

TEMBO Africa:

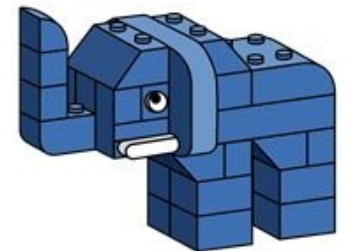
Seven sensors, five products, three services

Nick van de Giesen,

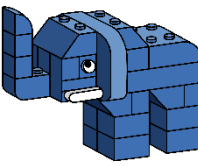
Hessel Winsemius, Frank Annor, Tomáš Fico, Eugenio Realini, Salvador Peña-Haro



TEMBO Africa: The work leading to these results has received funding from the European Horizon Europe Programme (2021-2027) under grant agreement n° 101086209. The opinions expressed in the document are of the authors only and no way reflect the European Commission's opinions. The European Union is not liable for any use that may be made of the information.



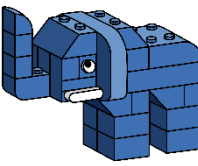
TEMBO Africa: Partners



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TEMBO Africa: Approach



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COMMENT | 14 August 2023

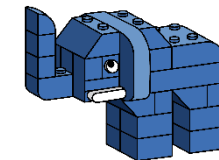
How to reduce Africa's undue exposure to climate risks

Africa is disproportionately exposed to catastrophic climate, hydrological and meteorological risks. Well-funded weather monitoring, nowcasting and early-warning systems must become a priority.

[Asaf Tzachor](#) , [Catherine E. Richards](#) , [Masilin Gudoshava](#), [Patricia Nying'uro](#), [Herbert Misiani](#), [Jemimah G. Ongoma](#), [Yoav Yair](#), [Yacob Mulugetta](#) & [Amadou T. Gaye](#)



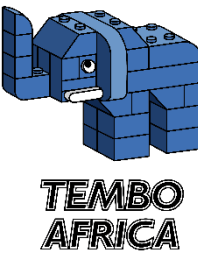
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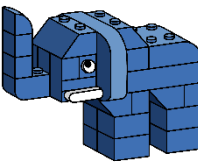
TEMBO Africa: Approach



1. Reduce costs ($<10\%$) \Rightarrow sensors / HR
2. Earn money \Rightarrow services
3. (Free products)



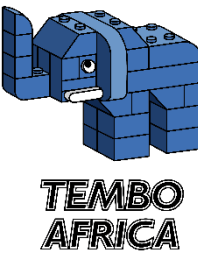
TEMBO Africa: Seven sensors



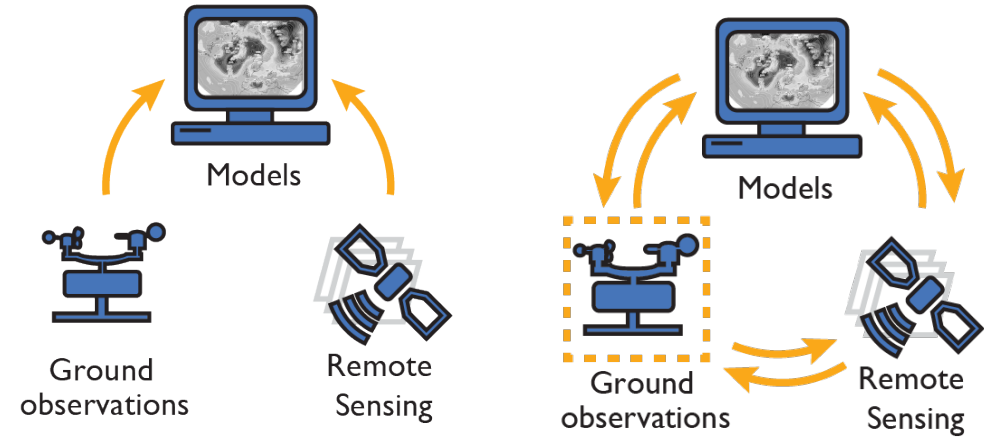
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Atmosphere	1.1 Commercial Microwave Links for rainfall estimates (WP5, ≥ 1 contract)
	1.2 X-Band radar for spatial rainfall estimates (WP5, ≥ 1 station)
	1.3 Intervalometers for rainfall detection and typification (WP5, ≥ 50)
Land Surface	1.4 Cost-effective neutron counters for large scale soil moisture (BLOSM) (WP6, 20 operational)
	1.5 Low cost GPS/GNSS receivers for mapping and multiple additional applications (WP7, 10 operational)
Open Water	1.6 Camera-based river discharge measurements (WP7, 10 operational)
	1.7 UAVs, fish-finders, and GNSS (WP3, 7, ≥ 10 water management systems)

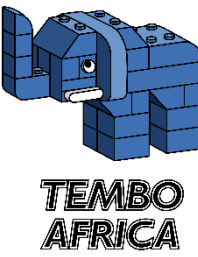
TEMBO Africa: Five products



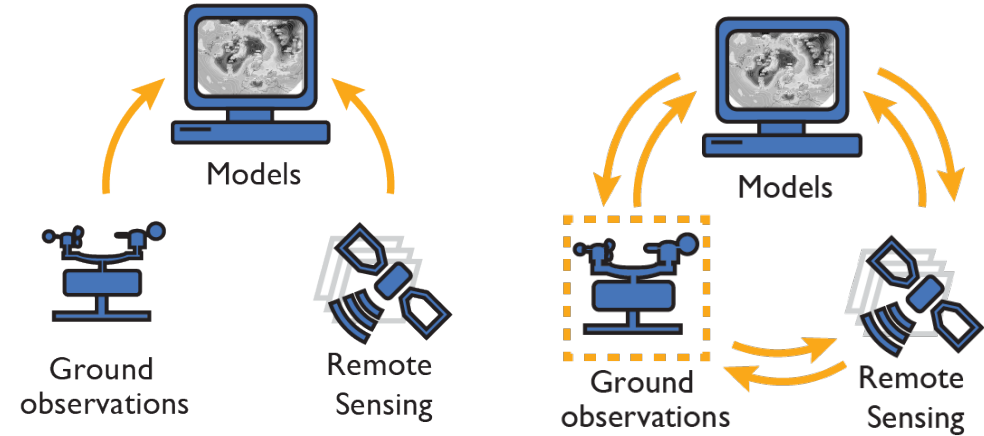
1. Rainfall Maps
2. Soil Moisture Maps
3. Open Water
4. River discharge
5. Floodplain Mapping & Bathymetry



TEMBO Africa: Five products

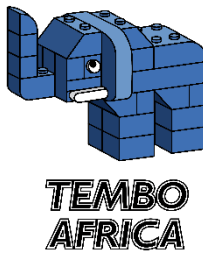


1. Rainfall Maps
2. Soil Moisture Maps
3. Open Water
4. River discharge
5. Floodplain Mapping & Bathymetry



GEOSS

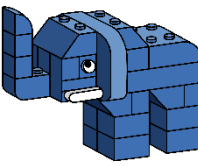
TEMBO Africa: Three Services



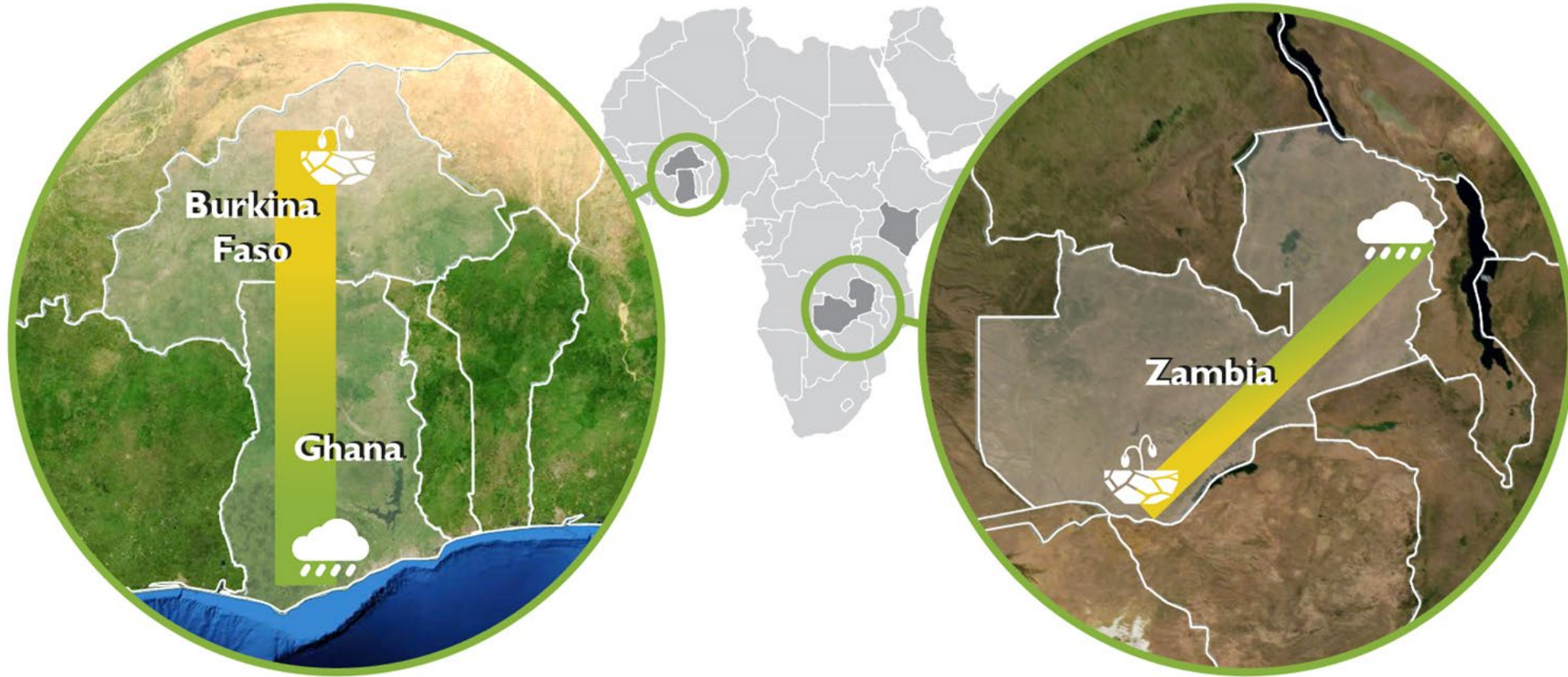
1. Flood Early Warning Systems
2. Reservoir Management
3. Agriculture Insurance



