Support for citizen science within TA7

V. Tokareva, M.Kramer, P. Limaye

What and why?

Goals

- Actively engage the public in citizen science projects such as Einstein@Home
- Provide incentives and access to data infrastructure and methods to involve the public in ongoing research

Motivation for CitSci at PUNCH4NFDI

Development of Citizen Science projects aligns with the following aims of the consortium:

- **Enabling future PUNCH science.** In TA7 one aims to educate and train the future generation of researches, including citizen scientists from general public
- **Strengthening the implementation of the FAIR principles.** By popularisation of FAIR data management in society as a whole
- **Sharing PUNCH4NFDI expertise with the wider science community.** In regard to CitSci.

These goals are all embodied in the PUNCH4NFDI **objective to "Educate professionals and non-professionals in data science technologies"**.

Workforce WP7.4.

Michael Kramer,
MPIfR/Uni Bonn,
WP4.7 Lead,
WP5.2 Lead

Pranav Limaye,
MPIfR/Uni Bonn

Victoria Tokareva,
KIT,
WP4.2 Coordinator

Ramesh Karuppusamy,
MPIfR/Uni Bonn

Acknowledgements: Jacob Tremblay (MPIfR/Uni Bonn, Oct 2022 - Oct 2023), Andreas Haungs (KIT, spokesperson of PUNCH4NFDI in the NFDI Consortial Assembly), P. Jütte (Aug 2023), Katia Kornetzki (Jan 2024)

Deliverables

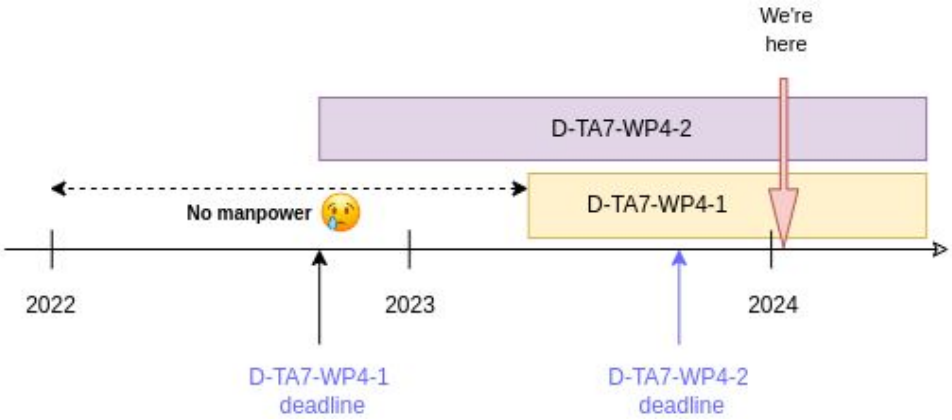
- D-TA7-WP4-1 (30 Sep 2022): Map out potential research applications in citizen science
- D-TA7-WP4-2 (30 Sep 2023): Prepare data sets and provide soft- and hardware infrastructure
- D-TA7-WP4-3 (30 Sep 2024): Pilot 6–12 month projects, engage schools and universities, evaluate results
- D-TA7-WP4-4 (30 Sep 2026): Launch further projects jointly with the physics community

Deliverables

Expectation:

- D-TA7-WP4-1 (30 Sep 2022): Map out potential research applications in citizen science
- D-TA7-WP4-2 (30 Sep 2023): Prepare data sets and provide soft- and hardware infrastructure
- D-TA7-WP4-3 (30 Sep 2024): Pilot 6–12 month projects, engage schools and universities, evaluate results
- D-TA7-WP4-4 (30 Sep 2026): Launch further projects jointly with the physics community

Reality:



Status for datasets and infrastructure

- Initial approach (by J.T.): Conversion of the Effelsberg old raw data to 'MBFITS' format for broader accessibility. This was found to be error-prone for a significant fraction of data files

- Conversion script has been upgraded:
  - Initial tests show successful conversions after script modifications
  - Ongoing checks to ensure errors from previous conversions are resolved

