Los chips Medipix: Tecnología y aplicaciones

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Sección de Microelectrónica, CERN

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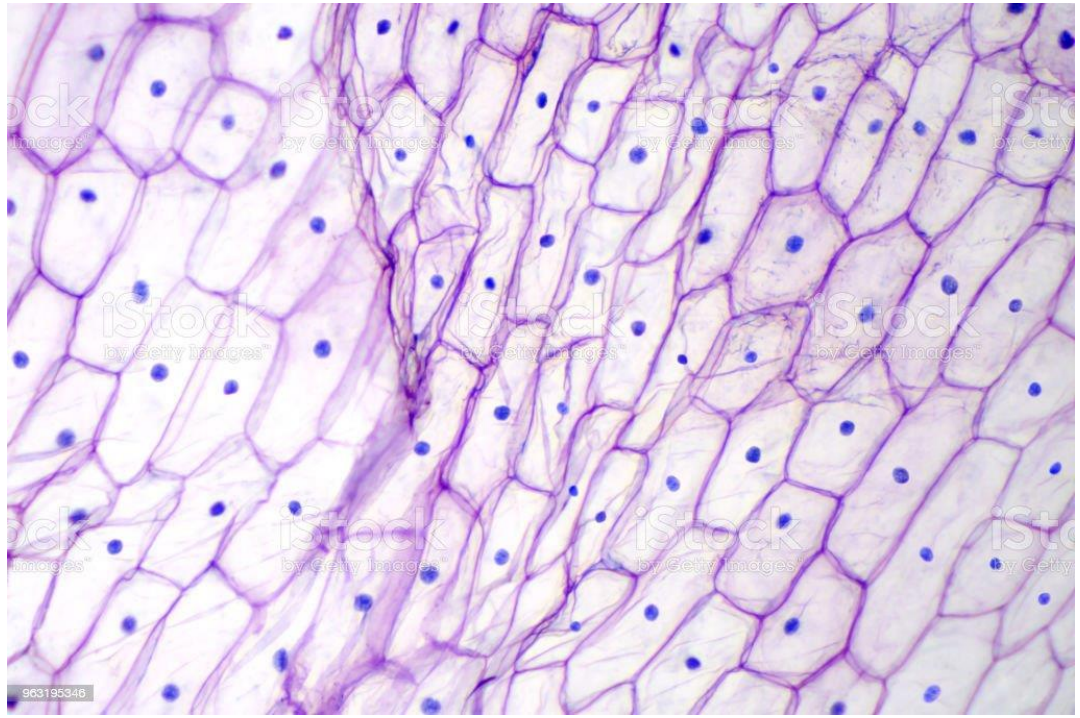
- Conclusión

Introducción

KERN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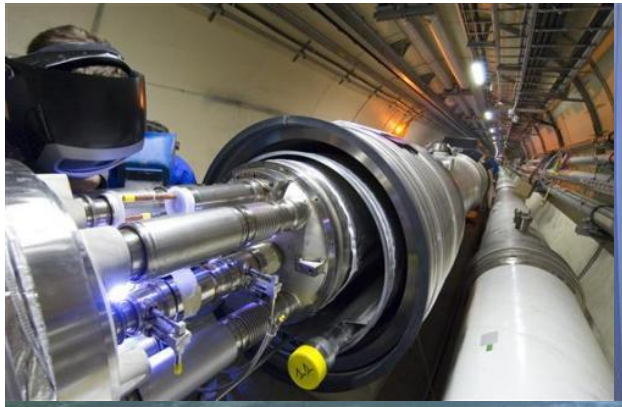
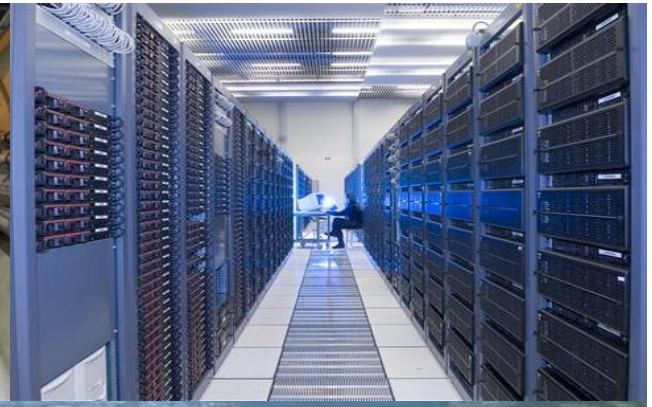
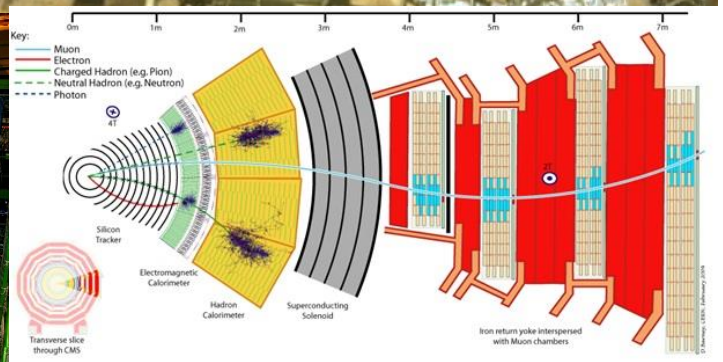
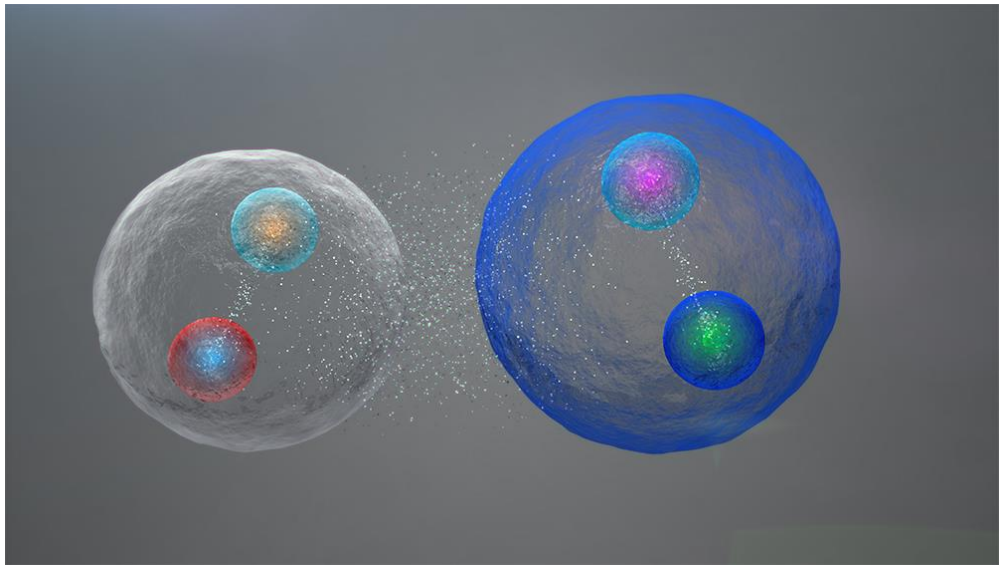


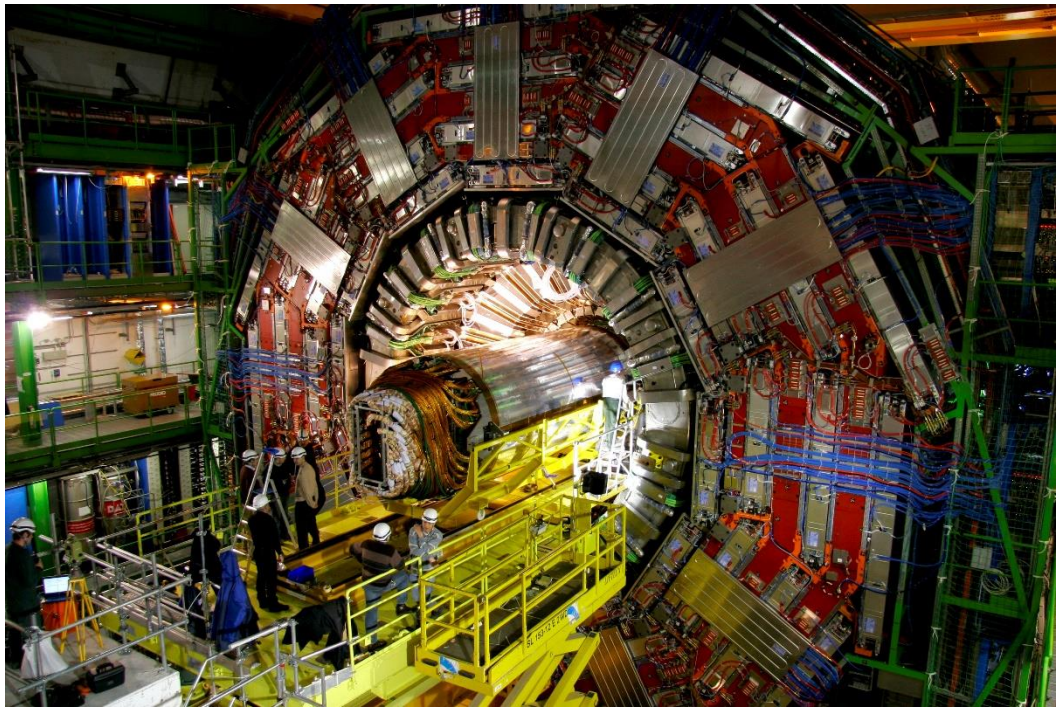


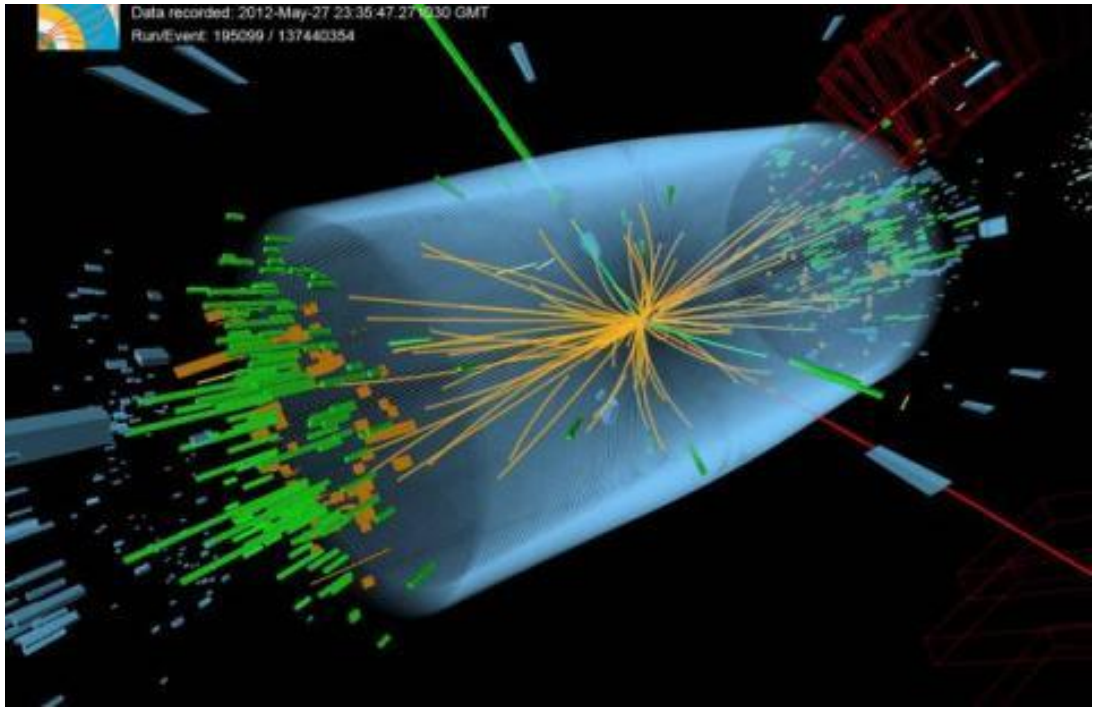




Para estudiar la estructura de la materia a la escala del attometro (10^{-18}m), utilizamos aceleradores de partículas, detectores i infraestructura para el análisis de datos.

Aceleradores + Detectores + Análisis de datos = **Attoscopio (10^{-18}m)**





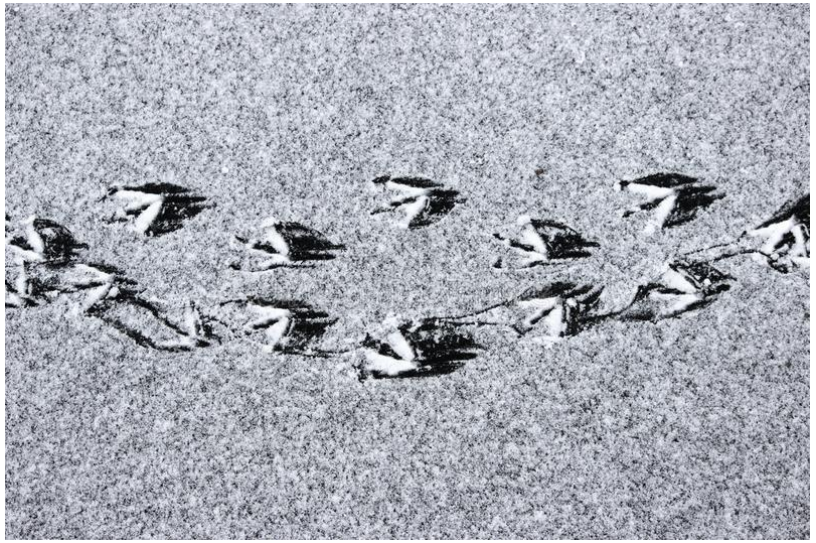
Los detectores del CERN son como **cámaras de fotos gigantes** con centenares de millones de canales, capaces de registrar 40 millones de fotos por segundo.

"Detector: instrumento que sirve para descubrir la presencia de algo a través de indicios"

https://www.freepik.com/vectors/detective

Detección de partículas

- Podemos reconocer las partículas por sus "huellas"
- Estas huellas indican de qué **tipo** de partícula se trata, su **energía**, la **carga** eléctrica, el punto donde se creó y su **trayectoria**
- Las huellas dependen no solo del tipo de partícula sino también del material del detector

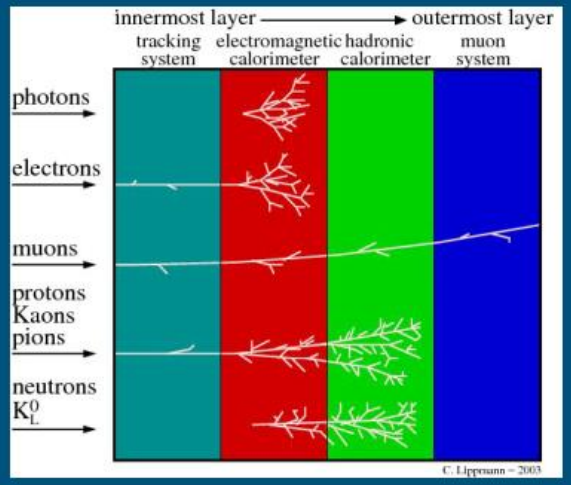


Experimentos de colisionadores

Para cada objeto hay que medir:

- Posición
- Energía
- Identificación

Medida de trayectorias



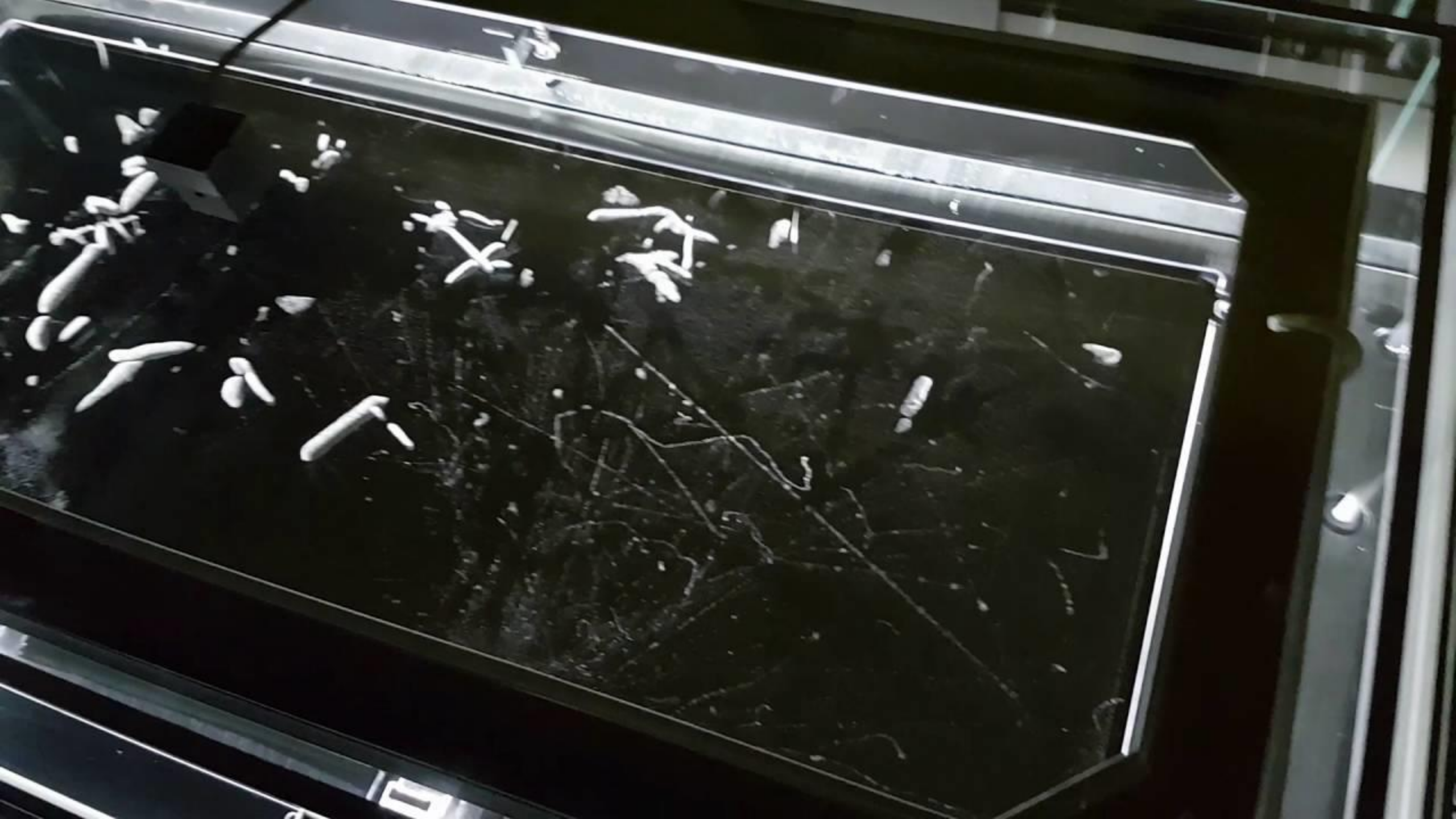
Medida de energía
Absorción total de las partículas.
Medida de curvatura en B

Detección de muones

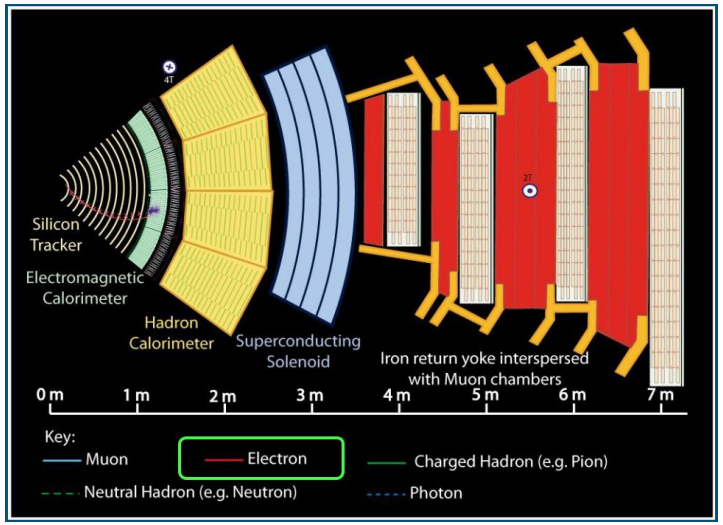
Poca cantidad de material	→	Alta densidad
Alta precisión	→	Menor precisión
Alta granularidad	→	Menor granularidad

