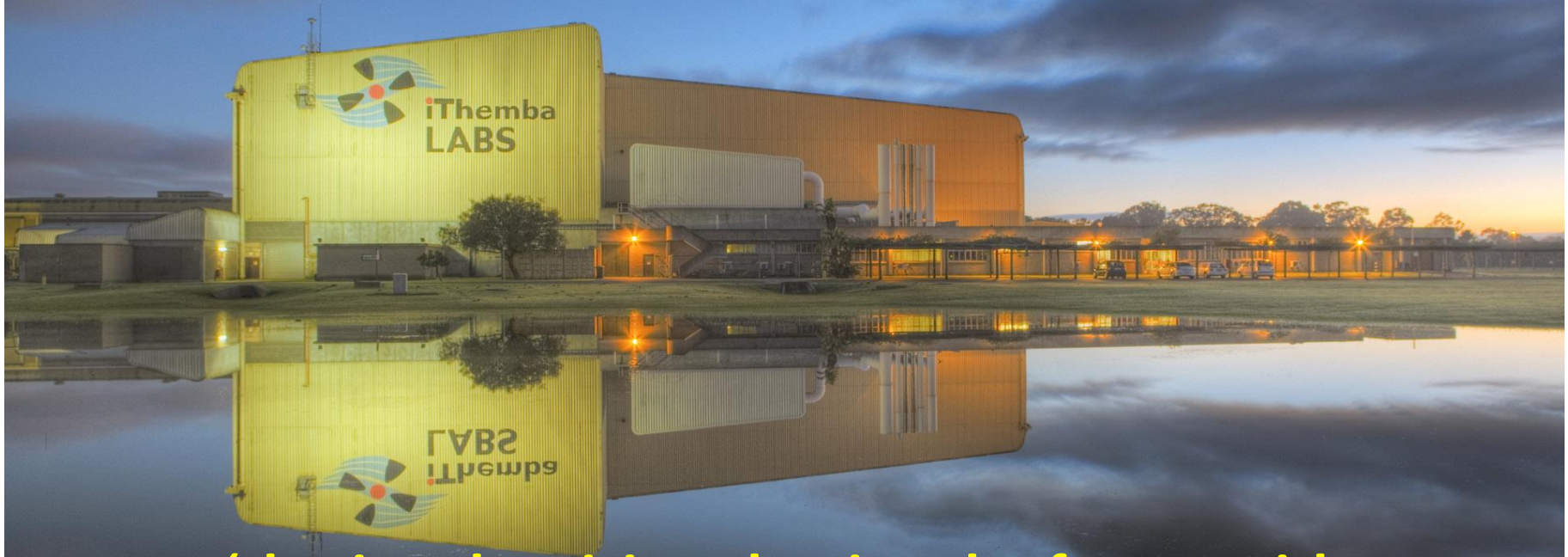


# iThemba LABS

Towards



‘sharing the vision shaping the future with  
SAIF (South African isotopes Facility)’

Copyright Herman du Plessis



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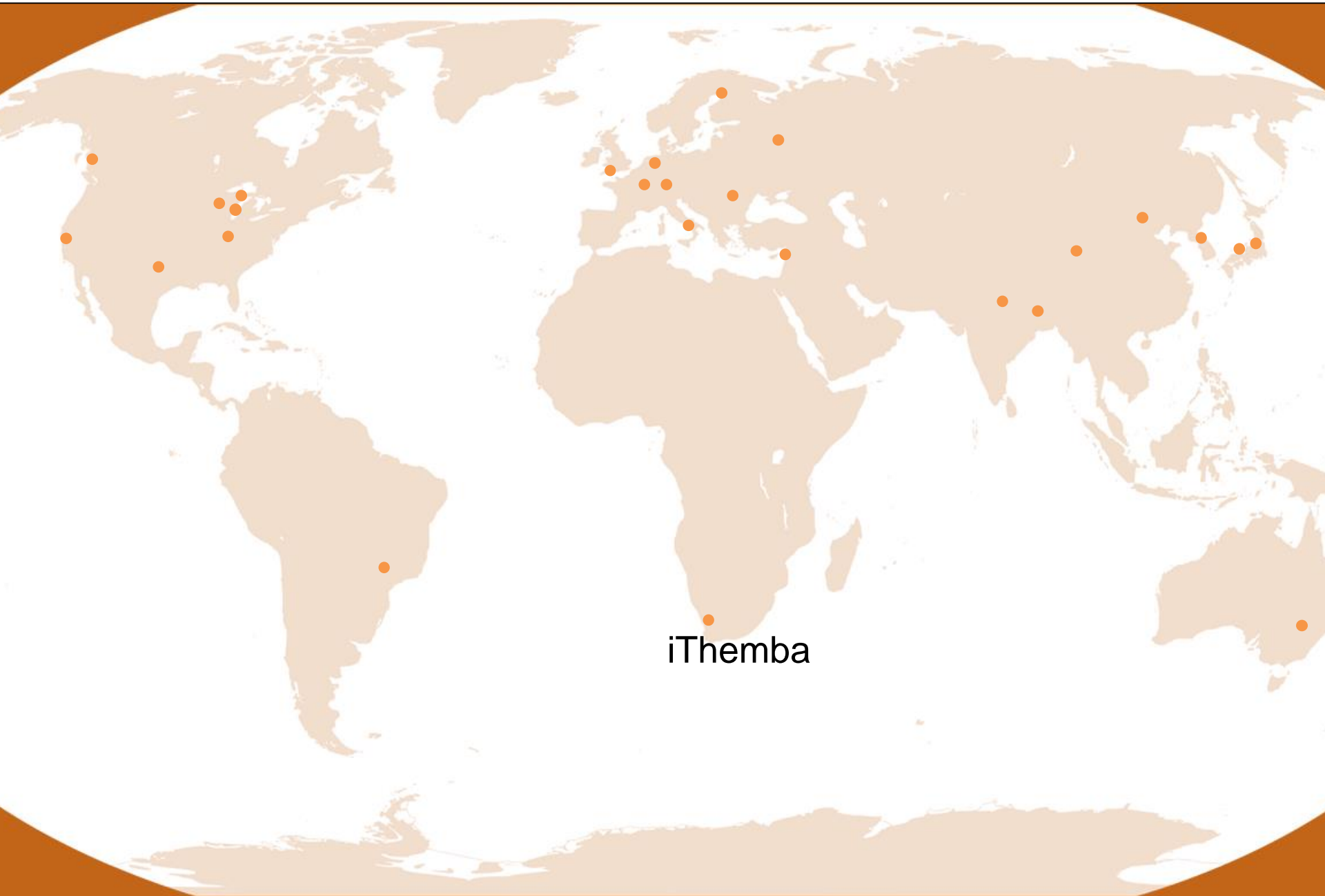
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**Faiçal Azaiez**



