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CERN

African School of Physics 2024 (ASP2024)
2024-07-12, Marrakech, Morocco

https://doi.org/10.5281/zenodo.12727018

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Physics Letters B 716 (2012) 1–29

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Observation of a new particle in the search for the Standard Model Higgs boson with the ATLAS detector at the LHC ☆

ATLAS Collaboration *

This paper is dedicated to the memory of our ATLAS colleagues who did not live to see the full impact and significance of their contributions to the experiment.

ARTICLE INFO

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Received 31 July 2012
Received in revised form 8 August 2012
Accepted 11 August 2012
Available online 14 August 2012
Editor: W.-D. Schlatter

ABSTRACT

A search for the Standard Model Higgs boson in proton–proton collisions with the ATLAS detector at the LHC is presented. The datasets used correspond to integrated luminosities of approximately 4.8 fb^{-1} collected at $\sqrt{s} = 7$ TeV in 2011 and 5.8 fb^{-1} at $\sqrt{s} = 8$ TeV in 2012. Individual searches in the channels $H \to ZZ^{(*)} \to 4\ell$, $H \to \gamma\gamma$ and $H \to WW^{(*)} \to e\nu\mu\nu$ in the 8 TeV data are combined with previously published results of searches for $H \to ZZ^{(*)}$, $WW^{(*)}$, $b\bar{b}$ and $\tau^+\tau^-$ in the 7 TeV data and results from improved analyses of the $H \to ZZ^{(*)} \to 4\ell$ and $H \to \gamma\gamma$ channels in the 7 TeV data. Clear evidence for the production of a neutral boson with a measured mass of 126.0 ± 0.4 (stat) ± 0.4 (sys) GeV is presented. This observation, which has a significance of 5.9 standard deviations, corresponding to a background fluctuation probability of 1.7×10^{-9}, is compatible with the production and decay of the Standard Model Higgs boson.

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1. Introduction

The Standard Model (SM) of particle physics [1–4] has been tested by many experiments over the last four decades and has been shown to successfully describe high energy particle interactions. However, the mechanism that breaks electroweak symmetry in the SM has not been verified experimentally. This mechanism [5–10], which gives mass to massive elementary particles, implies the existence of a scalar particle, the SM Higgs boson. The search for the Higgs boson, the only elementary particle in the SM that has not yet been observed, is one of the highlights of the Large Hadron Collider [11] (LHC) physics programme.

Indirect limits on the SM Higgs boson mass of $m_H < 158$ GeV at 95% confidence level (CL) have been set using global fits to precision electroweak results [12]. Direct searches at LEP [13], the Tevatron [14–16] and the LHC [17,18] have previously excluded, at 95% CL, a SM Higgs boson with mass below 600 GeV, apart from some mass regions between 116 GeV and 127 GeV.

Both the ATLAS and CMS Collaborations reported excesses of events in their 2011 datasets of proton–proton (pp) collisions at centre-of-mass energy $\sqrt{s} = 7$ TeV at the LHC, which were compatible with SM Higgs boson production and decay in the mass region 124–126 GeV, with significances of 2.9 and 3.1 standard deviations (σ), respectively [17,18]. The CDF and DØ experiments at the Tevatron have also recently reported a broad excess in the mass region 120–135 GeV; using the existing LHC constraints, the observed local significances for $m_H = 125$ GeV are 2.7σ for CDF [14], 1.1σ for DØ [15] and 2.8σ for their combination [16].

The previous ATLAS searches in 4.6–4.8 fb^{-1} of data at $\sqrt{s} =$ 7 TeV are combined here with new searches for $H \to ZZ^{(*)} \to 4\ell$,[1] $H \to \gamma\gamma$ and $H \to WW^{(*)} \to e\nu\mu\nu$ in the 5.8–5.9 fb^{-1} of pp collision data taken at $\sqrt{s} = 8$ TeV between April and June 2012.

The data were recorded with instantaneous luminosities up to 6.8×10^{33} $cm^{-2}s^{-1}$; they are therefore affected by multiple pp collisions occurring in the same or neighbouring bunch crossings (pile-up). In the 7 TeV data, the average number of interactions per bunch crossing was approximately 10; the average increased to approximately 20 in the 8 TeV data. The reconstruction, identification and isolation criteria used for electrons and photons in the 8 TeV data are improved, making the $H \to ZZ^{(*)} \to 4\ell$ and $H \to \gamma\gamma$ searches more robust against the increased pile-up. These analyses were re-optimised with simulation and frozen before looking at the 8 TeV data.

In the $H \to WW^{(*)} \to \ell\nu\ell\nu$ channel, the increased pile-up deteriorates the event missing transverse momentum, E_T^{miss}, resolution, which results in significantly larger Drell–Yan background in the same-flavour final states. Since the $e\mu$ channel provides most of the sensitivity of the search, only this final state is used in the analysis of the 8 TeV data. The kinematic region in which a SM Higgs boson with a mass between 110 GeV and 140 GeV is

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[1] The symbol ℓ stands for electron or muon.

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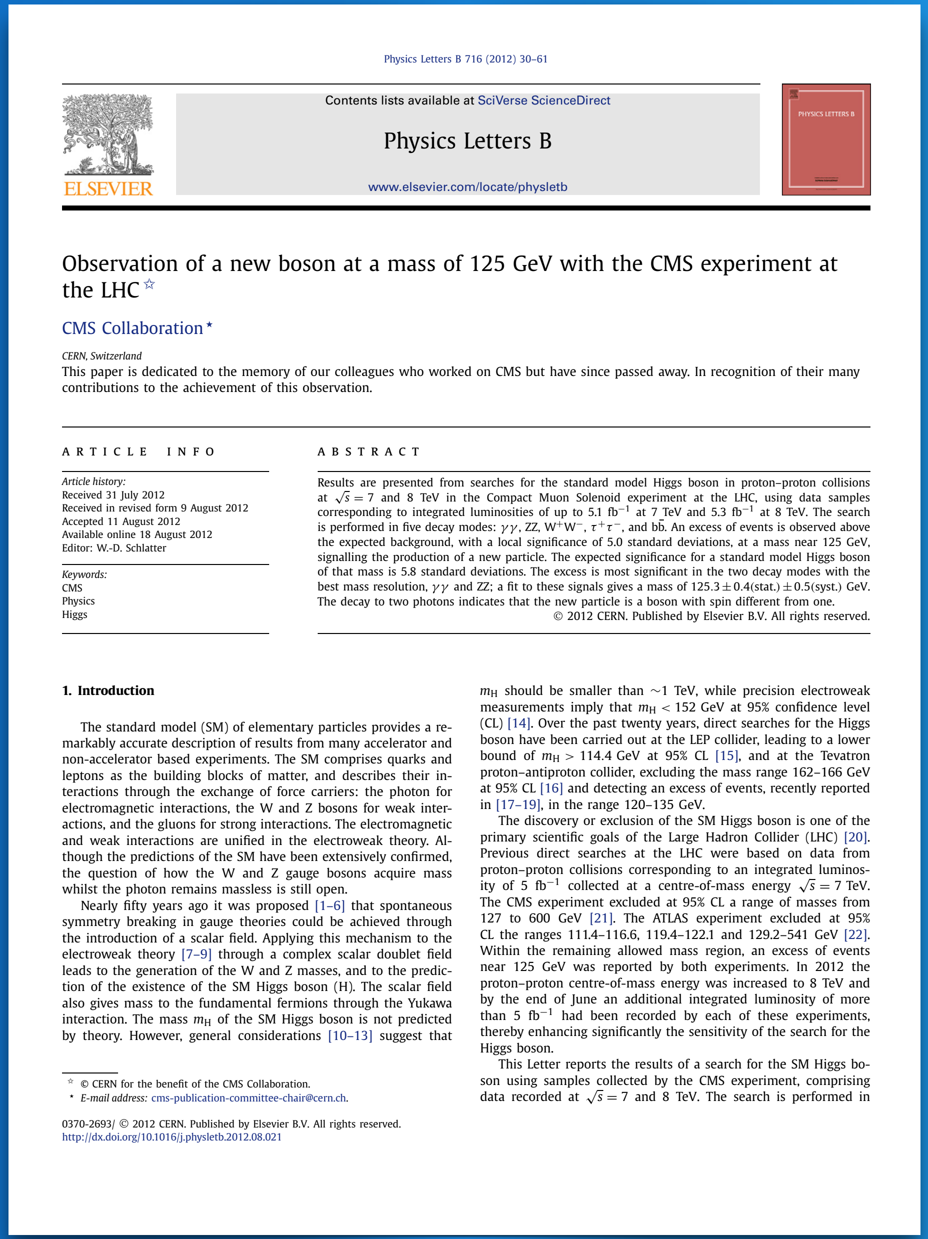

