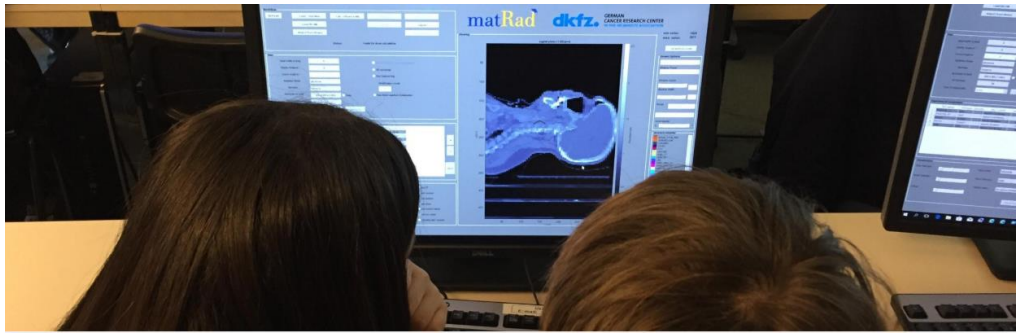
# *IPPOG Particle Therapy Masterclasses Integration to school curricula!*




**International multistakeholder project Youth at STEM for Sustainable Future**
**created by Barbora Bruant Gulejova**

PTMC has been included in 2024 on several occasions:

- **19 June 2024: Youth@STEM4SF, Gymnasium in Zurich, 45 students (13-18), 5 teachers** short adaptation of PTMC (2 hours) included in the school project presented by Yiota Foka and Luka Gandolfi
- **24 June 2024: Youth@STEM4SF, Gymnasium 40 students (16-18), 2 teachers**, 30 minutes version presented by Barbora Bruant Gulejova
- **3 September 2024: Youth@STEM4SF at Engineering Education Conference, Lausanne**
- **1 October 2024: Big Science Business Forum 2024, Trieste,** digital educational game on particle therapy proposal by Youth@STEM4SF competition winners from Slovenia

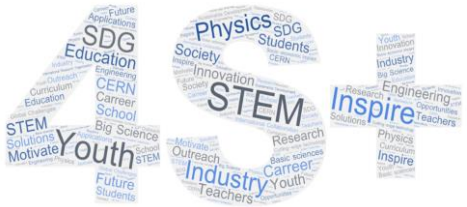
# Youth at STEM for Sustainable Future

*Pioneer high-school program connecting science with society & sustainability through interaction with industry & scientific role models of both genders*

**AIM:**

*Shape science high school curricula internationally*

*International multi-stakeholder concept developed (2019-2023) with*
*(Big) Science, Industry, Outreach, Education, Teachers, Education Policy makers, UN…*



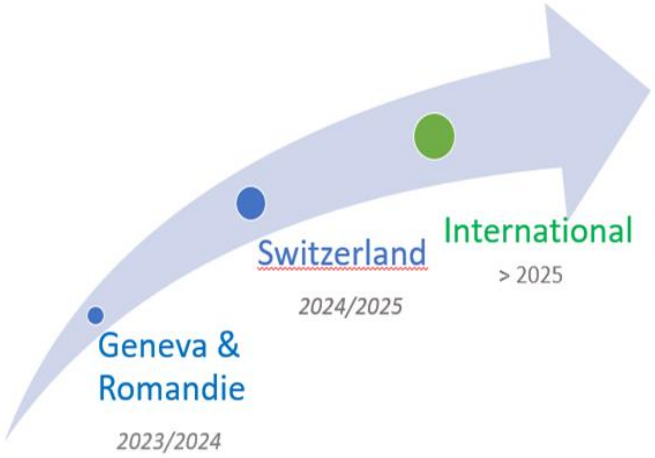

*Approved by multi-disciplinary experts and multiple stakeholders from several countries:*
*Switzerland, Slovakia, Spain, Sweden, Slovenia…*

***Swiss pilot success story in 2023:***

unesco

2022 IYBSSD 2023

International Year of Basic Sciences for Sustainable Development




***Scale up in 2024 + :***

THE EARTH-HUMANITY COALITION

2024 • 2033
International Decade of Sciences for Sustainable Development

education21 · SPS · scnat · Fondation H. Dudley Wright · The Earth-Humanity Coalition · BeLEARN · PERIIA · ENRIITC · CERN · ABB · mps · Daphne Technology · COMSOL · solstis · Empa · CAEN · Universität Bern · EPFL · Université de Genève · satw · GSI · Fincantieri · AREA Science Park · IS · IUPAP · IYBSSD 2022 · iaps · EPS · girep · Elettra Sincrotrone Trieste · INFN · OGS · INAF · BSRF 2024 · EURES · Friuli Venezia Giulia · fit · unitar · Rotary International · The Global Compact · ensa · ICTP · ESO