**iThemba  
LABS**  
Laboratory for Accelerator  
Based Sciences

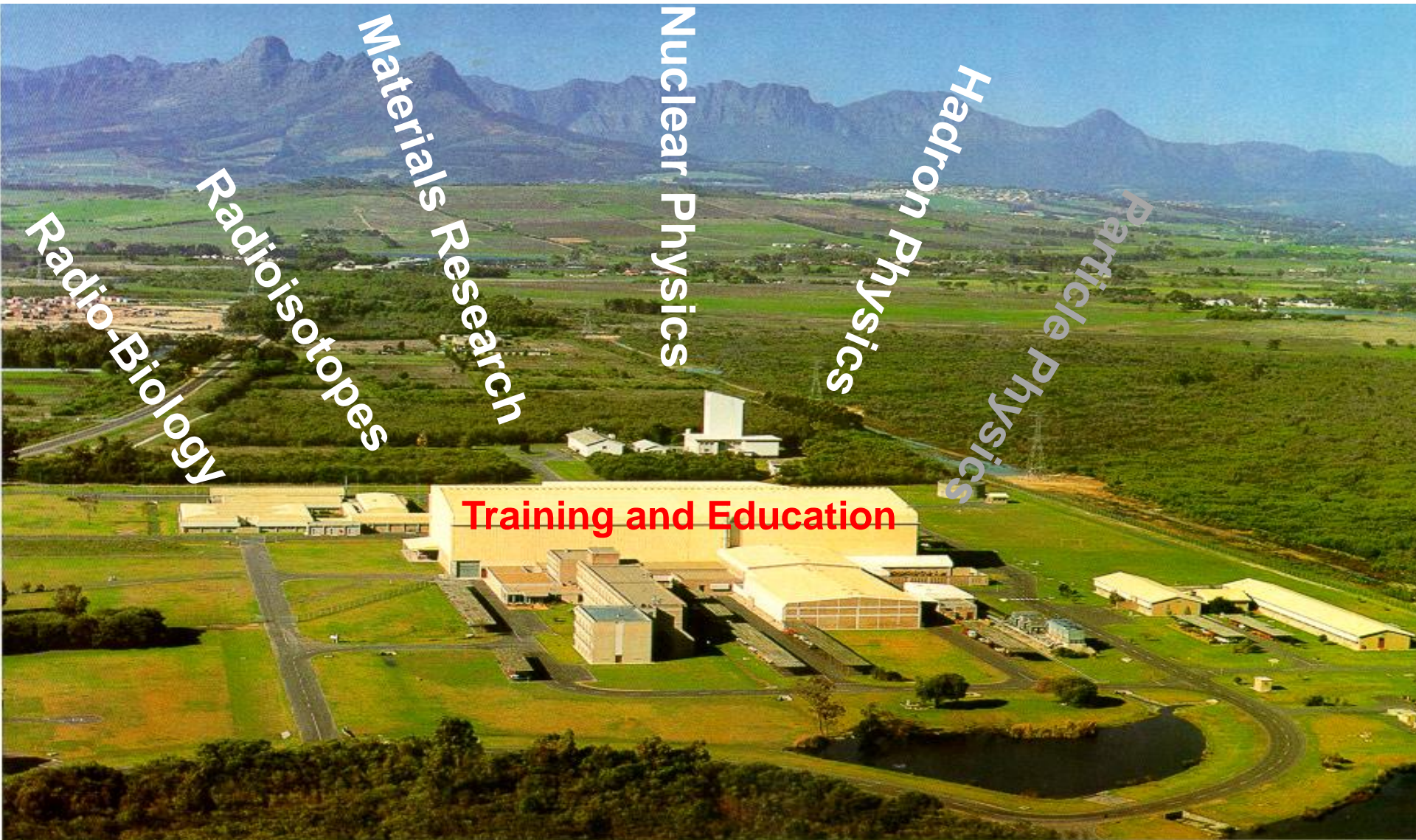
# The largest RI in the southern Hemisphere





# **iThemba LABS (Laboratory for Accelerator Based Science)**

**iThemba LABS provides research platforms for pure and applied research, development and training in Accelerator Based Sciences**



# iThemba: two Campuses

People ~ 300

Budget ~ 20 Meuros/year



(Cape Town)



(Gauteng)