Physics Letters B 716 (2012) 30–61

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Physics Letters B

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Observation of a new boson at a mass of 125 GeV with the CMS experiment at the LHC ☆

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ABSTRACT

Results are presented from searches for the standard model Higgs boson in proton–proton collisions at $\sqrt{s} = 7$ and 8 TeV in the Compact Muon Solenoid experiment at the LHC, using data samples corresponding to integrated luminosities of up to 5.1 fb^{-1} at 7 TeV and 5.3 fb^{-1} at 8 TeV. The search is performed in five decay modes: $\gamma\gamma$, ZZ, W^+W^-, $\tau^+\tau^-$, and $b\bar{b}$. An excess of events is observed above the expected background, with a local significance of 5.0 standard deviations, at a mass near 125 GeV, signalling the production of a new particle. The expected significance for a standard model Higgs boson of that mass is 5.8 standard deviations. The excess is most significant in the two decay modes with the best mass resolution, $\gamma\gamma$ and ZZ; a fit to these signals gives a mass of 125.3 ± 0.4(stat.) ± 0.5(syst.) GeV. The decay to two photons indicates that the new particle is a boson with spin different from one.

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1. Introduction

The standard model (SM) of elementary particles provides a remarkably accurate description of results from many accelerator and non-accelerator based experiments. The SM comprises quarks and leptons as the building blocks of matter, and describes their interactions through the exchange of force carriers: the photon for electromagnetic interactions, the W and Z bosons for weak interactions, and the gluons for strong interactions. The electromagnetic and weak interactions are unified in the electroweak theory. Although the predictions of the SM have been extensively confirmed, the question of how the W and Z gauge bosons acquire mass whilst the photon remains massless is still open.

Nearly fifty years ago it was proposed [1–6] that spontaneous symmetry breaking in gauge theories could be achieved through the introduction of a scalar field. Applying this mechanism to the electroweak theory [7–9] through a complex scalar doublet field leads to the generation of the W and Z masses, and to the prediction of the existence of the SM Higgs boson (H). The scalar field also gives mass to the fundamental fermions through the Yukawa interaction. The mass m_H of the SM Higgs boson is not predicted by theory. However, general considerations [10–13] suggest that m_H should be smaller than ~1 TeV, while precision electroweak measurements imply that $m_H < 152$ GeV at 95% confidence level (CL) [14]. Over the past twenty years, direct searches for the Higgs boson have been carried out at the LEP collider, leading to a lower bound of $m_H > 114.4$ GeV at 95% CL [15], and at the Tevatron proton–antiproton collider, excluding the mass range 162–166 GeV at 95% CL [16] and detecting an excess of events, recently reported in [17–19], in the range 120–135 GeV.

The discovery or exclusion of the SM Higgs boson is one of the primary scientific goals of the Large Hadron Collider (LHC) [20]. Previous direct searches at the LHC were based on data from proton–proton collisions corresponding to an integrated luminosity of 5 fb^{-1} collected at a centre-of-mass energy $\sqrt{s} = 7$ TeV. The CMS experiment excluded at 95% CL a range of masses from 127 to 600 GeV [21]. The ATLAS experiment excluded at 95% CL the ranges 111.4–116.6, 119.4–122.1 and 129.2–541 GeV [22]. Within the remaining allowed mass region, an excess of events near 125 GeV was reported by both experiments. In 2012 the proton–proton centre-of-mass energy was increased to 8 TeV and by the end of June an additional integrated luminosity of more than 5 fb^{-1} had been recorded by each of these experiments, thereby enhancing significantly the sensitivity of the search for the Higgs boson.

This Letter reports the results of a search for the SM Higgs boson using samples collected by the CMS experiment, comprising data recorded at $\sqrt{s} = 7$ and 8 TeV. The search is performed in

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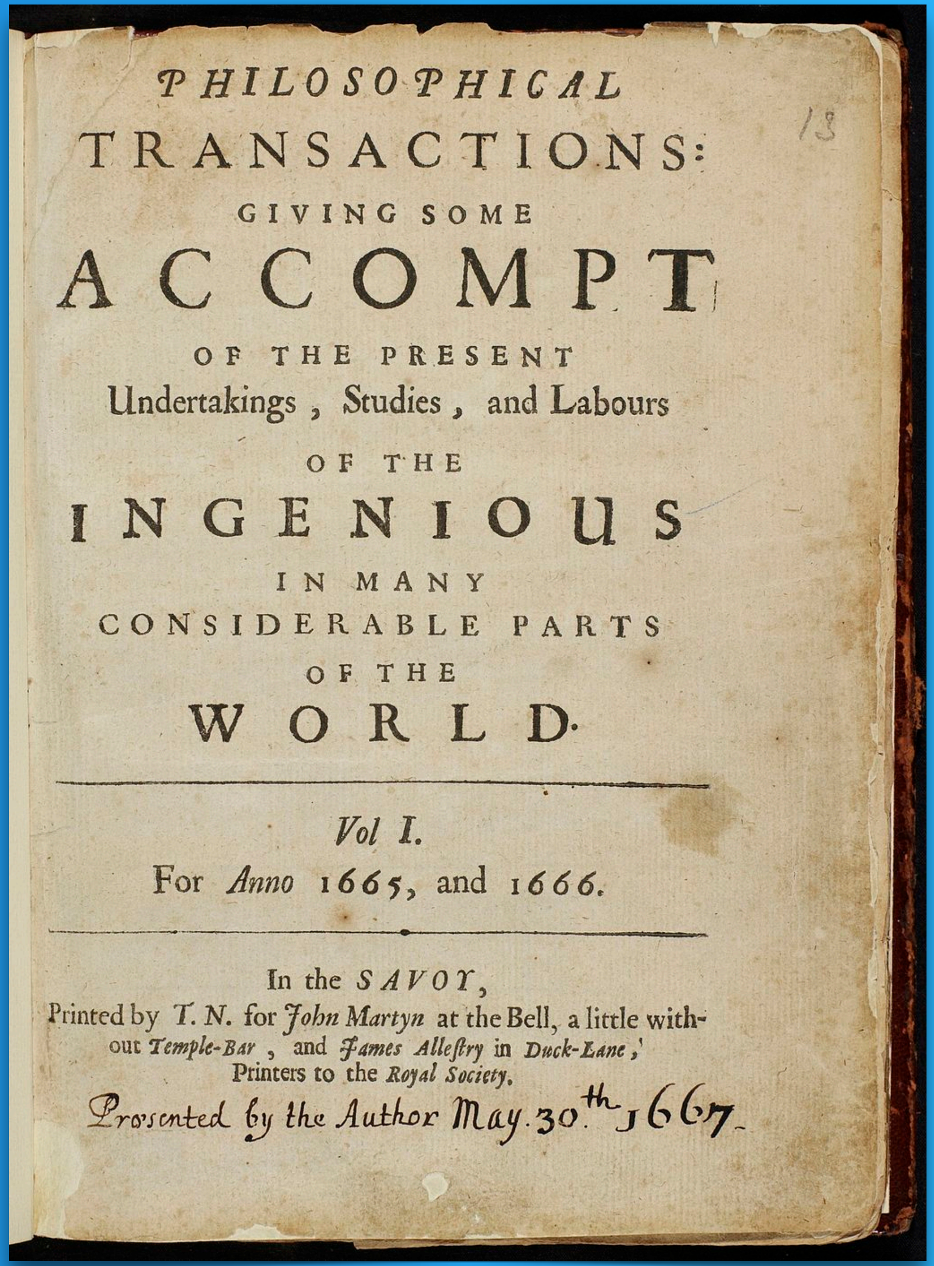

