INTERNATIONAL MASTERCLASSES
HANDS ON PARTICLE PHYSICS

CHEP 2019

New developments for ALICE MasterClasses and the new Particle Therapy MasterClass

Łukasz Graczykowski, Piotr Nowakowski (WUT)

Yiota Foka (GSI)

on behalf of IPPOG and IMC Steering Group

November 7, 2019

ADELAIDE SOUTH AUSTRALIA

IPPOG

INTERNATIONAL MASTERCLASSES

hands on particle physics

International MasterClasses
IMC aim: motivate the next generation of scientists!

- IMC brings **fundamental research** results and methods into the **classroom**

- New developments expanding the scope and reach

  Theme: ions from fundamental research to therapy
  - ALICE – framework and new measurement
  - new Particle Therapy Masterclass

- For details see:
  - on IPPOG by S. Goldfarb (T8, Nov. 5 11:00)
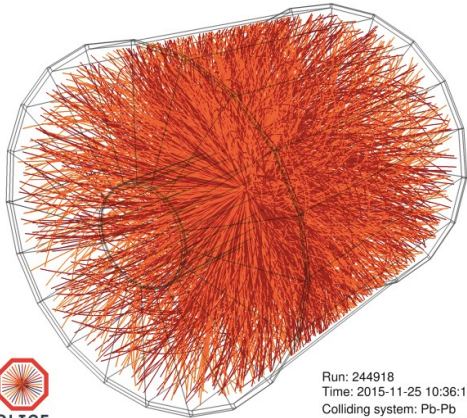 - on IMC by F. Ould-Saad (T8, Nov. 4 15:00)

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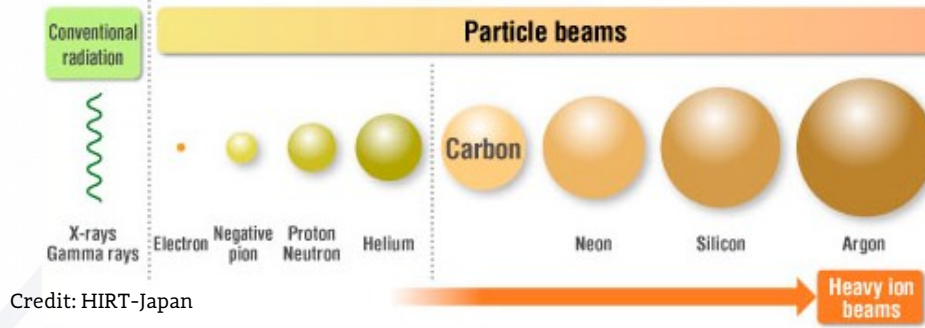
INTERNATIONAL
MASTERCLASSES
hands on particle physics
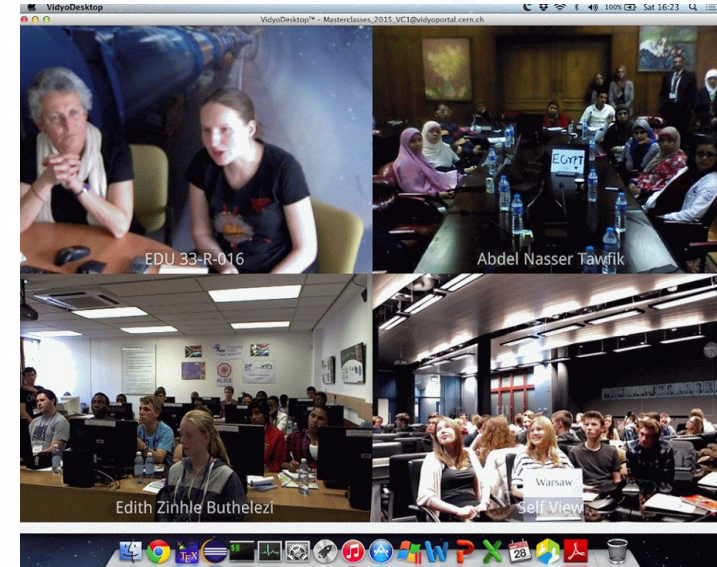
Radiation & ion beams

fundamental science
QGP studies

Credit: CERN

Credit: HIRT-Japan

applied science
medicine

Credit: HIT Heidelberg

Run: 244918
Time: 2015-11-25 10:36:18
Colliding system: Pb-Pb
Collision energy: 5.02 TeV
ALICE