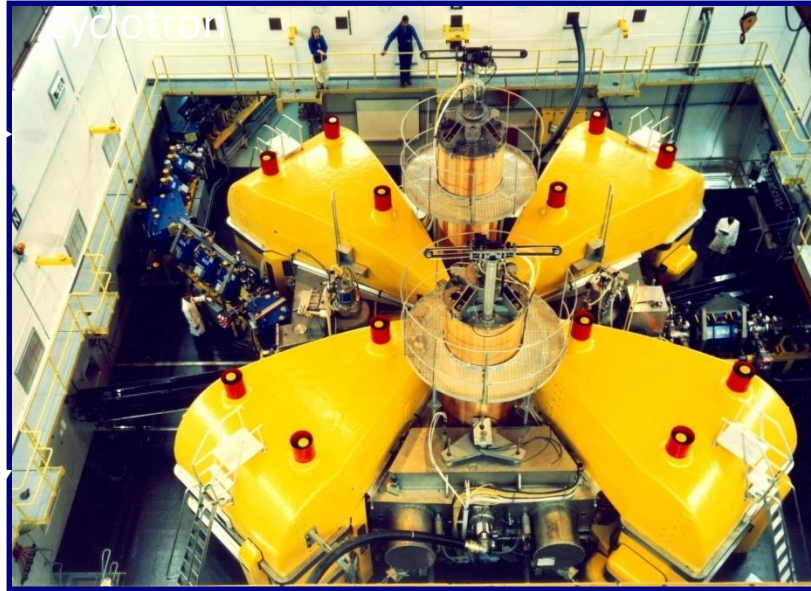


# Accelerators complex at iThemba LABS

Injector cyclotron 1



Separated sector cyclotron



K11 Cyclotron



Injector cyclotron 2

3MV Van de Graaff



6MV Tandem



# Users facility for universities

University of the Western Cape

University of Cape Town

University of Stellenbosch

Cape Peninsula University of Science and Technology

University of the Witwatersrand

University of Pretoria

North West University

Fort Hare University

University of Kwazulu Natal

University of Zululand

North West University

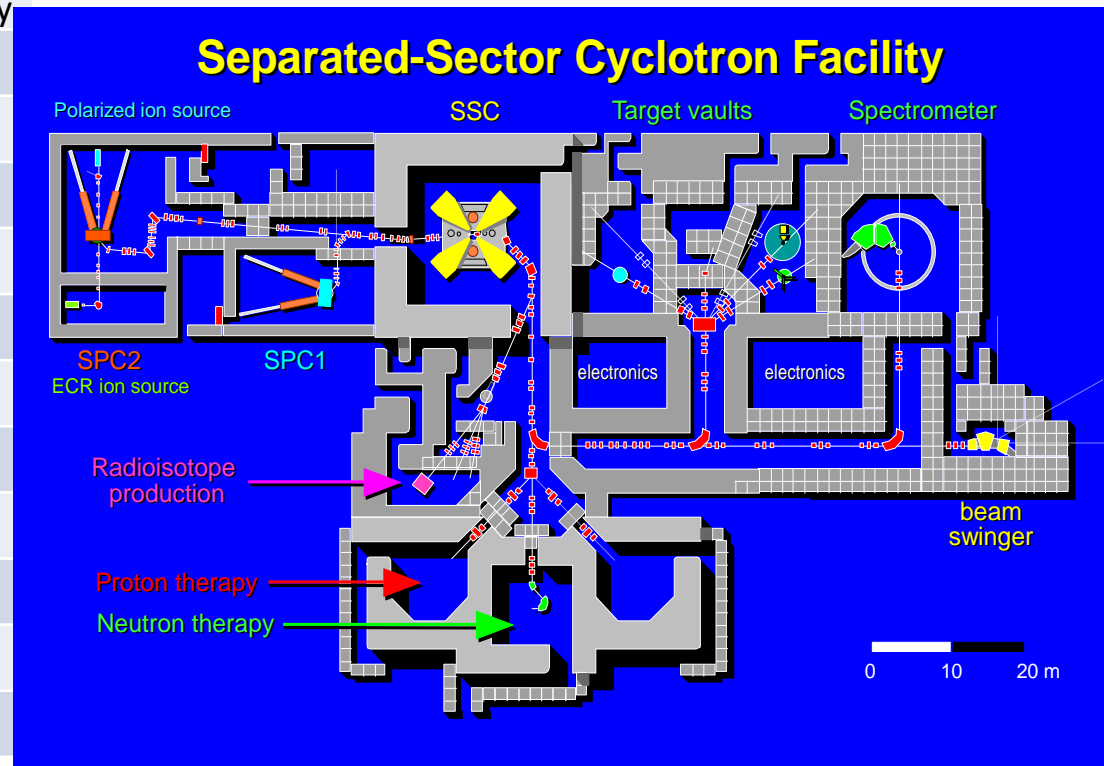
Nelson Mandela Metropolitan

University of Limpopo

University of Venda

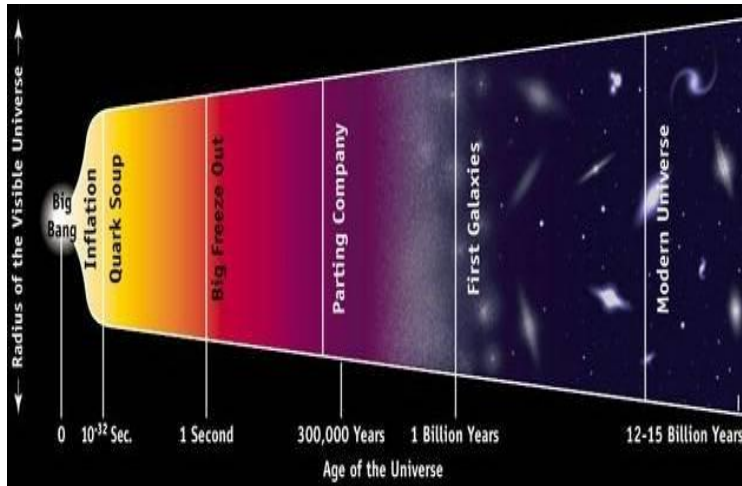
University of Johannesburg

- Proton Therapy: 200 MeV p
- Neutron Therapy: 66 MeV p,  $\sim 40\mu\text{A}$
- Isotope Production: 66 MeV p, up to  $350\mu\text{A}$
- Nuclear Physics: various beams (p, alpha and heavy ions)



**But also for many users from Europe, Asia and America**

# The research

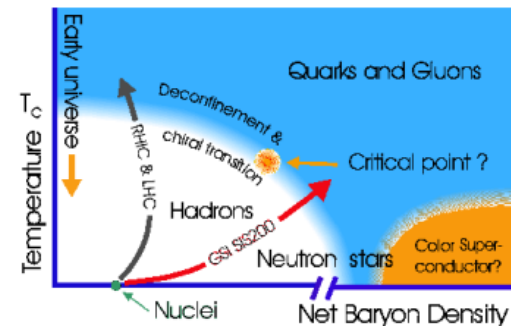


Probe quark-hadron phase transition of the **primordial Universe** (few  $\mu\text{sec}$  after the Big Bang)

$$\mathcal{L} = \frac{1}{4g^2} G_{\mu\nu}^a G_{\mu\nu}^a + \sum_f \bar{q}_f (i \gamma^\mu D_\mu + m_f) q_f$$

where  $G_{\mu\nu}^a \equiv \partial_\mu A_\nu^a - \partial_\nu A_\mu^a + gf_{abc} A_\mu^b A_\nu^c$   
and  $D_\mu \equiv \partial_\mu + i t^a A_\mu^a$