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Presented by the Author May 30th 1667

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*Michael Nielsen

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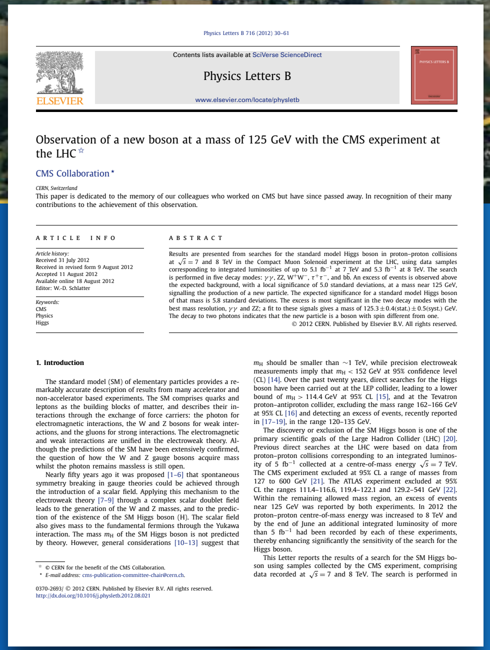
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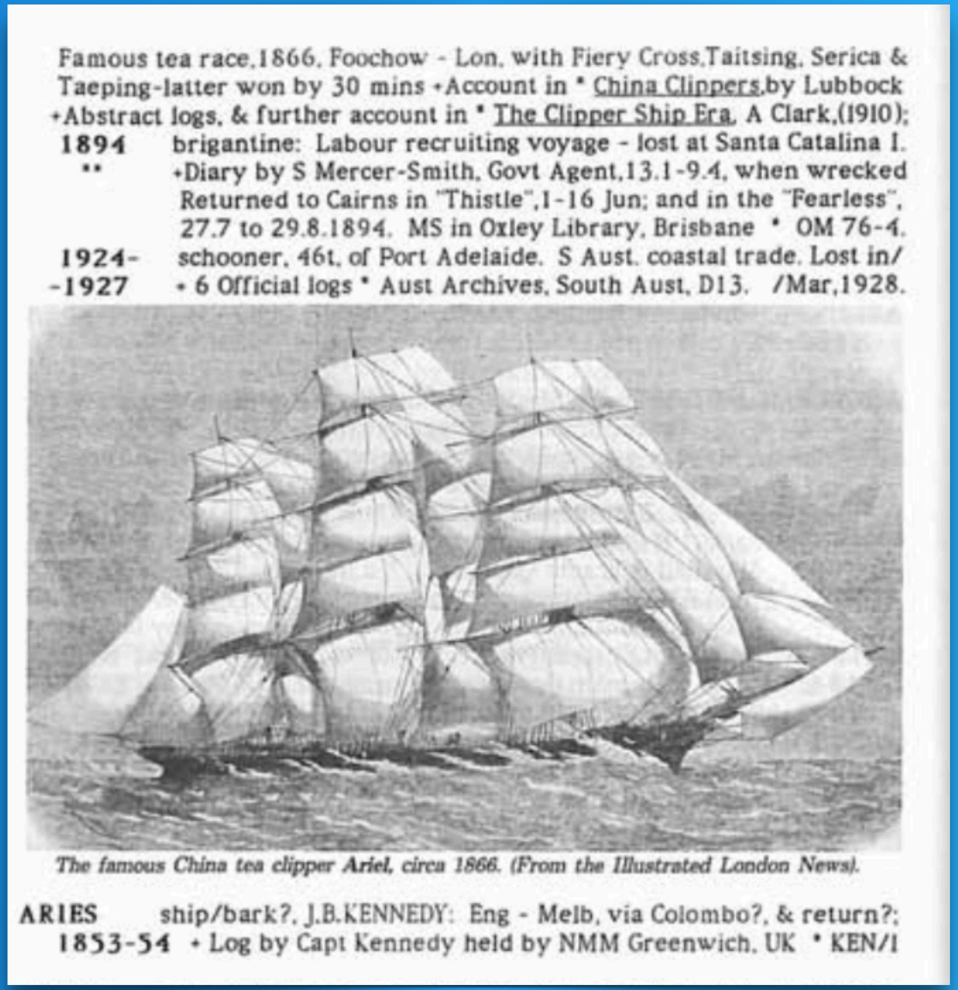
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1894 brigantine: Labour recruiting voyage - lost at Santa Catalina I.
" +Diary by S Mercer-Smith, Govt Agent,13.1-9.4, when wrecked Returned to Cairns in "Thistle",1-16 Jun; and in the "Fearless", 27.7 to 29.8.1894. MS in Oxley Library, Brisbane * OM 76-4.

1924- -1927 schooner, 46t, of Port Adelaide. S Aust. coastal trade. Lost in/ + 6 Official logs * Aust Archives, South Aust, D13. /Mar,1928.

The famous China tea clipper Ariel, circa 1866. (From the Illustrated London News).

ARIES 1853-54 ship/bark?, J.B.KENNEDY: Eng - Melb, via Colombo?, & return?; + Log by Capt Kennedy held by NMM Greenwich, UK * KEN/1

Ships logs from 18th century used for climate research

Source: University of Sunderland. "18th Century Ships' Logs Predict Future Weather Forecast." ScienceDaily. ScienceDaily, 6 October 2009. <www.sciencedaily.com/releases/2009/10/091006104627.htm>