# Youth at STEM for Sustainable Future

- Thematic day with industry visits
- Competition and Follow-up
- New missing teaching resources **co-creation**

(students, teachers, industry and research, education experts, education authorities)


## Recognition by Swiss education authorities

*«Perfect example of pioneer program implementing new Swiss high school education plan, in terms of connection to SDGs, transversal skills and capacity building for informed career choices»*

*Swiss national competence centre for education on sustainable development*

éducation21

**OBJECTIVE:** Create an official portfolio of missing digital high school education resources connecting science with societal issues, recognised by national education authorities.

- **First co-creation Hackathon 5-6 Sept 2024 Bern with 8 Swiss teams** – 2 winning games sustainable housing insulation, sustainable transport powering) currently under development with EPFL experts
- **Big Science Business Forum international edition March + October 2024, Trieste** – 2 winning games from Slovenia (particle therapy for cancer, sustainable ships powering)

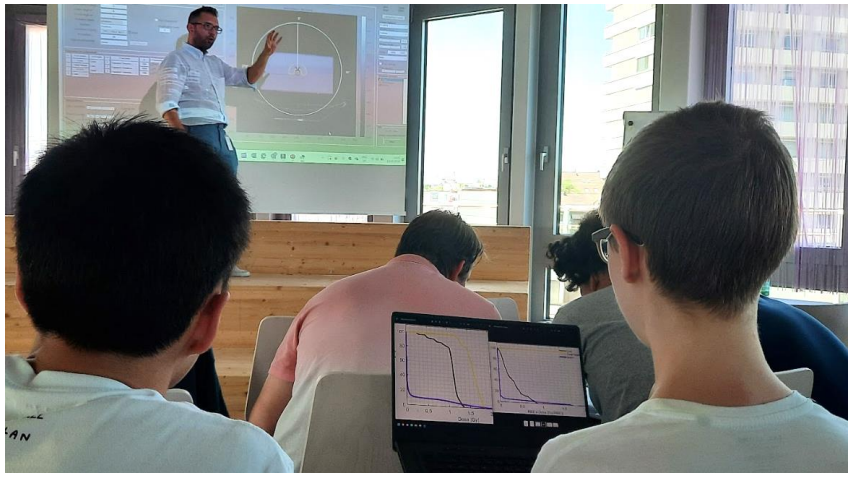
Graasp

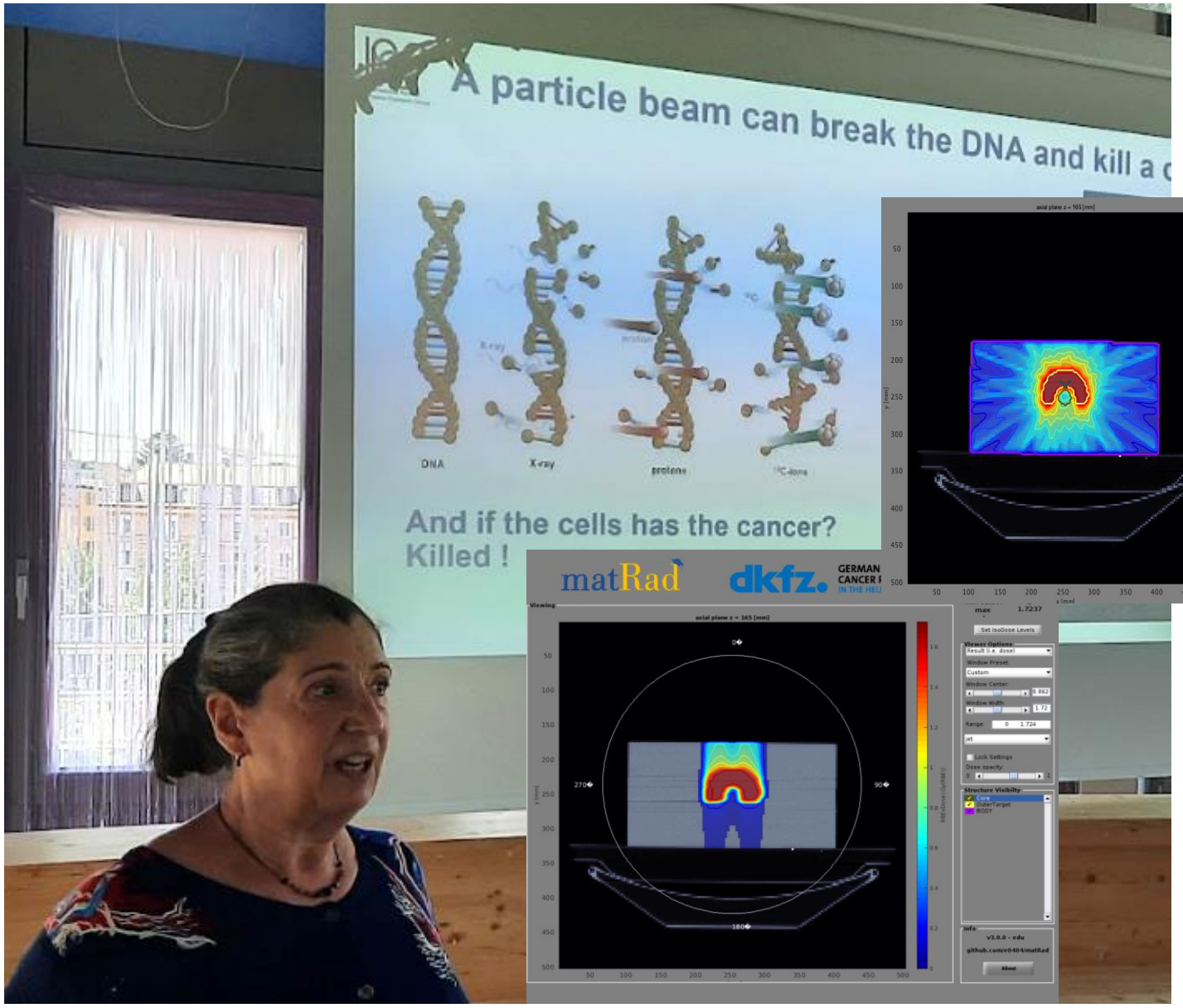
**Your all-in-one learning experience platform**

Build, explore, and share engaging educational resources

EPFL

# *“Particle Therapy for Cancer” 2-hours workshop at Youth@STEM4SF day,* Zurich, June 2024



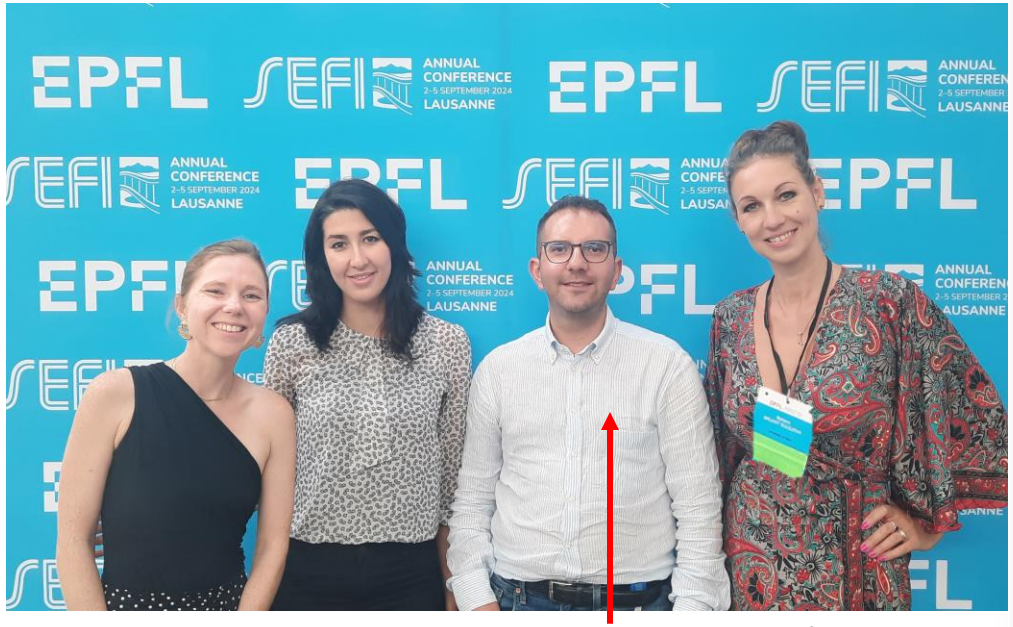



# *Workshop dedicated to research & industry contributors of Youth@STEM4SF to showcase what they do for society and how to turn it digital open educational resources*

