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College of science and Technology,
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5/4/2021



Africa school for Physics (ASP) alumni seminars

“ Where are they now?”, “What happened to the students after they attended ASP?”

I am ASP Alumni 2016





In this presentation

About Dr Cyulinyana Marie Chantal



STEM Activities

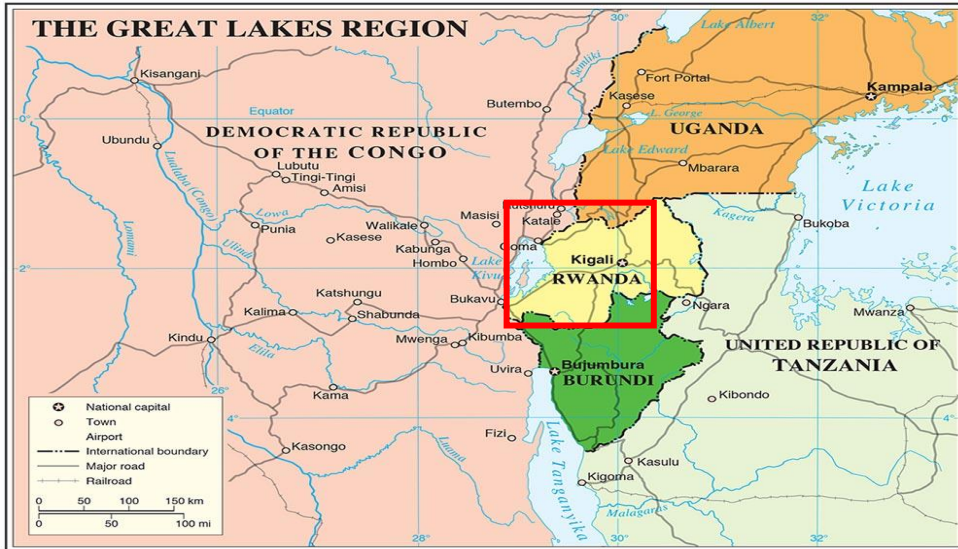


The overview on the current project



what is next?

About Rwanda



- Geographical coordinate: East Africa at 2°00'S 30°0'E, landlocked
- Altitude: 1000-4507 m
- Climate: temperate tropical highland
- Humidity: 80%
- Temperature: 20° - 30° C
- Precipitation: 1028 mm (annual)
- Sunshine duration: 11-12 hours/day
- Area : 26388 km²
- Population ~12 Millions
- To date, 59.7% of **Rwandan** households have **access to electricity**.

- Installed capacity: 210MW , 50% from hydropower. Solar contributes only 5.7%

Study background



2019–2021 **Postdoctoral Fellow**, *University of the Witwatersrand, Physics department, South Africa.*

Speciality: Modelling and Optimization of novel solar energy technologies.

2014–2018 **P.h.D in Physics**, *Solar Irradiance Research Group, Physics Department, University of Johannesburg , South Africa.*

Speciality: Research on Solar Radiation Modeling. Studying the interaction of incoming solar radiation with atmospheric constituents in order to determine surface solar radiation at given location. The modeled solar potential is used for renewable energy applications.

2009–2011 **M.Sc in Physics**, *University of the Witwatersrand , Johannesburg, South Africa.*

Speciality: Research on Alternative energy conversion/generation. Solar thermal and thermodynamic energy: Solar trough plant system.

2008–2009 **PGD in Mathematical sciences**, *University of Stellenbosch, Cape Town, South Africa.*

Speciality: Mathematical sciences. My essay project was on solar thermal energy system: solar trough plant and energy storage.

2003–2007 **B.Sc in Sciences**, *Kigali Institute of Education, Kigali, Rwanda.*

Domain: Physics-Chemistry with Education



AIMS



**National
Research
Foundation**



RAWISE

Rwandan Association for Women in Science and Engineering



**African School of Fundamental
Physics and Applications**

Brief background of my research

Modelling and optimization of solar energy technologies to ensure reliable supply of demand.

My PhD project was on solar radiation modelling; Reproducing ground level solar radiation characteristics observed in tropical climates using theoretical and computational model.

The long-term aim was to build a database on solar potential in Rwanda based on our atmospheric parameters (ongoing).

UKRI-GCRF Education as a Driver of Development Research Grant: Gendered Journeys: the trajectories of STEM students and graduates through higher education and into employment, in India and Rwanda
The Gendered Design in STEAM for LMICs project Improving the design process for housing and public spaces based on women's experiences in Rwanda

My current research is based on heat transfer analysis and numerical simulation of a cavity receiver of a parabolic trough solar collector. A prototype is being built on the school of Physics roof to (Wits). Aiming to validate our numerical results .

International Collaboration



STEM ACTIVITIES



Email: info@rawise.org.rw

Website: <https://www.rawise.org.rw/>

Twitter: [@STEMWomenRwanda](https://twitter.com/STEMWomenRwanda)

Facebook: [@STEMWomenRwanda](https://www.facebook.com/STEMWomenRwanda)

LinkedIn: [Rwandan Association for women in Science and Engineering \(RAWISE\): Overview | LinkedIn](https://www.linkedin.com/company/Rwandan-Association-for-women-in-Science-and-Engineering-(RAWISE)-Overview-|LinkedIn)

RAWISE mission

To increase the number of girls in STEM, building and educating capable and skilled women in different areas of STEM, cultivating an entrepreneurship and research spirit in them



RAWISE Objectives

1

Encourage young women to take up studies in sciences and engineering;

2

Provide workshops to develop the careers of scientists and engineer's female;

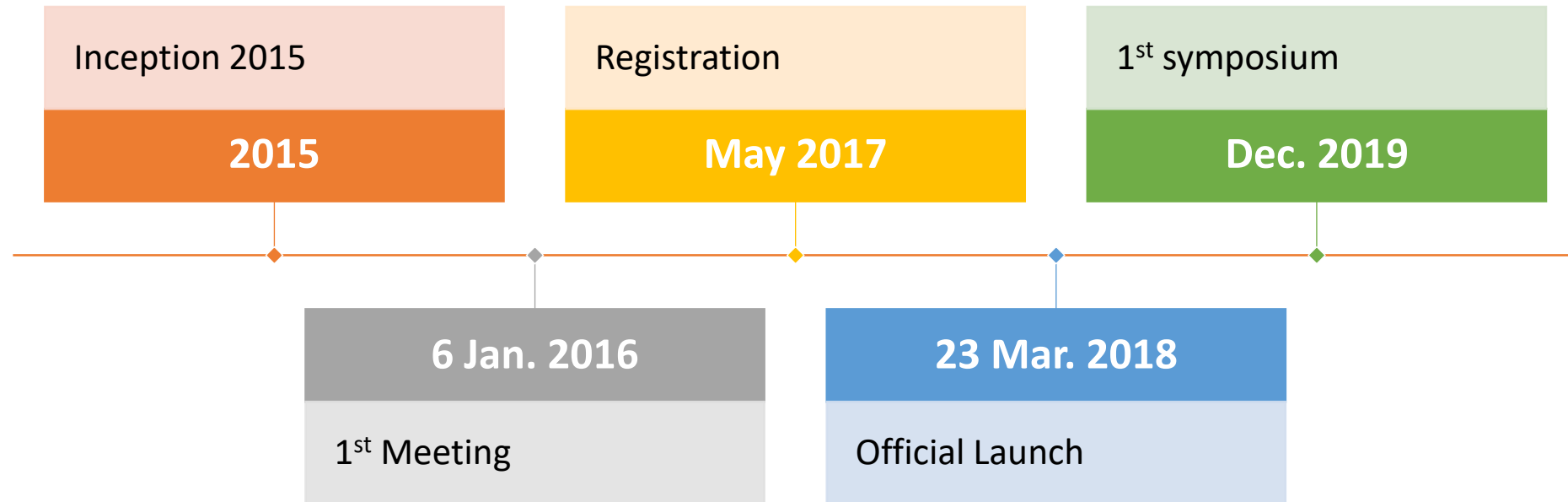
3

Increase and promote female's participation in science and technology professions in Rwanda;

4

Conduct research on the STEM-relate projects.