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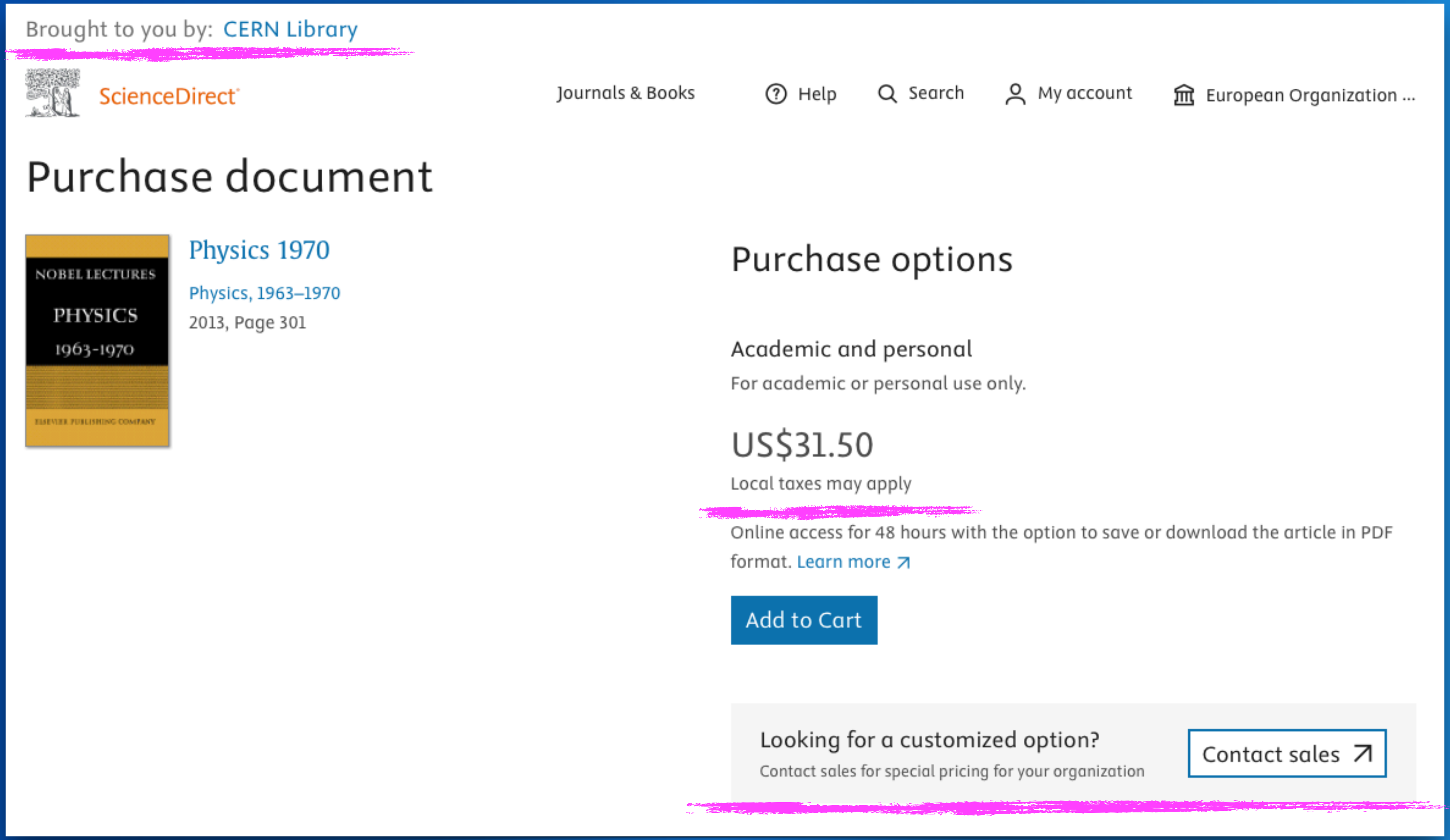

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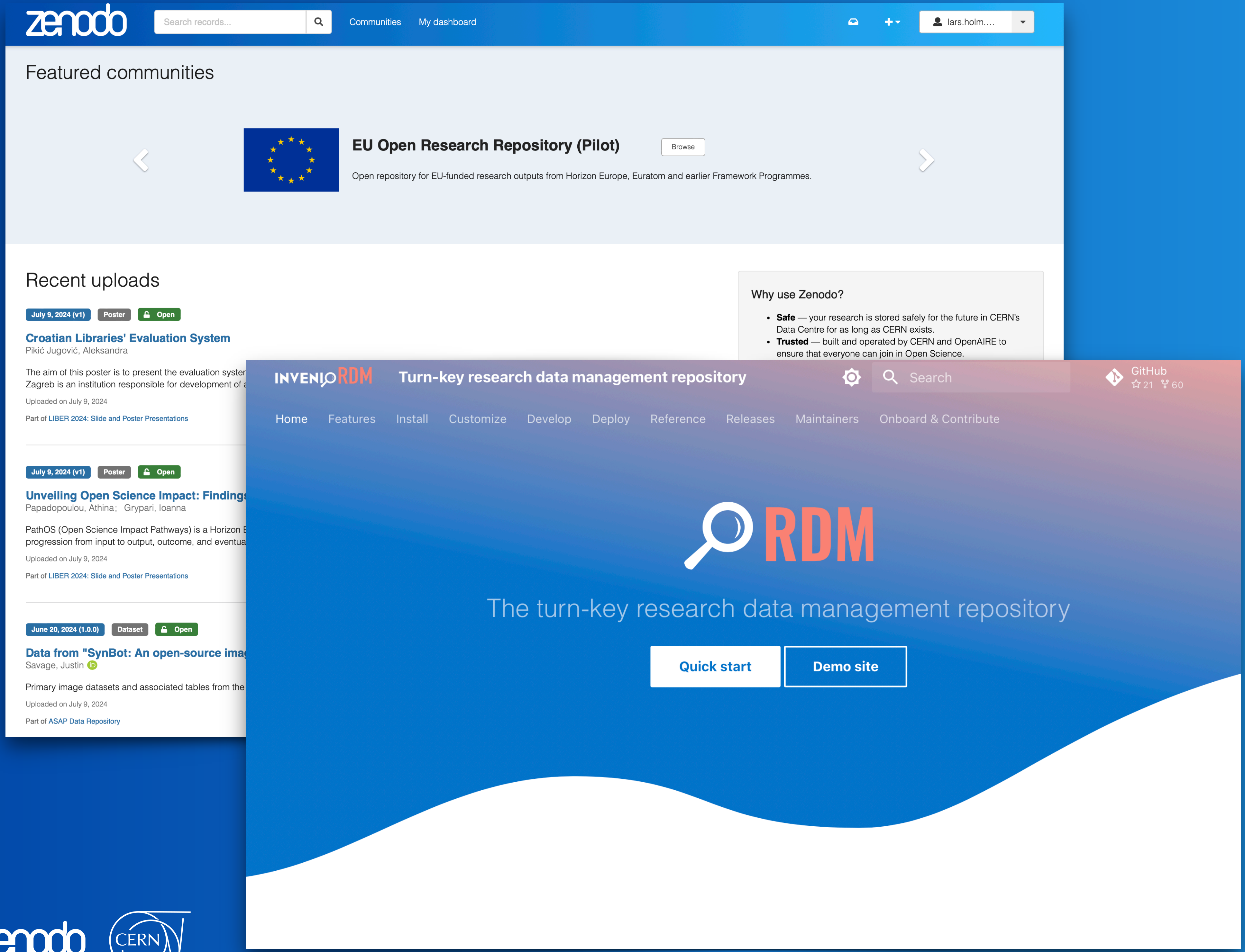
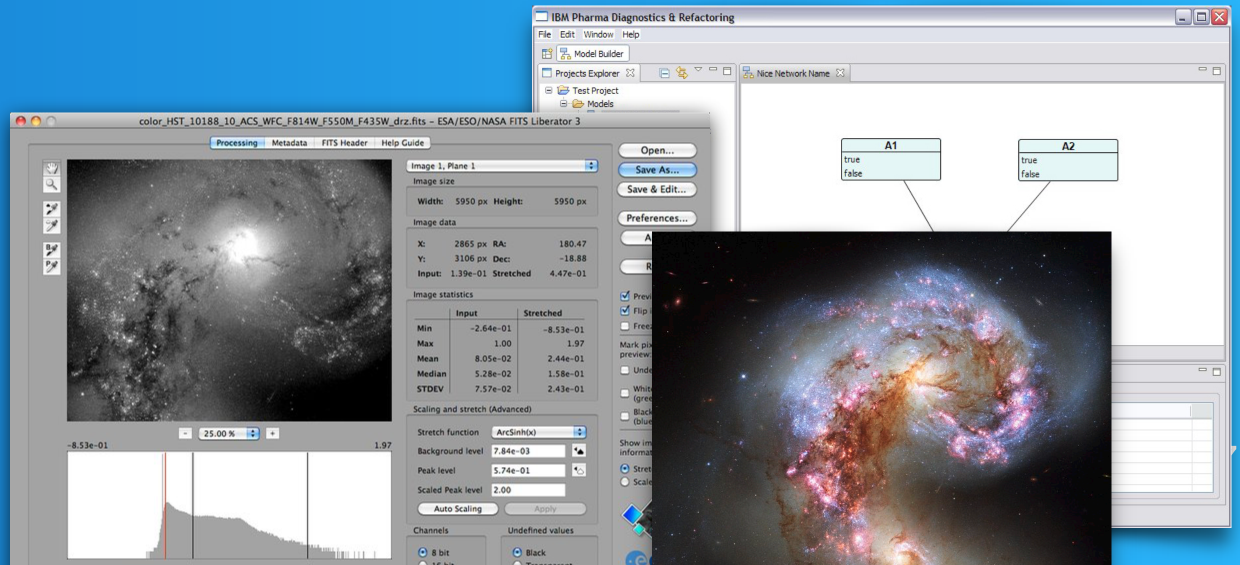


