

ANNEXURE A – PROJECT PLAN

Note: This project plan is covered under the NRF iThemba LABS/CPUT Memorandum of Understanding

1. Project title and Overview

Project Title	Design and development of the ALICE CRU user logic firmware for the MID readout chain
Project Description (Background, Objective, Methodology)	<p><u>Project Abstract:</u> This project forms part of the ongoing ALICE (A Large Ion Collider Experiment) detector upgrade for the European Organization for Nuclear Research known as CERN. NRF iThemba LABS contributes to the ALICE Muon spectrometer upgrade, in particular, the Muon Identifier (MID). NRF iThemba LABS is responsible for the CRU firmware user logic development, including setting up a fully-equipped testbench for the data acquisition readout chain as well as develop the firmware code and maintenance thereafter. These activities are reported and coordinated through the MID Common Readout Unit (CRU) collaboration composed of members from South Africa (iThemba LABS), France (Subatech, Clement-Ferrand) and Switzerland (CERN). However, this particular project will focus solely on the MID CRU user logic development and testing thereof.</p> <p><u>Project Description:</u> This project which will form part of a masters in engineering, concerns the development of the user logic firmware for the MID readout chain. Recent tests conducted on the MID readout chain showed potential limitations in data rates if data are collected without a pre-analysis performed with the firmware of the CRU. Therefore, alternative solutions are required. This research project will provide a new approach of processing data using a customized common readout unit user logic firmware provided by the ALICE Collaboration, to meet these requirements. The MID CRU user logic firmware is designed for the CRU FPGA using VHDL (VHSIC-HDL, Very High-Speed Integrated Circuit Hardware Description Language) as per requirement by the ALICE CRU core team. To accomplish this task, it is important to understand the requirements of the user logic firmware as well as the expectation in line with the ALICE online-offline (O²) data format. The MID CRU user logic firmware is expected to perform the following functions:</p> <ul style="list-style-type: none"> • Receiving raw data from the front-end electronics (FEE) via GBT links and transmit it to the central CRU firmware after reformatting and zero suppression of data. • Receiving continuous trigger information from the central trigger processor (CTP)/timing and trigger system (TTS) via CRU firmware.

	<ul style="list-style-type: none"> Handling errors found in the front-end electronics data. <p><u>Project Scope and Expectations:</u></p> <p>The scope is limited to the development of the user logic firmware for the MID readout chain: CRU, FEE, CTP/TTC, FLP (O²). Involvement with these systems is limited to the interfaces and input/output characteristics of those. Furthermore, integration with the existing system is only tested through conformance with established requirements and practice as per ALICE regulations at CERN. For the purpose of this project, the MID user logic firmware should be developed for a full readout crate (2 GBT links) composed of 16 local cards and 1 regional card. Expected tests for conformance should include testing the user logic firmware using:</p> <ul style="list-style-type: none"> Intel Quartus prime 18.1 pro Modelsim – Intel FPGA Realistic testbench available in room S64 at iThemba LABS
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2. Contacts:

2.1. iThemba LABS's Project Manager 1

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2.2. iThemba LABS's Project Manager 2

Name: Dr S.V Förtsch
Telephone number: 021 843 1022
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2.3. The institution's Project Manager

Name: Dr A. Raji
Telephone number: 021 959 6563
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3. Terms:

3.1.

Starting date: 01 February 2020
Completion date: 31 December 2021

The project is fully funded by the NRF iThemba LABS and, collaborator (France and CERN) support is facilitated through SA-CERN funding from the NRF.

The project may not be terminated due to lack of progress and/or deliverables

4. SCOPE OF SERVICE – TO BE PROVIDED BY THE INSTITUTION

(Details required)

- A comprehensive literature review
- Design and Development of ALICE CRU user logic prototype.