Some of RAWISE achieved milestones



RAWISE PILLARS AND ACTIVITIES



RAWISE PILLARS

Community Building

Groups and one to one mentoring

STEM incubation center

internal memberships (pair)

Raising awareness, schools, general public, at national level

Career Development

Soft skills

Professional skills

Influencing STEM Policy

Gender wise research

International & national institutions, organizations and GoR

Promote Gender research

Grant applications

Publications

Summary of RAWISE Past activities

Outreach in secondary schools (+20)

RAWISE itself, in collaboration with OWSD NC, FEMENG, WIS initiative, AIMS TTP,...)

Career development workshops (one was international)

sponsored by OWSD , NSCT, UNESCO, ICTP, EAIFR, UR, ect.

Gender focused projects

2 projects are in have been awarded, collaborating with UK university and UR

RAWISE SYMPOSIUM

Soft skills, scientific research presentations

Celebration WIS and science Events

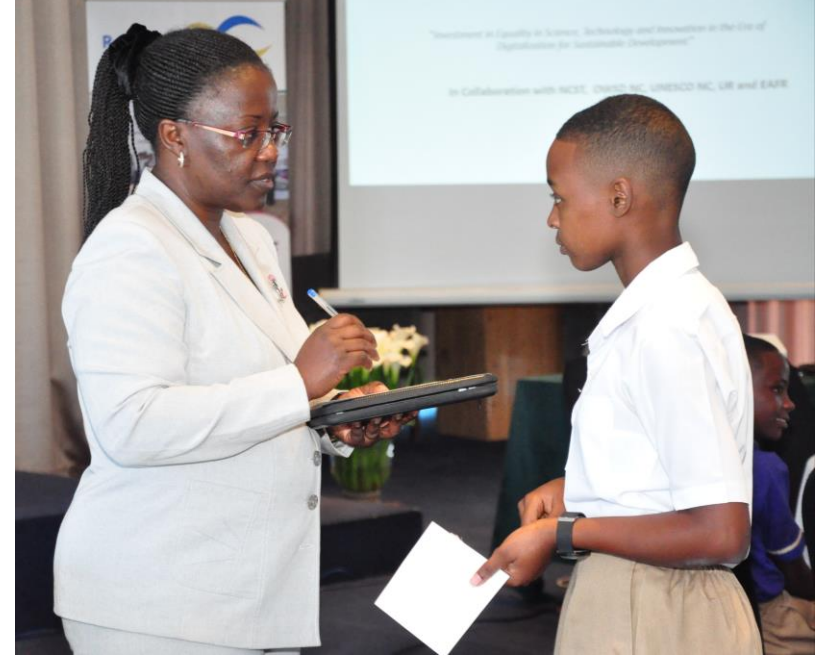
IWGS, WIS Awards ceremony)

RAWISE response to covid-19

motivational message, conceptual questions



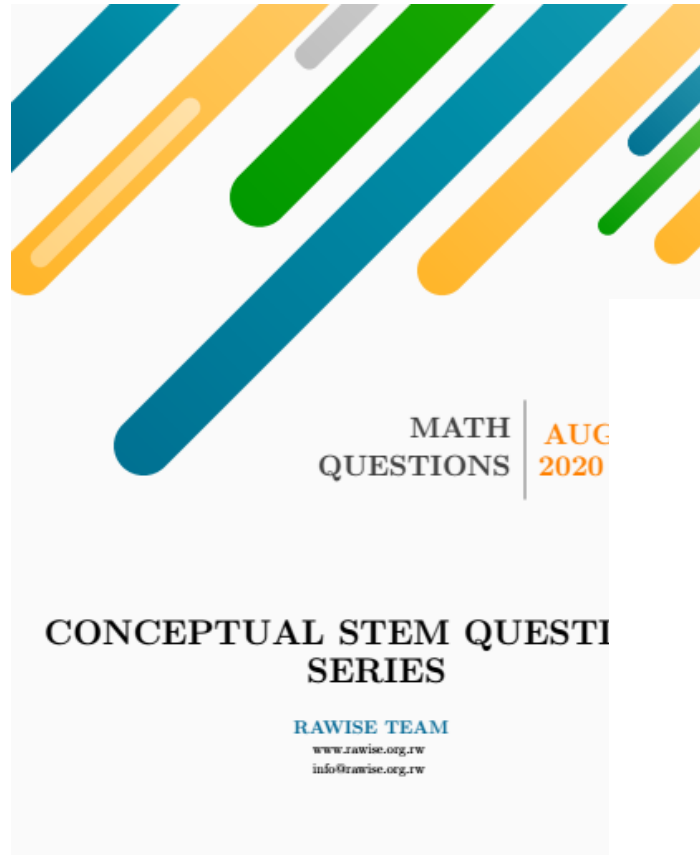




**Celebration WIS and science
Events (IDWGS 2020)**







During this COVID19 lockdown, I would like to give a message to young sisters and brothers who are worried about their future.

Dear sisters and brothers, it is time to think about how you can seize this opportunity while you are staying at home with your family to show them what you have learned at school in STEM. You can try to practice what you have learned for instance by making clean cooking stoves, soaps, lamps, candles, vegetable garden, biogas, compost,....This will keep you connected, updated and innovative

stay at home # stay safe #respect the GoRs instructions against COVID# stay connected# stay updated # be innovative #do not waste your time # the future is brighter for hard workers and big thinkers

Message from Aloysie Manishimwe, assistant lecturer at the university of Rwanda (UR-CST), and RAWISE Member

CONCEPTUAL STEM QUESTIONS TO HELP SECONDARY SCHOOL STUDENTS REVISING THEIR LESSONS WHILE STAYING HOME PHYSICS



2020

RAWISE TEAM
www.rawise.org.rw,
info@rawise.org.rw
7/24/2020 20

In recognition of her "Demonstration of Additional Efforts to Promote Science among Women and Girls in Rwanda"



Ms. Rita Clemence MUTABAZI
Science Leadership Award

In recognition of her "Research Productivity widely recognised, and has made significant impact to the Society"



Dr. Edwige KAMPIRE
Researcher Award

In recognition of her "Innovation in creating physical and tangible solutions useful to society that promote science"