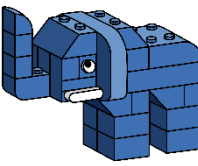
TEMBO Africa: Transects



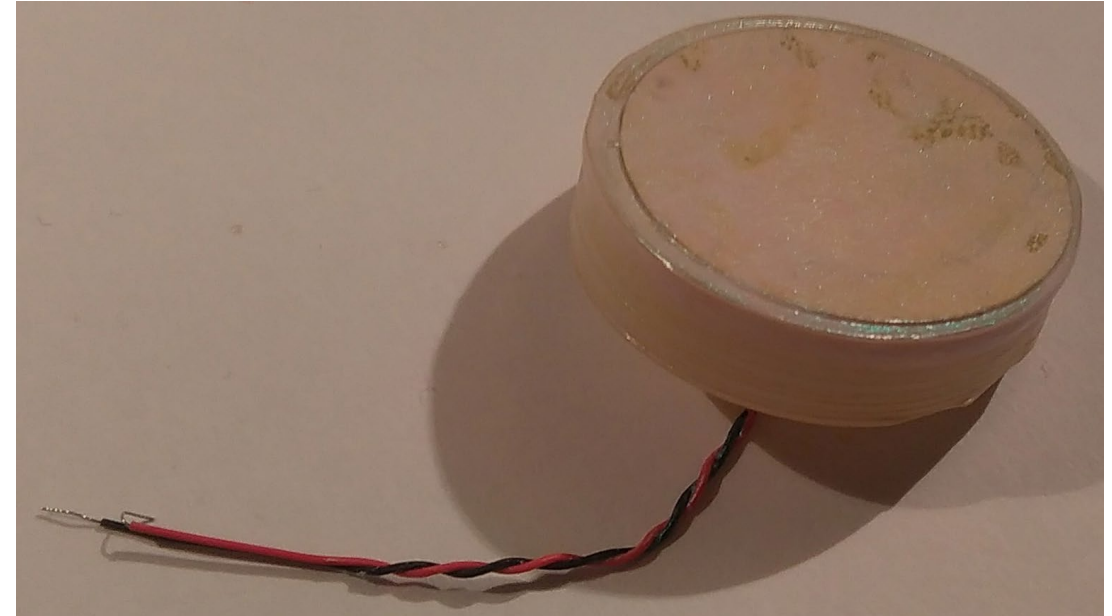
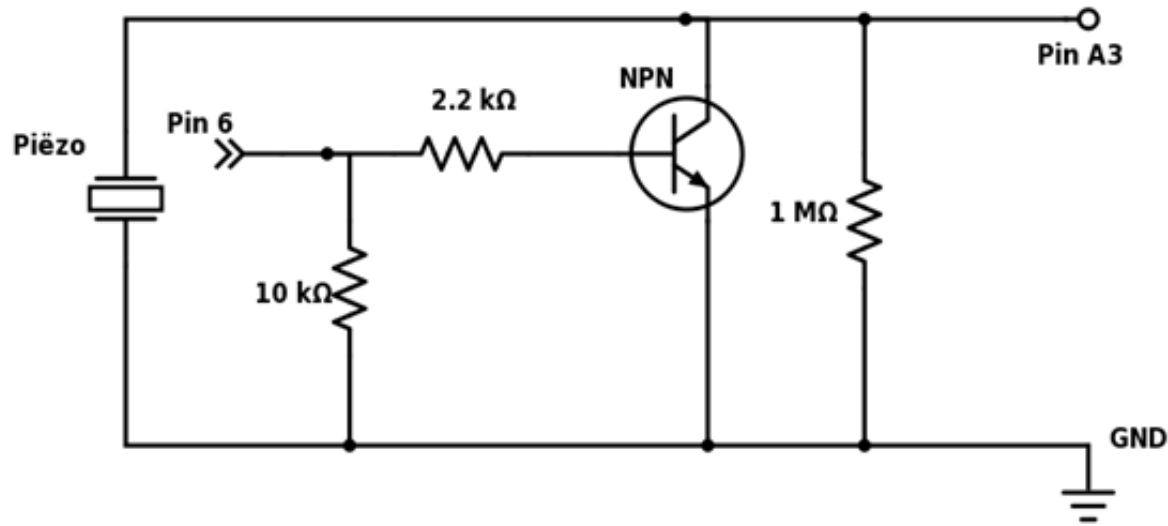
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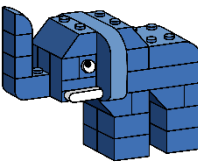
TEMBO Africa: Intervalometer



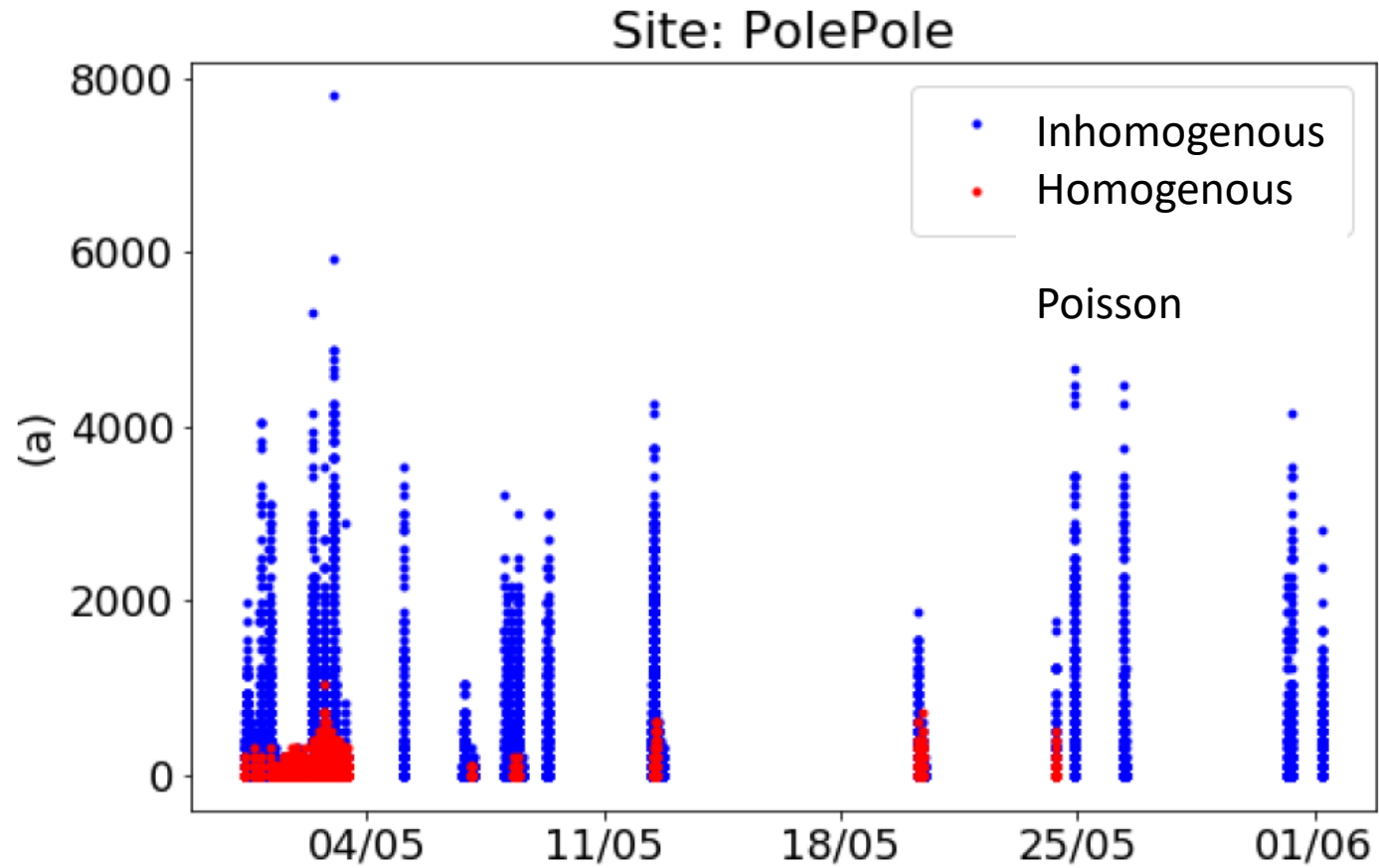
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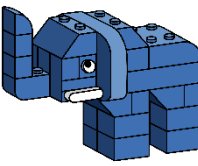
TEMBO Africa: Intervalometer