- Currently, the efforts are focusing on primary data conversion and management, as well as exploring opportunities enhance accessibility beyond the FITS format for easier visualization and interpretation by outsiders in Radio Astronomy

Future plans for datasets and infrastructure

- Significant portion of data expected to be converted into FITS by Q1/2024
- Discussions are planned with Effelsberg operator for optimal utilization of these data products for visualization and analysis by the wider community
- Further discussions are needed for concrete plans on data utilization and accessibility enhancements

Mapping out potential research applications

Pt. I: Review:

- Definitions - what is our subject?
- Environment - what does already exist?
- What do we know about our audience and their motivations?
- CitSci projects in PUNCH Sciences

Pt. II: Analysis:

- Data collection
- Data cleaning
- Analysis design and implementation: Criteria? What is popular? What brings results?

Pt. III: Results and discussion:

- What can we contribute?

What is Citizen Science?

Citizen science is a collaborative approach to scientific research in which members of the public, who may not have formal scientific training, actively participate in various stages of the scientific process.

Citizen science include:

- **Data Collection** (*CREDO*)
- **Data Analysis** (*Zooniverse - Galaxy Zoo, Name that neutrino, etc.; Kaggle - IceCube - Neutrinos in Deep Ice, Higgs Boson Machine Learning Challenge, etc.*)
- **Calculations** (*SETI@Home, Einstein@Home*)
- **Problem Solving and Innovation** (*Foldit*)
- **Public Engagement and Education** (*iNaturalist*)
- **Community-Based Research** (*Flint Water Study*)
- **Scientific Research and Discovery** (*Einsten@Home* - pulsar discoveries)

Citizen Science Landscape

Other national level organisations: Citizen Science Network Austria (CSNA), Australian Citizen Science Association (ACSA)

Audience of Citizen Science*

Method

- Projects with > 100k accounts
- Stat methods: Lorenz curves + Gini index
- Statistics:
  - SETI: cumulative
  - others: 30 days in Nov 2019
- Def. active users: >=1 task during 30 days in Jun 2021

General

- Projects: SETI@home + 9 largest on BOINC (Computing); Analyzing (Zooniverse, Foldit, Eyewire, EteRNA); eBird, iNaturalist (Sensing)
- Monthly active users, Jun 2021, total ~750k
- 52%-92% male (over the projects)
- In general Europe and US-centric
- Highly educated and rather young audience

*According to [1] Strasser BJ, Tancoigne E, Baudry J, Piguet S, Spiers H, Luis-Fernandez Marquez J, et al. (2023) Quantifying online citizen science: Dynamics and demographics of public participation in science. PLoS ONE 18(11): e0293289. https://doi.org/10.1371/journal.pone.0293289

[2] Füchslin, Tobias; Schäfer, Mike S; Metag, Julia (2019). Who wants to be a citizen scientist? Identifying the potential of citizen science and target segments in Switzerland. Public Understanding of Science, 28(6):652-668. DOI: https://doi.org/10.1177/0963662519852020

Audience of Citizen Science-1*

Computing

- Monthly audience, Jun 2021: 71k
- 10% contributing 71%
- > 60% are in the field of science or IT
- SETI - the biggest project: >14mio people total
- Demographics (SETI):
  - 90% male
  - med age 34
- BOINC: 15 PFLOPS/24h -> “comparable to fastest supercomputers” (Horeka: 17 PFLOPS - 15th in Europe)

Analyzing

- Monthly audience, Jun 2021: 23k
- 10% contributing 79%
- Gender: 68% male (Galaxy Zoo)
- Age :
  - projects, such as Galaxy Zoo - many school-age participants (35%)
  - Gamified projects (FoldIt): 65% of the participants are < 30 y.o. (median age =25)
- Occupation (FoldIt): 80% in science or IT
- Background (FoldIt): 90% in science or IT

Sensing

- Monthly audience, Jun 2021: 665k
- 10% contributing 69%
- Gender:
  - iNaturalist: 56% male
  - eBird: 51% male
- Highest participation (iNaturalist): Europe, USA and countries with rich biodiversity - Costa Rica, Panama, Taiwan, etc.
- Only biological projects

Data collection - in progress…

What? Data about existing CitSci projects within “PUNCH Sciences” (particle, astroparticle, astro-, nuclear physics and LQCD are under consideration)

Where?

