



Nordic accelerator school MOOC

Nordic Particle Accelerator Project (NPAP) and beyond

christine.darve@ess.eu

2022-12-20

<https://cdarve.web.cern.ch/>

Short biography – Christine Darve

<https://cdarve.web.cern.ch/>

Diplome d'ingenieur UTBM, Institut Polytechnique de Sevenans (FR),
"Thermomechanical of System and Materials"

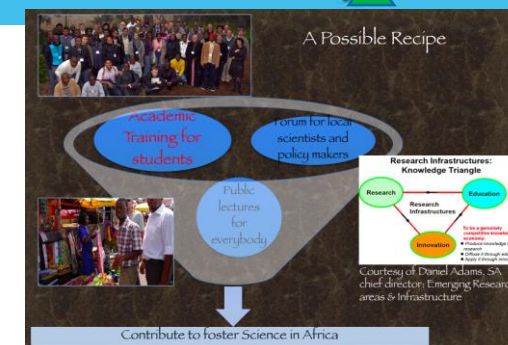
PhD Northwestern University (USA), "Phenomenological and Numerical Studies of
Helium II Dynamics in the Two-Fluid Model"

20 years as **Engineering Scientist at CERN, FNAL, and ESS**

From design to operation of particle accelerators in large scale
collaborations (incl. Large Hadron Collider, Cryogenic Magnets
and Cavities, LH₂ absorber, ESS Superconducting LINAC)

Main volunteering organisations:

- [Forum on International Physics \(FIP\)](#), Chair-elected, American Physical Society (APS)
- [Nordic Particle Accelerator Program \(NPAP\)](#) (schools, MOOC) co-founder, organiser and lecturer
- [African School of Physics and Applications \(ASP\)](#) co-founder, organiser and lecturer
- Physique-sans-frontieres (1998 Sc. Secretary) "WWW: A Windows on Science and Technology", Sarajevo



IDEAL: Influence and Transform communities to reach technological paradigms,
applicable to societal challenges

Topics of interest: *Fundamental Physics and Applications based on Accelerator Science*

Education as a vector for development !

Outline

- NPAP: From Summer Schools to Massive Open Online Courses (MOOCs)
- Beyond NPAP: Accelerating Teaching and more educational platforms

Science Transcending Boundaries !

The European Accelerator Landscapes

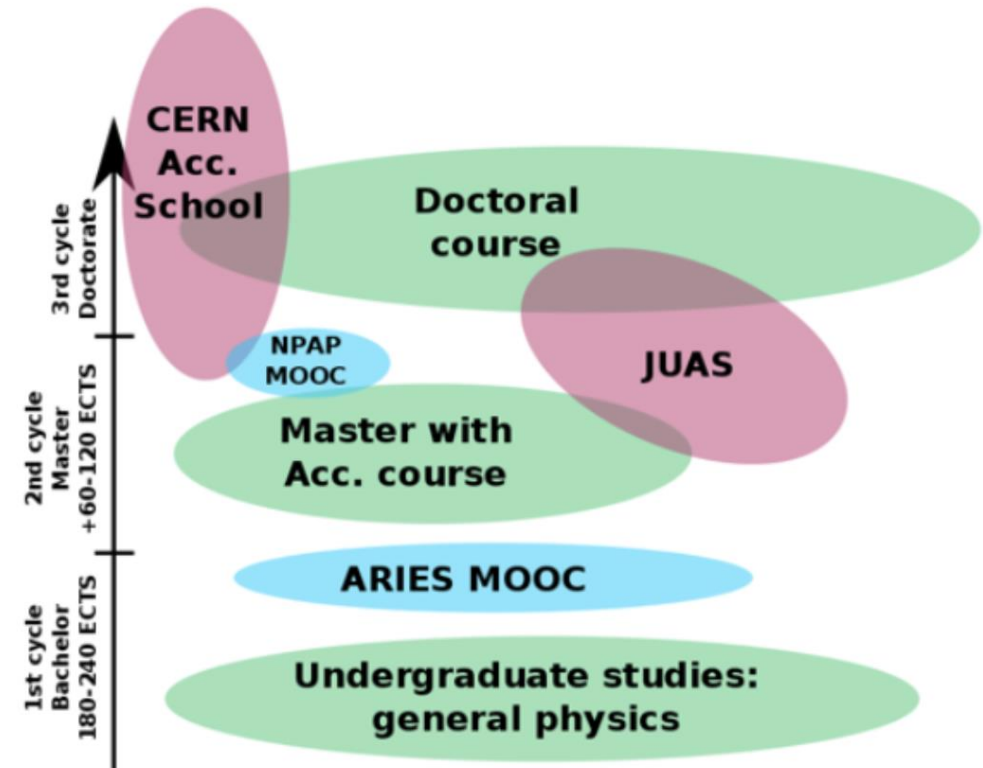
Nordic Particle Accelerator Project (NPAP)

Existing educative platforms and programs:

- ✓ Accelerator schools: JUAS, CAS, HASCO, USPAS, ACAS, ASP, etc
- ✓ University programs (e.g. Aarhus, LU)
- ✓ EU-TIARA market surveys
- ✓ EU-ARIES and [I.FAST](#)

Why do we need new Pedagogical tools for Accelerator science?

