



Cosmic-Ray Extremely Distributed Observatory: nowe możliwości badawcze w astrofizyce

Piotr Homola
IFJ PAN

AGH, Kraków, 28.10.2016

Outline



1. Motivation

- a bit of philosophy: thinking top → down
- (only) big questions

2. Ultra-High Energy Cosmic Rays (UHECR)

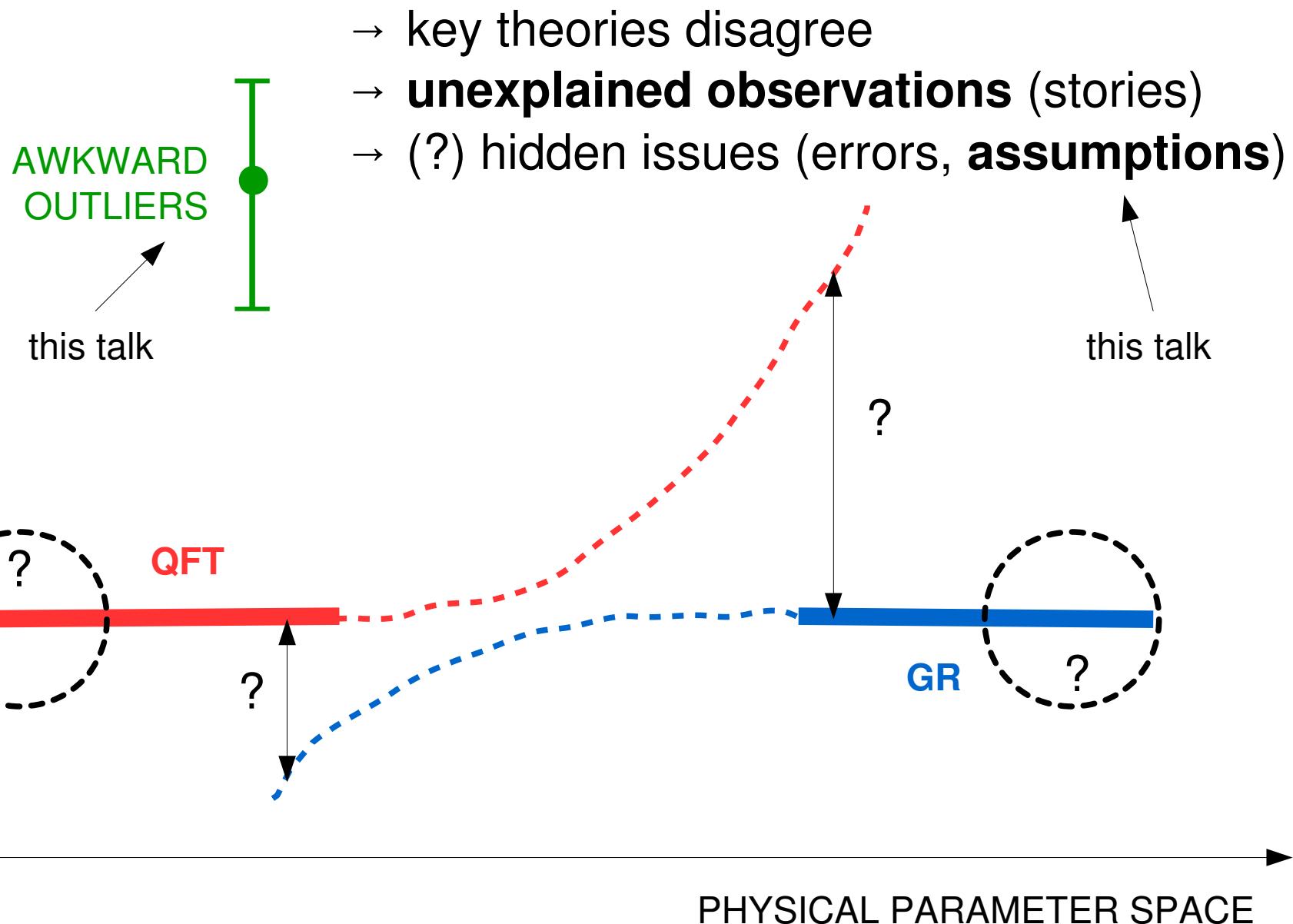
- photons and super-preshowers

3. Generalizing UHECR detection strategy

4. Cosmic-Ray Extremely Distributed Observatory

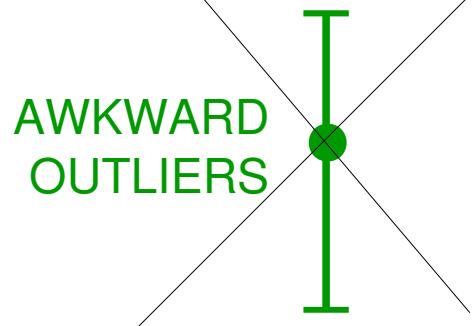
5. Uncharted realm and/or ocean of opportunities?

Understanding the Universe

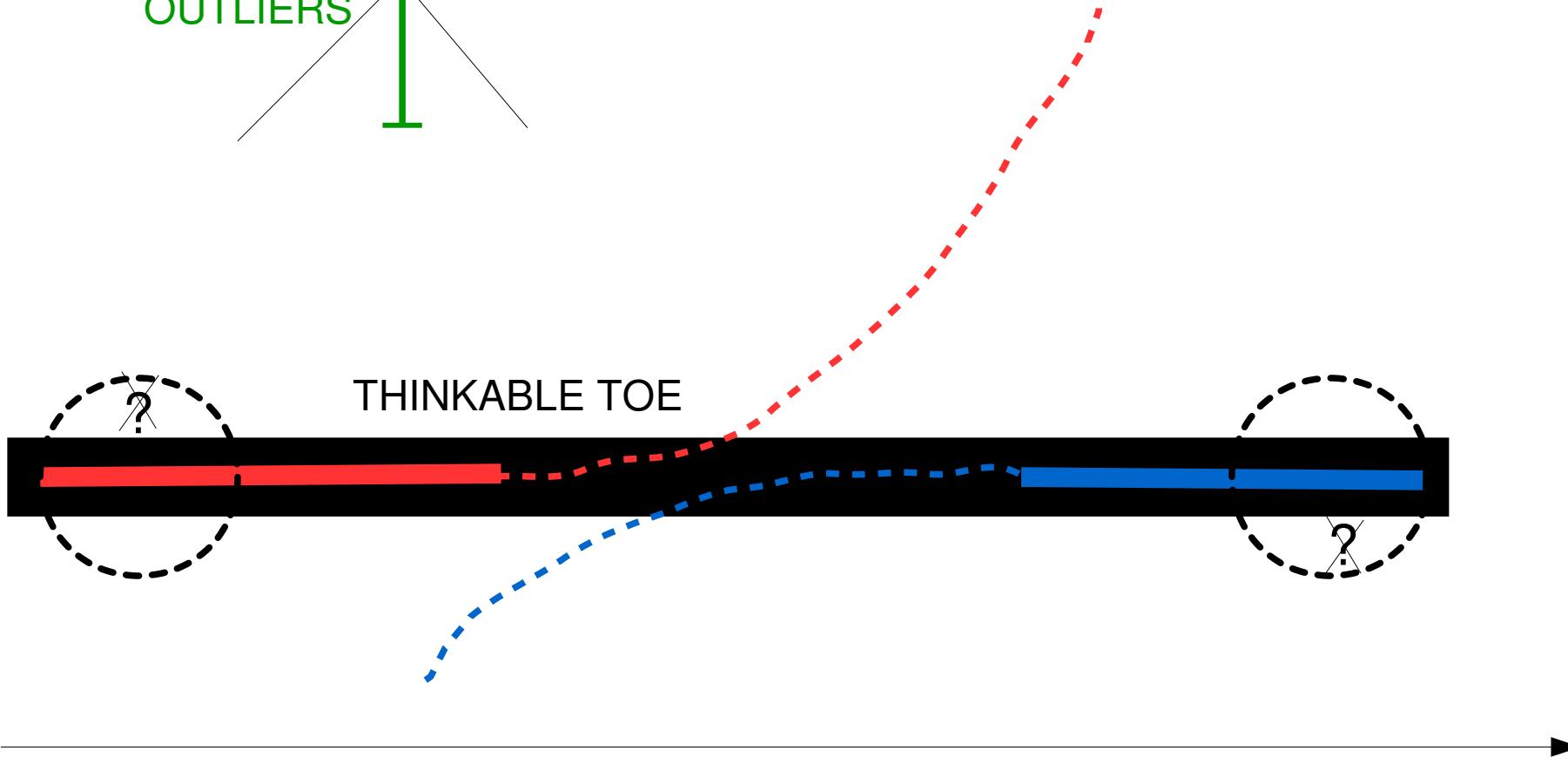


Ways towards a unifying theory (TOE): **bottom** → **up**

Thinking **bottom** → **up**:
understanding a bigger picture based on the known ingredients



AWKWARD
OUTLIERS

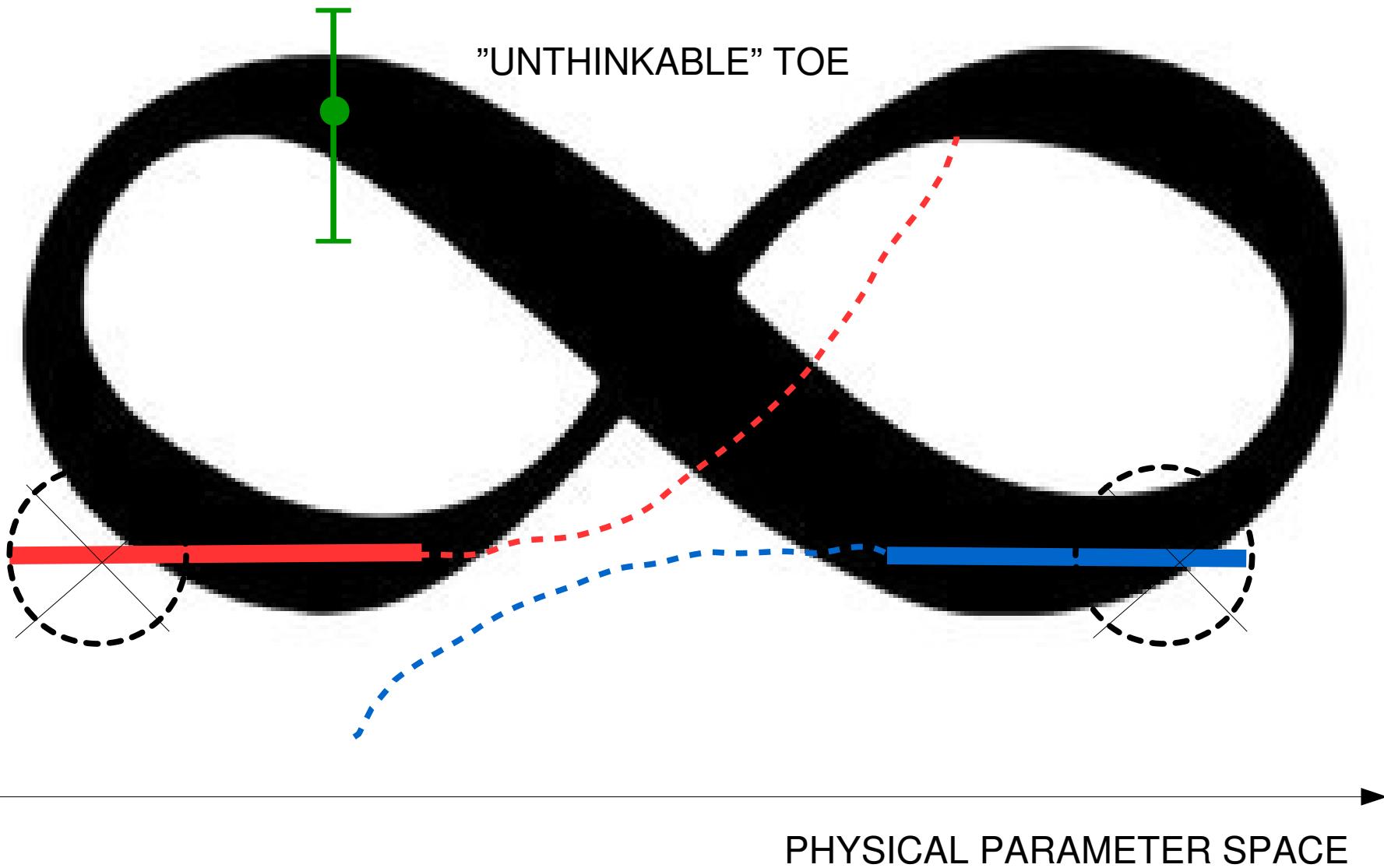


PHYSICAL PARAMETER SPACE

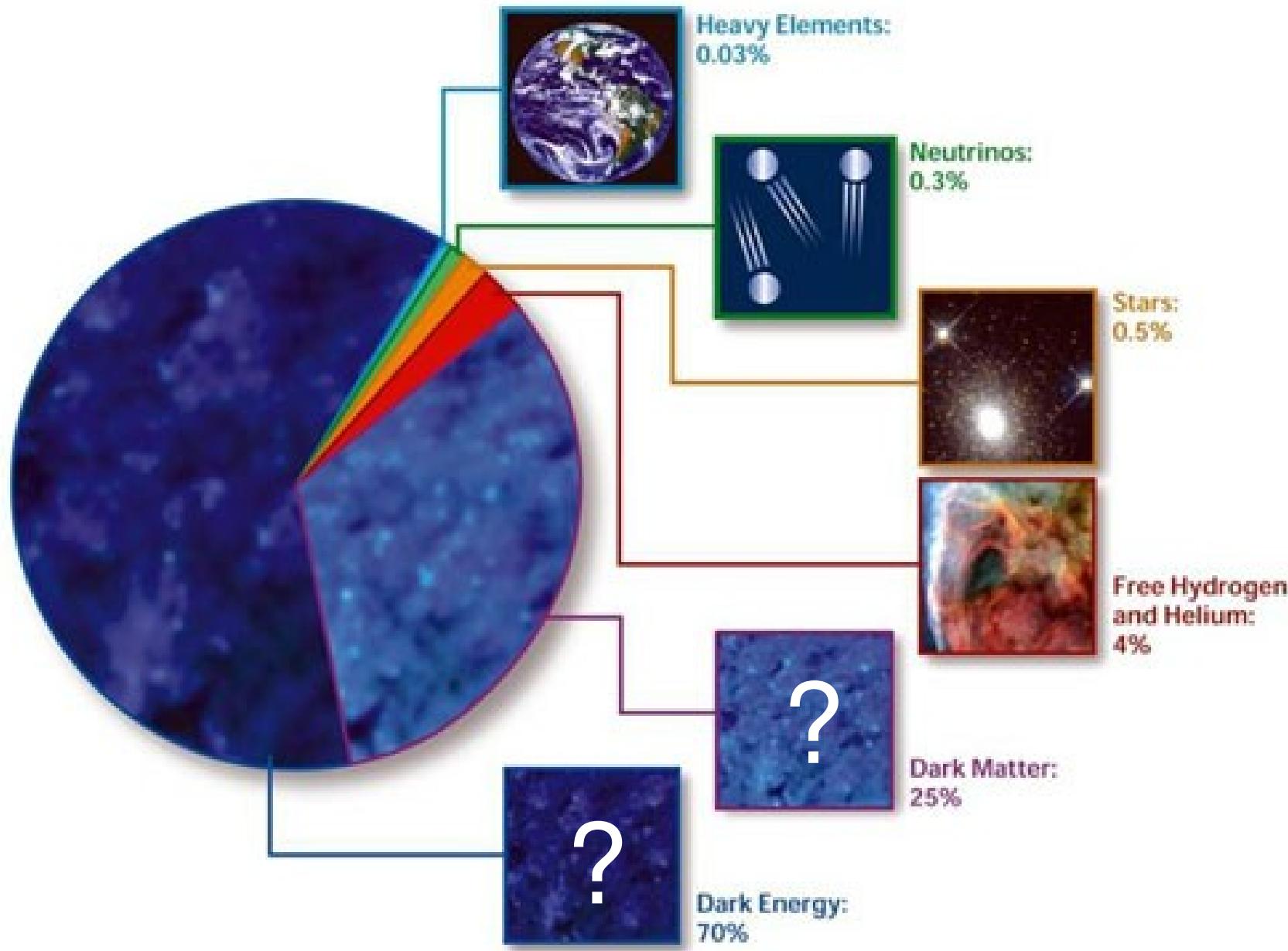
Ways towards a unifying theory (TOE): top → down

Thinking **top → down**:

understanding a bigger picture assuming hypothetic objects/laws



COMPOSITION OF THE COSMOS



UHECR - one mystery more

https://en.wikipedia.org/wiki/List_of_unsolved_problems_in_physics

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List of unsolved problems in physics

From Wikipedia, the free encyclopedia

Main article: *List of unsolved problems*

Some of the major **unsolved problems in physics** are **theoretical**, meaning that existing theories seem incapable of explaining a certain observed **phenomenon** or **experimental result**. The others are **experimental**, meaning that there is a difficulty in creating an experiment to test a proposed theory or investigate a phenomenon in greater detail.

Contents [hide]

- 1 Unsolved problems by subfield
 - 1.1 General Physics/Quantum Physics
 - 1.2 Cosmology and general relativity
 - 1.3 Quantum gravity
 - 1.4 High energy physics/particle physics
 - 1.5 Astronomy and astrophysics
 - 1.6 Nuclear physics
 - 1.7 Atomic, molecular and optical physics
 - 1.8 Condensed matter physics
 - 1.9 Biophysics
- 2 Problems solved in recent decades

„Ultra-high-energy cosmic rays

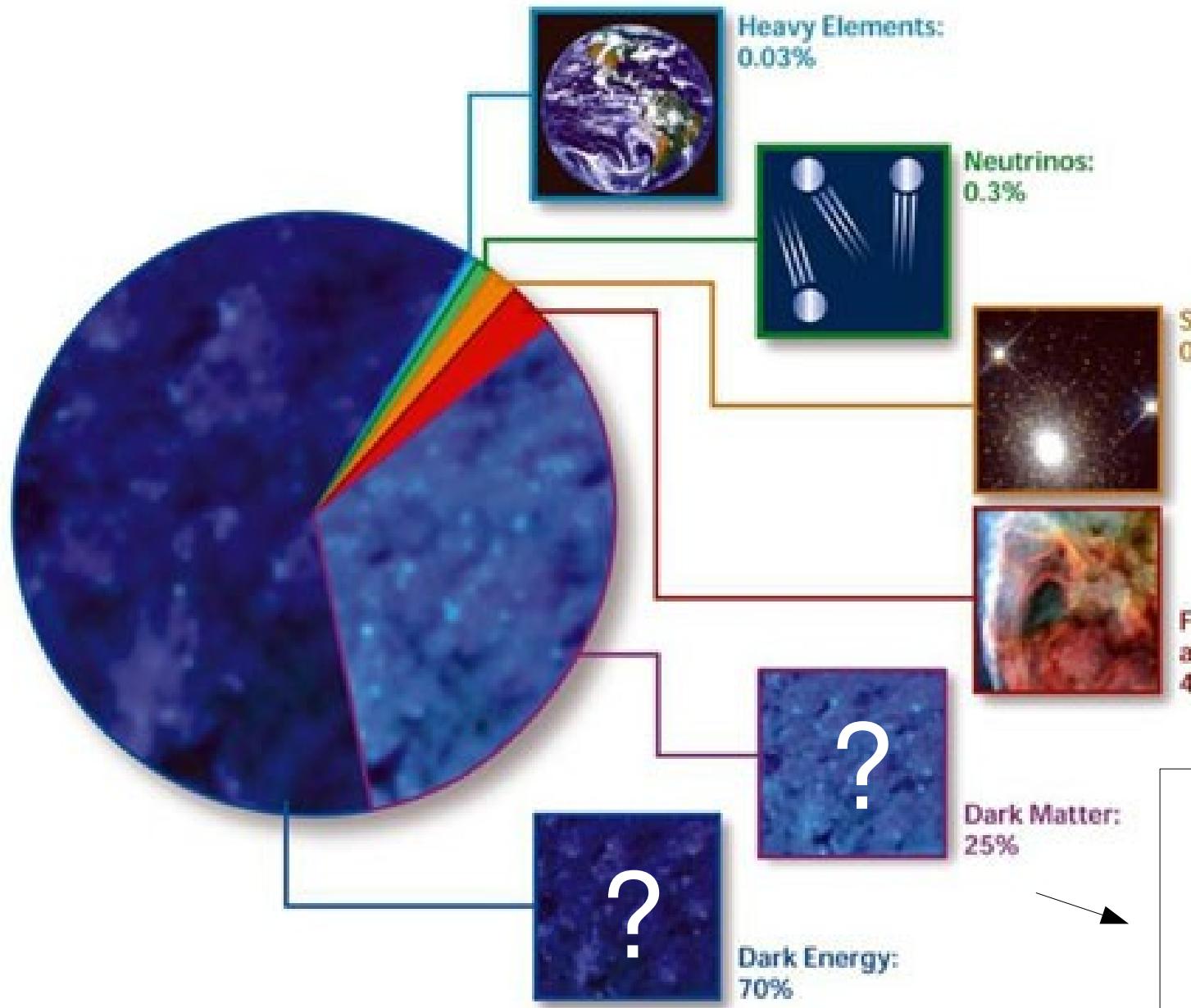
Why is it that some cosmic rays appear to possess **energies** that are **impossibly high**, given that there are no sufficiently energetic cosmic ray sources near the Earth? Why is it that (apparently) some cosmic rays emitted by distant sources have energies above the Greisen–Zatsepin–Kuzmin limit?”

