Outreach of Applications for Society

https://docs.google.com/document/d/10KIu9nDx_Cliz16QYE7LqgtncfrwWWzB31ZRT7vDLR0/edit

IPPOG Working Group: "Outreach of Applications for Society"

Formed October 2018 at 16th IPPOG meeting:
See panel report:
https://indico.cern.ch/event/742487/contributions/3147691/attachments/1729453/2794540/Panel_Outreach_PP_applications_report.pdf

Conveners:
Barbora Bruant Gulejova, Yiota Foka

Advisors:
Manuela Cirilli, Manjit Dosajnh, Anais Rassat

REMIT and STRATEGY:

1) Collect information about applications from PP and fundamental research in general used for the benefit of the society: stories, pictures, videos, animations, presentations, articles, posters….

2) Write easy understandable stories of fundamental research applications for society, which are currently missing and will be part of the IPPOG resource database (category "PP and society")

Outreach of Applications for Society

4) Resources to be used:
   - KT webpage
   - links and materials provided by CERN experts (see general resources below)
   - CERN brochures: on impact, KT reports etc…
   - search for companies, who are part of the stories and work with them (CAEN, etc.)

   - find all here:
   https://docs.google.com/document/d/1vJnm2a7wmzHVHpM_0xUVeNw_JMPqmwQIbdZ-HwUozGc/edit?usp=sharing
   - Inspiration would come also from the panel discussion on "**Outreach on the benefits to society from fundamental research**" on Friday morning at IPPOG meeting:
   https://indico.cern.ch/event/767060/timetable/?view=standard

5) Format of the stories:

Abstract
Structure of the body
Pictures
Resources
Related links

In general the aim is to provide material within a context (preferably text) associating the different resources (photos, animations etc)

6) Recommended length: ~ 2 pages

Outreach of Applications for Society

TOPIC	RESOURCES	COMMENT	PERSON(S)	STATUS
All applications	General resources			
Medical applications	General medical applications resources			
PET	Material from Martin Wensveen (CERN) https://drive.google.com/open?id=1YbwygQPNc_6Qd0Z4ninEGqNfcQTN_vRI + Intreview to be done later; + Maybe include CAEN PET scanner kit	PET using new type of dense scintillating crystals; CERN has pioneer contribution to forerunner of PET;	Yiota Despina Andrej	
RMI		PET and MRI imaging combined in single device thanks to new generation of CERN detectors		
Hadron therapy	Material from Hans Specht (GSI) https://drive.google.com/open?id=1eSggw2CtmKKbUL7N0KJ0DqXHcBHRZQZ3 + interview to be done later	treating tumours with beams of protons and light ions reducing the radiation exposure of healthy issue (3 HT centres in Europe built in collaboration with CERN; CERN supports development of miniature linear accelerators for proton	Katharina Bulatovic	https://docs.google.com/document/d/1NRGDrLeS-Spr9BfRg1GlYmvm__rFgrizCFF

A nice example: GPS

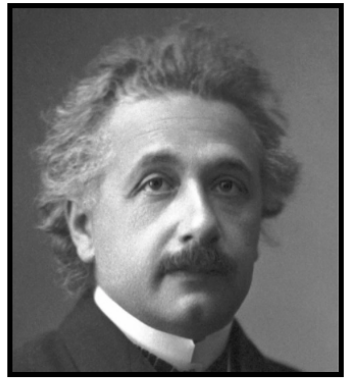
by lorenzo.galante@to.infn.it

GPS and Einstein Theories			Lorenzo	https://docs.google.com/document/d/1LjDjQFMkSj4hYjHrNaTF4OaEhxiIX

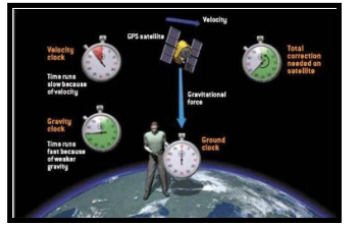
WANT TO KNOW WHERE YOU ARE?
BETTER KNOWING ABOUT EINSTEIN's THEORIES

Abstract.
Can Research in theoretical Physics and in mathematical structures bring innovation? The question touches on complex issues and is still open to many possible answers. Here we report one example about the Einstein's Theory about Space and Time.

The Story.
Nowadays is very easy to know where we are and when we are in a certain position. We just have a look at our GPS. The Global Positioning System which relies on 24 satellites that transmit information on where they are. Your GPS unit registers the exact time at which it receives that information from each satellite and then evaluates how long it took for the individual signals to arrive. In first approximation, by multiplying the elapsed time by the speed of light, it can figure out how far it is from each satellite, compare those distances, and find its own position. What is less known is that in order to perform this task with precision we have to take into account both the Einstein's theories about space and time. It's not that difficult to understand why. The GPS tells our position in space and time and both space and time are ruled by the theories of Special and General Relativity.



This video can give you a good overview of the situation.



The return of a favour.
The GPS wouldn't exist if it were not for Relativity. However it has found the way to return the favour to the Einstein's theories. How? With a launch failure of one of the satellites. In this video the full story.

Useful LInks:

https://www.wired.com/2011/06/st-equation-gps/ [short article from "Wired"]

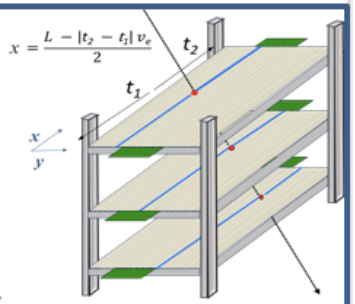
http://theconversation.com/how-einsteins-general-theory-of-relativity-killed-off-common-sense-physics-50042

CENTRO FERMI
Museo Storico della Fisica e Centro Studi e Ricerche Enrico Fermi

M.Trimarchi: A GNSS measurement for High School Students of EEE Project

Extreme Energy Events
Science inside Schools

- The EEE experiment is an outreach project by Centro Fermi, in collaboration with INFN,CERN and MIUR, designed to study Cosmic Rays and related phenomena, via a synchronous sparse network of 56 tracking detectors installed in Italian High Schools, each made of 3 MRPC detectors, deployed over an area covering more than 10° in latitude and 11° in longitude, corresponding to more than 3 x 10^5 km^2.



