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LPSC Grenoble and Stellenbosch University, ZA

[GDR Deep Underground Physics plenary meeting](#)
9–11 Oct 2024 , IP2I Lyon

From SAUL to PAUL



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Towards the South African Underground Laboratory (SAUL) ☆

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June 2023 : <https://arxiv.org/abs/2306.12083>

Cornell University We gratefully acknowledge member i
arXiv > hep-ex > arXiv:2306.12083 Search... Help | Advance

High Energy Physics – Experiment

[Submitted on 21 Jun 2023]

Paarl Africa Underground Laboratory (PAUL)

Robert Adam (5 and 1), Claire Antel (14), Munirat Bashir (23), Driss Bencheikroun (18), Xavier Bertou (20), Markus Böttcher (8), Andy Buffler (7), Andrew Chen (4), Rouven Essig (22), Jules Gascon (12), Mohamed Gouighri (19), Trevor Hass (1), Gregory Hillhouse (6), Abdeslam Hoummada (18), Anslyn John (1), Pete Jones (3), Youssef Khoulaki (18), Luca Lavina (13), Lerothodi Leeuw (2), Mantile Lekala (9), Robert Lindsay (2), Roy Maartens (2), Yin-Zhe Ma (1), Fairouz Malek (11), Peane Maleka (3), Jacques Marteau (12), Rachid Mazini (21), Thebe Medupe (8), Bruce Mellado Garcia (4), Marcello Messina (15), Lumkile Msebi (2), Chilufya Mwewa (26), Zina Ndabeni (3 and 7), Richard Newman (1), George O'Neill (16), Fabrice Piquemal (10), Lydia Roos (13), Daniel Santos (11), Silvia Scorza (11), Fedor Simkovic (24), Ivan Stekl (25), Yahya Tayalati (17), Smarajit Triambak (2), Zebulon Vilakazi (4), Shaun Wyngaardt (1), JJ van Zyl (1) ((1) Stellenbosch University–South Africa, (2) University of the Western Cape–South Africa, (3) iThemba LABS–South Africa, (4) University of the Witwatersrand Johannesburg–South Africa, (5) Square Kilometre Array Observatory–South Africa, (6) Botswana International University of Science and Technology–Botswana, (7) University of Cape Town–South Africa, (8) North West University Potchefstroom–South Africa, (9) The University of South Africa, (10) LP21, CNRS–IN2P3, Université Bordeaux–France, (11) LPSC, CNRS–IN2P3, Université Grenoble Alpes–France, (12) IP21, CNRS–IN2P3, Université Claude Bernard Lyon–France, (13) LPNHE, CNRS–IN2P3, Sorbonne Université Paris–France, (14) Université de Genève–Switzerland, (15) LNGS, Gran–Sasso–Italy, (16) European Spallation Source ERIC Lund–Sweden, (17) Mohammed V university of Rabat–Morocco, (18) Hassan II university of Casablanca–Morocco, (19) Ibn Tofail University of Kenitra–Morocco, (20) Centro Atómico Bariloche, CNEA/CONICET–Argentina, (21) Institute of Physics, Academia Sinica, Taipei–Taiwan, (22) Stony Brook University, USA, (23) Ibrahim Badamasi Babangida University–Nigeria, (24) Comenius University Bratislava–Slovakia, (25) IEAP CTU Prague–Czechia (26) Brookhaven National Laboratory, USA)

Founding Symposium

<https://indico.cern.ch/event/1316503/>



Symposium on Science at PAUL (Paarl Africa Underground Laboratory)

14–18 Jan 2024
Du Kloof Lodge, Du Toitskloof Mountains
Africa/Johannesburg timezone

- Overview
- Timetable
- Book of Abstracts
- Participant List
- Speaker List
- Venue and Accommodation
 - └ Important dates
 - └ Excursions and social programme
 - └ Fees payment
- Organizing Committee

Contact at SSP

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The Paarl Africa Underground Laboratory (PAUL) is envisaged being established off the Huguenot Tunnel in the Du Toitskloof Mountains, between the towns of Paarl and Worcester in the Western Cape Province of South Africa. PAUL is envisaged to be an underground laboratory with a floor space of about 600 square metres and a total volume of 10240 cubic metres, Ref: [arXiv:2306.12083 \[hep-ex\]](https://arxiv.org/abs/2306.12083)