- CSA, "Platforms for hosting participatory science projects" by CSA [24],
- Projects, recommended by ECSA [4]

What else?

- Kaggle competitions by PUNCH sciences’ communities
- Aggregated statistics from [1], Quantifying Online Citizen Science [5]

[3] Citizen Science Association (CSA). Platforms for hosting participatory science projects. https://participatorysciences.org/resources/platforms-for-hosting-participatory-science-projects/. Accessed: 2023-10-01

[4] European Citizen Science Platform, Project search: https://eu-citizen.science/projects?country=DE

[5] Strasser Group, Quantifying Online Citizen Science, https://doi.org/10.26037/yareta:lklrzxq3njdhhh4hdzt6nrwdz4

Data collection - in progress…

Step 1. List the platforms. Exclude unnecessary

Name	Projects in fund. physics	Link (to the project)	About project	About the platform
	Smartphone Astrophotography	https://www.anecdata.org/	Astrophotography. Collect smartphone photographs	
Anecdata	Night Sky Light Pollution	https://www.anecdata.org/	Astrophotography. Study light pollution by taking ph	https://www.anecdata.org/pages/about, Bar Harbor, Maine (USA)
	Hubble, constant at the speed of light	https://www.citsci.org/proj	No publ attention, no information, no data	International online platform, 1142 projects, but only ca 350 of them h
CitSci.Org	NF Sky Snorkel Survey	https://www.citsci.org/proj	No publ attention, no information, no data	
FieldScope	-			Scope: Geography, run by BSCS Science Learning (before by Nationa
GLOBE Observer	-			Scope: environment and changing climate. Very international project.
iNaturalist	-			Scope: Biodiversity
Zooniverse	19 Projects in "Physics", 27 in Space + archive			
SciStarter	100 projects in the categories "Astronomy+space" and "Phys	https://scistarter.org/finder?active=true&topic=13&topic=8		CS platform by Arizona State University (USA)
BOINC-based	7 phycics projects			
	Radio Galaxy Zoo: LOFAR		as well on BOINC and Zooniverse	
Bürger schaffen Wissen	Einstein@Home – Astrophysics for everyone		as well on BOINC and Zooniverse	
yoyo@home - computing platform for na	Muon	https://www.rechenkraft.n	The Muon project was founded in UK. Yoyo is a BOINC based platform itself	
EU-Citizen.Science	13 projects in "Astronomy and Space", 7 in "Physics"			