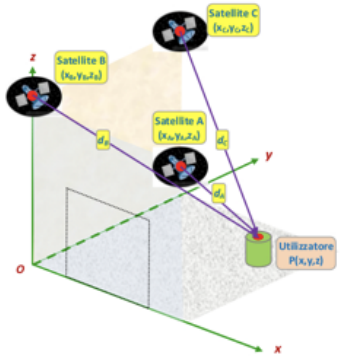
EEE High school students are involved in monthly Coordination Meetings and yearly General Conferences

- Students report about their scientific activities
- Researchers propose General Lessons and Masterclasses

10° Conference on Centro Fermi Projects – Turin 2019

- Researchers of Istituto Nazionale di Ricerca Metrologica proposed a masterclass on "Simulation of GNSS fuctioning by measuring the range between local representative receiver and satellites

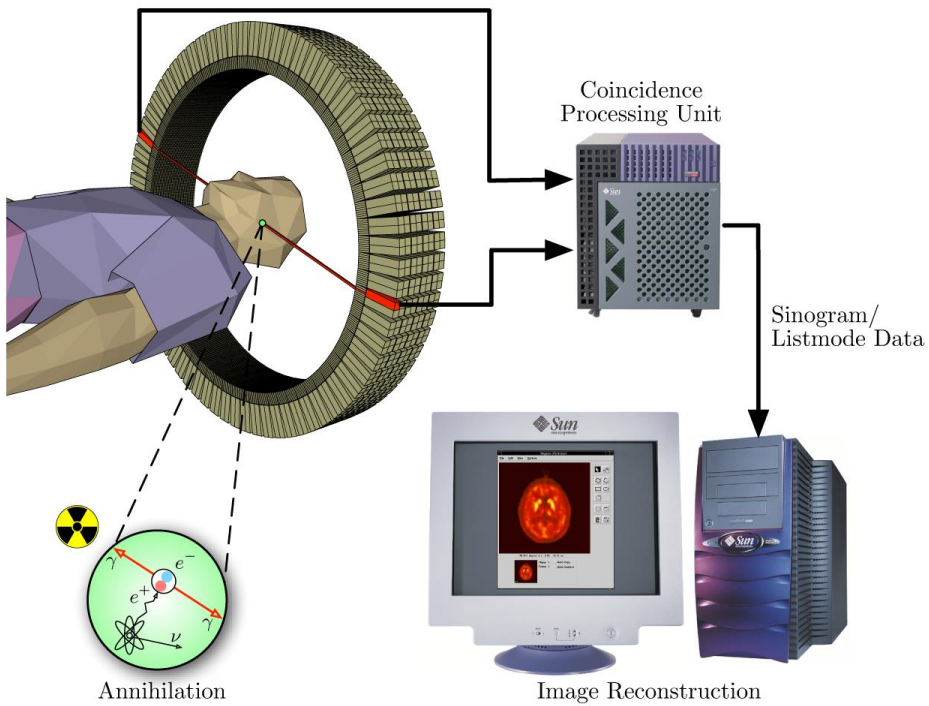
- Tasks of the GNSS masterclass:
- Measurement of the satellites positions and their distances from an object
- Obtain the object position by inverting the GNSS equations
- Theory and code on the IPPOG database



POSITRON EMISSION TOMOGRAPHY

By Despina

Under construction
(.doc, .ppt, .ppt(poster)



Principle

Positron-emission tomography (PET) focuses on differences in the body's metabolism. PET uses molecules involved in metabolic processes, which are labelled by a positron-emitting radioisotope. The molecule, once injected, is taken up in different proportions by healthy and cancerous cells. The emitted positrons annihilate with electrons in the surrounding atoms and produce a back-to-back pair of γ rays of 511 keV. The γ radiation is detected to reveal the distribution of the isotope in the patient's body.

Required equipment

Photon detectors with good energy resolution (for low-energy photons) and high efficiency
Application (from particle physics)
The photon detectors used are basically are scintillators coupled to photomultipliers; development of TOF (Time-Of-Flight) PET is of particular interest, since it provides accuracy in localizing the tumor with less dose for the patient.

Detectors used

NaI(Tl) with PMTs in the early PET scanners
New scintillators introduced in the course of the years (already developed for particle physics experiments)
BGO ($Bi_4Ge_3O_{12}$)
CsI(Tl)
LSO (Lu_2SiO_5: Cerium-doped lutetium oxyorthosilicate) etc
Photomultiplier tubes evolved to multichannel photomultipliers, Avalanche Photodiodes (APDs) and Silicon PhotoMultipliers

About TOF-PET

Useful Links

Positron Emission Tomography and CERN (history of PET)
https://drive.google.com/file/d/1YbwygQPNc_6Qd0Z4ninEGqNfcQTN_vRl/view

Recent developments in PET Detector Technology
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2891023/

https://cerncourier.com/a/clearpem-clarifies-breast-cancer-diagnosis/

New opportunities for high time resolution clinical TOF PET
https://link.springer.com/article/10.1007/s40336-019-00316-5

Total body PET
https://explorer.ucdavis.edu/media/video
https://explorer.ucdavis.edu/news

https://physicsworld.com/a/pennpet-explorer-acquires-first-human-images/

https://www.youtube.com/watch?v=Op0eTSYXx8g

Particle Therapy
By Yiota

Outreach of Applications for Society: Particle Therapy

Ions for cancer therapy: next generation facility to propel cancer research and therapy with heavy ion beams.