The following are some of the research topics being considered at PAUL:

- Dark Matter search
- Ultra-low level radioactivity measurements for climate science
- Double beta-decay search
- Radiation biology
- Studies of antineutrinos from the Koeberg PWR (about 70 km away)

Supporting Institutions



Sponsors



The Opportunity for an Underground Lab in Africa and The Strategic location of the Huguenot-Tunnel

Du Toitskloof Mountain

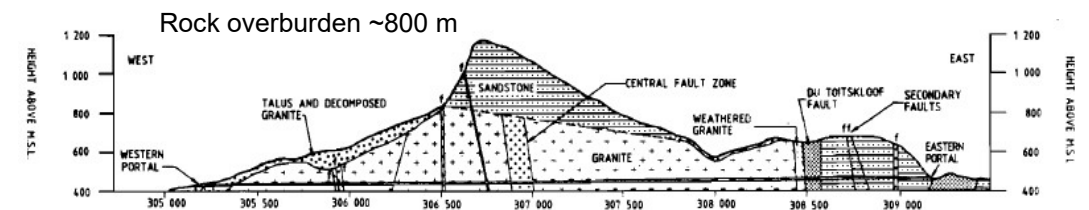
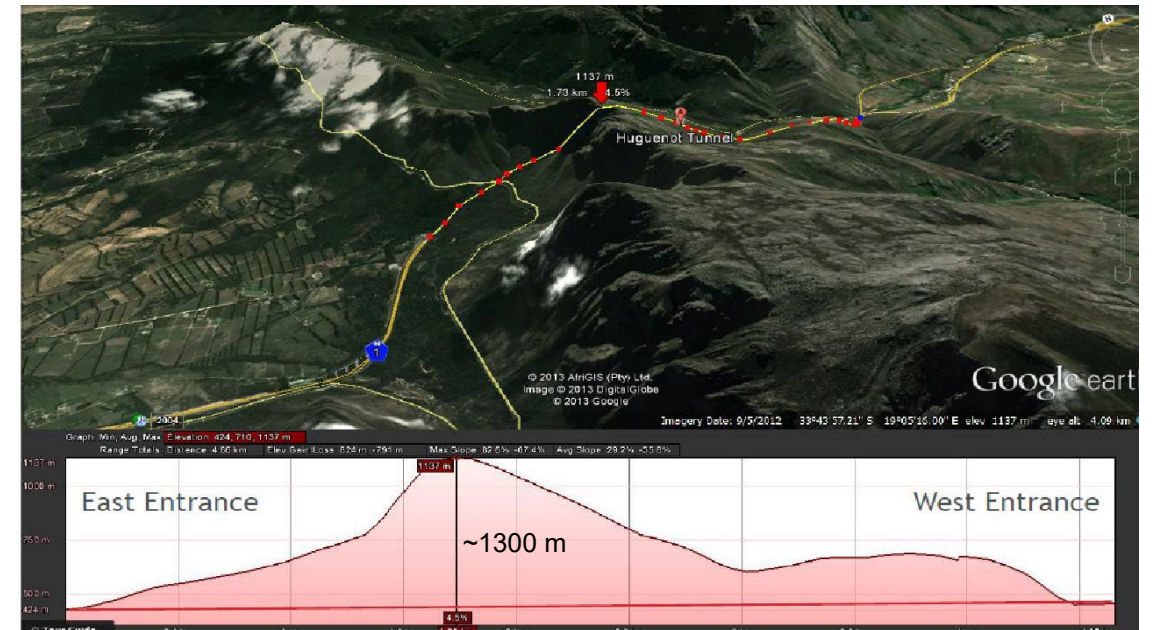


Fig 3: Post-pilot bore geology

The Huguenot-Tunnel



South Bore

- Operating car traffic tunnel since 1988;
- Tunnel length: 3900 m;
- Worcester -> Paarl.