?

?

?

COMPOSITION OF THE COSMOS



**indirect DM
search with
UHECR (γ_{UHE})!**

gamma ray

X-ray

ultraviolet

visible

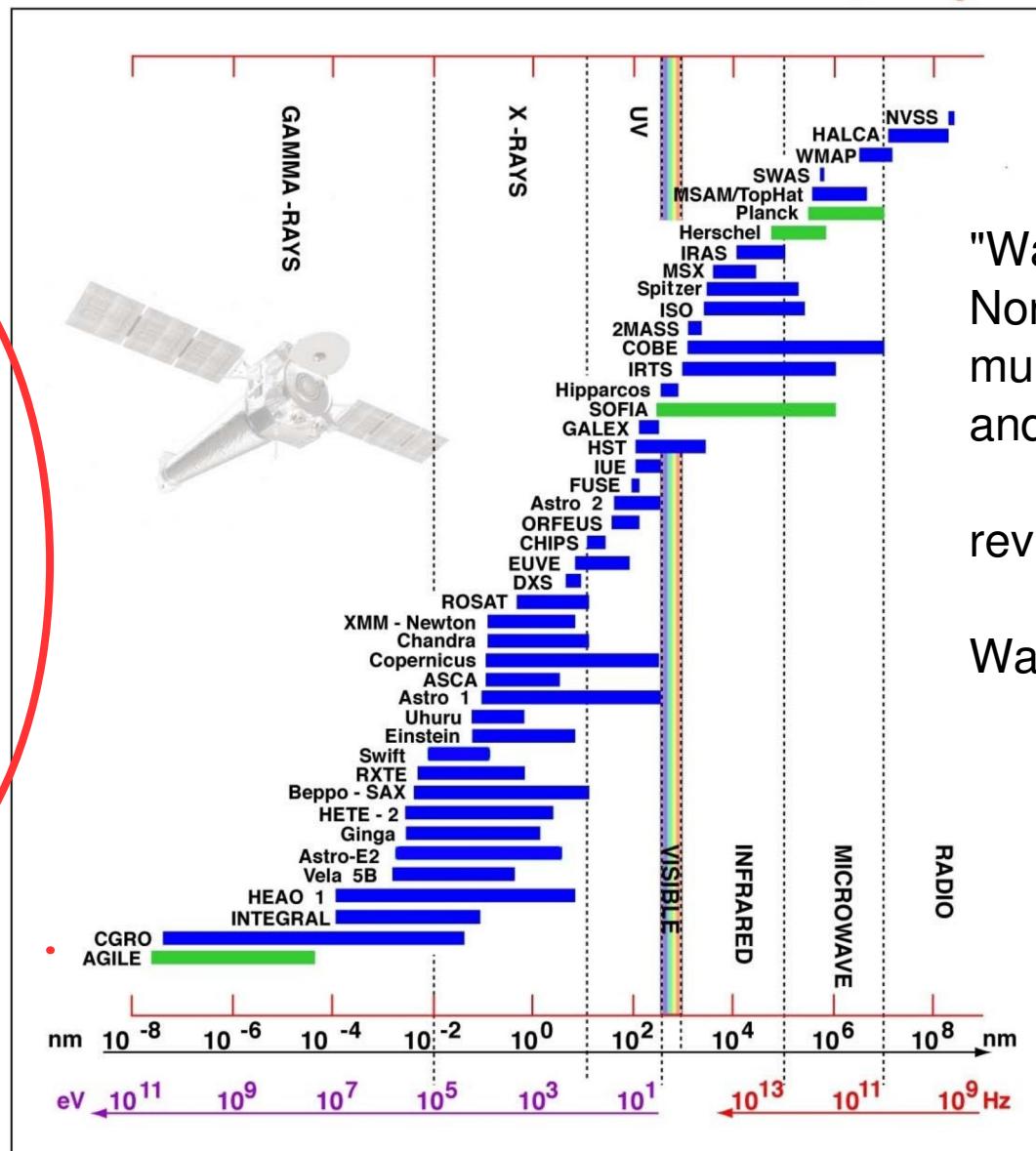
infrared

microwave

radio

From gamma rays to radio

Why
nothing
here
???



"Warsaw Workshop on
Non-Standard Dark Matter:
multicomponent scenarios
and beyond",
review by C. Weniger
Warsaw, 2-5.06.2016

<http://nssdc.gsfc.nasa.gov/astro/astrolist.html>

Short history of ultra-high energy cosmic rays (UHECR)

Particles coming to Earth from Space

1912. Electroscopes discharge faster with increasing altitude → rays of extraterrestrial origin: V. Hess (Nobel prize 1936).

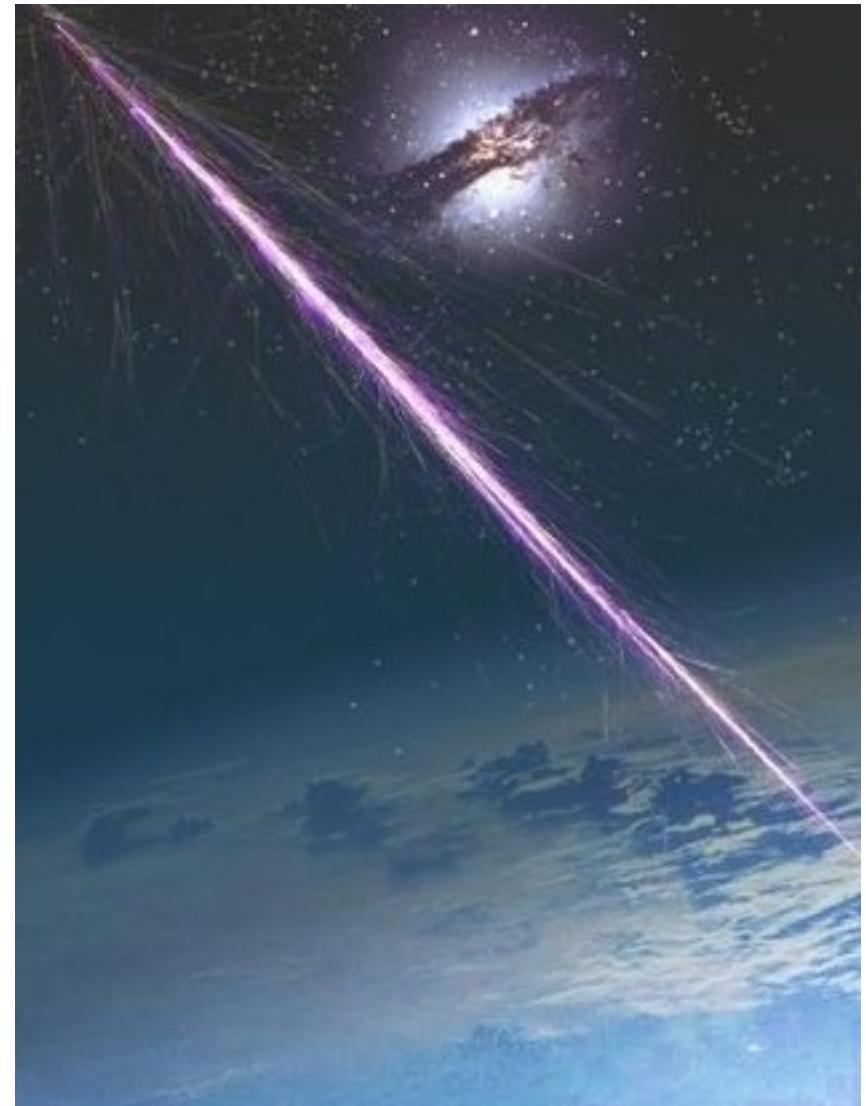
1932. Discovery of antimatter (positron): C. Anderson (Nobel prize 1936).

1937. Discovery of muons: S. Neddermeyer and C. Anderson → particle physics begins.

1938. Extensive air showers (EAS)
→ $E > 10^{15}$ eV: P. Auger

1962. First EAS at 10^{20} eV: J. Linsley
→ what and why can have so huge energies???

.... high time for a next breakthrough?



Energy spectrum of cosmic rays

Ranges:

energy: > 10 orders of magnitude

flux: > 30 orders of magnitude

→ diverse physics (sources)

→ diverse detection techniques

Flux rapidly decreases with energy ($\sim 10^{-3}$),

Highest energies → the most demanding challenges:

→ technical:

extremely low flux (at $E=10^{20}$ eV

1 particle / km² millenium), but now:

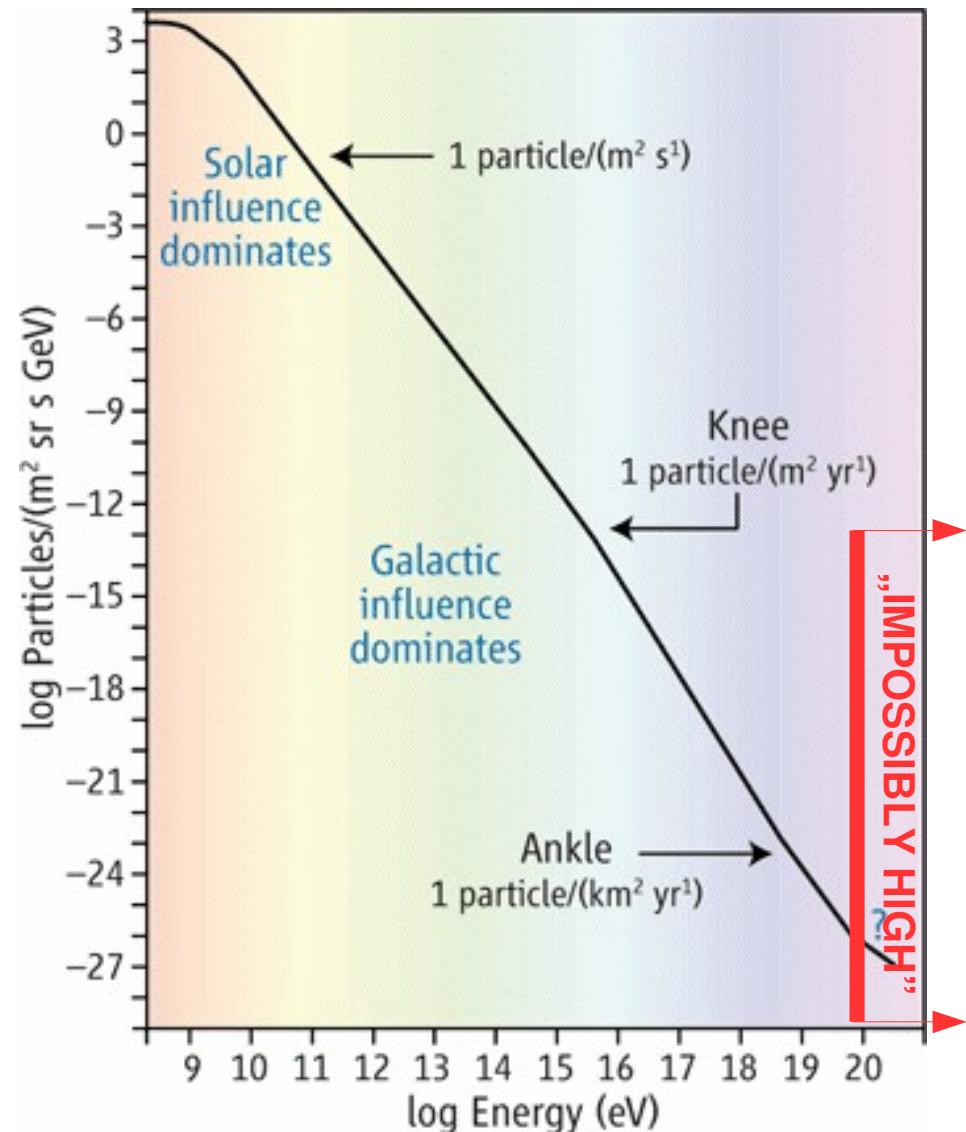
the Pierre Auger Observatory (~ 3000 km²)

→ scientific:

What are UHECR? Where they come from?

How do they propagate?

Do photons contribute to the UHECR flux?



Photons as UHECR: testing astrophysical scenarios

Bottom → Up: Astrophysical scenarios

acceleration of nuclei (e.g. by shock waves)

+ „conventional interactions”, e.g. with CMBR

- sufficiently efficient astrophysical objects difficult to find
- small fractions of photons and neutrinos – mainly nuclei expected

Top → Down: Exotic scenarios (particle physics)

Decay or annihilation of the early Universe relics

→ hypothetical supermassive particles of energies $\sim 10^{23}$ eV

→ decay to quarks and leptons → hadronization (mainly pions)

- large fraction of photons and neutrinos in UHCER flux

DARK MATTER!

Let's test the hottest DM scenario!

2-component flavor-mixed DM (2cDM), $\Delta m = 10^{-8}$

neutralinos, **sterile neutrinos**, photon and axion, ..., **monopoles, super-heavies**

Mikhail V. Medvedev (2010, 2014)

ISSN 1751-8113

Journal of Physics A
Mathematical and Theoretical

Volume 43 Number 37 17 September 2010

iopscience.org/jphysa

IOP Publishing

113

PRL 113 (7), 070201–079901, 15 August 2014 (256 total pages)

PHYSICAL
REVIEW
LETTERS™

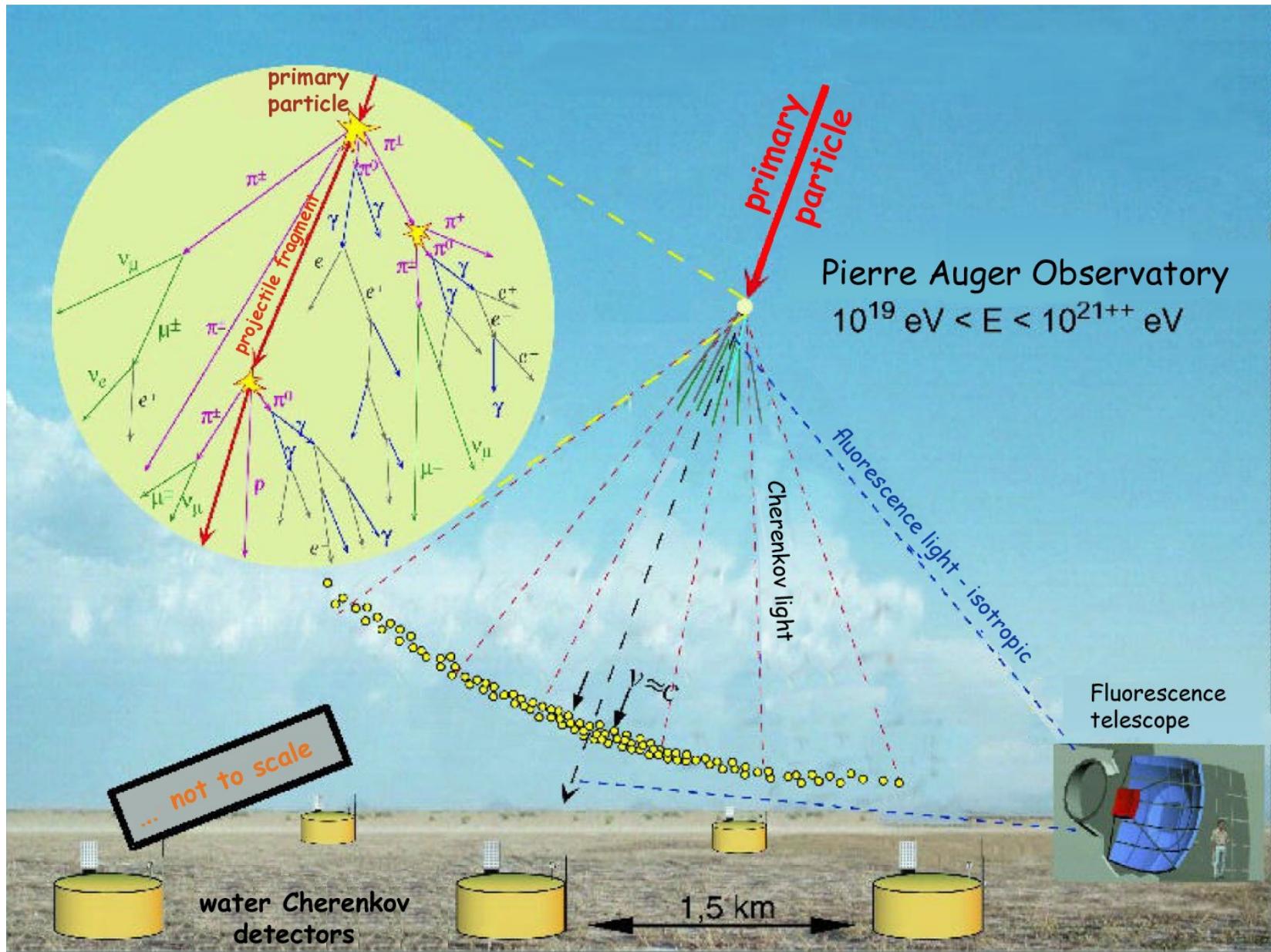
Articles published week ending 15 AUGUST 2014

Published by
American Physical Society™

APS physics

Volume 113, Number 7

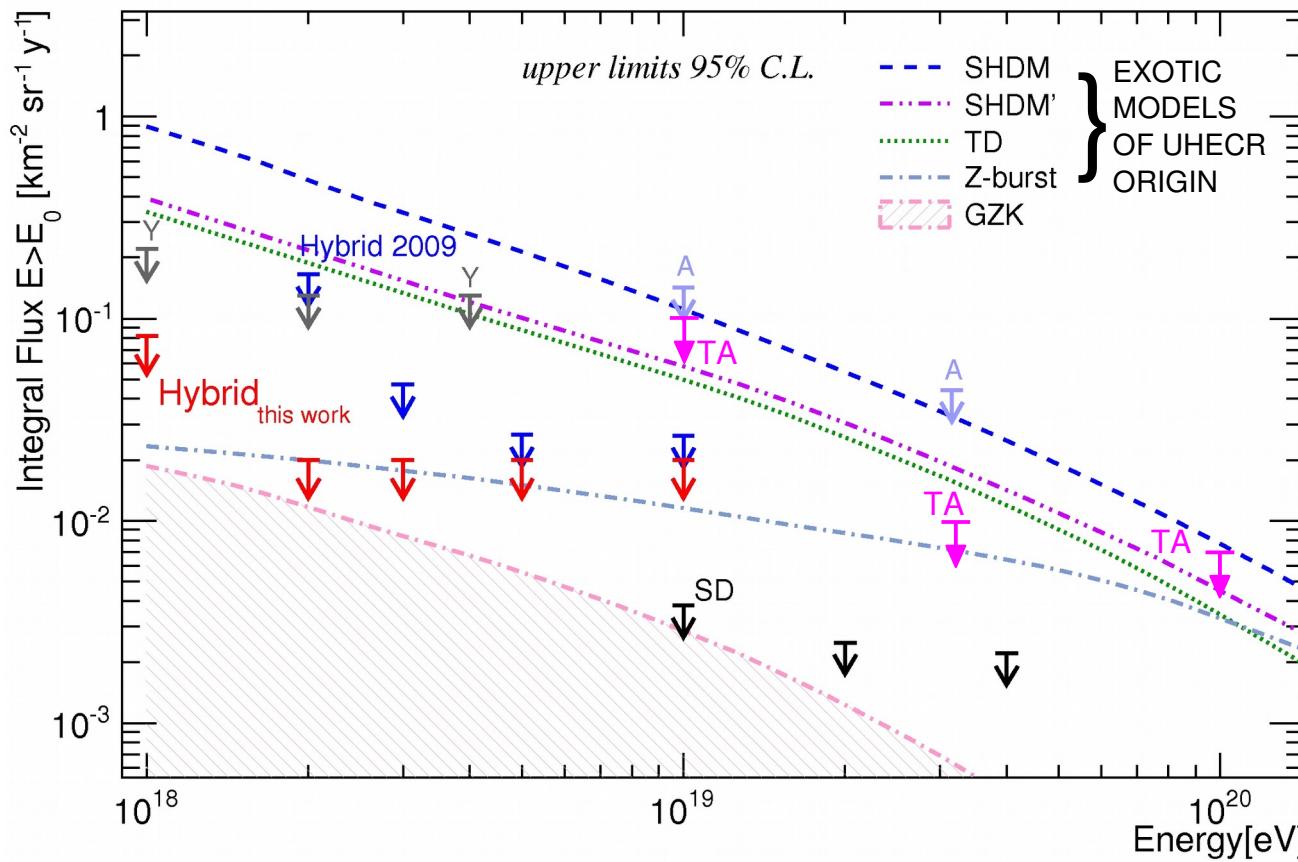
Detection of UHECR at the Pierre Auger Observatory