Data collection - in progress…

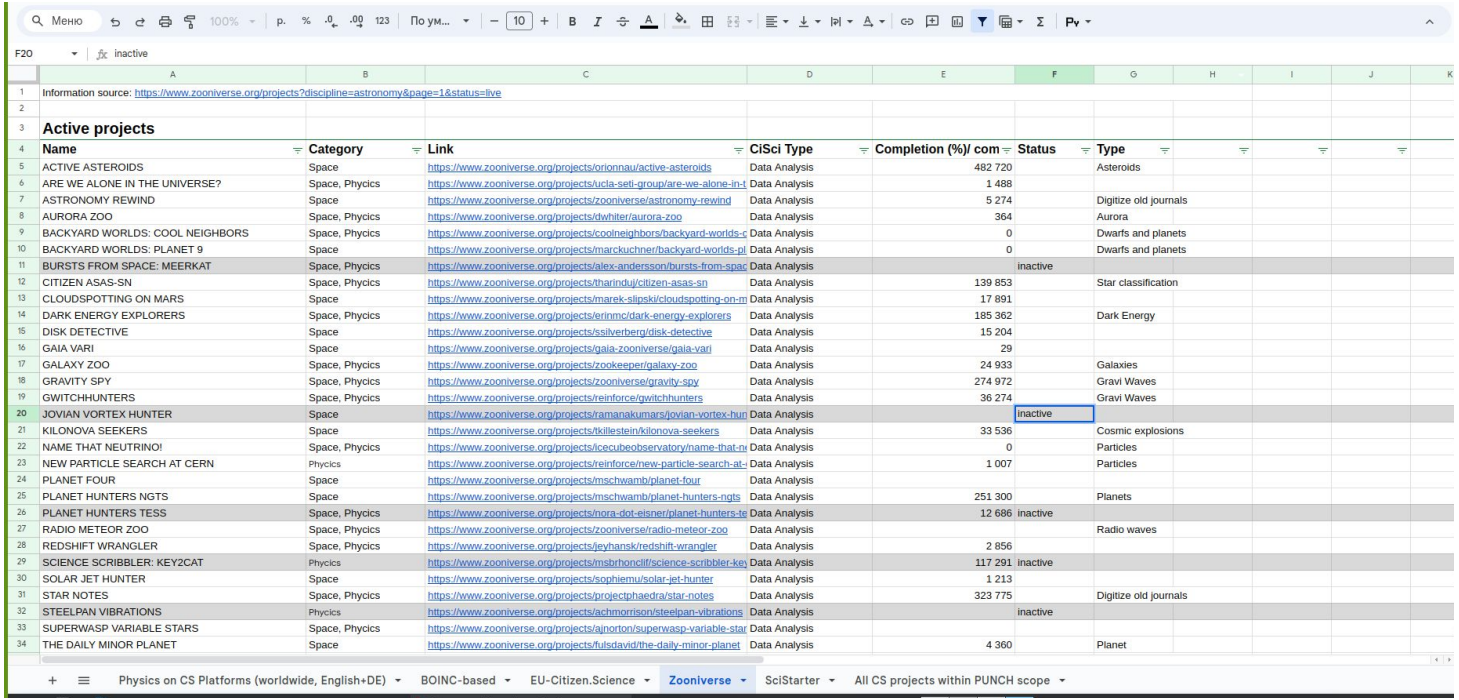
Step 2. Study CitSci projects on each platform. Exclude unnecessary. Collect more data about interesting ones

Eu-citizen.science:

	A	B	C	D	E	F	G	H	I	J
1										
2	**Name**	**Science Topics**	**Participation tasks**	**Difficulty**	**Link**	**Note**	**Ongoin**	**Data**	**Location**	Country/R
3	Radio Meteor Zoo	Astronomy & Space	Classification or tagging	Medium	https://eu-citizen.science/project/396, https://I	As well on Zooniverse	1	S, the Belgian RAdi	National	Belgium
4	OSDG Community platform	Citizen science project on Sustainable Development Goals					0			
5	CoAstro - @n Astronomy Condo	Astronomy & Space				Unclear description. Doesn't look like CS pr	0			
6	Identificación de asteroides cercanos a la T	Astronomy & Space, F	Classification or tagging		https://near.cab.inta-csic.es/main/index.php	Last updated in 2019	0		National	Spain
7	Cities at night	Environmental project					1			
8	Nixnox	Light Pollution							Global	
9	Street Spectra	Street lamps and their emi	Classification or tagging, Geolocation, Photogra		https://eu-citizen.science/project/317					
10	The Star-Spotting Experiment (Stjärnförsöket)	Light Pollution	Data Entry, Geolocation, Observation				0		Macro-regional	Europe
11	Proyecto #Servet	Astroparticle physics?	DIY hacking/making		https://eu-citizen.science/project/300	Balloon experiments. More outreach than citizen science			National	Spain
12	Asteroid Hunters	Astronomy & Space	Classification or tagging		https://cazasteroides.org/en/		0		National	Spain
13	REINFORCE				https://reinforceeu.eu/	A citizen-science initiative. In it's framework a pack c	1		Macro-regional	Europe
14	Dark Sky Meter	Light Pollution	Photography						Global	
15	Radio Galaxy Zoo: LOFAR	Astronomy & Space	Identification			As well on Zooniverse				
16	GenerationSolar	Ecology & Environment	Data Entry, Identification							Spain
17	Romania geomagnetic map	Geophysics							National	Romania
18	ScienceAtHome	Quantum physics	Playing games		https://www.scienceathome.org/quantum/games/	More educational/outreach				Denmark
19										