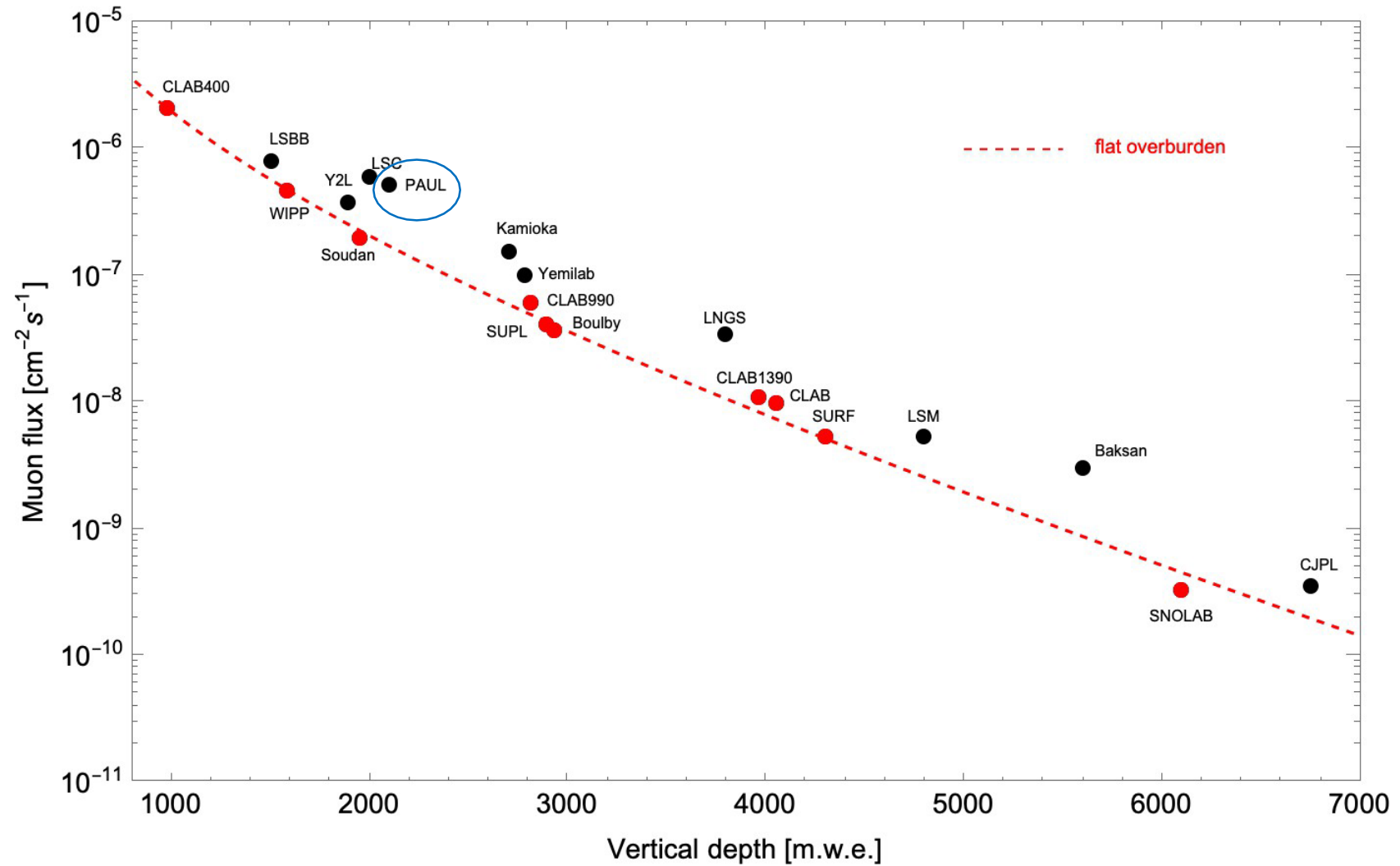
North Bore

- Service tunnel since 1988;
- Being upgraded in 2025 to operate car traffic, 2 lanes;
- Paarl -> Worcester.

The envisaged sciences

- **Dark Matter** search (compare Northern and Southern hemisphere data)
- To **complement** indirect searches for Dark Matter (e.g. with SKA)
- **Ultra-low radioactivity**
- **Biological science** (effect of cosmic radiation on cells and reference organisms – **radiation biology**)
- **Possibly anti-neutrino monitoring** (radiated from Koeberg Nuclear Power Station) (**neutrino physics**) ?