The battle against cancer is a priority for our society. Twenty years after the design of the initial generation of such facilities[1], the time is ripe for a **breakthrough in accelerator technology and treatment modalities** that will make cancer treatment with heavy ion beams accessible to a larger fraction of people. After years of experimentation and clinical trials, the use of particle beams for radiotherapy of cancer has proven its advantages over conven many types of cancer[2] (with **particle beams** leaving a low surrounding the tumour). The goal of particle therapy is not requires a smaller and less expensive infrastructure, but to pr alternative tool for the fraction of tumours that are **not cura better survival rates** or **lower recurrences** when treated with

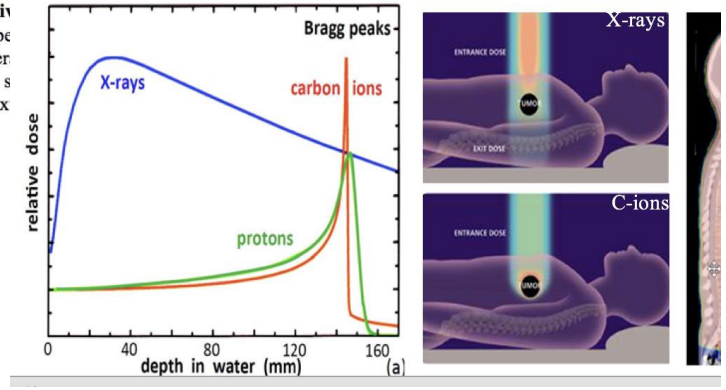
In the past decades, therapy with protons has become widely as 24 centres in Europe[3]. Therapy with **heavy ions** instead, in s or X-rays, is delivered only in four centres in Europe primar **required infrastructure**. Thanks to their higher energy depos are effective for tumours resistant to X-rays and protons, p deposit a lower overall dose. Recent tests of combining heavy encouraging results in reducing diffused cancers, via the immur released during heavy ion treatment. In addition to Carbon, ther with other heavy ions as well as a strong demand for **clinical** treatment procedures.

All these elements lead to consider heavy ion therapy as **one** However, to make it accessible to a larger fraction of the Europ a breakthrough with respect to the present generation of com drastically needed. The new infrastructure must be **innovati sustainable**; to propel this new generation, it must have a spe extensive use of **superconductivity** is proposed for the acceler and operation costs, and also to adopt innovative beyond s modalities in order to provide users and patients with ex requirements for future experimentations and clinical trials.

A more verbose example: extracts from proposal for design study: next generation ion facility for cancer therapy

X-rays (photons) radiotherapy (RT) is a widely used treatment modality to fight various types of cancer, exploiting the damage made by radiation to the cells' DNA when the radiation dose is concentrated on the tumour. X-rays have a dose distribution in tissues characterised by an almost exponential attenuation and absorption, delivering a large energy near the beam entrance, reaching a maximum at few cm depth, and then continuing to deposit significant amounts of energy beyond the cancer target. To minimise the radiation dose and the damage to the healthy tissues around the tumour, X-ray RT is usually administered from different angles, which improves the situation but still leaves important radiation doses in the surrounding tissues. The X-rays for RT are produced by relatively small electron linear accelerators installed in hospitals; more than 3500 RT units are presently installed in the EU[4]. This treatment technique has now reached a high level of sophistication, in terms of simulations, planning, delivery and the introduction of high-precision techniques as Intensity-Modulated RT (IMRT) based on 3D CT and MRI diagnostic imaging.

The **high radiation dose around the tumour** remains however a major concern, in particular in the treatment of tumours close to critical organs or for young patients that ha[illegible] secondary tumours in the surrounding organs in their lifetime. Impaired q have sustained damage to organs close to the tumour is another cause for



In Europe GSI was the first to treat 440 patients with carbon ions. This subsequently led to the construction of the HIT-facility in Heidelberg and then Marburg (Germany). Thus far, around 28.000 patients have received carbon treatment at 13 functioning centres in Japan, Germany, Italy, Austria and China. Further facilities are being planned in USA, South Korea, Taiwan and France. Although the number of patients treated with ions adds up to only about 15% of those treated with protons (Figure 6), carbon centres have reported impressive disease-free survival rates with their initial studies.

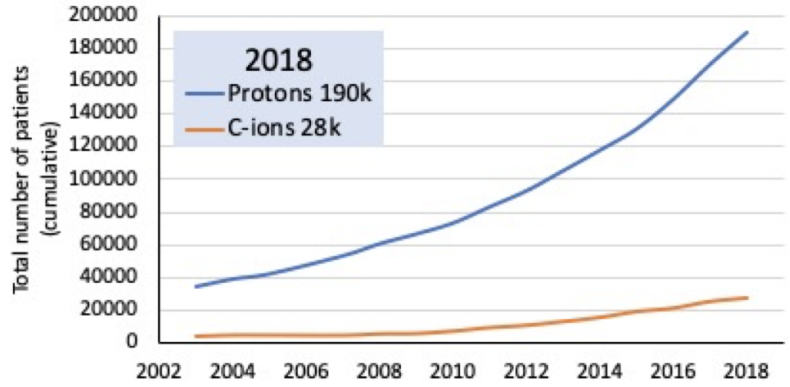


Figure 6: Patients treated with protons and C-ions worldwide. Source: PTCOG.

The present state of clinical knowledge still requires further evidence-based medicine and more comparative clinical trials aimed at confirming and extending the use of heavy ion therapy.