Ms. Eva Liliane UJENEZA
Rising Star Award

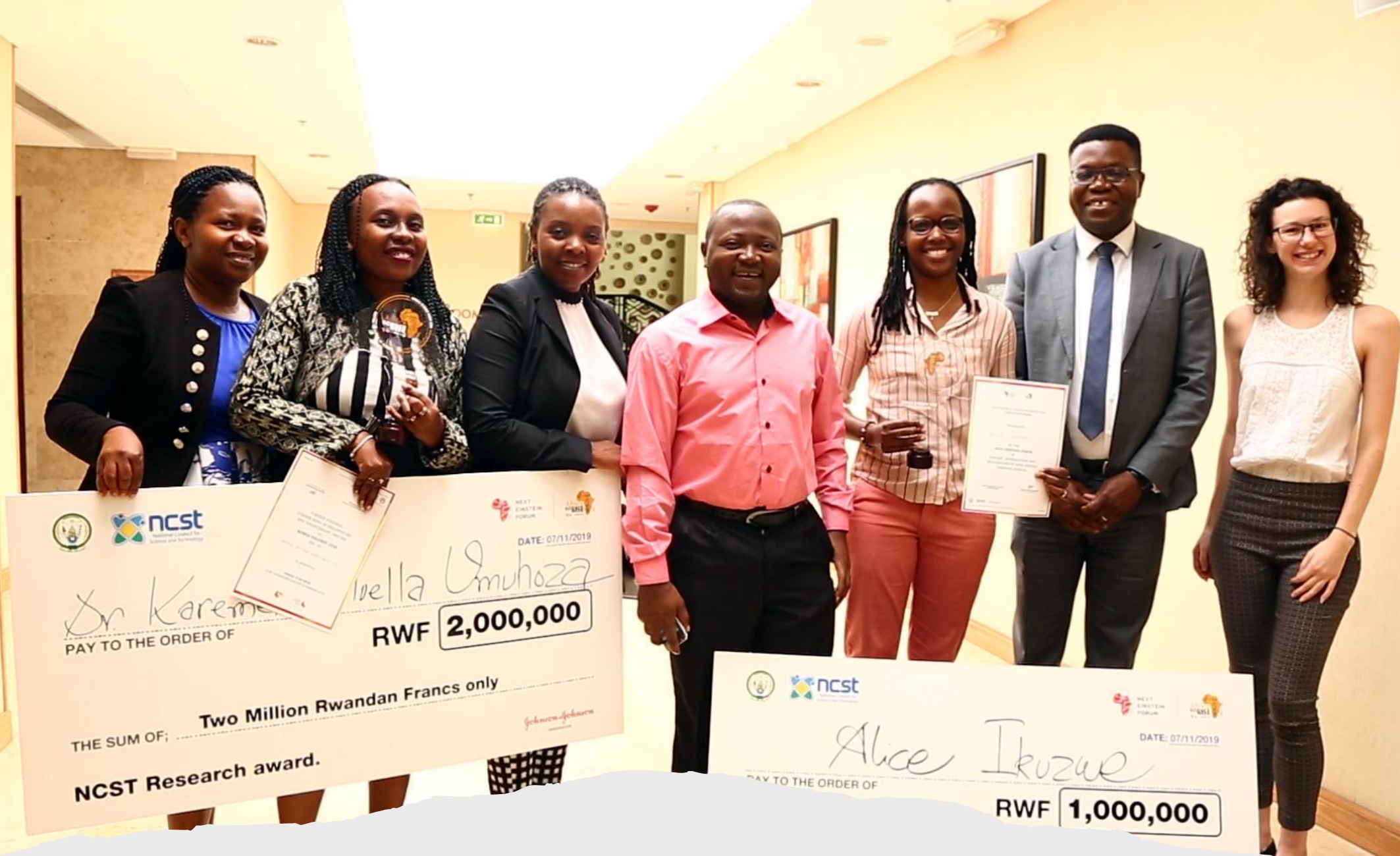
In recognition of her "Contribution to improving the odds of the next generation of youth female scientists in the career"



Ms. Dative NYIRANTEZIRYAYO
Champion of Science Award

IDWDGS 2020 and 2021 Celebration





WEST AFRICAN FORUM
DATE: 07/11/2019

Dr Karema Uwuhiza
PAY TO THE ORDER OF

RWF **2,000,000**

THE SUM OF; **Two Million Rwandan Francs only**
NCST Research award.

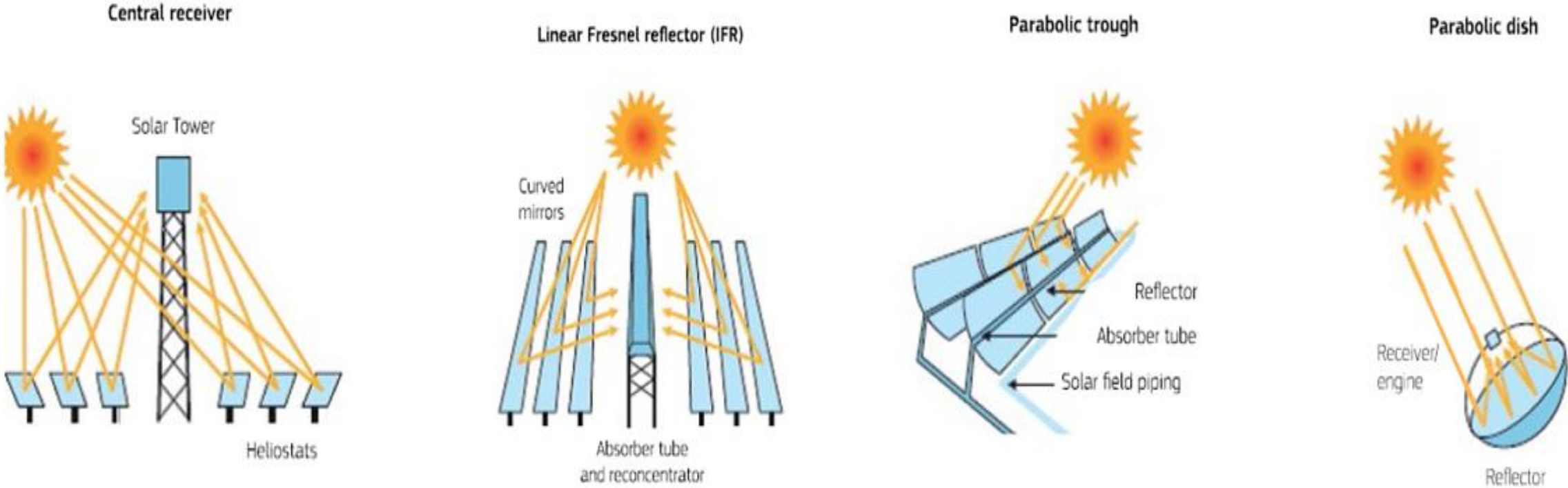
WEST AFRICAN FORUM
DATE: 07/11/2019

Alice Ikozae
PAY TO THE ORDER OF

RWF **1,000,000**

The System performance analysis of a novel solar parabolic trough with cavity receiver unit

Concentrated solar power (CSP): concentrating solar power, concentrated solar thermal systems generate solar power by using mirrors or lenses to concentrate a large area of sunlight onto a receiver.



[https://energypedia.info/wiki/Concentrating_Solar_Power_\(CSP\)_-_Technology](https://energypedia.info/wiki/Concentrating_Solar_Power_(CSP)_-_Technology)

Background on the parabolic trough solar collector

Among different types of solar thermal systems for collecting the solar energy, the parabolic trough solar collector offers more temperature range and lower cost