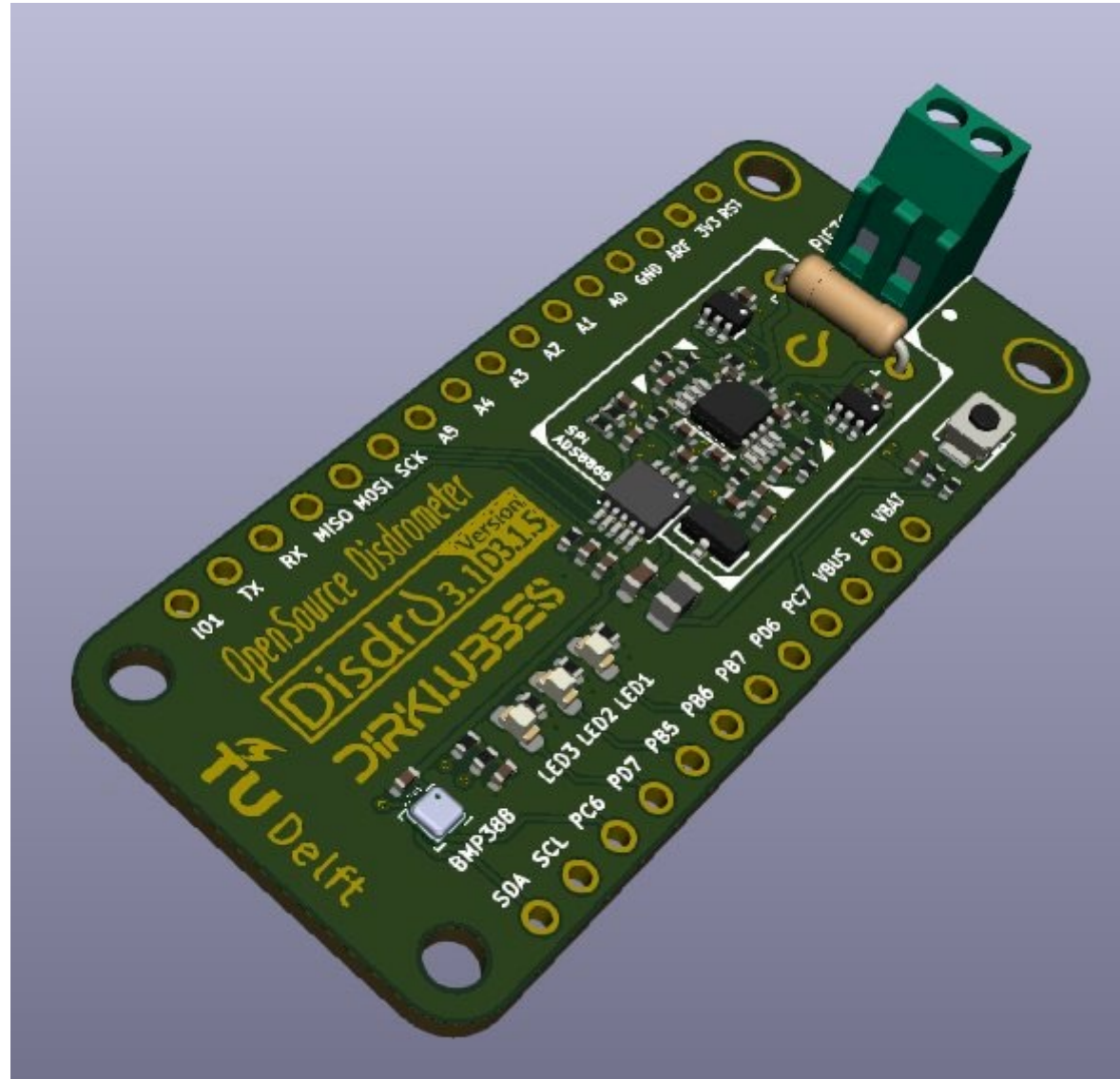
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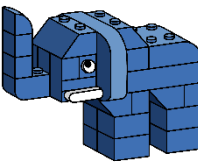
TEMBO Africa: Intervalometer



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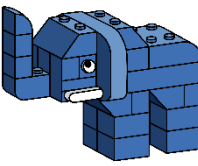
TEMBO Africa: Intervalometer



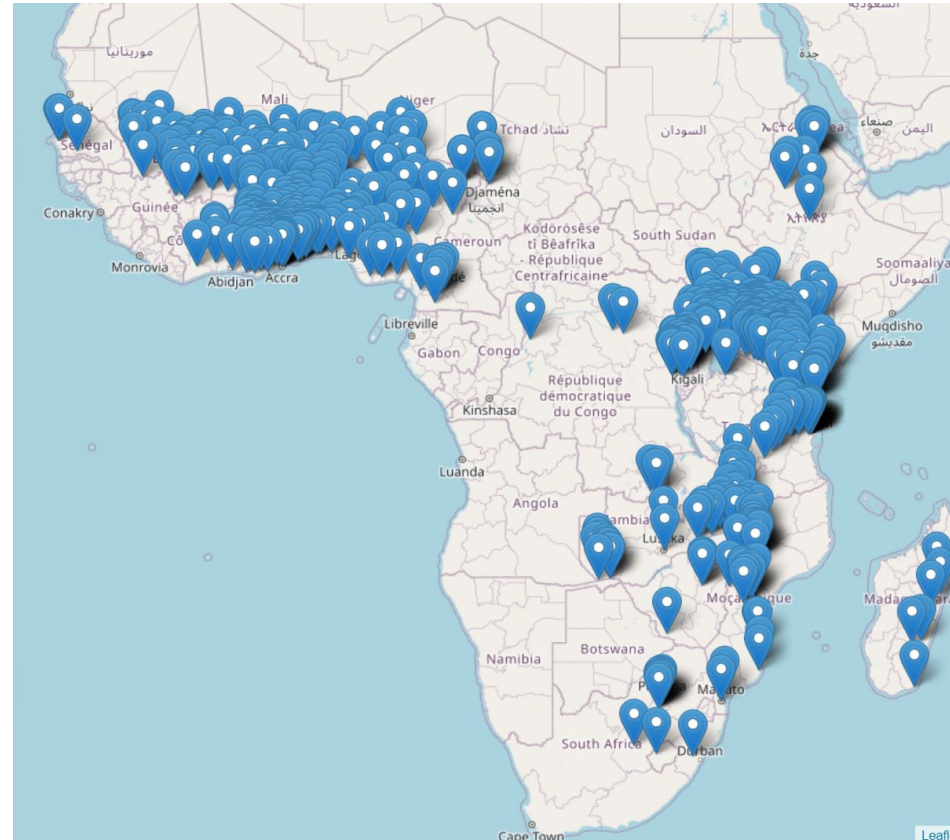
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TEMBO Africa: Intervalometer

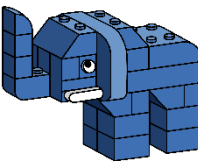


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TAHMO Network 600+ stations

TEMBO Africa: BLOSM



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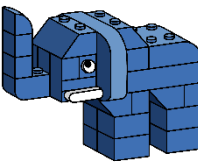
Soil moisture