Data collection - in progress…

Zooniverse:



Меню | 100% | По ум… | 10 | F20 | inactive

Information source: https://www.zooniverse.org/projects?discipline=astronomy&page=1&status=live

Active projects

Name	Category	Link	CiSci Type	Completion (%)/ com	Status	Type
ACTIVE ASTEROIDS	Space	https://www.zooniverse.org/projects/orionnau/active-asteroids	Data Analysis	482 720		Asteroids
ARE WE ALONE IN THE UNIVERSE?	Space, Phycics	https://www.zooniverse.org/projects/ucla-seti-group/are-we-alone-in-t	Data Analysis	1 488		
ASTRONOMY REWIND	Space	https://www.zooniverse.org/projects/zooniverse/astronomy-rewind	Data Analysis	5 274		Digitize old journals
AURORA ZOO	Space, Phycics	https://www.zooniverse.org/projects/dwhiter/aurora-zoo	Data Analysis	364		Aurora
BACKYARD WORLDS: COOL NEIGHBORS	Space, Phycics	https://www.zooniverse.org/projects/coolneighbors/backyard-worlds-c	Data Analysis	0		Dwarfs and planets
BACKYARD WORLDS: PLANET 9	Space	https://www.zooniverse.org/projects/marckuchner/backyard-worlds-pl	Data Analysis	0		Dwarfs and planets
BURSTS FROM SPACE: MEERKAT	Space, Phycics	https://www.zooniverse.org/projects/alex-andersson/bursts-from-spac	Data Analysis		inactive	
CITIZEN ASAS-SN	Space, Phycics	https://www.zooniverse.org/projects/tharinduj/citizen-asas-sn	Data Analysis	139 853		Star classification
CLOUDSPOTTING ON MARS	Space	https://www.zooniverse.org/projects/marek-slipski/cloudspotting-on-m	Data Analysis	17 891		
DARK ENERGY EXPLORERS	Space, Phycics	https://www.zooniverse.org/projects/erinmc/dark-energy-explorers	Data Analysis	185 362		Dark Energy
DISK DETECTIVE	Space	https://www.zooniverse.org/projects/ssilverberg/disk-detective	Data Analysis	15 204		
GAIA VARI	Space	https://www.zooniverse.org/projects/gaia-zooniverse/gaia-vari	Data Analysis	29		
GALAXY ZOO	Space, Phycics	https://www.zooniverse.org/projects/zookeeper/galaxy-zoo	Data Analysis	24 933		Galaxies
GRAVITY SPY	Space, Phycics	https://www.zooniverse.org/projects/zooniverse/gravity-spy	Data Analysis	274 972		Gravi Waves
GWITCHHUNTERS	Space, Phycics	https://www.zooniverse.org/projects/reinforce/gwitchhunters	Data Analysis	36 274		Gravi Waves
JOVIAN VORTEX HUNTER	Space	https://www.zooniverse.org/projects/ramanakumars/jovian-vortex-hun	Data Analysis		inactive	
KILONOVA SEEKERS	Space	https://www.zooniverse.org/projects/tkillestein/kilonova-seekers	Data Analysis	33 536		Cosmic explosions
NAME THAT NEUTRINO!	Space, Phycics	https://www.zooniverse.org/projects/icecubeobservatory/name-that-ne	Data Analysis	0		Particles
NEW PARTICLE SEARCH AT CERN	Phycics	https://www.zooniverse.org/projects/reinforce/new-particle-search-at-c	Data Analysis	1 007		Particles
PLANET FOUR	Space	https://www.zooniverse.org/projects/mschwamb/planet-four	Data Analysis			
PLANET HUNTERS NGTS	Space	https://www.zooniverse.org/projects/mschwamb/planet-hunters-ngts	Data Analysis	251 300		Planets
PLANET HUNTERS TESS	Space, Phycics	https://www.zooniverse.org/projects/nora-dot-eisner/planet-hunters-te	Data Analysis	12 686	inactive	
RADIO METEOR ZOO	Space, Phycics	https://www.zooniverse.org/projects/zooniverse/radio-meteor-zoo	Data Analysis			Radio waves
REDSHIFT WRANGLER	Space, Phycics	https://www.zooniverse.org/projects/jeyhansk/redshift-wrangler	Data Analysis	2 856		
SCIENCE SCRIBBLER: KEY2CAT	Phycics	https://www.zooniverse.org/projects/msbrhonclif/science-scribbler-key	Data Analysis	117 291	inactive	
SOLAR JET HUNTER	Space	https://www.zooniverse.org/projects/sophiemu/solar-jet-hunter	Data Analysis	1 213		
STAR NOTES	Space, Phycics	https://www.zooniverse.org/projects/projectphaedra/star-notes	Data Analysis	323 775		Digitize old journals
STEELPAN VIBRATIONS	Phycics	https://www.zooniverse.org/projects/achmorrison/steelpan-vibrations	Data Analysis		inactive	
SUPERWASP VARIABLE STARS	Space, Phycics	https://www.zooniverse.org/projects/ajnorton/superwasp-variable-star	Data Analysis			
THE DAILY MINOR PLANET	Space	https://www.zooniverse.org/projects/fulsdavid/the-daily-minor-planet	Data Analysis	4 360		Planet