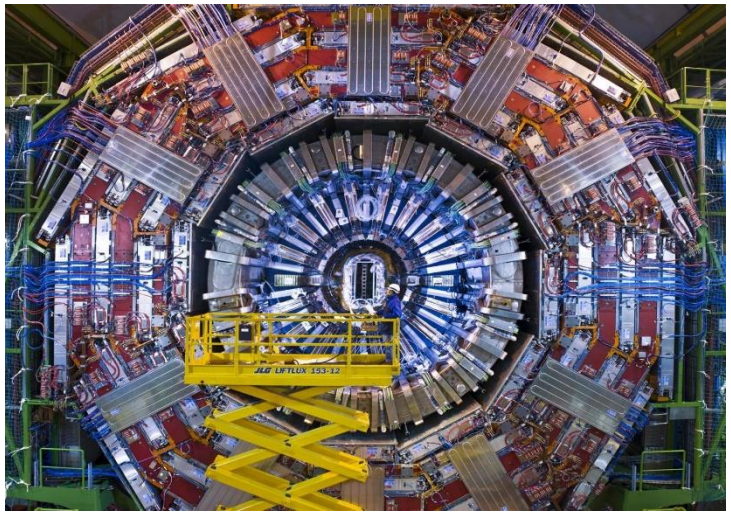
Cada familia de partículas interacciona de forma diferente con los materiales que encuentra (una huella característica)

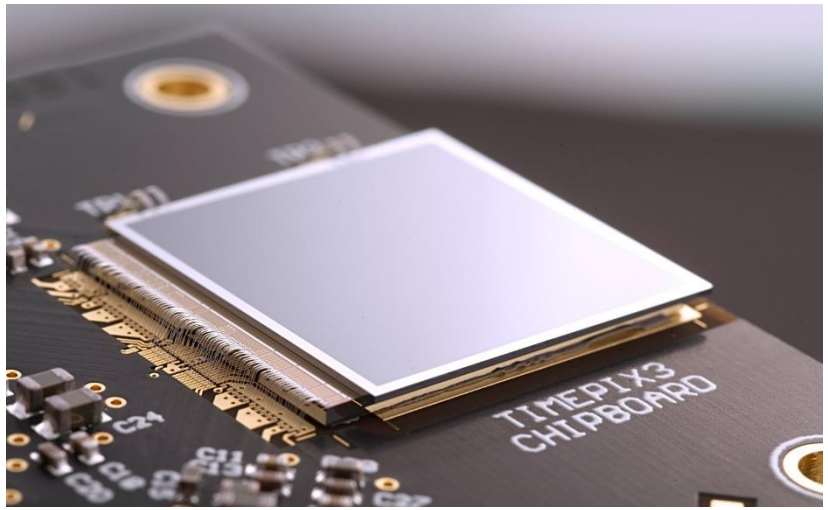
Imagen: Jesus Puerta Pelayo



Detectores de trazas





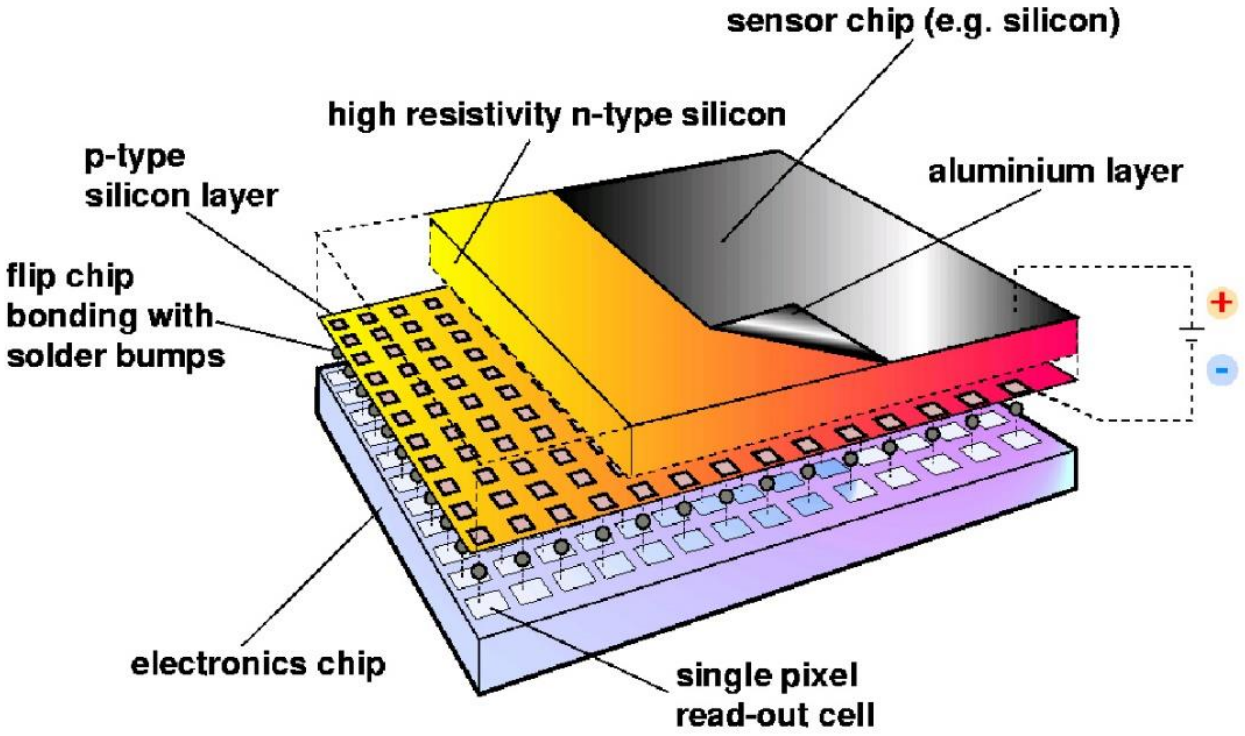


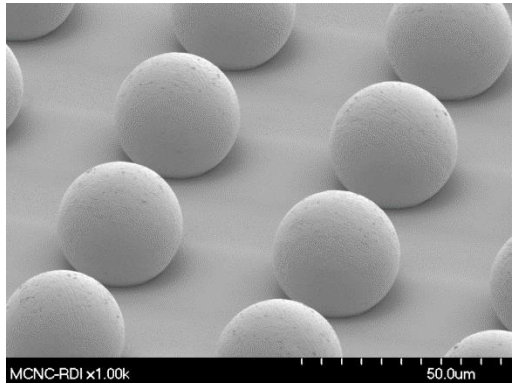
Especificaciones de los detectores de trazas (tracking detector):

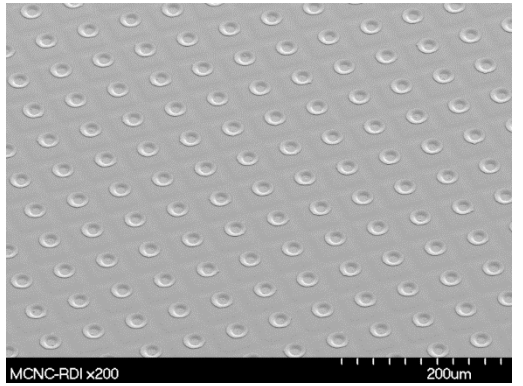
- Procesado individual de la señal depositada en el sensor para cada partícula
- Asignación de les partículas al instante de la colisión (25ns/40MHz)
- Resolución espacial del orden de decenas de micrómetros
- Masa mínima
- Bajo consumo de potencia
- Resistencia a la radiación

Actualmente solamente la tecnología de pixeles híbridos cumple con estas especificaciones

Introducción a los detectores de píxeles híbridos

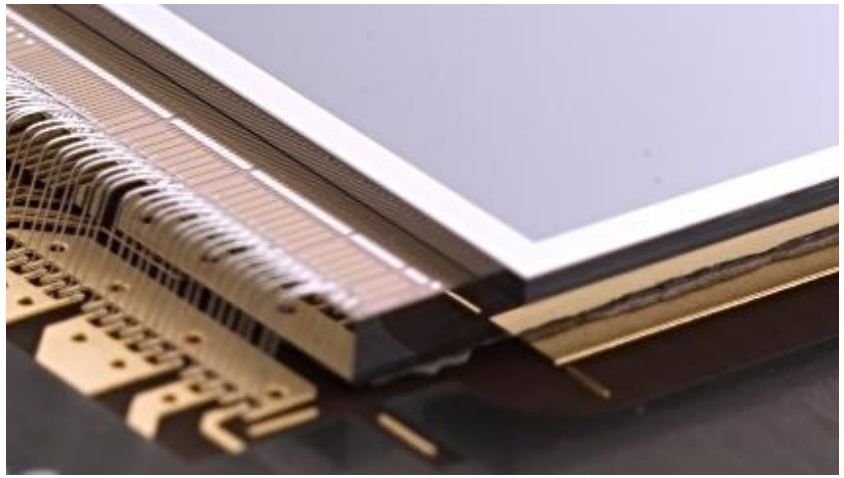


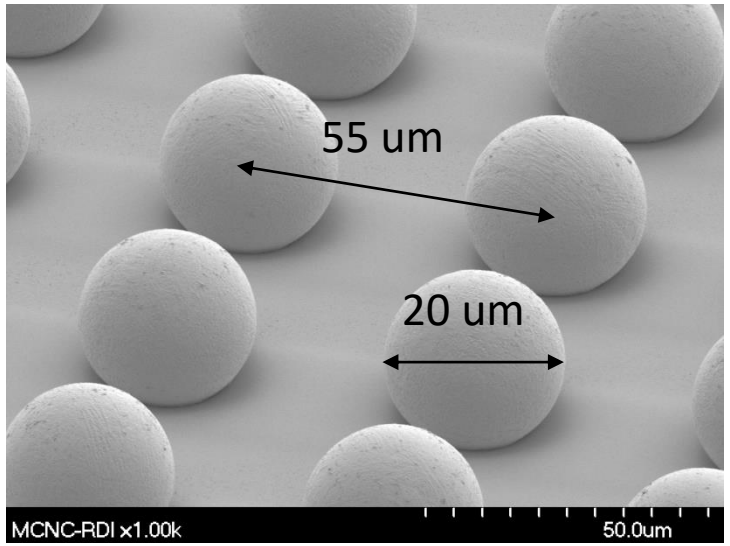


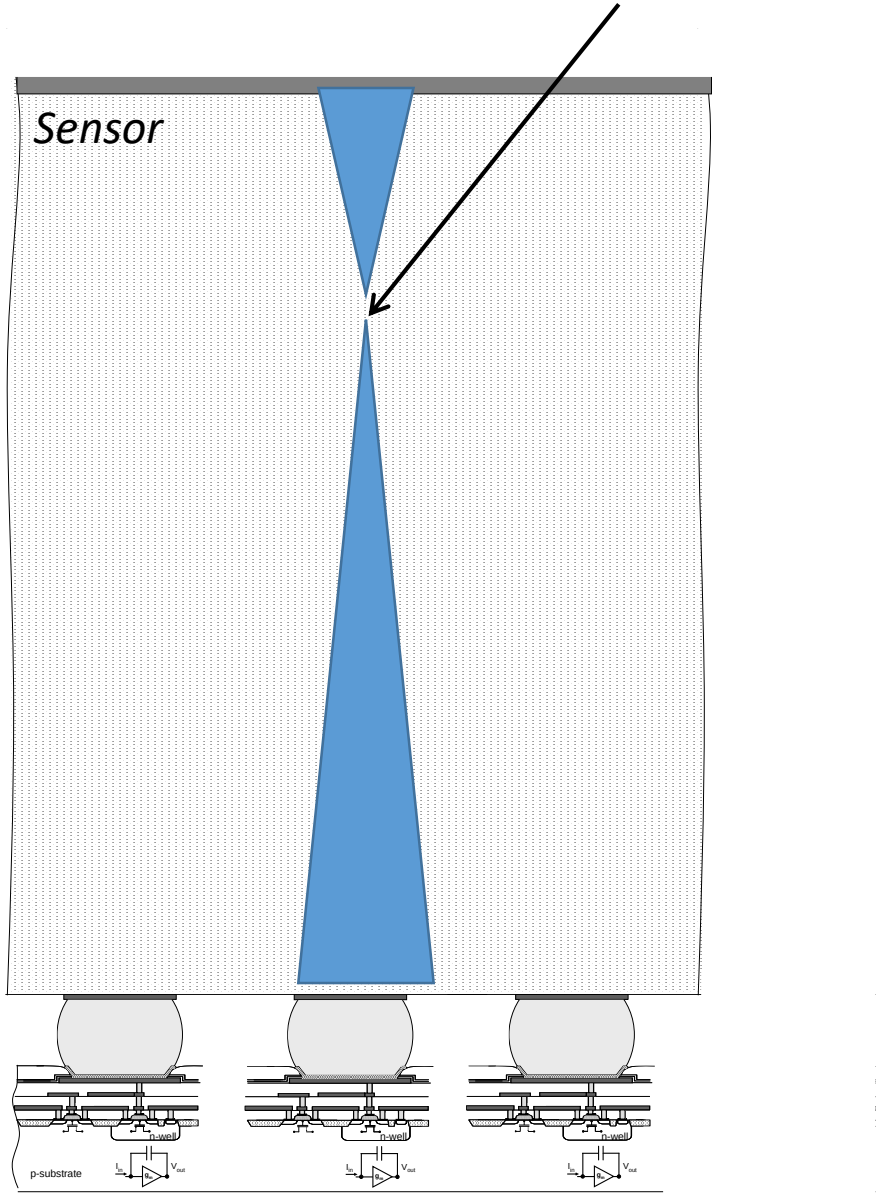


- Un detector de píxeles híbrido es una matriz de elementos microscópicos sensibles a la radiación cada uno de los cuales está conectado a su propia electrónica de lectura
- El sensor y la electrónica están implementados en substratos diferentes y se pueden optimizar por separado

Los detectores híbridos







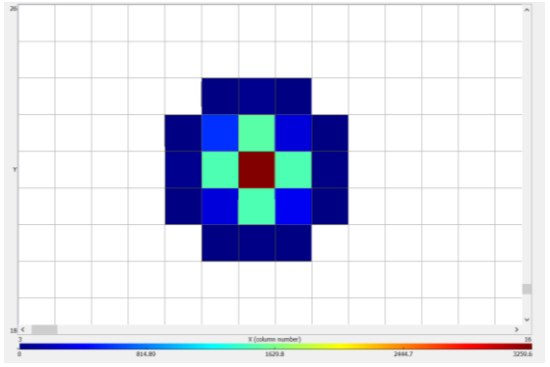
Electrónica de lectura

Information from the incoming beam

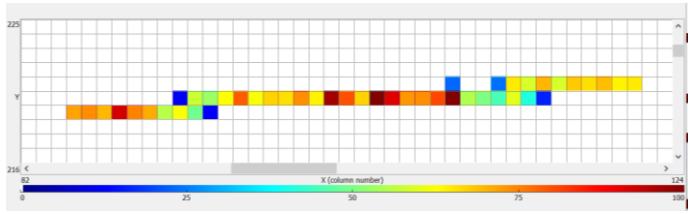
- The number of particles deposited during a given exposure time
- The energy deposited by a particle
- The time of arrival

Information from the incoming beam

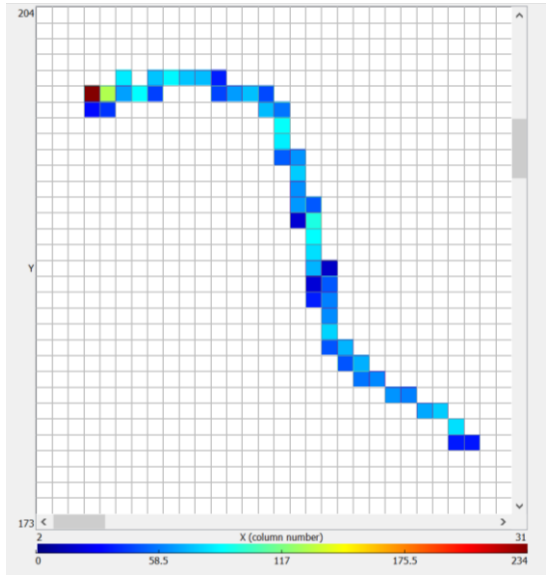
- The number of particles deposited during a given exposure time
- The energy deposited by a particle
- The time of arrival
- The incoming type of particle, based on the shape of the cluster of pixels responding to a single charge deposition event



~270µm



~2mm



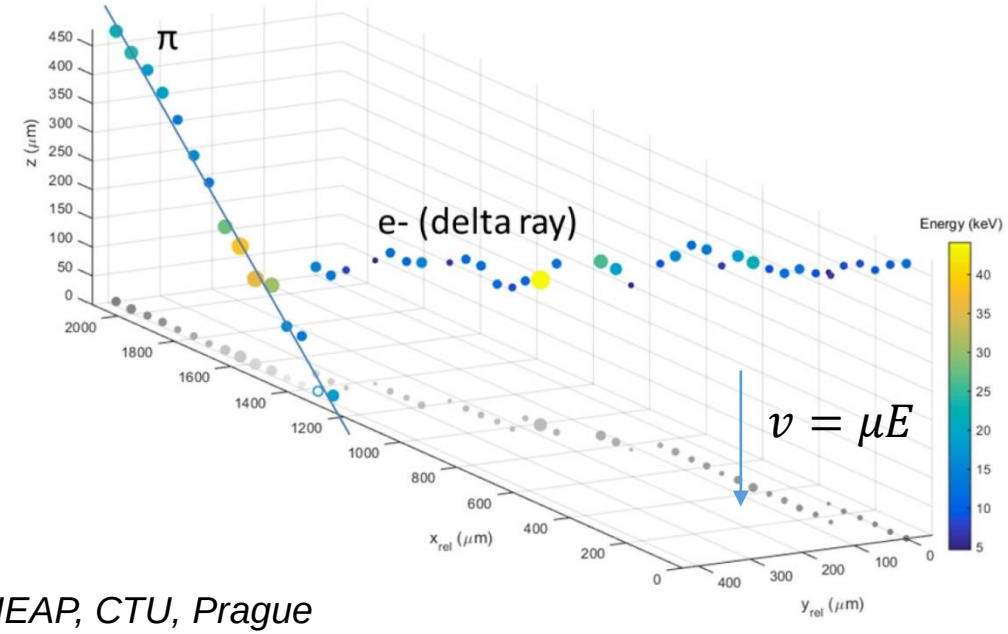
~1.3mm

Timepix data, 55µm pixels

Information from the incoming beam

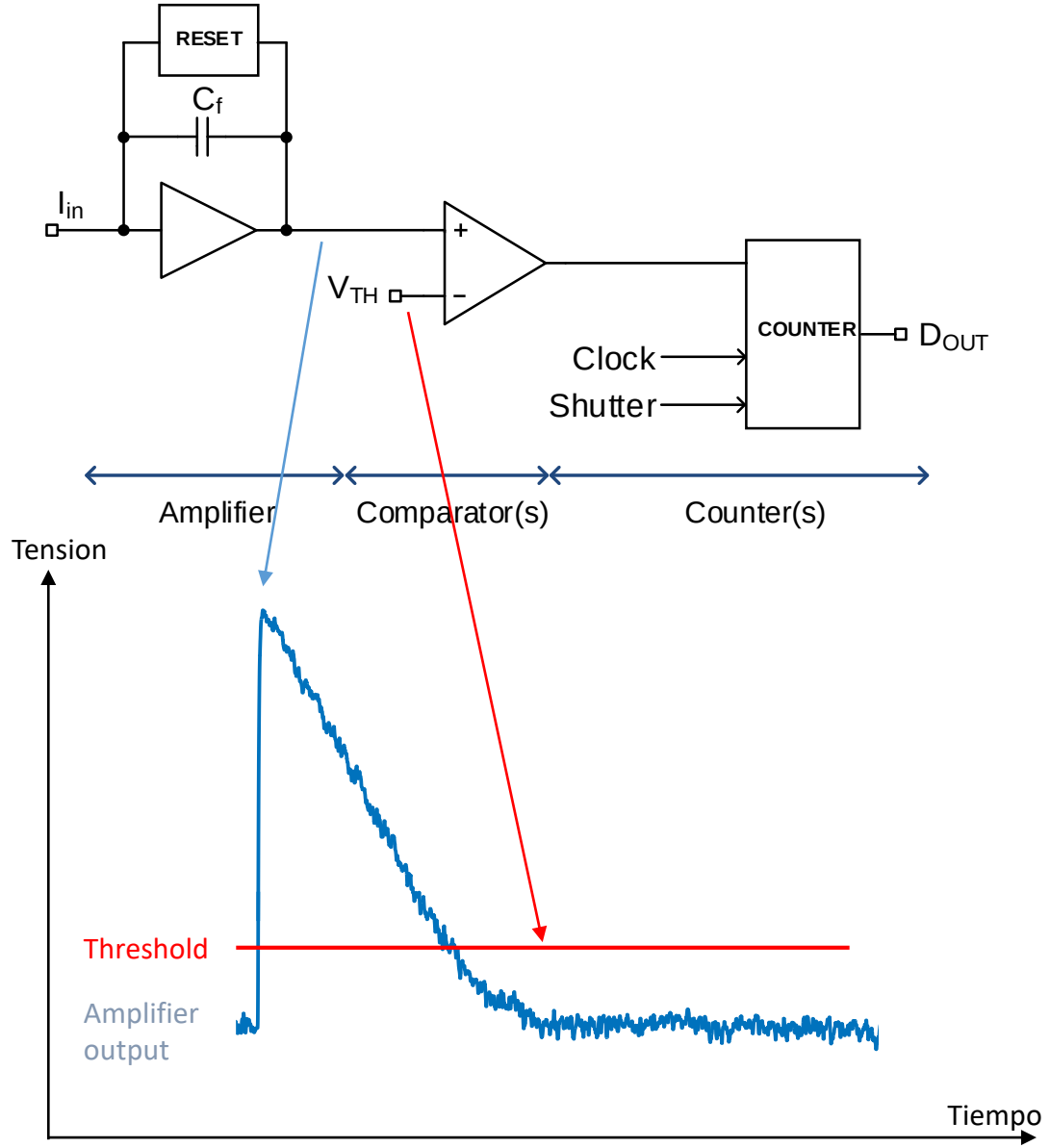
- The number of particles deposited during a given exposure time
- The energy deposited by a particle
- The time of arrival
- The incoming type of particle, based on the shape of the cluster of pixels responding to a single charge deposition event
- The angle of incidence of the incoming charged particle based on the difference of time of arrival of the drifting charge in the different pixels