## 52nd annual conference of European Society for Engineering Education (SEFI)

SEFI ANNUAL CONFERENCE 2–5 SEPTEMBER 2024 LAUSANNE

***Educating Responsible Engineers***




PTMC presented by Luca Gandolfi

**Engineering a Sustainable Future:**

**Inspiring next STEM generation by Innovation**

B. Bruant Gulejova
University Bern, Albert Einstein Center for Fundamental Physics LHEP
Bern, Switzerland
0009-0001-5134-9398

D. Gillet
EPFL, REACT Group
Lausanne, Switzerland
0000-0002-2570-929X

Proceedings paper!

***Conference Key Areas***:

*Outreach and openness: industry and civil-society in engineering education*
*Teaching the knowledge, skills and attitudes of sustainable engineering*

***Keywords***: *STEM education, Innovation, Sustainable Development, High School*

**ABSTRACT**

The aim of the workshop is to foster a synergetic collaboration between engineers / industry professionals and educators, teachers and students, with goal to address STEM education gaps related to the Sustainable Development Goals (SDGs). Engineers and science experts will be encouraged to reflect on the societal impact of their work and explore ways to transform this impact into inspirational educational content, in form of novel Open Education Resources (OERs) for high, middle and primary schools, which will enhance the accessibility and inclusiveness in sustainable development education. This collaborative co-creation approach has a potential to revitalise engineering education by fostering awareness about sustainability challenges, inspiring future generations, and equipping them with the knowledge to engineer the sustainable future.

**1 INTRODUCTION**

**1.1 Background and Motivation**

Lack of the interest of youth, especially girls, to engage in studies and careers in STEM (Science, Technology, Engineering, Mathematics) subjects, and in particular physics and engineering, is a contra-productive trend. Solutions for global challenges, innovations and technologies, which are needed for sustainable development and economic prosperity, heavily rely on expertise in science and research, but also future society leadership with transversal skills and ability to take fact-based decisions. Even if jobs in STEM grow 3 times faster than in other sectors, the lack of qualified workforce (especially engineers) is strongly felt by tech and physics-based industries already today.

**3 RESULTS**

**3.1 Inspiring engineering stories for sustainable future**

***3.1.1. Hadron therapy for cancer***

Luca Gandolfi (Tera *Foundation on Oncological Hadron Therapy Accelerator*) and Yiota Foka (GSI [15]) presented the educational program connecting STEM, in particular particle physics with medicine, particle therapy for cancer treatment, particular sensitive topic. Under the umbrella of the International Particle Physics Outreach Group (IPPOG) [16] International MasterClass programme [17], a Particle Therapy MasterClass (PTMC) [18, 19] package was developed, where particle physicist reach to high schools students (e.g. in 2021 online version attracted 1500 students in 20 countries). The main idea is to (a) provide a basic understanding of cer radiation therapy, (b) demonstrate that fundamental properties of particle eractions with matter, which are used for detection in physics experiments, are also e basis for treating cancer tumours; and (c) show that the same accelerator technologies are used in both, research laboratories and therapy centres. During this experience students use the become a team of medical doctors and scientists, using the open-source professional Treatment Planning software matRad, developed for research and training by DKFZ, the German cancer research institute, Heidelberg. With this tool students simulate the radiation of cancer and healthy tissue with different types of particles (photons (X-rays), protons, ions…) learning how important it is to understand the physics of interactions of different elementary particles. Students experience that photons irradiate also healthy tissue before and after the target (tumor), while protons and ions (e.g. carbon) deposit their energy at the target only, and thus spare the healthy tissue.

Short adaptation of the PTMC (which is usually the whole day activity) has been implemented at the Youth@STEM4SF day in Zurich in June 2024. The aim is to develop short user-friendly gamified version of the matRad PTMC, that would be accessible online (e.g. in form of Graasp OERs) without need of installation of software package, and providing an engaging, inquiry-based learning tool implementable to science curricula for the use by the high school teachers.