Further studies will bring heavy ion therapy, particularly multi-ion therapy, into the realm of precision and personalised medicine and will allow exploring emerging treatment modalities (such as microbeams or FLASH therapy).

What is the societal IMPACT of particle physics?

JENAS 2019

Knowledge Transfer
Accelerating innovation

Manuela Cirilli
CERN Knowledge Transfer Group

NuPECC

www.nupecc.org

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- Members' Addresses
- Terms of Reference
- Meetings
- Presentations Archive
- NuPECC Indico
- Calendar of Events
- Members' Area

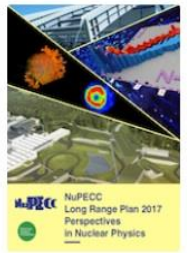
ACTIVITIES

- NuPECC Task Force
- IUPAP WG9
- STRONG2020
- ENSAR2
- Small Scale Facilities
- ECT*
- PANS
- NUPEX
- Miscellaneous Links

PUBLICATIONS

Full List
1990-2019

Long Range Plan
Perspectives in Nuclear Physics



Nuclear Physics News
Online/PDF

NEWS

FAIR Construction Progress Video
September 2019

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- Conference Support
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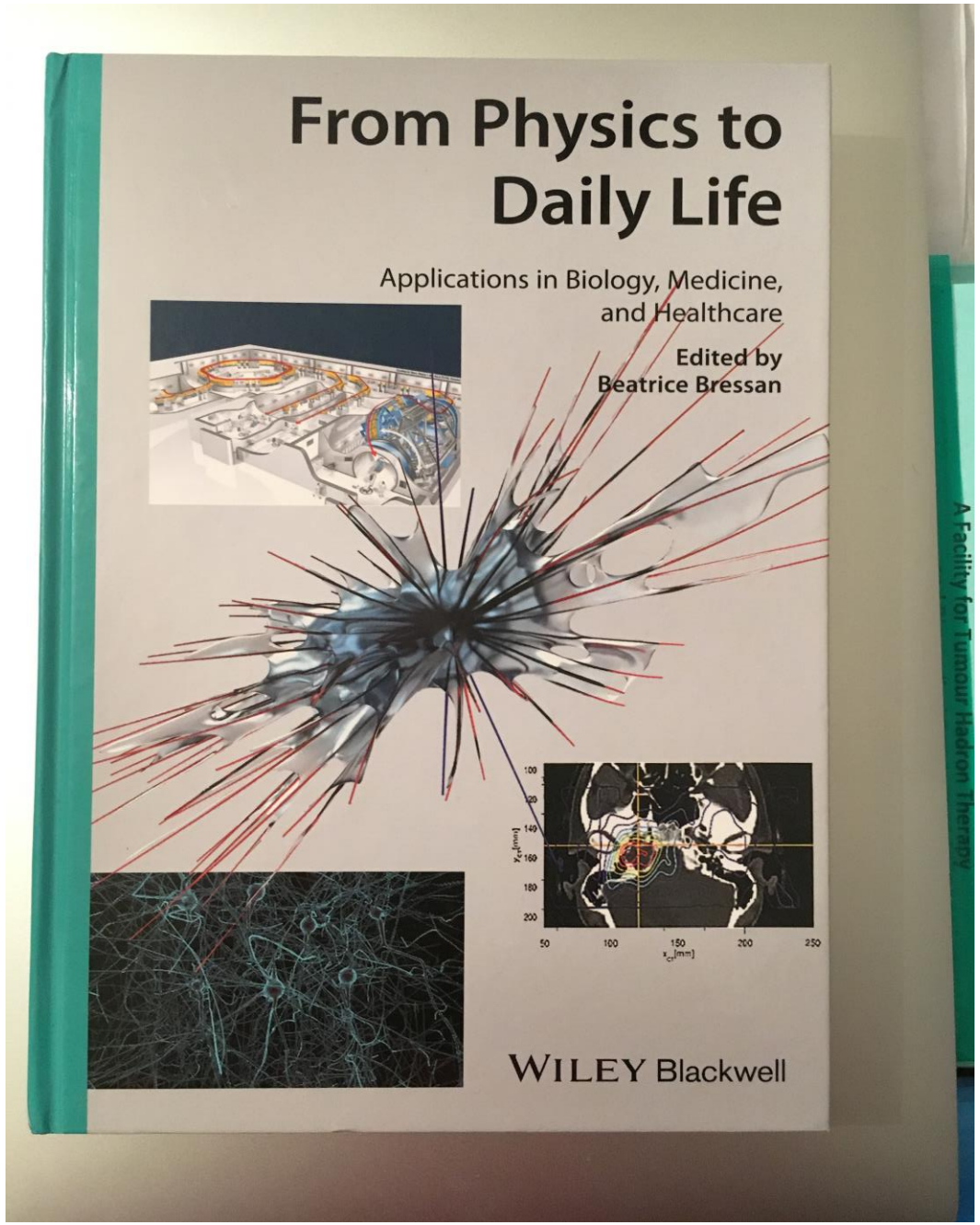
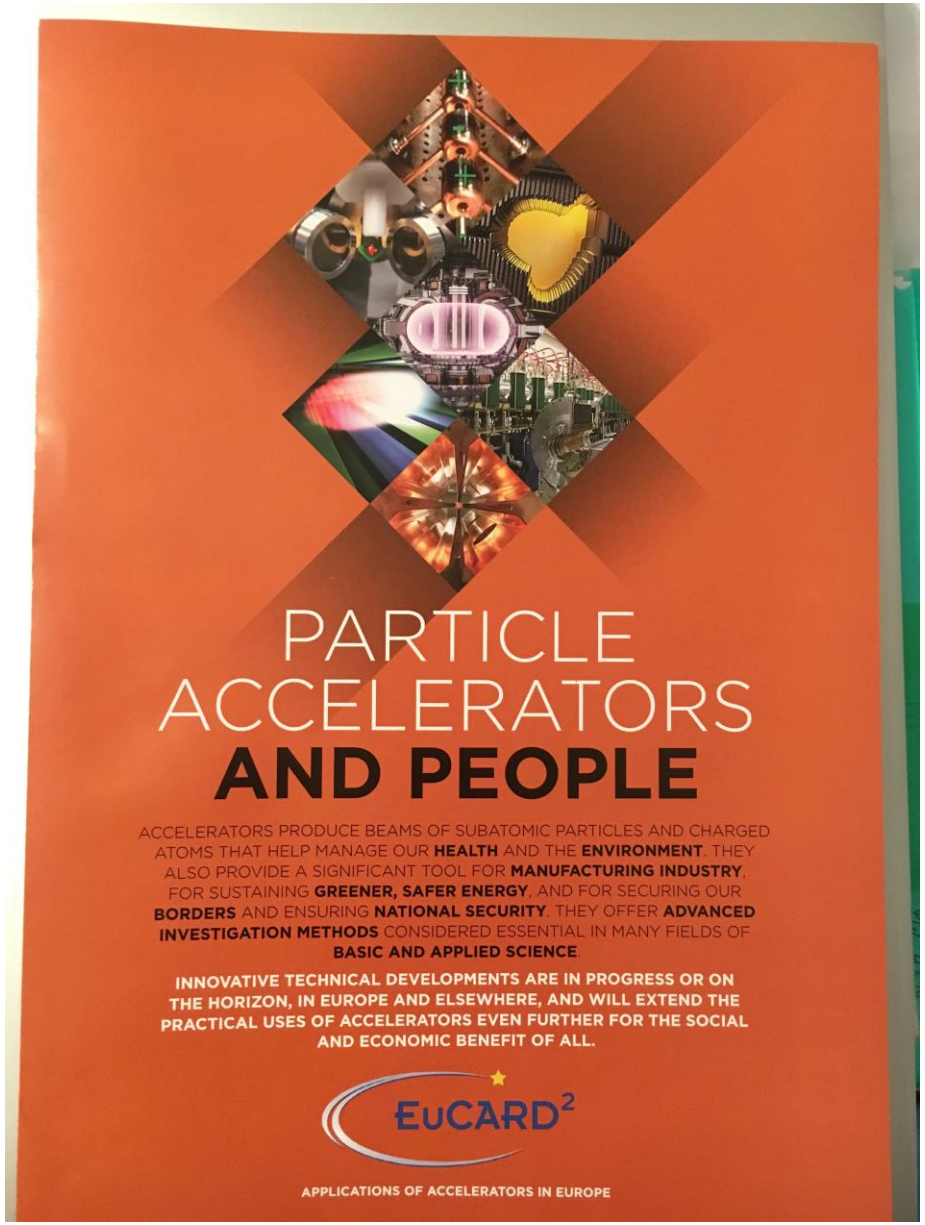