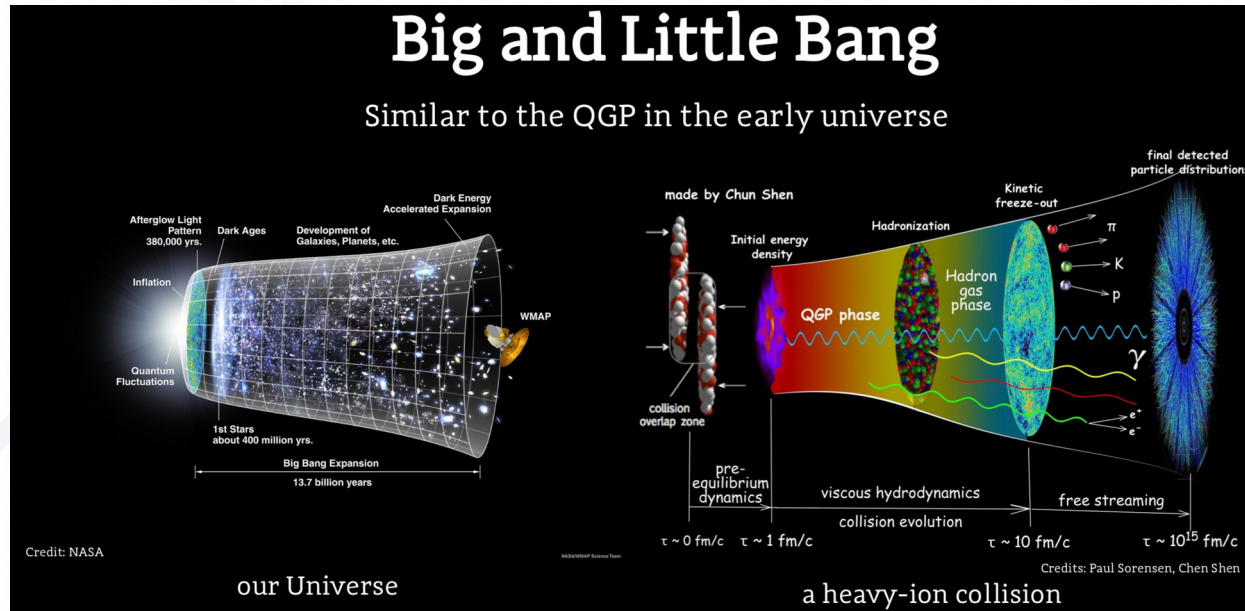Credit: T. Nomiya, NIRS Japan

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From heavy-ion physics to therapy

Probing the early Universe with heavy-ion collisions

Big and Little Bang
Similar to the QGP in the early universe

our Universe

a heavy-ion collision

Ion (carbon) therapy pioneered at GSI

**Implemented at HIT in Heidelberg**

ALICE MasterClasses

ALICE at LHC/CERN

Dedicated heavy-ion experiment

**Study of multitude of observables
to explore matter under
extreme conditions**
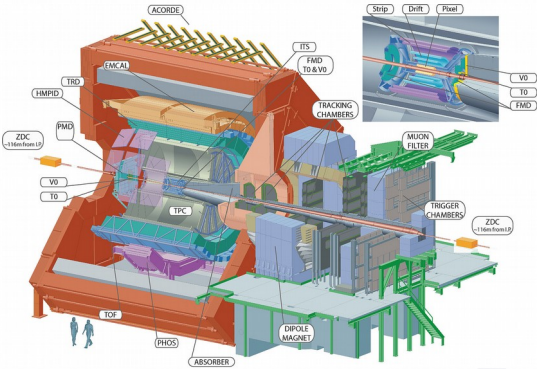
- **Challenging tracking**
- **Almost all known PID techniques**
- **TPC: heart of ALICE for tracking and
  dE/dx**

- **ALICE MasterClass measurements:**
  1) strange particles production
  2) R_{AA} – nuclear modification factor
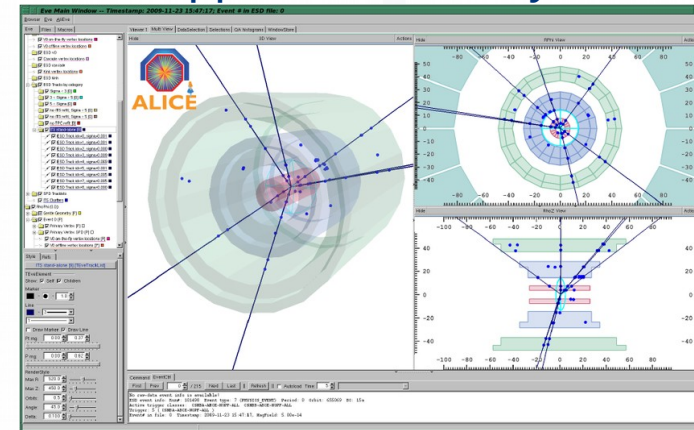 **3) J/Ψ suppression (in progress)**