60 deg
p+ in n Si sensor, Timepix3
500µm thick
V_{bias} = 130V
Colour (and diameter) indicate charge
Measured z resolution ~50µm



Measurement B. Bergmann, S. Pospisil, IEAP, CTU, Prague

Los detectores de píxeles híbridos



- Sistema “noise hit free” (sin detecciones falsas)
- Medidas posibles:
  - Presencia/ausencia de partícula en intervalo de tiempo
  - Cámara: Numero de cuentas durante el tiempo en el que el obturador esta abierto — *Medipix
  - Energía (Midiendo la amplitud o la duracion)
  - Tiempo de llegada — *Timepix
- Limitación: tiempo muerto (“dead time”)

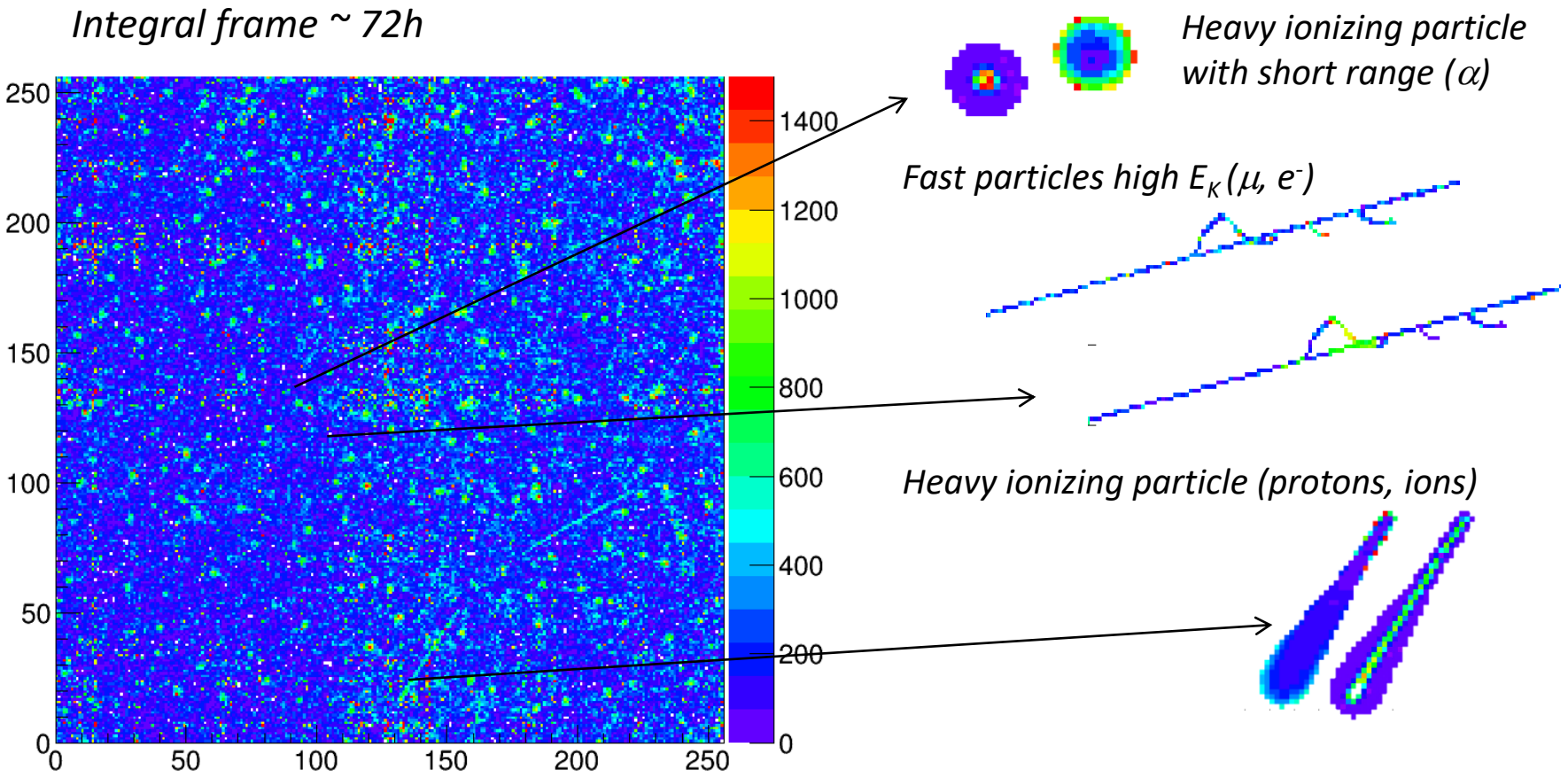
** Simplificación, para mas información, ver transparencias adicionales*

Demostración

Demostración

- Ideas clave:
- Chip Timepix
- Matriz de 256x256 pixeles
- Pixeles de 55μm
- Lectura de “fotogramas” (tiempo de adquisición configurable)
- El pixel se activa solamente si hay señal de una partícula que ha depositado toda o parte de su energía
- La señal de cada pixel del sensor se procesa individualmente
- Cada tipo de partícula interacciona de forma diferente con el sensor de silicio

Energy and time measurements with cosmic particles



Timepix chip: matrix of 256x256 pixels

Different particles present a different signature in their interaction with the pixelated semiconductor detector

Bonus

Introducción a la radiación

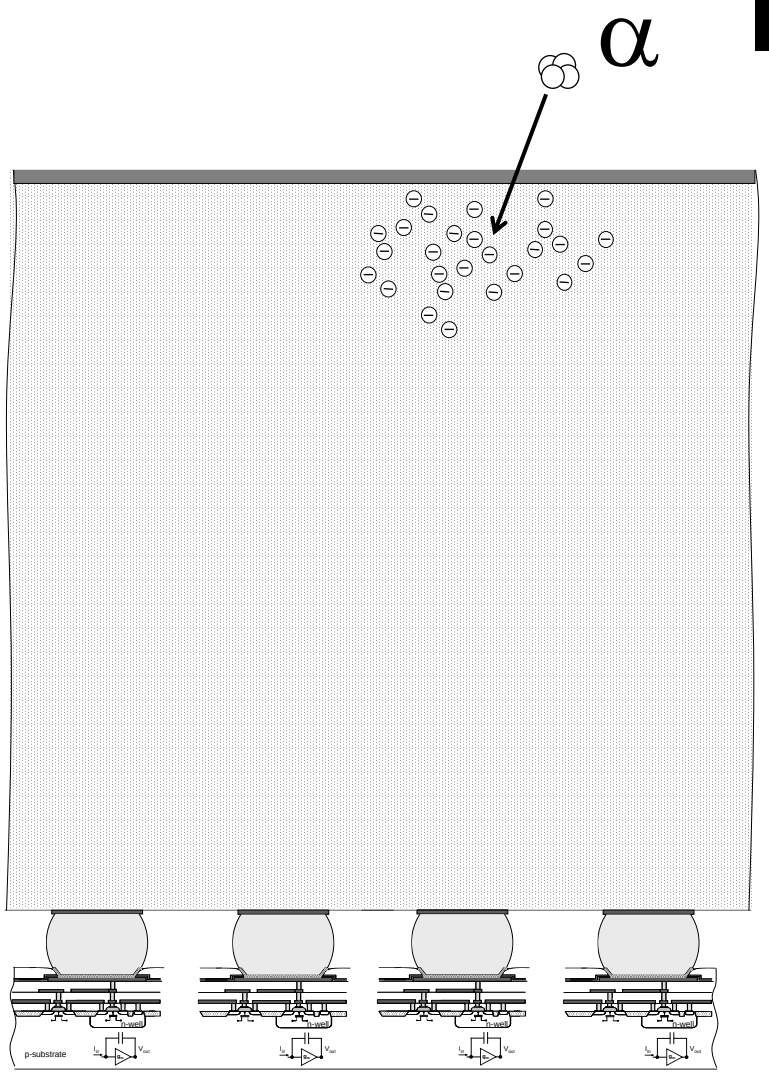
Definiciones

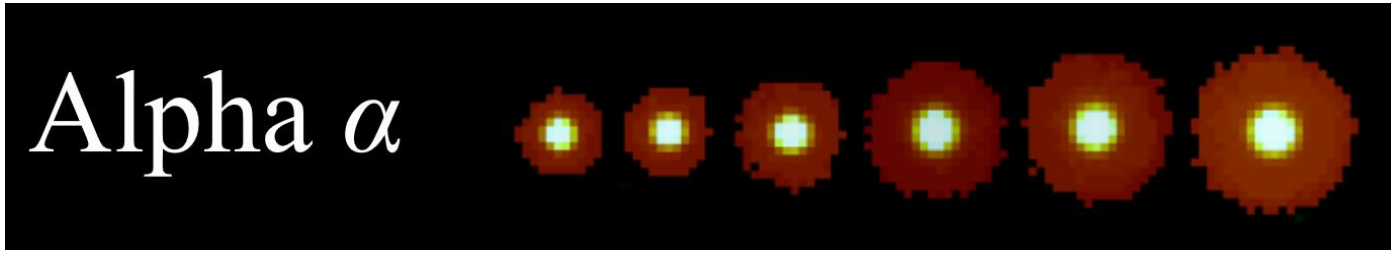
Radiación es la emisión de energía en el espacio en forma de ondas electromagnéticas o en forma de partículas altamente energéticas (electrones, protones, iones, etc.).

La **radioactividad** es un fenómeno físico por el cual ciertas sustancias con núcleos atómicos inestables, se transforman espontáneamente perdiendo energía en forma de rayos de partículas, para adquirir unos núcleos atómicos más estables i de menor masa.

Radiación con carga eléctrica	Radiación sin carga
Partículas α, Iones pesados	Neutrones
Electrones (β^-), Positrones (β^+), Muones (μ^+, μ^-), Taus (τ^+, τ^-)	Fotones (Rajos X, rajos γ)

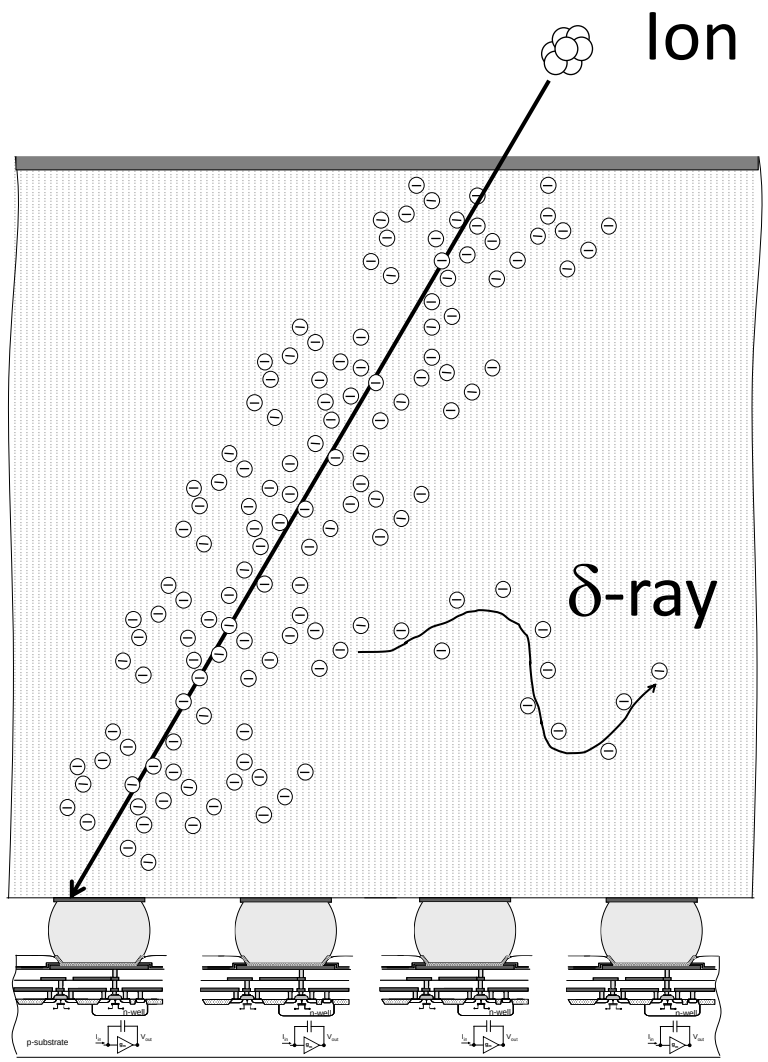
Partículas α





- He nuclei: 2 protons and 2 neutrons
- Interact strongly with matter due to their charge (coulombic forces) and to their mass
- At their typical speeds they can only travel a few centimeters in air. They can be stopped by a sheet of paper
- In their interactions with electrons in the absorbing material, α particles can generate δ rays

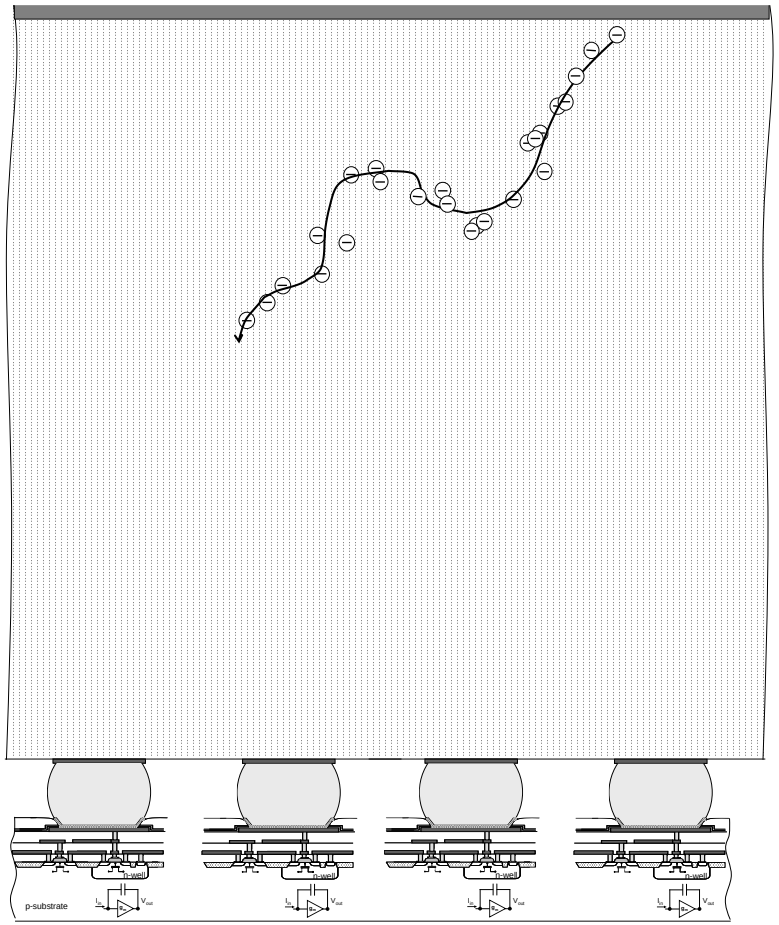
Iones pesados

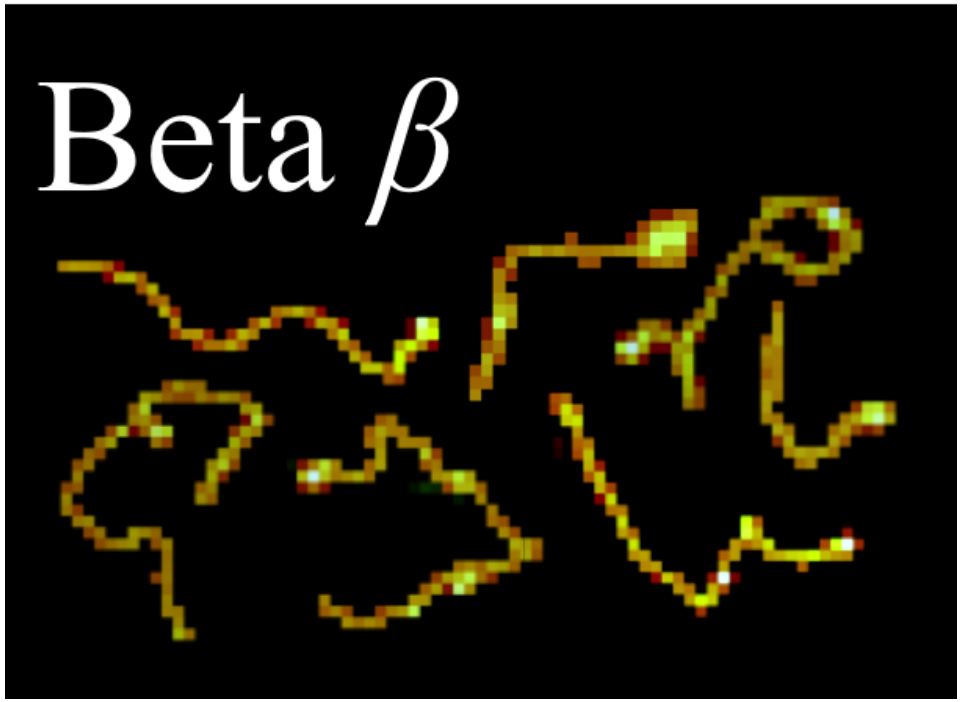


- A heavy ion is an ionized atom (heavier than He)
- Interact strongly with matter due to their charge (coulombic forces) and to their mass
- In their interactions with electrons in the absorbing material, they can generate δ rays

