron Beams at Jefferson Lab 12 GeV

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3 June 2018

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J. Arrington, M. Battaglieri, J. Bernauer, V. Burkert, A. Celentano, L. Elouadrhiri, F.-X. Girod, J. Grames, L. Marsicano, C. Muñoz Camacho, S. Niccolai, A. Puckett, A. Schmidt, E. Voutier…

120 Physicists from 39 Institutions

	I (nA)		Beam	Time
	e^-	e^+	Polarization	(d)
Two-photon exchange				
TPE @ CLAS12	60	60	No	53
TPE @ SupRos	-	1000	No	18
TPE @ SBS	40000	100	Yes	55
Generalized Parton Distributions				
p-DVCS @ CLAS12	75	15	Yes	83
n-DVCS @ CLAS12	60	60	Yes	80
p-DVCS @ Hall C	-	5000	No	56
Test of the Standard Model				
A' search	-	10-100	No	180
			Total Data Taking Time	**525**

Table 1. Characteristics of a positron experimental program at Jlab.

« These measurements all have significant physics interest. The proposers should carefully evaluate feasibility and present the best case possible in a future proposal. »

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JRA13 : Update on progress (P3E-2)

K. Aulenbacher, I. Chaikovska, W. Hillert, D. Lott, G. Moortgat-Pick, E. Voutier

- Combined PhD project bewteen the University of Hamburg and the University Paris-Saclay for the design of a high power target to operate a PEPPo-like polarized positron source

  → *Target simulation and design evaluation at Orsay*

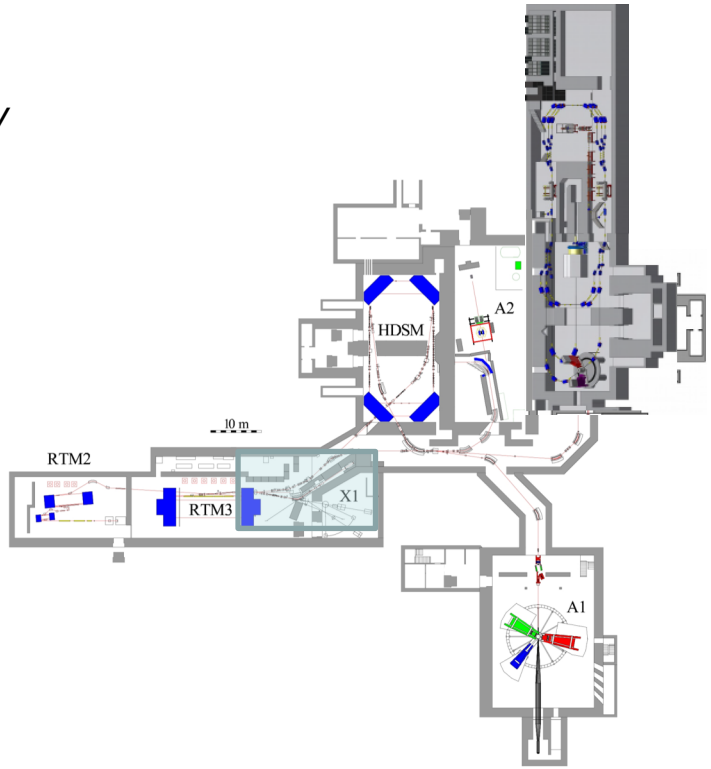
  → *Target tests at Mainz*

  → *Analyses of target materials at Hamburg*

PETRA-3 beam for Material Analysis

High-energetic synchrotron radiation (50-200 keV) with high brilliance for Roentgen diffraction

Point-like analysis of material surface and bulk



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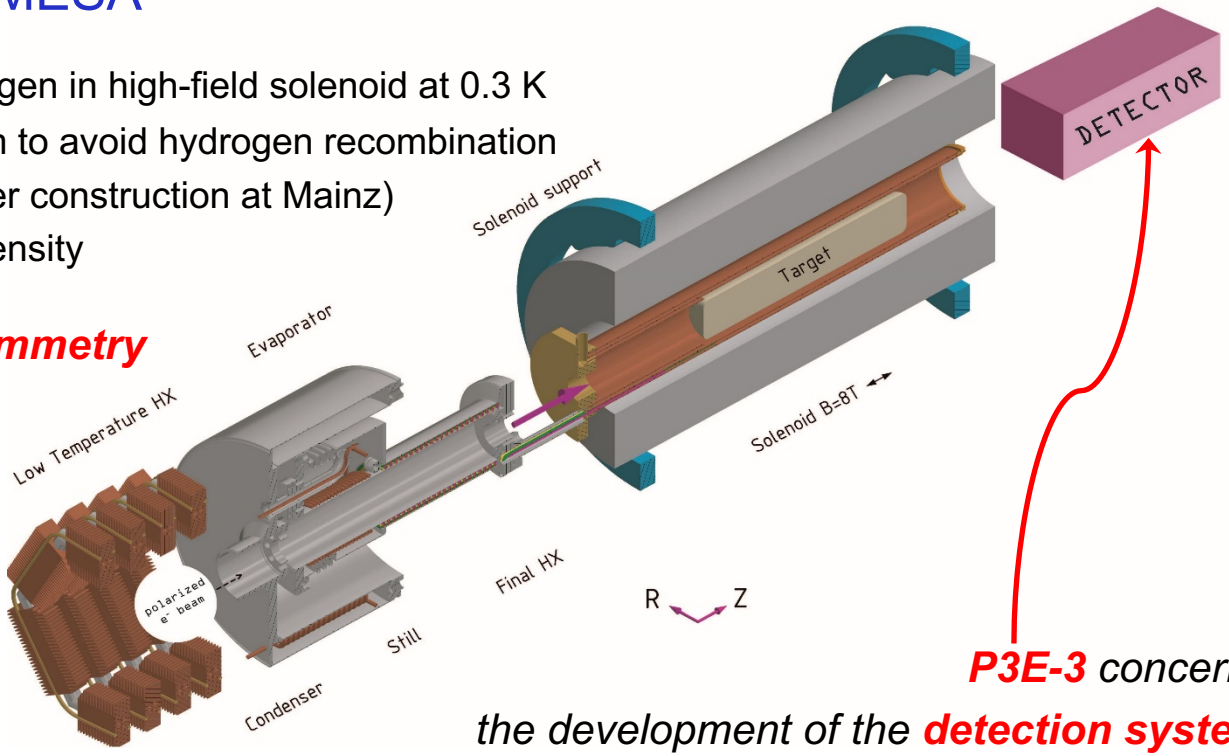
JRA13 : Update on progress (P3E-3)

