
Survey of PID EoIs

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Introduction

Procedure:

- We were allocated 10 Eols, classified by the organisers as PID
- In the following slides, we will give a very brief summary of each, and a table of synergies, according to R&D key words we assigned.
 - we looked for synergies both between these 10 Eols, and with Eols not allocated to us that we spotted
- No attempt at any quality evaluation or ranking !

Some immediate observations:

- Even within these 10 Eols, there is great diversity, although common themes can be identified (see later)
- A few Eols had perhaps been misassigned, when classified as PID
- Synergies with other topics mean that certain Eols could be reassigned if necessary
- Not all Eols follow the 1:2 EC:other budget division (highlighted with *)

Development of innovative materials with fast-timing capabilities for application in radiation detectors (EoI:2)

Participating labs/univs

CERN, ICCUB (Barcelona)
RINP (Minsk), UNIMIB (Milano)
FZU (Prague), Uni Vilnius

Participating companies

CRYTUR, Glass to Power

Total Budget

1740 k€

Requested budget

574 k€

Industrial partners

already identified ?

Y

Are partners European ?

Y

Non European partners

Y

- Not experiment specific - focus is scintillator based detectors
- Investigation of scintillating materials with very fast emission process, new ways to structure them and development of readout system
- Infrastructure for fast timing process investigation
- Develop some prototype detectors

Could have also been classified under 'calorimetry'

Ultra-fast timing detector for large-area time-of-flight (TORCH) (EoI:10)

Participating labs/univs

CERN, Bristol.

Oxford, Warwick

Participating companies

Photek

Total Budget

600 k€

Requested budget

200 k€

Industrial partners

already identified ?

Y

Are partners European ?

Y (UK)

Non European partners

N

- Not experiment specific – but possible deployment in a future LHCb upgrade the most immediate application in mind (others exist, e.g. TauFV, FCC-ee...)
- Precise time-of-flight (~10 ps) over large area with Cherenkov light
- Work until now largely supported with Advanced ERC grant. A large prototype has been constructed and partially equipped with MCPs. Support is sought to fully equip prototype, continue development of MCPs & evaluate performance.

Photon detectors for hadron PID at high momenta with compact RICHes (EoI: 24)

| | | |
|--|---|--------|
| <u>Participating labs/univs</u> | <u>Budget</u> | 450 k€ |
| INFN, Trieste, Charles Univ., INFN, Bari | <u>Requested budget</u> | 150 k€ |
| USTC university (China) | <u>Industrial partners already identified ?</u> | Y |
| <u>Participating companies</u> | <u>Are partners European ?</u> | Y |
| Incom, Inc., Company, USA | <u>Non European partners</u> | Y |

- Not experiment specific, but applications identified (e.g. COMPASS++, EIC, CEPC)
- Compact RICHes require photodetectors with good QE, granularity and robust operation in magnetic fields. Two parallel areas of development:
 - UV sensitive MPGD-based PDs operating without window with radiator gas
 - visible light PDs with good time resolution: LAPPD and MCPs

Development of a large-area scintillating tile detector using SiPM readout with excellent time resolution for the SHiP muon system (EOI:39)

Participating labs/univs

INFN, Frascati, INFN, Bologna,
Univ. of Bologna, FBK

Participating companies

FBK ? ['?' on this slide, and others,
merely reflects uncertainty
about how to classify FBK]

Total Budget

360 k€

Requested budget

120 k€

Industrial partners

already identified ?

N (FBK?)

Are partners European ?

Y

Non European partners

N

- Specifically intended for muon system of SHiP experiment
- Investigation of plastic detectors and large-area photodetectors (SiPM) with fast timing (~250 ps per station) properties
- Select suitable scintillator; develop large area SiPMs; develop readout and construct 32 tile 'module 0'

SiPMs for PID devices of Cherenkov detectors (EoI 54)

Participating labs/univs

INFN, Padova, INFN, Torino,
Jozef Stefan Institute, FBK
Nagoya

Participating companies

FBK ?

Total Budget

486 k€

Requested budget

162 k€

Industrial partners

already identified ?

N (FBK?)

Are partners European ?

Y

Non European partners

Y

- Not experiment specific, but work has in mind applications in Cherenkov detectors of HL-LHC, Belle II, NA62...
- Main goal is to improve robustness under neutron irradiation, while maintaining low cost, high efficiency & good time resolution

Timing and position fiber hodoscope to equip beam lines to test timing detectors (EoI 65)

Participating labs/univs

INFN, Roma, INFN, Milano Bicocca,
Fbk, ETH

Total Budget

400 k€

Requested budget

133 k€

Participating companies

PETSYS

Industrial partners

already identified ?