Radiación β

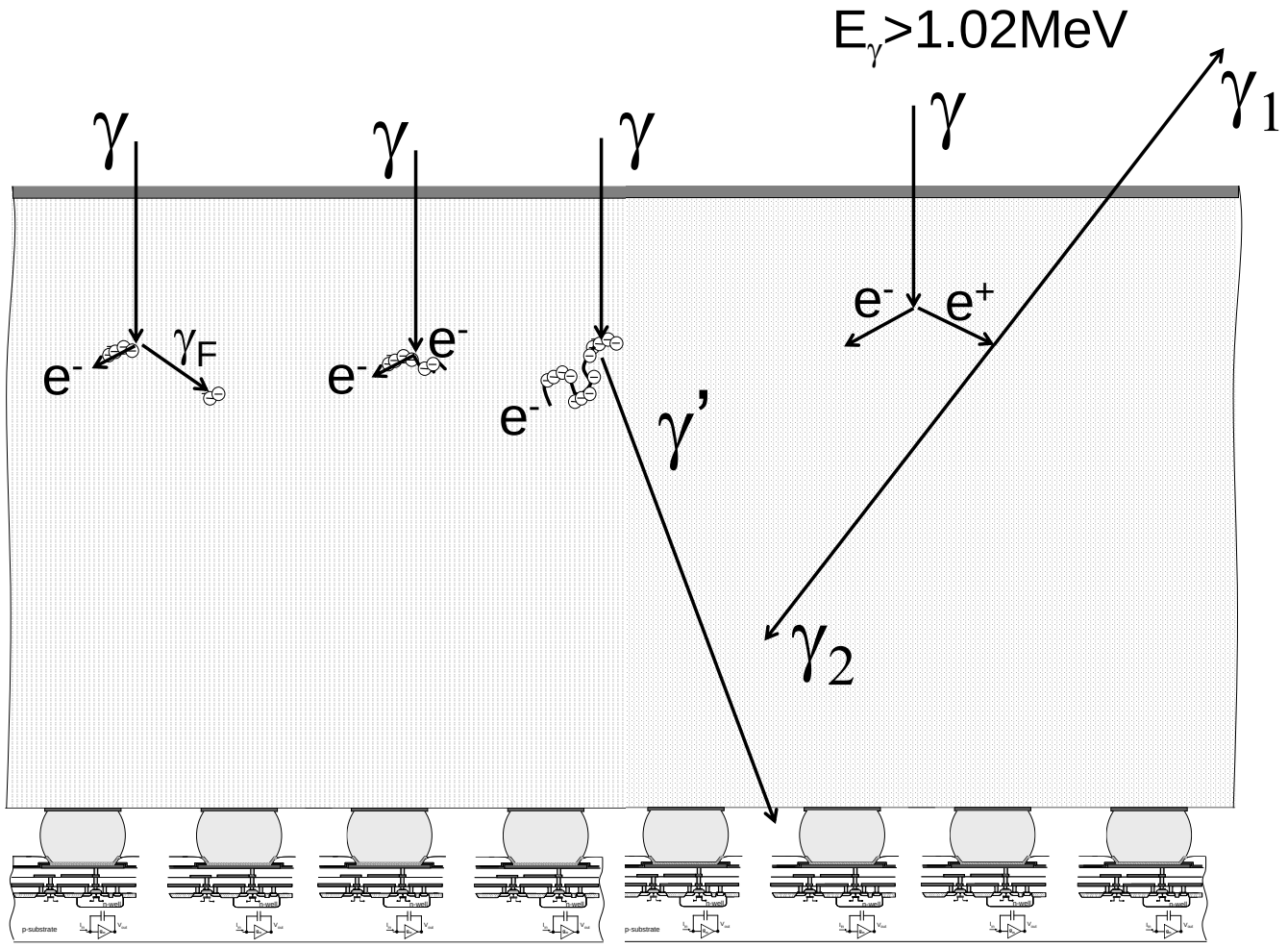
β^-





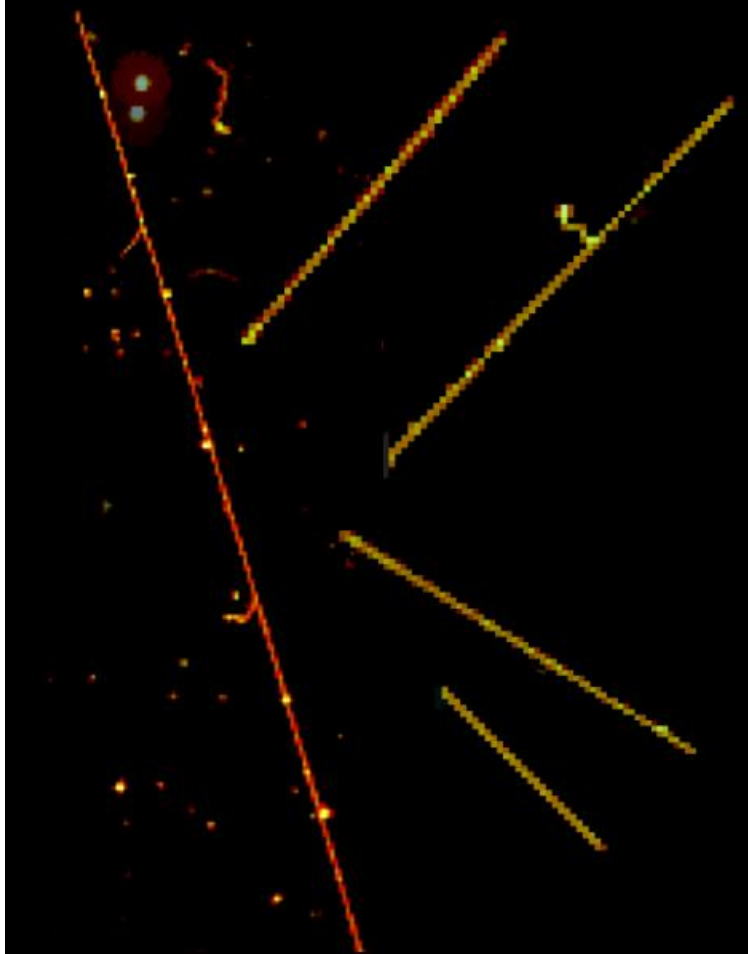
- Beta radiation consists of electrons (β^-) (or positrons (β^+)).
- Electrons follow random trajectories inside the absorbing material because they have the same mass as the electrons with which they interact

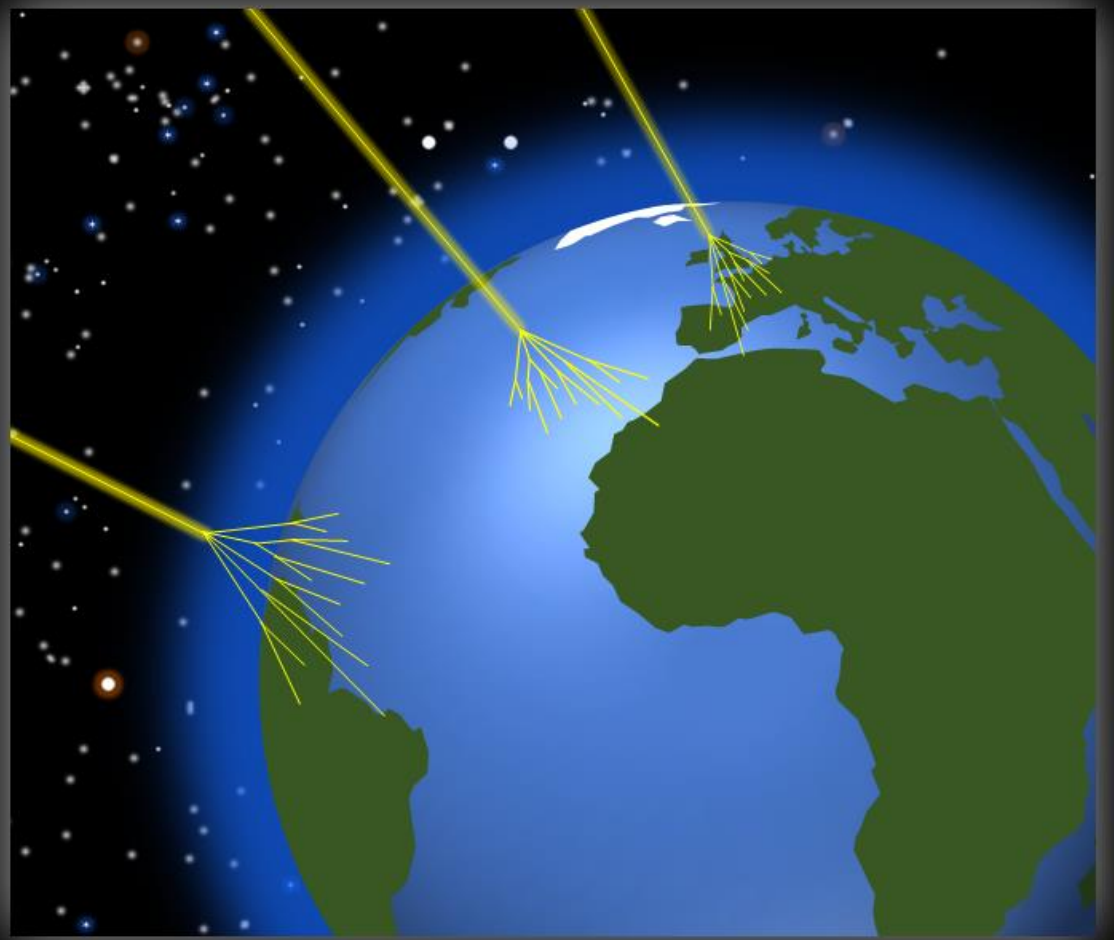
Rayos X y radiación γ



- Gamma radiation consists of high energy photons
- Photoelectric effect, Compton scattering, pair production

Muon μ





Las colaboraciones Medipix

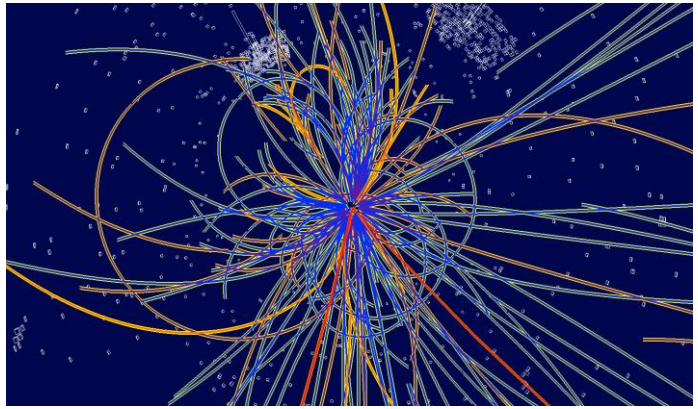
Google My Maps

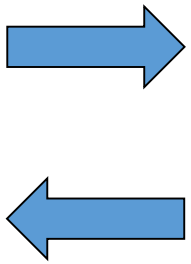
Google My Maps

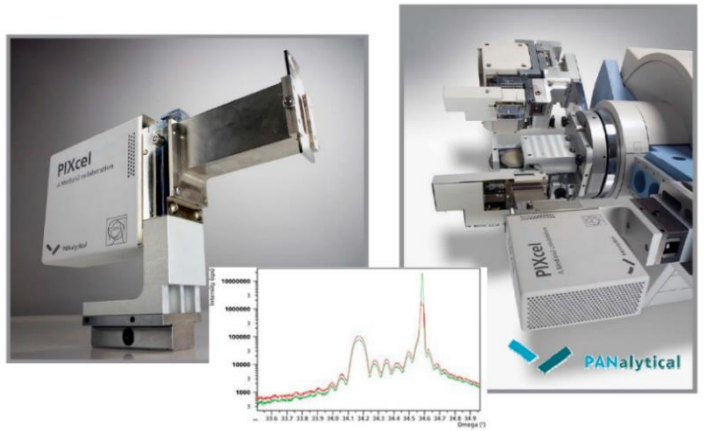
Google My Maps

Las colaboraciones Medipix

- Se crearon para desarrollar detectores de píxeles híbridos y sus aplicaciones
  - Chips Medipix: procesado rápido de la información en el pixel
  - Chips Timepix: procesado “off-line” (más información por evento, flujo de partículas inferior)
- ¡Science driven!
- Los chips están diseñados en la sección de microelectrónica del CERN
- Los colaboradores desarrollan sistemas de lectura e instalan los sistemas de detectores en sus aplicaciones
- Cuando los sistemas están bien caracterizados se pueden dar licencias de comercialización (e.g. Medipix3: 2 licencias de exclusividad, 5 de no exclusividad)
- Ejemplo de spin-off y spin-back hacia la física de altas energías







Aplicaciones: Dosimetria en el espacio

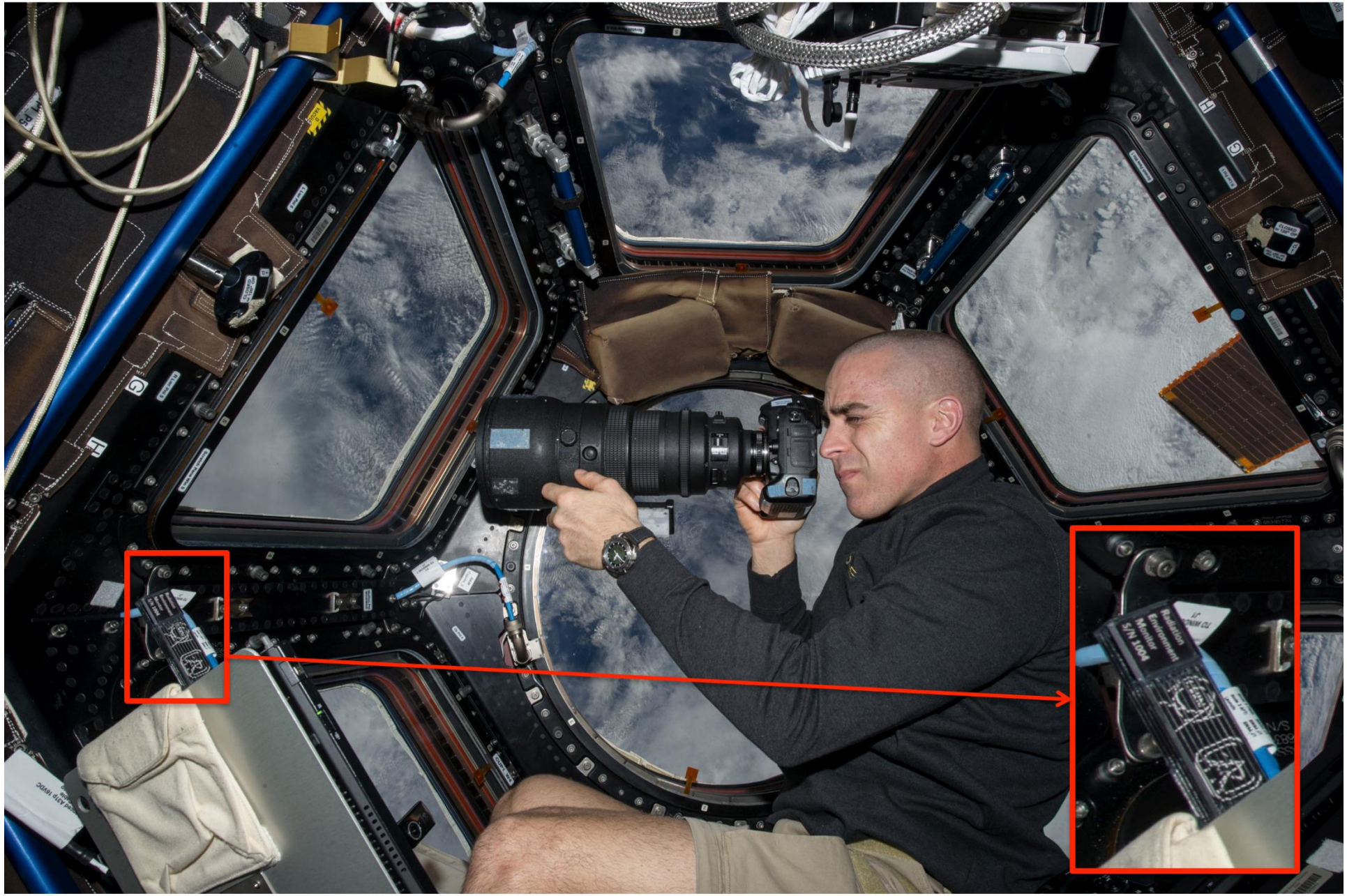
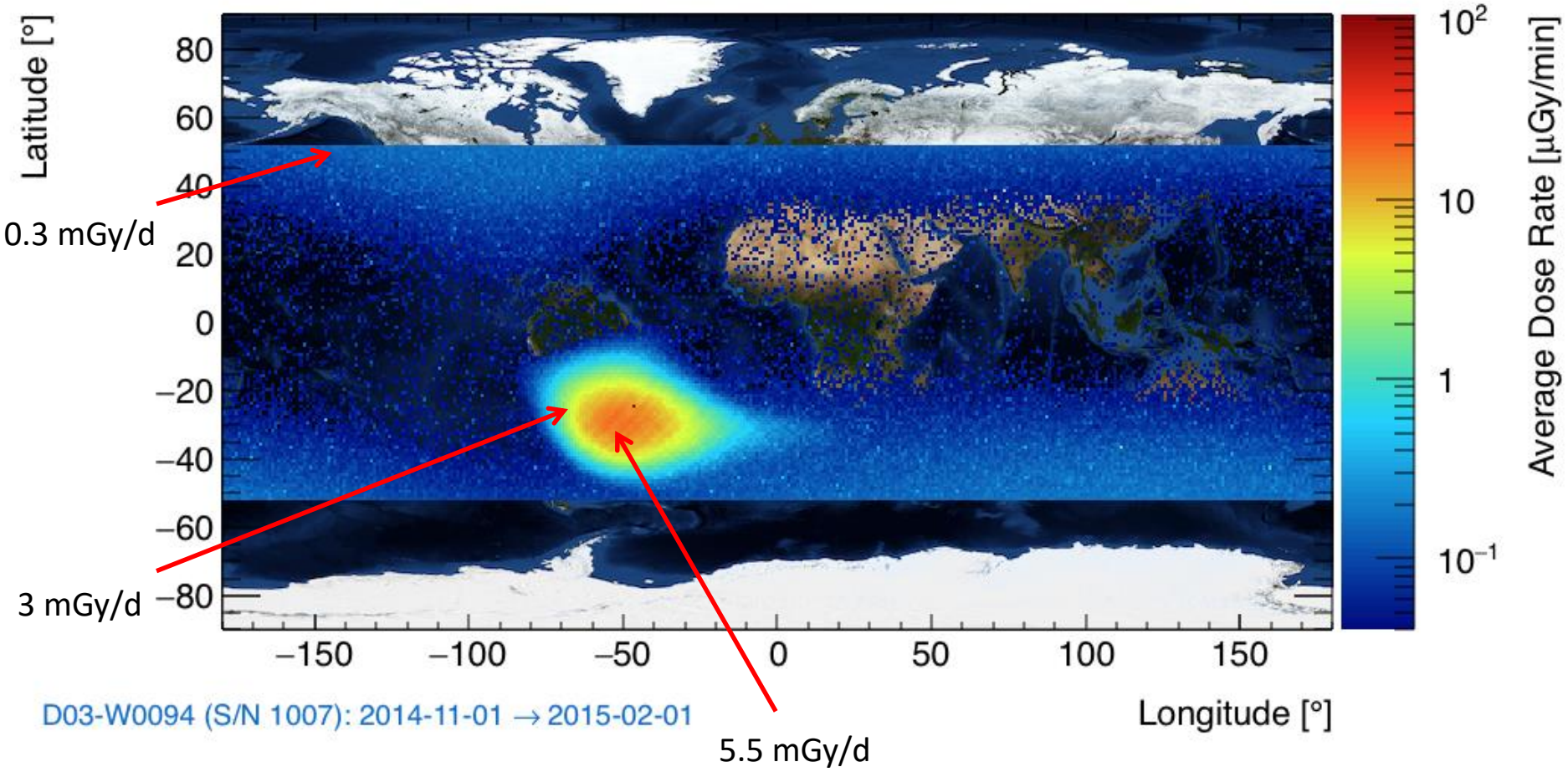


Image of the astronaut Chris Cassidy working near the Timepix USB on the International Space Station (Courtesy of NASA, photo ref. no. iss036e006175)

REM Dose Rate Data (μG/min)

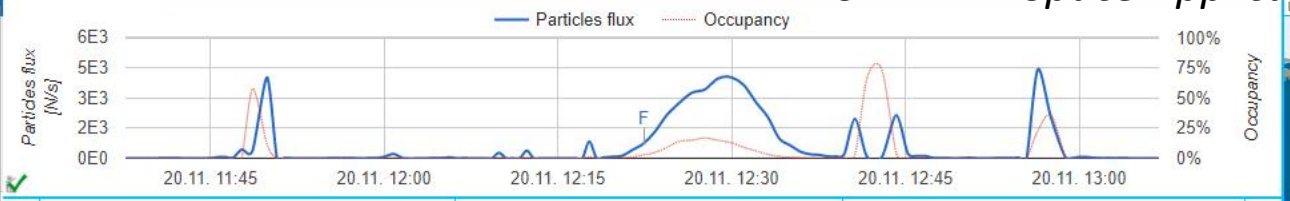


Proba-V satellite (820km)

SATRAM: Space Application of Timepix based Radiation Monitor

Meeting Information - Zoom | SATRAM/Timepix visualization

satram.utef.cvut.cz



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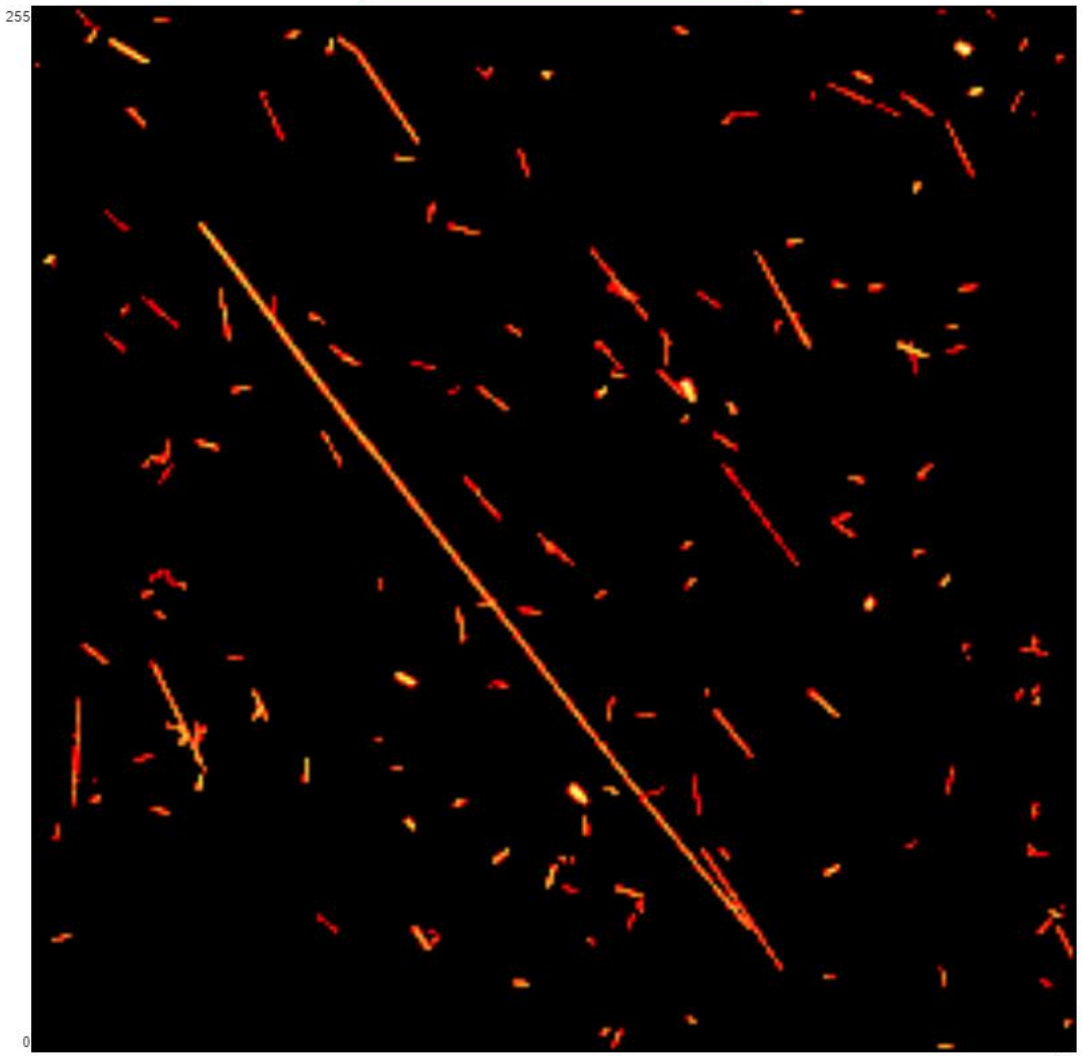


Cluster type	Sum	Particles flux	Energy flux [MeV]	H
Dot	4	20	0.311	
Small blob	9	45	3.489	
Heavy blob	4	20	38.797	
Heavy track	2	10	26.582	
Straight track	4	20	20.761	
Curly track	123	615	339.531	
Sum:	146	730	429.472	

Histograms

Type of histogram: Volume [keV]

Max number of bins

Min. value

Max. value

Additional frame data

This data are from the first frame in the integral mode.