UHECR composition paradigm: „no photons”

At the highest energies photon fractions < 1%

AUGER, ICRC 2011 + TA 2013



Hybrid – AUGER '11 (hybrid detector)

Hybrid 2009 – AUGER '09 (hybrid detector)

SD – AUGER '08 (surface detector)

A – AGASA '02

Y – YAKUTSK '07

TA – Telescope Array '13

SHDM, TD, Z Burst: Gelmini et al. '08

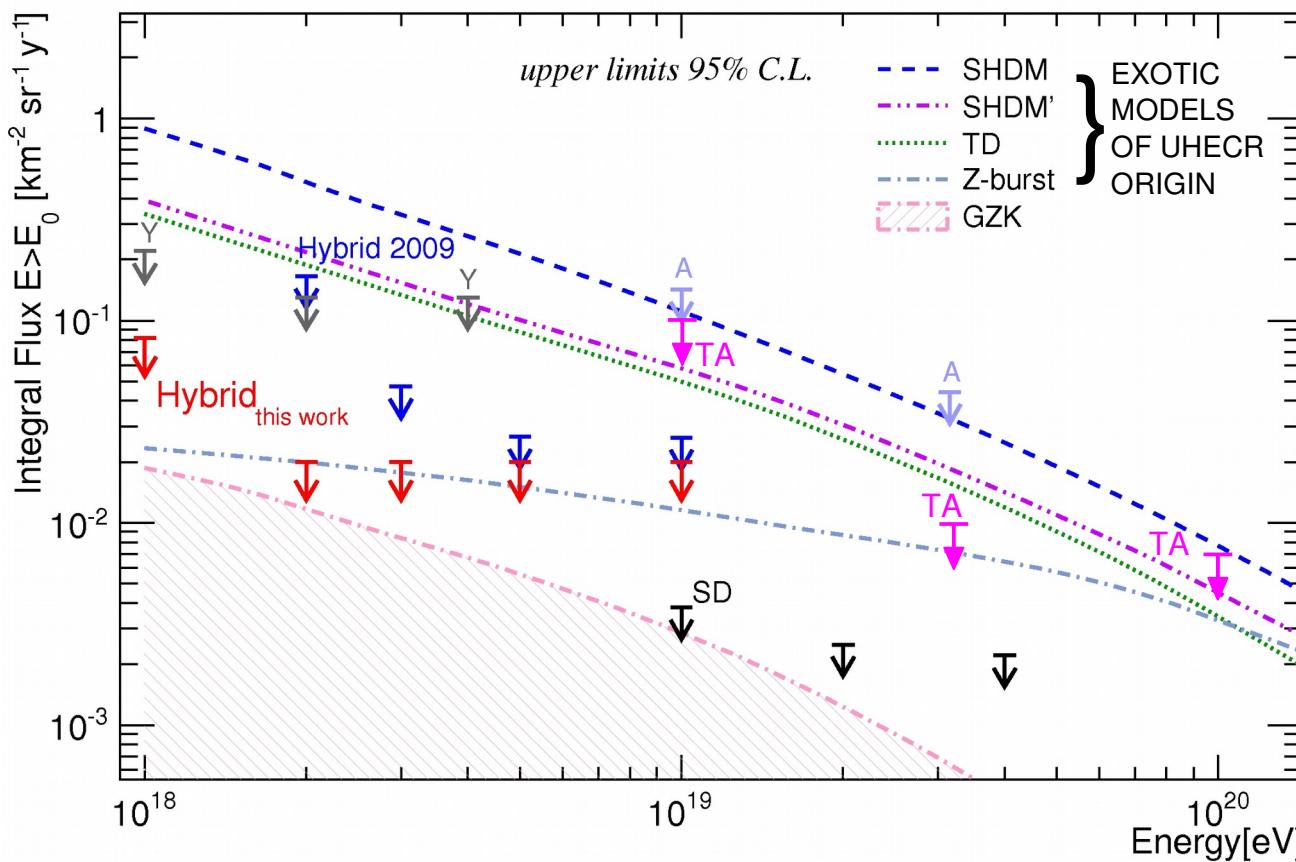
SHDM': Ellis et al. '06

→ exotic (Dark Matter) scenarios severely constrained!

UHECR composition paradigm: „no photons”

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SHDM, TD, Z Burst: Gelmini et al. '08

SHDM': Ellis et al. '06

→ exotic (Dark Matter) scenarios severely constrained! *)

*) Understand well: limits apply to single photons, assume no screening eg. within exotic models of interactions, structure of a photon and the spacetime structure that could manifest at UHE...

Experimental evidence about γ_{UHE}

γ_{UHE}

no interactions / screening

Earth

NOT OBSERVED

γ_{UHE}

unexpected interactions,
screening, ...

ELECTROMAGNETIC
CASCADES (**SUPER-**
PRESHOWERS)

Earth

NOT TRIED SO FAR...

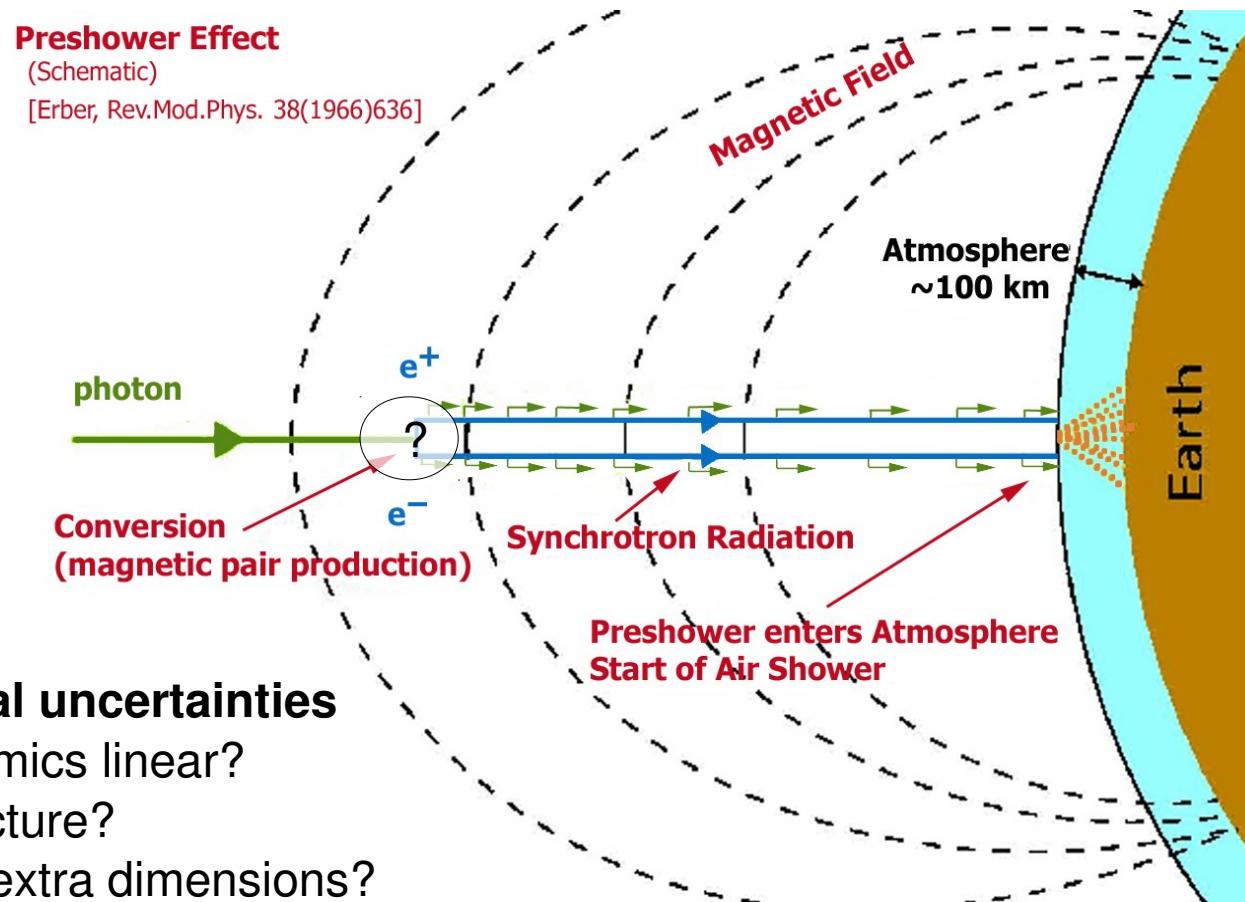


CREDO!

(Super-)preshowers: a must to study UHE photons

(super-)preshower:

- contains typically (**>1000**) 100 particles
- created at around (**>10000**) 1000 km a.s.l.)



?

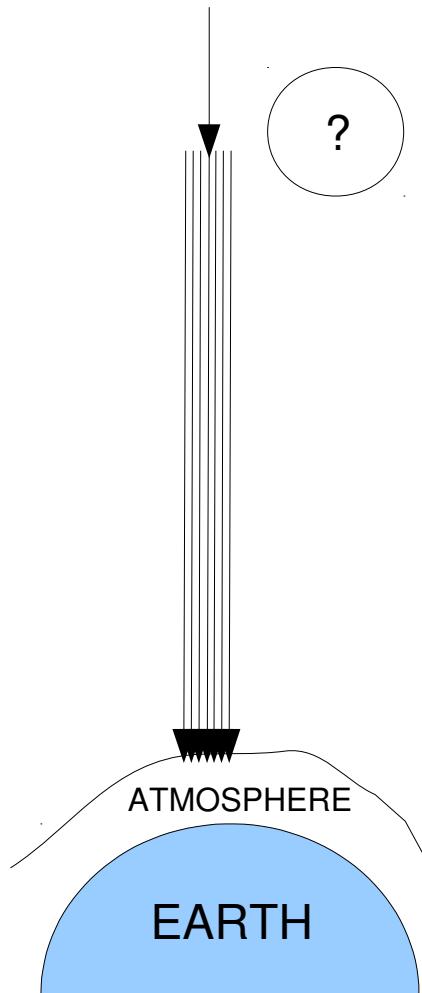
- : fundamental uncertainties
- electrodynamics linear?
 - photon structure?
 - spacetime: extra dimensions?

→ dependence on E and B_{\perp} (to be seen in data?)

Classes of super-preshowers (SPS)

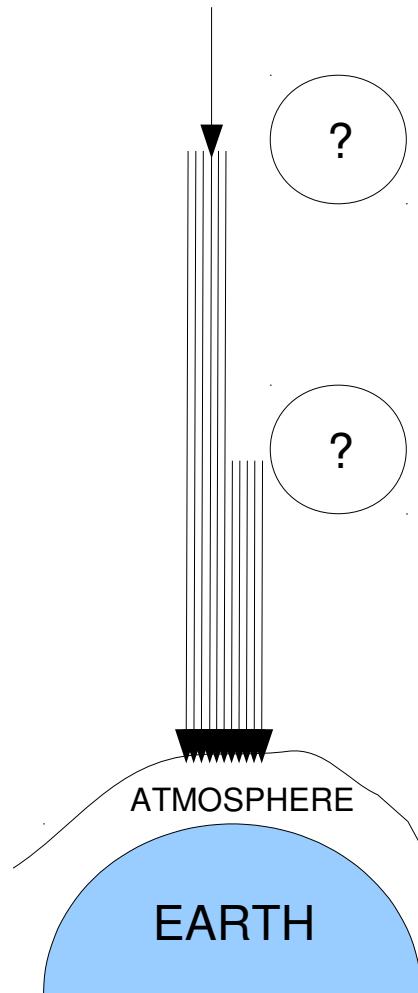
A: γ_{UHE}

(e.g. 10^{20} eV)



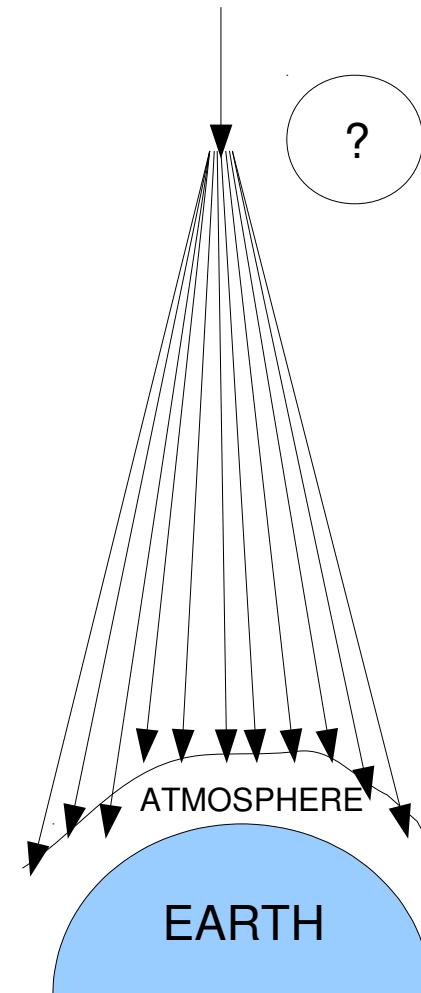
B: γ_{UHE}

(e.g. 10^{20} eV)



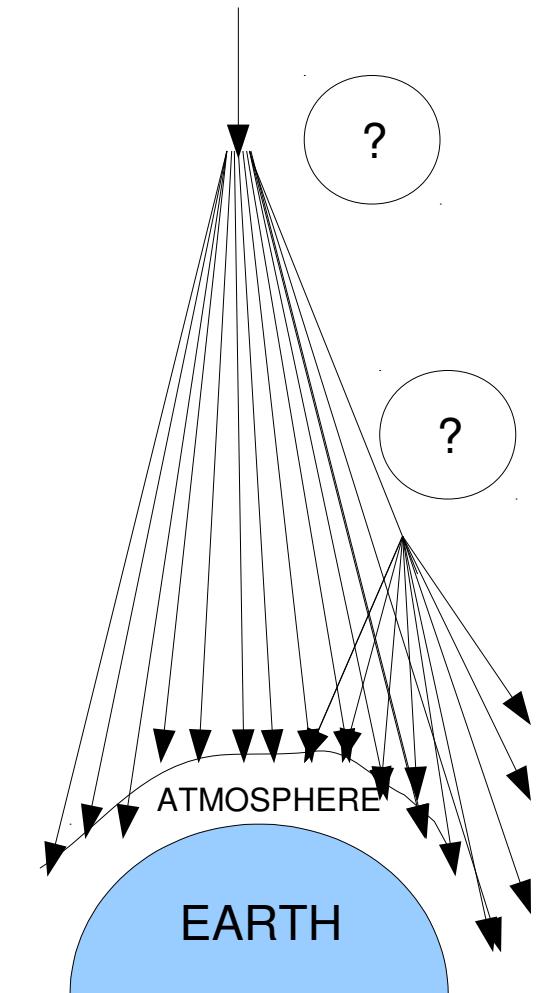
C: γ_{UHE}

(e.g. 10^{20} eV)



D: γ_{UHE}

(e.g. 10^{20} eV)



Δx : small
 Δt : small

Δx : small
 Δt : large

Δx : large
 Δt : small

Δx : large
 Δt : large

Classes of super-preshowers

A: γ_{UHE}

(e.g. 10^{20} eV)

B: γ_{UHE}

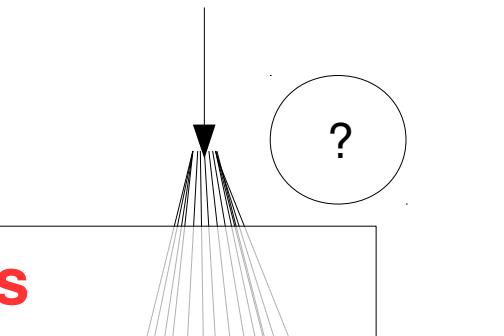
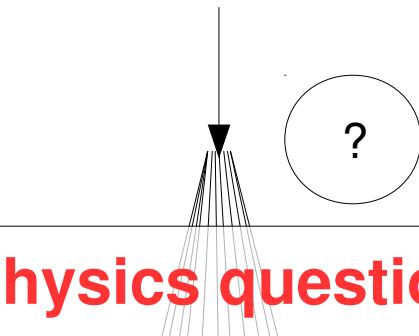
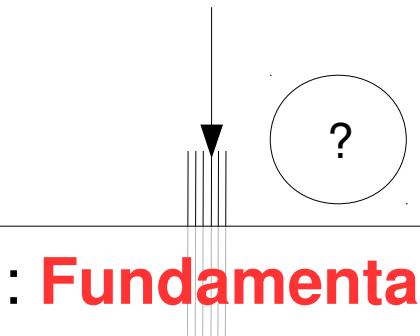
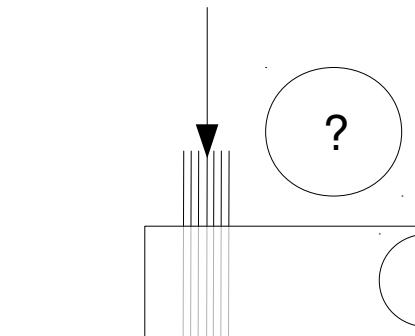
(e.g. 10^{20} eV)

C: γ_{UHE}

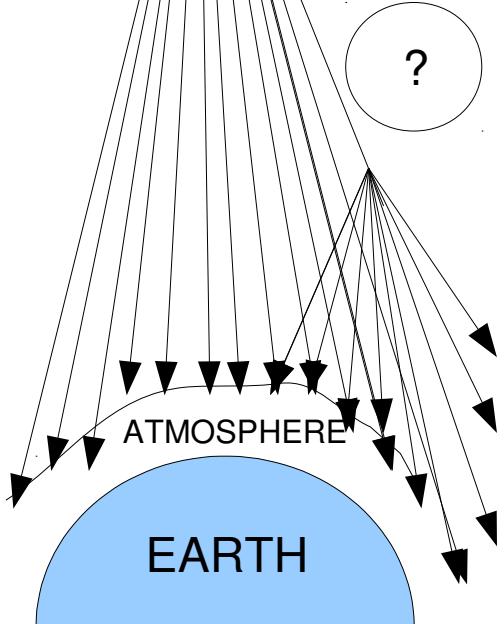
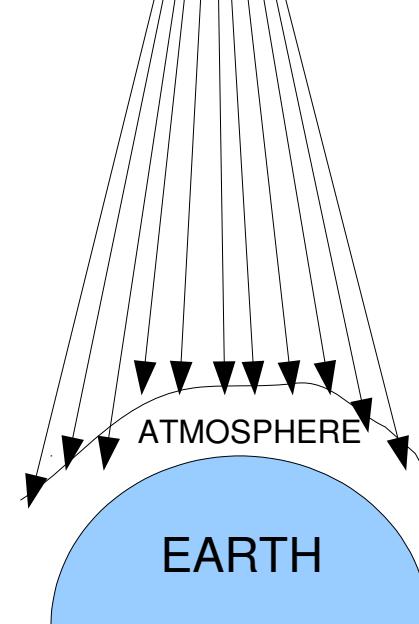
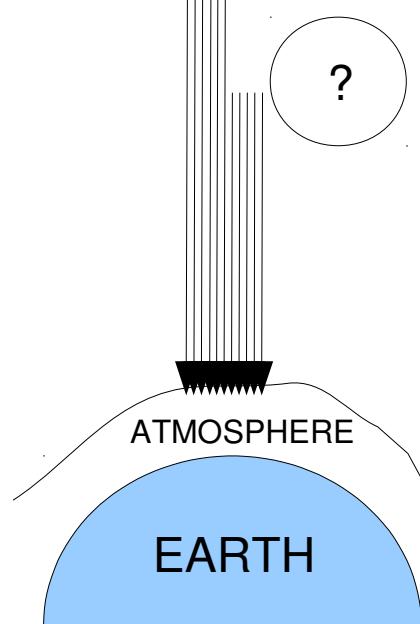
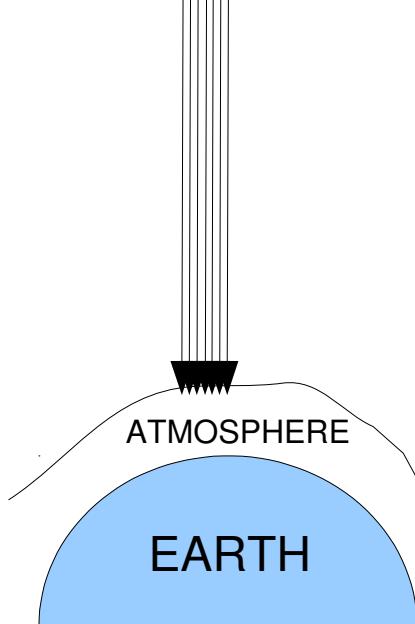
(e.g. 10^{20} eV)

D: γ_{UHE}

(e.g. 10^{20} eV)



: Fundamental physics questions



Δx : small
 Δt : small

Δx : small
 Δt : large

Δx : large
 Δt : small

Δx : large
 Δt : large

Super-preshowers motivated by data! (1)

- In A derivative with $\log E$? It has been
-) recently observed (in data which are
- s public!!!) that the electromagnetic ob-
- e servables have a consistently differ-
- e behavior from the hadronic ob-
- and tend to diverge as
- o energy.

g
:-

ACCESS RESTRICTED!