***3.1.2. Engineering innovation for water preservation***

One of the challenges we face as a society today, is the clean water scarcity. The innovative solutions are required that only science and technology can provide. The innovative start-up GJOSA [20], created by SWATCH engineers, and integrated to LOREAL, provides Swiss engineering innovation for water preservation. Intelligent solutions engineer at GJOSA, Caroline Jackson, presented how skills learned in STEM are applied at GJOSA technology to create water-efficient showerheads that reduce water consumption without compromising user experience, while minimizing waste.

Designing a water-saving showerhead relies heavily on various scientific concepts learned in engineering classes [21,22]. Fluid dynamics plays a crucial role in understanding how water flows through pipes and nozzles, ensuring efficient flow with minimal water consumption. The continuity equation aids engineers in calculating how reducing the nozzle size increases water speed while using less volume. Thermodynamics also comes into play, as the showerhead is designed to conserve not only water but energy, reducing the need to heat excess water. Finally, problem-

# 3. Results

## 3.1. Inspiring engineering stories for sustainable future

### *3.1.1. Hadron therapy for cancer*

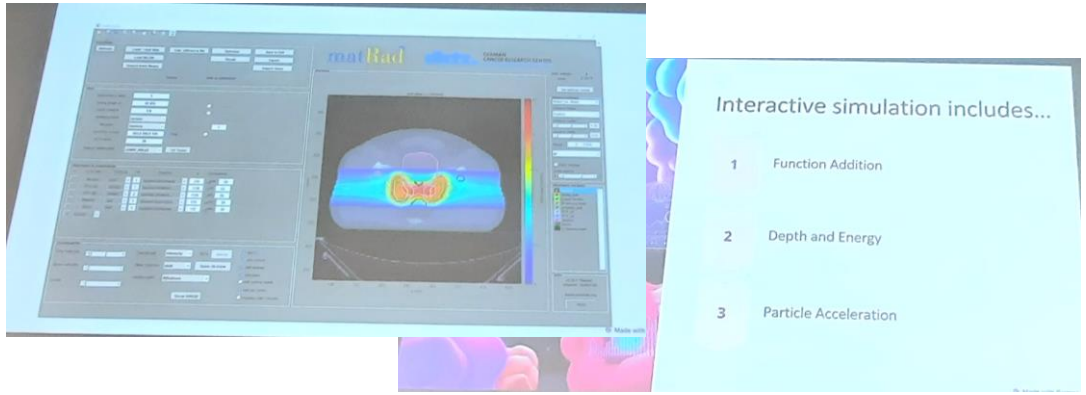
Luca Gandolfi (Tera *Foundation on Oncological Hadron Therapy Accelerator*) and Yiota Foka (GSI []) presented the educational program connecting STEM, in particular particle physics with medicine, particle therapy for cancer treatment, particular sensitive topic. Under the umbrella of the International Particle Physics Outreach Group (IPPOG) [] International MasterClass programme [], a Particle Therapy MasterClass (PTMC) [, ] package was developed, where particle physicist reach to high schools students (e.g. in 2021 online version attracted 1500 students in 20 countries). The main idea is to (a) provide a basic understanding of cancer radiation therapy, (b) demonstrate that fundamental properties of particle interactions with matter, which are used for detection in physics experiments, are also the basis for treating cancer tumours; and (c) show that the same accelerator technologies are used in both, research laboratories and therapy centres. During this experience students use the become a team of medical doctors and scientists, using the open-source professional Treatment Planning software matRad, developed for research and training by DKFZ, the German cancer research institute, Heidelberg. With this tool students simulate the radiation of cancer and healthy tissue with different types of particles (photons (X-rays), protons, ions…) learning how important it is to understand the physics of interactions of different elementary particles. Students experience that photons irradiate also healthy tissue before and after the target (tumor), while protons and ions (e.g. carbon) deposit their energy at the target only, and thus spare the healthy tissue.

Short adaptation of the PTMC (which is usually the whole day activity) has been implemented at the Youth@STEM4SF day in Zurich in June 2024. The aim is to develop short user-friendly gamified version of the matRad PTMC, that would be accessible online (e.g. in form of Graasp OERs) without need of installation of software package, and providing an engaging, inquiry-based learning tool implementable to science curricula for the use by the high school teachers.

# *Youth@STEM4SF competition award ceremony, IUPAP satellite event at Big Science Business Forum, 1 October 2024*


**Winning project:**

*From smashing protons in search of new particles to finding cancer treatment*




**IPPOG's support very welcome!**