Reference to other U - LABS



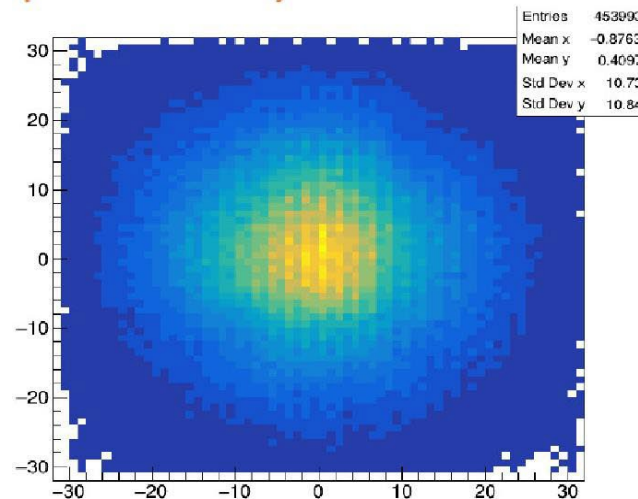
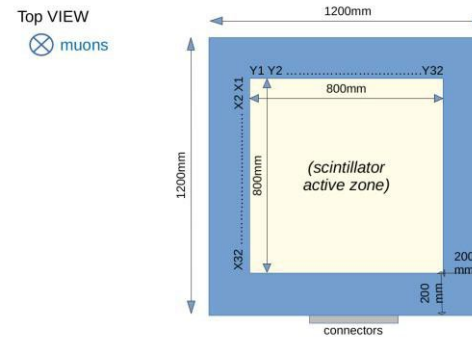
Courtesy; Aldo Ianni, April 2024

Radiation measurement inside the tunnel to establish the specifications of PAUL facility

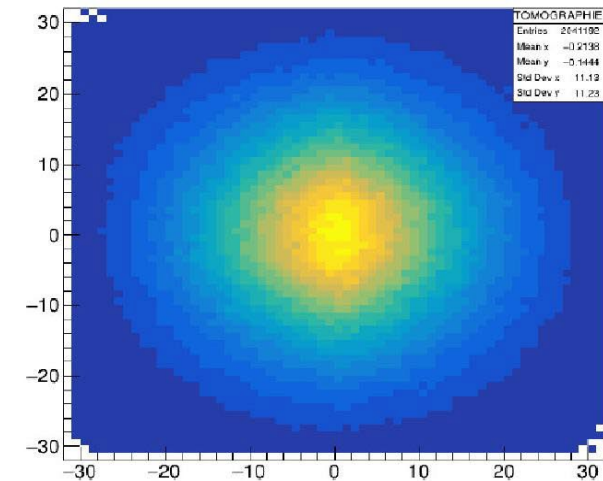
Cosmic measurements open sky at Stellenbosch university + University of the Western Cape



