NARRATIVE

I. **Statement of purpose**: *In 1-2 sentences, please summarize the aim(s) of the project.*

Local manufacturing of open-source devices for medical labs in Africa: prototyping stage in Cameroon.

II. Project summary: *Please provide a brief (1-2 paragraphs) summary of your project, explaining why it is relevant.*

Medical labs across Cameroon and Africa are facing a lack of equipment due to high up-front costs, lack of consumables, limited local maintenance skills and proprietary technologies. This situation strongly contributes to deepening inequalities in access to quality healthcare. Our project aims to show the proof-of-concept that Open Source devices for medical labs can address this issue; that is why we are applying for this 12 months grant.
If funded, at the end of the project, we will release a set of prototypes of high quality and inexpensive open-source devices enabling medical labs in Cameroon to perform some important medical analysis and tests. To facilitate their replication and redistributed manufacturing across Africa, we will share all the documentation and the designs of these tools under an open license permitting their use and modification. Moreover, through its capacity and capability building dimension, the project will strongly empower young Africans involved in STEM.

III. Detailed project description: *Please provide a more detailed account of the project you described above (no more than 5 pages). The following points should be addressed in the proposal:*

1. Rationale (description of problem(s) and reasons for addressing them)

Medical devices are scarce in resource-limited healthcare facilities across Africa because they are expensive and those devices that are present are not in a usable state the majority of the time. This situation is intensified by the lack of training to maintain these equipment locally ; spare parts are hard to obtain, and service engineers may need to charge thousands of dollars for international travel. In addition to the maintenance issues, a lot of medical devices are patented and licensed to a company, making the final product closed by default. Trying to remedy this problem as part of the Mboalab mission to catalyse sustainable local development through Open Science and contribute to the Common good, we would like to build Open Source devices for medical labs.

2. Context/niche (briefly describe other work being carried out on these issues within your context and your organization's unique contribution to the issue

Local manufacturing addresses the infrastructural barriers that prevent imported or donated equipment from being properly used, and can facilitate the diffusion of innovation into healthcare practice. It also allows local stakeholders to fit their products to their context, for example building in resilience to power outages, or working with non-proprietary, locally-available consumables. Nowadays Open science is the best and fair approach to support local manufacturing. That is why the crux of our approach is the use of "open source hardware", where designs for easily replicated, high quality diagnostic tools are shared under a license permitting their use, sale, and modification.
Indeed, over the last few years, an increasing number of open-source hardware designs have been released, with the potential to transform medical devices through the use of digital fabrication and inexpensive, well-engineered parts from mass-produced consumer goods. Amongst these open-source

hardware designs we (the Mboalab team) have identified some that can be used to perform basic medical analysis and tests relevant for our context. These medical laboratory equipments are :

Hematology	Bacteriology	Biochemistry	Other
·Tabletop centrifuge ·Hematocrit centrifuge with scales · Rotator · Orbital Shaker ·Differential counters for microscopy ·Microscope	· Autoclaves (Pressure Pot) ·Magnetic heating stirrer ·Incubator ·Sterile hood/ Safety cabinet ·Microscope	·Hemoglobin electrophoresis tank	·3D Printed Pipettes ·DIY Incinerator ·3D printed Pipettes and tube racks ·3D printed DIY Automatic antibiotic disk dispensers

With all the open-source equipments mentioned above, we can perform the following medical analysis and tests :

- Malaria diagnosis,
- Anemia diagnosis,
- Hemoglobin analysis,
- Stool analysis,
- Urine analysis,
- Typhoid fever diagnostic (Widal),
- Stool and urine culture;
- Blood culture

The Mboalab is already contributing to address this issue through the Open source Incubator[1] we built ; our prototype is currently used in some local universities in Cameroon and has been replicated in Ghana. Also, we are working to develop a rapid diagnostic test for typhoid fever[2]. Finally but no the last, we are manufacturing enzyme locally in Cameroon, with the goal to make them affordable accross Africa[3].