- Evaluation of the user logic prototype at iThemba LABS facilities. Including:
 - Simulation tests
 - Realistic tests

Possible exclusion from the current project

- None

5. **DELIVERABLES**

(Documentation and other items to be provided by the institution)

No.	Deliverables
1	Copy of the code and simulation files
2	Copy of the thesis

6. **CONTRIBUTION**

6.1. **Availability facility/infrastructure**

A fully functional testbench setup is available in S Block room S64 at iThemba LABS. It is equipped with the MID front-end electronics prototype card, with an embedded GBT chip, CTP/Local Trigger Unit (standalone emulator of the TTS), CRU card loaded on the new generation Dell R740 First Level Processor (FLP) server and a fully populated VME crate (powered by a VME Power Supply) composed of Front-end cards: 1 regional card, 16 local cards and 1 J2 bus backplane, provided by the collaborators from Subatech (Nantes, France). The FLP is fully equipped with the installation of the CRU-O² software and Intel Quartus prime pro 18.1 (licensed) for the configuration and design of the user logic firmware.

CPUT will not supply any specialised equipment necessary for this project

6.2. **Funding implication**

About R90 000 will be available via iThemba LABS RAIP funds to fund the student (including tuition fee).

Since this project requires travel to CERN (Geneva, Switzerland) for a period of time, the travel funds will fully be sponsored by the SA-CERN program.

If, on withdrawal or refusing re-registration, the candidate shall not repay any of the above. However, the student is expected to provide a fully operational CRU user logic firmware to complete their studies as per contract with iThemba LABS.

7. **OWNERSHIP OF EQUIPMENT**

Equipment to be procured using funding contributed by NRF iThemba LABS	NRF iThemba LABS	Institution
The infrastructure and tools used are property of NRF iThemba LABS	100%	0%

8. **COLLABORATORS**

These activities will be coordinated within **CPUT** and the MID collaboration: NRF iThemba LABS, Subatech and Clement-Ferrand (France) as well as experts from CERN (Switzerland). Progress will be closely monitored in house, via weekly meetings, the ALICE

Run Coordination 2 meetings and by MID experts such as **Dr. Christophe Renard** (in charge of the design of the front-end electronics), **Dr. Diego Stocco** (in charge of the online-offline system) and **Prof Alessandro Ferretti** (ALICE MID project coordinator). Additional support will come from CERN CRU experts such as **Dr. Filippo Costa** (in charge of the CRU software) and **Dr. Olivier Bourrion** (in charge of the CRU firmware).

9. INSTITUTION RESEARCH AND TEAM MEMBERS

Names	Roles	Contact details
Dr. Atanda Raji	Supervisor	RajiA@cput.ac.za (021) 959 6563
THYS-DINGOU D.O	Master candidate	0712004894

10. MILESTONES

10.1. The following table sets out the stages of the project, and reporting dates. (At any time, the Parties can revise the Project to ensure that the requirements of iThemba LABS are being met)

No.	Milestones	Completion dates
1	Initial Literature Review	February 2020
2	Visit to CERN to meet with collaborators	February 2020
3	Make the necessary adjustments in consultations with CRU experts at CERN.	June 2020
4	Presentation of the progress to collaborators during the ALICE Mini and ALICE Weeks.	July 2020
5	Progress report and Feedback: <ul style="list-style-type: none"> Comprehensive literature review Design and implementation Verification and validation Evaluation of results 	August 2020
6	Evaluation of results continue	October 2020
7	Thesis write up	January 2021

11. IPR ACT

11.1. THE PARTIES ACKNOWLEDGE THE PROVISIONS OF THE IPR ACT

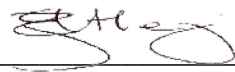
11.2. Is the Project to be funded by NRF iThemba LABS on full cost basis as referred to in Section 15(4) of the IPR Act?

☐ Yes **X**
☐ No
 (tick where applicable)

For and on the behalf of NRF iThemba LABS

For and on the behalf of the Institution


FOR: NRF iThemba LABS

Sign: 

Name: Ass. Prof. EZ Buthelezi
Project Manager 1

Date: 26 November 2020

Place: Somerset West

Sign: 

Name: Dr. Siegfried Förtsch
Project Manager 2

Date: 26 November 2020

Place: Durbanville

FOR: Institution

Sign: 

Name: Dr Atanda Raji
Project Manager

Date: 25/11/2020

Place: Bellville