XY mapping of PAUL detector



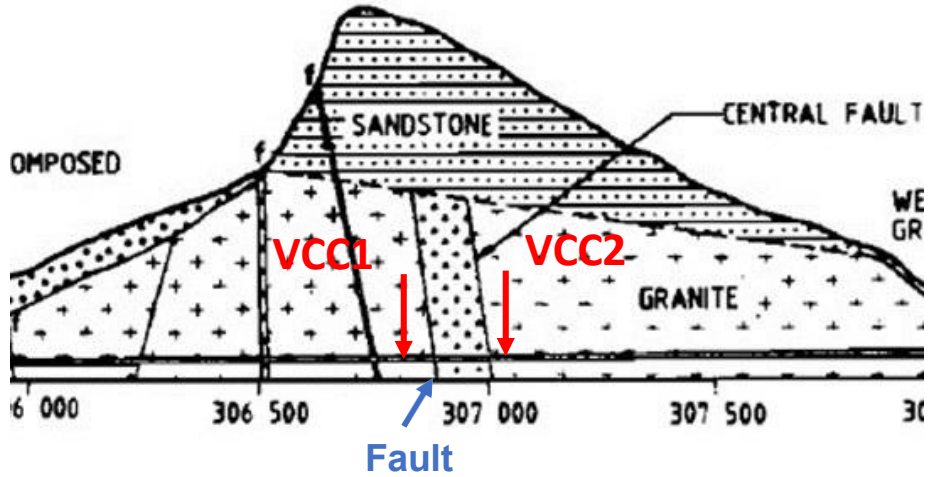
At Stellenbosch University



At University of the Western Cape

Measurements are on-going inside the tunnel

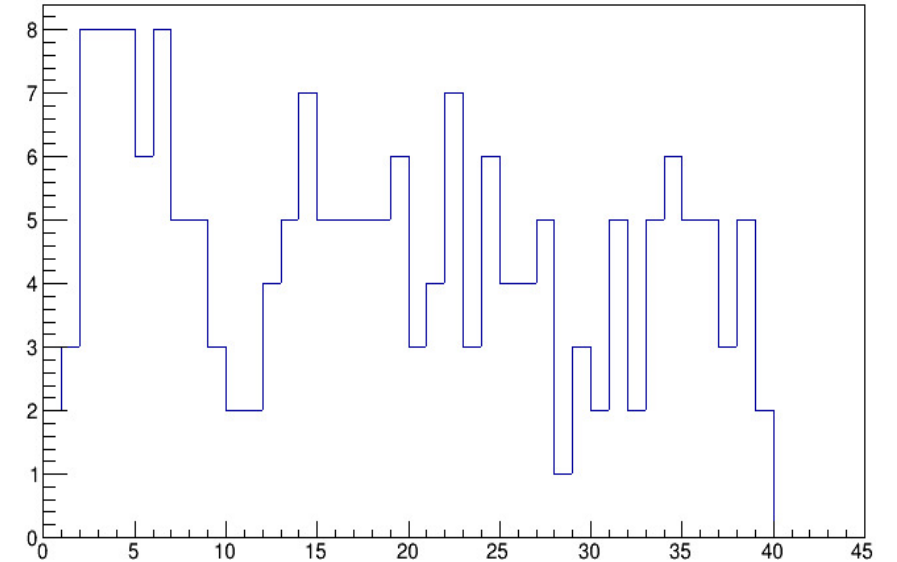
at the position VCC2 → **~5 cosmic/per day** and 200m towards VCC1 → **~3 cosmic/per day**
(~max overburden)