1. Learn about 2 basic properties of strong interaction: **(de)confinement**, **chiral symmetry breaking (restoration)**



2. Study the **phase diagram** of **QCD matter**



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ALICE@LHC

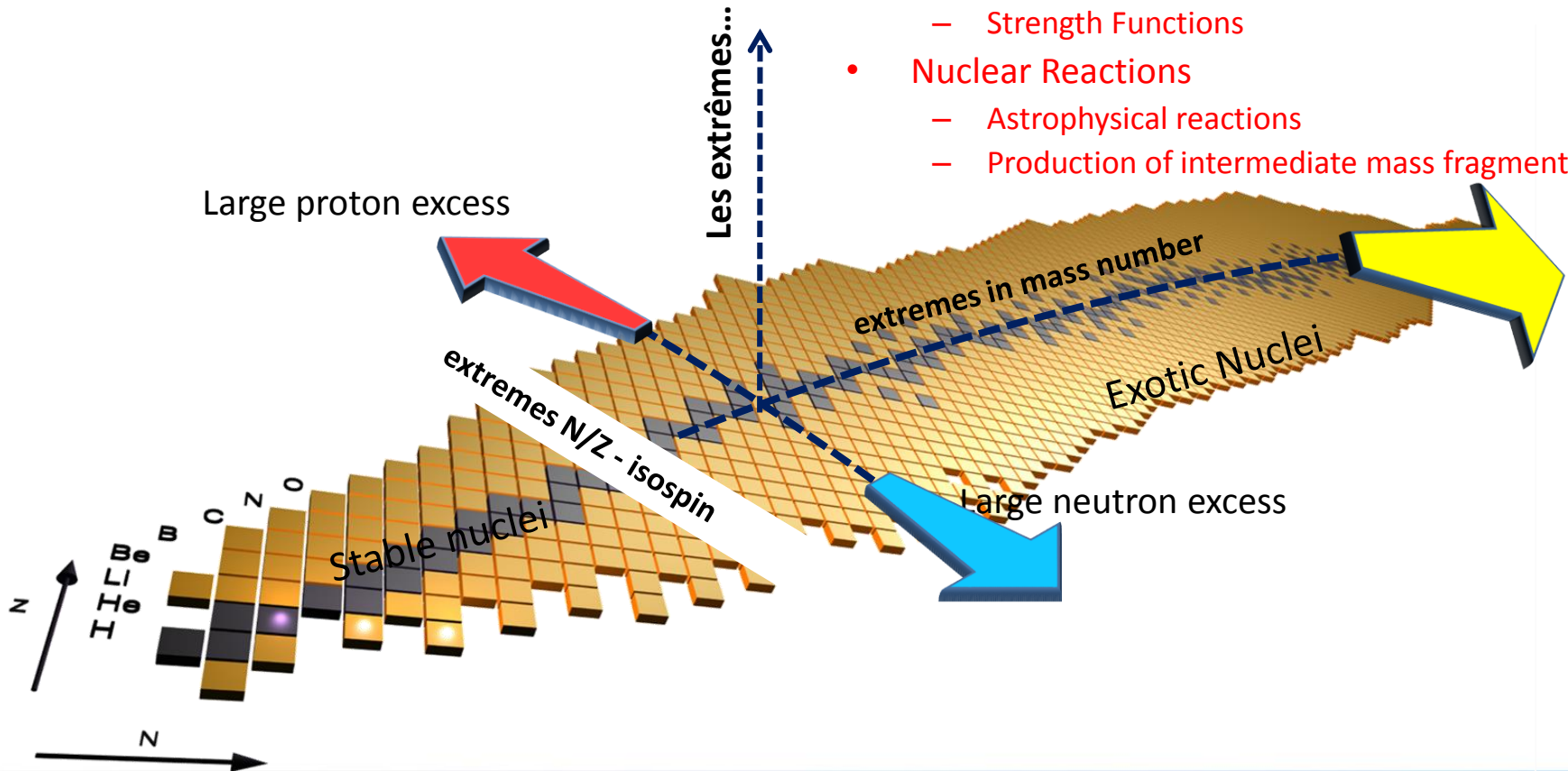


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# The research

- Nuclear Structure
  - Vibrational States
  - Pairing Isomers
  - Shape-Coexistence
  - Nuclear Clusters
  - Chirality
  - Giant Resonances
  - Strength Functions
- Nuclear Reactions
  - Astrophysical reactions
  - Production of intermediate mass fragments