Physics on CS Platforms (worldwide, English+DE) | BOINC-based | EU-Citizen.Science | Zooniverse | SciStarter | All CS projects within PUNCH scope

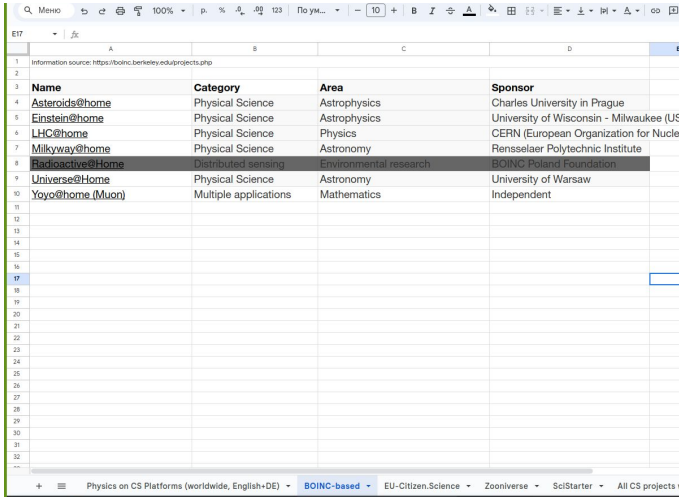
Data collection - in progress…

SciStarter:

A1:E1 | Information source: https://scistarter.org/finder?active=false&topic=13&topic=8