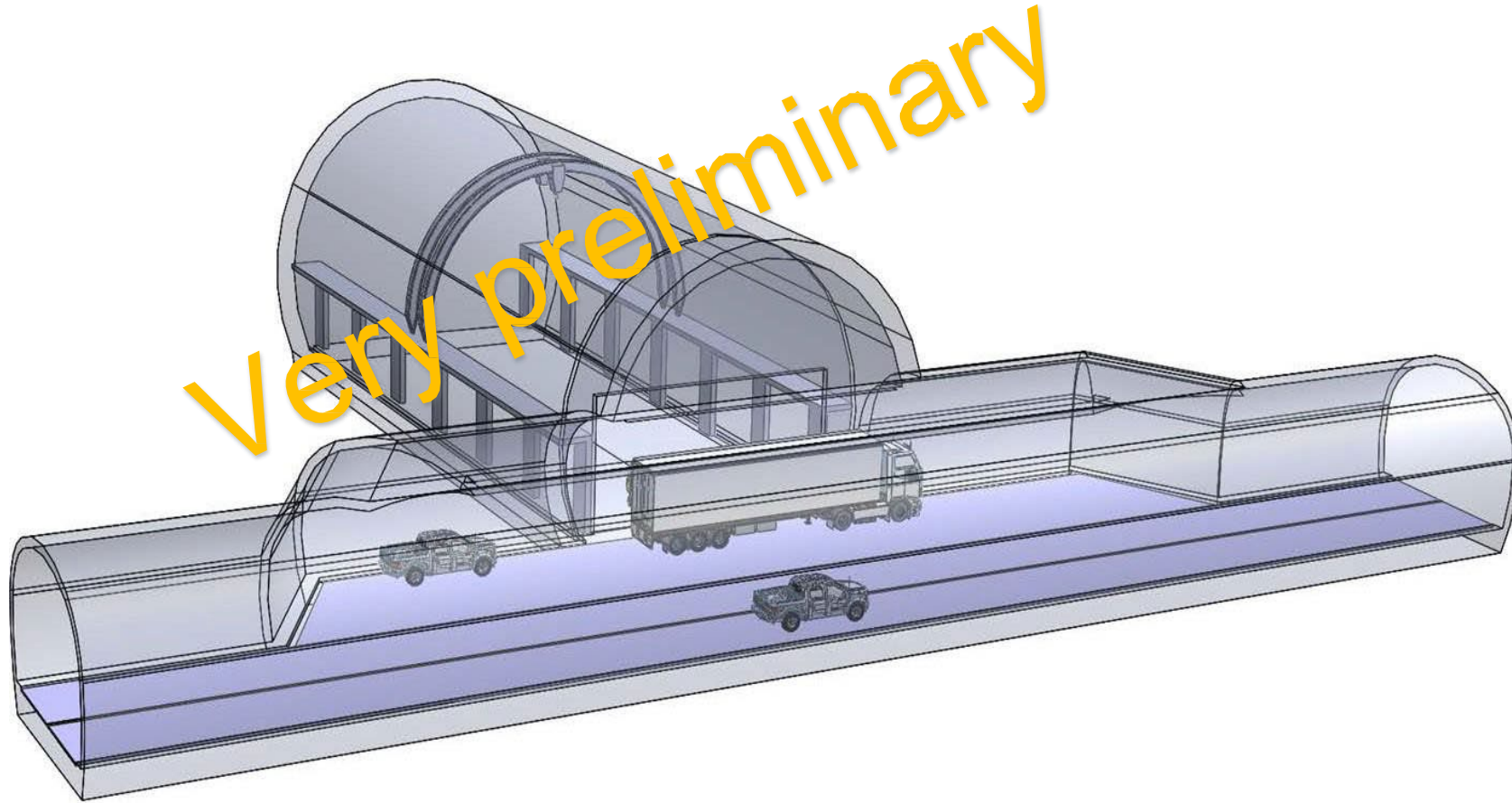
VCC1

VCC2

Events time distribution



Mock-up of the facility



A possible 10,000 m³ laboratory (40x16x16)

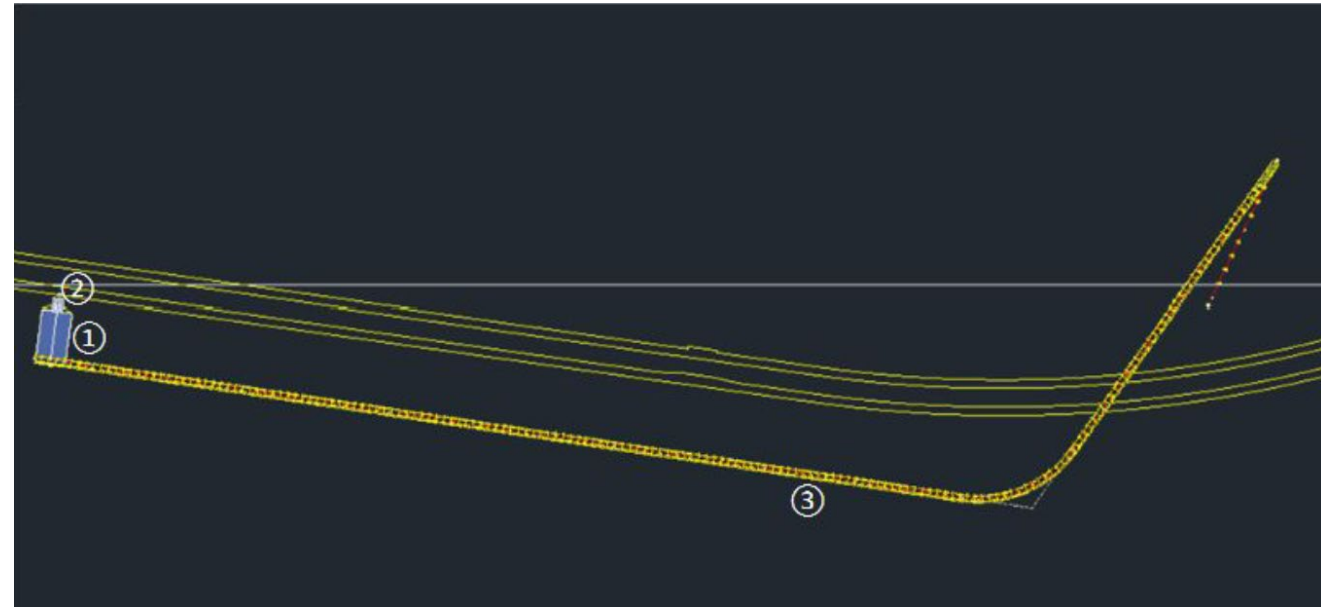
2 options under study in the South-Bore

(September 2024)

- ① The construction of the PAUL cavern adjacent to the Huguenot Tunnel **South Bore**.
- ② The Huguenot Tunnel South Bore will be widened locally to allow for staff drop-off/collection and minimal parking.
- ③ Construction of a direct access tunnel between the PAUL and Huguenot Tunnel South Bore
- ④ An auxiliary access tunnel between the PAUL and Huguenot Tunnel South Bore to ensure emergency egress in case of a fire or similar emergency in the PAUL facility.