Edward van Amelrooij



Cosmic rays

TEMBO Africa: BLOSM



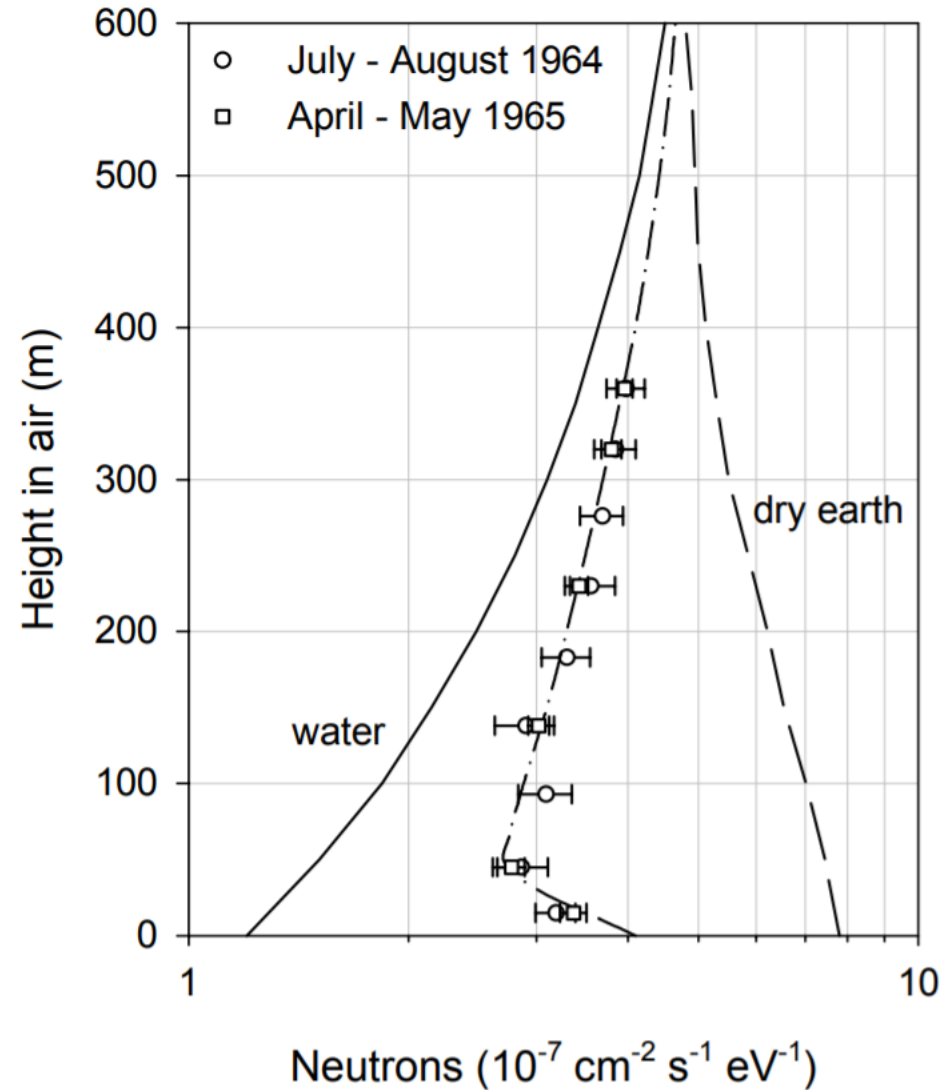
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Cosmic rays

Neutrons:

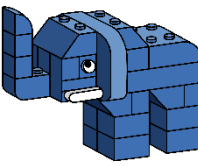
Fast (20,000 km/s)

Thermal (200 km/s)



Hendrick and Edge (1966)

TEMBO Africa: BLOSM



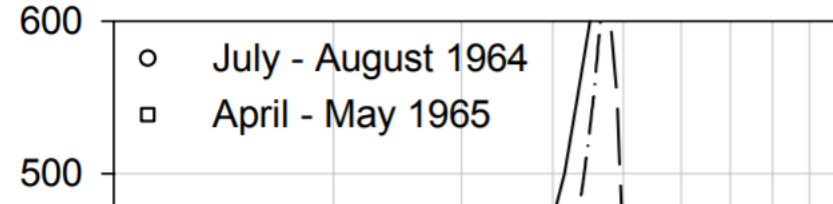
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Cosmic rays

Neutrons:

Fast (20,000 k

Thermal (200



Hendrick and Edge (1966)

Neutrons ($10^{-7} \text{ cm}^{-2} \text{ s}^{-1} \text{ eV}^{-1}$)

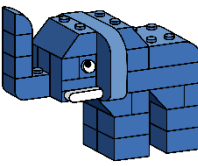
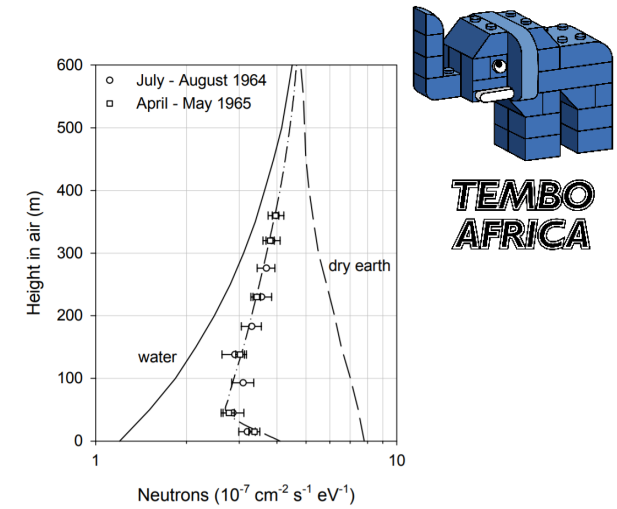
TEMBO Africa: BLOSM

Soil moisture

Cosmic rays:

Large radius (300m)

$$\frac{n_{fast}}{n_{thermal}} \propto \theta$$



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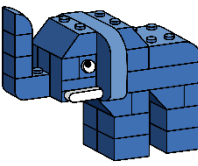
TEMBO Africa: BLOSM

Soil moisture



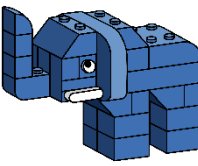
COSMOS (r=300m): ^3He

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TEMBO Africa: BLOSM



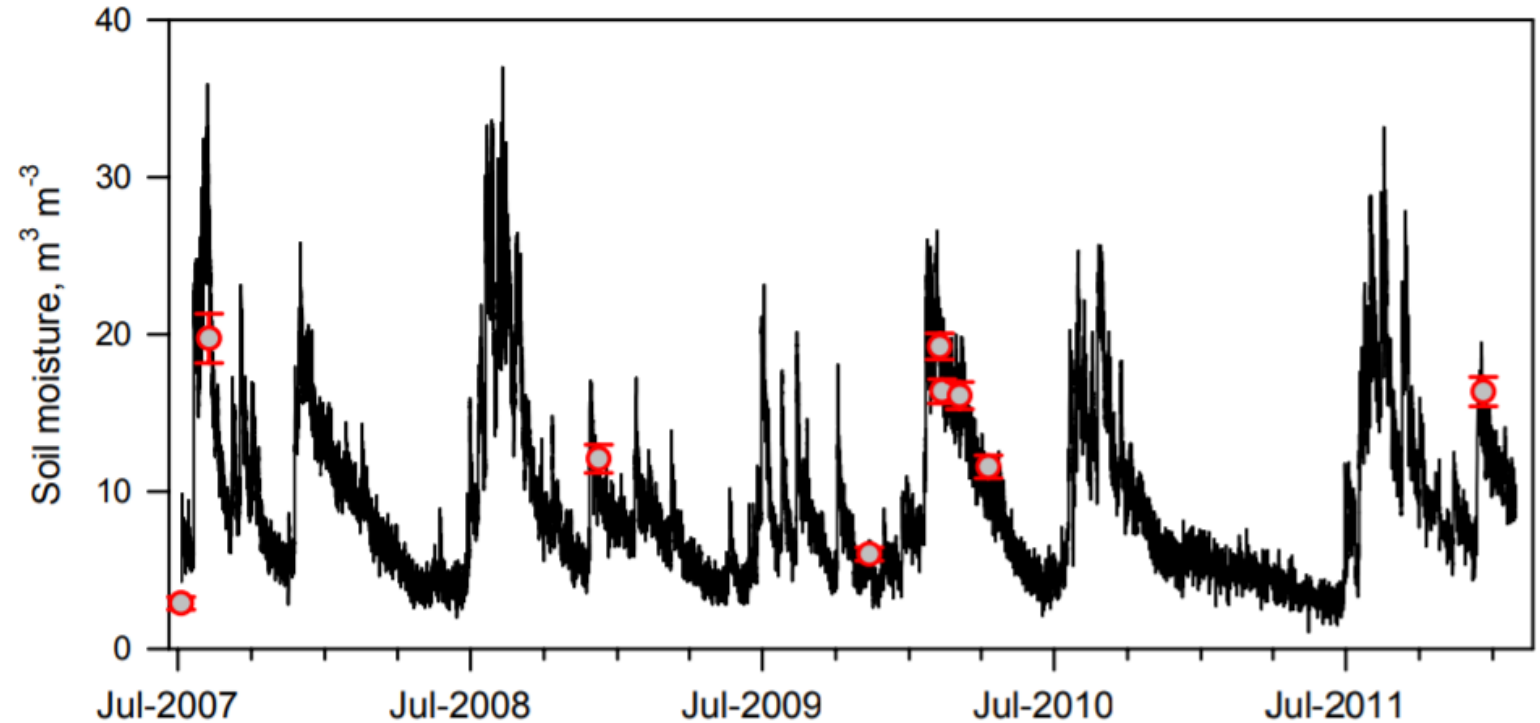
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Soil moisture

Cosmic rays:

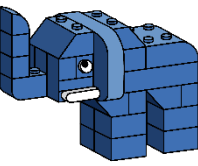
Fast (20,000 km/s)

Thermal (200 km/s)