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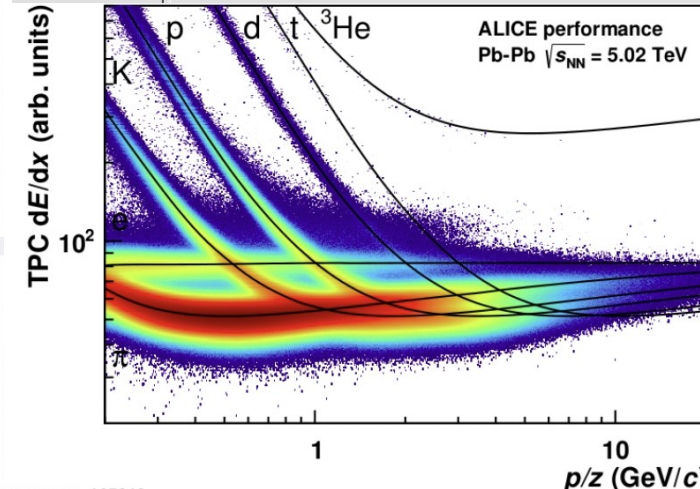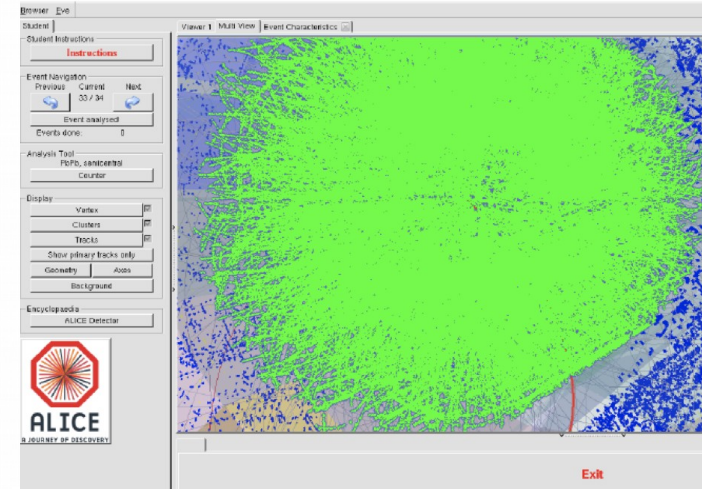
ALICE MasterClass

M. Tadel (T8, Nov. 5 16:30)

first pp event seen by ALICE

Based on ROOT (EVE):

– simplified **event display**, close to the one used in the control room

– visual analysis of small sample of events (~50)

– statistical analysis of larger samples (fitting, background parameterization)

– "writing code"

InvariantMass

Total: 2497
Background: 1005
Signal: 1492
Mean: 497.542077±0.148371
σ: 4.882929±0.154867

ALICE MasterClass – new developments

Initial work by GSI/CERN Summer Student
Taken over by WUT dedicated programmer

- Macros → standalone app

- Common framework
  - all three exercises share core classes
  - *in future*: possibility to use data from other experiments

- Source code on CERN GitLab:
  https://gitlab.cern.ch/pinowako/masterclass-continued

- CMake build system

- Available versions:

  Windows 10

  - Linux (AppImage binary, clickable, **ROOT embedded!**)
  - **Windows** (Visual Studio compiled, installer, clickable, **ROOT embedded!**) – **first time provided**
  - VirtualBox machine (pre-configured Ubuntu)