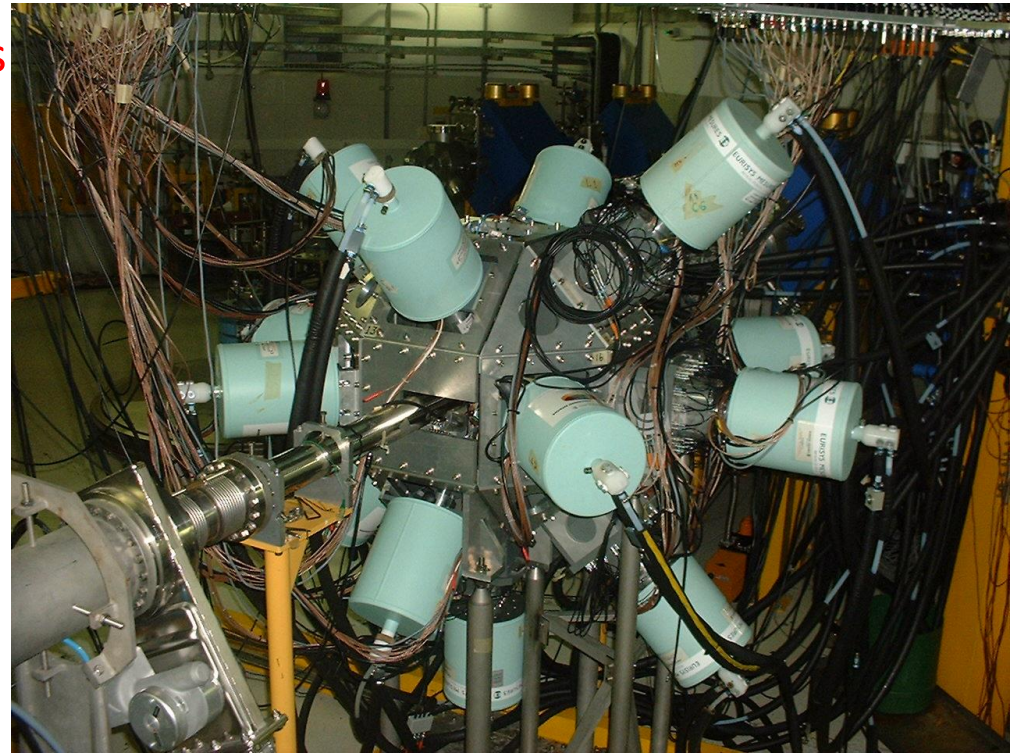


# The AFRODITE $\gamma$ -detector Array (in UPGRAD)

9 Compton suppressed Clover detectors  
(+ 8 Planar Ge )

in 2017 will be 18 Clovers

+5 Clovers in 2017 (funded)  
(+4 Clovers funding request submitted)



1 “TIGRESS” type segmented Clover

# K=600 magnetic spectrometer a high resolution QDD spectrometer for light ions



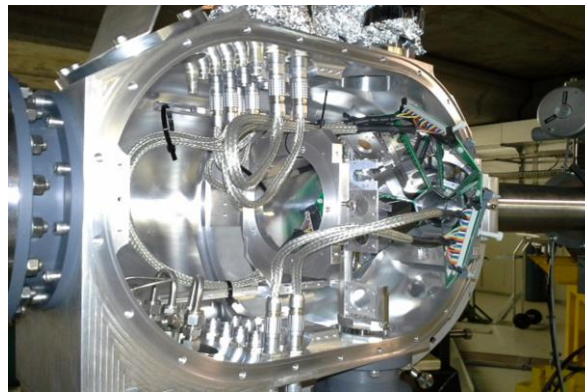
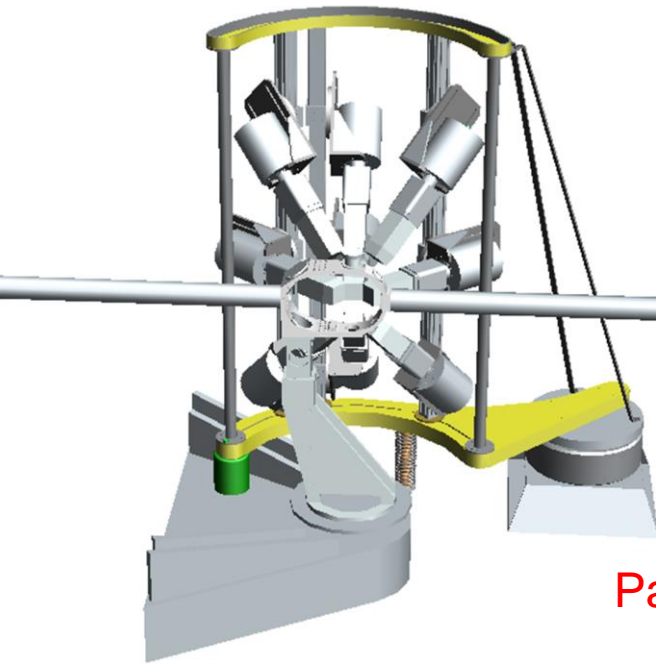
Upgraded for operation at zero degrees ( $0-2^\circ$ ) and small angles ( $3-5^\circ$ )