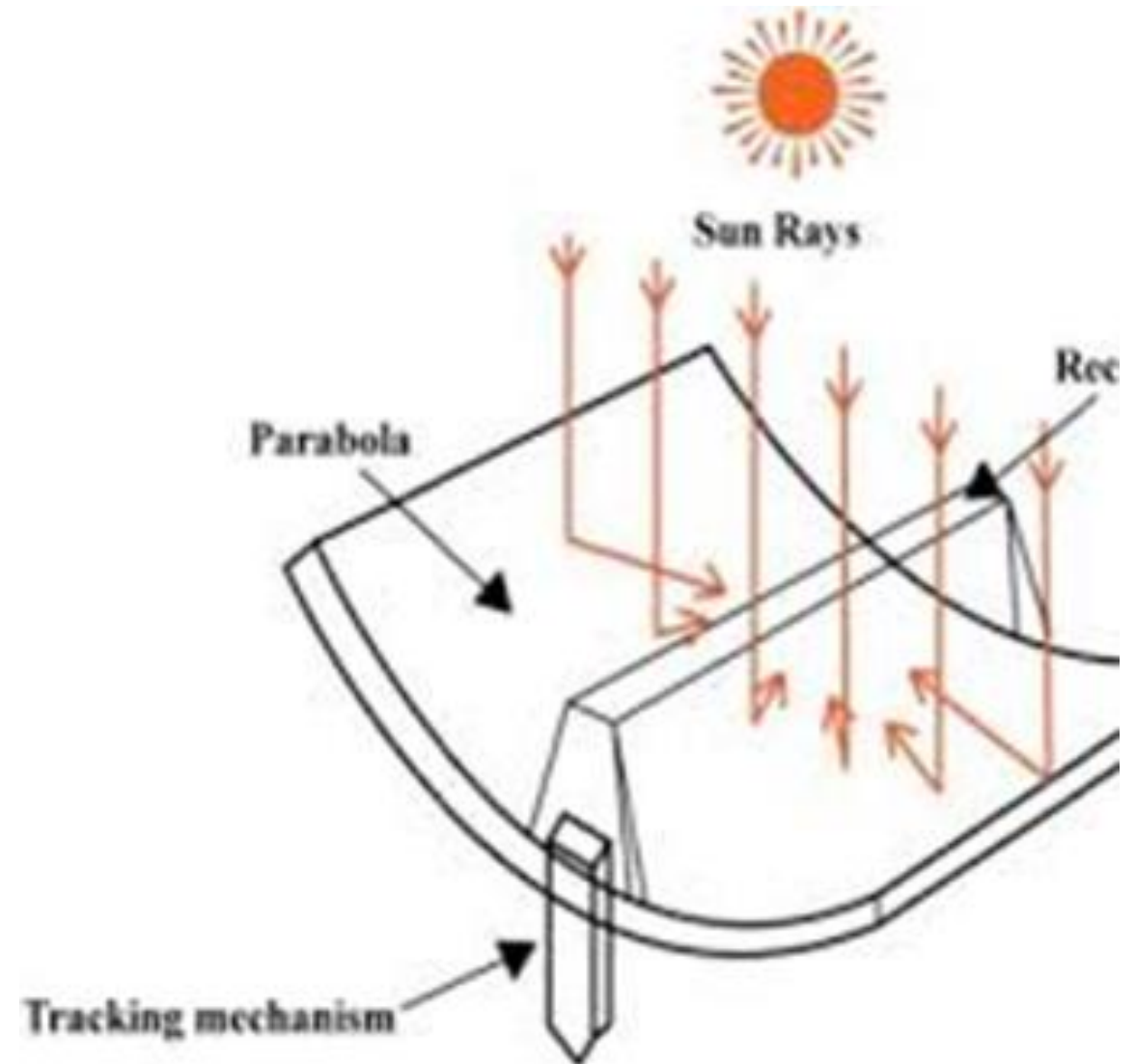
Parabolic trough collector (PTC) is one such concentrating collector which has proven its usefulness in medium–high temperature applications.

PTC technology is simpler and feasible when compared with similar types of solar collectors .

It has a huge industrial application as it is mainly concerned with high-temperature steam and electricity generation

Along with many advancements in the system, system modelling is also an important step for maximizing system performance

5/4/2021



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Why this project?

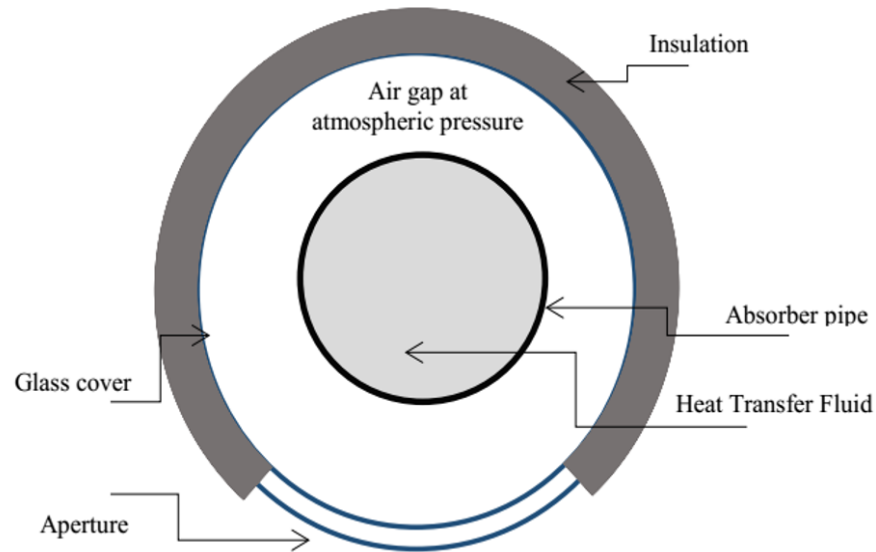


Kaxu and Xina solar one in SA

- ✓ The vision 2030 for South Africa is to utilize renewable energy resources to generate 42% of its electricity
- ✓ The Parabolic Trough Collector (PTC) technology should be one of the solutions to that.
- ✓ Solar energy offers a clean renewable source, and it has been one of the most rapidly growing green energy technologies.
- ✓ Hot mirror is a good alternative comparative to selective coatings is that they deteriorate thermally at temperatures around 680K (400oC)
- ✓ The logical extension of this research is the so-called cavity limit, which promises to be one of the most efficient technologies of its kind but has never before been tested experimentally
- ✓ Our technology innovation intends to produce cheap electricity from a renewable source in an environmentally friendly way using a solar through type system
- ✓ An introduction of cavity receiver is one of the solutions to reduce this and at the same time would help to increase the concentration ratio of the system

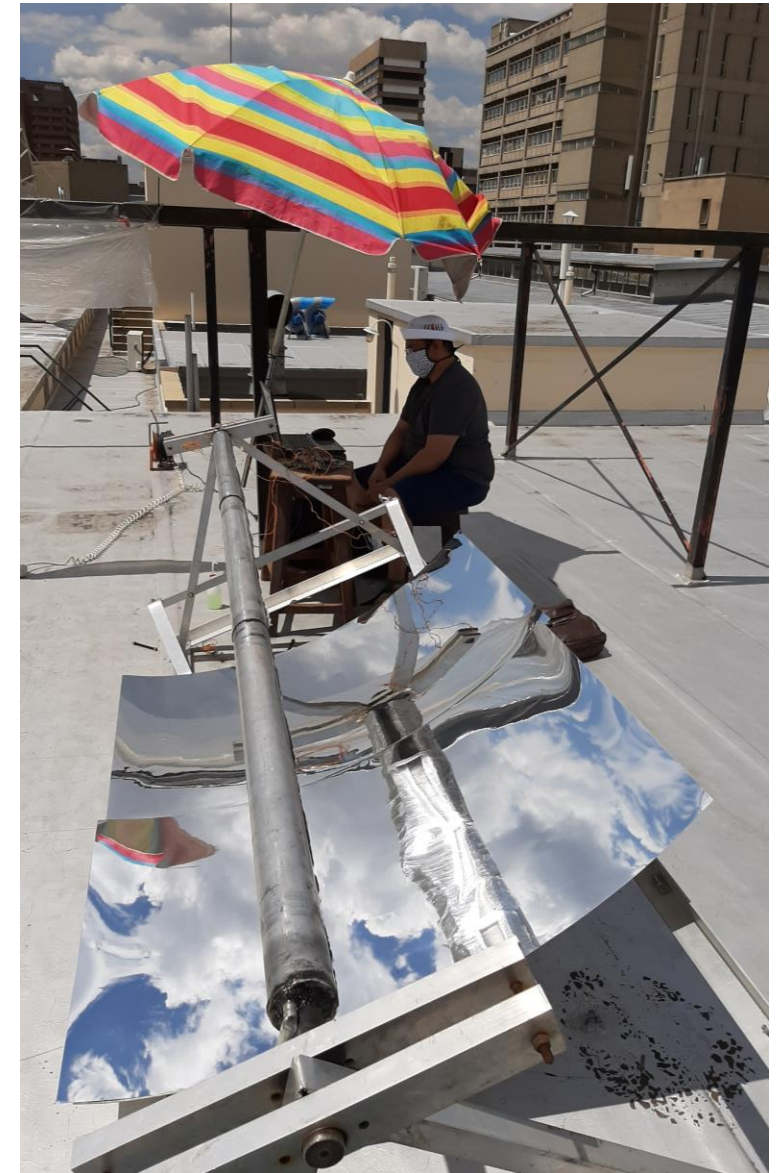
Why this project ?