$dA/d\log E$



Super-preshowers motivated by data! (2)

VOLUME 50, NUMBER 26

PHYSICAL REVIEW LETTERS

27 JUNE 1983

Possible Observation of a Burst of Cosmic-Ray Events in the Form of Extensive Air Showers

Gary R. Smith, M. Ogmén, E. Buller, and S. Standil

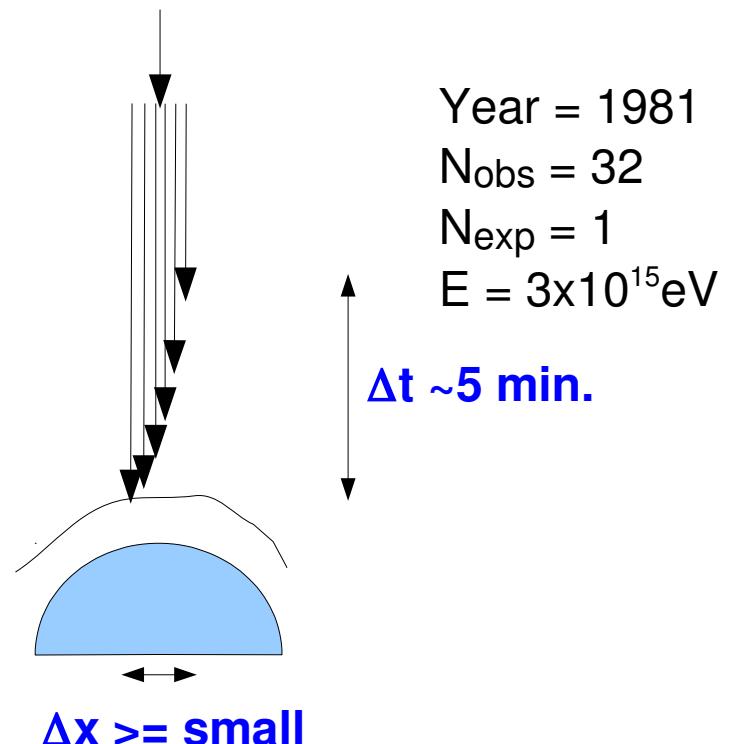
Physics Department, University of Manitoba, Winnipeg, Manitoba R3T 2N2, Canada

(Received 7 April 1983)

A series or burst of 32 extensive air showers of estimated mean energy 3×10^{15} eV was observed within a 5-min time interval beginning at 9:55 A.M. (CST) on 20 January 1981 in Winnipeg, Canada. This observation was the only one of its kind during an experiment which recorded 150 000 such showers in a period of 18 months between October 1980 and April 1982.

PACS numbers: 94.40.Pa, 94.40.Rc, 95.30.-k

PH: Super-preshower class B?



Super-preshowers: motivated by data! (3)

VOLUME 51, NUMBER 25

PHYSICAL REVIEW LETTERS

19 DECEMBER 1983

Observation of a Burst of Cosmic Rays at Energies above 7×10^{13} eV

D. J. Fegan and B. McBreen

Physics Department, University College Dublin, Dublin 4, Ireland

and

C. O'Sullivan

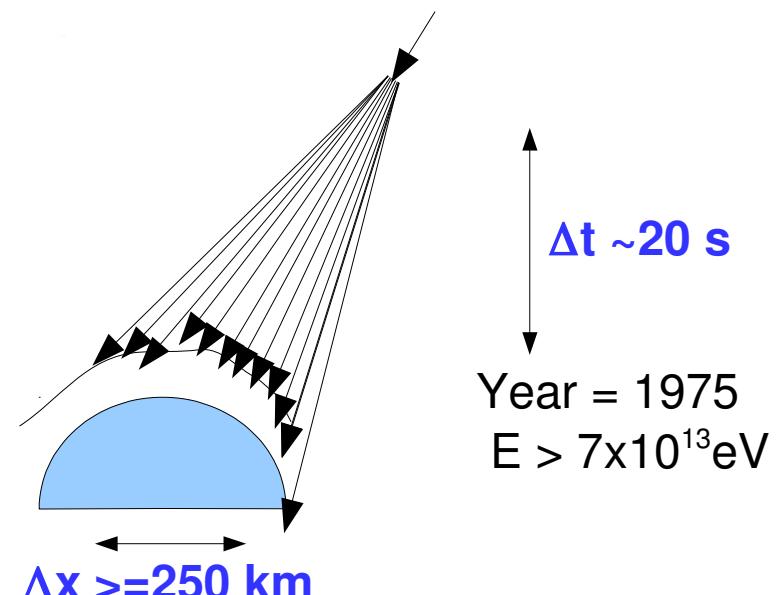
Physics Department, University College Cork, Cork, Ireland

(Received 14 September 1983)

The authors report on an unusual simultaneous increase in the cosmic-ray shower rate at two recording stations separated by 250 km. The event lasted for 20 s. This event was the only one of its kind detected in three years of observation. The duration and structure of this event is different from a recently reported single-station cosmic-ray burst. The simultaneity of the coincident event suggests that it was caused by a burst of cosmic gamma rays. There is a possibility that this event may be related to the largest observed glitch of the pulsar in the Crab Nebula.

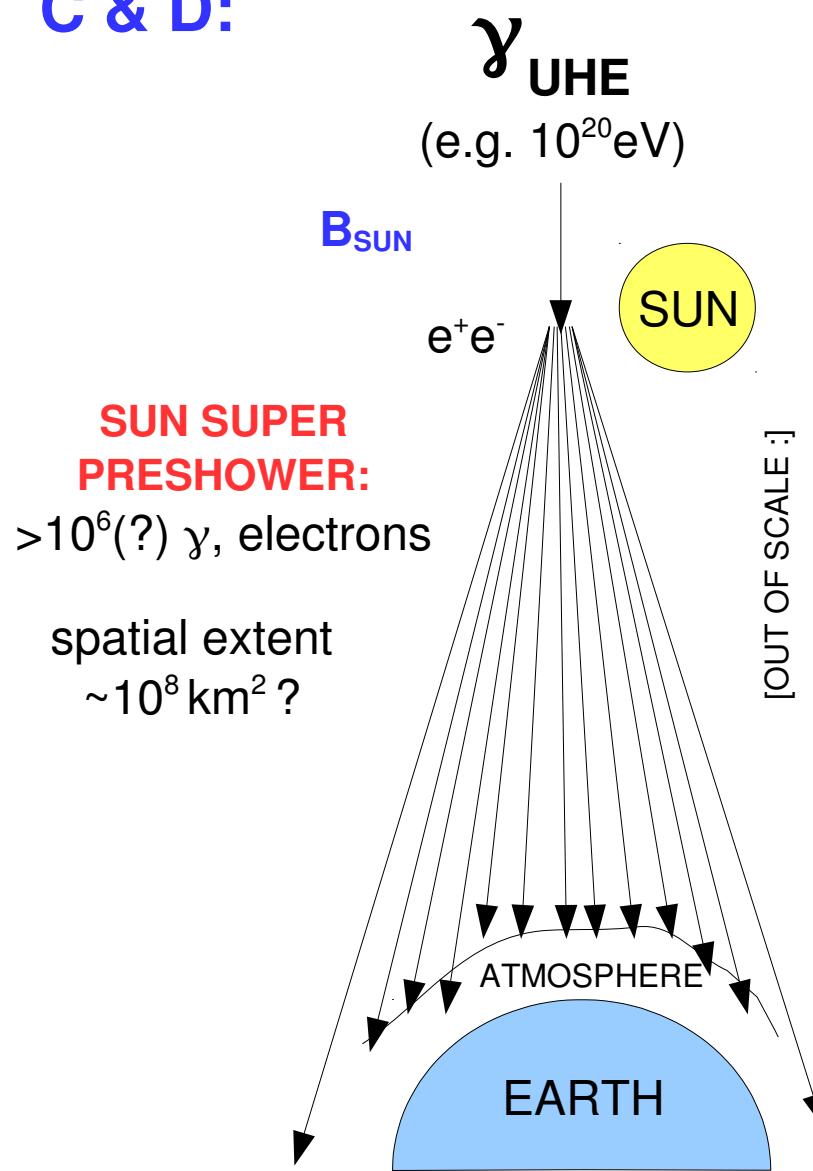
PACS numbers: 94.40.Pa, 95.85.Qx, 97.80.Jp

PH: Super-preshower class D?

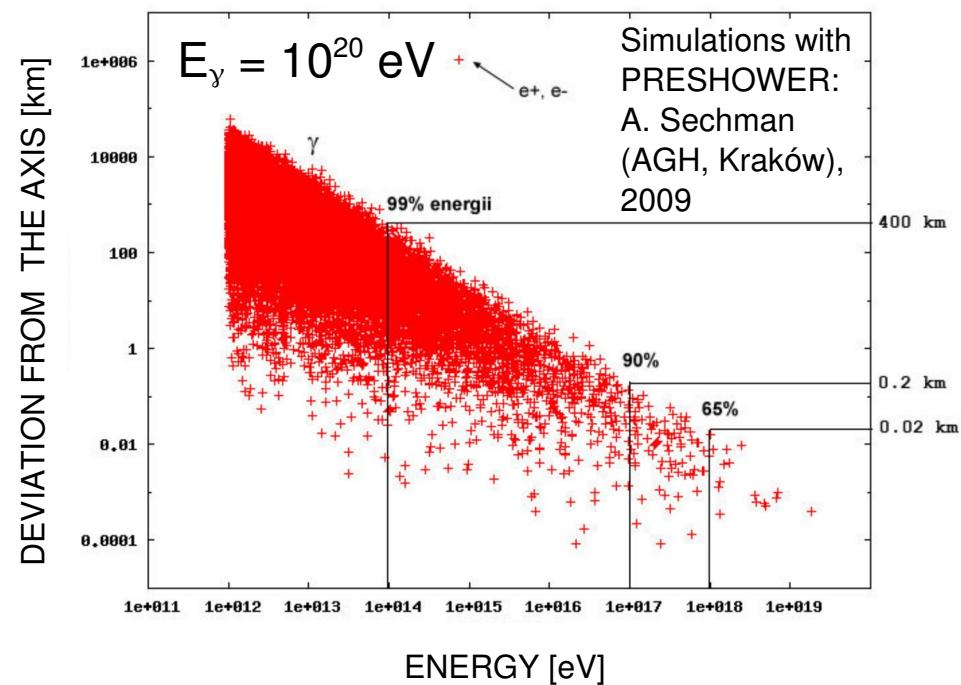


“Classical” super-preshowers: vicinity of the Sun

C & D:

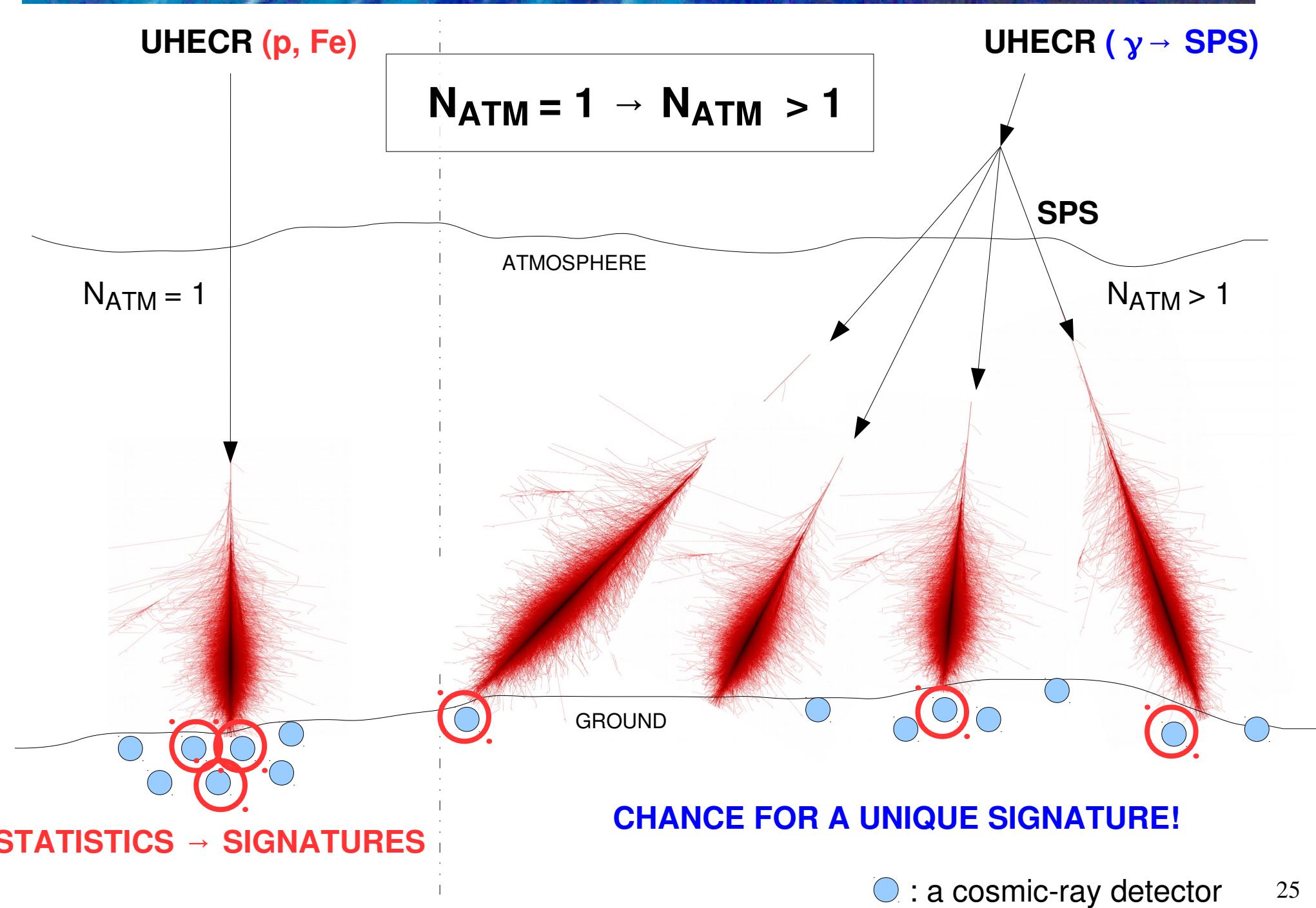


→ First calculations: W. Bednarek 1999
(low energies not treated → extent \sim tens of km)

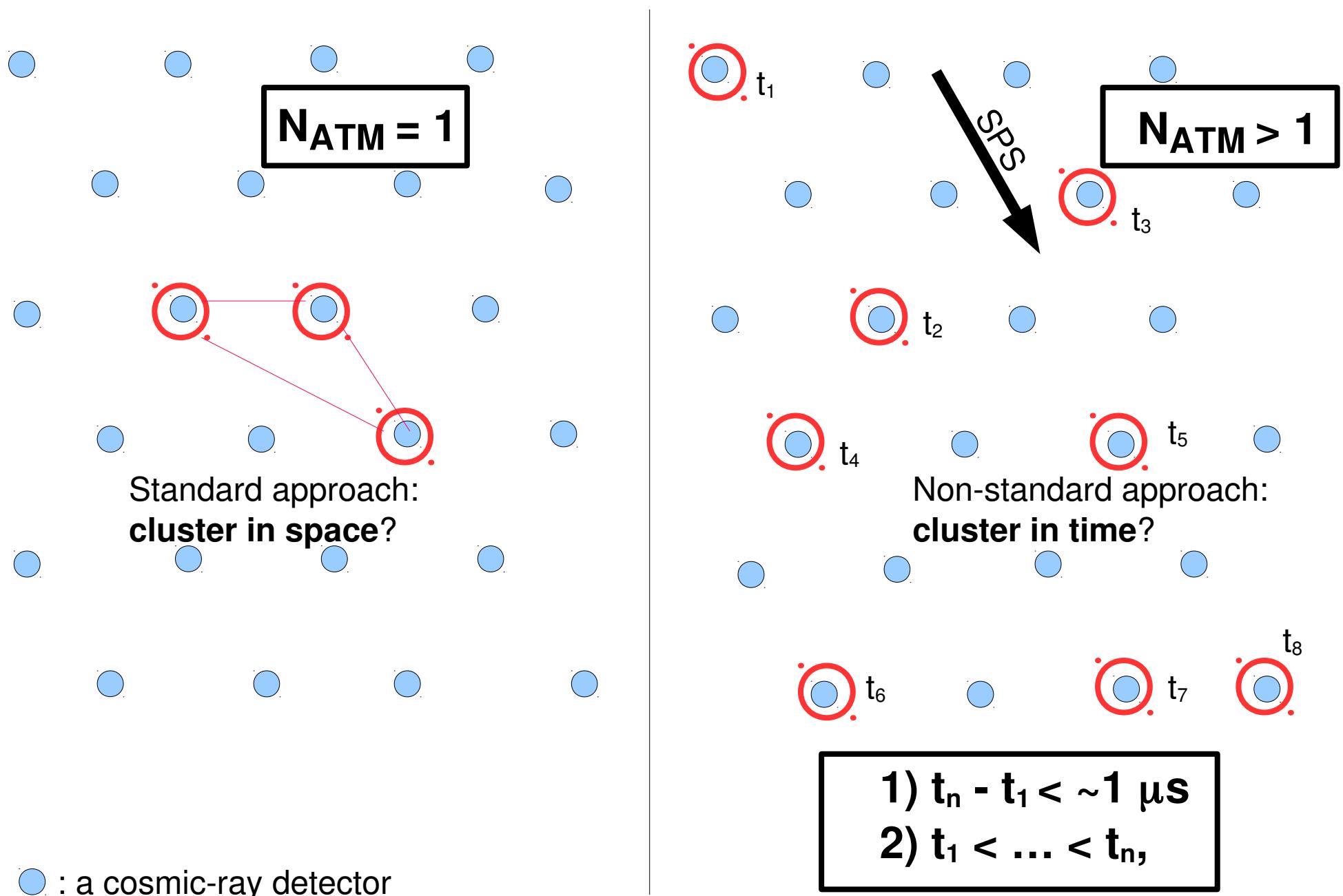


- front 10000 km wide?
- (over)compensates smaller solid angle?
- particle density on ground?
- **n isolated, time-ordered triggers?**

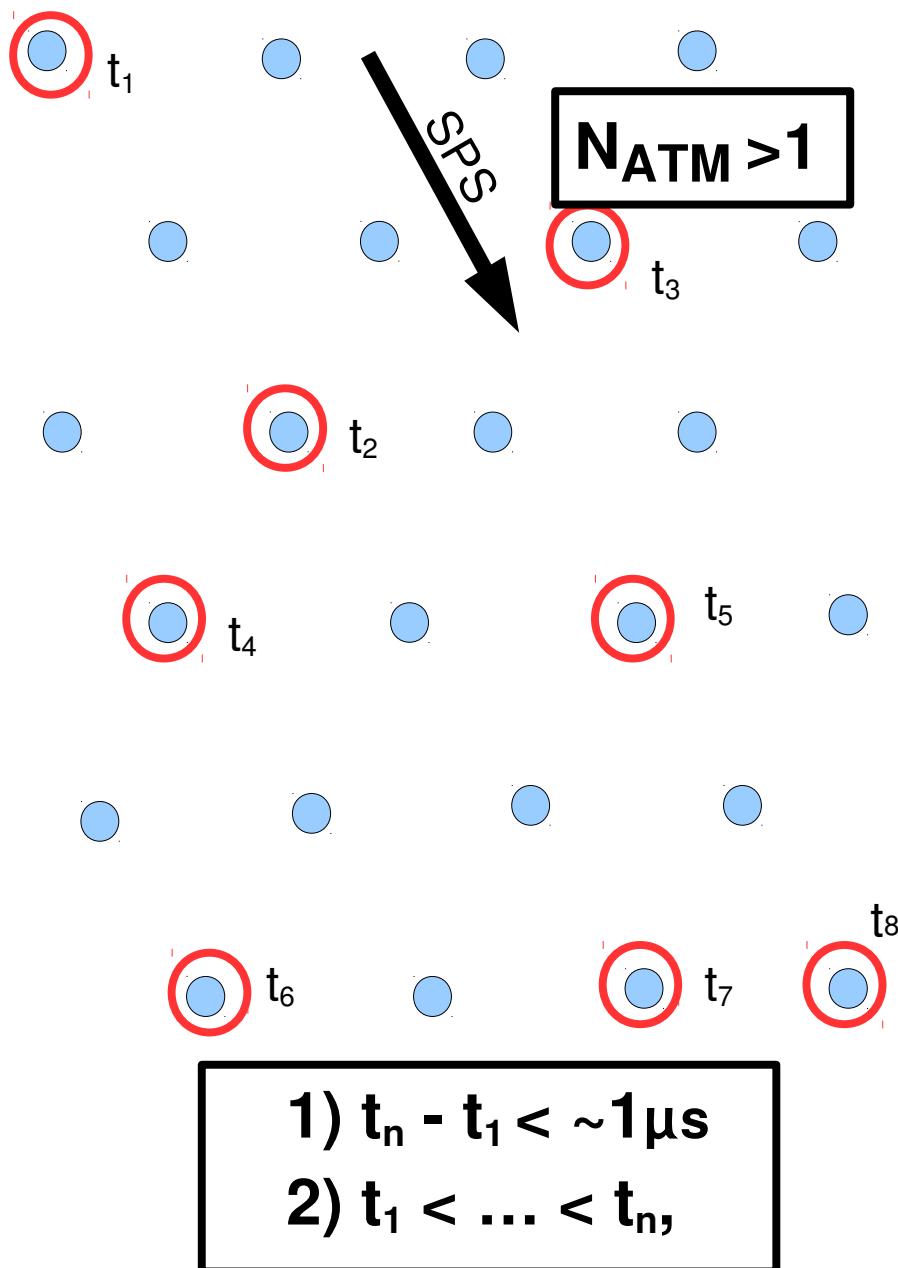
Generalization of UHECR research



A chance for a **unique** super-preshower **signature**



A chance for a **unique** super-preshower **signature**



Chance for a statistical coincidence for $n=30$, assuming Auger trigger rate 100 Hz:

$$P_{\text{acc}} = \sim 10/30! * 0.16^{30} = \text{ridiculously small chance}$$

sensitivity to $n_{\text{LOW}} < n < 30$
 $n_{\text{LOW}} = ?$

NEW TRIGGER: easy implementation, no hardware manipulation, no risk, ...