# K=600 magnetic spectrometer

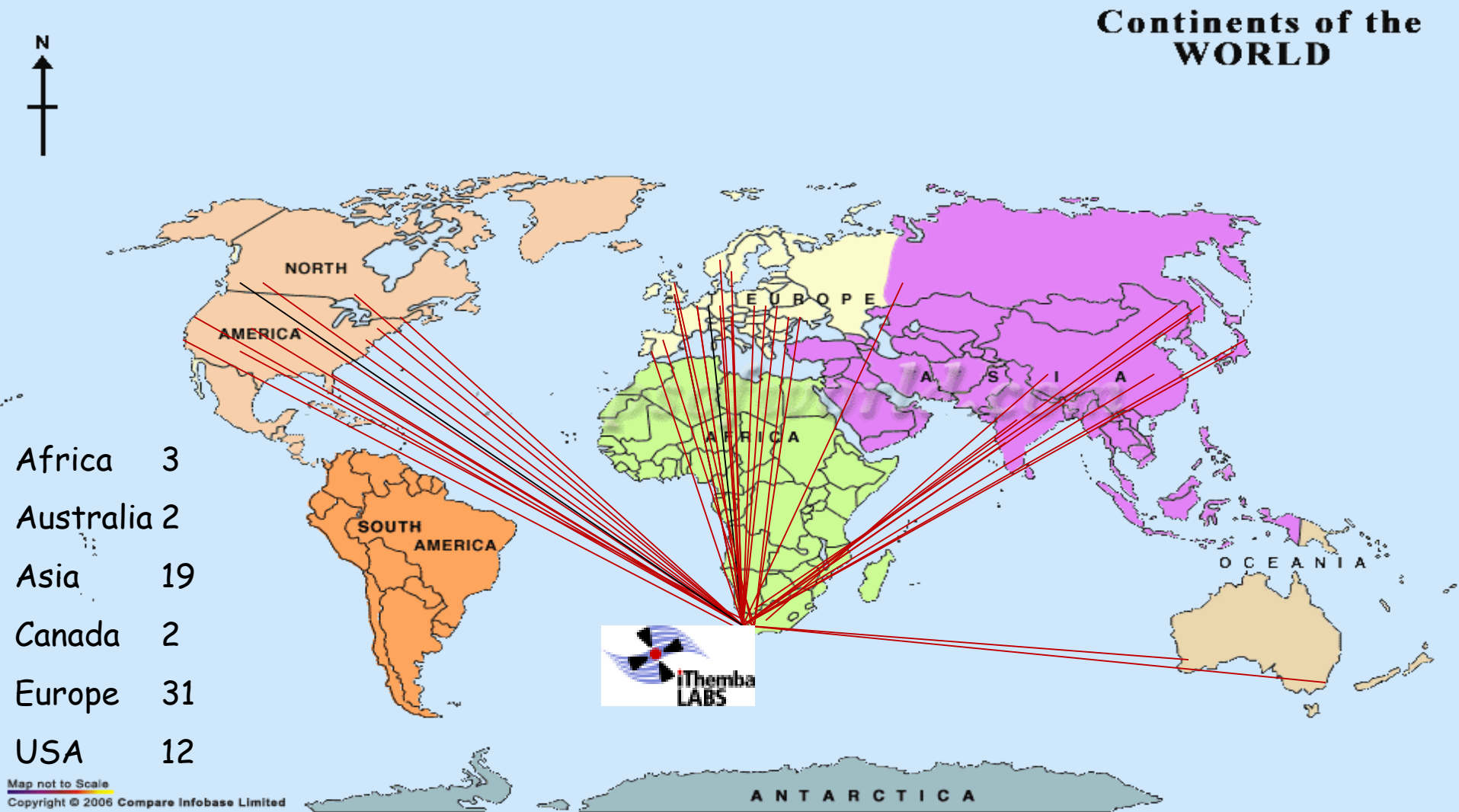
## Recent developments

$\gamma$ -ray and light particles detection



Particle - $\gamma$  coincidence with K600 at  $0^\circ$   
8 Clovers at 17 cm from target

# iThemba LABS: Radioisotopes R&D



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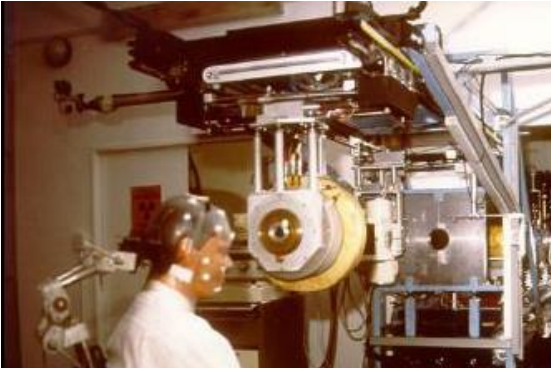


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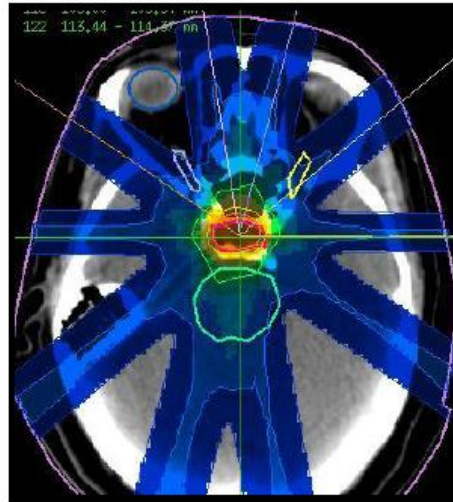


# Neutron Therapy & Proton Therapy

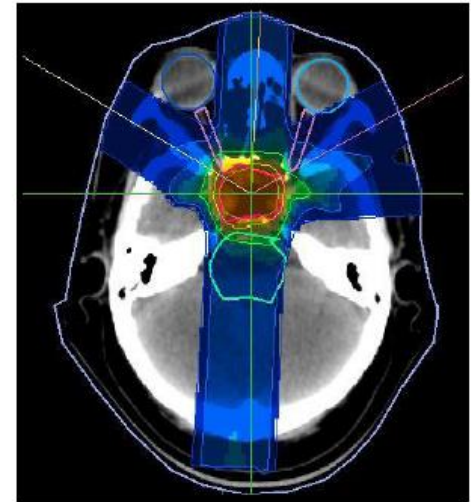
Unique in the southern hemisphere



## PROTON PLANS: PITUITARY ADENOMA



Plateau irradiations



COMBINATION  
Plateau and SOBP irradiations



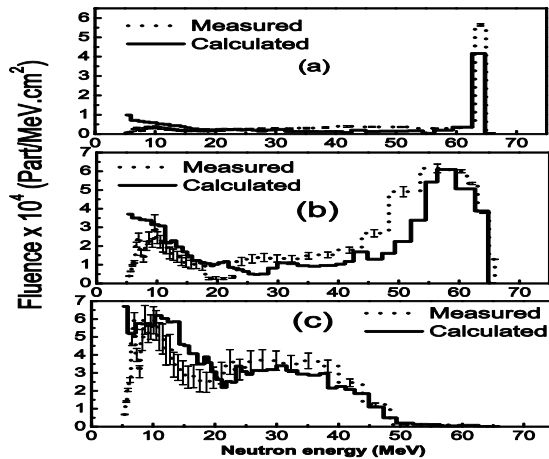
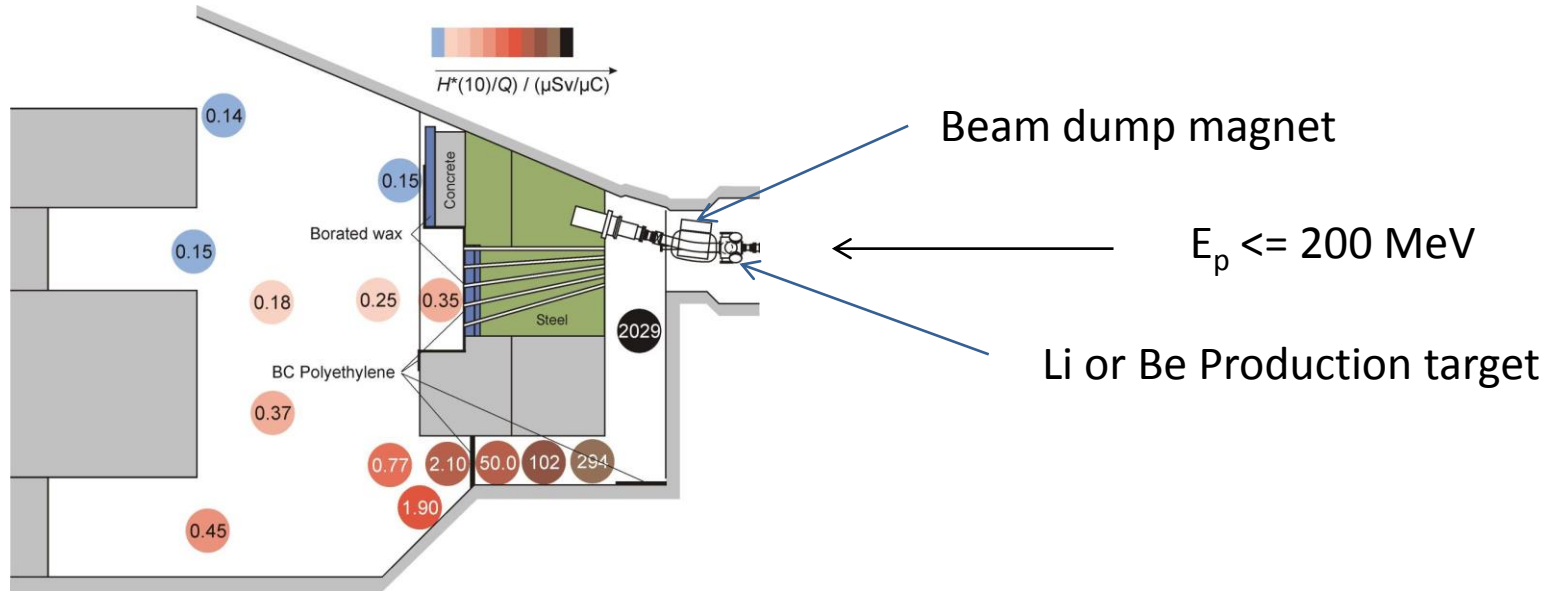
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# Fast neutron facility