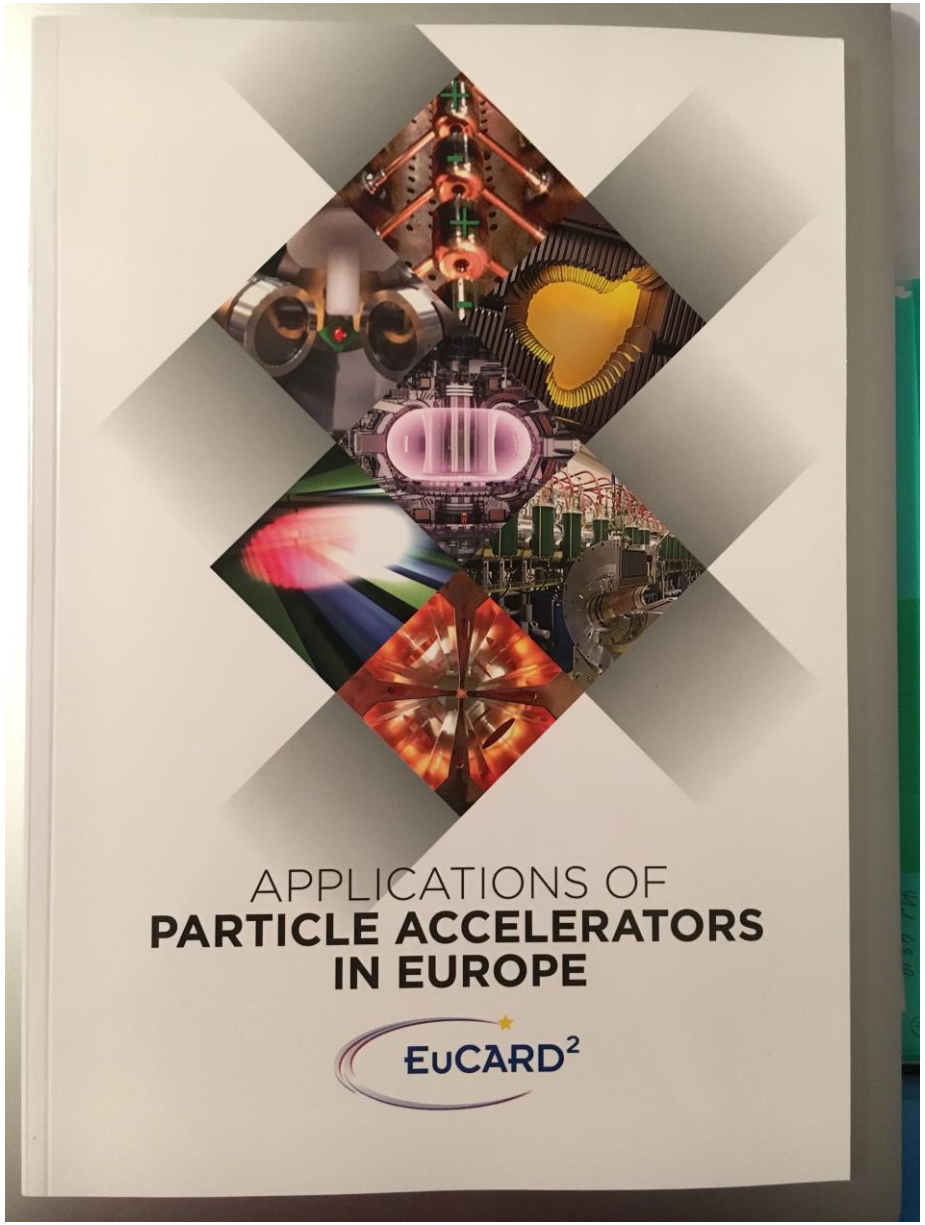
More resources

Special Edition for 60th CERN anniversary, 2 volumes
Accompanied by related lectures

Chapter on PET
Accompanied by presentation and interview
on “human aspects story” by MW (still to be processed)

More resources: Accelerators for people EuCARD2





Workshop on Ions

for Cancer Therapy, Space Research and Material Science

SPACE RESEARCH WORKSHOP ON IONS FOR CANCER THERAPY MATERIAL SCIENCE

Chania, Crete, Greece

26 - 30 August 2017

Workshop Main Topics

28-30 of August at Great Arsenali

Particle therapy status
- Centres worldwide
- Treatment planning and imaging novel methods
- Challenges, new R&D directions

Space research and dosimetry
Nanotechnology, electronics and material research
Modelling and benchmarking of experiments
Novel accelerators and training

Public Events

26 of August - science fair at Neorio Moro
27 of August - public talks at Great Arsenali
30 of August - coffee with scientists at Neorio Moro

https://indico.cern.ch/e/ions2(

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PIMMS2 @CERN

Workshop
Location Archamps, France
Venue: European Scientific institute (ESI)
Dates: 19-21 June 2018

Ideas and technologies for a next-generation facility for medical research and therapy with ions

Proposal submitted 12 nov 2019

https://indico.cern.ch/e/ions2018

MAIN TOPICS:
- EXISTING FACILITIES
- CURRENT INITIATIVES
- NEW TECHNOLOGIES
- DESIGN PARAMETERS
- TECHNICAL OPTIONS

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CERN ARIES esi FAIR EMMI GSI ENLIGHT

More resources

Public Event, scenario and material

IONS2017 https://indico.cern.ch/e/ions2017

Sunday 27 august at 20:15

While people come play animations
- of event displays (as we had them in the big laptop)
- videos from CERN and GSI/FAIR
- http://cds.cern.ch/record/2020780
- http://cds.cern.ch/record/1495143
- tp://cds.cern.ch/record/1228924

Last film before starting:
a. *video on CERN: http://cds.cern.ch/record/986165*

Start
2. YF welcome and explaining the basic idea
3. YF thanks to all locals that helped: list of names and titles
4. YF call Kanelos to greet the public

5. **YF call Kalliopi for singing**

6. YF call Tasos Liolios (15'')
   a. Tasos: Fundamental research, CERN, basics of accelerators, LHC program, discoveries: Higgs, Matter-AntiMatter, Quark-gluon-plasma….
   Stress greek contributions

7. YF fill in: CERN is best known for Higgs boson discovery and Nobel price but as Tasos Liolios said ALICE is using collisions of lead ions to create and study quark gluon plasma, a primordial type of matter that existed at the early universe after the big bang

8. **YF call Kalliopi for singing** (to have time to call Despina)

9. YF call Despina Chatzifotiadou, virtual visit at CERN, ALICE control room
   - *Despina: see video on ALICE*
   - *http://cds.cern.ch/record/1018975?ln=en*
   - Despina: about QGP and ALICE via vidyo (< 15'')

11. YF call Christina Kourkoumeli (15'')
    a. Christina: research at CERN and education
    b. CERN beam for schools; you will have the opportunity of a presentation by Curiosity science team (application for beam, listed 10th)
    c. IPPOG and MasterClasses
    d. Creations
    e. Activities in Greece

12. YF call Astrinos Tsoutsoudakis
    - Astrinos: presentation of the activities of the team

13. YF fill in: while the primary aim is to develop the tools (accelerators and detectors) for fundamental research purposes, we always try to identify cases of use in everyday life. Some notable examples are: the web….
    Most importantly: the use os such tools in medicine and in particular diagnosis and therapy of cancer that is the todays theme

12. YF call Manjit (15''):
    a. see video as an intro: http://cds.cern.ch/record/1611721?ln=en
    b. Manjit: developments for research and their applications for cancer therapy
    c. *Manjit: see video as summary:* http://cds.cern.ch/record/2002120

    An interactive virtual visit to a hadrotherapy centre:
    http://www.cern.nymus3d.nl/maps# (not used)