- School levels are typically advanced
- Domains/Field complementarity; User communities
- To provide sustainable and “users-friendly” tools



**Develop capacity in Northern Europe with
emphasize on MAXIV and ESS**

Useful links

- ✓ [Innovation Fostering in Accelerator Science and Technology \(I.FAST\)](#)
- ✓ [JUAS – European Scientific Institute](#)
- ✓ [CERN Accelerator School \(CAS\)](#) , e.g. [Introduction to Accelerator Physics 2016](#)
- ✓ [US Particle Accelerator School: USPAS](#)
- ✓ MOOC [ARIES](#) : [Accelerator Research and Innovation for European Science and Society](#)
- [HERCULES](#) European courses [via ESRF](#)
- [FASEM: Joint French-Swedish school on X-rays and Neutrons techniques](#) and [Indico Link](#)
- [At CERN](#) and [at Diamond](#) at Fermilab ([Lederman Science center](#)); [SciTech Hands On Museum](#)
- Science and engineering videos of [Veritasium](#)
- Science Communications: [LightSources.org](#) and [Accelerating News](#)
- Brochures: LAAAMP and APS brochures: [Acc. and Beams](#) and [Advanced Light Sources](#)

Nordic Particle Accelerator Schools



Team building

Nordic Particle Accelerator School 2015 → The proof of Concept

- 90 students
- Education in accelerator technology
- Visit of MAXIV and ESS



Anders Karlsson
NPAP Coordinator (LU)



Deana Ekberg Nannskog
NPAP Project Manager (LU)



Karima Kandi (LU)



Julius Kvissberg (Evi)



Christine Darve (ESS)



Francesca Curbis (MAXIV)



Søren Pape Møller (AU)



Erik Adli (OU)



Sverker Werin (MAXIV)



Pedro Fernandes
Tavares (MAXIV)



Maja Olevgård (UU)



Pauli Heikkinen (JU)

NPAP - Team building



Nordic Particle Accelerator School 2015 → The proof of Concept



Grant for the Nordic Particle Accelerator Program

Main deliverables: 2 summer schools and 3 MOOCs

Strategic partnership and building cross-sectoral bridges

Support innovative practices from international to regional to organisational and individual levels



Erasmus+

Application Form

Call: 2015

KA2 - Cooperation for Innovation and the Exchange of Good Practices

Strategic Partnerships for higher education

Nordic Particle Accelerator Project MOOC



Nordic Particle Accelerator Project (NPAP) - MOOC

MOOC1: Particle Accelerators introduction

- Launched in August '19
- 5110 learners enrolled

Accelerators for Synchrotron Light

Light and Light Sources
Accelerator to make light
The development of accelerators for synchrotron light

Photon light sources and MAXIV

Synchrotron radiation
Bending magnets, wigglers and undulators
Free Electron Lasers

Spallation source and ESS

Introduction and neutron science
European Spallation Source

Particles Colliders

Introduction to Particles Colliders
The LHC and its experiments
Linear Colliders
Future Circular Colliders

Plasma Wakefield (to be completed)

MOOC2: Fundamentals of accelerator technology

- Launched in March '19
- 3918 learners enrolled

RF-System

Introduction to RF-systems
RF cavities
Waveguides
RF Amplifiers
More about cavities

Magnets technology for accelerators

Magnets part1/2/3

Beam Diagnostics

An overview
Beam intensity and position
Transverse Beam Profile
Longitudinal Beam Profile
Beam Loss Monitoring

Basics of Vacuum techniques

An overview and motivation
Residual gases and vacuum regions
Vacuum equipment
Other vacuum components

MOOC3: Medical Applications of Particle Accelerators

- Launched in Nov. '18
- 5988 learners enrolled

@ 19 Dec 2022

Introduction to the course and radiotherapy

Introduction
Biological rational for radiotherapy
Intro. to the electron linac for radiation therapy

Electron Linacs for radiation therapy

The multi-energy electron Linac structure
Dose delivery to the patient

Proton therapy 1

Rationale of proton therapy
Accelerators for proton therapy
Treatment delivery of proton therapy

Proton therapy II and production of medical radionuclides

Heavy ion therapy
Challenges in pr. th. and heavy ion th.
Introduction to medical radionuclides
Production of medical radionuclides