- New webpage: https://alice-masterclass.web.cern.ch
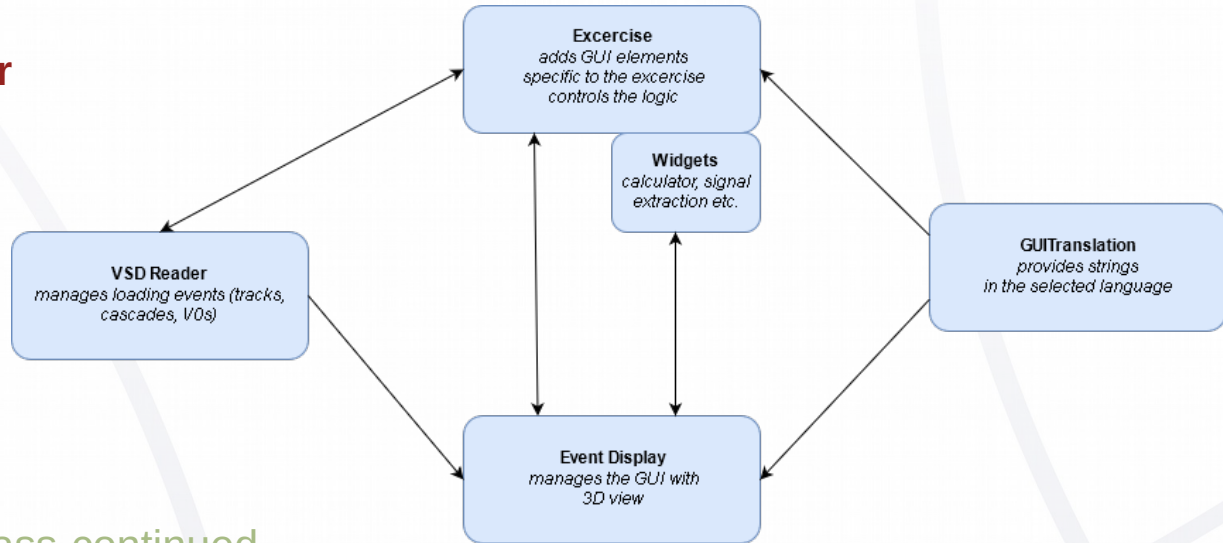
Piotr Nowakowski > masterclass-continued > **Details**

M **masterclass-continued** ⊘
Project ID: 71281

⚖ GNU GPLv3   ⟳ **752** Commits   ⌥ **2** Branches   ⚑ **4** Tags   🗎 **759.1 MB** Files

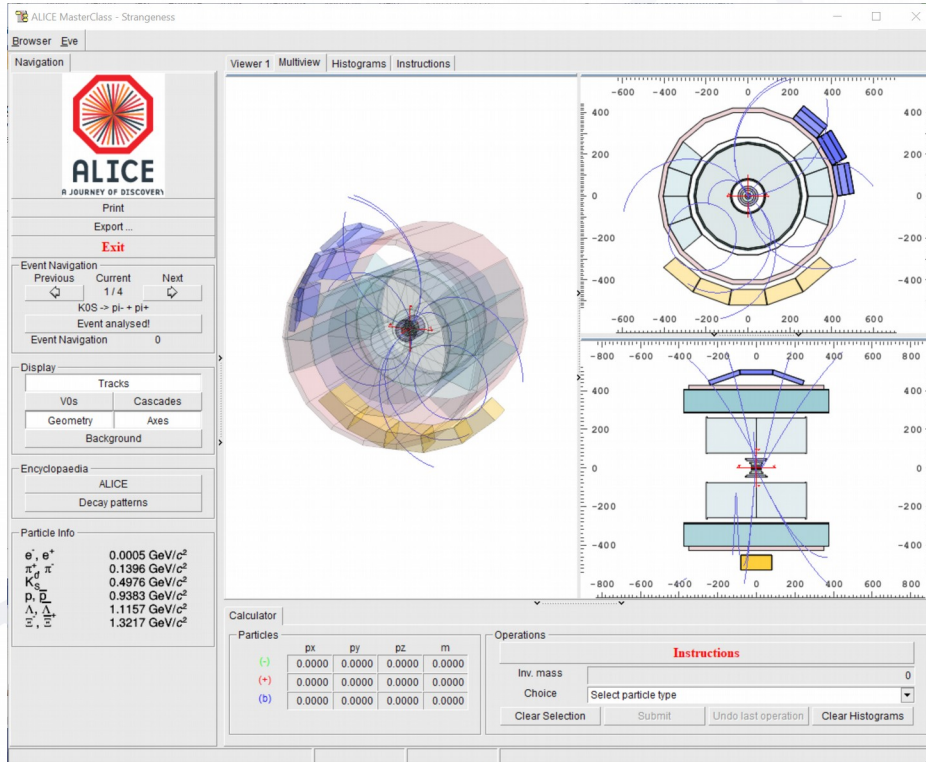Continuation of the ROOT-based MasterClass refactor.

Łukasz Graczykowski (WUT)

ALICE MasterClass – how does it look like?

