# WP7B

Timing (M)RPC

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# We share the same tasks as for MPGD but adapted to (M)RPC

| Task ID | Task | Performance Goal | ECFA DRD Theme |
|---|---|---|---|
| T1 | Optimize the amplification technology towards large-area detectors | Uniformity over m2 (time resolution, rate capability, efficiency) | 1.1, 1.3 |
| T2 | Enhance timing performance | Time resolution < 100 ps for large area detectors (> 1m x 1 m) | |
| T3 | Enhance rate capability | Time resolution < 200 ps with a few kHz/cm2 | |
| T4 | Spatial resolution and read-out granularity | Spatial resolution of mm with low number of readout channels | |
| T5 | Stability, robustness and longevity | Uniform gain in time | |
| T6 | Material studies | - Radiation-hardness<br>- Longevity | |
| T7 | Gas studies for precise timing applications | - Eco-friendly mixtures<br>- Recuperation<br>- Ageing mitigation<br>- CO2 -based mixture with geometrical quenching | |
| T8 | Modelling and simulation of timing detectors | Modelling and simulation of timing detectors | |
| T9 | Readout electronics for precise timing | - Low-noise FEE<br>- Large dynamic range – Fast rise time<br>- Multi-channel readout solution for timing detectors | |
| T10 | Precision mechanics and construction techniques | Precise mechanics (a few tens of µm) over relatively large active areas ( > 1 $m^2$) | |
| T11 | Common framework and test facilities for precise timing R&D | Test bench for precise timing studies | |

| Milestones and Deliverables | Title | Description | Start Date | End Date |
|---|---|---|---|---|
| M7.B.1 | Production of small MRPC with different technologies | Production of small detector O(10 cm) of 4-8 gaps prototypes using different technologies | 0 | 12M |
| D7.B.1 | Production of large MRPC with different technologies | Two techniques to build large 4-8 gap RPC will be used. One is using the standard fishing line-based method and the second is using home-made spacers. The two techniques will be worked out to ensure efficient gas circulation as well as gas tightness system. The cassette to host the detectors and their readout electronics with reduced dead zones will be also designed and produced. | 12 | 24 M |
| M7.B.2 | Review of timing readout electronics | Review of the needed electronics components to achieve 100 ps for strips and pad-like and performance comparison between direct and differential readout techniques. | 12M | 24M |
| D7.B.2 | Production of large PCB of strip and PAD-based pickup configurations equipped with electronics able to reach better than 100 ps time resolution | To exploit the timing performance of MRPC, large PCBs hosting the strip or the PAD need to be designed and produced. These PCBs should be read out using a system equipped with Front-End electronics able to reach tens of ps time resolution and an acquisition system able to deal with a large amount of data. The possibility to reach sub-millimetre spatial resolution with the same readout electronics and adequate PCBs will be investigated | 24M | 36M |
| M7.B.3 | Production of a small single cell MRPC with very high-rate capability | Conception and construction of a small MRPC using low resistive material to achieve high rate detection capability with excellent time resolution | 0 | 18M |
| D7.B.3 | Production of a stable (single cell) MRPC with very high-rate capability (> 50 kHz/cm2) and time resolution better than 100 ps | The MRPC developed in the task will use low resistivity material and thin gas gap to achieve both high rate and excellent time resolution. This intends to provide T0 for ToF-based PID system in fixed target experiments and colliders. It will also be used as a reference for high rate and detector test | 18M | 36M |
| M7.B.4 | Construction of small double-gap RPC | The goal is to build a few small double-gap RPC featuring time resolution better than 200 ps. | 0 | 18M |
| D7.B.4 | Construction of large-area double-gap RPC with a time resolution better than 200 ps | we aim to develop a large area standard single/double gap RPC with O(200 ps) by optimizing the gas gap thickness and the gap assembly procedures. To achieve high efficiency, dedicated low threshold readout should be implemented | 18M | 36M |
| M7.B.5 | Tests of small (M)RPC chambers with eco-friendly gas mixtures | The goal is to validate the performances of the new chambers and their electronics using eco-friendly gases | 12M | 24M |
| D7.B.5 | Timing and spatial resolution studies versus different gas mixtures | The different kinds of (M)RPC developed in the previous tasks will be thoroughly tested to validate their performances. This concerns the so-called standard gas mixture (TFE, Isobutane/CO2, SF6) but more importantly the gas mixtures using eco-friendly gases studying the impact of the latter on the detector performances | 24M | 36M |

**Internal organization**

➢ Deliverables responsibilities

- ❑WP47B.1 : Alberto Bianco, Natsuki Tomida
- ❑WP47B.2 : Weihao Wu
- ❑WP47B. 3: Ingo Deppner
- ❑WP47B.4 : Daryon Ramos Lopez
- ❑WP47B.5 : N.A (can wait)

Several meetings: one with results already obtained within WP7B. Others will come soon.

https://indico.cern.ch/event/1405493/

New comers

We were joined by:

RCNP, Kyoto Sangyo (Kyoto) and Academia Sinica and NCU (Taiwan)

# Conclusion

D7B.1:no show stopper. Several groups have started to conceive and build large (M)RPC detectors with spacers and fishing lines

D7B.2: Several groups have started to design large ASU to host timing readout electronics with pads. Strips-based PCB is no issue (CMS iRPC like). The readout electronics will be common with WP5 and DRD6

D7B.3: High rate MRPC is challenging but with new low resistivity materials like Tsinghua glass this is rather achievable in the two coming years

D7B.4: double-gap with thin gas gap with better than 200 ps has already nice results

D7B.5: new eco-friendly gases are been tested in (M)RPC to assess their impact on timing. When large detectors equipped with timing electronics will be ready the tests will be completed.

WP7B deliverables are achievable within 3 years starting from January 2025