Nordic Particle Accelerator Project MOOC



Example: MOOC2: Fundamentals of accelerator technology

<https://www.coursera.org/learn/fundamentals-particle-accelerator-technology>

About this Course

5,694 recent views

Did you know that particle accelerators play an important role in many functions of today's society and that there are over 30 000 accelerators in operation worldwide? A few examples are accelerators for radiotherapy which are the largest application of accelerators, altogether with more than 11 000 accelerators worldwide. These accelerators range from very compact electron linear accelerators with a length of only about 1 m to large

[SHOW ALL](#)

WHAT YOU WILL LEARN

- ✓ You will learn the basic technology of particle accelerators.
- ✓ You will understand the basic principles for how particles are accelerated, and how they can be guided.
- ✓ You will learn about different ways to monitor the beam.
- ✓ You will learn about vacuum: Why we need vacuum in accelerators; Where particles that give rise to pressure comes from; How one creates vacuum



100% online

Start instantly and learn at your own schedule.



Flexible deadlines

Reset deadlines in accordance to your schedule.



Intermediate Level

Basic physics at undergraduate level



Approx. 17 hours to complete

Suggested: 4 weeks of study with 5-8 hours/week



English

Subtitles: English

Nordic Particle Accelerator Project MOOC



Coursera Architecture

coursera

Courses

Specializations

Institution

Groups

Help



christine.da

Fundamentals of
particle accelerator
technology (NPAP
MOOC)

View as learner

Content

• Edit Content

Course Resources

Discussion Forums

Learning Objectives

Asset Library

Plugin Manager

Versions

Feedback

Grading

Scheduling

Messages

Introduction to RF-systems

Reading: Introduction
Published 10m

Video: General introduction
Published 2m

Reading: Basic concepts 1
Published 10m

Quiz: Quiz Introduction
Published 6m

Video: Outline of the RF-system
Published 2m

Quiz: Outline of RF-system
Published 6m

+ Video + Reading + Quiz + More

RF-cavities

Video: Pill-box cavities
Published 5m

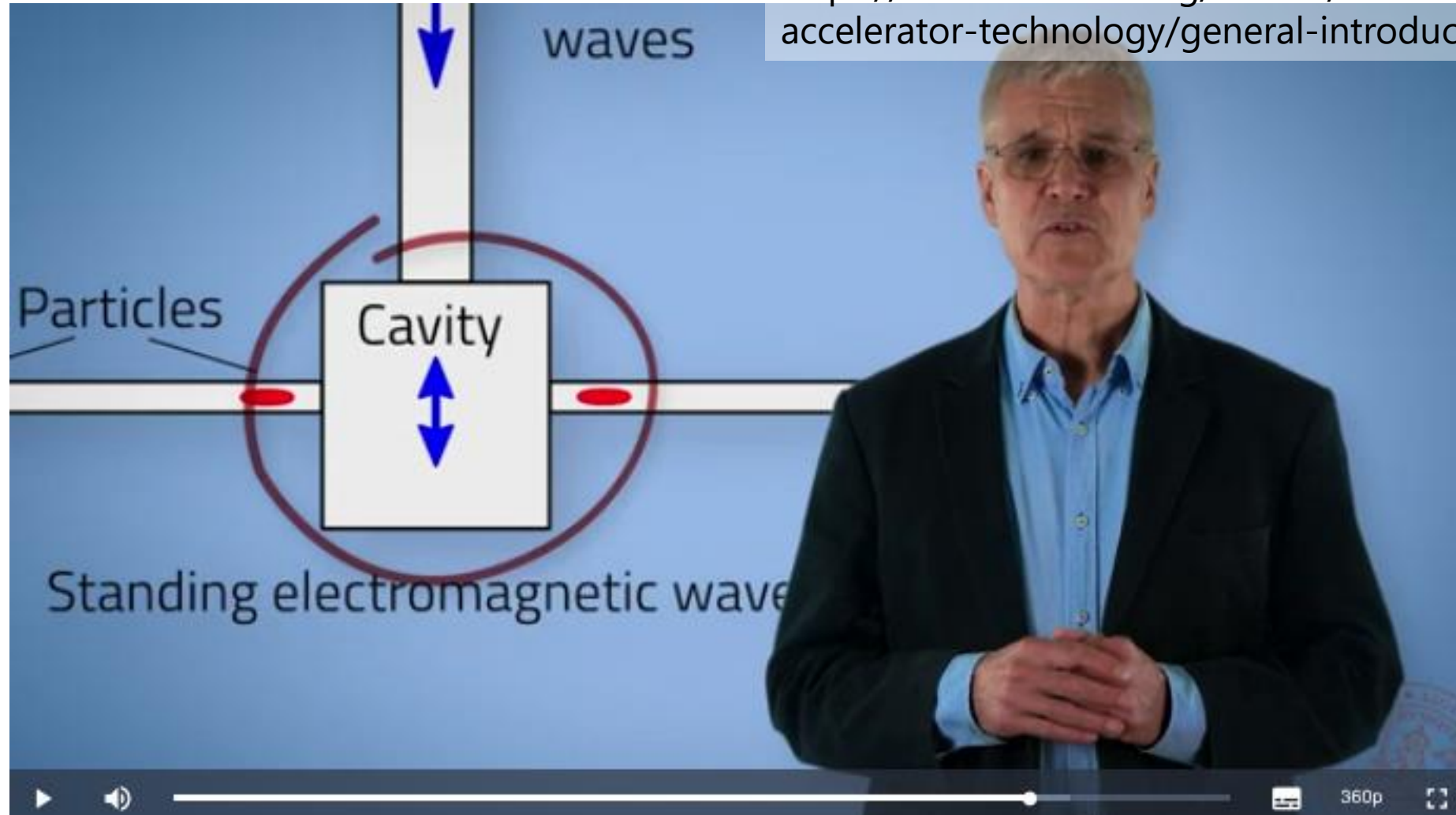
Reading: A mathematical description of the pillbox cavity