Proba-V power status
0.32, 28.99

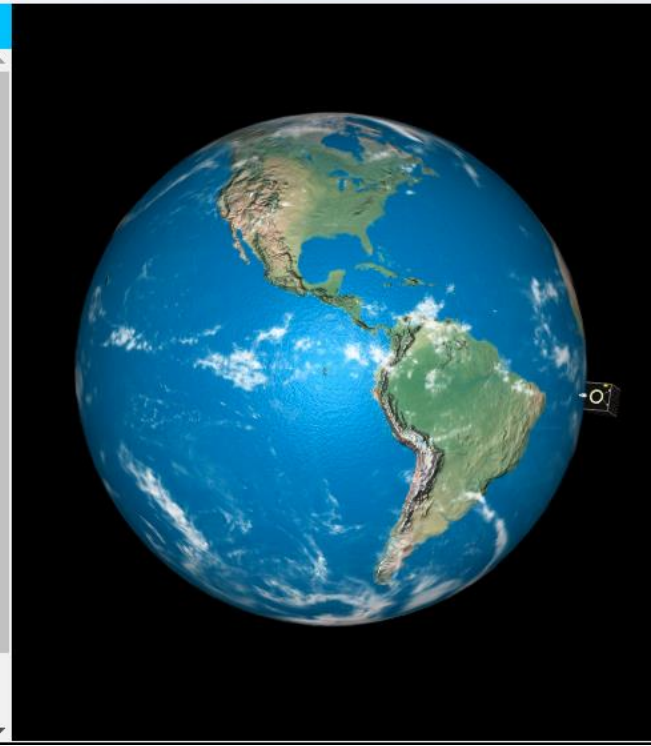
B field strength
-1.468e-5, 7.87e-6, -8.91e-6

Proba-V thermal status
17.84, -237.35, 8.07, 13.69

PSU failures
0

Bias voltage

PSU status



Status: All server queries done. (622ms)

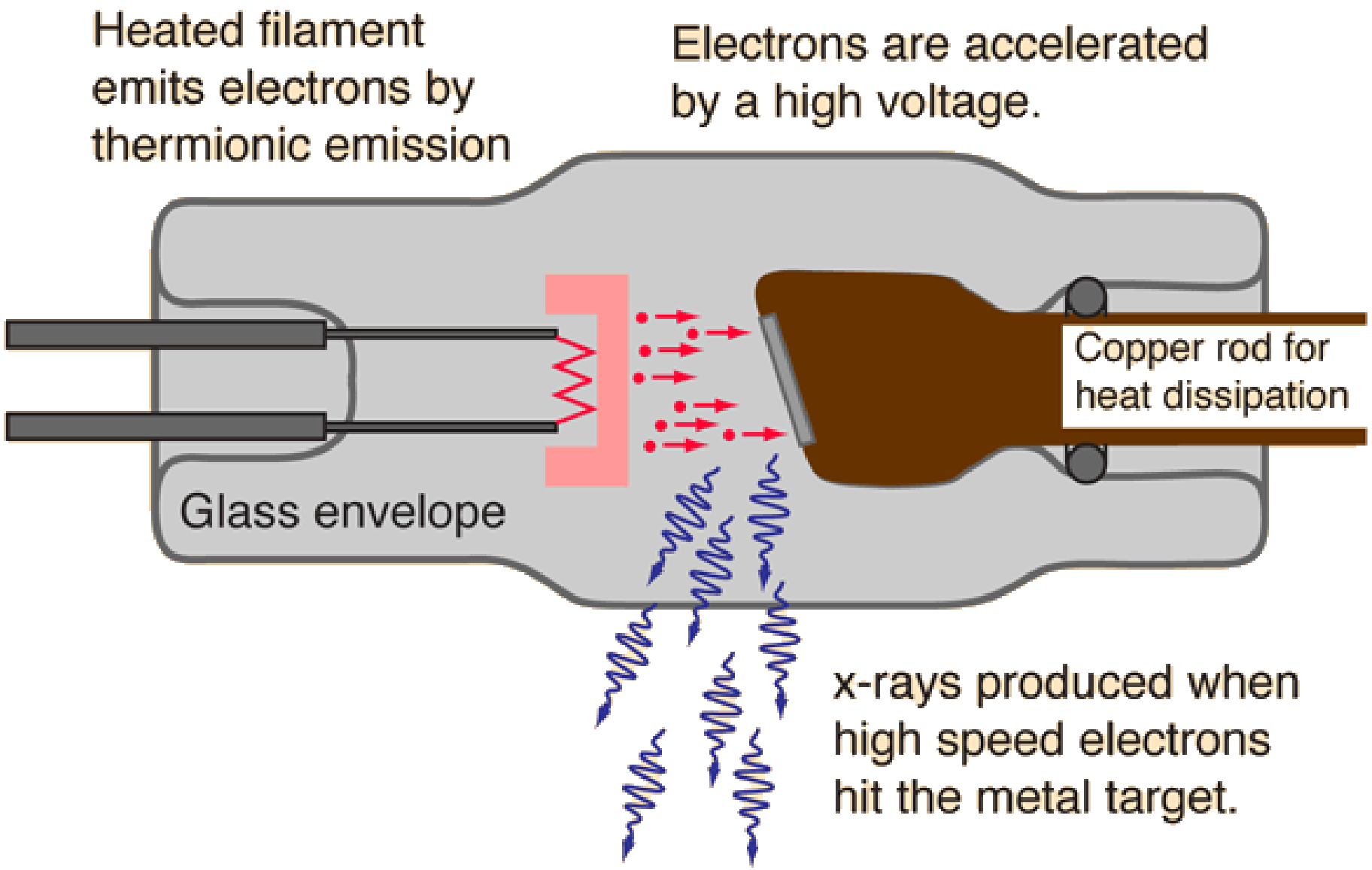
Timepix deployments in Outer Space: Heritage + ongoing developments

Human flight/Dosimetry: LEO/on board ISS/2012, Radiation effects/Space Weather: spacecraft/satellite payloads/Proba-V/2013

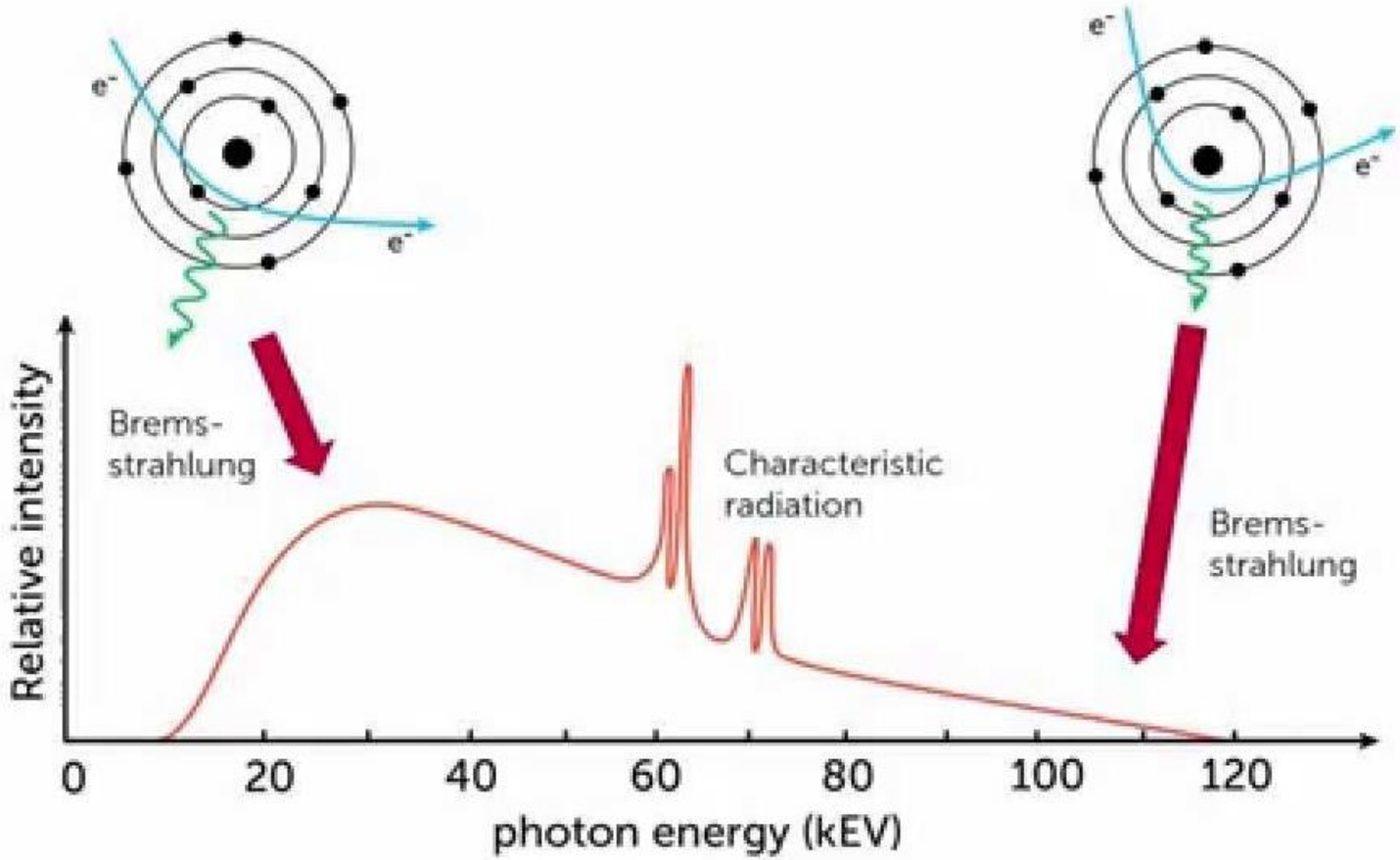
Orbit	Launch	
		Spacecraft payloads: Micro-satellites
LEO, 820 km	May 2013	❑ SATRAM-Timepix on board **ESA Proba-V satellite** QinetiQ ESA (in LEO orbit since May 2013), successful commissioning, continuous data taking
LEO, 600 km	July 2014	❑ LUCID-5xTimepix array payload on board **TechDemoSat-1 SSTL-UK satellite** Langton Ultimate Cosmic-ray Intensity Detector, successful commissioning, continuous data taking
LEO, 600 km	1Q-2019	❑ Particle telescope/2x stack Timepix for **RISESAT satellite** Tohoku U./Japan (ongoing, FM delivery 3Q 2018, launch 4Q 2018/1Q2019)
		Spacecraft payloads: nanosatellites/cubesats
LEO, 500 km	June 2017	❑ Focal plane X-ray detector 1xTimepix/X-ray telescope 1D optics on board **Cubesat VZLUSAT-1**, successful commissioning continuous data taking
CIS-lunar/deep space	2020	❑ Timepix radiation monitor payload on board **BioSentinel cubesat** for **NASA-ORION flight EM1**, NASA Ames
		Spacecraft payloads: large satellites
GEO 36000 km	>2020	❑ Miniaturized Radiation Monitor MIRAM, for **ESA/ARTES telecommunication satellites at GEO orbit**
		Sub-orbital sounding rockets
LEO, 200 km	April 2018	❑ Focal plane X-ray detector 2xTimepix/X-ray telescope 2D optics REX payload Penn State U. for **NASA WRX-R sounding sub-orbital rocket**, launched 4th April 2018, successful operation, data collected, payload retrieved
		Pressurized/manned space modules
LEO, 420 km	Aug 2012	❑ Miniaturized Quantum imaging on-line space radiation dosimeters/Radiation Environment Monitors REM 5xTPX on board **ISS-NASA**, successful commissioning, continuous data taking, NASA JSC
MEO, 6000 km	Dec 2014	❑ 2x Battery Operated Radiation Detectors BIRD-Timepix fully autonomous operation, **NASA Orion Exploration Flight Test EFT-1**, successful commissioning, continuous data taking , NASA JSC
LEO, 420 km	May 2017	❑ Energetic Particle Telescope EPT-Timepix 2x stack on board **ISS-NASA**, successful commissioning continuous data taking, NASA JSC
CIS-lunar/deep space	2020	❑ Hybrid Electronic Radiation Assessor HERA-Timepix for **NASA-ORION flights EM1** and **EM2**, NASA JSC

Aplicaciones: Radiografia

Generación de rayos X



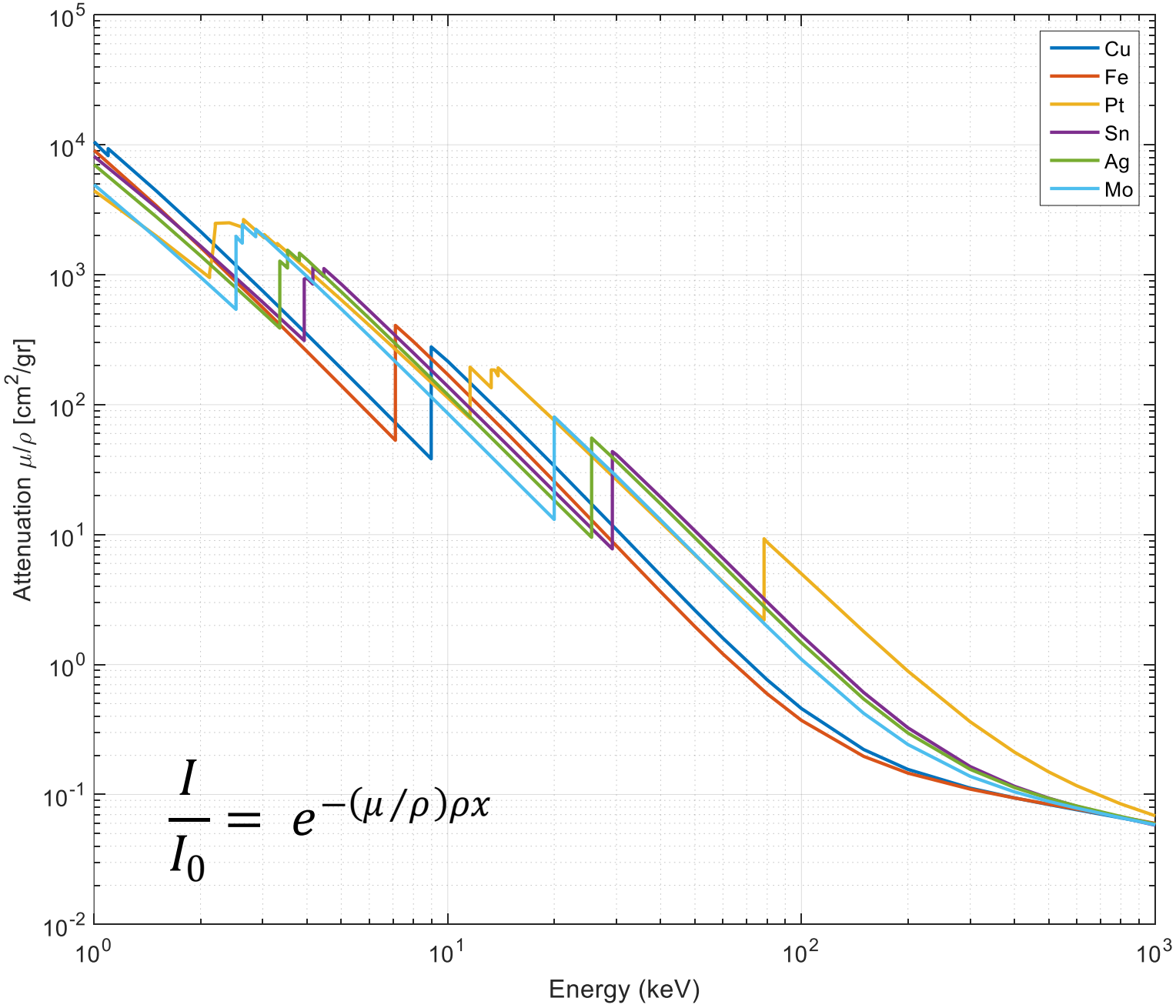
X-ray generation - spectrum

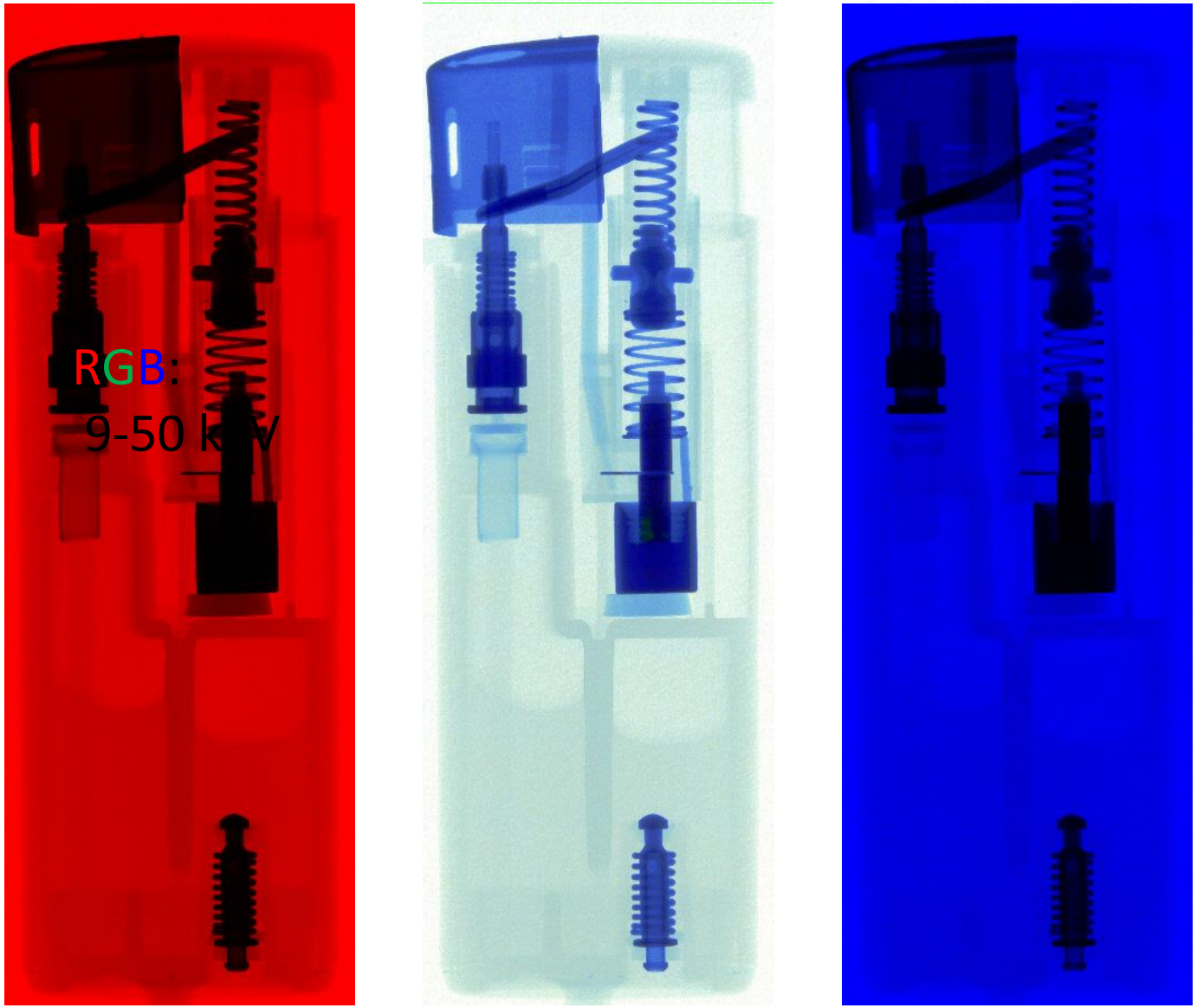


Un electrón de alta energía que impacta el interior de un átomo puede generar fotones de rayos-X por el hecho de que su trayectoria sea desviada por el núcleo atómico sin que altere en su recorrido la estructura electrónica del átomo que ha sido atravesado.