14. YF call Kalliopi: singing

15. YF call Giorgos Dedes (30'')
    a. Giorgos presentation on details on cancer therapy

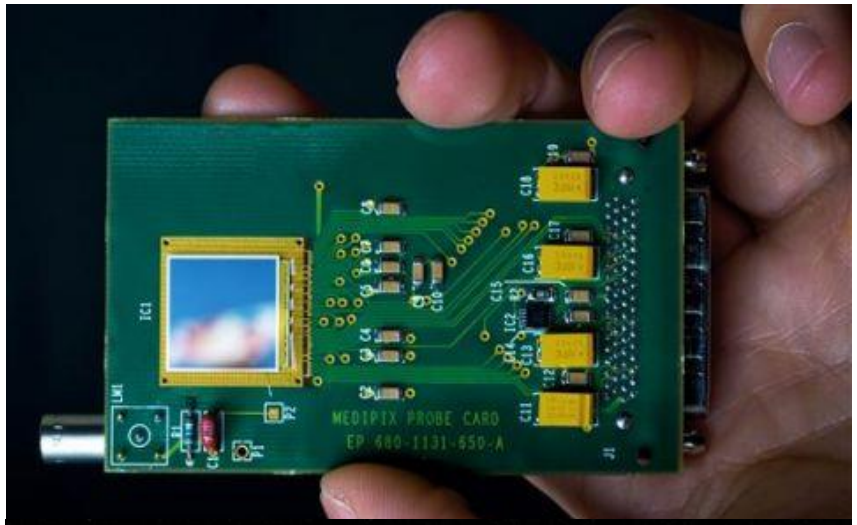
16. YF call Kalliopi: singing

17. YF call speakers for questions

18. YF call Kalliopi: last song, flowers !!

More resources

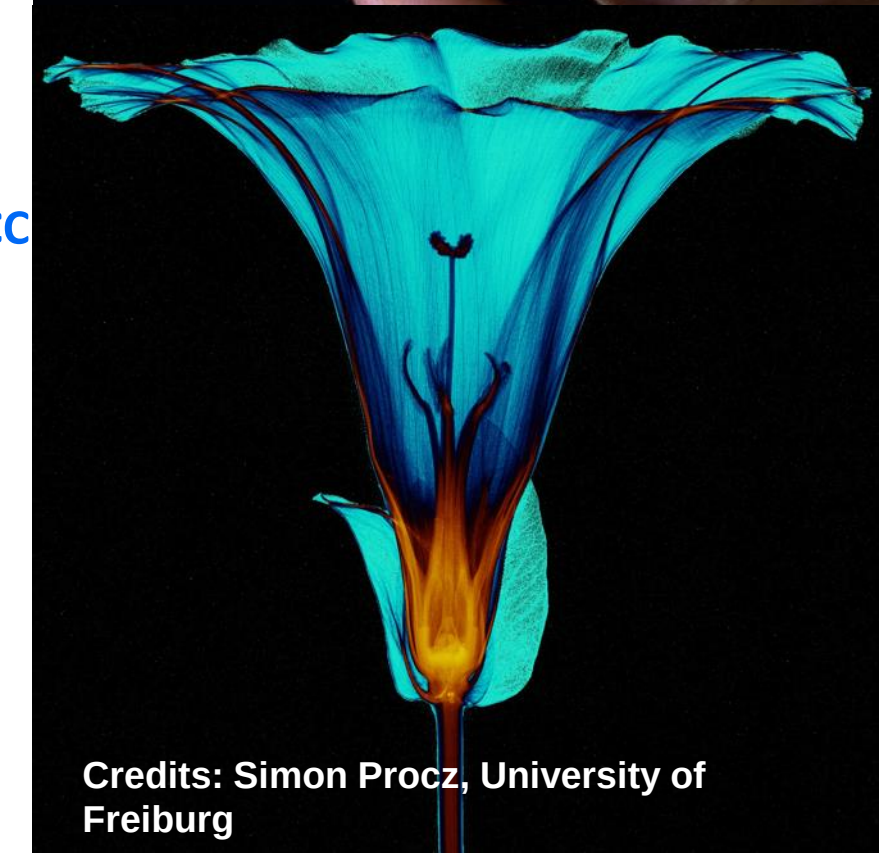
From particle tracking to Medipix: seminars and brochure



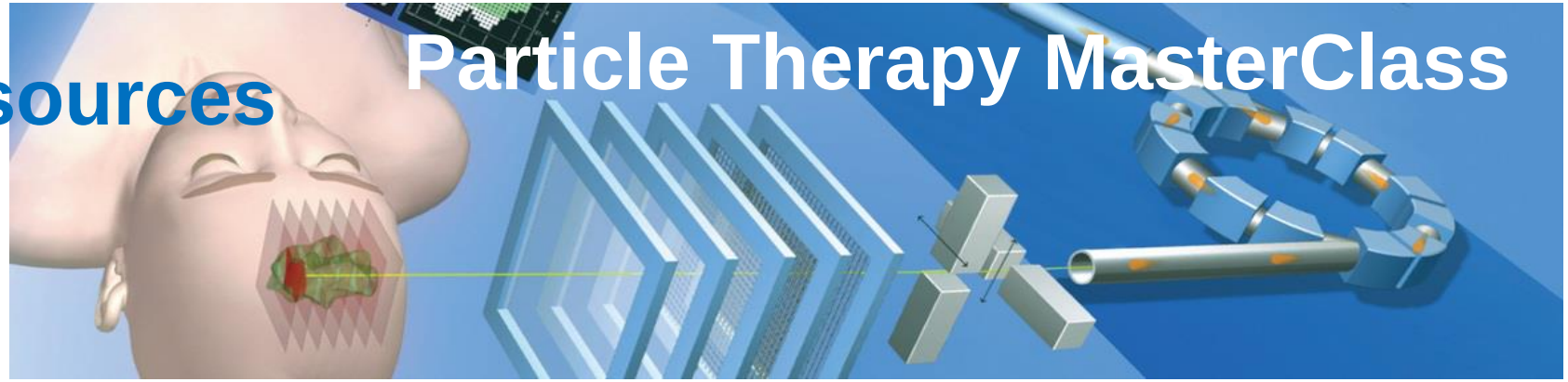
High Energy Physics development :