Nordic Particle Accelerator Project MOOC



Example of Lecture

<https://www.coursera.org/lecture/fundamentals-particle-accelerator-technology/general-introduction-wf3CB>



Nordic Particle Accelerator Project MOOC

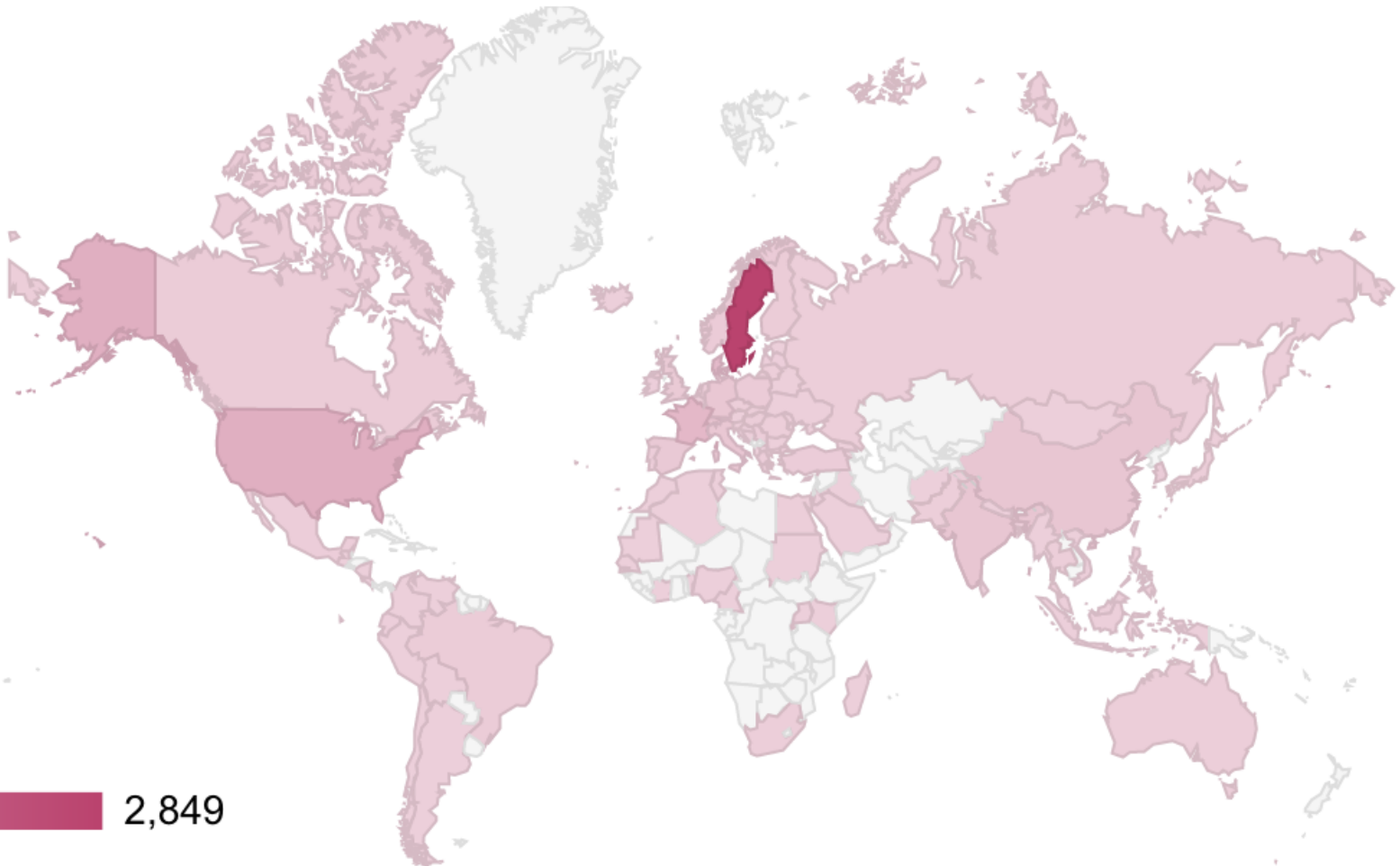


Few statistics

Stats for All Time

We have reached out 100 Countries worldwide !