- ✓ Reduction in thermal radiation losses which improves solar to electric conversion efficiency
- ✓ The use of more appropriate and robust materials which facilitate construction, maintenance and prolong lifetime.
- ✓ our aim is to test the economic viability of our innovation, with the hope of eventually providing licensing for our technology to power plants in order to deliver cheap and reliable electricity nationally
- ✓ Our approach differs in that we encase the receiver in a highly reflective metallic cavity, which traps the thermal radiation more effectively than other methods.
- ✓ We have simulated this approach with the result that we may reach higher efficiencies at higher temperatures than previously possible, while using less fragile, cheaper and durable materials.

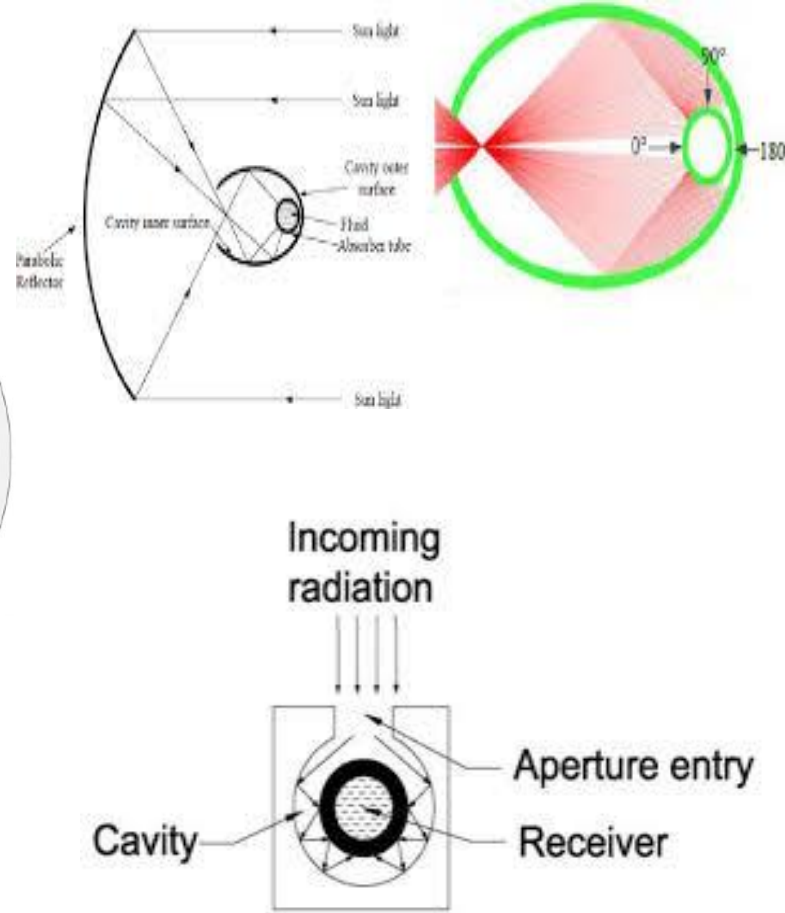
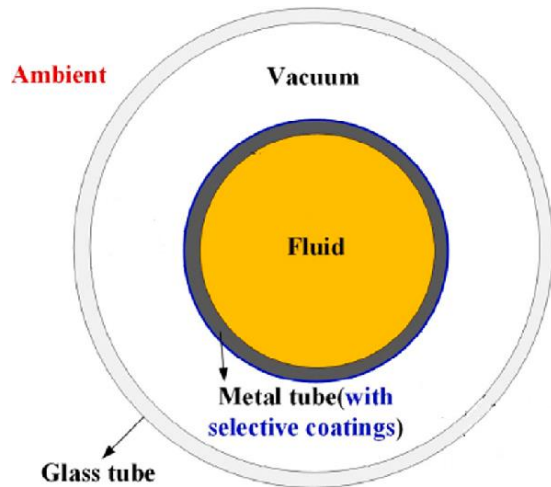


Solar concentrator on the Wits physics roof (Prototype)

A novel design for the receiver unit which aims to decrease the radiant energy losses while raising the temperature of the working fluid



A receiver Cavity

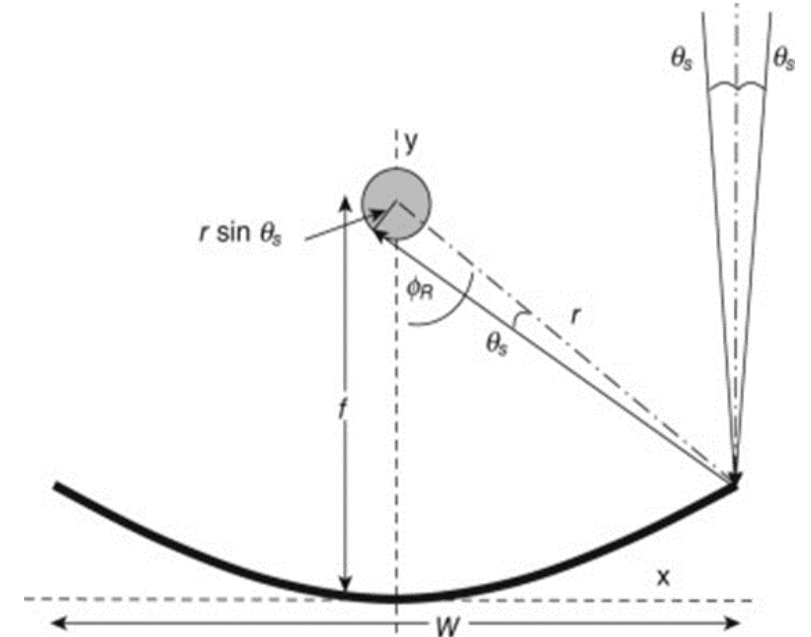
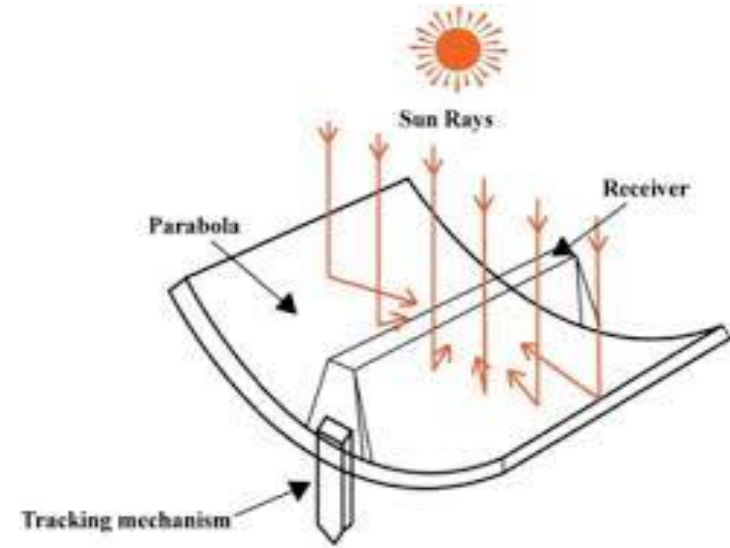


The evacuated receiver unit of the PTC is a system which has been used for decades, an alternative technique is being established nowadays that can overcome its shortages and compete in terms of efficiency, performance, and cost-effective. This is the cavity receiver system.