(Presentación ADMIRA Enero 2020, E. Graugés)

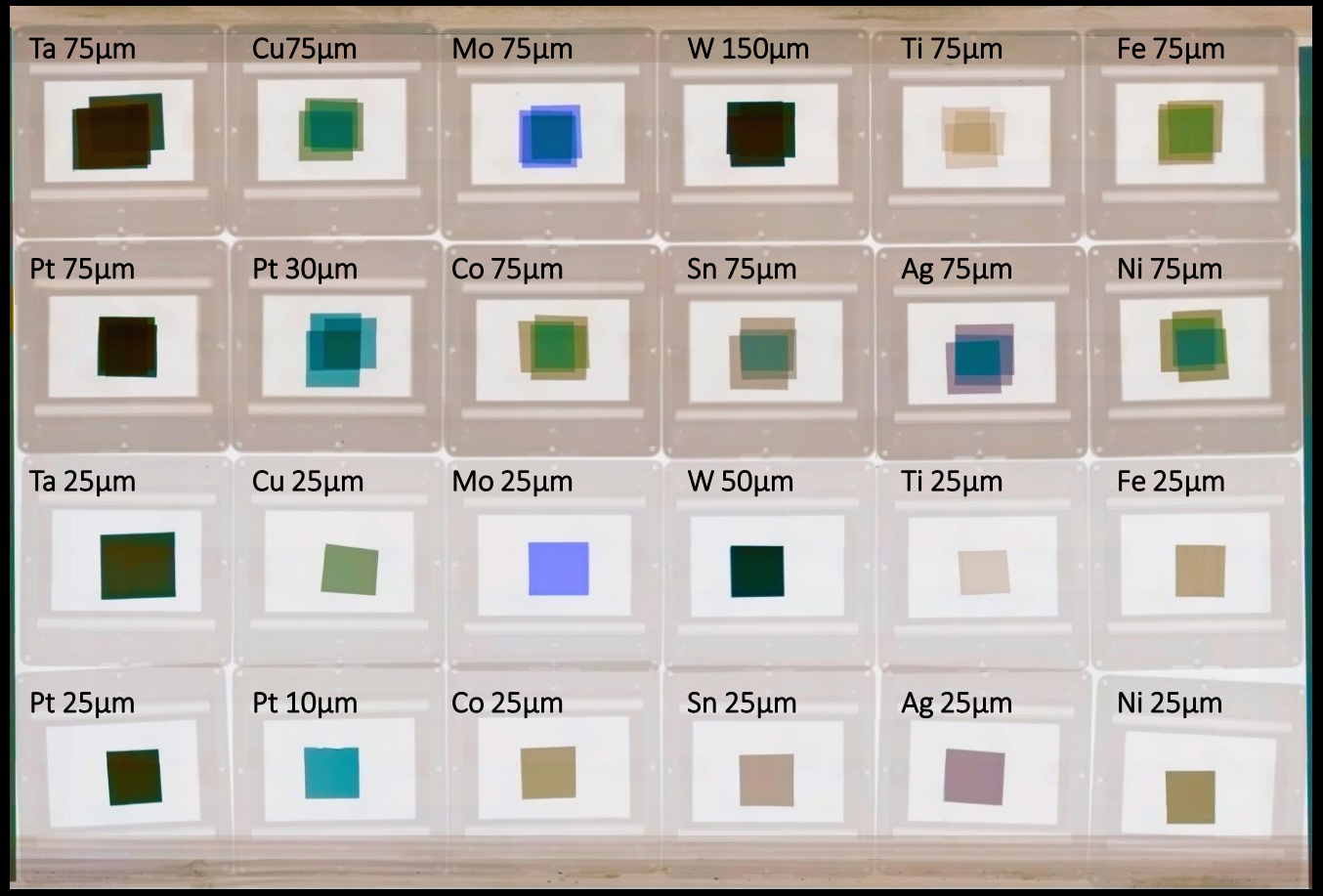
“Energia”=“Color”


Cu
Fe
Pt
Sn
Ag
Mo
Attenuation μ/ρ [cm^2/gr]
Energy (keV)
10^5
10^4
10^3
10^2
10^1
10^0
10^{-1}
10^{-2}
10^0
10^1
10^2
10^3
$\frac{I}{I_0} = e^{-(\mu/\rho)\rho x}$



Courtesy: S. Procz et al.

The regular vs “colour” X-ray imaging of test samples



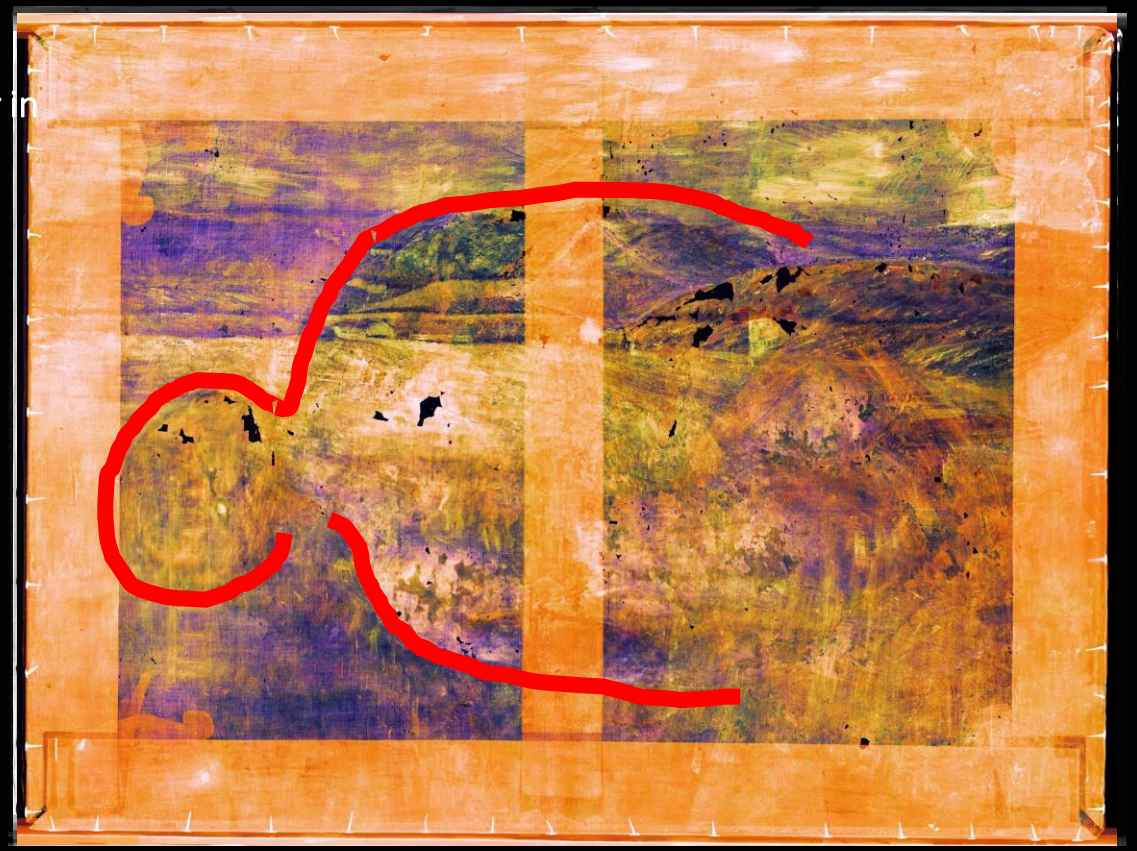
J. Jakubek

BBC Click on Fake Art – InsightART's X-ray colour imaging of art!
https://youtu.be/1xUD0BUzgtQ

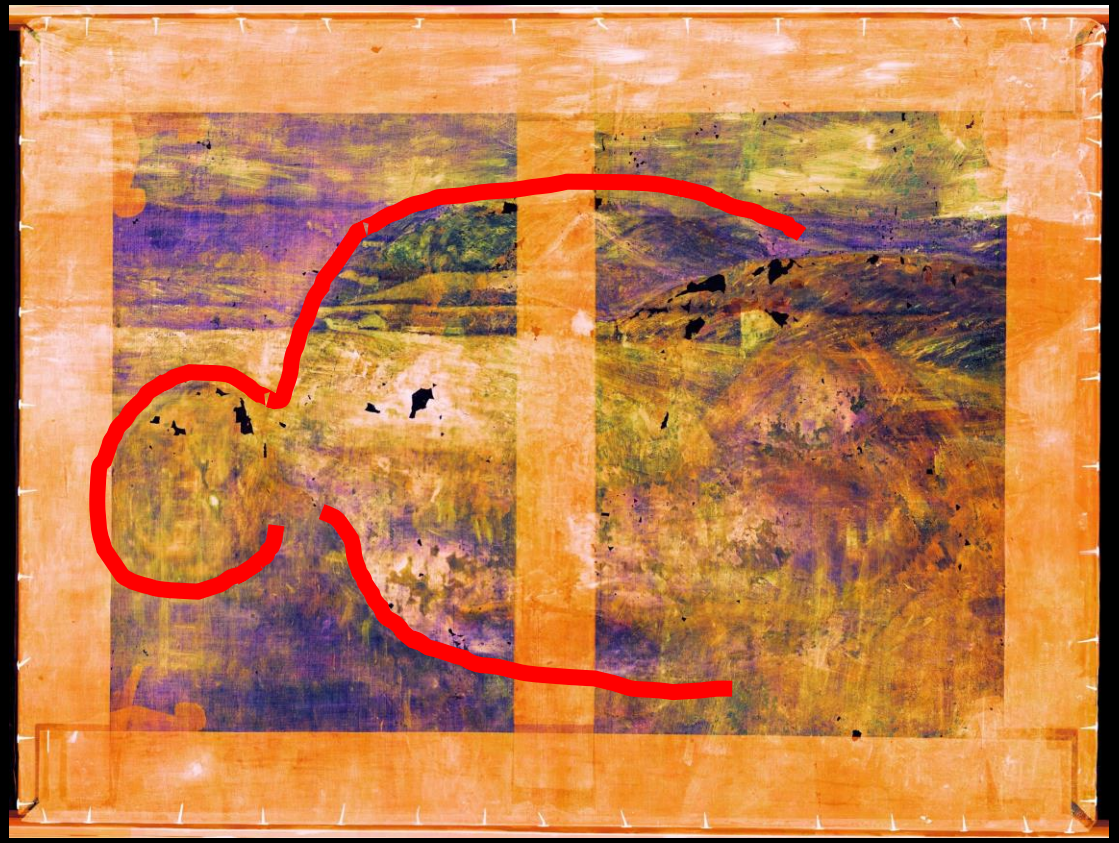
Signed
Vincent van Gogh

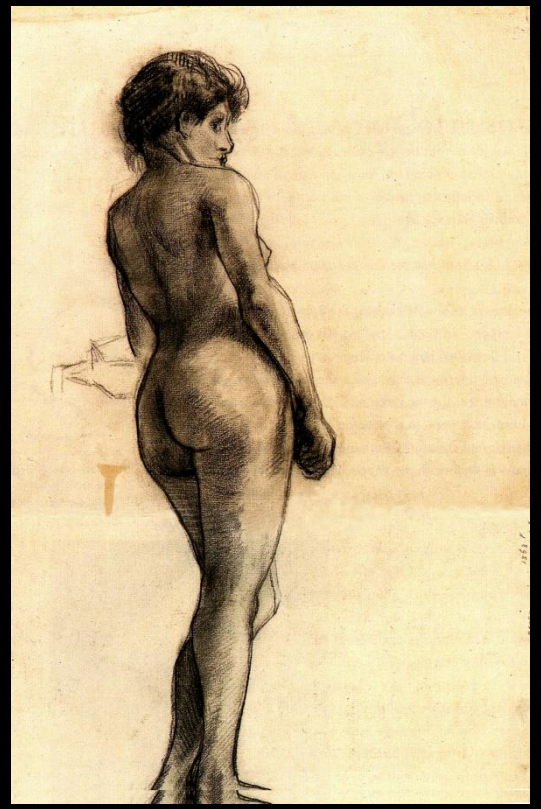
La Crau with Montmajour in the backgroud

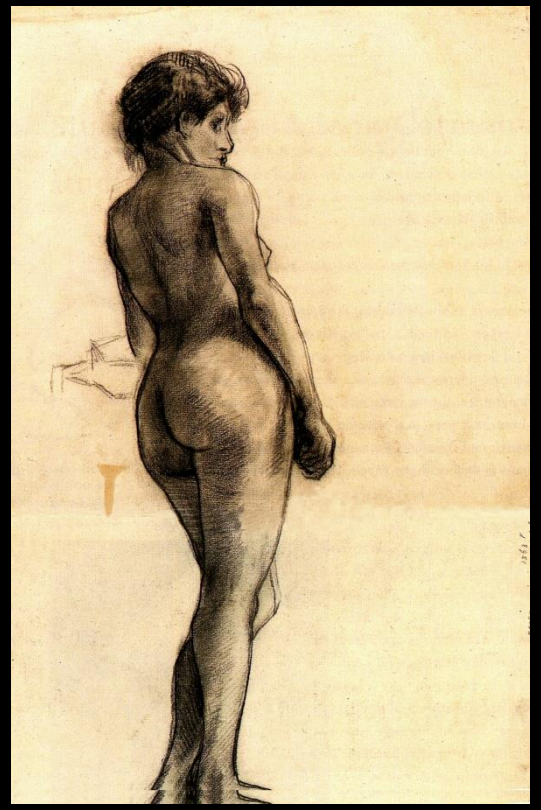
~1888



INSIGHTART







MBI MARS clinical trial image (1x12 Medipix3RX with CdZnTe detectors (~24cm^2))
200K pixels
Wrist with titanium screw and steel wire

Scanner installed at Centre Hospitalier Universitaire Vaudois (CHUV), Lausanne, Switzerland

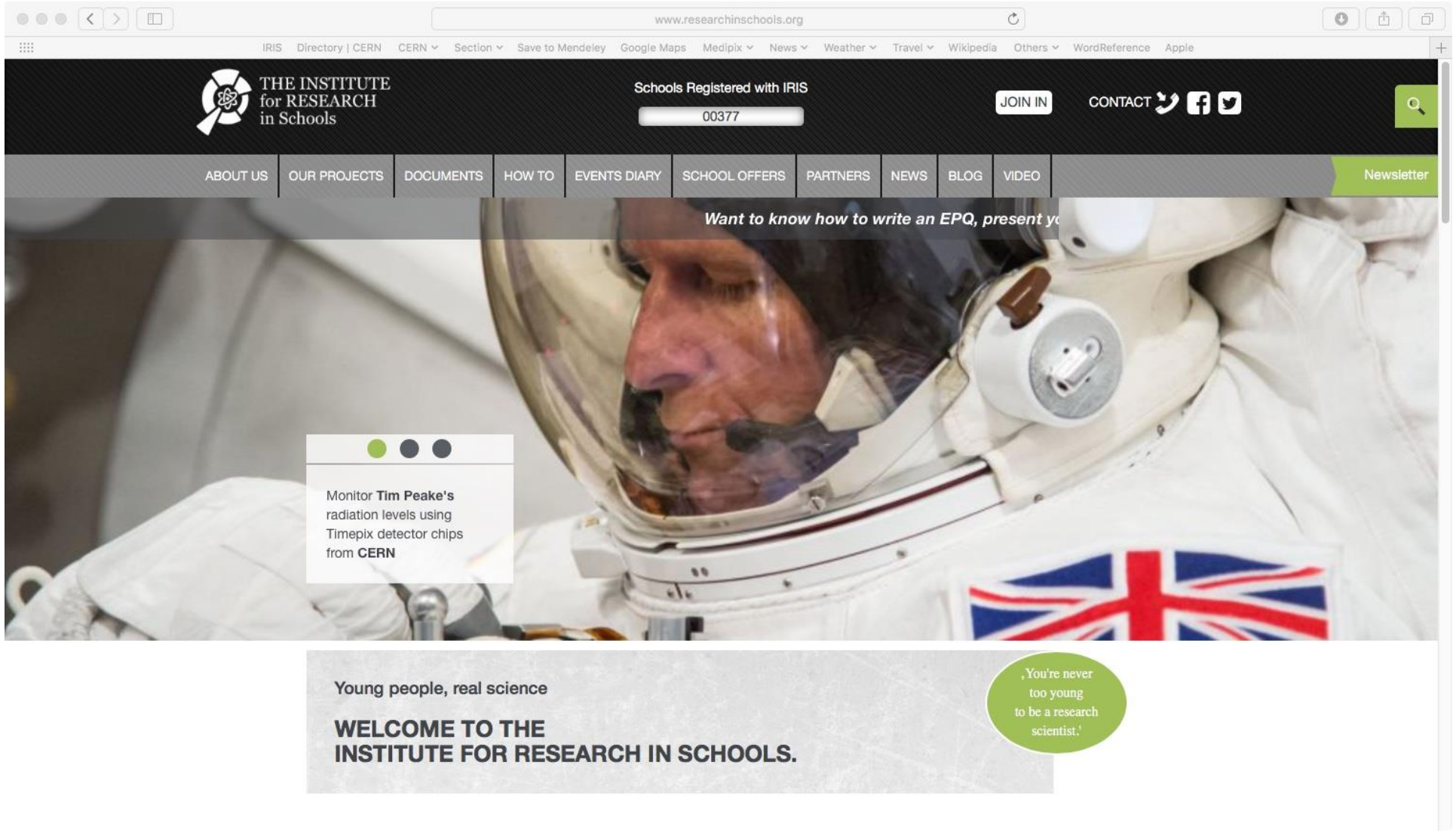
Courtesy: MARS team

Educación

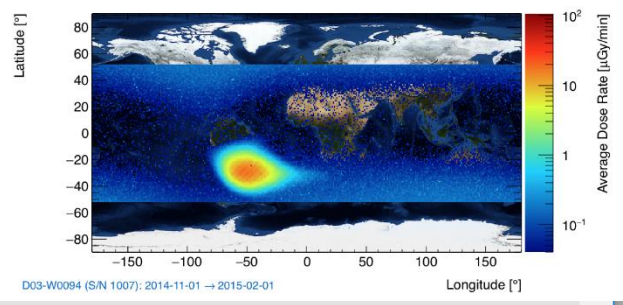
CERN@school

Simon Langton School, Canterbury, England

Institute for Research in Schools



http://www.researchinschools.org/



Welcome to the IRIS Data Server

You can access full background information on this project at http://researchinschools.org/TIMPIX/ ? If you have any queries please contact timpix@researchinschools.org

Please click here to download data released as part of the TimPix project.

The filenames identify the date and period of time the measurements cover. For example, 151215_0001-2359_Detector_3 is a set of measurements taken from detector number 3 on the 15 th December from 00:01 to 23:59.

The files are in CSV format and can be opened in a spread sheet application.

There are a number of different columns and the contents are slightly different to the TimPix 101 data set. This data release includes the fields:

- Latitude
- Longitude
- Altitude
- Timestamp (UNIX time format)
- Start_time to indicate when the measurement was taken
- Acq_time is the length of the measurement
- Frame energy is given in keV
- n_pixel is the number of pixels that received a hit during the measurement
- occ_pc is the occupancy of the detector in this measurement as a percentage. This is the number of hit pixels divided by the detector's total number of pixels.

Solar eclipse investigation: data from the 2015 solar eclipse is now available for analysis. This data set includes space and ground-based measurements. Access the data set here

Please click here to download the data

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Outline

Abstract

Keywords

1. History of the CERN@school project using Timepix tec...

2. CERN@school develops into a national project

3. The development of the Institute for Research in Schools

4. Other uses of the Timepix detector in education

5. Conclusion

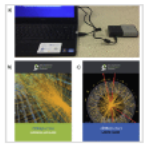
Acknowledgements

Appendix. LUCID and TechDemoSat-1

References

Show full outline

Figures (2)



ELSEVIER

Radiation Measurements

Available online 7 May 2019, 106090

In Press, Corrected Proof

Transforming education with the Timepix detector - Ten years of CERN@school

B. Parker [a, b], L. Thomas [a], E. Rushton [a, c], P. Hatfield [a, d]

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https://doi.org/10.1016/j.radmeas.2019.03.008

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Abstract

The history and use of the Timepix detector as an educational tool is outlined. The CERN@school project which lends the Timepix technology to schools has been developing for the last ten years with over 300 schools involved and thousands of students. Resource materials and online support is available and schools have used the technology both to support curriculum activities and provide stimulus for

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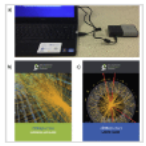

Abstract

The history and use of the Timepix detector as an educational tool is outlined. The CERN@school project which lends the Timepix technology to schools has been developing for the last ten years with over 300 schools involved and thousands of students. Resource materials and online support is available and schools have used the technology both to support curriculum activities and provide stimulus for student research. Student work includes research on radiation levels during a solar eclipse and a payload launched in space. Research projects with the Timepix technology have led to the development of the Langton Ultimate Cosmic ray Intensity Detector (LUCID) which has enabled students to develop an understanding of radiation in space and large scale data analysis. Feedback on the impact of these projects is discussed alongside plans for expansion of access to this technology. Possibilities for progress in the next ten years are suggested to include the gradual replacement of the Geiger Müller tube in schools with this technology. This would make invisible ionising radiation visible and transform the understanding young people have of radiation. Alongside this transformation of the teaching and learning of radioactivity there is potential for further development of student expertise in analysing data from Timepix detectors in space. The opportunities this technology offers to students in school are vast and students have valuable roles to play in the use and application of the technology over the next ten years. It is hoped that not only are these developments in the UK but also across Europe and beyond.