- ① The construction of the PAUL cavern adjacent to the Huguenot Tunnel **South Bore**.
- ② A direct access tunnel between the PAUL cavern and the Huguenot Tunnel South Bore will be provided to allow emergency egress
- ③ An access adit, approximately 1.9 km long and 6 m in span, shall be constructed to give access to the PAUL facility for the day-to-day personnel access, deliveries and collection. This access adit shall also be designed to allow parking and turning for vehicles.



Current Progress

- During May 2024 an agreement was signed between University of Stellenbosch (US) and SMEC Engineering Consultants to prepare a Conceptual Design for PAUL;
- August 2024 - Requirements for the conceptual design was redefined;
- August 2024 - Regular Design meetings with SMEC kick-off
- Conceptual Design will be provided in design Sprints rather than a full design at a later period, this allows the PAUL SC members to continually make changes and provide input to the design.
- September 2024 - Stakeholder list compiled
- September 2024 - Draft Risk Register prepared
- Major Risks identified as (Access, geotechnical and land acquisition)

Current Estimated Timelines

Very preliminary

- SANRAL (South African National Roads Agency Limited) tender issued 31 October 2024 - tender close 10 January 2025
- Draft Concept Design PAUL - May 2025
- Preliminary and Detailed Design are estimated to each take 6 months to complete
- Tunnel construction to start in late 2025 up to 2032

Support and Networking

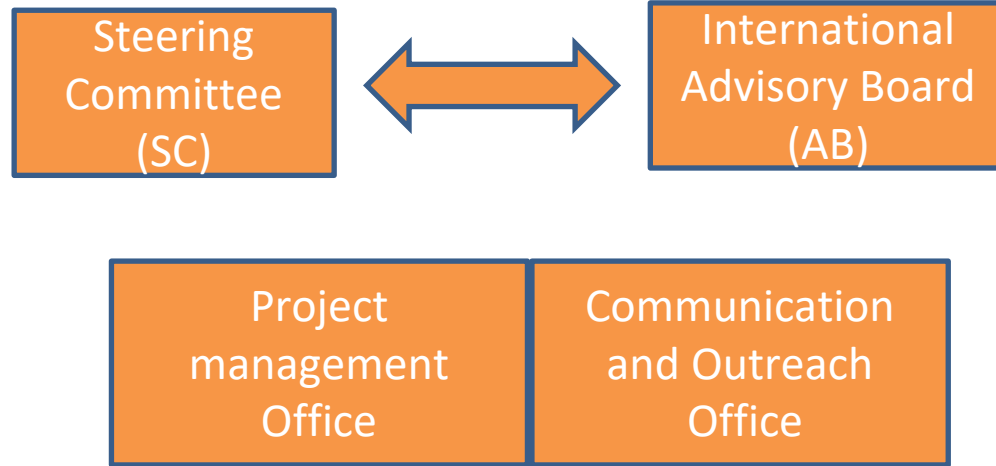
- PAUL project Launched January 2024, **R 5M (250 K€) DSI Seed-Funding**, Feasibility Study on-going;
- 5 years grant for the International Research Network programme with CNRS:

PAULINE :<https://pauline.in2p3.fr/>

- Other programmes being submitted or on-going:
 - PHC PROTEA: <https://www.campusfrance.org/fr/protea> (submitted 30/05/2024)
 - Horizon Europe MSCA Staff Exchange (call deadline 05/02/2025)

PAUL project Organisation chart

<https://twiki.cern.ch/twiki/bin/view/PaulLab/WebHome>



Task Forces



- █ Operationnal
- █ Not yet kicked-off – call for volunteers to coordinate

Note: PAUL not yet a legal entity

PAVING THE WAY FOR PAUL Together



NUCLÉAIRE
PARTICULE