- neutron dosimetry
- radiobiological effectiveness of fast neutrons
- detector development
- Neutron induced cross sections



The Future at iThemba is **SAIF** :  
the **S**outh **A**frican **I**sotope **F**acilities

(Expanding partnerships across disciplines, sectors and world  
regions  
with isotopes for science and society)



# iThemba-SAIF three pillars towards iThemba-CARN

- 1- ACE-BI: African Center for Exotic – Beams and Isotopes
- 2- South African Centre of Excellence for Sub-Atomic Physics (iThemba-CE)  
The hub to **CERN, FAIR, JINR**
- 3- South African Institute of Nuclear Technology and Science (SAINTS)  
(Gateway to Nuclear technology for Africa)

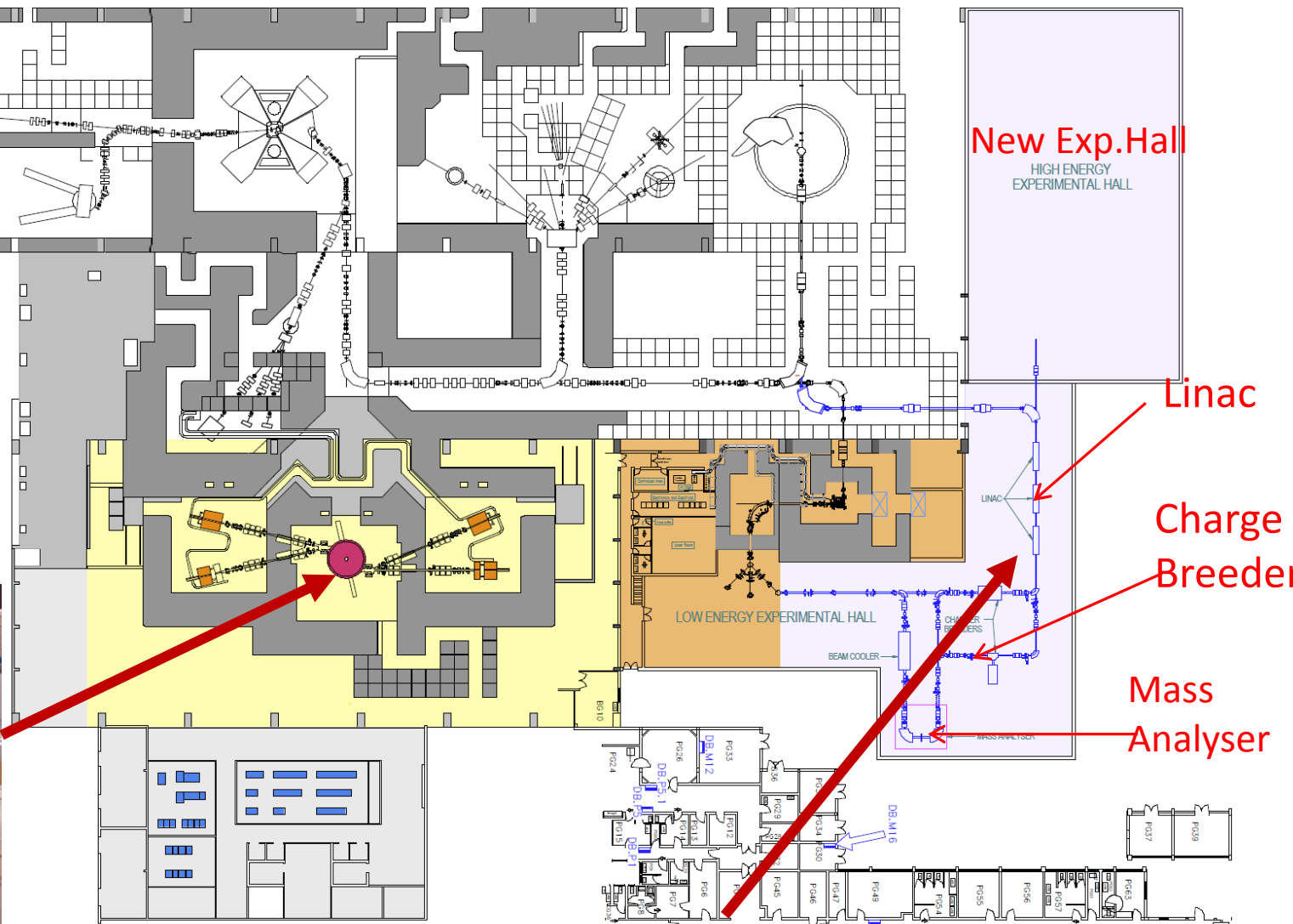
Ultimate Goal is to work on the concept of CARN for iThemba