**In December 2022
15,000 NPAP students**



1 2,849

Next MOOC... Accelerating Teaching



New ERASMUS+ grant

ERASMUS+ grant for a project called “Accelerating Teaching – approaching particle accelerators and new scientific research through online professional development” ([article](#))

EU SchoolsNet, Malmö University, Copenhagen University, Lund University including MAX IV and Vattenhallen, Experimentarium science centre in Copenhagen.
CERN and many others as observers



The primary aspect of the project will be to construct the online resource, but it will also evaluate and explore teachers' experiences from the course, as well as from their use in classroom and non-classroom settings. The project builds on an existing set of summer schools and MOOC, also funded by an ERASMUS funding back in 2015, called Nordic Particle Accelerator Program ([NPAP](#))



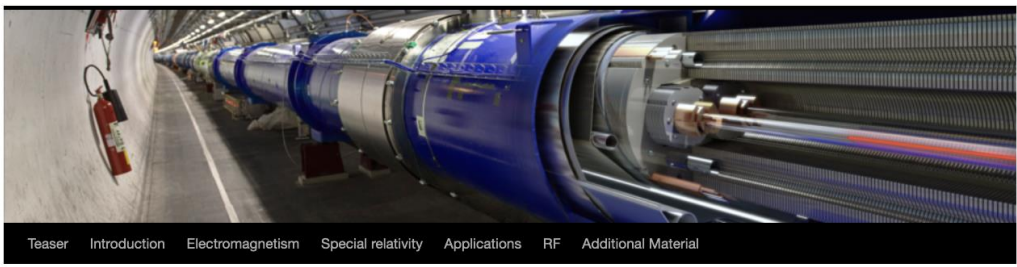
Complement: Next MOOC and I.FAST

Accelerate your Innovative EcoSystem

[Ref: NPAP and Accelerating News](#)

An online course about particle accelerators

Massive Online Open Course on
Accelerator Science and Technology



The course

This course is aimed at student between their 3rd and 5th year of University. It provides an introduction to what are particle accelerators and what they are used for.

If after following this course you would like to know more about particle accelerator, you are encourage to apply to one of the [European Universities teaching Accelerators Physics at graduate level \(Master or PhD\)](#).

[Teaser](#)

[Introduction to Particle Accelerators](#)

[Electromagnetism](#)

[Special Relativity](#)

[Applications of Accelerators](#)

[Radiofrequencies for Particle Accelerators](#)

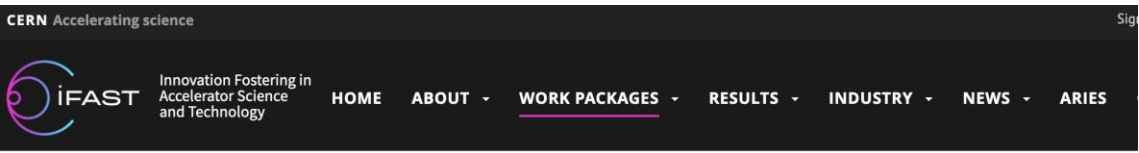


Work funded by ARIES
This work is funded by the ARIES project. ARIES is co-funded by the European Commission Grant Agreement number 73087.

Search

Licence

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Quick links

- WP1: Management
- WP2: Communication
- WP3: Industry engagement
- WP4: Innovation, materials
- WP5: R&D strategies
- WP6: Novel concepts
- WP7: Light sources
- WP8: Magnets
- WP9: Cavities
- WP10: Technologies
- WP11: Sustainability
- WP12: Applications
- WP13: Technology

WP2: Training, communication and outreach for accelerator science and technology

Objectives

- Provide communication, dissemination and outreach tools required to address the project's goals
- Engage the network of communication officers from the major institutes of the European accelerator community
- Set up a Challenge-Based Innovation (CBI) scheme focused on the societal applications of particle accelerators
- Set up a scheme for industrial engineers and technicians to receive training in advanced accelerator technologies
- Facilitate knowledge transfer between the laboratories and industrial companies

Tasks

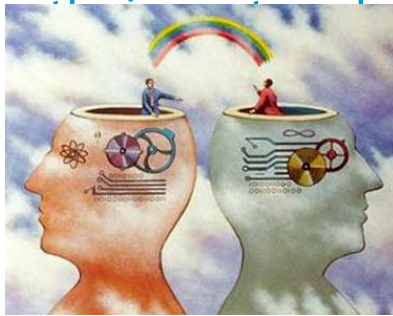
Task	Name	Task Leader
2.1	Management	Ph. Burrows (UOXF)
2.2	Communications and outreach	A. Le Gall (CERN)
2.3	Challenge-Based Innovation (CBI) with particle accelerators	N. Delerue (CNRS)
2.4	Industrial Training associated with Knowledge Transfer	T. Ekelof (UU)