→ **why not?**

→ **unique signature
(of New Physics?)**

CREDO: mission organized for super-preshowers

Cosmic-Ray Extremely Distributed Observatory

Status March 2016:
„an idea“

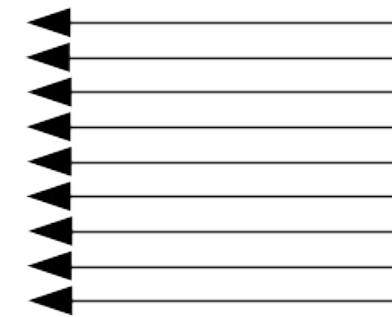


DATABASE/
INTERFACE

Central database/interface: access to everything for everybody

CREDO

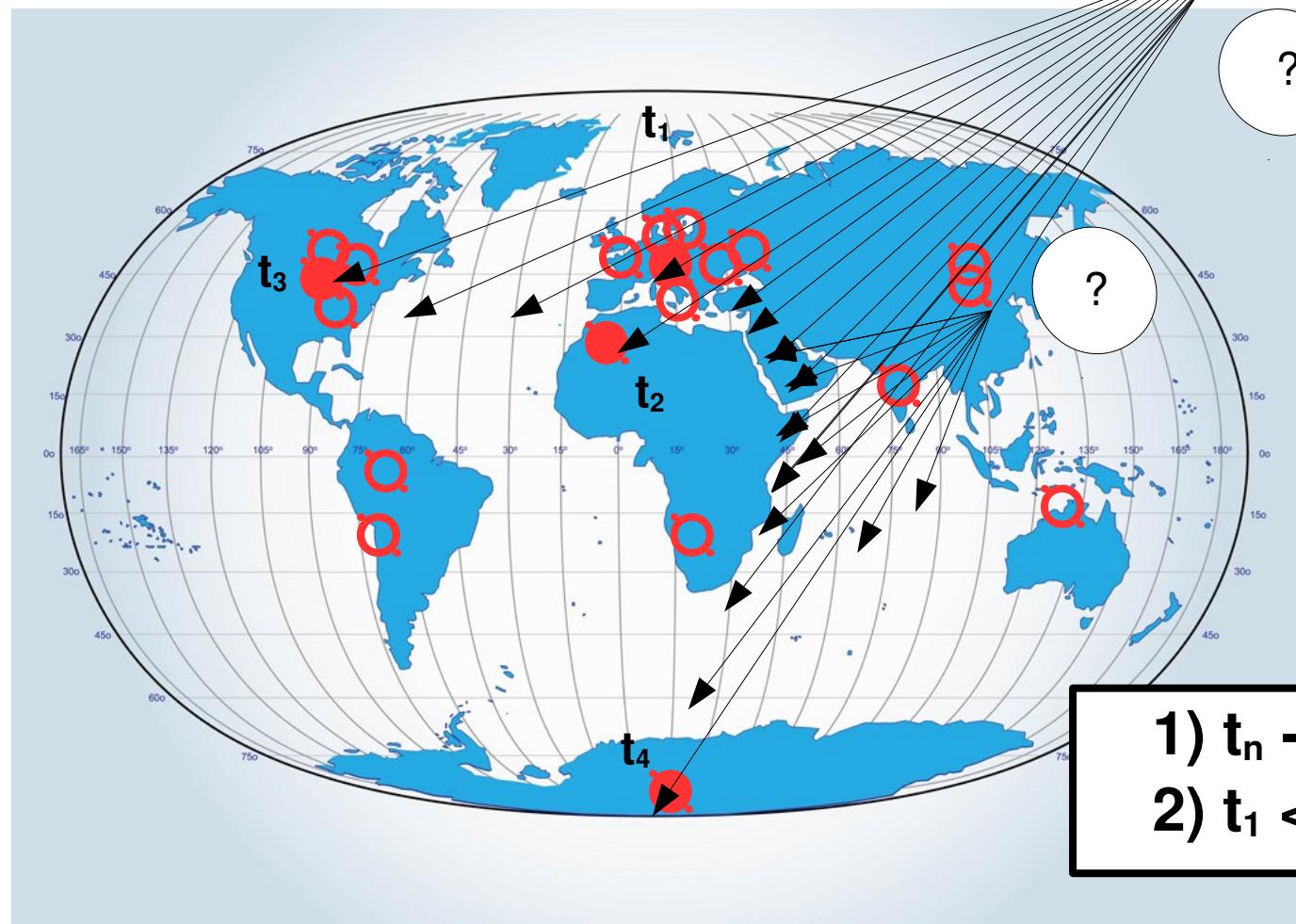
THE QUEST FOR UNEXPECTED



γ_{UHE}
(e.g. 10^{20} eV)



Citizens strengthen trigger capabilities of the educational arrays with smartphone networks



Citizens browse the data looking for „improbable” time-space coincidences

- 1) $t_n - t_1 < \sim 1 \mu\text{s}$
- 2) $t_1 < \dots < t_n,$

- indirect search for New Physics manifestations!
- verification of „classic” QED predictions (preshower @ Sun)

CREDO Inauguration Meeting, 30.08.2016, INP PAS

CREDO
THE QUEST FOR UNEXPECTED

Cosmic-Ray Extremely Distributed Observatory: Inauguration Meeting

30 August 2016
Institute of Nuclear Physics, Polish Academy of Sciences
Krakow, Poland

[Current registrants \(47\)](#) [47 registrants]

Name	Institution	Position	City	Country
Mr. ADAMIK, Andrzej	IMP - Institute Astronomical Observatory	Guest	Krakow	POLAND
Mr. ALIBIADA, CHIRIBAVENTI, Katarzyna	Institute of Nuclear Physics PAN		Krakow	POLAND
Dr. BARTKIEWICZ, Małgorzata	IFJ PAN		Krakow	POLAND
Dr. BORYSOWIAK, Halina	Institute of Nuclear Physics, PAN		Krakow	POLAND
Dr. BURAKOWSKI, Lukasz	IFJ PAN		Krakow	POLAND
CHUDONOWSKA, Asia	Instytut Fizyczny Polskiej Akademii Nauk		Krakow	POLAND
CHWASTEKOWIAK, Jacek	Institute of Nuclear Physics	Guest	Krakow	POLAND
CUZYDOWSKI, Miroslaw	Fudan University		Krakow	POLAND
Dr. DZHIMALI, Ning	Institute of Nuclear Physics PAN		Krakow	POLAND
GOERA, Dietmar	Hannover University		Hannover	GERMANY
Dr. HOMOLA, Piotr	Institute of Nuclear Physics PAN		Krakow	POLAND
MAGIERA, Paweł	AGH		Krakow	POLAND
Dr. MARINKOVIC, Dragana	IPNS FMV Novi Sad		Novi Sad	SERBIA
Dr. MAZUCHA, RWAJEWICZ, Jozefina	Cracow University of Technology (now under construction)		Krakow	POLAND
Dr. MICHALIK, Józef	NCBI		Krakow	POLAND
Mr. KAJETANOWICZ, Maciej	NCBI		Krakow	POLAND
Dr. KOBZOWI, Olaf	Institute of Nuclear Physics PAN		Krakow	POLAND
Dr. KOLECKI, Maciej	NCBI		Krakow	POLAND
KOPANIOWSKI, Kamil	Institute of Nuclear Physics PAN		Krakow	POLAND
Dr. KUBICKI, Weronika	Instytut Fizyczny PAN		Krakow	POLAND
Mr. KUBICKI, Tomasz	Instytut Fizyczny PAN		Krakow	POLAND
Dr. KULIKOWSKI, Dariusz	Instytut Fizyczny PAN		Krakow	POLAND
Mr. KURPIELSKI, Paweł	Instytut Fizyczny PAN		Krakow	POLAND
Dr. LADINSKI, Krzysztof	Instytut Fizyczny PAN	Professor	Louvain	UNITED STATES OF AMERICA
Dr. LINDNER, Daniel	University of Regensburg	Guest	Dobie	GERMANY
Mr. LINDNER, Maciej	University of Regensburg		Dobie	GERMANY
Mr. LUSZCZAK, Jerzy	AGH University of Science and Technology		Krakow	POLAND
Mr. MACHOWSKI, Jacek	IFJ PAN		Krakow	POLAND
Mr. MAREK, Michał	AGH University of Science and Technology		Krakow	POLAND
Mr. MATEJKO, Miroslaw	Jagiellonian University		Krakow	POLAND
Mr. MIELEWSKI, Jędrzej	National Centre for Nuclear Research		Lodz	POLAND
Mr. PIOTROWIACZ, Czesław	IFJ PAN		Krakow	POLAND
Dr. PIKALA, Jan	Institute of Nuclear Physics PAN		Krakow	POLAND
SHIBUMI, Chait	UC Irvine's Yerkes		Irvine	UNITED STATES OF AMERICA
Dr. SKARBIERIAK, Jacek	Institute of Nuclear Physics, PAN		Krakow	POLAND
STYLIK, Klaudiusz	Fudan University Krakow in Tadmon		Krakow	POLAND
Mr. SUŁUCHOWICZ, Oskar	Institute of Mathematics, Polish Academy of Sciences		Wrocław	UKRAINE
Mr. SUŁEK, Mateusz	Cracow University of Technology		Krakow	POLAND
Dr. SZYMKOLESKI, Jacek	National Centre for Nuclear Research		Lodz	POLAND
Dr. SZYDEŁKO, Katarzyna	Jagiellonian University		Krakow	POLAND
Prof. WATSON, Alan	University of Leeds		Leeds	UNITED KINGDOM
Prof. WIBERG, Tatjana	University of Lüneburg		Lüneburg	POLAND
Dr. WIBRUCHOWSKA, Alicja	IFJ PAN		Krakow	POLAND
WILCZYŃSKI, Henryk	Institute of Nuclear Physics, PAN		Krakow	POLAND
Dr. WICZBIAK, Katarzyna	Institute of Nuclear Physics PAN		Krakow	POLAND
Mr. ZAMORA, Juan Alberto	IFJ PAN	PostDoc	Dubna	RUSSIA

Diversified community (AGH: 6.3%)

Colorful science

Cosmic-Ray Extremely Distributed Observatory: Inauguration Meeting

hosted by Prof. Horodek (Institute of Nuclear Physics PAN), Karpinski Wiesław (Institute of Nuclear Physics PAN, Krakow, Poland)

on Friday, 30 August 2016 from 10:30 to 18:00 (Europe/Warsaw)

Institute of Nuclear Physics, Polish Academy of Sciences (Seminar Room 5301)

ul. Bema 11, 31-321 Krakow, POLAND

Dear guests: Videoconference will be available after opening the link:
<https://tinyurl.com/y87v2m6y> (Vidyo) or <https://tinyurl.com/y87v2m6y> (Vidyo).

and installing the Vidyo program.

In order to test Vidyo before the conference, you may consult the CREDO page:
<http://information.astrofizyka.mech.edu.pl/credo/vidyo/credo.html> and <http://information.astrofizyka.mech.edu.pl/credo/vidyo/credo.html>

Tuesday, 30 August 2016

10:30 - 11:00 Registration / Coffee

11:00 - 11:30 Introduction Session

Comments: Dr. Piotr Horodek (Institute of Nuclear Physics PAN); Dr. Karpinski Wiesław (Institute of Nuclear Physics PAN, Krakow, Poland); Dr. Niels Dittus (IfP PAN)

21:00 Welcome 30 Speaker: Prof. Henryk Wilczyński (IFJ PAN, Krakow)

Material: [\[Watch\]](#) [\[Download\]](#)

21:10 Philosophical reflections: how do we live in the universe? 30 Speaker: Dr. Piotr Horodek (Institute of Nuclear Physics PAN)

Material: [\[Watch\]](#) [\[Download\]](#)

21:20 Open questions on *Dark Matter* (the last lecture) 30 Speaker: Dr. József Jakab (Csepel University of Technology)

Material: [\[Watch\]](#) [\[Download\]](#)

21:30 UHE CR and *Dark Matter* 30 Speaker: Dr. Jan Pąkala (IFJ PAN, Krakow)

Material: [\[Watch\]](#) [\[Download\]](#)

21:40 UHE photon inter actions: the source lectures 30 Speaker: Dr. József Jakab (Csepel University of Technology)

Material: [\[Watch\]](#) [\[Download\]](#)

21:50 Interactions in super-cosmology: the open problems 30 Speaker: Dr. Piotr Horodek (Institute of Nuclear Physics PAN)

Material: [\[Watch\]](#) [\[Download\]](#)

22:00 CREDO in astrogeophysics in the future 30 Speaker: Dr. Piotr Horodek (Institute of Nuclear Physics PAN)

Material: [\[Watch\]](#) [\[Download\]](#)

22:10 CREDO as a citizen science project: what can we expect? 30 Speaker: Dr. József Jakab (Csepel University of Technology)

Material: [\[Watch\]](#) [\[Download\]](#)

Lunch (Coffee break 13:30 - 14:30) **Afternoon 14:30 - 16:30**

Comments: Prof. Dr. Piotr Horodek (IFJ PAN, Krakow); Dr. Piotr Horodek (Institute of Nuclear Physics PAN)

15:30 CREDO longer notes 30 Speaker: Dr. Piotr Horodek (Institute of Nuclear Physics PAN); Karol Karpinski (IFJ PAN, Krakow)

Material: [\[Watch\]](#) [\[Download\]](#)

15:40 Super-spheres in the long wavelength components of CREDO 30 Speaker: Claus Klement (CERN)

Material: [\[Watch\]](#) [\[Download\]](#)

15:50 Our online informatics learning for super-cosmology 30 Speaker: Dr. Dominik Góra (Adam Mickiewicz University, Poznań)

Material: [\[Watch\]](#) [\[Download\]](#)

16:00 Cosmic aspects of particle recognition in the context of astrophysics 30 Speaker: Dr. Angelo Salvo (INFN-Catania (Istituto di Fisica))

Material: [\[Watch\]](#) [\[Download\]](#)

16:10 Cosmic rays in the ATLAS detector 30 Speaker: Dr. Karpinski Wiesław (Institute of Nuclear Physics PAN, Krakow, Poland)

Material: [\[Watch\]](#) [\[Download\]](#)

16:20 Dark Matter: challenges and limits in the super-cosmology context 30 Speaker: Prof. Mihály Mészáros (University of Kansas)

Material: [\[Watch\]](#) [\[Download\]](#)

16:30 Coffee

Concluding Session

Comments: Dr. Piotr Horodek (Institute of Nuclear Physics PAN)

16:45 Example of additional CREDO applications: no-regional precursor 30 Speaker: Dr. József Jakab (Csepel University of Technology)

Material: [\[Watch\]](#) [\[Download\]](#)

17:00 CREDO: the simplest rules of a collision sites 30 Speaker: Dr. Piotr Horodek (Institute of Nuclear Physics PAN)

Material: [\[Watch\]](#) [\[Download\]](#)

17:15 Summary and Discussion 30



programy aktualności galerie

OGŁĄDAJ NA ŻYWO ▾

nauka i edukacja ▾ Smartfonowe obserwatorium

NAUKA I EDUKACJA NAUKA I EDUKACJA

SMARTFONOWE OBSERWATORIUM

Publikacja: 30 sierpnia 2016, 20:53 Źródło: TVP3 Kraków - Kronika



FAKTY ▾ OPINIE ▾ ROZRYWKA ▾ ZDJĘCIA

Banner wiodący

RMF 24 ▾ Fakty ▾ Nauka ▾ Projekty ▾ CREDO: Pożycz nauce smartfona, może dostaniesz... Nobla

Projekt CREDO: Pożycz nauce smartfona, może dostaniesz... Nobla



wyborcza.pl
KRAKÓW



Wiadomości Inwestycje Komunikacja Sport Kultura ▾ Magazyn Krakowski Więcej ▾ Kontakt

Wyborcza.pl / Kraków / Wiadomości z Krakowa

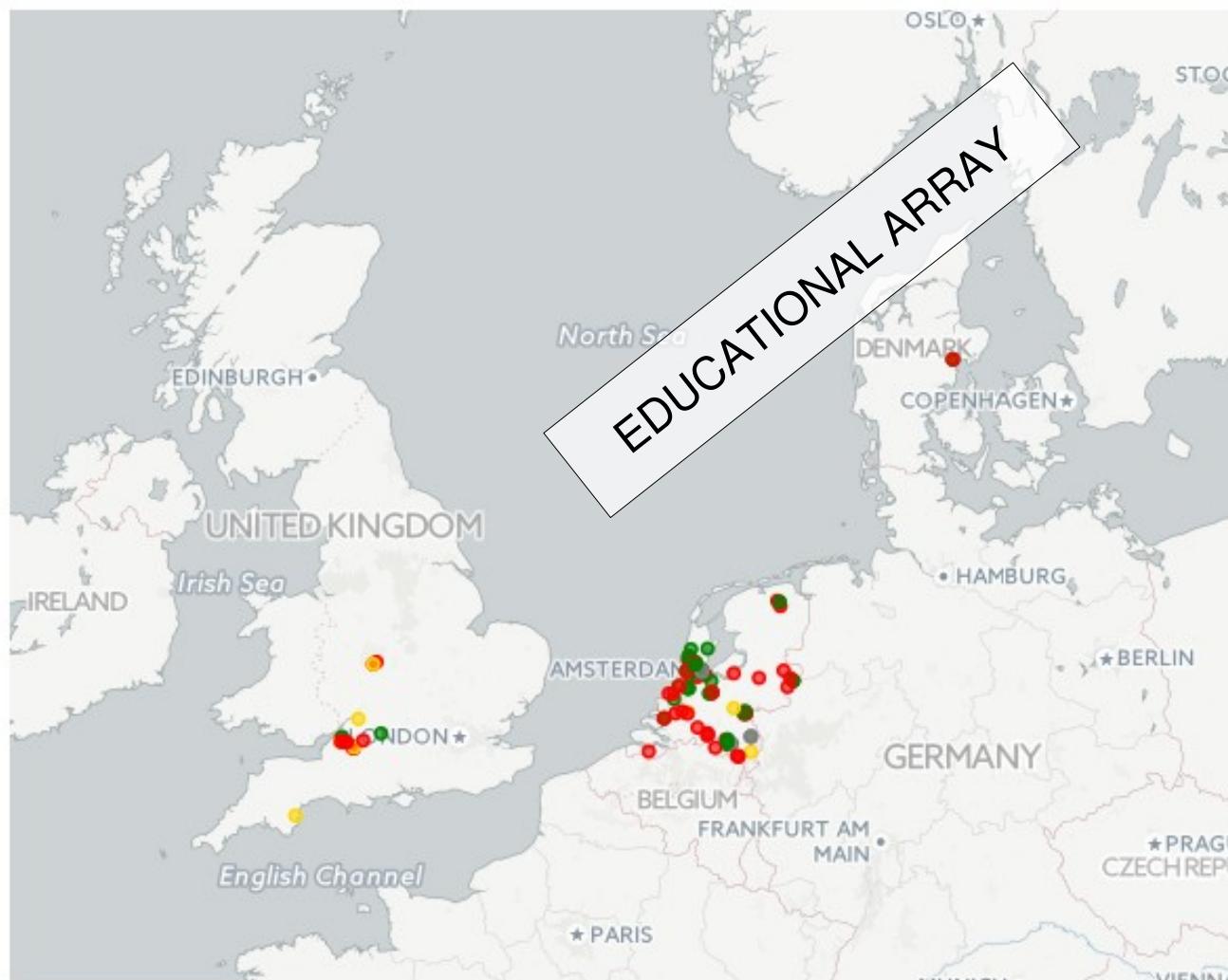
Masz smartfona? Zostań odkrywcą, obserwuj promieniowanie kosmiczne

Ada Chojnowska 05.09.2016 09:00

Examples of CREDO players: HiSPARC



Map of HiSPARC stations



Stations

[List by Number](#) [Location](#) [Name](#)

[Map](#) [Overview](#)

[Data](#) [Coincidences](#)

Data availability

Station Link to data
Station No data received

Current status

- Up (51)
- Problem (13)
- Down (62)
- Unknown
- Link to status

Region map

[Cluster](#) Link to map

Examples of CREDO players: DECO



HOME PROJECT APP DATA EDUCATION RESEARCH FAQ CONTACT

SMARTPHONES + APP!