**SAIF**



**ACE-ISOTOPES**



**ACE-BEAMS**

# ***ACE-BEAMS research plans***

Nuclear Astrophysics: Synthesis of the Elements  
**r-process**

Solid State Physics with RIBs

Materials Analysis with RIBs

# ACE Phases

## Phase 0: (Funded 2.8m Euro)

- Design Study ( 0.6m Euro )
- Test Ion Source/"Demonstrator" ( 2.2m Euro )  
(using 66 MeV p from SSC)

## Phase 1:

- 70 MeV Cyclotron and beam lines
- Isotope Production Target Stations

## Phase 2:

- LERIBs : the Low Energy radioactive ISOL Beams

## Phase 3:

- Laser Ionization, mass separation, charge breeding
- Post-acceleration (existing SPC2 and SSC)
- Experimental Facilities



# Advantages

- a much lower start-up cost (Phase 1)
- a much shorter construction time (Phase 1)
- the maximum net annual revenue from isotope production of R158M realized
- it allows the low-energy test-facility to be used far sooner as a competitive research platform
- Isotope production completely separated from research with the SSC

Already:  
SSC Beams priority is for Nuclear Physics research  
(the end of weekend experiments)

# SAINTS: South African Institute of Nuclear Technology and Science (Gateway to Nuclear technology for Africa)

## African Collaborations Country/University

1. Mozambique (Eduardo Mondlane University)
2. Zambia (University of Zambia)
3. Botswana (Univ. Botswana, + BIUST)
4. Nigeria (University of Ile-Ife + CERD)
5. Sudan (Univ. Sudan Science & Tech)
6. Cameroon (University of Yaounde)
7. Ghana ( University of Ghana)
8. Ethiopia: (University of Addis Ababa)
9. Senegal (Cheik Anta Diop University)
10. Algeria (COMENA)
11. Senegal (Cheik Anta Diop University)
12. Burkina Faso
13. Egypt



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African Institutions Collaborating with iThemba LABS

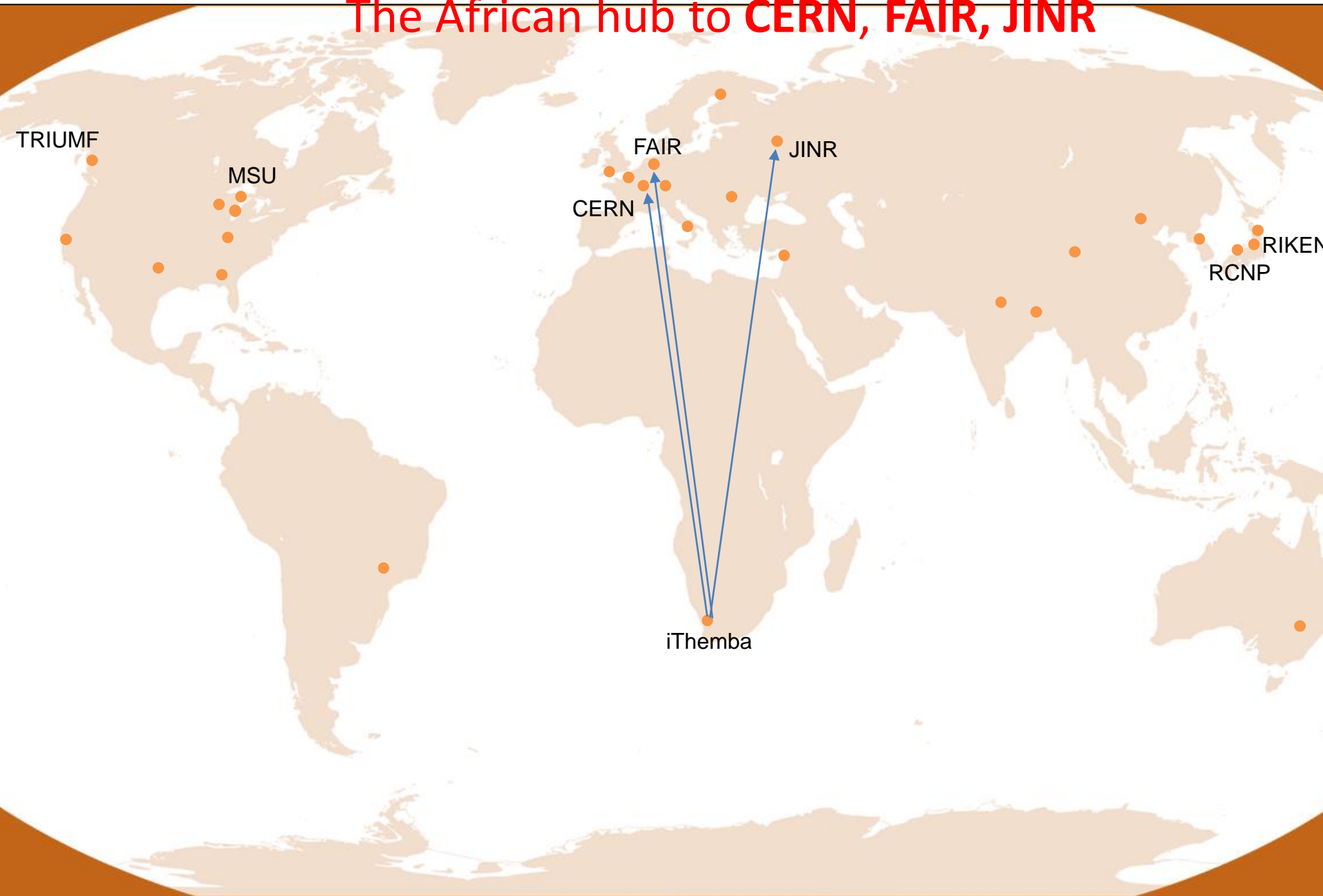


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# South African Centre of Excellence for Sub-Atomic Physics

## The African hub to **CERN**, **FAIR**, **JINR**



Ultimately iThemba should  
become CARN  
(the African CERN)....



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iThemba means hope!



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