- **Particle tracking detectors**
- **Allows counting of single photons in contrast to traditional charge integrating devices like film or CC**

Seminar:
https://indico.cern.ch/event/820083/attachments/1861456/3061478/KTSeminarMC.pdf



More resources



- Presentations
- Posters
- Animations
- Demos
- Photos
- Events

https://indico.cern.ch/event/840212/

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pt.mc@cern.ch

ENLIGHT Animations

Short video presetation of the ENTERVISION project

Initial Training Network for hadron therapy

Events

15.09.2019 CERN Open Days

01.10.2019 Open Science Days at Montenegro

3.04.2020 Public event at Sarajevo

CERN Open Days stand

The CERN Open Days took place on 14th and 15th of September 2019. The ENLIGHT stand presented animations and the Particle Therapy Masterclass. There were in total four screens. Two of them were showing ENLIGHT animations, one about the Carbon ions facility and procedure of treatment, and the other about a future project that is going to use real time imaging while treating patients. There was also a thouch screen with an interactive virtual visit to a Carbon ions facility. The demo of the Particle Therapy Masterclass was shown on a fourth screen at the end of the stand. Two posters were complementing the stand, one about the Particle Therapy Masterclass and one about collaborative strategies for meeting the global need for cancer radiation therapy treatment.

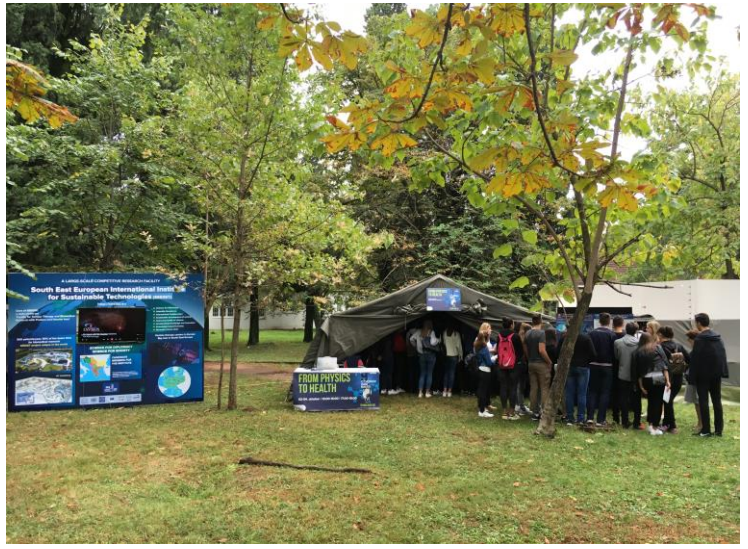
More resources

Open Science Days Montenegro

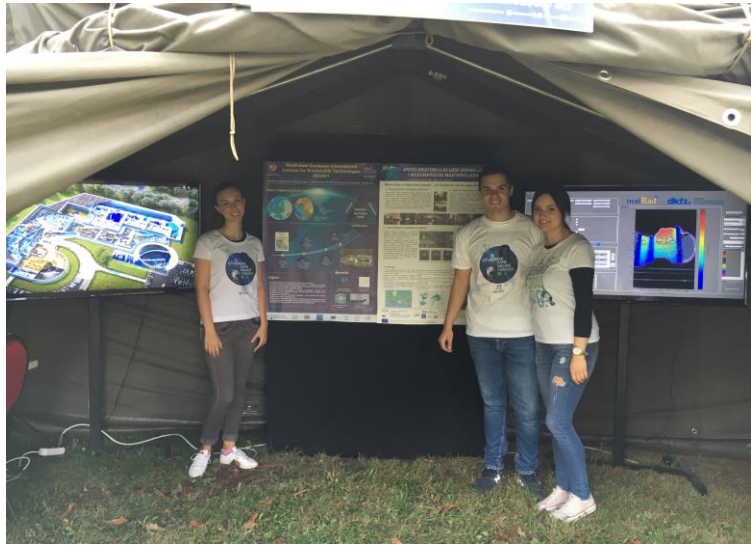
By Djurdjina Bulatovic

9th year, organised by ministry of science, 5 days (~80 000 E)
Addressing schools (morning) and families (afternoons and Saturday)

Media and Press: TV, interviews, articles



Video provided, more material coming



ACTIONS

1. Pasquale:

- summary outline of existing outreach web page in Italian and English
- links of divulgation and educational material (in Italian and some in English):

-http://edu.lnf.infn.it/schede-divulgative/

-http://edu.lnf.infn.it/approfondimenti/

-http://www.lnf.infn.it/media/lezioni.html

Then, a lot of online lectures for teachers, students, kids and general public.
This need a free registration:
https://accendiscienza.lnf.infn.it/

INFN portal for divulgation, scientific activity and, soon, also App:
http://scienzapertutti.infn.it/

ACTIONS

1. Jonivar: WiFi link provided (text to come)
2. Djurdjina Bulatovic: summary of Open Science Montenegro fair (expo material in Montenegrin language)
1. Despina: continuation of PET
2. Despina: muon tomography in progress
3. Marina: text on GPS measurement (resources)
4. Yiota: continuation on accelerators/PET (pdf of Eucard2 books and brochures)

Presentations in indico:

- Marina Trimarchi : GPS measurements on EEE experiment
- Despina Hatzifotiadou : PET and Cultural heritage (muon tomography)
- Manuela Cirrili : JENAS 2019 report
- Yiota Foka : Particle Therapy and Accelerators for society
- Djurdjina Bulatovic : Open Science Days Montenegro