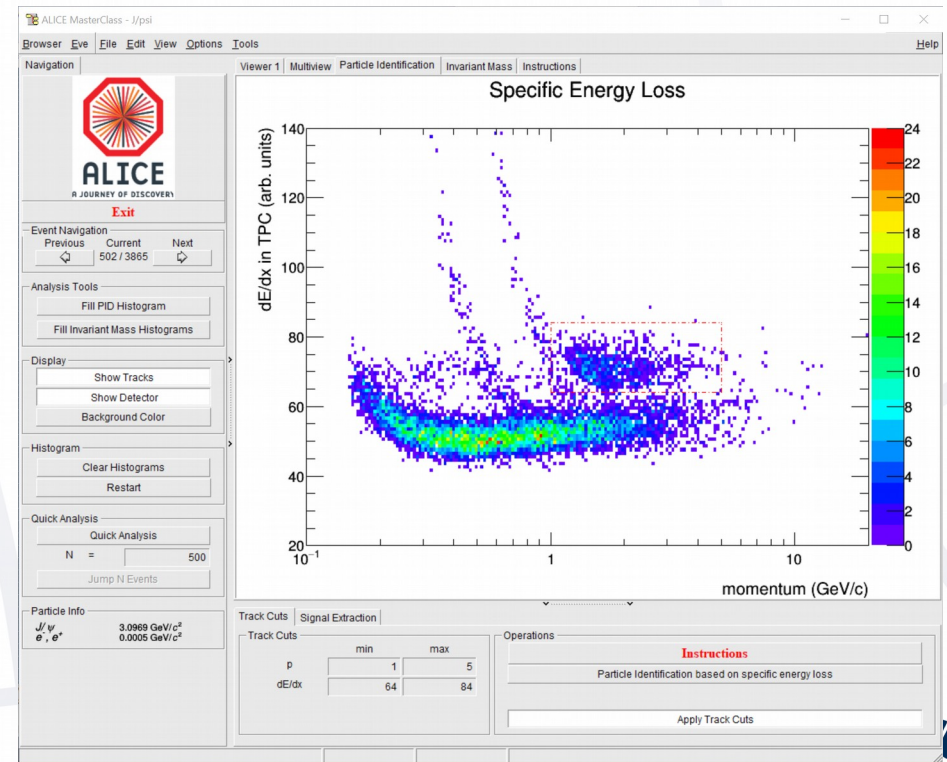**Looking for strange particles**
visual analysis