Zreda et al. (HESS, 2012)

TEMBO Africa: BLOSM

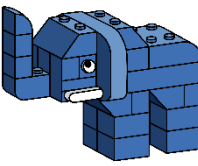


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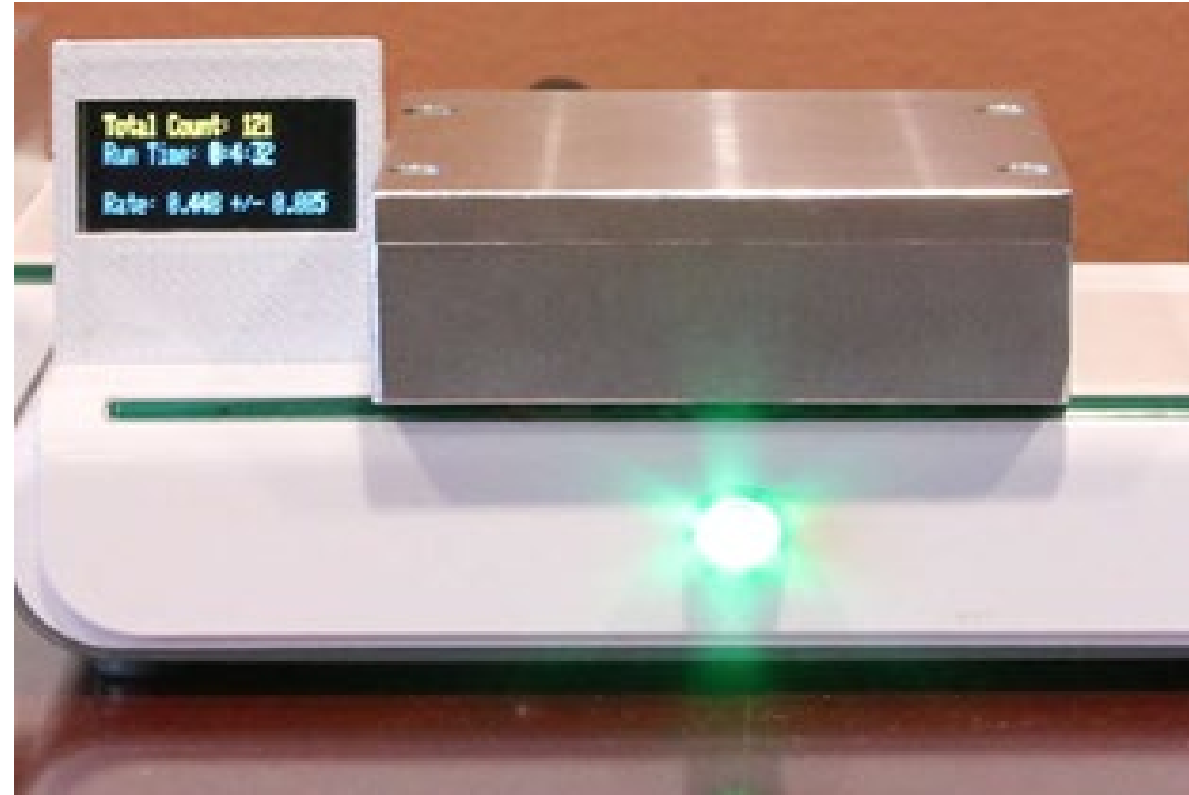
^3He



TEMBO Africa: BLOSM

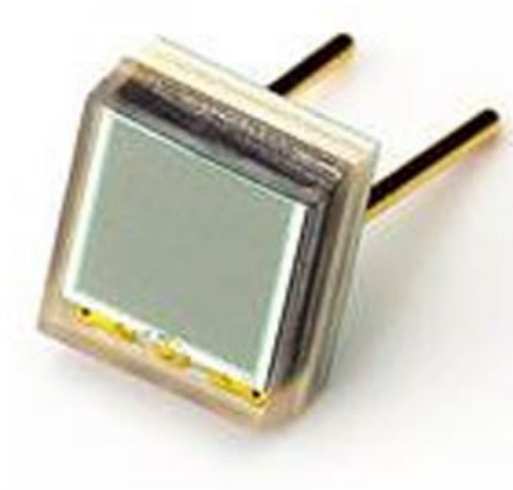
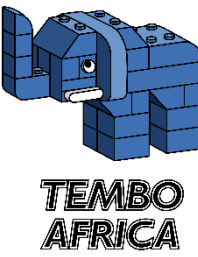


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\$100 muon detector (Spencer Axani, MIT)

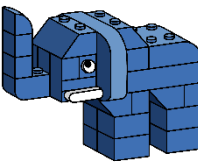
TEMBO Africa: BLOSM



Silicon Photon Multiplier (SiPM)

\$100 muon detector (Spencer Axani, MIT)

TEMBO Africa: BLOSM



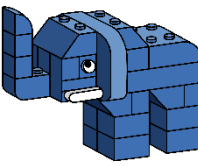
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Boron: 20% ^{10}B !!!

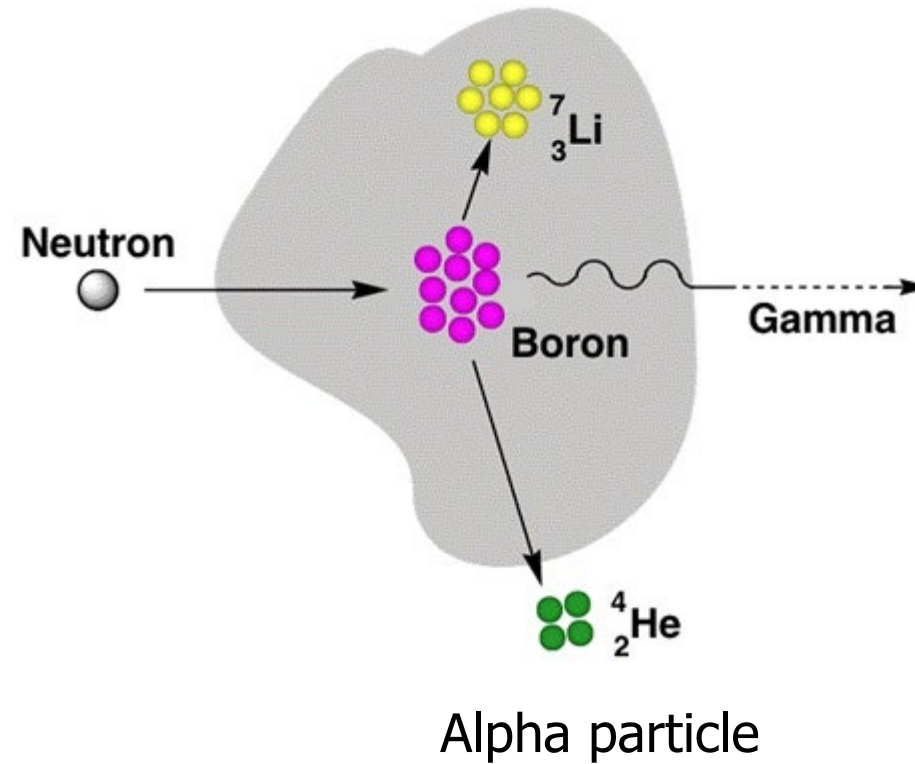
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TEMBO Africa: BLOSM

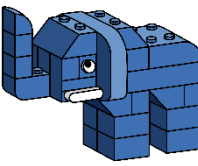


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BN

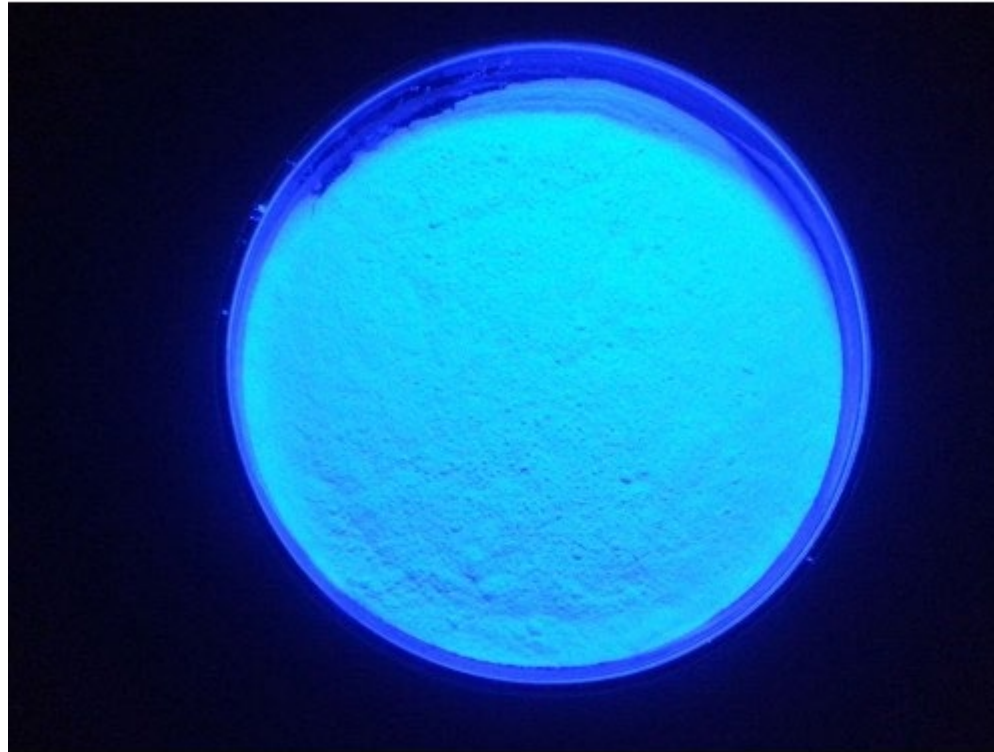


TEMBO Africa: BLOSM



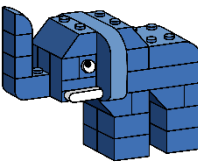
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ZnS(Ag)



