**Template JRA**

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| **Work package number** | WP27 | **Start date** | 01/06/2019 |
| **Activity Type** | Joint Research Activity | | |
| **Work package acronym** | JRA9-TIIMM | | |
| **Work package title** | Tracking and Ions Identifications with Minimal Material budget | | |

1. Work carried out and overview of progress
   1. **Project objectives**

*[Please give an overview of the project objectives for the third reporting period (June 2022 – July 2024), with regard to the overall objectives as described in the Annex 1 of the Grant Agreement and summarized below.]*

This JRA is focused on a technological innovation in the field of tracking detectors for experiments in the hadron physics area like ALICE at CERN, and in the more general area of LHC particle physics experiments and as well in the low energy range ion tracking and identification needed in the patient particle treatment in medical physics. Common needs to those applications is to combine a precision tracking with energy loss measurement to be used for particle identification, and very low level of crossed material to minimize multiple scattering.

* 1. **Progress made during the reporting period towards the objectives**

*[Please describe the progress made during the third reporting period in line with your Gantt chart and the project overall tasks as described in the Annex 1 of the Grant Agreement and summarized below.]*

***Table 1.2 Progress made during the reporting period for each task***

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| --- |
| ***The final goal of demonstrating particle identification capability of a precise tracking device with low crossed material will be evaluated with the final sensor test.***  ***The work breakdown structure of the TIIMM WP is structured in five tasks. They are:***  ***Task 1: Definition of the needed sensor characteristics*** |
|  |
| ***Task 2 and 3: Design of the sensors themselves*** |
|  |
| ***Task 4 and 5: Testing of the performances*** |
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**1.3 Highlights of significant results**

*[Include an overview of the project results towards the objectives in line with the structure of the Annex 1 to the Grant Agreement*.*]*

1. Critical Implementation risks and mitigation actions

**2.1 Risk materialization**

*[Provide the information on the project risks described in Annex 1 to the Grant Agreement*.*]*

1. Failure in the production of sensors at Tower Jazz silicon foundrey (low)

Whether the risk has materialized? (Yes/No)

**No**

**2.2 Risk-mitigation measures applied**

*[Please indicate whether the risk-mitigation plan described in Annex 1 to the Grant Agreement and corresponding to the risk number was applied in the reporting period*.*]*

1. We propose from the beginning two submissions to mitigate the risk.

Whether the risk-mitigation plan was applied? (Yes/No)

**Yes, we submitted twice. But considering that the first submission was successful the second one was implemented also to study further the architecture and also in this case it was with a positive result.**

**2.3 Comments/new risk-mitigation measures proposed**

*[Provide any significant comments on the risks encountered and the mitigation plan applied. Give any unforeseen risks encountered during the reporting period and not mentioned above*.*]*

In the reporting period (June 2022 - July 2024) two main difficulties prevented the complete achievement of the work-package's final objective:

- the lack of personnel to be hired to contribute to the project at the INFN site of the Frascati laboratories. As many as two recruitment attempts (public selections) were unsuccessful.

- in the last ten months of the period a serious personal problem of the work-package responsible effectively stopped the activity that mainly depended on him.

3. Deviations from Annex 1 (Description of Action) and Annex 2 (Estimated budget for Action) (if applicable)

**3.1 Deviations from planned objectives and tasks, and their impact on the progress of the work package**

*[Explain the reasons for deviations, the consequences and the proposed corrective actions.]*

**3.2 Deviations between actual and planned person months**

*[Explain deviations between actual and planned person-months. If applicable, propose corrective actions.]*

1. Deliverables and milestones tables

**4.1 Deliverables**

*[Please list all the deliverables due in this reporting period, as indicated in Annex I.*

*Deliverables must also be accompanied by a short report (deliverable description and technical documentation, such as photo, list of publications, etc.), so that the European Commission has a record of their existence.]*

***Table 4.1 List of deliverables***

| **Deliverable No.** | **Deliverable name** | **Lead Beneficiary** | **Nature** | **Dissemination level[[1]](#footnote-1)** | **Delivery month from Annex I** | **Delivered**  **(yes/no)** | **Actual delivery month** | **Comments** |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| D27.2 | Report on PID  performances of final device | 30 - INFN | Report | PU | 62 |  |  |  |

*In case a deliverable has been delivered in the reporting period and a report exists in the Participant Portal, you can indicate “uploaded report” in correspondence of a deliverable*

**4.2 Milestones**

*[Please complete the table if milestones are specified in Annex I.*

*Milestones will be assessed against specific criteria and performance indicators as defined in Annex I.]*

***Table 4.2 List of milestones***

| **Milestone number** | **Milestone name** | **Lead beneficiary** | **Delivery month from Annex I** | **Delivered**  **(yes/no)** | **Actual delivery month** | **Comments** |
| --- | --- | --- | --- | --- | --- | --- |
| MS62 | Final device working and  characterized | 30 - INFN | 62 |  |  |  |

**4.3 Deliverable Reports**

*[Please provide, per each deliverable listed in Table 4.1, a brief description, including if possible some technical documentation (photos, list of publications, etc.). Use as many pages as needed per each report.]*

The final goal of the project ( MS62 ) was not completely achieved mainly due to the two difficulties presented above. In any case, the second prototype was built as planned and the relevant functionality measurements were carried out at the AIFIRA (2 MeV and 3 MeV) and CYRCE (6 MeV to 25 MeV) facilities at the in2p3 laboratory in Strasbourg. Those facilities have the potential to produce only low-energy protons compared to what is needed to be investigated in the area of Hadrontherapy.

The preliminary results of the measurements carried out last spring, mentioned above, are summarised in the following plots for two different modules:

­­­Immagine che contiene testo, diagramma, linea, schermata

Descrizione generata automaticamenteImmagine che contiene testo, diagramma, linea, Diagramma

Descrizione generata automaticamente

ToT mean variation for module 10 (left) and module 13 (right)

We finally plot on Figure 16 the evolution of the cluster charge as function of the energy deposited in the EPI layer as expected from SRIM simulation.

Immagine che contiene testo, linea, Diagramma, schermata

Descrizione generata automaticamente

# The variable on the horizontal axis of the graph ‘Charge deposited in the EPI layer (ke)’ is deduced from the following graphs obtained from a numerical simulation (SRIM) of the charge deposited in the epitaxial layer of the sensor. In the plot we can see a clear correlation between the measured charge by the prototype and the simulated charge released in the epitaxial layer of the sensor.

Immagine che contiene testo, linea, diagramma, Diagramma

Descrizione generata automaticamente

Charge generated in the EPI layer by a proton

The reported measurements are certainly flattering about the characteristics and possibilities of this sensor with regard to the goal of the work pakage. At the same time, it must need to mention that measurements at higher energies and with higher atomic number ions such as helium, carbon and possibly oxygen are lacking. Such measurements can only be made at facilities other than those present in the Strasbourg laboratory and are essential for obtaining the Milestone 62 mentioned above.

1. PU = Public

   PP = Restricted to other programme participants (including the Commission Services).

   RE = Restricted to a group specified by the consortium (including the Commission Services).

   CO = Confidential, only for members of the consortium (including the Commission Services). [↑](#footnote-ref-1)