	A	B	C	D	E
1	Information source: https://scistarter.org/finder?active=false&topic=13&topic=8				
2					
3	**Name**	**Scope/ Category**	**Link**	**CiSci Type**	**Completion**
4		Astronomy & Space, Physics			
5	Citizen CATE 2024 (Citizen Continental-America Telescopic Eclipse 2(	Astronomy & Space, Physics	https://eclipse.boulder.swri.edu/citize	Observation	
6	Solar Max International Eclipse Project	Astronomy & Space, Physics	https://scistarter.org/solar-max	Observation	
7	Solar Jet Hunter SciStarter Affiliate badge	Astronomy & Space, Physics			
8	Globe at Night SciStarter Affiliate badge	Astronomy & Space, Physics			
9	DEB Initiative (Dynamic Eclipse Broadcast Initiative)	Astronomy & Space, Physics			
10	Eclipse Soundscapes: Data Collector SciStarter Affiliate badge	Astronomy & Space, Physics			
11	Eclipse Soundscapes: Observer SciStarter Affiliate badge	Astronomy & Space, Physics			
12	Eclipse Megamovie	Astronomy & Space, Physics			
13	SunSketcher	Astronomy & Space, Physics			
14	The Sungrazer Project	Astronomy & Space, Physics			
15	Planet Hunters TESS	Astronomy & Space, Physics			
16	Disk Detective SciStarter Affiliate badge	Astronomy & Space, Physics			
17	Radio JOVE	Astronomy & Space, Physics	https://radiojove.gsfc.nasa.gov/		
18	Redshift Wrangler	Astronomy & Space, Physics			
19	The Daily Minor Planet	Astronomy & Space, Physics			
20	Air Quality Citizen Science	Air Quality			
21	Do-It-Yourself Relativity Test	Astronomy & Space, Physics	https://scistarter.org/do-it-yourself-relativity-test		
22	Dark Energy Explorers SciStarter Affiliate badge	Astronomy & Space, Physics			
23	Aurorasaurus	Astronomy & Space, Physics			
24	Backyard Worlds: Cool Neighbors SciStarter Affiliate badge	Astronomy & Space, Physics			
25	Chesapeake Water Watch (CWW)	Astronomy & Space, Physics			
26	Are we alone in the universe?	Astronomy & Space, Physics			
27	Dark Sky Meter	Astronomy & Space, Physics			
28	Heliophysics Audified: Resonances in Plasmas (HARP)	Astronomy & Space, Physics			
29	Jovian Vortex Hunter	Astronomy & Space, Physics			
30	NASA-JPL/Caltech	Astronomy & Space, Physics			
31	Exoplanet Watch	Astronomy & Space, Physics			
32	Journey North	Astronomy & Space, Physics			
33	JunoCam	Astronomy & Space, Physics			
34	Eclipse Ballooning Project	Astronomy & Space, Physics			
35					

BOINC:



E17 | Information source: https://boinc.berkeley.edu/projects.php

	A	B	C	D
3	**Name**	**Category**	**Area**	**Sponsor**
4	Asteroids@home	Physical Science	Astrophysics	Charles University in Prague
5	Einstein@home	Physical Science	Astrophysics	University of Wisconsin - Milwaukee (US
6	LHC@home	Physical Science	Physics	CERN (European Organization for Nucle
7	Milkyway@home	Physical Science	Astronomy	Rensselaer Polytechnic Institute
8	Radioactive@Home	Distributed sensing	Environmental research	BOINC Poland Foundation
9	Universe@Home	Physical Science	Astronomy	University of Warsaw
10	Yoyo@home (Muon)	Multiple applications	Mathematics	Independent

Physics on CS Platforms (worldwide, English+DE) | BOINC-based | EU-Citizen.Science | Zooniverse | SciStarter | All CS projects

What's next?

- Collect more data
- Find similarities for popular projects
- Find, what is missing for projects in data-intensive physics
- Define other data insights
- Review motivation and involvement component in CitSci projects

=> Define recommendations for development CitSci projects in PUNCH Sciences

In progress:

Agreement with AEI - Hannover on Citizen Science project using MeerKAT data set of globular clusters (as part of **D-TA7-WP4-4**). Collaboration with TA 5

Upcoming:

V. Tokareva, M. Kramer, A. Haungs, R. Karuppusamy, "Citizen Science in Data-Intensive Physics: PUNCH4NFDI Perspective", talk at DPG Spring Meeting - 2024, Karlsruhe, 8.03.24.

Thank you for your attention!

Victoria Tokareva (KIT) victoria.tokareva@kit.edu