["Accelerate your Innovative EcoSystem"](#)

Particle Accelerators for User Communities



Technology and knowledge transfer are the pillars of the development of this innovative ecosystem, using scientific communication, education and collaboration as



African School of Fundamental Physics and Applications

Photons and **Neutrons** in the quest to solve societal challenges

Research Infrastructures like Light Sources and Neutrons Sources are perfect tools for discoveries, e.g. COVID-19 structure, battery materials.

In this second ASP lecture serie, we focus on the description of such infrastructures and the power of photons and neutrons.

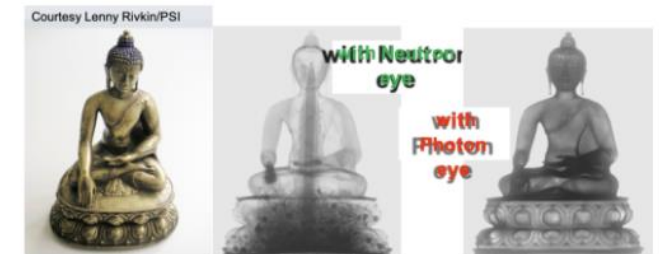
- **Part A:** From November 24 to December 15, 2020
- **Part B:** From January 12 to February 2, 2021

Two examples to learn more about particles accelerators and foster science in developing communities:

African School of Fundamental Physics and Applications (ASP)

In-person & online courses, conferences for students, teachers and learners since 2010 ([intro](#))

- e.g. Synchrotron and Neutron based diffraction and spectroscopic techniques



Images of Buddha using a Neutron Source and a Light Source



MOOC1
Introduction to
Particle Accelerators
(NPAP MOOC)



MOOC2
Fundamentals of
Particle Accelerator
Technology (NPAP
MOOC)



MOOC3
Medical Applications
of Particle
Accelerators (NPAP
MOOC)

Transfer of Knowledge

African School of Fundamental Physics and Applications (ASP) - as a start-up



SEVEN editions completed since 2010 !

ASP2022 in Port Elisabeth / Gqeberha (SA)



A non-profit organization created by a small group of worldwide scientists to stimulate and include more African talented physics students in the world scientific community

The aim of the school is to build capacity in African countries, to harvest, interpret, and exploit the results from physics experiments with particle accelerators, and to increase proficiency in related applications and technologies.

- To contribute to a world w/ equal access to knowledge
- To support financially up to 90 (+97virtual) African students for 2 to 3-week classes
- To establish a biennial educative program to be hosted across Africa
- To provide high quality classes by international re-known Scientists

Transfer of Knowledge

African School of Fundamental Physics and Applications ([ASP](#))



TOPICS OF INTEREST – Broad range of Physics Teaching

Theoretical Physics

- Nuclear and Particle Physics
- Beyond the Standard Model
- Astro-particle physics and Cosmology
- Theoretical Heavy-ion physics
- Linux tutorials

Experimental Physics

- Particle Detectors
- Particle Identification and Data Analysis and statistics
- Exp. Particle physics, current status of the field
- Exp. Nuclear Physics
- Exp. Heavy Ion Physics
- Exp. Astro-particle Physics

Accelerator and Applications and GRID

- Accelerator physics and Technology
- Physics of Particle Beams
- Instrumentation
- Medical Applications
- Neutron and Light Sources
- Energetics and solid state
- GRID and computing
- Digital Library

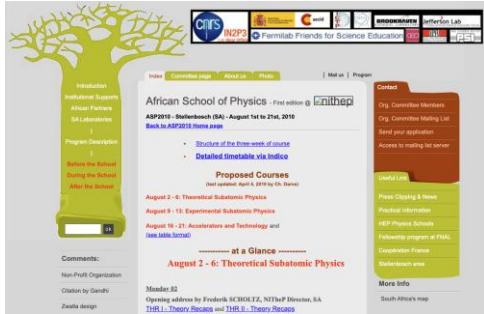
Transfer of Knowledge

<https://www.africanschoolofphysics.org>



ASP in a nutshell - Educating developing communities

From: [ASP2010](#) **to** ONLINE [ASP2020](#) and [ASP2022](#) (Nov 28 – Dec 9, 2022)



- 94 students from 40 African countries in-person engagements,
- an additional up to 97 for online participation
- 80 in-person SA high school teachers
- 450 in-person high school pupils (Dec 5-9) from the region around Gqeberha.

In-person and online !