How does it work?

A PTC focuses the reflected solar rays from the parabolic reflector onto a target or cavity receiver (i.e., which contains the absorber tube) that is located at the focal line, resulting in very high local heat fluxes.

The reflected solar radiation is absorbed and converted to thermal energy and transferred to the heat transfer fluid (HTF) flowing in the absorber tube. The process of the photo-thermal conversion is complex, and the distribution of the solar energy flux on the absorber is the boundary condition for heat transfer calculation



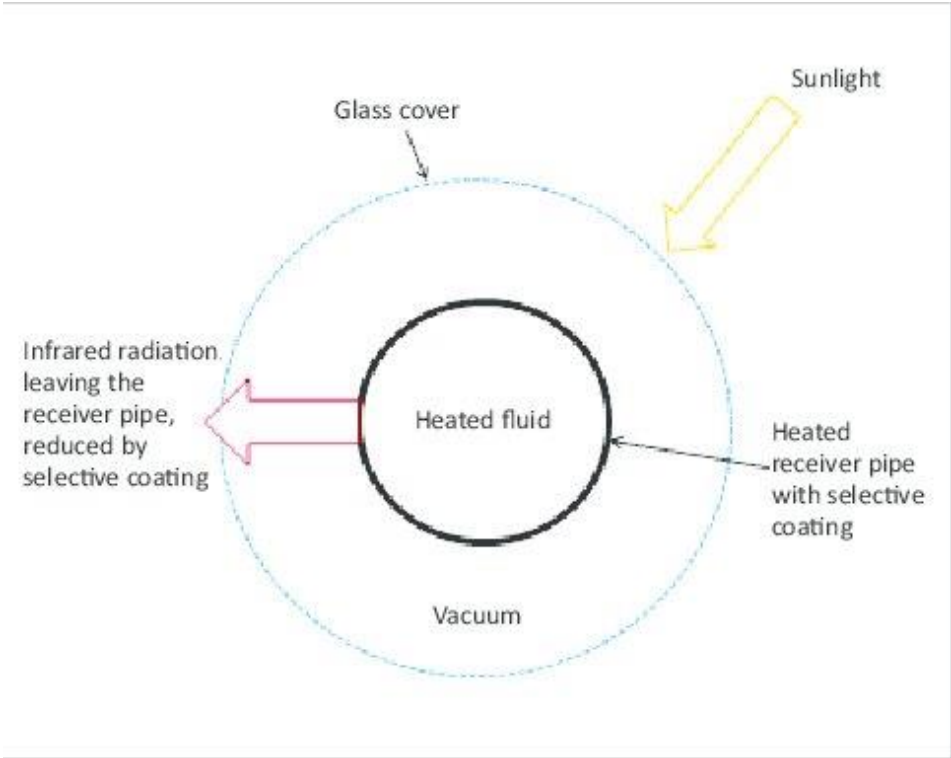
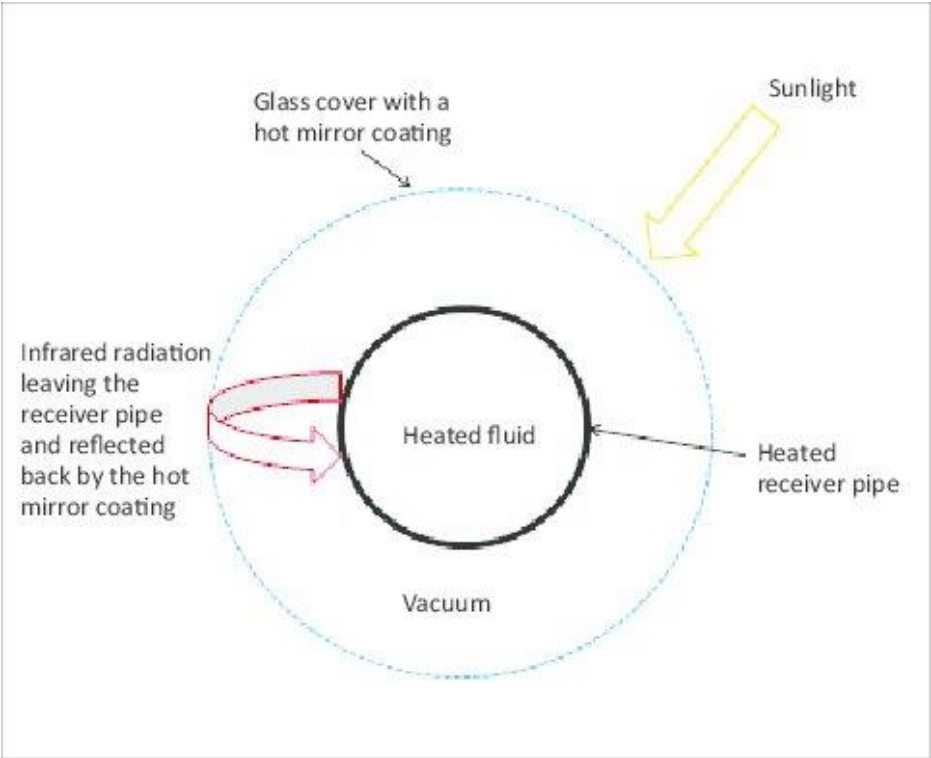
The performance of solar collector-receiver systems