Fluoresces

TEMBO Africa: BLOSM



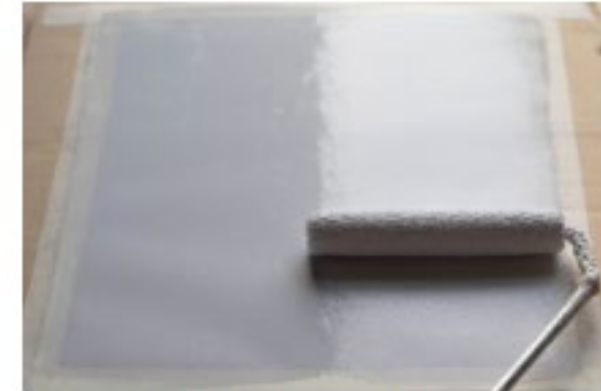
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(a) An example of a small Mylar strip to be painted



(b) Application of the first layer



(c) Adding new layers



(d) Application of the first layer of PVA



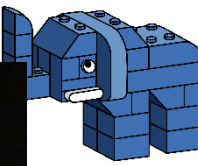
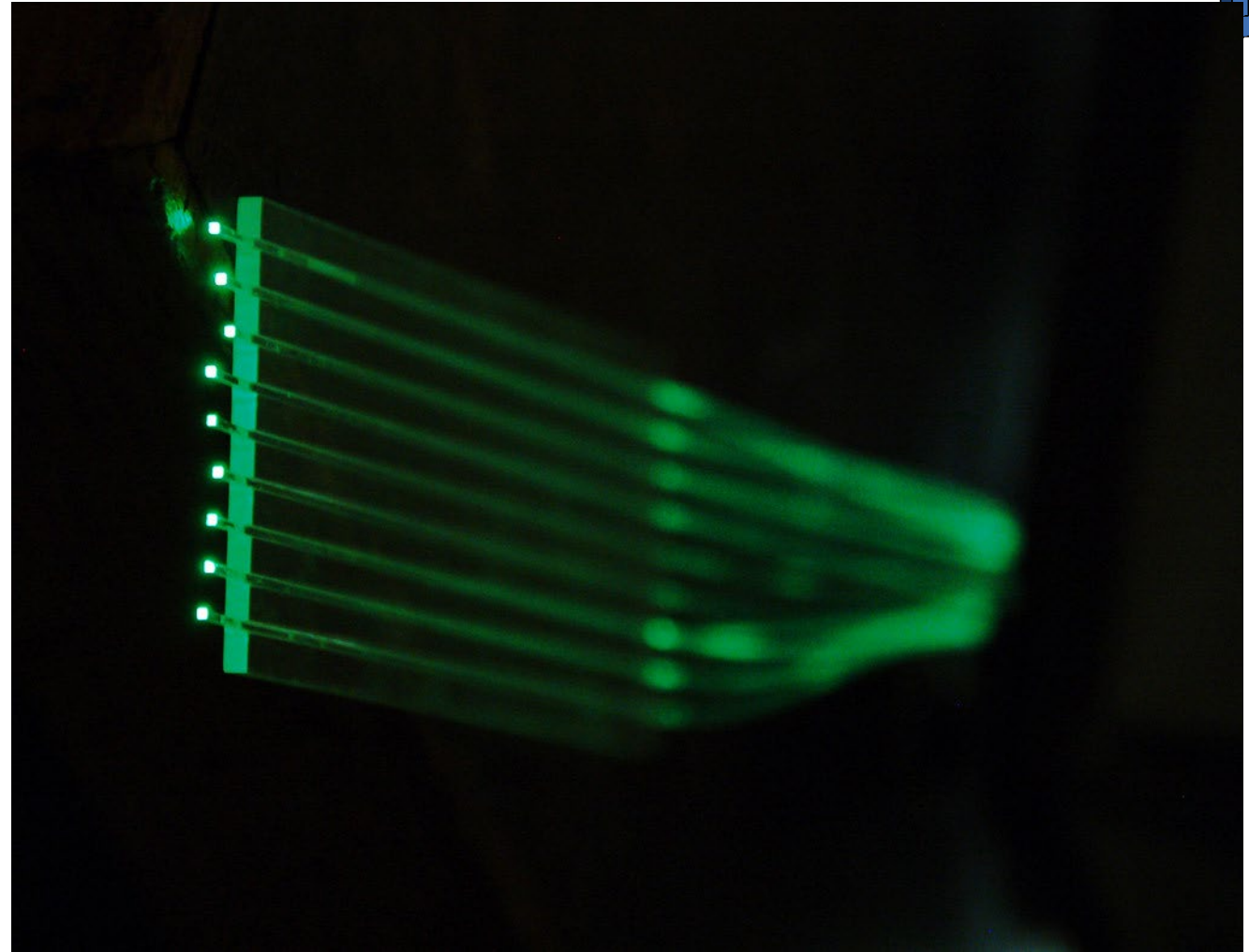
(e) Surface texture of final result



(f) Ribbon can be coiled without cracking the paint

TEMBO Africa: BLOSM

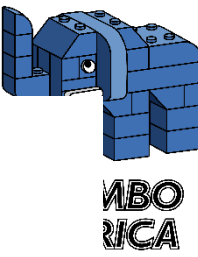
Wavelength Shifting Fibers



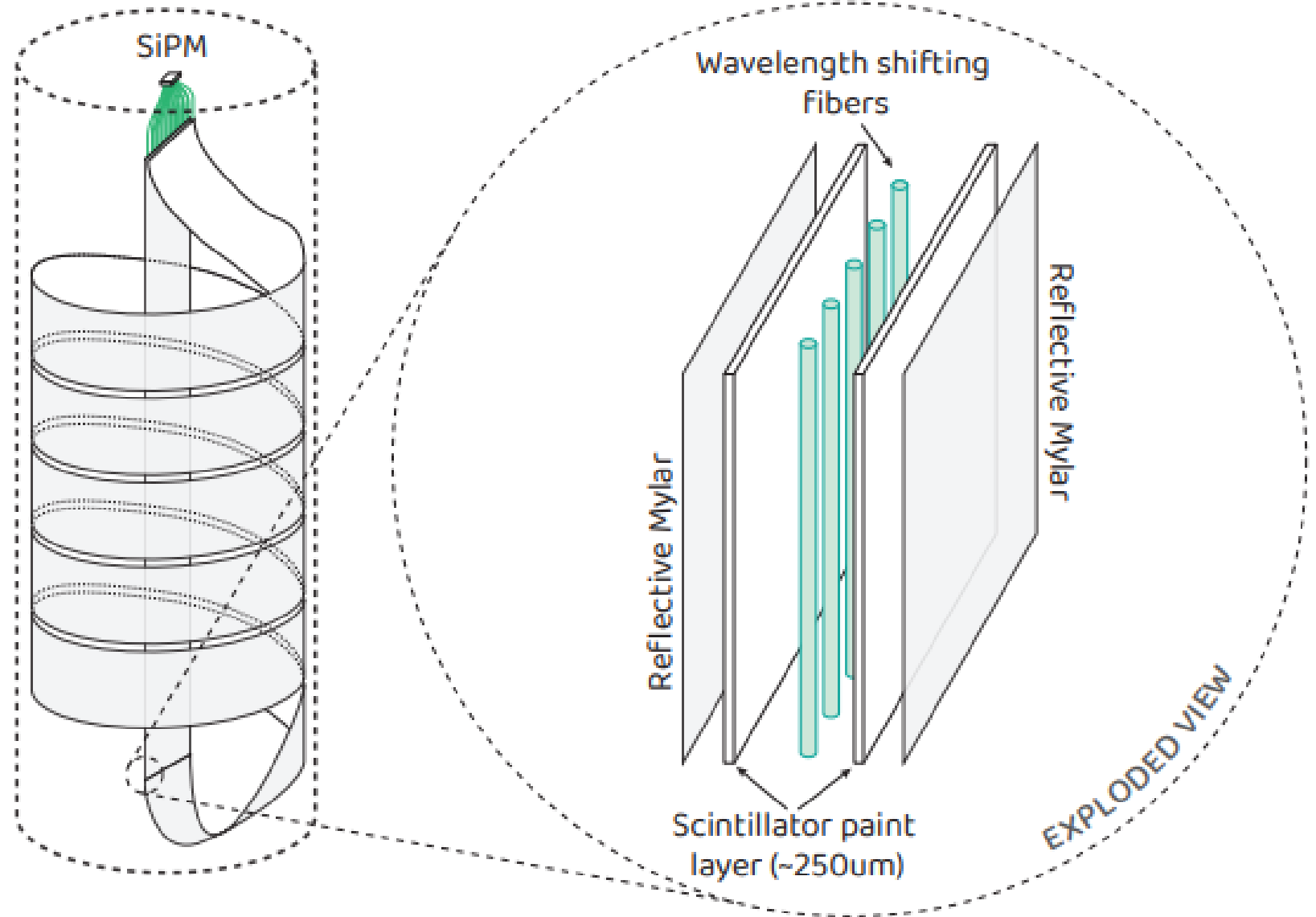
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Kuraray