DATA



Examples of CREDO players: CRAYFIS

CRA
YFIS

About Contact Map Blog Paper Login



Total Exposure i

10 years, 155 days, 8 hours

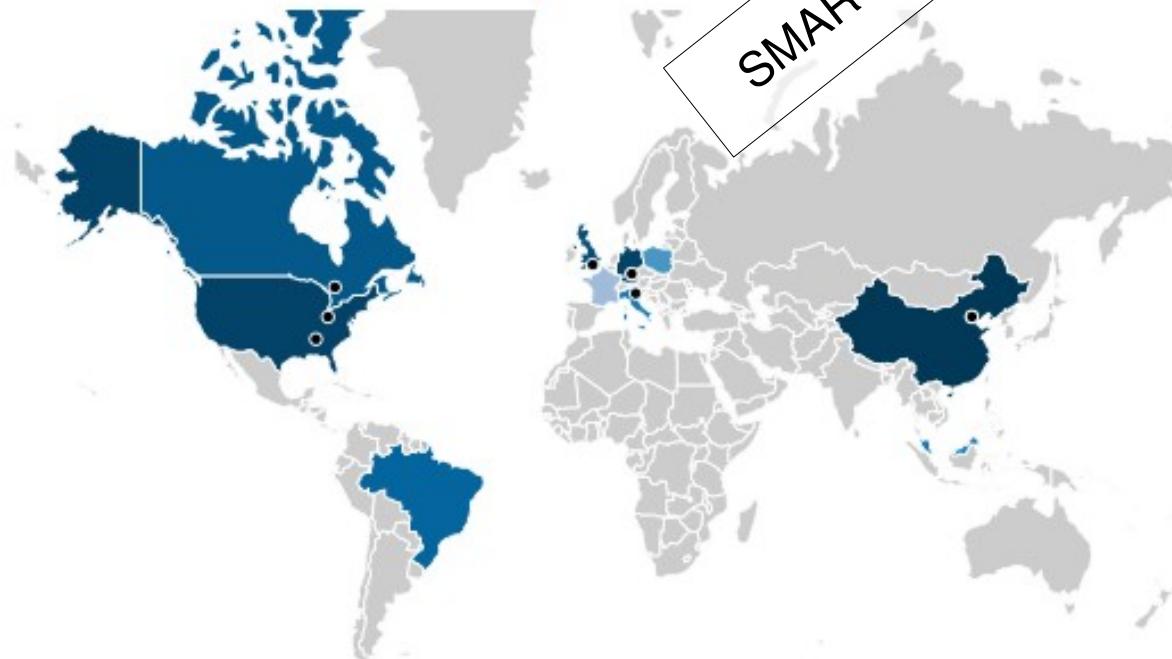
Unique Devices

413

Candidate Hits i

48,495,266

Network Map i



SMARTPHONES + APP!

National Ranking

Rank	Country	Score <small>i</small>
1	China	2,042,569
2	Germany	1,153,009
3	United States	1,141,242
4	United Kingdom	603,228
5	Canada	351,886
6	Brazil	129,957
7	Italy	28,007
8	Malaysia	27,862
9	Poland	5,265
10	France	279

by Paweł Jagoda, AGH, since 30 Aug 2016



Examples of CREDO players: JINR

Shower of knowledge

News

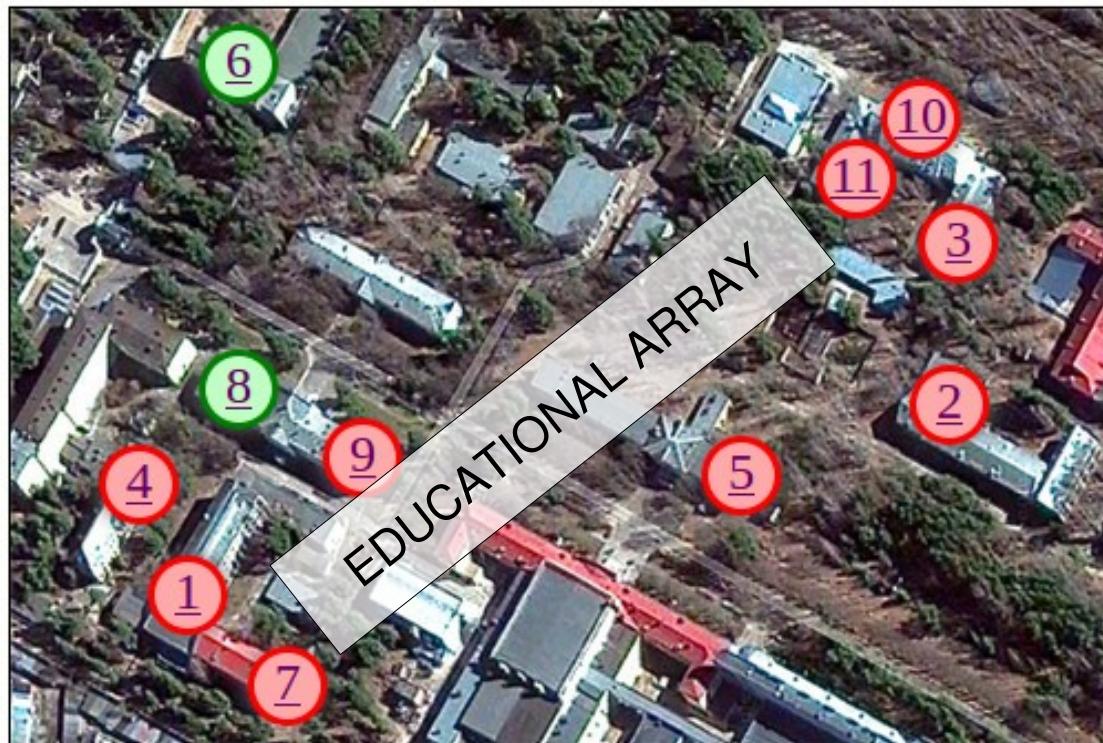
Project▼

Setup▼

Manual

About site

Contacts



Welcome, dear Guest!

We are glad to see you in our laboratory of cosmic rays. We suggest you to start from surfing through the available sections and try to make the simplest analysis of real experimental data, which our station provides continuously. We hope that it will entice you and you will become a permanent and full-fledged member of our international laboratory.

Examples of CREDO players: INP PAS, Krakow

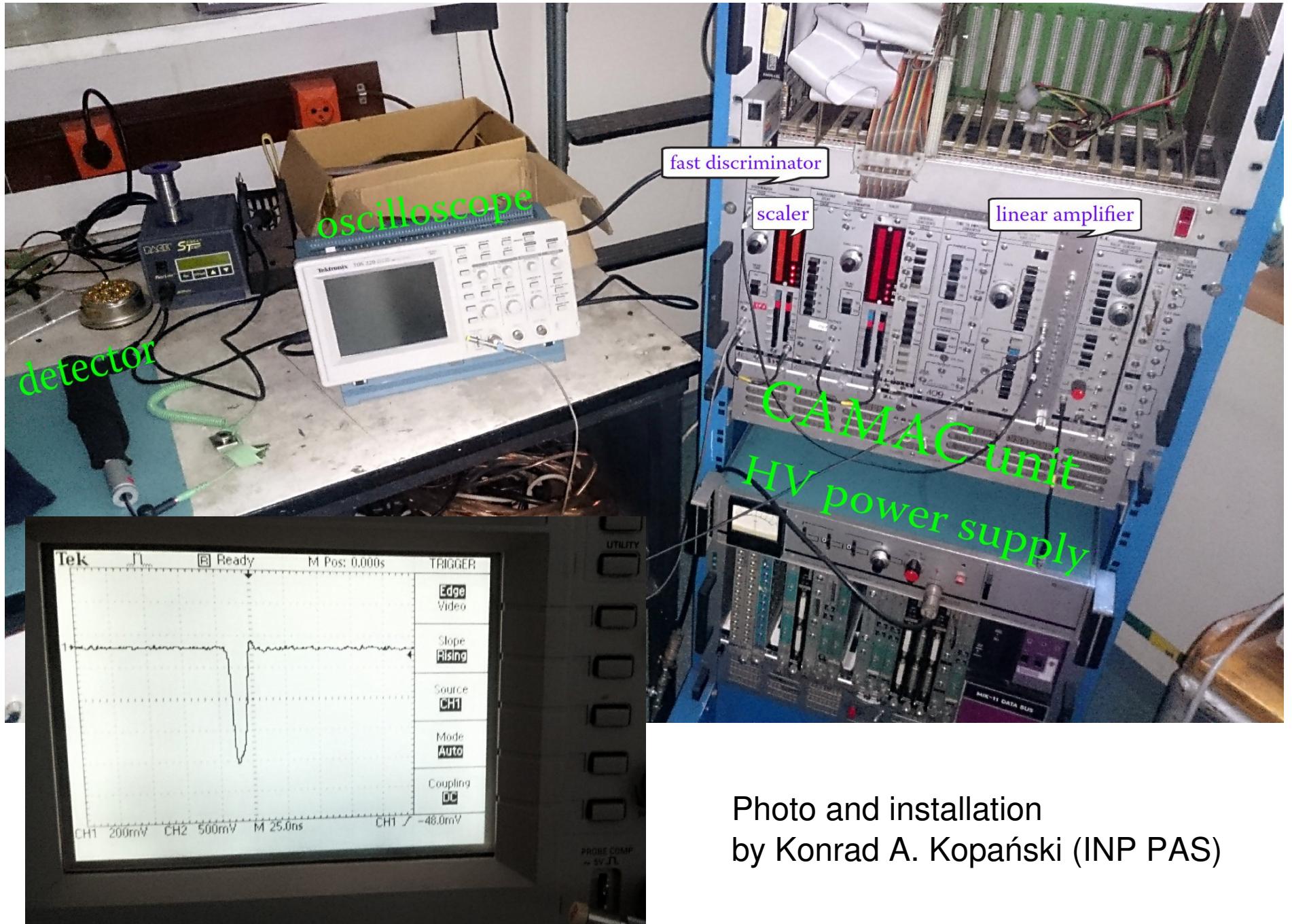


Photo and installation
by Konrad A. Kopański (INP PAS)

Large Experiments and CREDO

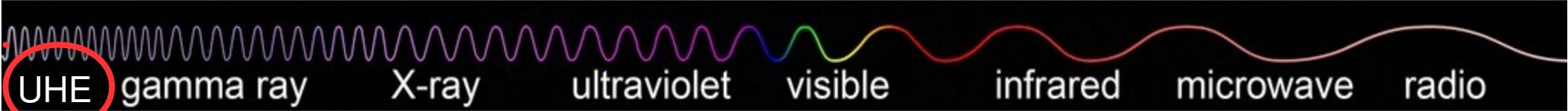
On the formal way to contribute:

- Pierre Auger Observatory (cosmic rays)
- Baikal-GVD (neutrinos)
- MAGIC (gamma rays)

About initiating a formal way:

- ATLAS

EVERY cosmic ray detector can contribute to CREDO
CREDO can provide alerts to EVERYBODY



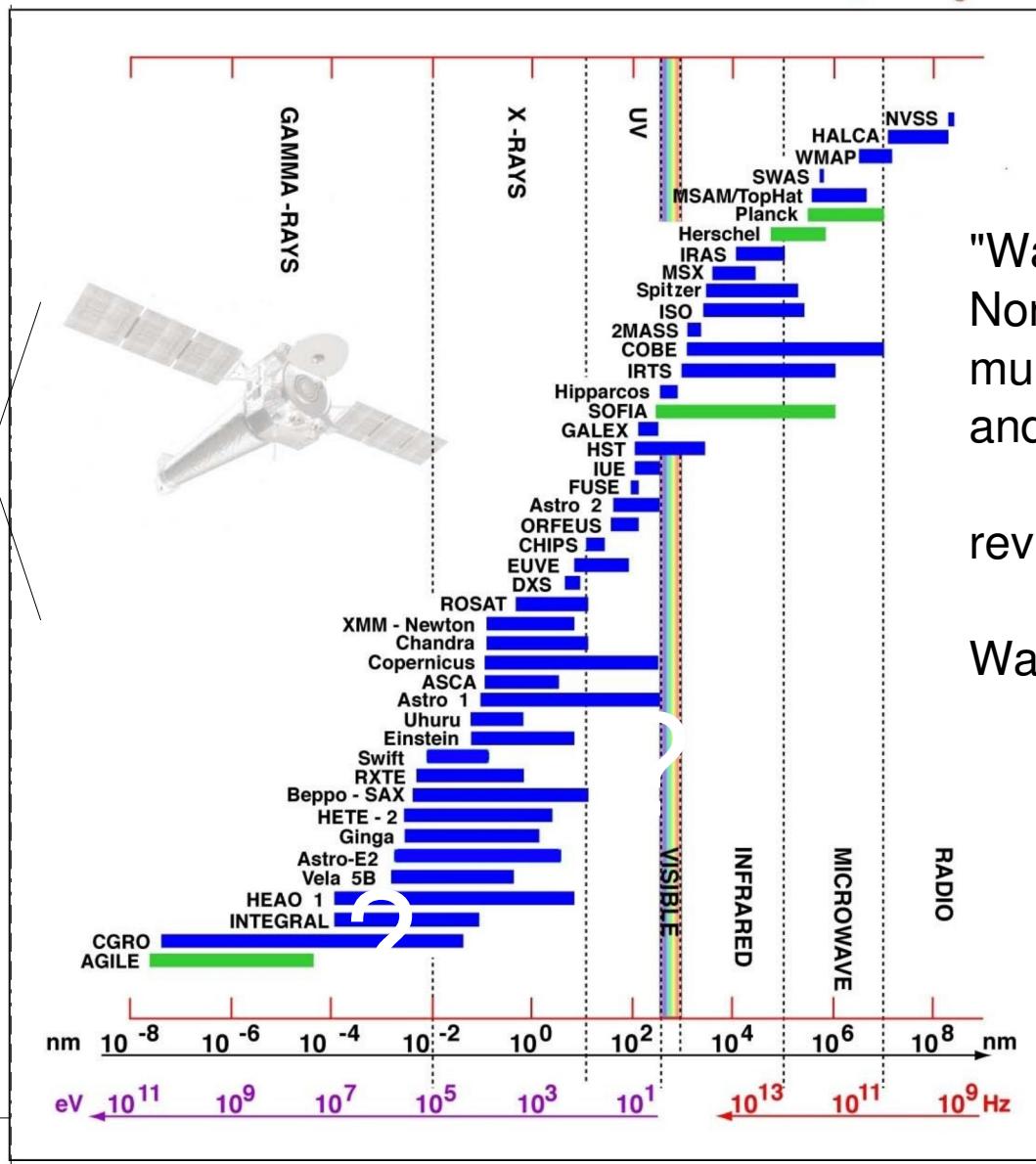
PH:
Even more
ways for
indirect DM
search:
**ultra-high
energy
photons**
+
**SUPER
PRESHOWERS?**

- Pierre Auger Observatory
- Telescope Array
- CREDO

...

$>10^{19}$

From gamma rays to radio



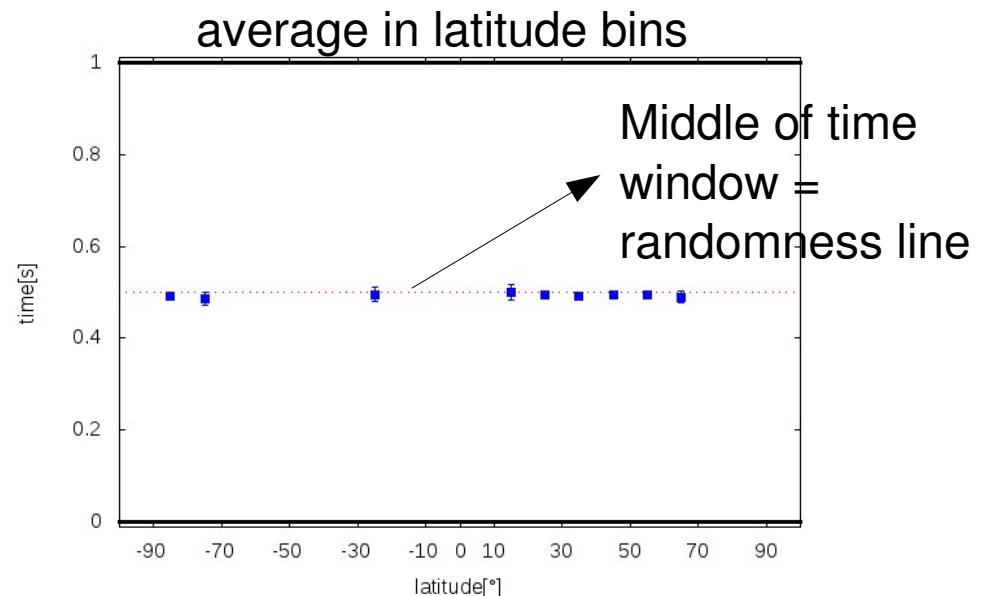
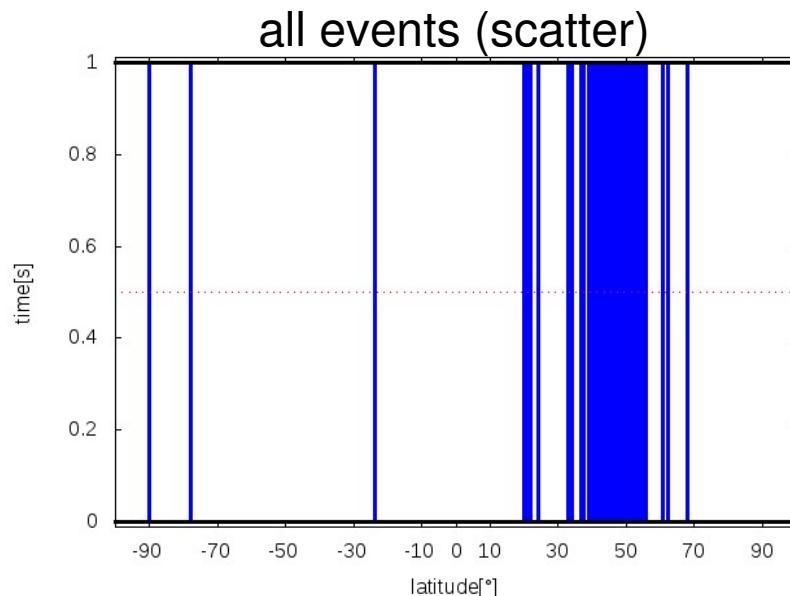
"Warsaw Workshop on
Non-Standard Dark Matter:
multicomponent scenarios
and beyond"