High School Teachers Program
1-week intensive workshop

Student Program
3-week intensive school
• 3rd year of University to Ph.D.

ASP Conference
1-week International Conference

- Participation of ASP Alumni
- Part. Research Faculties
- Networking & collaborations

Mentorship/ Coaching Program

- Work with Academic Advisors
- Connect Students w/ Researchers
- Place students at Labs
- Support students & help address their academic needs

ASP	Host Country	Applicants	Students	Mentorship	Teachers	Pupils	Conference
2010	South Africa	125	65	Continuously, even when there is no formal school			
2012	Ghana	138	50				
2014	Senegal	330	70				
2016	Rwanda	429	75	Program formalized in 2016. Runs continuously	20	150	
2018	Namibia	523	85		63	> 1200	+60
2020	Morocco						
2021	Online	N/A	94				+649

@ African Light Source – ASFAP → African Accelerator School ?

APS and FIP principle

The openness of the FIP agenda reflects the grassroots origin of this Forum.

Advancing the knowledge of physics and its diffusion by fostering cooperation and communication among physicists of all countries.

Further synergies with the program of the African School of Fundamental Physics and Applications and IUPAP

[* APS Free Trial Student Membership](#)



4288 FIP members in 2022

Year	FIP members
2018	4186
2019	4179
2020	3794
2021	4067
2022	4288

PHYSICS MATTERS

Monthly colloquia series "Physics for Development"

LIVE on-line colloquia that will primarily target and involve some test centers, selected from within the partner countries of the **SESAME** project supported by the APS.

Visit our 27 Past colloquia and forums recordings
and
Attend our next event

PHYSICS MATTERS — On-line Colloquia Series Video



Watch the latest PHYSICS MATTERS edition: **"SPECIAL FORUM : "PHYSICS MATTERS to celebrate the 100 years of existence of the IUPAP"**



[Click Here to View Past PHYSICS MATTERS Colloquia](#)

Date	Title	Speaker	Additional Information
November 22, 2022	"PHYSICS MATTERS to celebrate the 100 years of existence of the IUPAP"  [Description_IUPAP_SPIRO_DAWSON_GREENE_PEPEALTARELLI]	Michel SPIRO IUPAP, CERN, IN2P3 & CEA Silvana Ponce Dawson University of Buenos Aires & IUPAP Laura Greene NHMFL, APS & IUPAP Monica Pepe-Altarelli CERN & IUPAP FR - AR - US - CH	See slides [Slides_Michel_SPIRO] [Slides_Silvana_Ponce_Dawson] [Slides_Laura_Greene] [Slides_Monica_Pepe_Altarelli] See also International Union of Pure and Applied Physics (IUPAP) has turned 100 years