- 25 years building tools for researchers
- 12 years @ CERN Head of Open Science Repositories
- Software engineer



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Open Science is a critical accelerator for the achievement of the UN Sustainable Development Goals

UNESCO

Overview

Publications

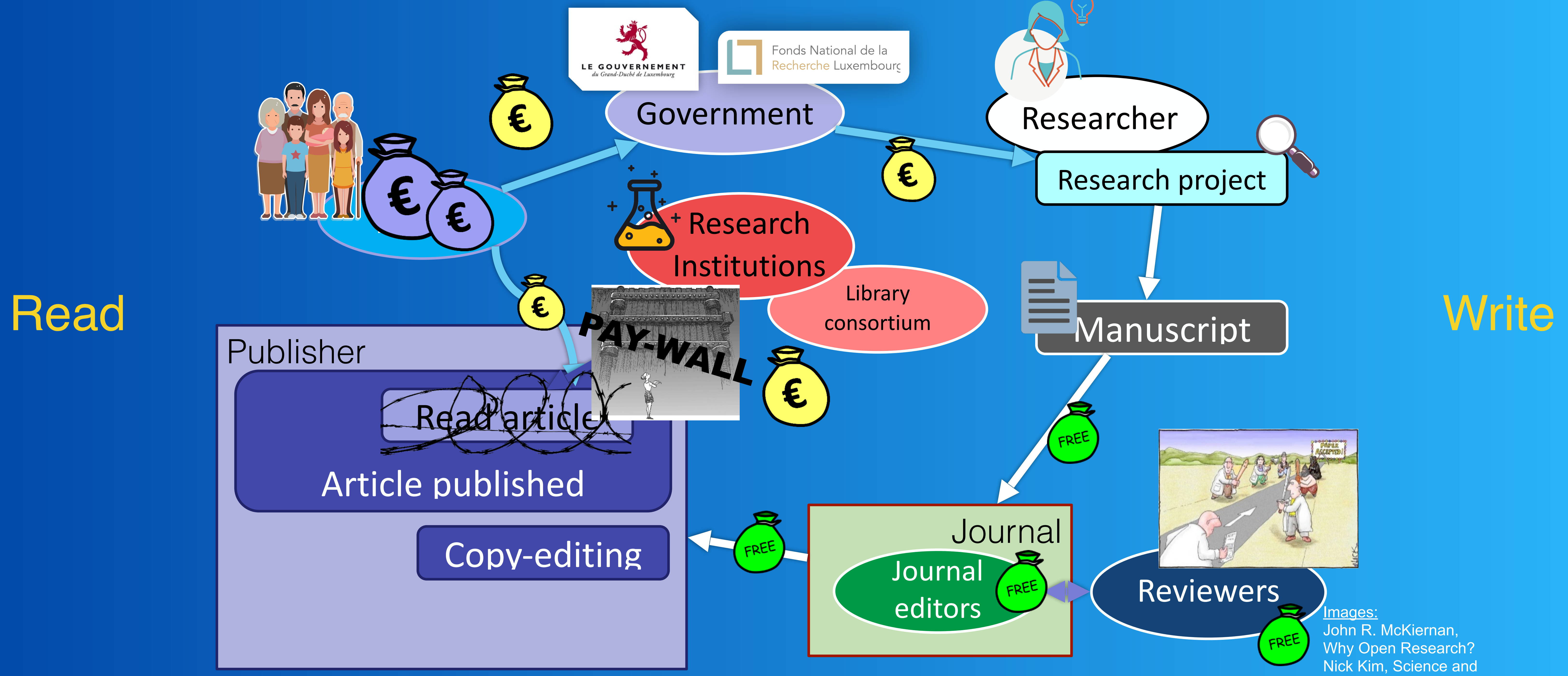
- Scientific publishing
- Copyright / licensing
- Open access
- Publishing pitfalls
- Information sources

Data / Software / …

- Open data case studies
- FAIR Principles
- Persistent identifiers & metadata
- Data publishing 101

Scientific publishing, copyright & licensing

Publishing and double dipping



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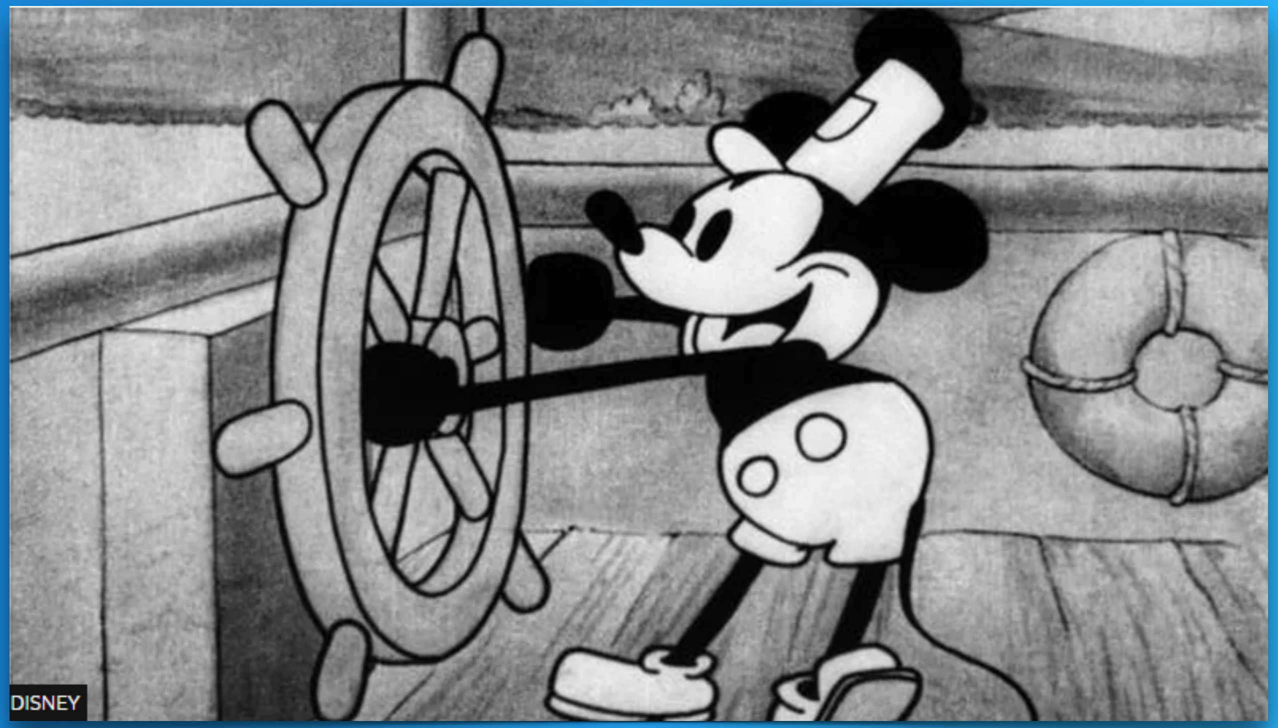