review by C. Weniger

Warsaw, 2-5.06.2016

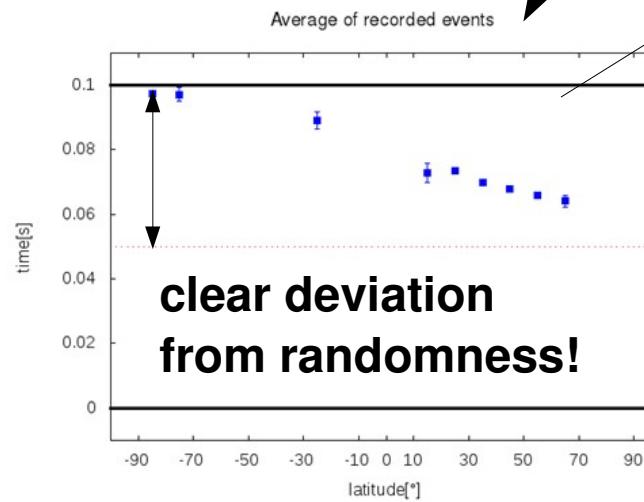
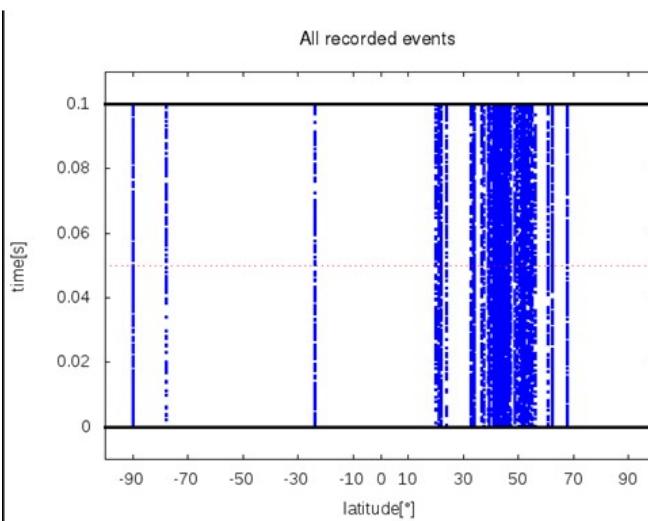
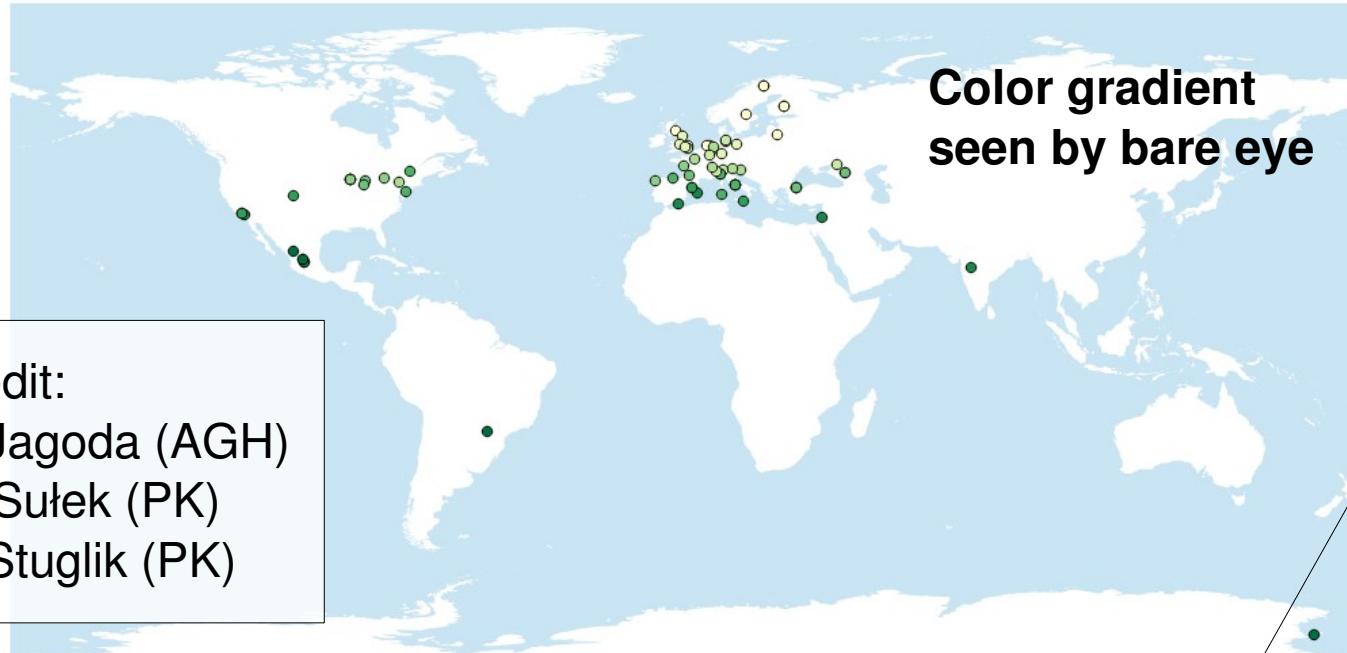
the simplest CREDO analysis: “NO SIGNAL” simulation

Credit:
P. Jagoda (AGH)
M. Sułek (PK)
S. Stuglik (PK)



the simplest CREDO analysis: “SIGNAL” simulation

Credit:
P. Jagoda (AGH)
M. Sułek (PK)
S. Stuglik (PK)



alerting potential

Good candidate
for unique
super-preshower
signature

Middle of time
window =
randomness line

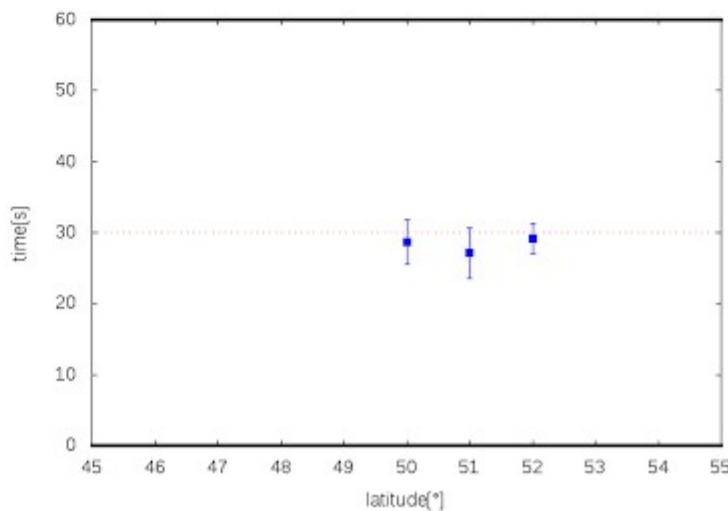
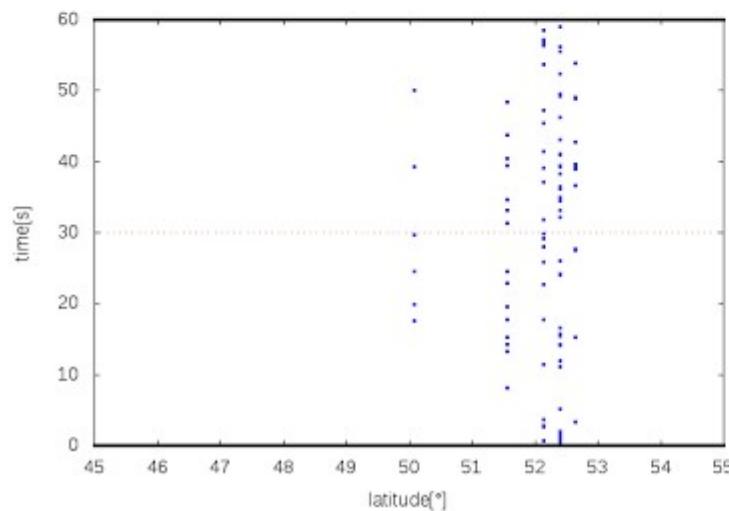
CREDO: the first real data classification

Credit:
P. Jagoda (AGH)
M. Sułek (PK)
S. Stuglik (PK)



All recorded events

Average of recorded events



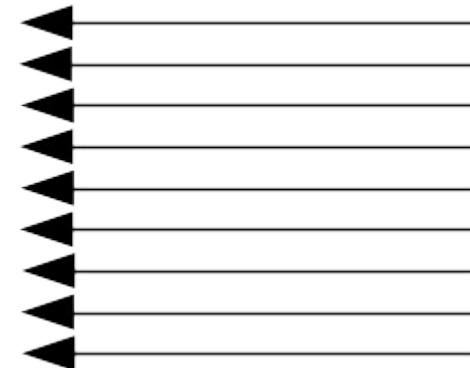
→ random...

The citizen science potential of

CREDO

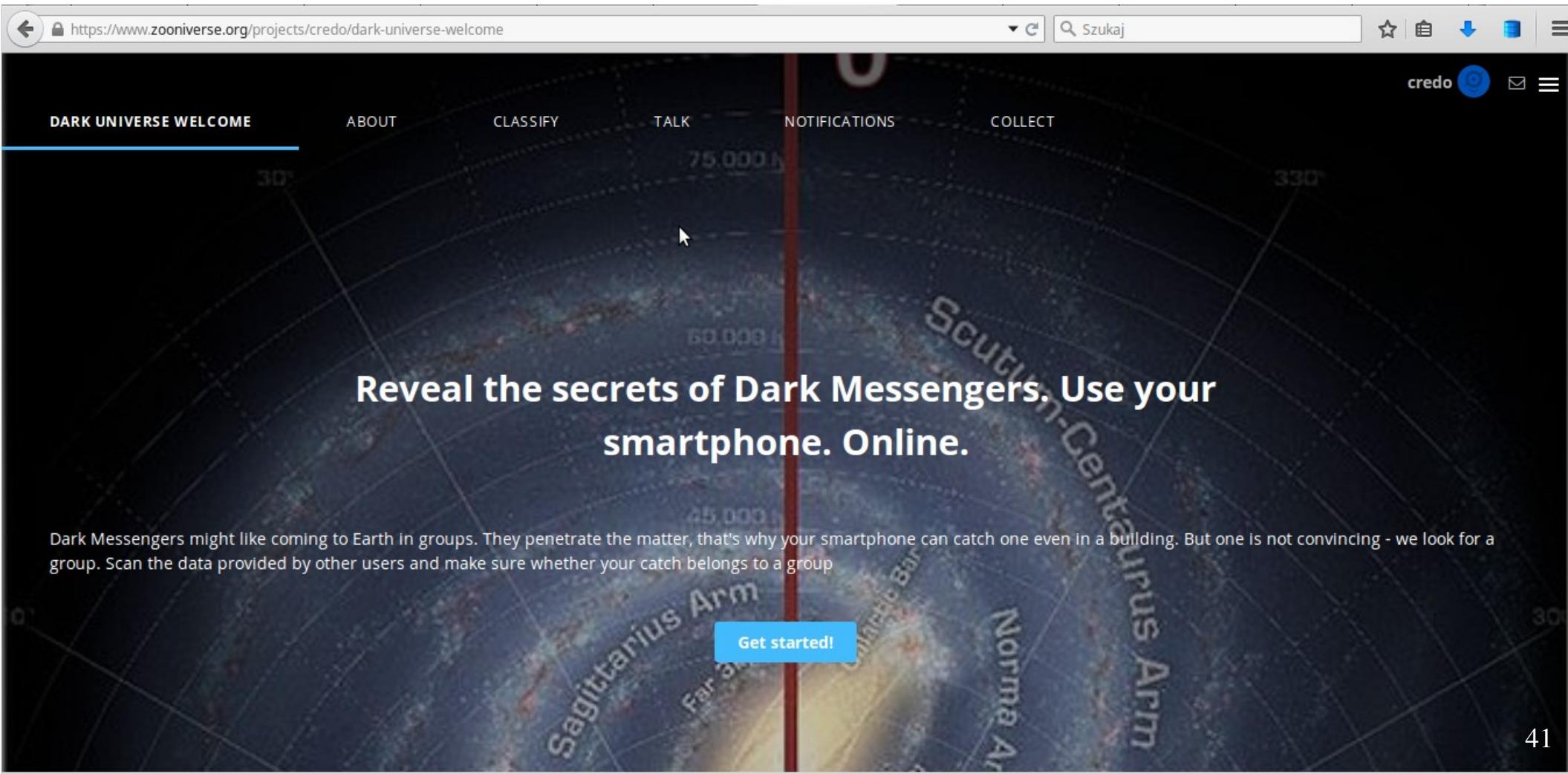


THE QUEST FOR UNEXPECTED



https://www.zooniverse.org/projects/credo/dark-universe>Welcome Szukaj

DARK UNIVERSE WELCOME ABOUT CLASSIFY TALK NOTIFICATIONS COLLECT



Reveal the secrets of Dark Messengers. Use your smartphone. Online.

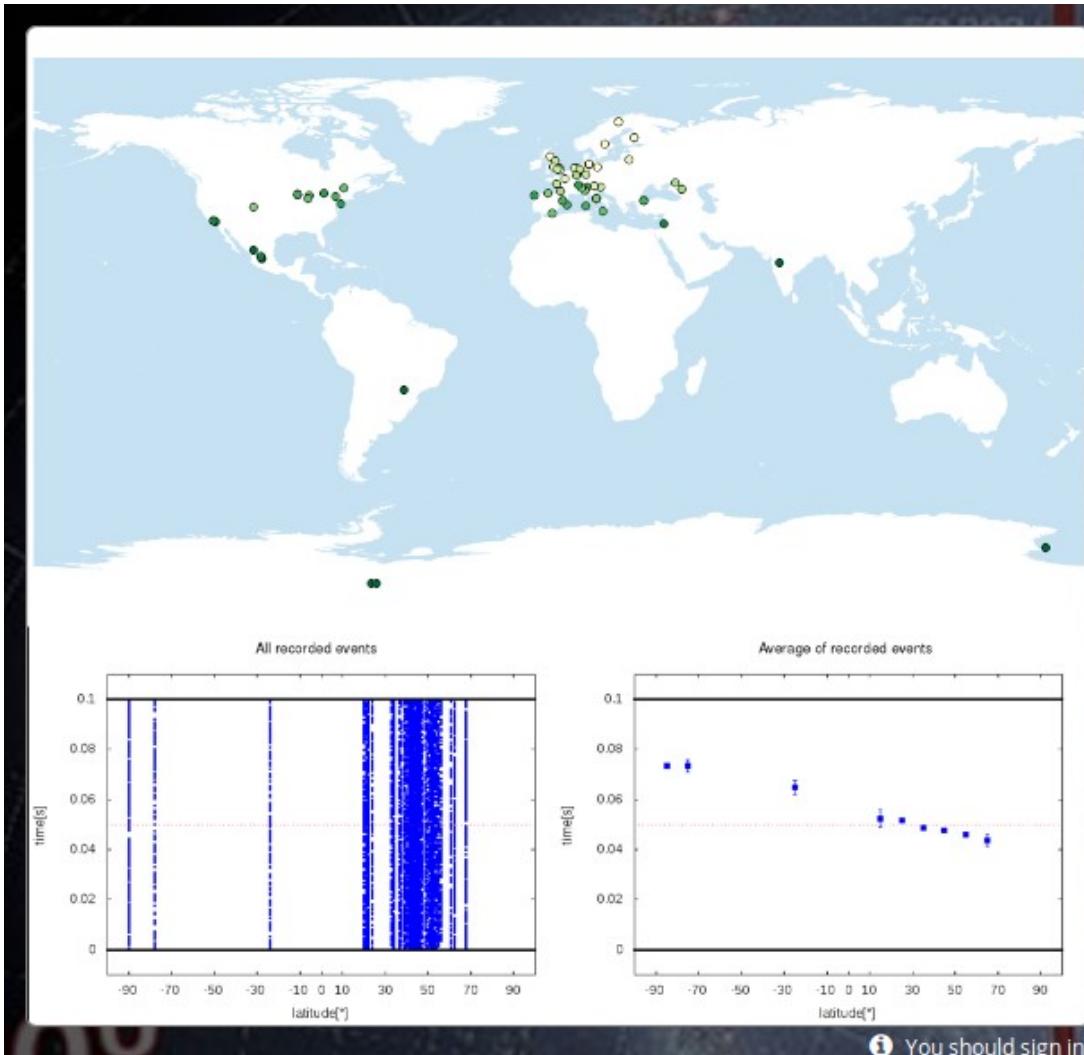
Dark Messengers might like coming to Earth in groups. They penetrate the matter, that's why your smartphone can catch one even in a building. But one is not convincing - we look for a group. Scan the data provided by other users and make sure whether your catch belongs to a group

Get started!

credoo

41

CREDO citizen science: Dark Universe Welcome



Is this a strange pattern?

- I see a strange pattern or color gradient
- This must be a pure coincidence
- I'm not sure

Need some help with this task?

Show the project tutorial

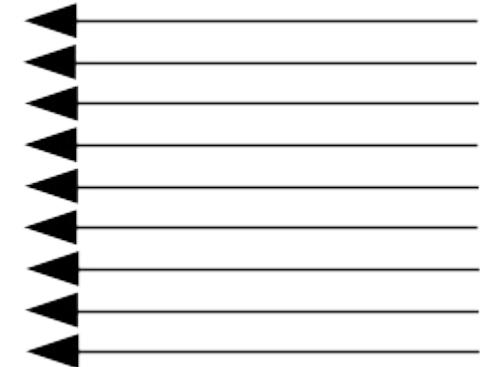
Credit:
P. Jagoda (AGH)
M. Sułek (PK)
S. Stuglik (PK)

What is your vote? [a child can do this...]

CREDO



THE QUEST FOR UNEXPECTED



CREDO by *definition*: **the larger the better**

CREDO to be successful **needs as many people as possible**:

- **for devices**
- **for crowdsourcing**

Citizen science for CREDO: not an option, **a must!**

Positive side effects of citizen science



Summer practice 2016 in NZ15:

4 students working on CREDO citizen science interface

After summer practice 2016 in NZ15 (**no obligation to work**):

9 students colleagues continue or ready to join CREDO

$$4 \rightarrow 9 = 225\% \text{ effect :)}$$

Why?

Student = scientific partner?

Visible importance of work (TV)?

Ambitious scientific perspective given?

How to cultivate such an enthusiasm for science?

More sites like this + a system

HOME

PROJECTS

PEOPLE

PARTNERS

BLOG

SUBMIT

CONTACT US

LOGIN



Garage of Complexity

The Jagiellonian University Makerspace

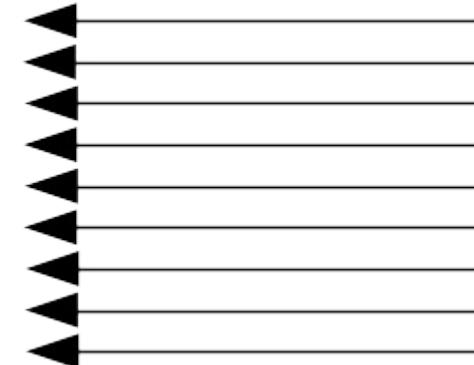
6.10.2016: Why don't we have a similar place at IFJ PAN, PK, AGH?

28.10.2016: IFJ PAN ready (Garaż Możliwości); PK on the way; AGH ...?