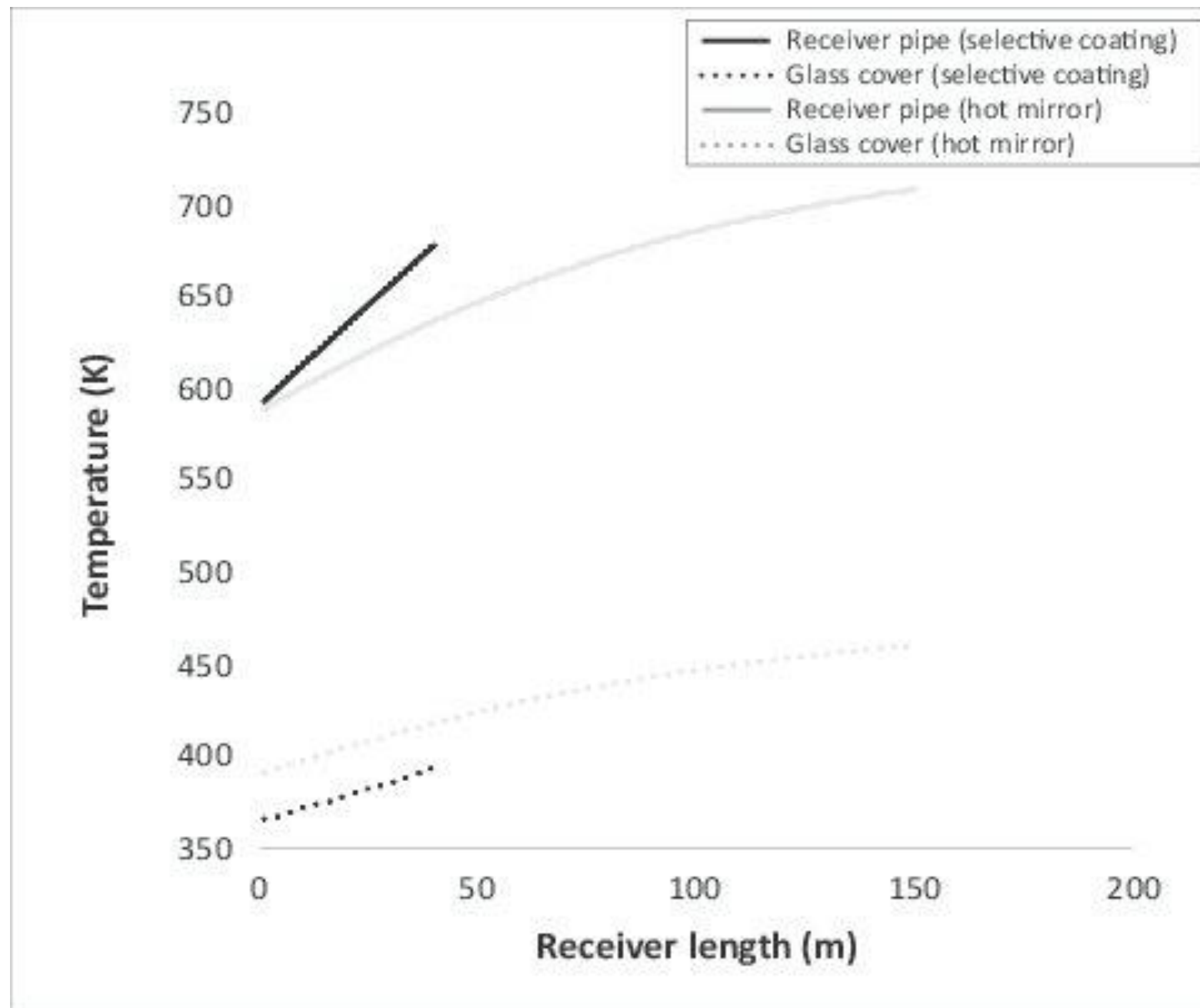
The performance of solar collector-receiver systems is evaluated by the concentration ratio, which is the ratio of the incident flux to the ambient solar flux. A high concentration ratio usually means that the concentrator can focus solar radiation efficiently.

Previous Findings

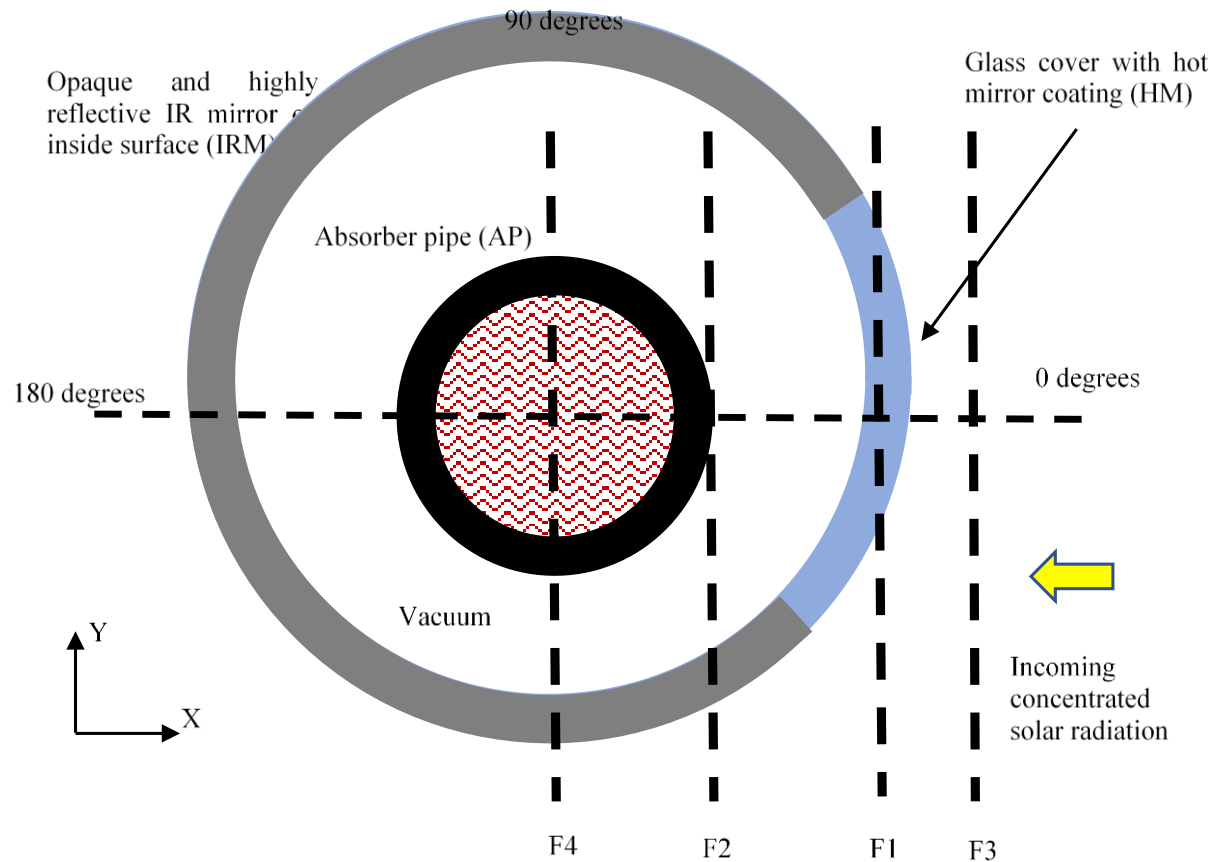
- ✓ The mathematical expressions of the heat transfer processes of the materials of the cavity mirror, hot mirror, and other potential materials, as well as the geometric parameters, were derived based on conservation of energy law (Part of My Msc, Vector thesis, and Khaled thesis Cyulinyana, M.C. and Ferrer, P., 2011, Mohamad, K. and Ferrer, P., 2019., Kaluba, V.S. and Ferrer, P., 2016)
- ✓ Analytical models have been developed using heat transfer principle and they have been compared to different alternative ways using simulations. The use of the hot mirror was shown most viable due to its ability to work at high temperature for thermal fluid. It is used as an alternative way to reduce heat losses in high temperature region.
- ✓ Previous study showed that the hot mirror receiver effectively reduced the IR losses at higher temperatures, reduced the thermal stress on the glass cover and suggested use in a hybrid system.

Receiver with selective coating and Hot Mirror





On going cases



A- Study the effect of the focal line at 4 different position at the receiver unit of PTC.