Y

Are partners European ?

Y

Non European partners

N

- Not experiment specific
- Instrumentation for test beam & scintillator based detectors
- Development of fast timing hodoscope based on scintillating fibers and SiPM
- Focus on testing different fibres, coupling to SiPMs & development of readout electronics.

Perhaps better classified under 'test-beam facilities' ?

Precision instrumentation for high-rate and high-intensity laser-electron experiments (68)

Participating labs/univs

DESY, LAL

Total Budget

850 k€

Requested budget

322 k€*

Participating companies

none

Industrial partners

already identified ?

N

Are partners European ?

Y

Non European partners

N

- Not experiment specific – but applications in future HEP e^+e^- colliders, LUXE experiment on EU-XFEL
- Proposal to build prototype of high-rate polarimeter for Compton scattering, with rate capabilities of 10^{10} e^- per shot.

Wrongly classified under PID ?

CRAFTIPIE: cryogenic ring Cherenkov radiator with fast timing for particle identification enhancement (EoI 92)

Participating labs/univs

CERN, INFN Ferrara + Genova +
Milano Bicocca, Jozef Stefan Institute,
STFC-UKRI, Cambridge

Participating companies

none

Total Budget

600 k€

Requested budget

300 k€*

Industrial partners

already identified ?

N

Are partners European ?

Y

Non European partners

N

- Oriented towards RICH of LHCb Upgrade II, but has more general applications
- Procure and operate SiPMs with high granularity, fast readout and green-light sensitivity. Emphasis on building readout electronics.
- Cryostat required for operation at -100° C

ELDORADO: enhancement of detector optics and radiator optimization (EoI93)

Participating labs/univs
CERN, Univ. of Genova,
STFC-UKRI

Participating companies
none

Total Budget 300 k€
Requested budget 150 k€*

Industrial partners
already identified ? N
Are partners European ? Y
Non European partners N

- Oriented towards RICH of LHCb Upgrade II, but has more general applications
- Three aspects:
 - Find eco-friendly replacement for CF₄ radiator
 - Work with industry to design spherical lightweight mirrors
 - Evaluate candidate radiators for p<10 GeV PID, e.g. hydrophobic aerogel

UV photocathode characterization & aging test facility for timing and PID (RICH) applications at CERN (EoI:147)

Participating labs/univs
CERN, HIP (Helsinki),
USTC Heifei (China)

Total Budget 108 k€
Requested budget 36 k€

Participating companies
N

Industrial partners
already identified ? N
Are partners European ? Y
Non European partners Y

- Not experiment specific
- Development of facility to characterize UV photocathodes
- Focus on QE and aging measurements
- Use facility to study novel materials and protection layers

Synergies

Common topics included the following:

- **Photodetectors**
Although with division between solid state / gas / visible / UV
- **Scintillator-based detectors**
Here there is clear synergy with some EoIs in the calo category
- **RICH detectors**
With some possible synergies in the gas detector category
- **Fast timing**
A common theme, but with variation in the definition of fast
($\sim 10 \rightarrow 250$ ps)

An attempt at a table of synergies

| Abbreviated title (Eol n°) | Focus of R&D keywords | | | | | | Synergies with other topics / related Eols |
|--|-----------------------|-------------------------|---------------------|-------------|-------------------|------------------------------|--|
| | Photo detectors | Scintillator technology | Cherenkov detectors | Fast timing | Gaseous detectors | Mechanics or Instrumentation | |
| Innovative materials with fast-timing capabilities (2) | X | X | | X | | | 65, Calo / 36, 74, 77, 91, 158 |
| TORCH (10) | X | | X | X | | | 54 |
| PDs for PID at high momentum (24) | X | | X | | X | | Gas-volume / 92, 93 |
| Large-area scintillator for ShIP (39) | X | X | | X | | X | Calo / 84, 86 |
| SiPMs for PID in Ch. detectors (54) | X | | X | | | | 92, Calo / 36 |
| Timing & position fiber hodoscope (65) | X | X | | X | | | Calo, Test beam infra. / 2, 77 |
| Instrum. for high-rate laser-electron experiments (68) | X | X | | X | | X | Calo ? |
| CRAFTIPIE (92) | X | | X | X | | | 24, 54, 93 |
| ELDORADO (93) | | | X | | X | X | 24, 92, Gas-volume, mech./ 41 |
| UV photocathode characterization (147) | X | | | | | | Irrad. & chara. |