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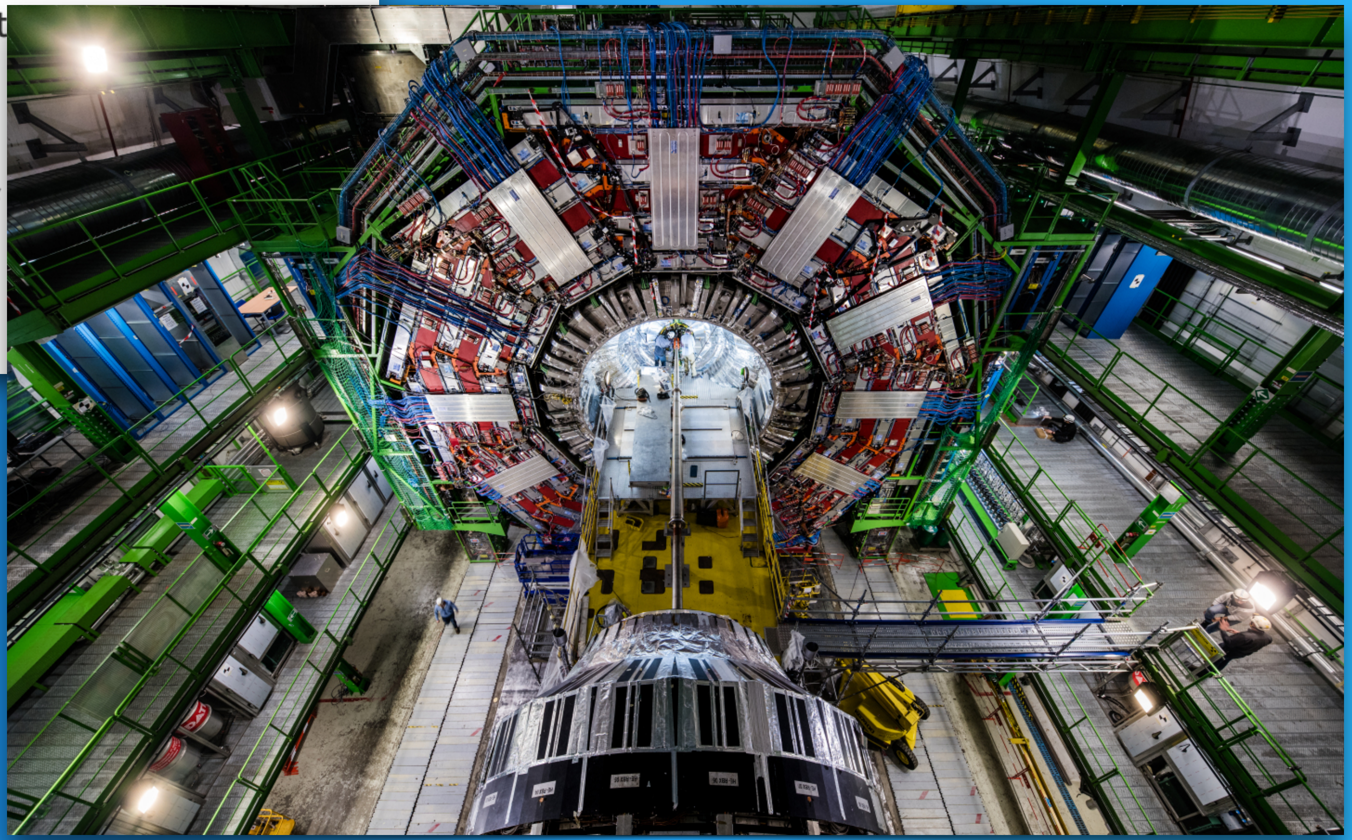

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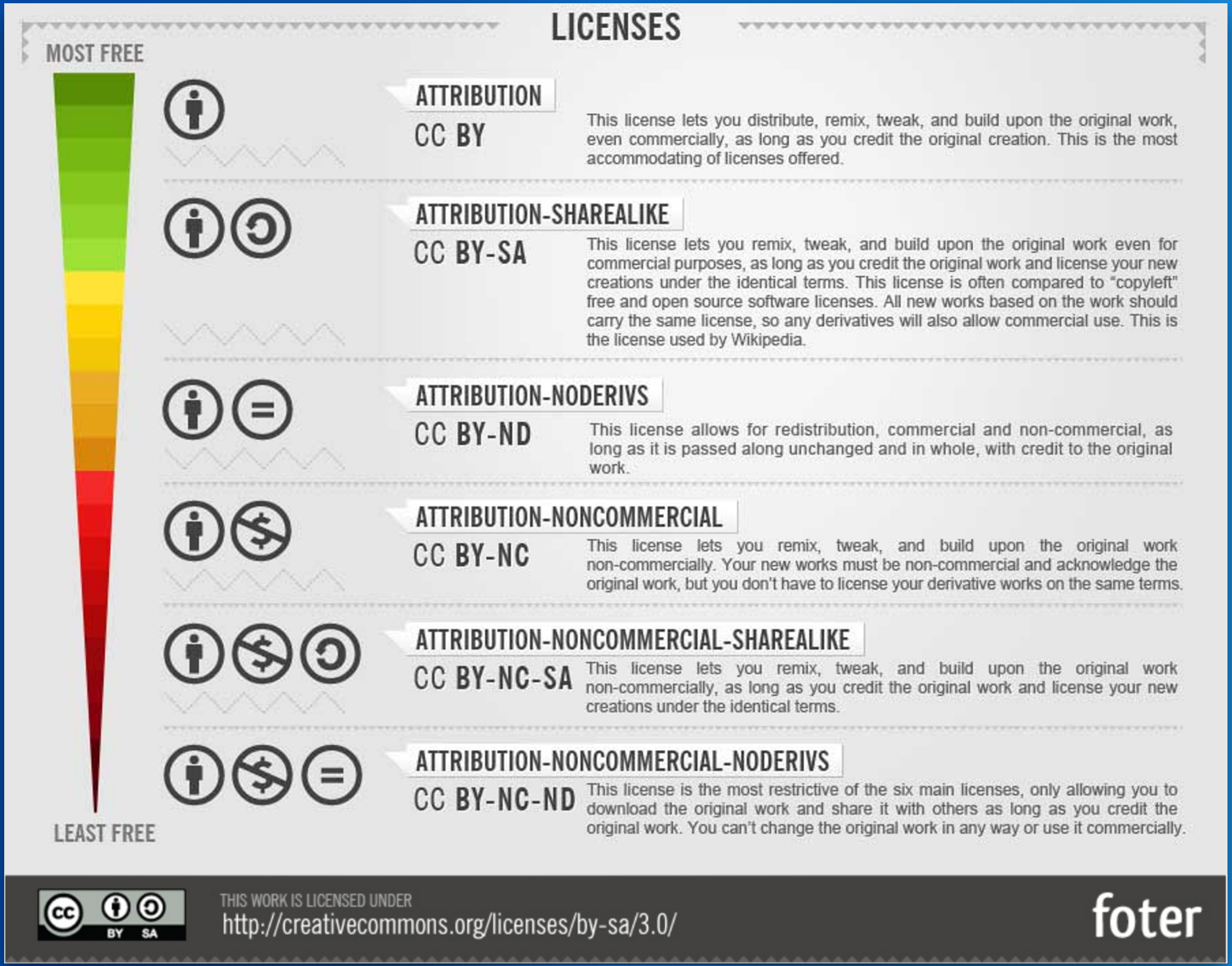