System prototype: Cracow Incubator of Scientific Discoveries (KION)

An ocean of opportunities:

CREDO



THE QUEST FOR UNEXPECTED

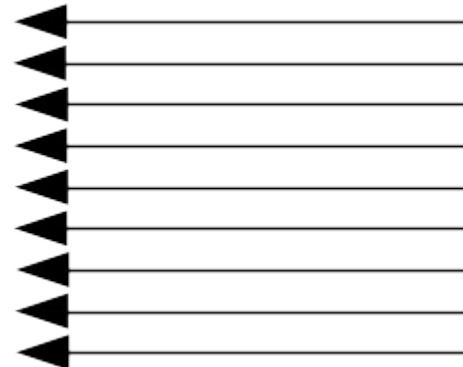
- fundamental science through astroparticle physics
- geophysics through cosmic-rays
- space weather / solar activity
- diversified engineering (wide range of cosmic-ray energies)
- connections to industry
- advanced/novel computing solutions required (cloud)
- all level education/training
- citizen science (people help science – science help people)
- outreach (popularization)

- synergy generator
 - at INP PAS: colleagues from 5 departments / 2 divisions involved;
 - joint efforts with Politechnika Krakowska WFIS and IF UJ, AGH (yet unofficial);
 - everybody welcome!**

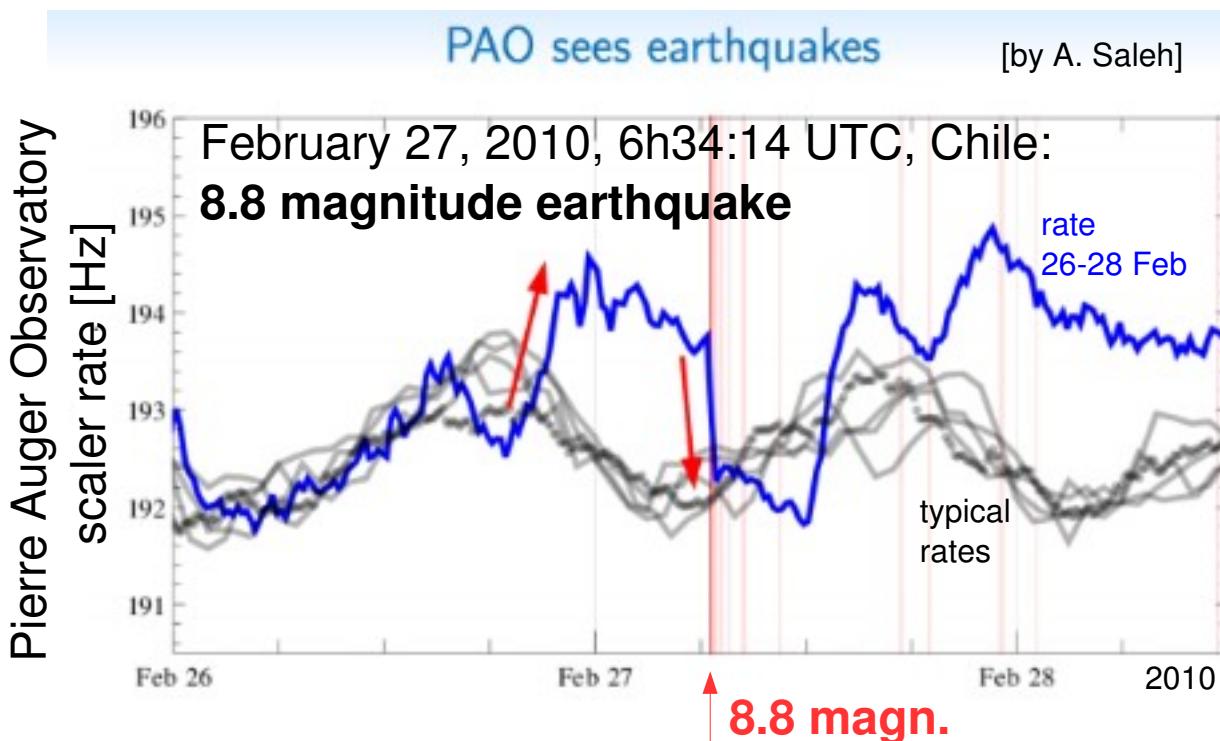
CREDO



THE QUEST FOR UNEXPECTED

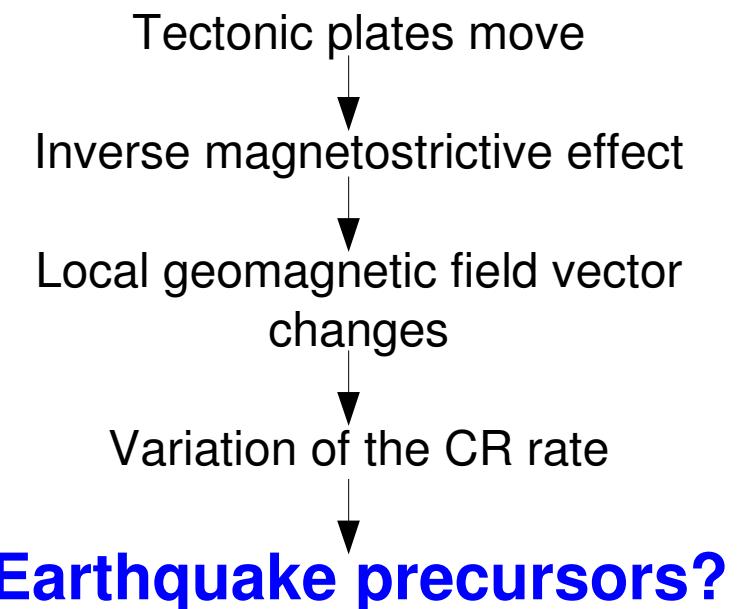


Scientific diversity example:



- Increase of CR before the earthquake
- Strong drop during the earthquake

→ CREDO-earthquakes task [already existing]



Summary

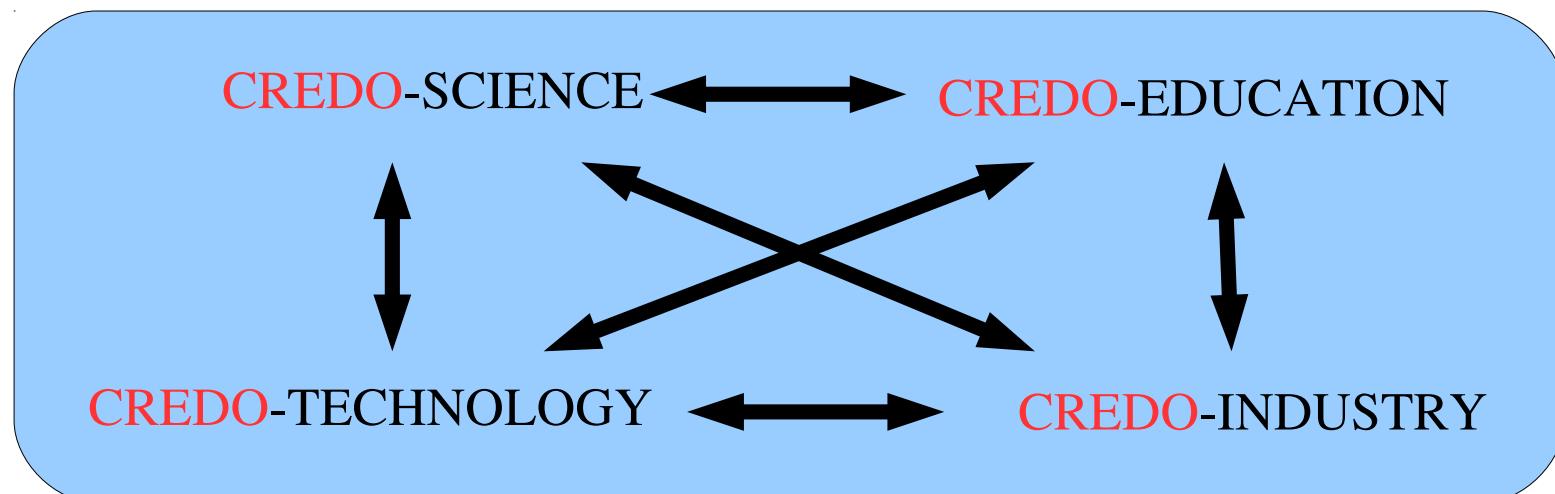
Cosmic-Ray Extremely Distributed Observatory:
a tool to explore **uncharted realm of science**?

„I do think CREDO has a unique capability of entering in
and exploring a completely **uncharted realm of science**.“

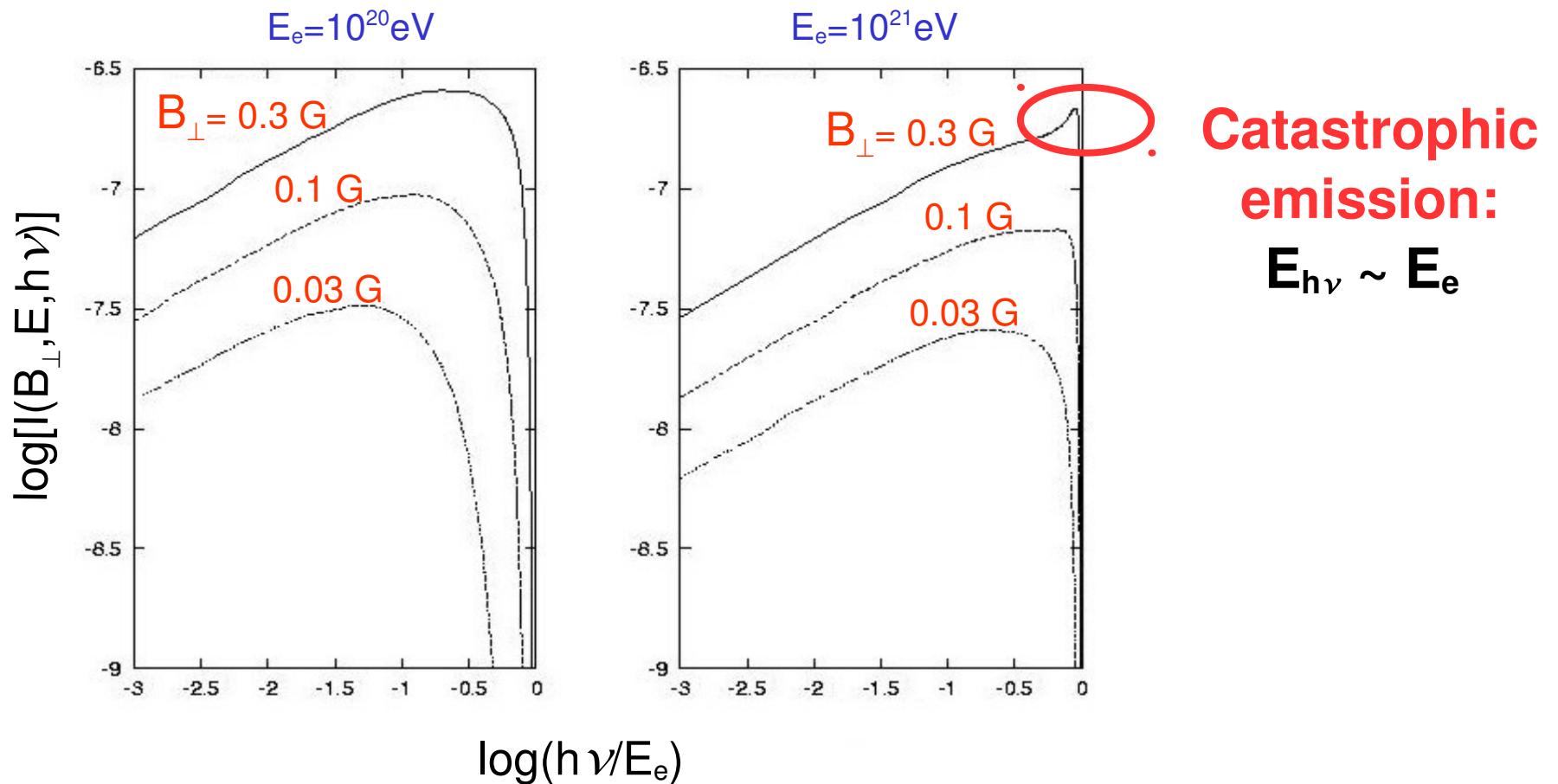
Mikhail V. Medvedev, (2cDM author, now involved in CREDO tasks: organization, theory, publications)

„Yes, but“: *Terra incognita* might turn out to be a desert...

CREDO guarantee of success:
ocean of opportunities / synergy generator under one roof (project)

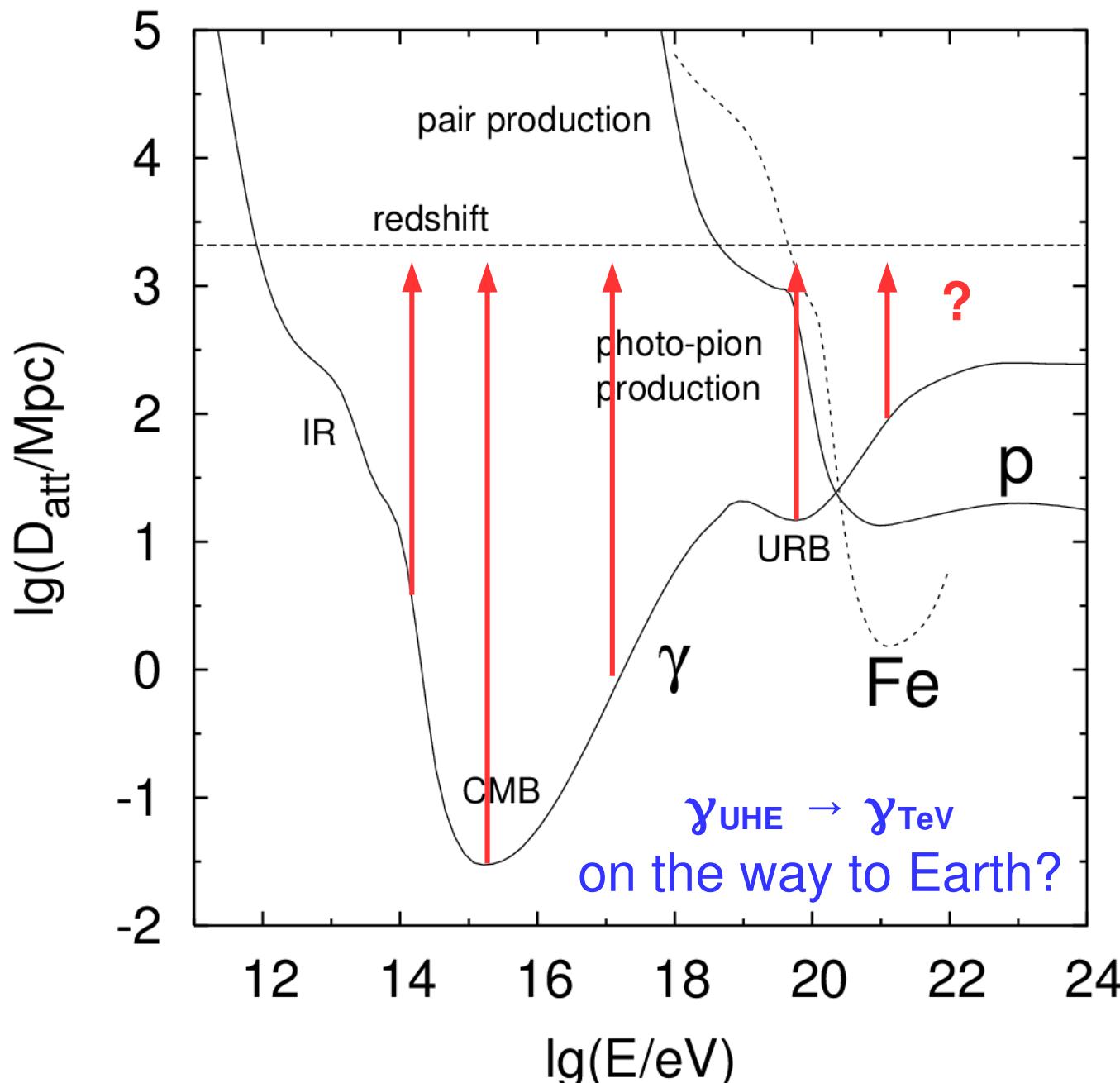


Magnetic bremsstrahlung of ultrarelativistic electrons

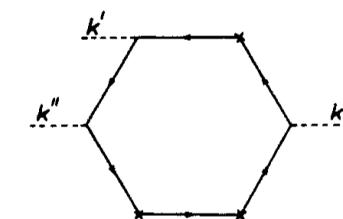
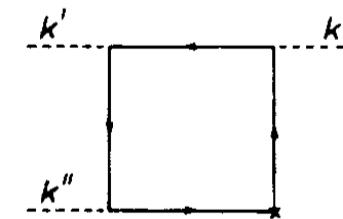


- probability of catastrophic emission increases with E
- similarly for monopoles? [question relevant for the Auger paper on monopoles]

γ_{UHE} travelling through the Universe: exotic example



PHOTON
SPLITTING???



HIGHER RATES IN
NONLINEAR
ELECTRODYNAMICS?

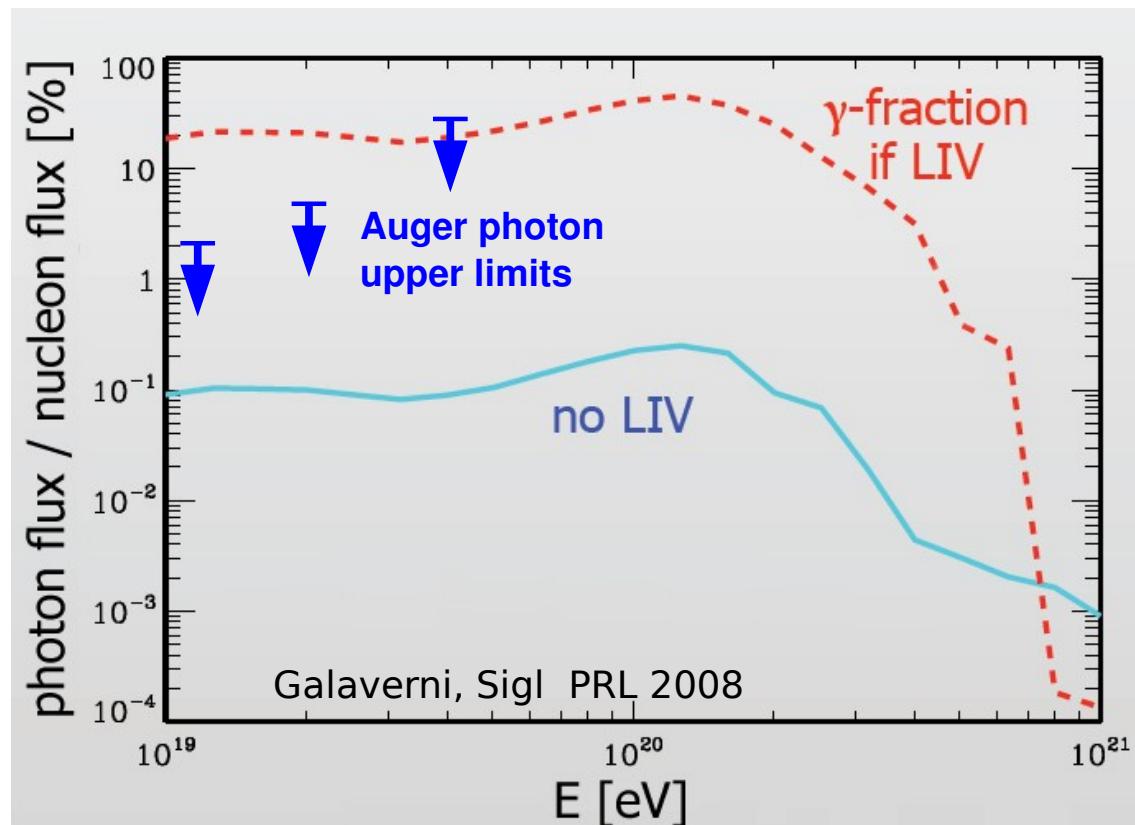
cf. Maccione & Liberati,
JCAP 08 (2008) 027

Probing fundamental physics: example

Testing Lorentz Invariance Violation (LIV) \rightarrow photon dissperssion relation modified?

$$\omega^2 = k^2 + \xi_n k^2 (k/M_{Pl})^n \rightarrow e^+e^- \text{ production threshold modified}$$

e.g. $\pi^0 \rightarrow \gamma\gamma$ $\gamma \cancel{\rightarrow} e^+e^-$ cascading of photons supressed



If LIV:

$$\xi_1, \xi_2 > 0$$

Upper limits based
on UHECR observations:

$$\xi_1 < 2.4 \times 10^{-15}$$

$$\xi_2 < 2.4 \times 10^{-7}$$

Naukowy Kapitał Entuzjazmu

Krajowy (Europejski) program na rzecz poprawienia konkurencyjności nauki polskiej (europejskiej) poprzez pełne wykorzystanie entuzjazmu naukowego, ambicji, dociekliwości i kreatywności ludzi młodych (przed uzyskaniem tytułu magistra)

*„szkic szkicu” projektu, Kraków, 20.09.2016
autor: Piotr Homola, IFJ PAN*

Mini-diagnoza przyczyn ograniczonej dynamiki wzrostu w polskiej nauce:

Młodzi, zdolni, ambitni ludzie zafascynowani nauką nie podążają scieżką kariery naukowej, tzn.

- 1) nie wybierają kierunków przyrodniczych;
- 2) nie kontynuują kariery naukowej po studiach;
- 3) rozoczynają / kontynuują karierę naukową zagranicą, bez planów powrotu

Niniejszy projekt dotyczy praktycznych rozwiązań w zakresie punktów 1) i 2) z perspektywami na zmiany odnośnie p. 3

I. Motto projektu (propozycja):

„Ścieżka Twojej kariery naukowej zaczyna się od postawienia pierwszego pytania bez odpowiedzi”

Sports analogy: enable opportunities to develop a scientific career early

Naukowy Kapitał Entuzjazmu: pilotage in Krakow

Cracow Incubator for Scientific Discoveries [Krakowski Inkubator Odkryć Naukowych]

Scientific Patrons (4):

IFJ PAN, UJ, POLITECHNIKA, AGH(?)

Supervisors (14): Ł. Bratek, N. Dhital, P. Homola, K. A. Kopański, K. Woźniak, B. Żabiński (all IFJ PAN), P. Warchał, J. Mielczarek (both UJ), D. Duraj, J. Jałocha-Bratek, S. Kubis, Z. Tabor (all Politechnika), K. Niedźwiedzki (?), M. Nocuń (?) (both AGH)

PhD students (3): K. Cheminant, O. Sushchov (both IFJ PAN), M. Michałek (Politechnika)

Students (8): M. Sułek, S. Stuglik, M. Czyżowski, R. Goryl, ..., ... (all Politechnika), M. Karpiel, P. Jagoda (both AGH)

Projects (4): CREDO-drones, CREDO-earthquakes, CREDO-array, CREDO-DUW

Sites (1): Complexity Garage (IF UJ)

Missing: Funding, business patrons, more sites (Garage at IFJ PAN?), more people, non-CREDO projects :)

Please join / help!