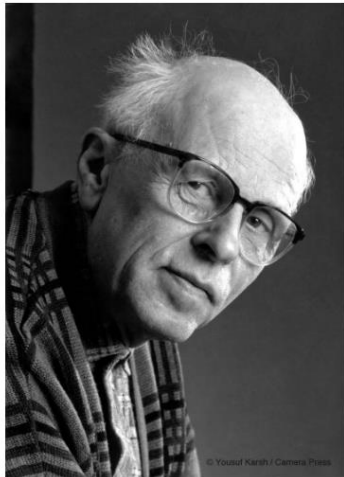
More International Synergies

SCIENCE FOR DEVELOPMENT & SCIENCE FOR PEACE – FIP

21 May 2021 - Physics, Peace, Human Rights: Sakharov-100

28 July 2022 – PHYSICS MATTERS
The Origin of SESAME (YouTube)

Physics, Peace, Human Rights: Sakharov-100



**PHYSICS, PEACE
HUMAN RIGHTS**
Sakharov-100: Celebrating Andrei Sakharov's
Contributions to Science and Humanity

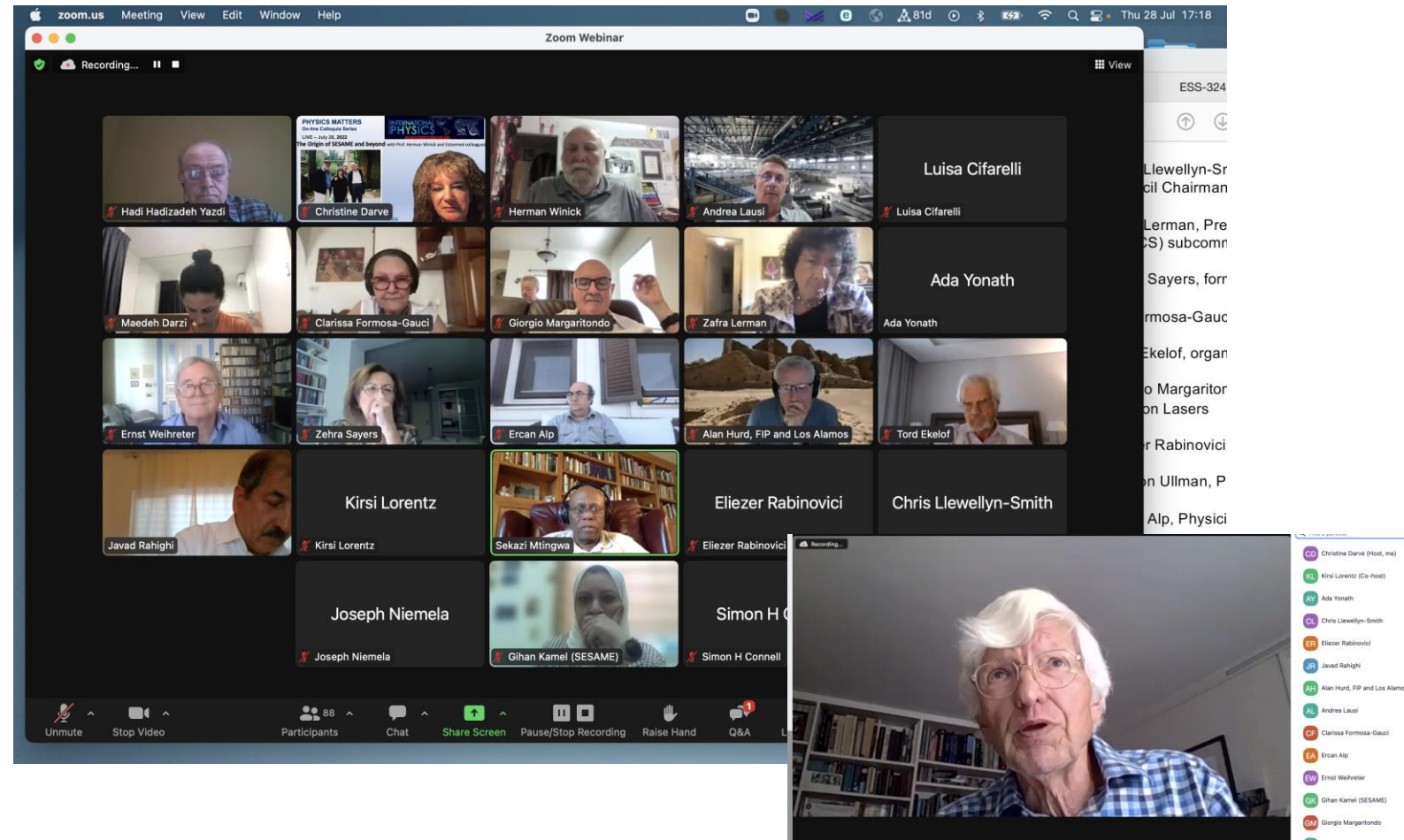
Friday, May 21, 2021 ONLINE 11:00 am – 4:00 pm EDT



AMERICAN PHYSICAL SOCIETY
Forum on the History of Physics
Forum on International Physics
Forum on Physics and Society
Committee on the International Freedom of Scientists
RUSSIAN-AMERICAN SCIENCE ASSOCIATION

Physics, Peace, Human Rights

Sakharov-100
Centennial of Andrei Sakharov's birth
Celebrating his contributions to science and humanity



IUPAP and Accelerator at APS Meetings,

Tuesday, March 7	FIP/D CMP	IUPAP@100: International Science in Changing Societal and Geopolitical Landscapes
IUPAP		Monica Pepe-Altarelli : 100 Years of Existence of the International Union of Pure and Applied Physics, IUPAP
		Silvina Ponce Dawson : The role of IUPAP to Increase the Inclusion of Women and Underrepresented Groups
		Chandralekha SINGH : Challenges and Opportunities in Physics Education for the 21st Century
		Laura Greene : Science Policy Advising and Diplomacy
		Steward Prager : Perspectives on Nuclear Threat and Global Security
April 15-18	FIP/ DPB	<u>Accelerate solving energy crisis : From Fission to Fusion</u>
		Ait Abderrahim Hamid, MYRRHA, " The perspectives of MYRRHA in solving the energy crisis"
		Mieczyslaw Witold Krasny, CERN, "A novel, Gamma-Factory-driven energy source — exploratory studies"
		Ahmed Dhall, PPPL, "Perspective of ARPAE in fusion, in particular R&D and market potential for fusion"
		Ali Haghigat, Nuclear engineering program at Virginia Tech, " Status and outlook of ADS at US"

Conclusion: Science for Society to transcend Boundaries



From Regional, European to International Educational transfer of knowledge

MOOC to support the use and construction of Particle Accelerators

Synergies between Education, Research Infrastructures, and Industry as leitmotif
Innovation is based on a collective and multidisciplinary approach.
Building together tomorrow world !

See more links at "[Accelerate your Innovative EcoSystem](#)"