3. Project goals (overall purpose and specific objectives)

Overall purpose

The aim of this project is to build open-source devices for medical labs that can be used to perform basics diagnosis in hospitals with limited equipment. This will enable better access to quality diagnosis by reducing the divide between sophisticated medical labs in rich countries and the lack of equipment observed in much of Africa in general and in Cameroon in particular. By achieving this goal, this project will strongly contribute to the Sustainable Development Goal 3 (SDG3): “Good health and wellbeing”.

Specific objectives

Objective 1 : build capacity of local biomedical engineers to produce, maintain, and develop open-source medical devices. Like that, we will contribute to the empowerment of young talented Africans involved in STEM ;

Objective 2 : promote the use of open source hardwares that can rapidly diffuse across the continent and facilitate the strong engagement between biomedical engineers, healthcare professionals, social scientists, policymakers and entrepreneurs.

4. Activities and timeline (the work you will do to achieve your goals, and when the various elements of this work will take place)

[1] https://wikifactory.com/+biolabkh/incubator

[2] https://openbioeconomy.org/news/developing-a-locally-manufacturable-typhoid-diagnostic-in-cameroon-new-project-for-2020/?fbclid=IwAR3jdMcWhOxAuIpfJKSpz7P-dXamXipAicSr2x_R21ada78lkLaky1kfgBE

[3] https://www.ceb.cam.ac.uk/news/open-enzymes-making-biotechnology-globally-accessible

4.1. Activities

- **Recruiting and training interns**
  - recruit two interns for the grant period (01 biologist and 01 engineer, including at least one woman) from local universities which are partners with the Mboalab. The recruitment will be done according to the rules of the Internship program of the Mboalab[4].
  - Train interns in open science values, practices and tools ; including coding, modelization, 3D printing and how to use platforms like GitHub.
- **Literature review**
  - perform literature review on open-source medical devices ;
  - identify other open source projects in addition to the list of open-source medical devices the mboalab team has listed in point 2 of this section ;
  - collect available designs from the open-source projects identified above ;
  - Select the open-source medical devices we are going to build if the grant is succesful.
- **Build open-sources medical devices**
  - use the available designs and build the different equipments with local consumables ;
  - when needed, improve the design ;
  - if necessary, develop new designs.
- **Documentation**
  - document the building steps of the open-source medical devices developed in this project ;
  - share the documentation with open licences in such a way that people can freely replicate, adapt or improve the model and the design across the world;
  - produce Open Educational Resources (OER)
- **Dissemination**

We will disseminate this work to the large public, funders, polycimakers, entrepreneurs, healthcare technology researchers and the growing community of “makers” outside of academia. Our dissemination strategy is based on :

  - design sharing sites such as Instructables, Github, Gitlab, Wikifactory, etc.
  - blog posts and social media such as Facebook and WhatsApp,
  - publishing in appropriate implementation science or development journals like Journal of Open Hardware[5] ;
  - publish the Mboalab book’s reporting all the activities we have done since the beginning : Collaboration, protocol, capacity building, OSH, etc. If successful, this grant will be the perfect opportunity to release this book and engage directly with organisations such as the WHO, UNIDO and national regulators to share our findings and recommendations.
- **Outreach activities**
  - attend and present during events taking place in Cameroon around technology, innovation & healthcare,

4.2. Timeline

We are planning to conduct the activities mentionned above in twelve (12) months ; starting when we are sure that the grant application is successful. The suggested timeline is the following :

	Month1	Month2	Month3	Month4	Month5	Month6	Month7	Month8	Month9	Month10	Month11	Month12

[4] https://www.mboalab.africa/biotech-internship-program/

[5] https://openhardware.metajnl.com/

Recruiting and training interns												
Literature review												
Build open-sources medical devices												
Documentation												
Dissemination & outreach												

4.3. Outputs

- accessible designs of open-source medical devices using local resources (in English and French) ;
- Proof-of-concept for a local manufacturing of open-source devices for medical labs ;
- book reporting stakeholder engagement, detailing capacity/capability building and pathways to impact for local manufacturing of open source hardware in Cameroon and in Africa.