J/Ψ suppression
electron PID

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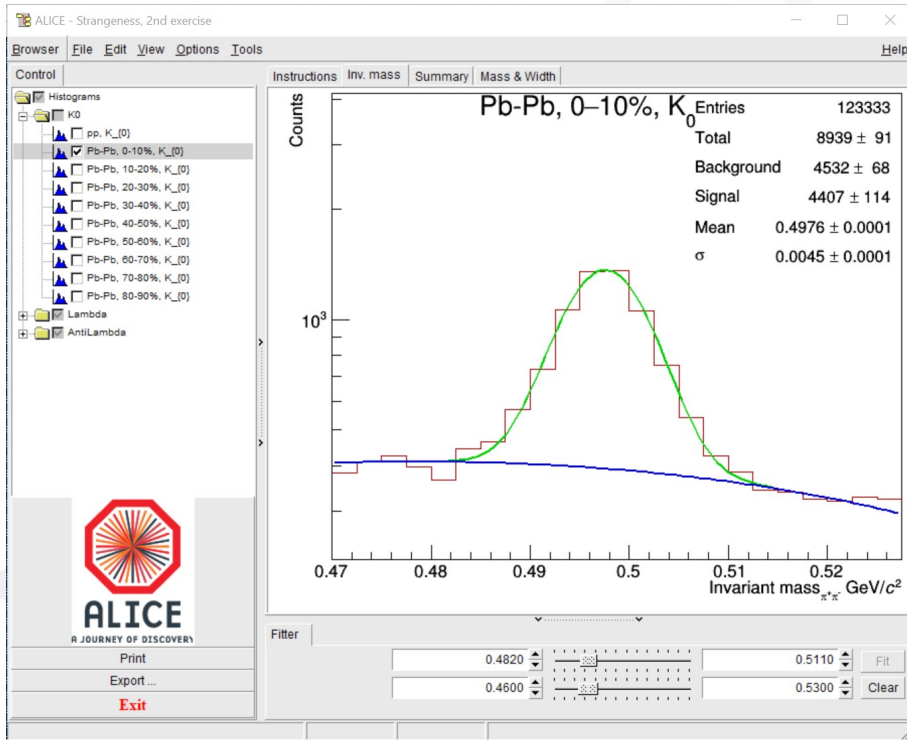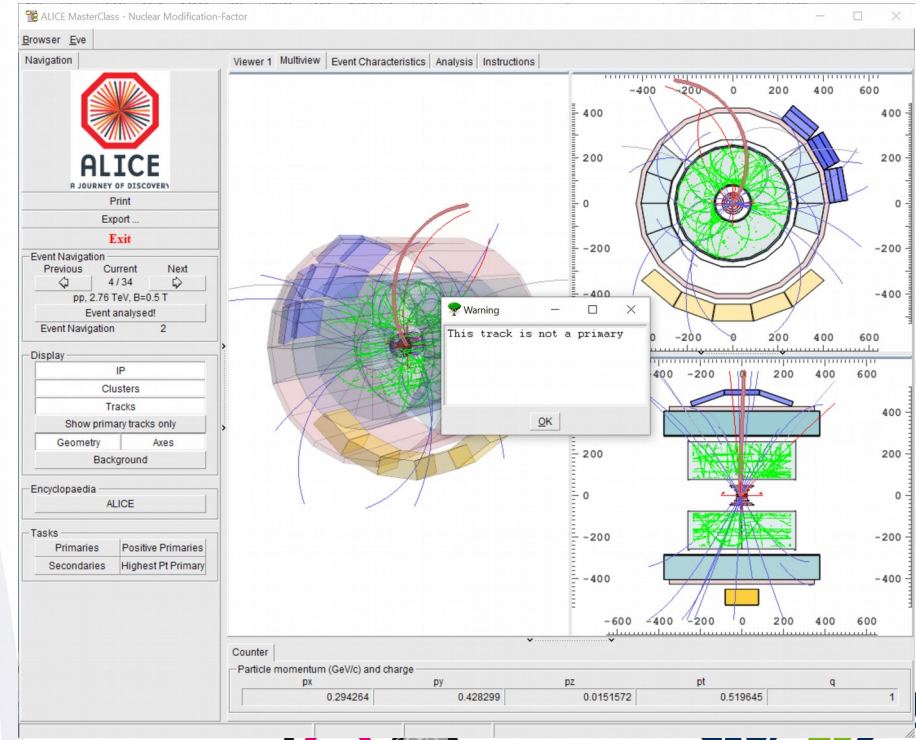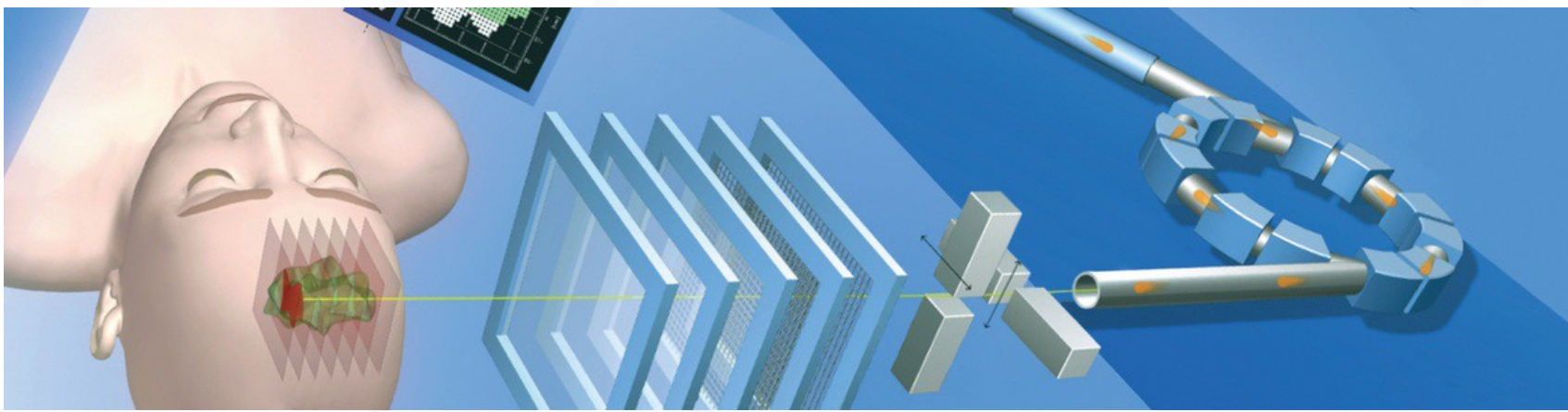
ALICE MasterClass – how does it look like?

Looking for strange particles
invariant mass fits

Nuclear modification factor (R_{AA})

selecting primary tracks

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INTERNATIONAL **MASTERCLASSES**
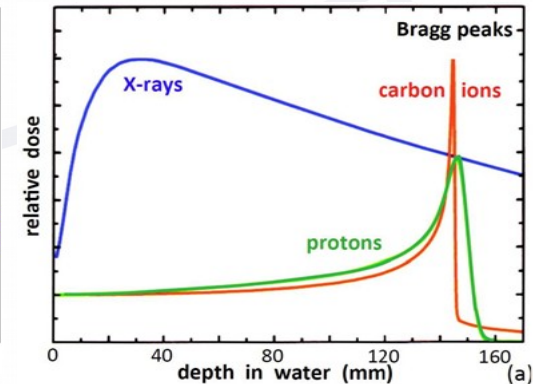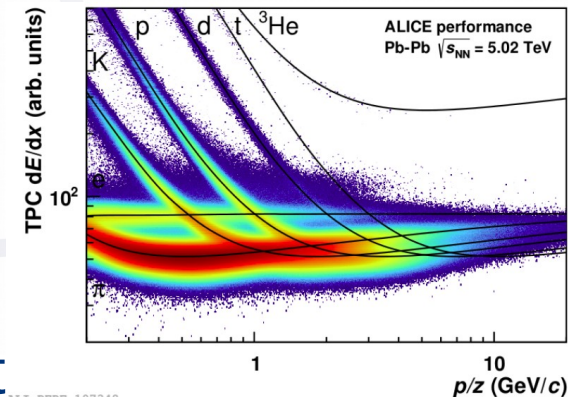hands on particle physics