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PLUMX View details

Incremento del 38% STEAM (chicos) x3 (chicas)

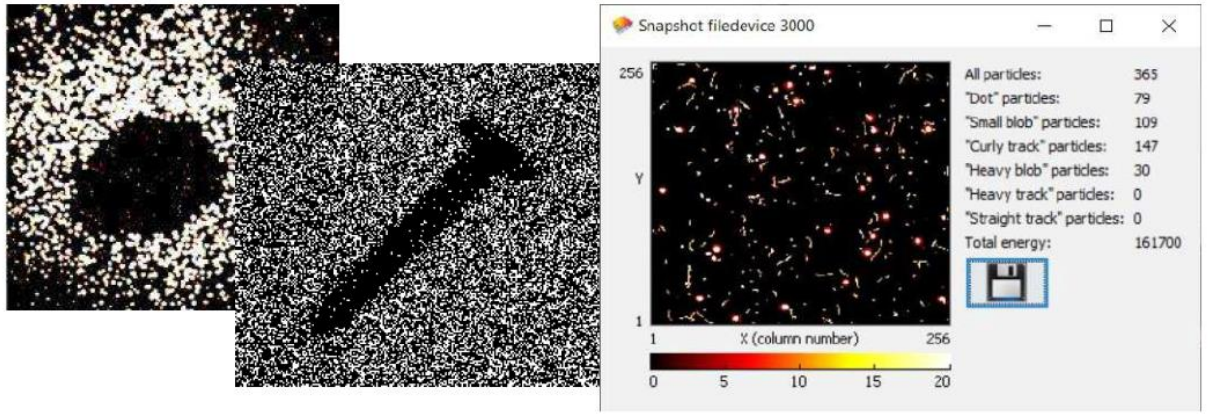
~7000 students used the detector between 2016 and 2019

Feedback

ENG US 07:21 30/06/2019

S E S T R A

School Education Set with Timepix for Radiation Analysis



Kit Components

- Particle Camera MiniPIX EDU with Timepix detector
- Software (acquisition, online visualisation, etc.)
- SZZ Alfa (241Am, α and γ source, 9.5 kBq)
- DZZ Gamma (241Am, γ source, 300 kBq, *optional*)
- Potassium Salt (β and γ source)
- Thoriated Tungsten Electrode (α, β and γ source)
- Uranium Glass (α, β and γ source)
- Mounting Rails
- Source Holder
- Camera Holder
- Aluminium, Stainless, Copper, Brass and Lead Plates
- Radiography Adapter Head and Samples with Hidden Patterns
- Vacuum Cleaner Grate Adapter
- Transport Case
- USB Cable

IEAP CTU in Prague
Husova 240/5, 110 00,
Prague, Czech Republic
http://www.utef.cvut.cz/ieap

https://medipix.web.cern.ch/

Advacam s.r.o.
U Pergmanky 12, 170 00,
Prague, Czech Republic
https://advacam.com/

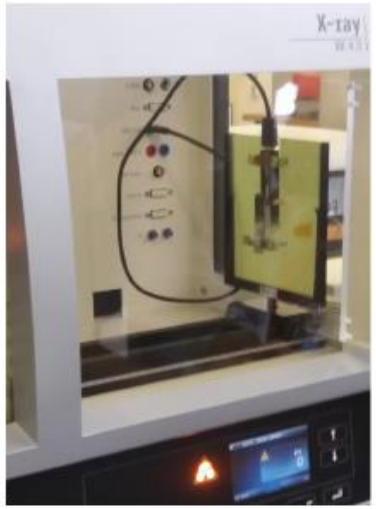
TIMEPIX en la escuela Sagrada Familia de Gavà

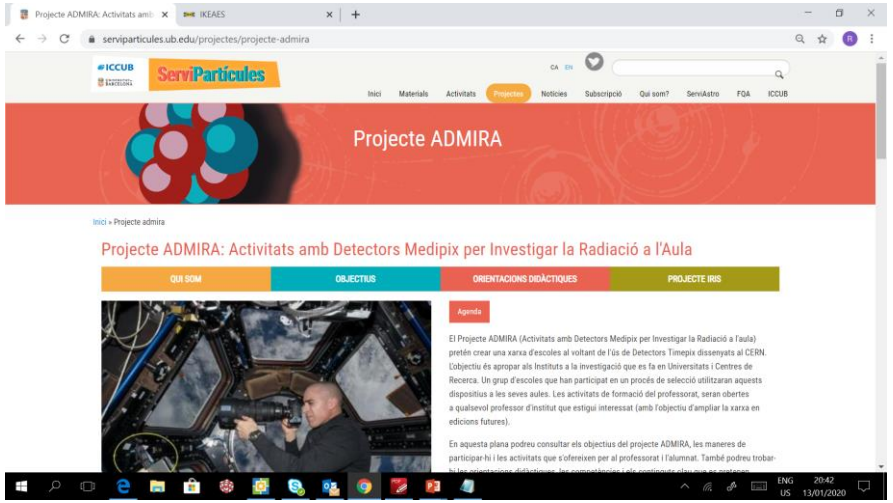
- Conferencia Mayo 2017
- Curso academico 2017-2018
  - 4 Trabajos de investigacion (Supervisión: D. Parcerisas)
    - Investigación teórica común de los 4 trabajos: Detector TIMEPIX, software PIXETPRO
    - Búsqueda de fuentes radioactivas
  - Práctica inicial

ADMIRA

Activitats amb Detectors Medipix per Investigar la Radiació a l'Aula

- **ADMIRA: Activitats amb Detectors Medipix per Investigar la Radiació a l'Aula**
- Objetivo (Acercar centros de investigación, universidades y escuelas de secundaria alrededor de la física de partículas)
  - Crear una **red de escuelas que comparten** dispositivos Timepix (cortesía de la sección de microelectrónica del CERN)
  - Los profesores comparten dispositivos, experiencias
  - Ofrecemos formación para profesores y estudiantes impartida por expertos
  - Estudiantes de secundaria participan en proyectos científicos reales
    - Trabajar en problemas en los que la solución no se encuentra en la última página
  - Impacto en muchas disciplinas (física, matemáticas, química, tecnología)



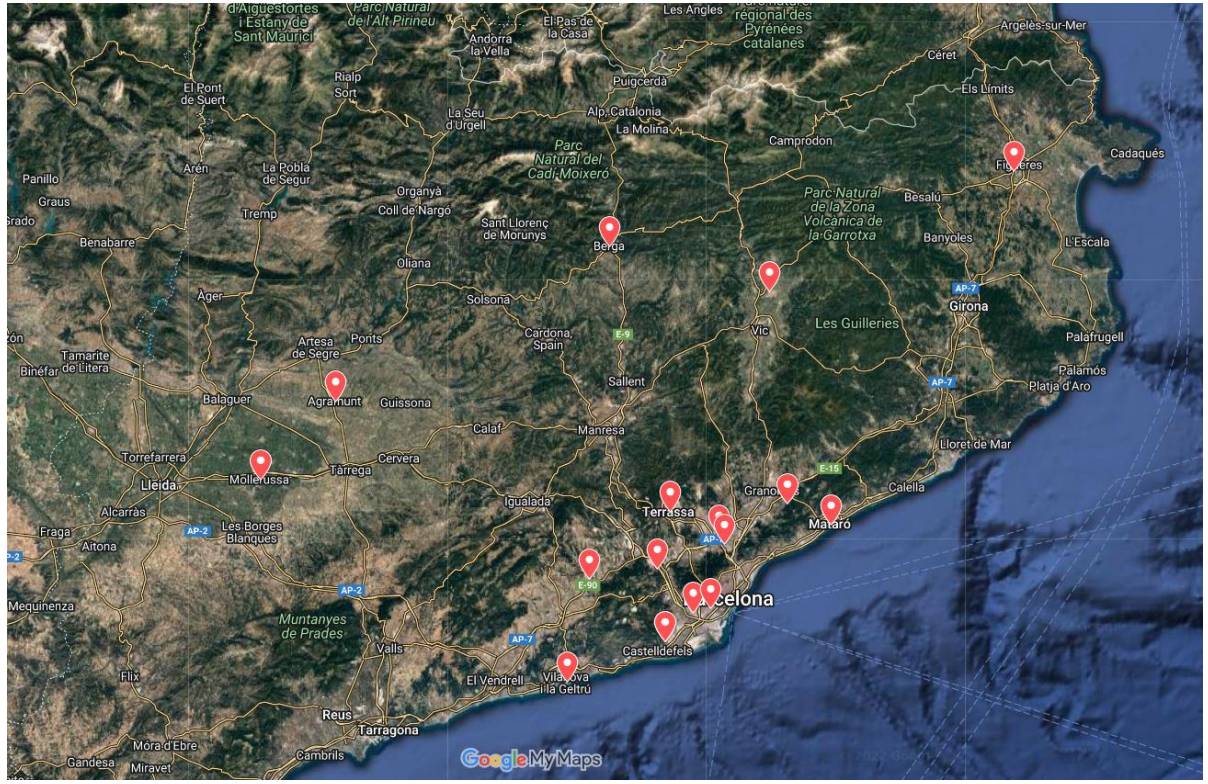


ADMIRA

Activitats amb Detectors Medipix per Investigar la Radiació a l'Aula

TEAM:

- Experimental Physics Department, CERN: R. Ballabriga, M. Campbell
- Institut de Ciències del Cosmos, University of Barcelona: A. Argudó, E. Pallarès, E. Graugés
- Institut de Desenvolupament Professional, University of Barcelona: L. Casas
- Schools: D. Parcerisas, D. Corrons, I. Huguet



The support from University of Barcelona is key (website, logistics for distributing the kit, access to conference rooms, certificates for teachers attending trainings)

Trabajo de investigación

Sagrada Familia, Gavà, Supervision: D. Parcerisas

<u>Trabajo de investigación</u>

Asignatura de 18 meses en bachillerato

Requiere investigación experimental

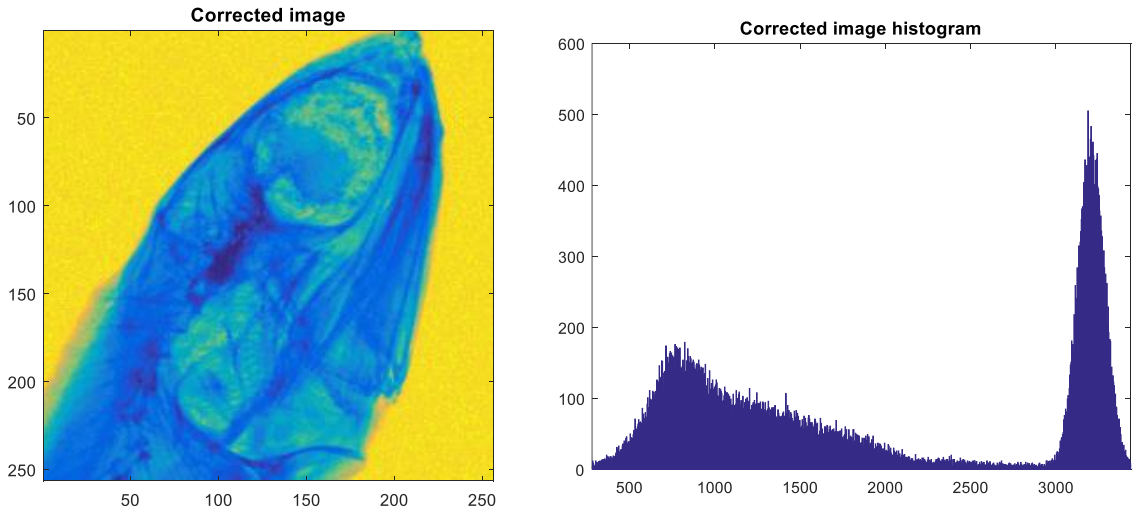
Timepix es una herramienta que permite diversidad de estudios

https://serviparticules.ub.edu/materials/llibres-i-manuals

Trabajo de investigación

- Dosimetría y radiación de fondo
- Rayos cósmicos
- Salud
- Detectores de partículas
- Computación e inteligencia artificial

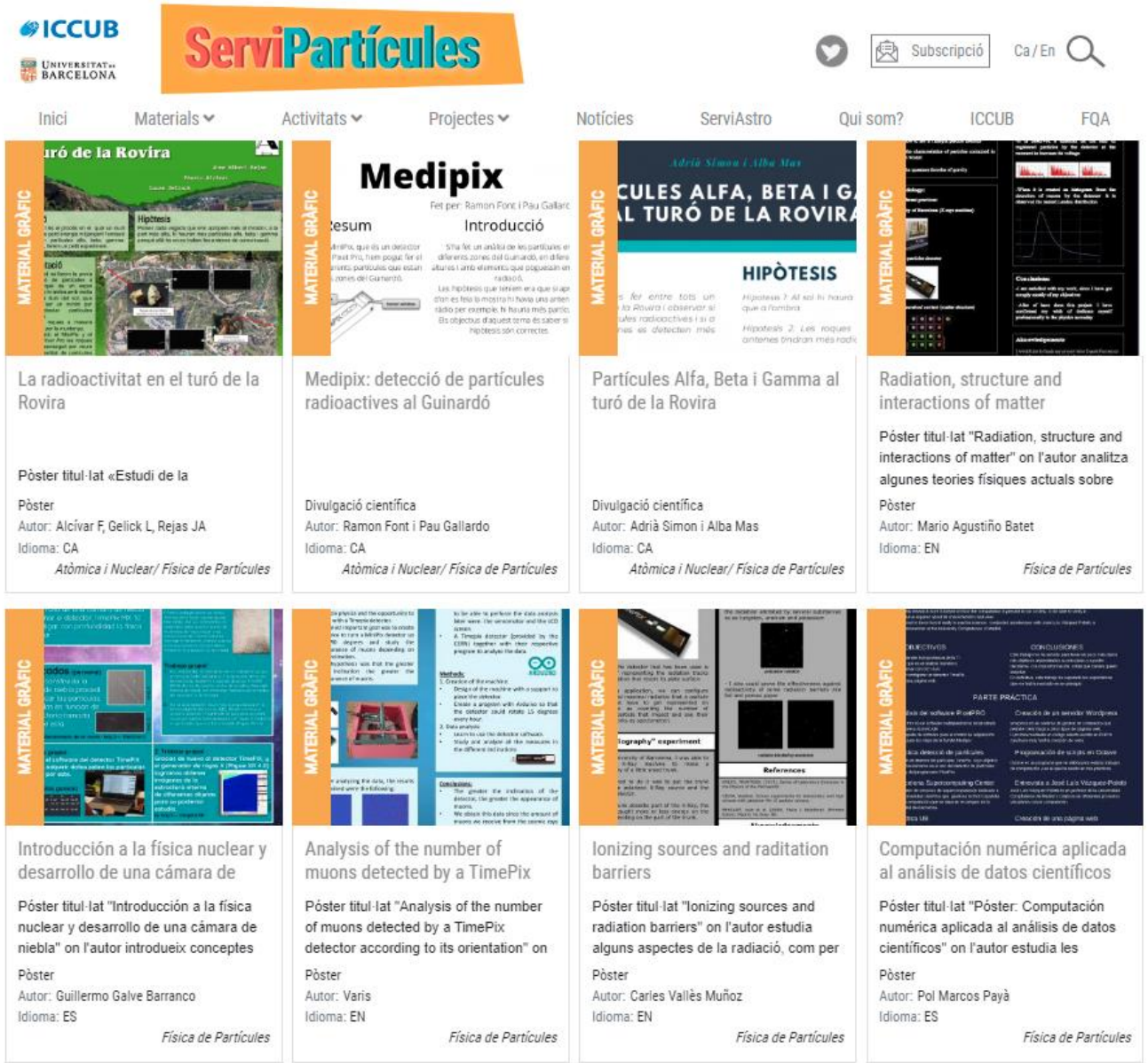
Esther Salvador, Sagrada Familia, Gavà



Bruguers Miranzo, Julia Gonzalez, Santo Angel Gavà

Ruben Castaño, Sagrada Familia, Gavà

Trabajo de investigación



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Prácticas

La radioactivitat que ens envolta

Presentació de les pràctiques de radioactivitat a l'aula.

Introducció

En aquest kit de pràctiques de radioactivitat a l'aula es facilita el material necessari perquè el professor pugui realitzar a l'aula un seguit d'experiències en física de radiacions.

L'enfoc d'aquestes experiències es treballar i observar efectes de radiacions beta i alfa sense la necessitat de recórrer a fonts radioactives perilloses per a les persones. La radioactivitat és un fenomen natural que ens envolta, i que moltes vegades els alumnes associen exclusivament a contextos amb dosis de radioactivitat molt elevada i perjudicial per als humans. Amb això, les dues pràctiques presentades en aquests material tenen dos objectiu fonamentals:

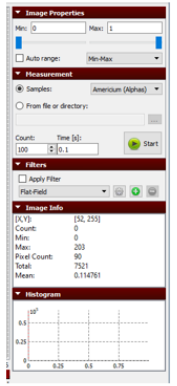
1- Treballar i estudiar els fenòmens de radioactivitat, mitjançant la mesura real i l'anàlisi posterior de les dades experimentals recollides.
2- Conscienciar a l'alumnat que els fenòmens de radioactivitat són habituals i estem envoltats d'ells en el nostre dia a dia, lluny d'associar el perjudici de la radioactivitat a exclusivament fonts perilloses per a les persones.

Les pràctiques i el contingut que en elles es treballen estan enfocats idealment per a ser treballat a nivell de batxillerat. Tot i això, són possibles simplificacions en els continguts a tractar i els càlculs a realitzar per part dels alumnes, de forma que pugui ser implementada en cursos d'ESO (més informació a la guia del professor, on es presenta una descripció detallada de les pràctiques, conjuntament amb un solucionari amb mesures reals obtingudes en realitzar les experiències).

Per realitzar aquestes experiències és altament recomanable tenir accés al sensor TIMEPIX, ja que tant el procés de mesura com de representació de dades resulta molt àgil i eficient. Tot i això, alternatives amb altres aparells de mesura de radiacions poden ser adaptats.

Tot el material descrit s'inclou en un pdf conjunt, el professor interessat pot fer posteriorment ús de les parts que li interessi independentment.

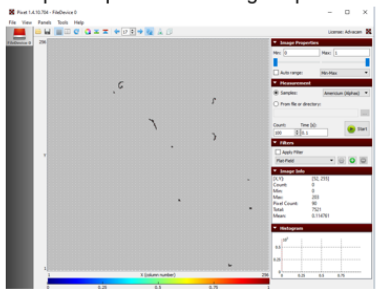
4. Sense utilitzar la mostra radioactiva, obriu la finestra del detector i premeu el botó Start per iniciar la captura de dades.

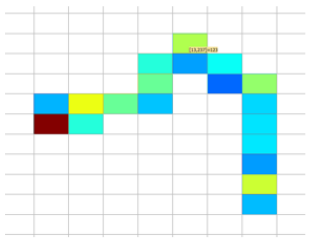


5. Una vegada acabada l'obtenció de les dades, tanqueu la finestra (el protector del xip).

Quan el procés d'obtenció de dades finalitzi, tanqueu el protector del xip.

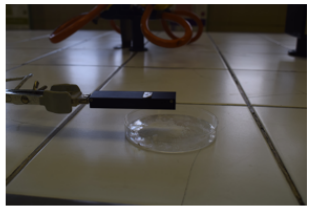
6. Compteu el nombre de Worms (cucs), que són trajectòries llargues i corbades produïdes per la radiació beta d'alta energia. Per assegurar-vos que les partícules beta són d'alta energia, amplia la imatge de cadascuna d'elles, i comprova que la seva energia dipositada és superior als 700 keV.





7. Dividiu el nombre de partícules detectades pel temps transcorregut (600 s). Obtindreu l'activitat de fons.

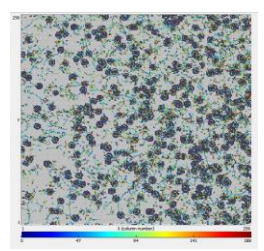
8. Subjecteu el detector verticalment a un suport amb anella de manera que estigui a un centímetre per sobre del banc, tal i com es mostra a la imatge de sota. Col·loqueu un vidre de rellotge o un tap d'ampolla sota la finestra del detector.