5. Project Staff and Resources (the staff and other major resources that will be required to carry out this project)

Mboalab staff

- Project coordinator, Department of Electromechanics, Mboalab
- Assistant, Department of Biotechnology, Mboalab

02 interns from local universities

- 01 intern with biology/health sciences background
- 01 intern with engineering/electromechanical background

Equipments (3D printer)
Consumables (electronics**,** 3D printer filament, plexiglass, woods...)
Communication

6. Partners (specific organizations and other stakeholders (networks, key government officials etc.), that will collaborate in the described activities)

- **Local universities** : University of Yaoundé I, University of Buea, Catholic University of Central Africa;
- **National ecosystem of innovation** : Ongola Fablab[6], International Fair for Young African Researcher[7];
- **"Makers" Communities**: GOSH[8] (Gathering for Open Science Hardaware), AfricaOSH[9], TReND in Africa[10].

7. Expected change (what is the change you hope to see by the end of this grant period?)

By the end of this grant period, we hope to build a body of knowledge and skills that enable a new generation of medical instruments that can be repaired/customised locally by young talented Africans. With the aim to see these open-source medical devices used to afford quality diagnosis to everyone, even in hospitals of rural zones without electricity.

[6] https://www.fablabs.io/labs/ongolafablab
[7] https://ifyar.com/en/accueil-english/
[8] http://openhardware.science/
[9] http://africaosh.com/
[10] https://trendinafrica.org/

8. Tracking progress (how will the organization measure progress toward achieving the desired outcomes/change? What information will be collected to demonstrate whether changes have occurred?)

The progress of the project will be measured through :

- **capacity and capability building of interns**
  - the number of open designs collected during the literature review;
  - the number of prototype built;
  - qualitative criteria like their capacity to provide the documentation of the prototypes they built; the adoption of open science values (sharing, openness, collaboration);
- **First diagnosis tests performed at the Mboalab with the prototype.**
- **Outreach activities:**
  - the number of designs released on GitHub;
  - the number of blogposts published;
  - the number of invitations received for events/the number of events attended/the number of presentations done during events;
  - feedbacks received through social media or during event we are attending;

9. Sustainability (how this work will be supported in the future both financially and programmatically)

Our experience with the Mboalab Open source Incubator[11] taught us that, once we have a good prototype working well, people and institutions will get interested. For the moment, we have built four incubators to support local labs in Cameroon and the feedback we are receiving is excellent and confirm that our incubator is working well. Without any doubt, we will have the same success with the open-source medical devices generated through this project. Like that, we can put in place a social business model to produce more cheap and high quality equipment for medical labs in Cameroon; while keeping the margin lower as possible (just what needed to pay salaries and consumables).
If this grant application is successful, it will allow us to achieve our short term vision which is the prototyping stage of open source medical devices. For our mid-term vision, we are planning to show evidence of the quality of Open source medical devices we built, by conducting a comparative study with the commercialized equipment. At this stage, we will engage a few hospitals and a few private labs as partners ; and the Ministry of Health as Governmental partners. Once we get all the evidence, we can move to our long-term vision, which deals with the compliance and all the certifications requested to scale up local manufacturing of open source medical devices across the global south.

10. Risk (description of the internal (organizational) and external factors and obstacles that could affect the project implementation and prevent you from reaching your goals. Provided that the work cannot be completed during the allotted time frame, the additional support that would be requested from the Open Society Foundations)

The first major challenge deals with access to the Internet and even to electricity which is still a problem in Cameroon. This could cause : delays in interactions between the members of the project ; inability to accomplish some tasks and a limited use of online tools and resources. The second difficulty concerns the time interns can take to acquire basics in coding, modelization and 3D printing; since digital fabrication is something relatively new in the local context.