Particle Therapy MasterClass

Aim: benefits for society from fundamental research

- direct applications for health of instrumentation: **accelerators, detectors, software**

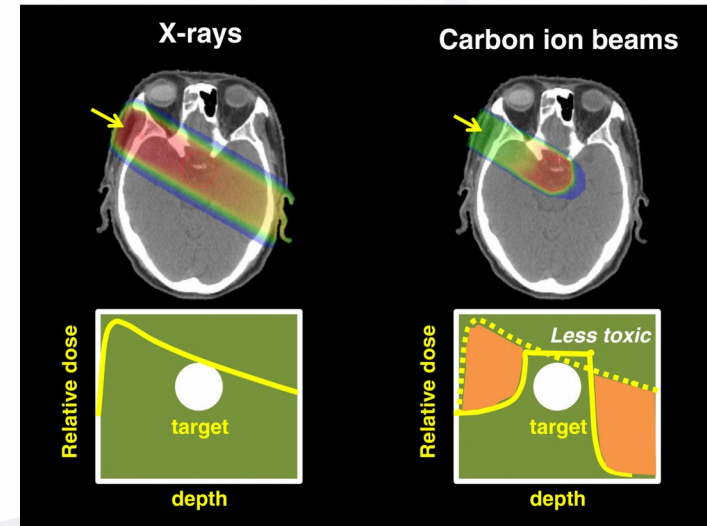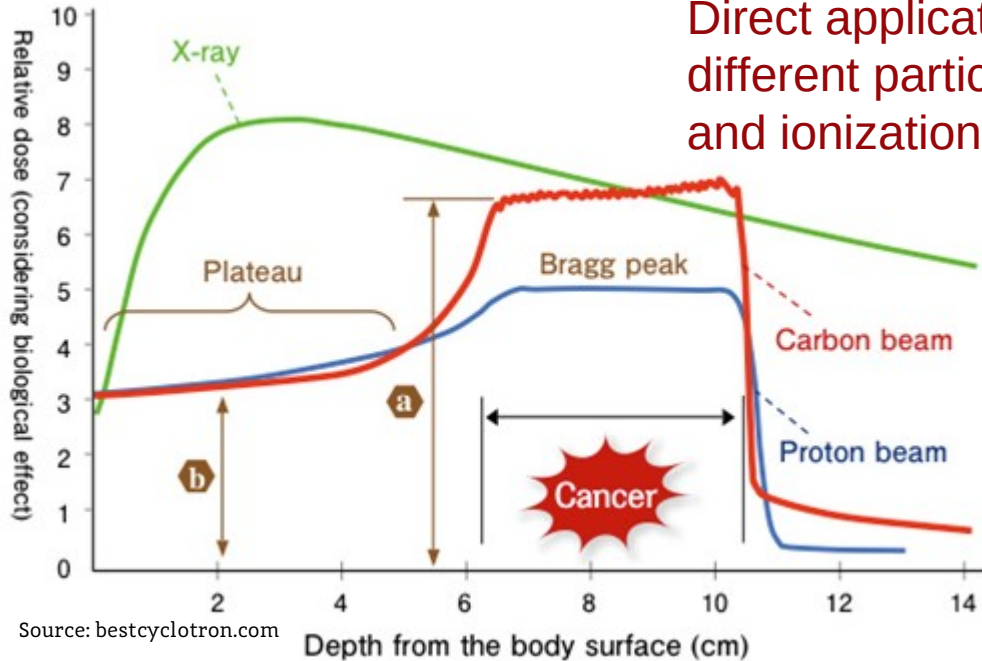- Aim: enhance awareness on hadron therapy cancer treatment

From Bethe-Bloch ionization for PID to Bragg peak for cancer therapy

Hadron therapy

- Hadron (proton, ion) therapy is precise and more effective way of treating cancer
- **Reduced dose for the surrounding tissue:**
  - preferred for children, pregnant women deep-seated and radio-resistant tumors