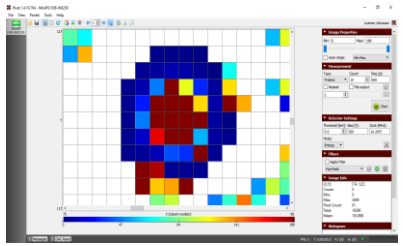


9. Peseu 2 grams de clorur de potassi, i dipositeu-lo al vidre de rellotge.

10. Obriu de nou la finestra del detector i premeu el botó Start per iniciar la captura de dades.

11. Una vegada acabada l'obtenció de les dades, tanqueu la finestra (el protector del xip).



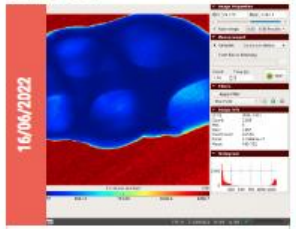


D. Corrons, H. Pino

Formación del profesorado

Aquells professors que s'hagin inscrit al Projecte ADMIRA rebran una formació, reconeguda per l'ICE de la Universitat de Barcelona. Part d'aquesta formació serà oberta a altres professors no participants en el projecte, mentre que algunes de les sessions seran exclusives per al professorat inscrit al programa.

CURSOS



Seminari Advacam en l'ús del Minipix en el món educatiu

El proper dijous dia 16 de juny tindrà lloc el seminari d'iniciació al detector MiniPix de l'empresa Advacam

A càrrec de: Carlos Granja, Advacam Prague
Lloc: Zoom
Hora: 16:00-18:00

Xerrades a escoles
Atòmica i Nuclear/ Física de Partícules

Jornada de formació al professorat del projecte ADMIRA

El proper dijous 21 d'abril reprenem les jornades de formació de

A càrrec de: Varis
Lloc: Facultat de Física de la Universitat de Barcelona
Hora: 16:00-20:00

Cursos
Física de Partícules

1 - Tutorials ADMIRA (1/4): Instal·lació PIXet Pro

Tutorials ADMIRA (1/4): Instal·lació de PIXet Pro

Autor: Daniel Parcerisas - Centre Educatiu Sagrada Família, Gavà

Cursos
Professorat infantil, primària, secundària i FP
Física de Partícules

3 - Tutorials ADMIRA (3/4): Configuració del detector

Tutorials ADMIRA (3/4): Configuració del detector MiniPIX en el programa PIXet Pro

Autor: Daniel Parcerisas - Centre Educatiu Sagrada Família, Gavà

Cursos
Professorat infantil, primària, secundària i FP
Física de Partícules

4 - Tutorials ADMIRA (4/4): Presa de mesures amb el

Tutorials ADMIRA (4/4): Presa de mesures amb el detector MiniPIX i el programa PIXet Pro

Autor: Daniel Parcerisas - Centre Educatiu Sagrada Família, Gavà

Cursos
Professorat infantil, primària, secundària i FP
Física de Partícules

La matèria fosca

Conferència tracta sobre què és la matèria fosca a càrrec de l'astrònom Xavi Luri

A càrrec de: Xavier Luri, ICCUB [IEEC-UB]
Hora: 09:30

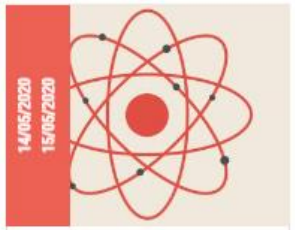
Cursos
Professorat infantil, primària, secundària i FP
Física de Partícules
Xavier Luri, ICCUB [IEEC-UB]

Antimatèria

Aquesta xerrada es du a terme en el context del projecte ADMIRA (Activitats amb Detectors Medipix per Investig

A càrrec de: Lluís Garrido, ICCUB

Cursos
Física de Partícules



Detectors de partícules semiconductors

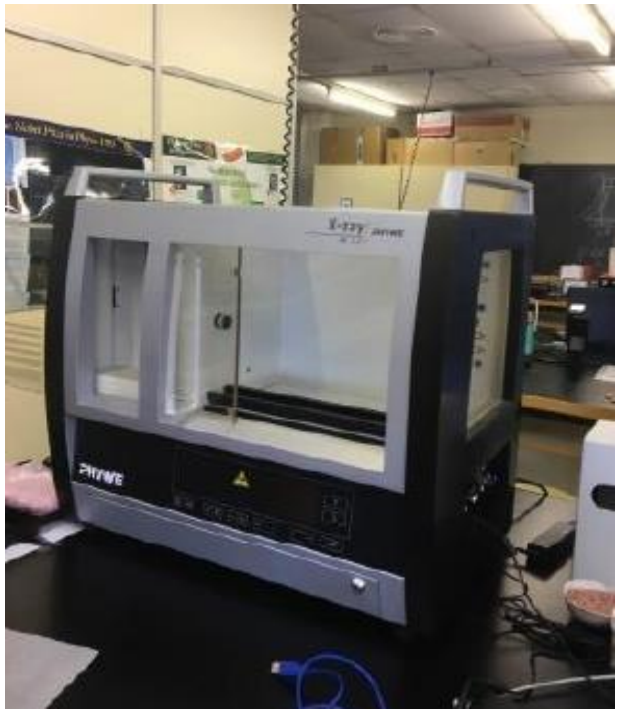
La xerrada, dividida en dues parts d'una hora cadascuna, començarà fent una introducció al CERN, als detectors de

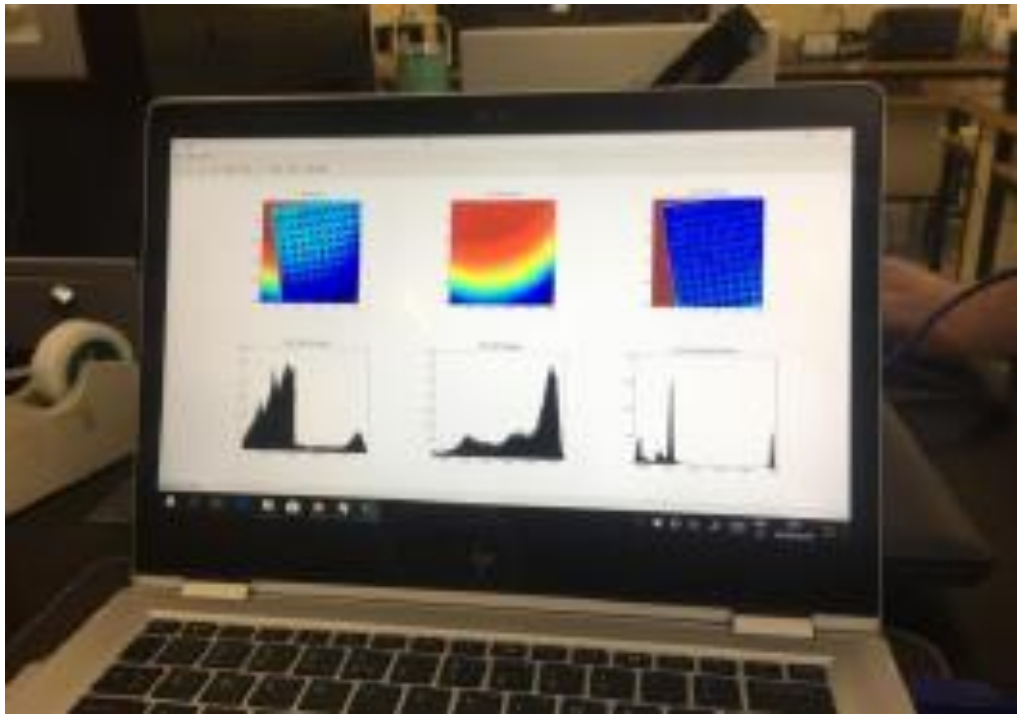
A càrrec de: Rafel Ballabriga, CERN

Cursos
Física de Partícules

https://serviparticules.ub.edu/projectes/projecte-admira/formacio-per-professors

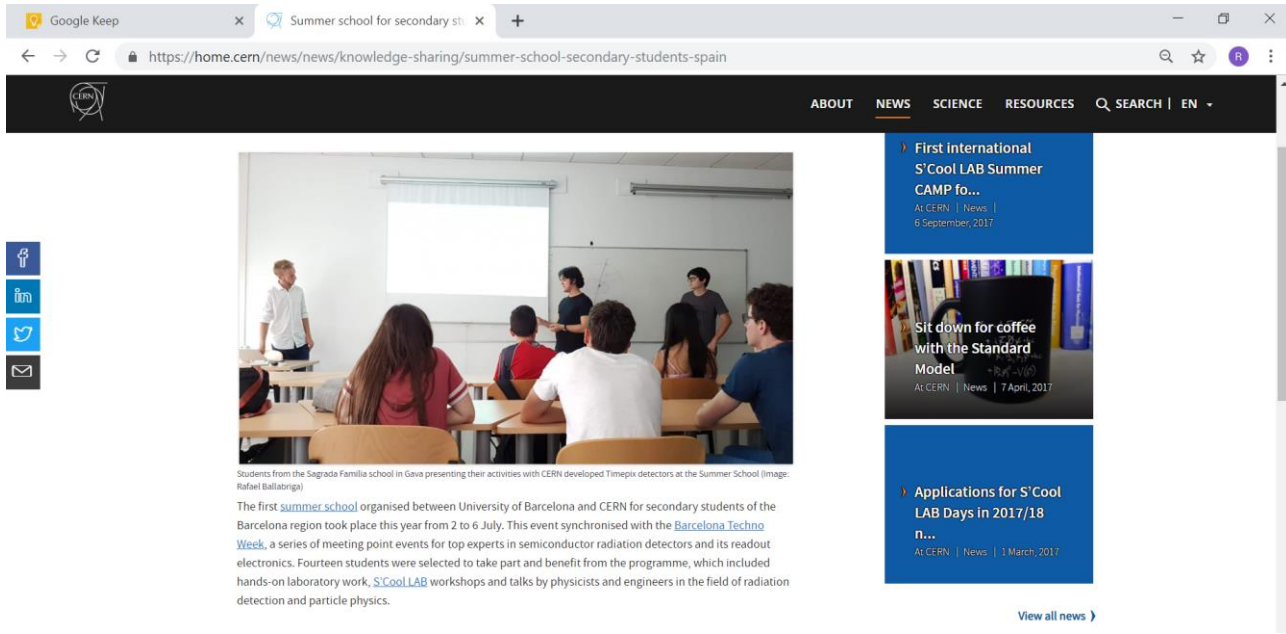
Visita centros a laboratorios de la UB





Visita escuela Santo Angel Gavà al CERN

Artículos web CERN



Artículo científico

OPEN ACCESS PAPER

Phys. Educ. **57** (2022) 025018 (14pp) iopscience.org/ped

ADMIRA project: teaching particle physics at high school with Timepix detectors

D Parcerisas[1,*], R Ballabriga[2,*], E Amorós[5], A Argudo[3], M Campbell[2], L Casas[4], P Christodoulou[2], R Colomé[5], D Corrons[6], V Curcó[7], M Enajas[8], C Granja[9], E Grauges[3], A Gou[10], E Lleó[11], X Llopart[2], E Pallares[3], H Pino[12], S Serra[13] and G Valero[14]

[1] Sagrada Familia School, Gavà, Barcelona, Spain
[2] Experimental Physics Department, CERN, Meyrin, Switzerland
[3] Institut de Ciències del Cosmos, University of Barcelona, Barcelona, Spain
[4] Institut de Desenvolupament Professional, University of Barcelona, Barcelona, Spain
[5] Vilafant High School, Vilafant, Girona, Spain
[6] La Salle School, Manlleu, Barcelona, Spain
[7] La Roca del Vallès High School, La Roca del Vallés, Barcelona, Spain
[8] Intermunicipal School of Penedés, Sant Sadurní d'Anoia, Barcelona, Spain
[9] Advacam, Prague, Czech Republic
[10] Quatre Cantons High School, Barcelona, Spain
[11] F. X. Lluch i Rafecas High School, Barcelona, Spain
[12] Learn It With Us, Barcelona, Spain
[13] Terrassa High School, Barcelona, Spain
[14] Joan Brossa High School, Barcelona, Spain

E-mail: d.parcerisas@safagava.edu and rafael.ballabriga@cern.ch

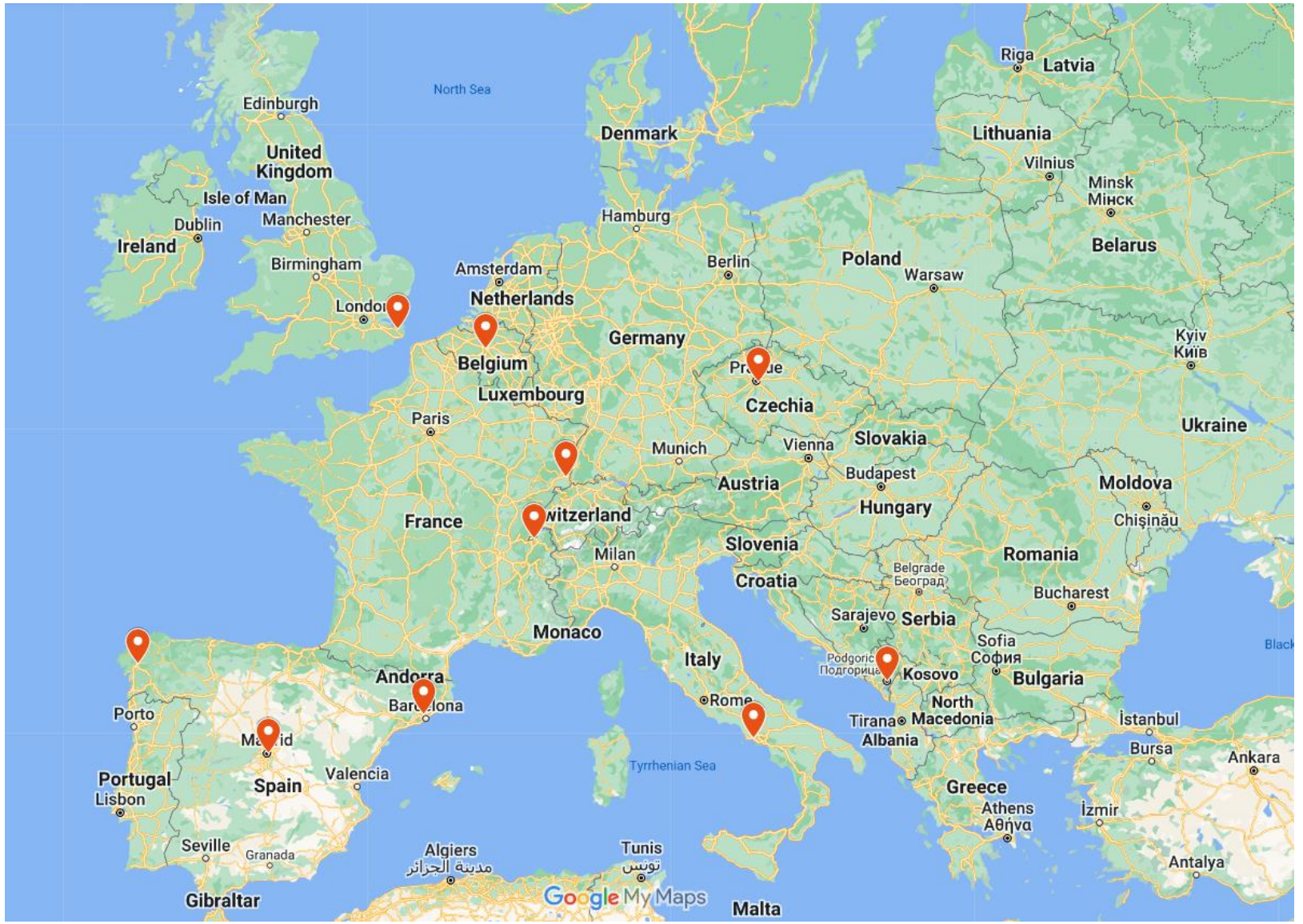
Abstract

This paper presents the case for how students can be helped to increase their scientific vocation by experimental work and the introduction of particle physics into pre-university studies. These two ideas are the two main lines of work of the ADMIRA initiative, which has been created by individuals belonging to different and complementary educational and research institutions. The initiative consists of a network of schools that share Minipix

https://iopscience.iop.org/article/10.1088/1361-6552/ac4143

What is next?

Minipix-Edu kits that have been distributed for educational purposes: The Timepix Teachers Network



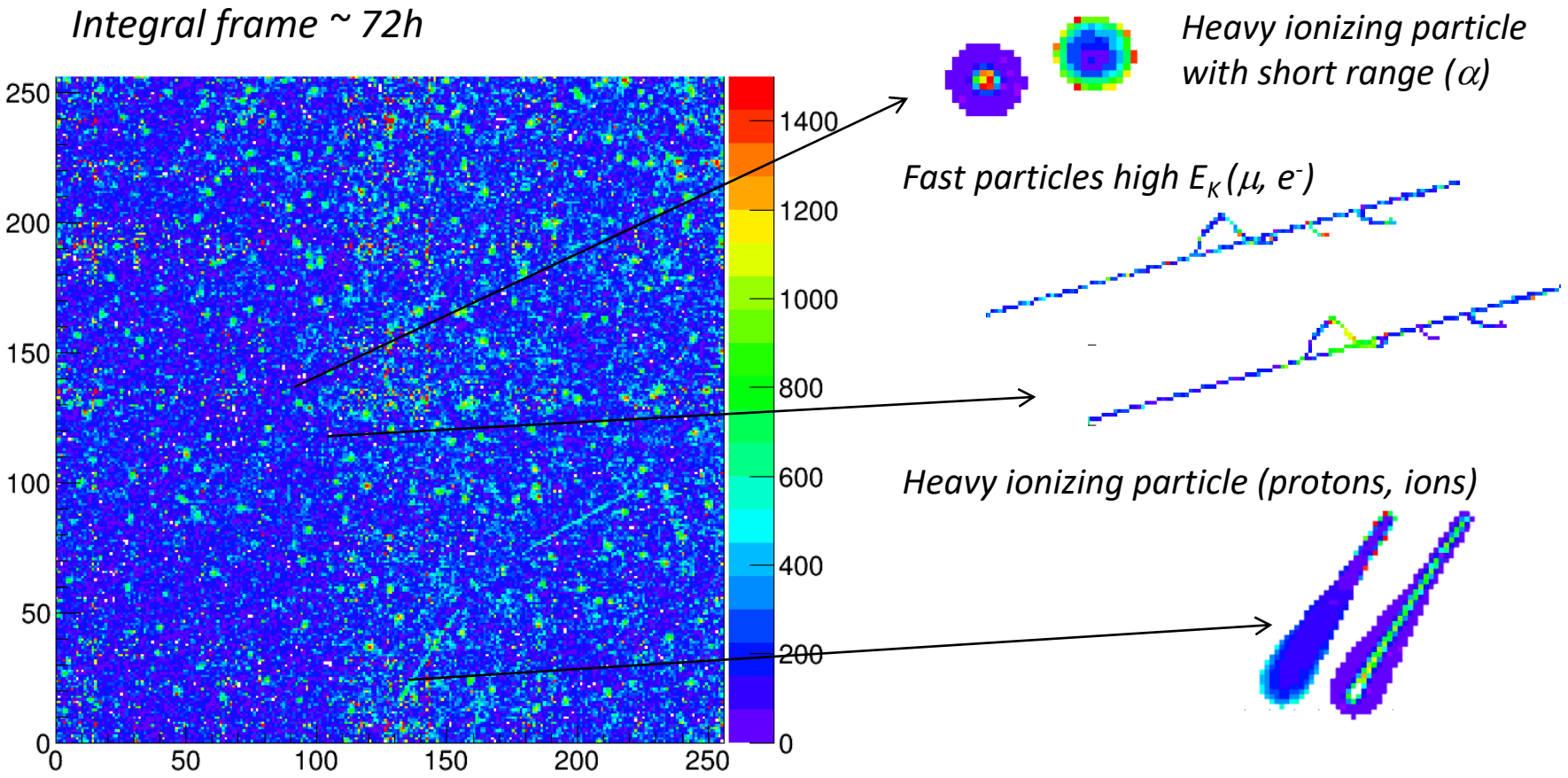
University of Barcelona has agreed to host a Timepix Teachers Network conference for students and teachers in June-July 2023

Let’s keep in contact and looking forward to see you there in person!

ICCUB
Institut de Ciències del Cosmos
UNIVERSITAT DE BARCELONA
EXCELENCIA MARÍA DE MAEZTU 2020-2023

Conclusión

Los Detectores Timepix permiten visualizar la radiación



Timepix chip: matrix of 256x256 pixels
Different particles present a different signature in their interaction with the pixelated semiconductor detector

El Ciclo del Conocimiento

Metodología Clásica

El Ciclo del Conocimiento

ADMIRA

Timepix Teachers Network

Muchas gracias