Reminder : Hydro-Møller polarimeter for on-line polarimetry at ~100 MeV

P2 @ MESA

- Trap and polarize atomic hydrogen in high-field solenoid at 0.3 K
- Cover walls in superfluid helium to avoid hydrogen recombination
- Requires dilution cryostat (under construction at Mainz)
- Never done with high beam intensity

➥ ***Measure double spin asymmetry***



P3E-3 *concerns the development of the* ***detection system***

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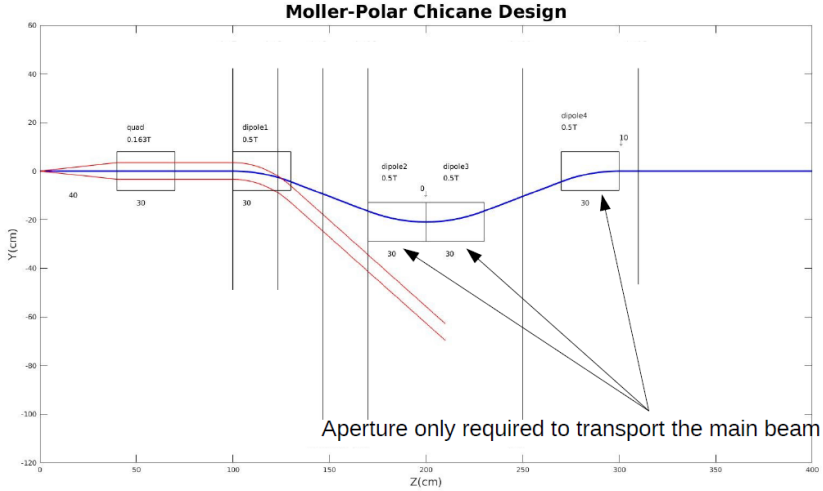
JRA13 : Update on progress (P3E-3)

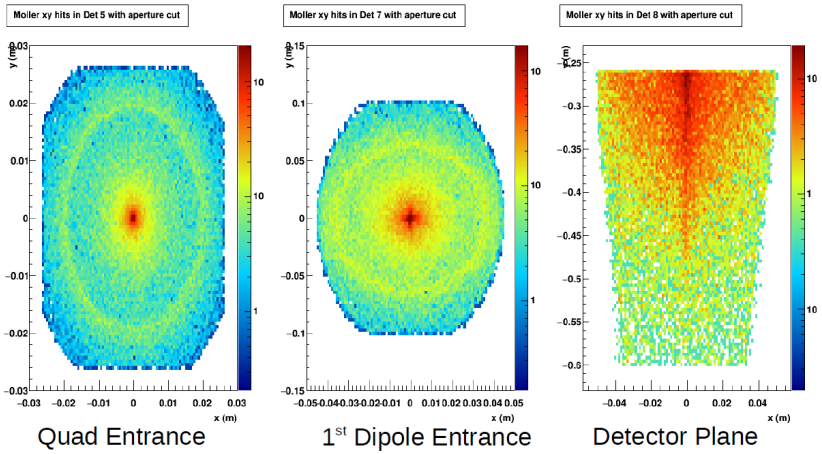
- First design available for a detection chicane to separate Møller and beam electrons
- Simulation tracks electrons from hydrogen through the magnet system up to the detector

  - To do: integrate with target and detector into the polarimeter simulation package (HYMOSIM)