Direct applications of different particle properties and ionization loss in matter
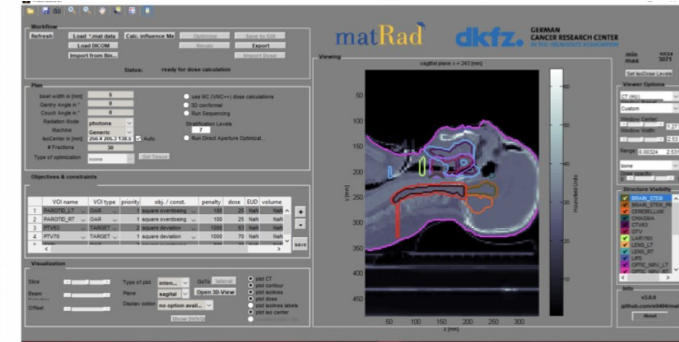

Source: bestcyclotron.com
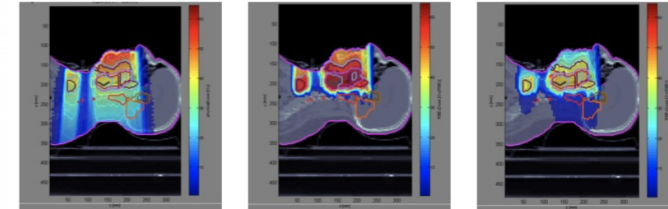

Source: EPMA J. 2013; 4(1): 9

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Particle Therapy MasterClass

- Based on **matRad** http://e0404.github.io/matRad/
  - developed by DKFZ in Heidelberg
  - professional and **open-source** toolkit for dose calculation
  - photon, proton, carbon ion therapy

- PTMC: **head and liver** data
- First test: locally at GSI Feb 2019
- Pilot: GSI, Heidelberg DKFZ, CERN Apr 2019
- IMC Steering Group Approval: GSI May 2019

Demo[4] of the matRad software kit for Treatment Planning .

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

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PTMC conferences, CERN Open Days

- Support and PR material available on the webpage

ENLIGHT, Caen, 2019

Open Days

CERN

Montenegro

First tests and pilot
GSI, CERN, DKFZ

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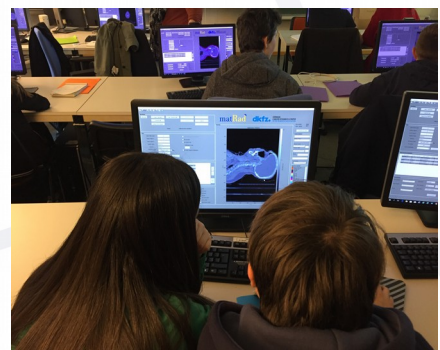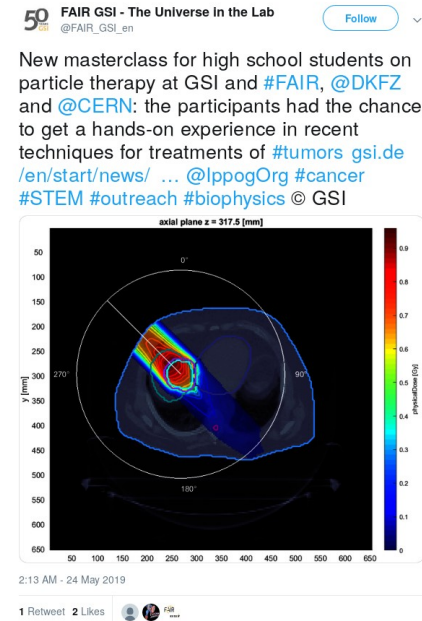
Particle Therapy Masterclass

- Presented and approved by IPPOG in 2019 for IMC 2020:
  - **to register:** https://indico.cern.ch/event/840212/page/18008-2020-ptmc-dates
- Advertised on webpages and Twitter (i.e. GSI)

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Outlook

- ALICE MasterClasses:
  - new framework ready to be tested by the collaboration
  - to be used for IMC 2020
  - *in future*:
    - possibility to extend to other experiments (geometry, data)
    - towards a web version (move to EVE-7?)

- Particle Therapy MasterClass:
  - approved by IPPOG in 2019 for IMC 2020
  - test and pilot sessions held in 2019
  - Institute registration for IMC 2020 open
    https://indico.cern.ch/event/840212/page/18008-2020-ptmc-dates

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Thank you!

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CERN (staff and users)

CERN: tutors
Loc Org: Nikolaos Charitonidis
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CERN/KT: Manuela Cirilli Anais Rassat Rita Ferreira
Giovanni Porcellana
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