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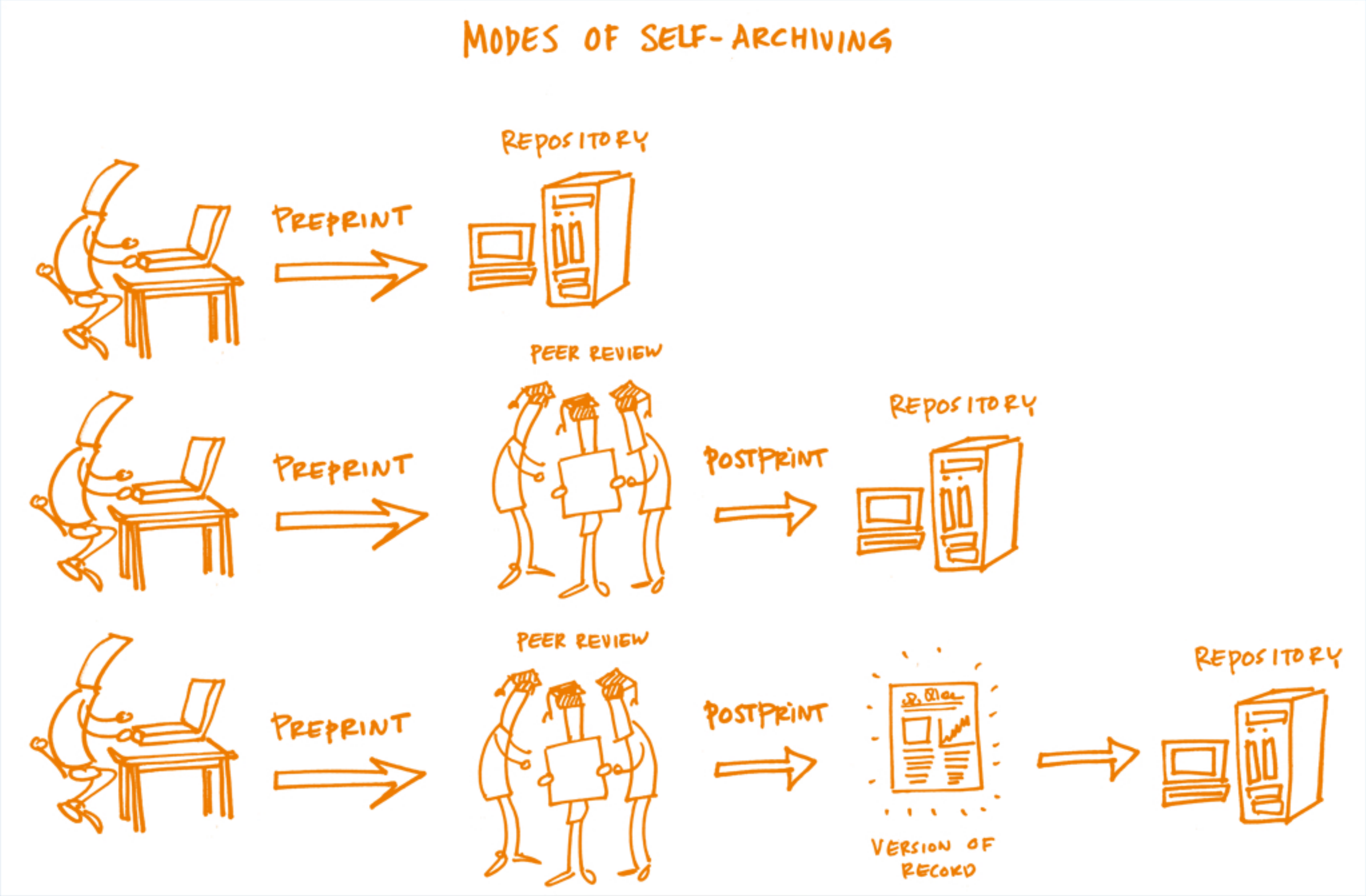

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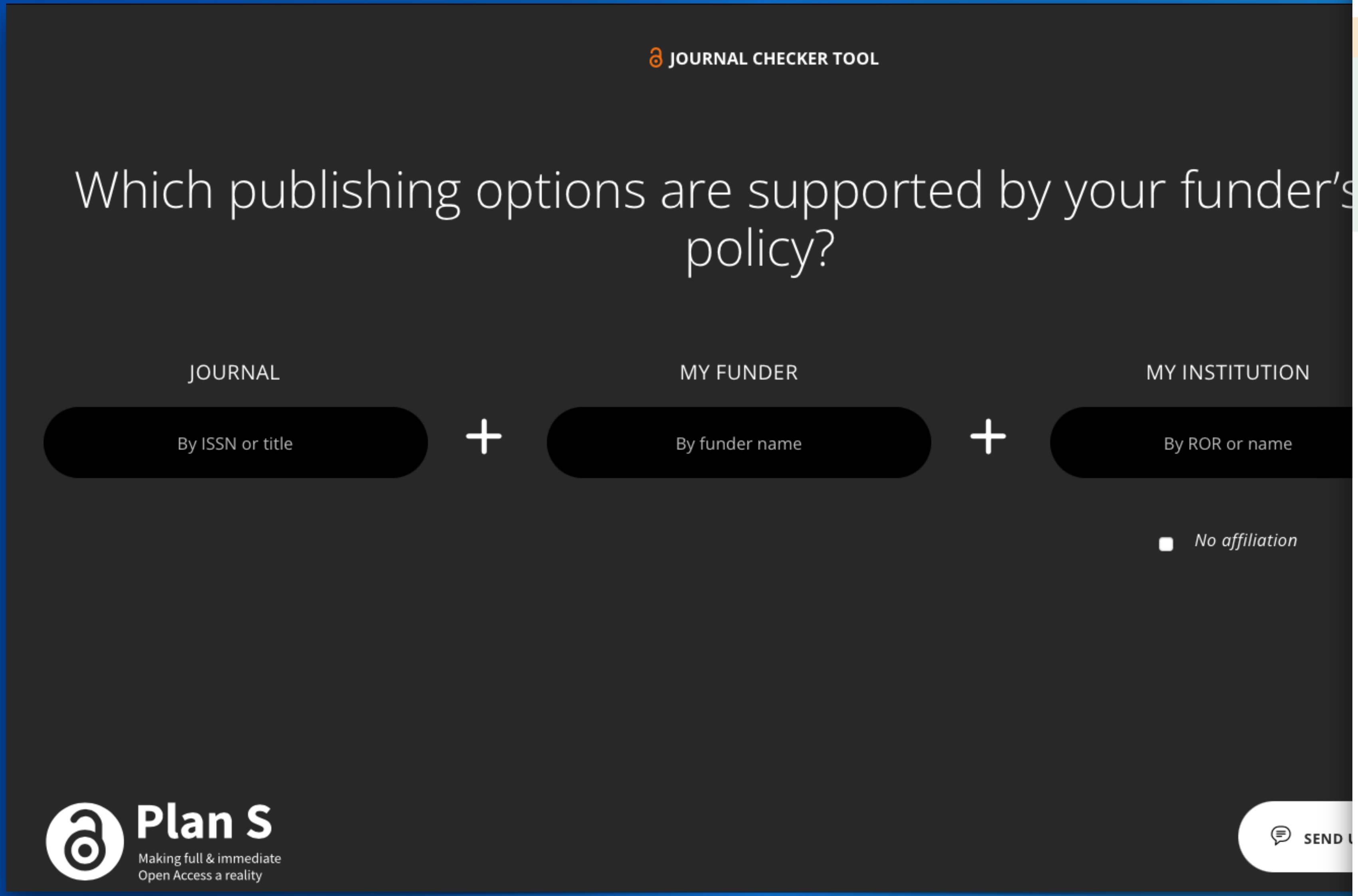