Contributions from

V. Tyukin, K. Kumar, R. Beminiwhatta, S. Riordan





Quad Entrance | 1st Dipole Entrance | Detector Plane

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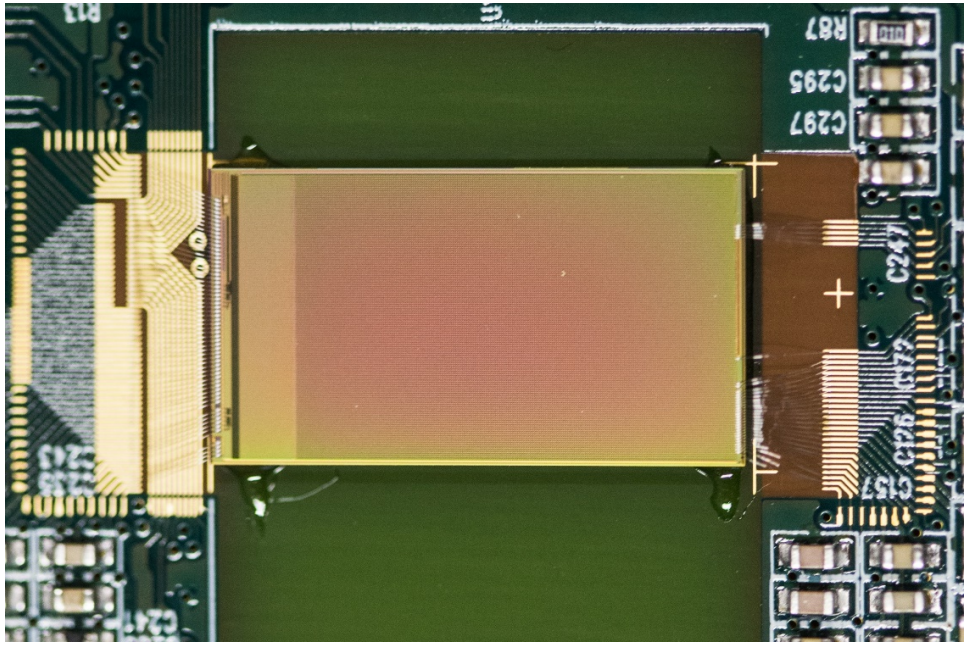
JRA13 : Update on progress (P3E-3)

- Candidate detector: High-Voltage Monolithic Active Pixel Sensors

  - First large (1.0x2.0 cm^2) fully characterized and opertional
  - Next batch will focus on integration issues (powering, interfaces)
  - Simulation ready to integrate into HYMOSIM



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JRA13 : Deliverables

- There are no deliverables due for Reporting Period 1 (18 months, June 2019-November 2020)
- All deliverables are due on M48 at the end of the project

Deliverable Number[14]	Deliverable Title	Lead beneficiary	Type[15]	Dissemination level[16]	Due Date (in months)[17]
D31.1	D31.1-Feasibility Report for an Intense Polarized Electron Source	1 - CNRS	Report	Public	48
D31.2	D31.2-Feasibility Report for an Intense Polarized Positron Source	1 - CNRS	Report	Public	48
D31.3	Technical Design Report for the polarimeter detector	9 - JGU MAINZ	Report	Public	48

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JRA13 : Milestones

- MS79 has to be achieved M18 (November 2020)

Milestone number[18]	Milestone title	Lead beneficiary	Due Date (in months)	Means of verification
MS79	GEANT4 simulation package of the polarimeter detector	1 - CNRS	18	Appropriate operation of the software

✓ Simulation of Møller process, magnet system and detectors running

• Need to be fully integrated

➥ *Expected completion :* ***September 2020***

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JRA13 : Milestones

- MS77 advancement control at M12 (May 2020)
- MS78 advancement control at M12 (May 2020)

Milestone number	Milestone name	Related work package(s)	Due date (in month)	Means of verification
MS75	Ion damage simulations	P3E-1	24	Benchmark model simulations against experimental results
MS76	Charge lifetime experiments	P3E-1	36	Publication (arXiv or peer reviewed journal) and/or Conference presentation
MS77	Simulation package of the positron source	P3E-2	42	Appropriate operation of the software (12/24/42)
MS78	Simulation package of the target stress	P3E-2	39	Appropriate operation of the software and cross-check with respect to experimental data (12/30/39)
MS79	GEANT4 simulation package of the polarimeter detector	P3E-3	18	Appropriate operation of the software

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JRA13 : Funding

WP31/JRA13 - P3E REQUESTED EC CONTRIBUTION PER BUDGETARY ITEM AND PER BENEFICIARY						
Contr. No	**Contractor Acronym**	**Personnel (EUR)**	**Other costs (durables, consumables, travel, workshops) (EUR)**	**Total direct costs (EUR)**	**Indirect costs (EUR)**	**Requested EC contribution (EUR)**
1	IPNO (+ JLab)	64000	2000 20000	86000	21500	107500
2	JGU	72000		72000	18000	90000
3	UH	40000	2000	42000	10500	52500
	TOTAL	**176000**	**24000**	**200000**	**50000**	**250000**

- IPNO and UH combined their manpower funding within a cotutelle PhD thesis project about a *High power target for low energy polarized positron source*
- JGU complemented its manpower funding to offer a 2 years term Post-Doctoral position

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JRA13 scientific activity continues to successfully develop

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