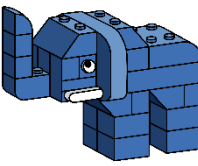
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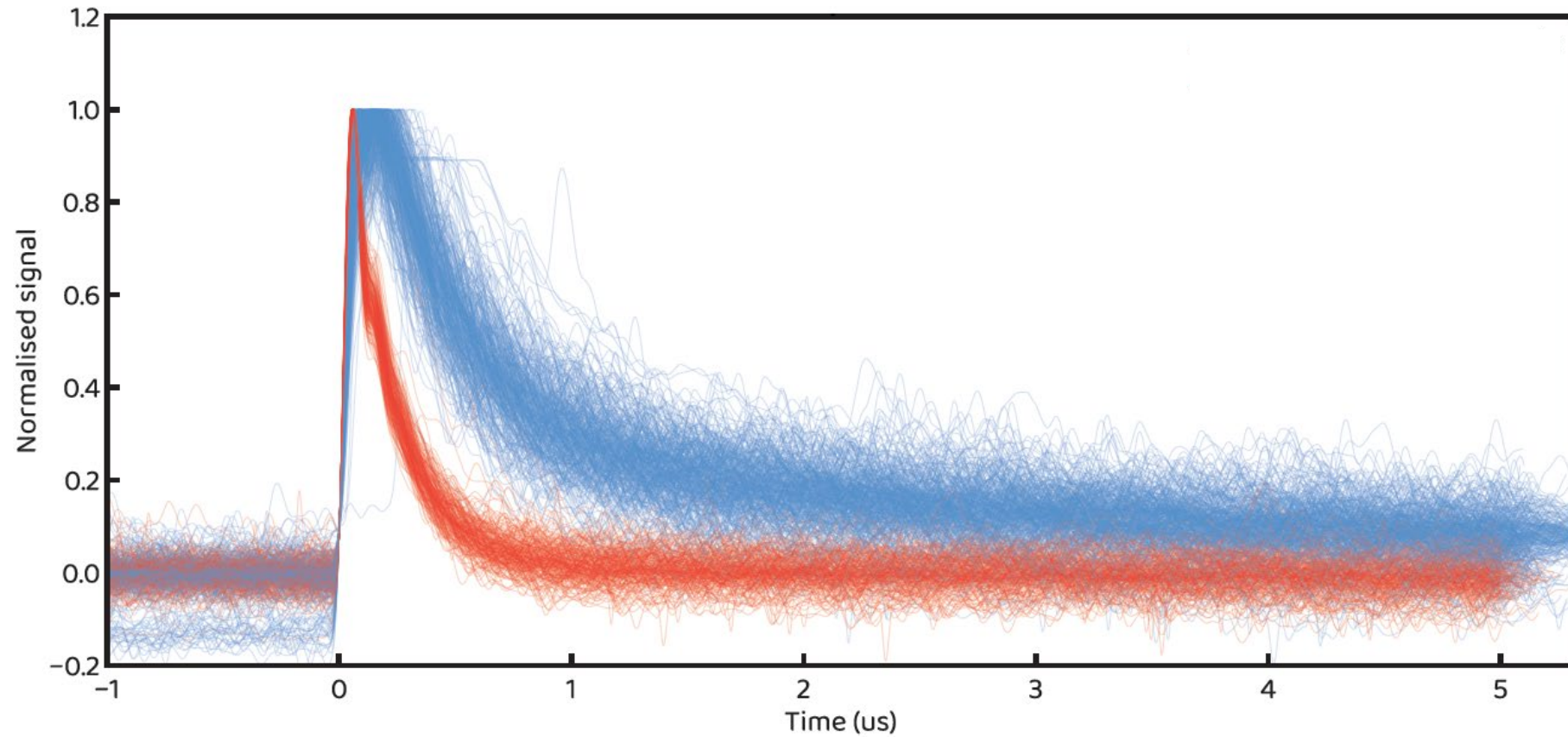
Sandwich