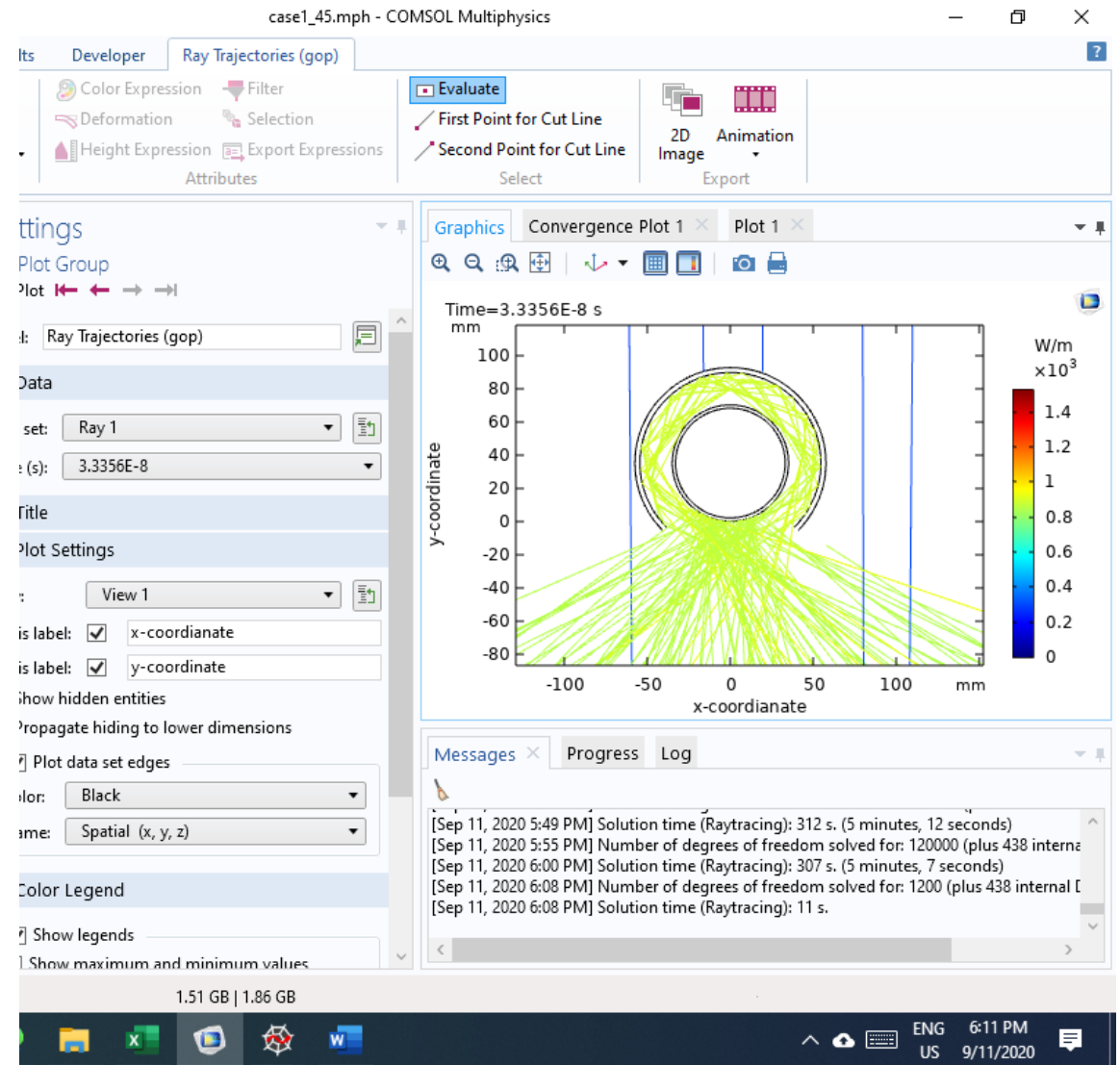
1. Adjusting the focal line to be on the center of the receiver unit
2. Adjusting the focal line to be on the absorber pipe of the receiver unit
3. Adjusting the focal line to be on the mid distance between the absorber and outer cover pipes of the receiver unit
4. Adjusting the focal line to be on the outer cover of the receiver unit

Ray tracing using COMSOL Multiphysics

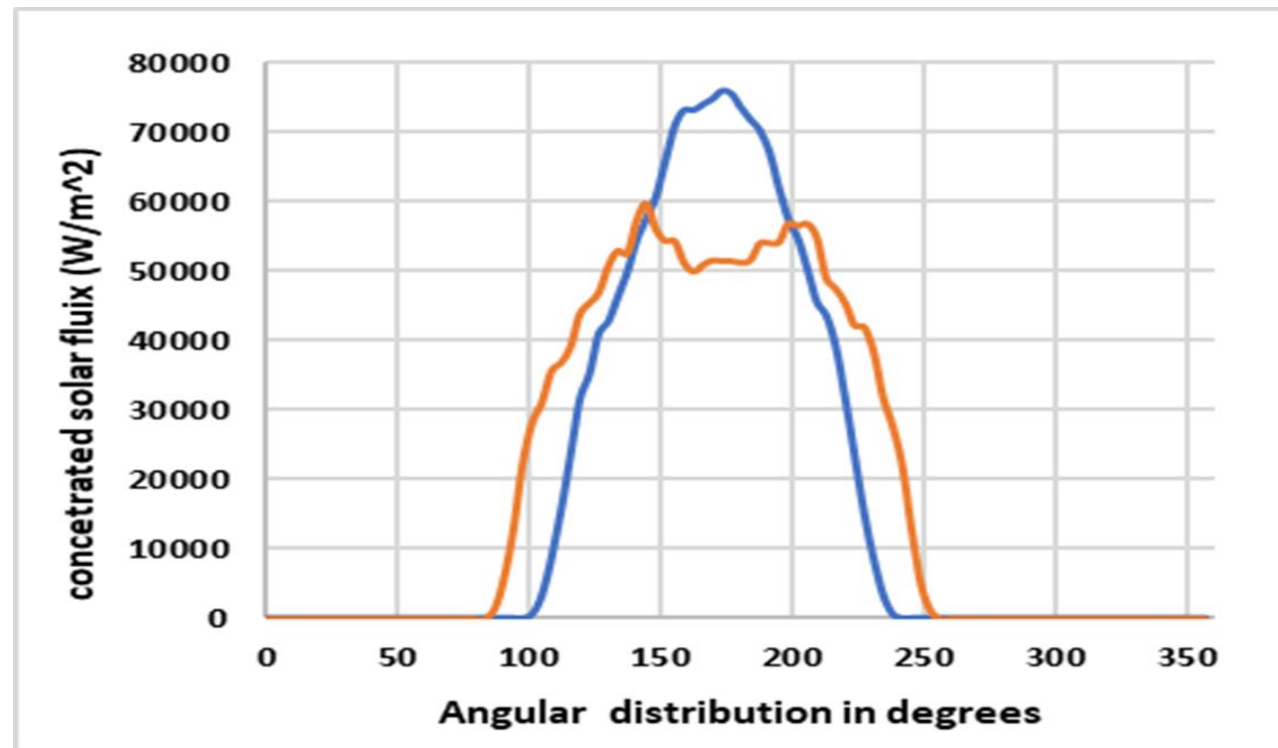
The ray tracing algorithm used to simulate the interaction of rays with surfaces uses the underlying finite element mesh (finite element method)

After tracing the rays, they are deposited on a given surface; here we are capable calculating the heat flux and deposited power the rays which can be used for the heat transfer model [32].

COMSOL software has a lot of features, and it is up to the user to defined what modules to use based on what she/he want to achieve. Each module has the build in equations as well.



Flux distribution at different rim angles (45 (blue) and 68 (red) degree)



What is next?

- ✓ Testing the solar trough collector (prototype) and initial data acquisition
- ✓ Calculation for thermal Efficiency: the variation of solar intensity with time. Variation of wind velocity with time, the variation of temperature difference between inlet and outlet temperature on daily basis.
- ✓ Optimization, further Data acquisition and evaluation

Acknowledgments

Prof. Philippe Ferrer

Dr. Khaled Mohamed

Prof. Hartmut Winkler

UJ Physics family

Wits and AIMS family

RAWISE members

Sources

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