IV. **Project Budget:** *Please submit the project budget in a separate document (preferably Excel). This document should provide a list of all relevant project expenses. These expenses may include equipment and other capital purchases, administrative costs (telephone, internet, etc.), organizational costs (meetings, travel, etc.), personnel costs, and overhead administrative costs. While there is no fixed limit on OSF contributions to a grantee's overhead costs, it is recommended*

[11] https://wikifactory.com/+biolabkh/incubator

that project grants cover no more than twenty percent contribution to an organization's overhead or administrative costs. The project budget should outline the total cost of each item, the amount of funding requested from the Open Society Foundations for each item, and the amount of funding you expect to receive from other sources (if the overall project budget exceeds the amount requested from the Open Society Foundations).A sample budget template is provided below (both in the format of an Excel spreadsheet and as a Word table); please modify one of them as necessary.

V. **Project Budget Narrative:** *Please describe in narrative form how the funds in the budget will be spent. If personnel costs are included, provide each person's name and attach brief bio-sketches or CVs (less than 2 pages each). Describe each person's role and responsibilities in this project and the percentage of their time that will be spent on this project.*

For this project, we are requesting a total funding of 23 980 USD from the Open Society Foundations. During the grant period, the budget will be distributed as follow:

- **Personnel Costs (37,53% of the total budget)**

This budget line is to pay salaries of two (02) full time positions and two (02) interns working partial time while studying. For the full time positions we are planning to hava **Élisée Jafsia, as the project coordinator**; he will join the Department of Electromechanics of the Mboalab. The Project Coordinator will be **assisted by Minette Shalo**; she will join the Department of Biotechnologyof the Mboalab. **Thomas Mboa,** the co-founder of the Mboalab, **will volunteer in this project.** He will ensure that the documentation is well conducted and that Open science values and ethics are respected during the project.

- Elisée Jafisia holds a M.Sc in Physics and a M.A. in Education; he has interests in mechanics, modelization, Artificial Intelligence and Machine Learning. He has a strong experience in 3D printing and coding. He has always been a volunteer at the Mboalab and used to work with us on short projects related to building open-source equipment.
- Minette Shalo holds a B.Sc in Biochemistry, she has interests in molecular biology, molecular epidemiology and diagnostic sciences. She has been part of the first batch of interns at the Mboalab; since then, she has always been a volunteer at the Mboalab and used to work with us on short projects related to medical biology.
- Thomas Hervé Mboa Nkoudou holds a PhD in Social Sciences, M.A. in Education and B.Sc in Biochemistry; he has interest in the Maker Movement in Africa. Thomas Mboa is working on digital technologies as a powerful tool of sustainable local development; with a critical approach through the concepts of technocoloniality and cognitive injustice. Due to his background in Biochemistry, Mboa is also deeply engaged to promote DIYbio and democratize Biotechnology in Africa; he is the co-founder of the Mboalab.

- **Communications Costs (22,10% of the total budget)**

This budget line is for dissemination of our results through formal and informal channels (blogpost, paper, book,etc.); the production of material to be used during outreach activities (flyers, etc.), documentation and specifically Open Educational Resource in order to continue to ensure capacity building online and across Cameroon and Africa. This budget will also support our communication in French and English; by this way, we will mitigate language barriers Africa are facing. Of course, the Internet and telephone costs are also part of this budget.

- **Equipments & consumables (14,60% of the total budget)**

With this budget line, we are planning to buy a professional 3D printer that we will use to print parts of the open-source devices we will build through this grant. Currently we are using an old 3D printer we built ourselves 02 years ago. This budget is also for consumables we are going to use to build our open-source devices (electronics**,** 3D printer filament, plexiglass, woods, etc.)

- **Meeting/Conference Costs** (10,43% of the total budget)

This budget line is for outreach activities across the country.

- **Overhead Costs** (9,09% of the total budget)

This budget line is for administrative purposes related to the management of the grant.

- **Professional Fees** (6,26% of the total budget)

This budget line is to outsource works we cannot perform at the Mboalab like laser cutting (because we don't have a laser cutter); carpentry, welding, etc. In addition, through this budget we will engage with professionals working in the informal sector; as you may know the informal sector represents the largest part of African economies in which youth and women are involved.

VI. Tax Determination Letter: *Please include a copy of your organization's tax determination letter if your organization is based in the United States.*