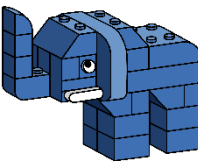
TEMBO Africa: BLOSM



First results

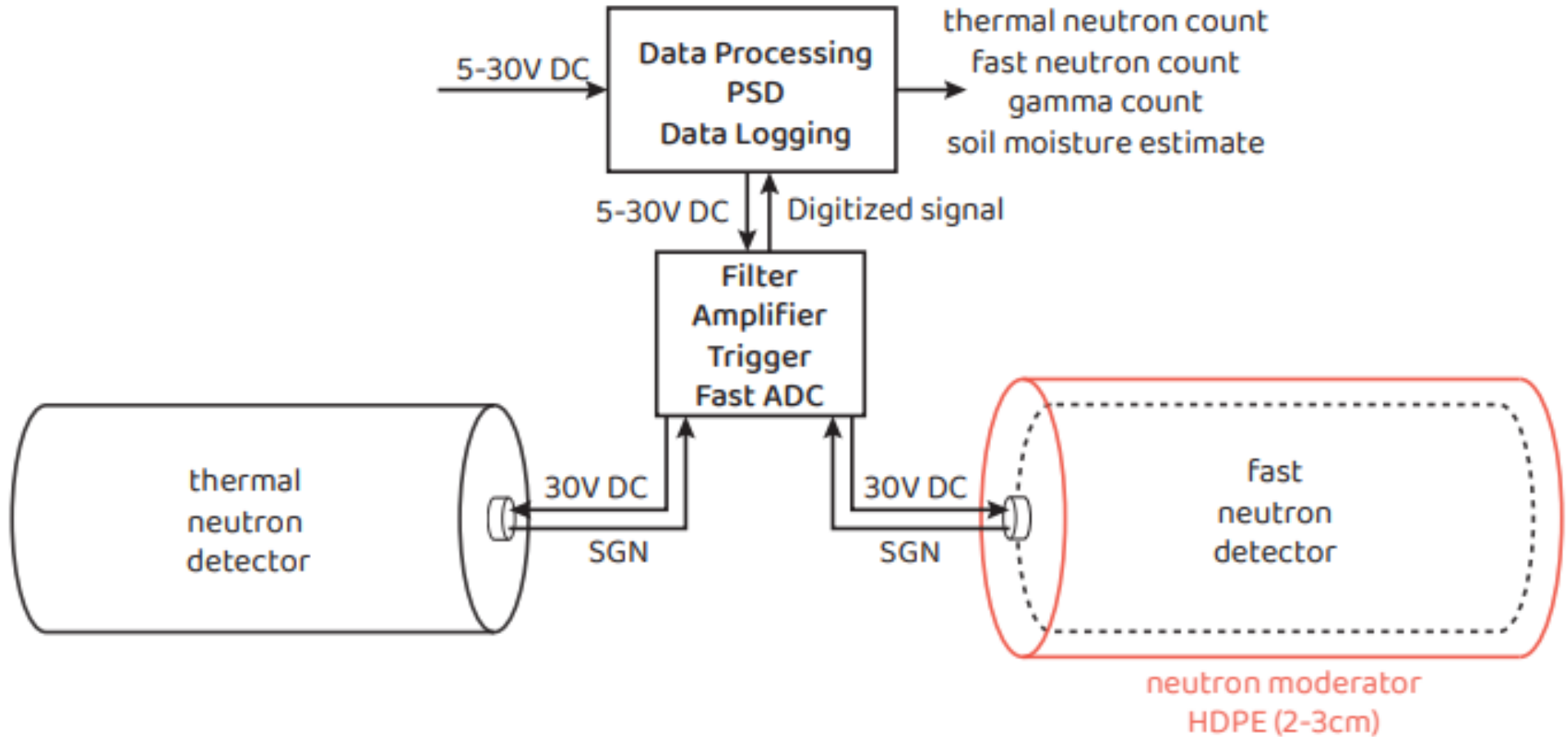


TEMBO Africa: BLOSM

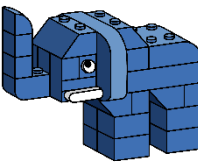


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System

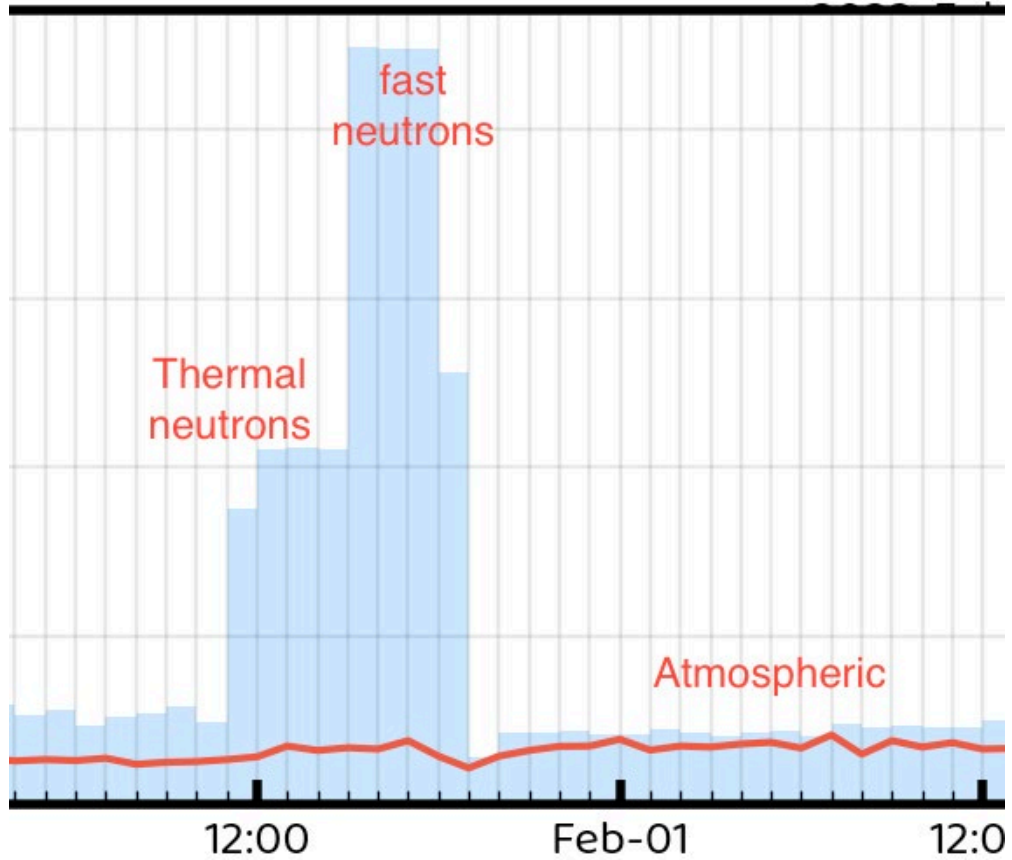


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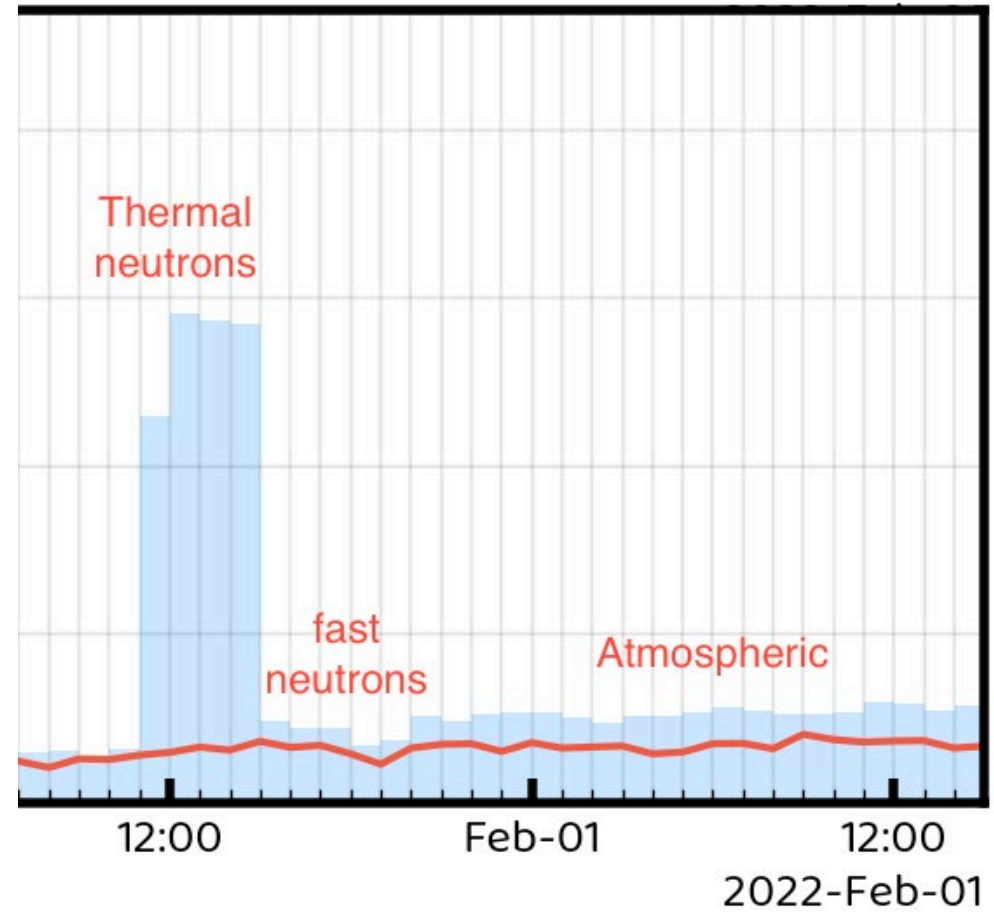


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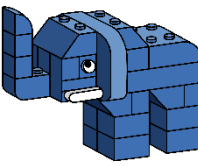
Moderated



Bare



TEMBO Africa: BLOSM

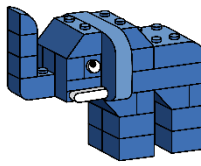


Soil moisture

Field



TEMBO Africa: GPS/GNSS



TWIGA



High precision positioning system for Ghana

Master thesis of Peter Verweij

Student: P.J. Verweij
Client: Prof. dr. ir. N.C. van de Giesen & A. Kriemeyer, MSc.
Chair: Dr. ir. J.C. Diehl
Mentor: Ir. S.M. Persaud

Date: 21 August 2020



remote sensing

Article

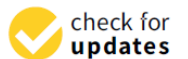
High Quality Zenith Tropospheric Delay Estimation Using a Low-Cost Dual-Frequency Receiver and Relative Antenna Calibration

Andreas Kriemeyer ^{*}, Hans van der Marel , Nick van de Giesen and Marie-Claire ten Veldhuis

Faculty of Civil Engineering, Delft University of Technology, 2628CN Delft, The Netherlands;
H.vanderMarel@tudelft.nl (H.v.d.M.); N.C.vandeGiesen@tudelft.nl (N.v.d.G.);
j.a.e.tenveldhuis@tudelft.nl (M.-C.t.V.)

* Correspondence: A.Kriemeyer@tudelft.nl

Received: 4 April 2020; Accepted: 25 April 2020; Published: 28 April 2020



PPP & Atmospheric moisture



23. November 2022

Low-cost sensor records the level of rivers

Measurement method developed at the University of Bonn could be suitable for flood warning systems

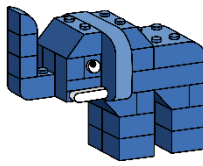
Researchers at the University of Bonn have developed a method that allows the water level of rivers to be monitored around the clock. The cost-effective sensor is for instance suitable for area-wide flood warning systems. The study has been published in the journal Water Resources Research.



TEMBO Africa: Cameras

Large Scale Particle Image Velocimetry

<https://openrivercam.readthedocs.io/>





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AFRICA**

Change video

Video object (584)

Video details

Site name:	Hommerich
File:	videos/1/20230922/20230922T064601.mkv
Camera config:	foscam at Hommerich
Timestamp:	Date: <input type="text" value="2023-09-22"/> Today  Time: <input type="text" value="06:46:01"/> Now  <small>Note: You are 2 hours ahead of server time.</small>

Data and time on which video was taken. If not provided by the user, this is taken from the file's time stamp

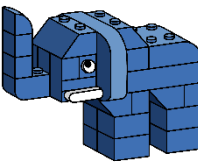
Results:



Video preview:



TEMBO Africa: Cameras



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Challenge:

Large rivers

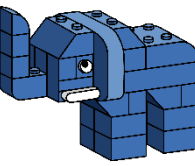
Natural floodplains (kms)



TEMBO Africa: Riverflow



1. Measure bathymetry (fish finder + GNSS)
2. Measure floodplain topography (UAV + GNSS + SRTM)
3. Measure level (GNSS and/or camera)
4. Measure speed at surface (camera)
5. Integrate along profile => Q
6. Repeat => $Q(h)$
7. Assimilate => error / change bathymetry



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Nick van de Giesen

n.c.vandegiesen@tudelft.nl