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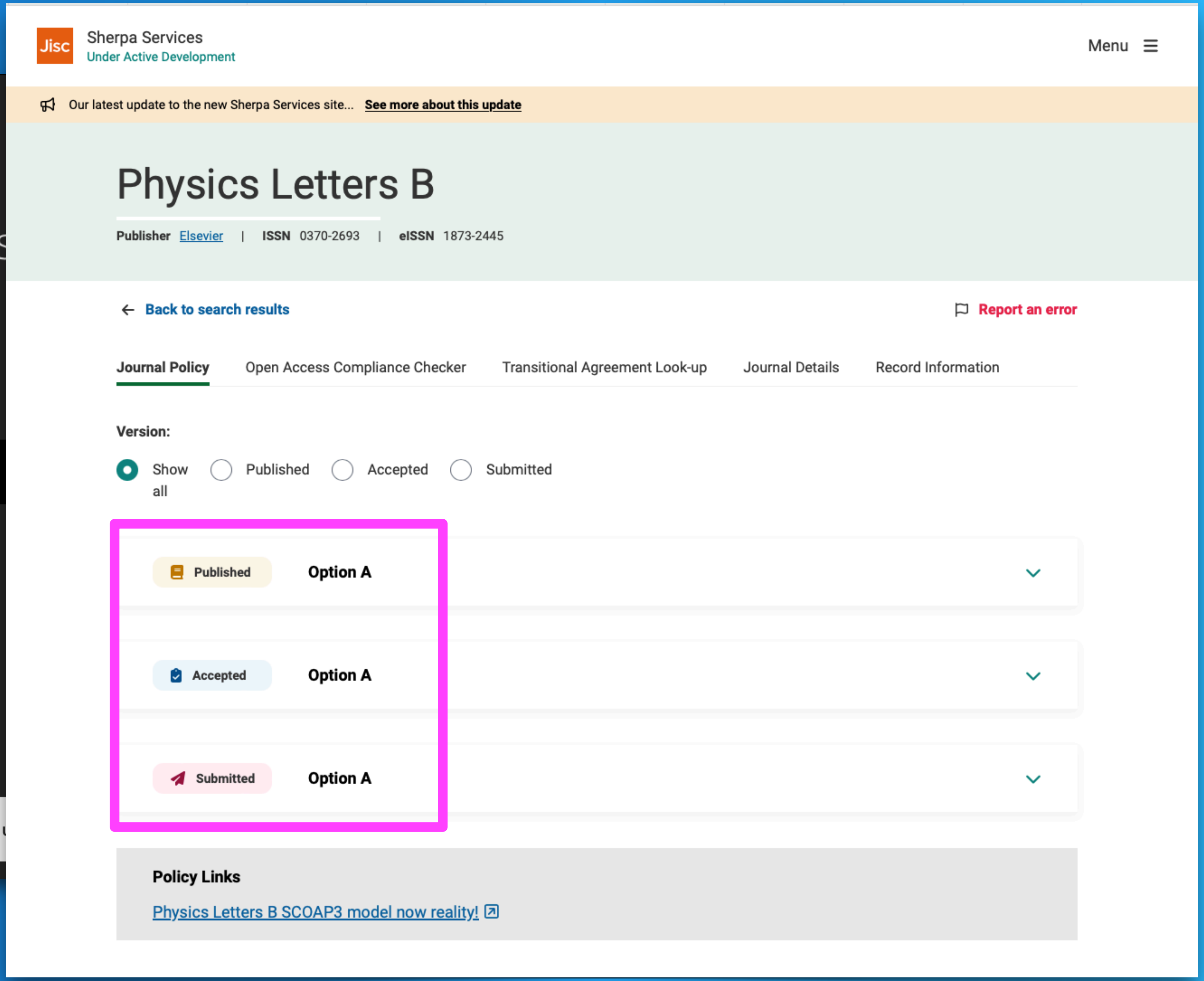

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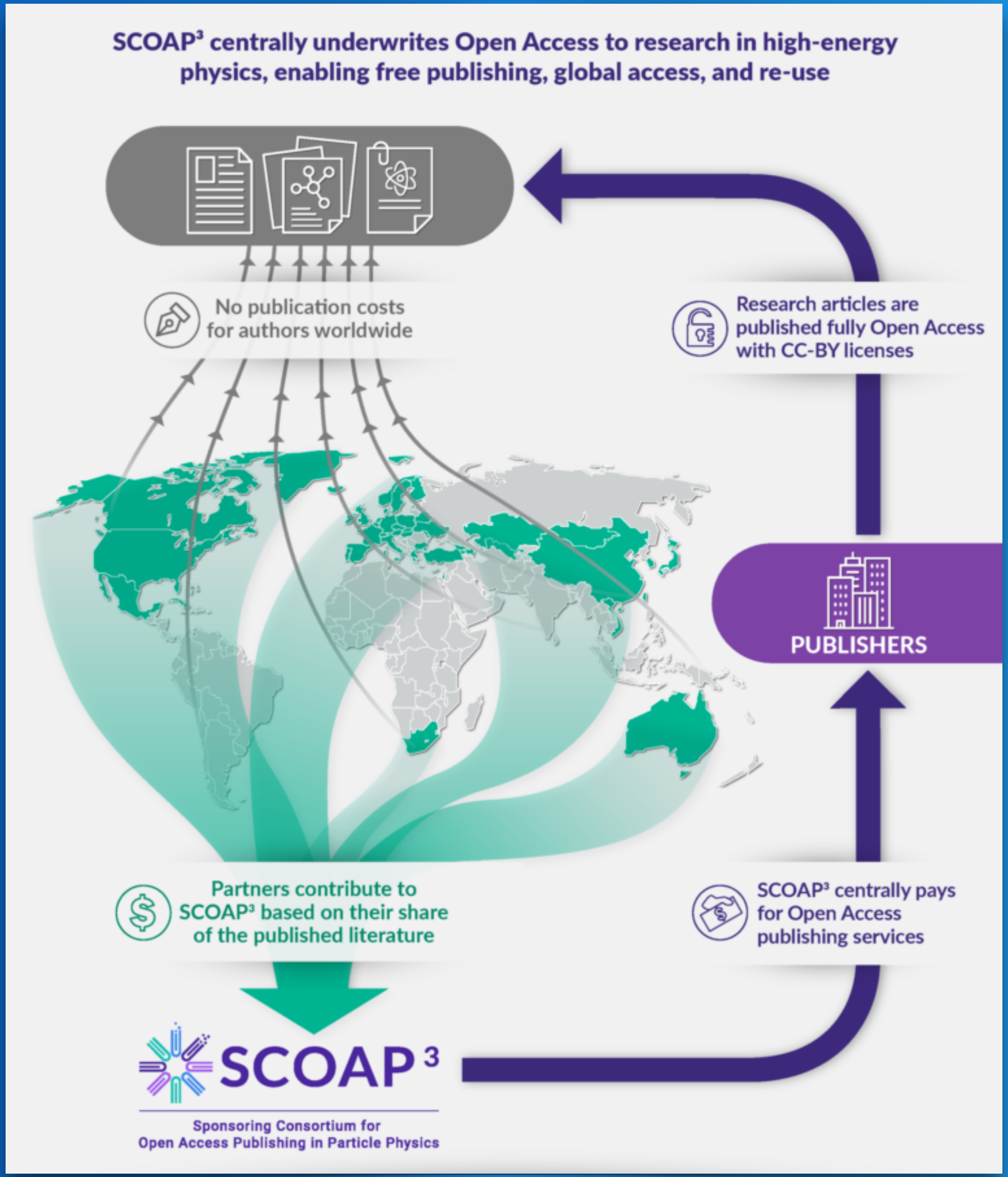

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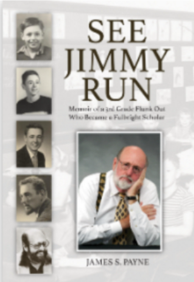

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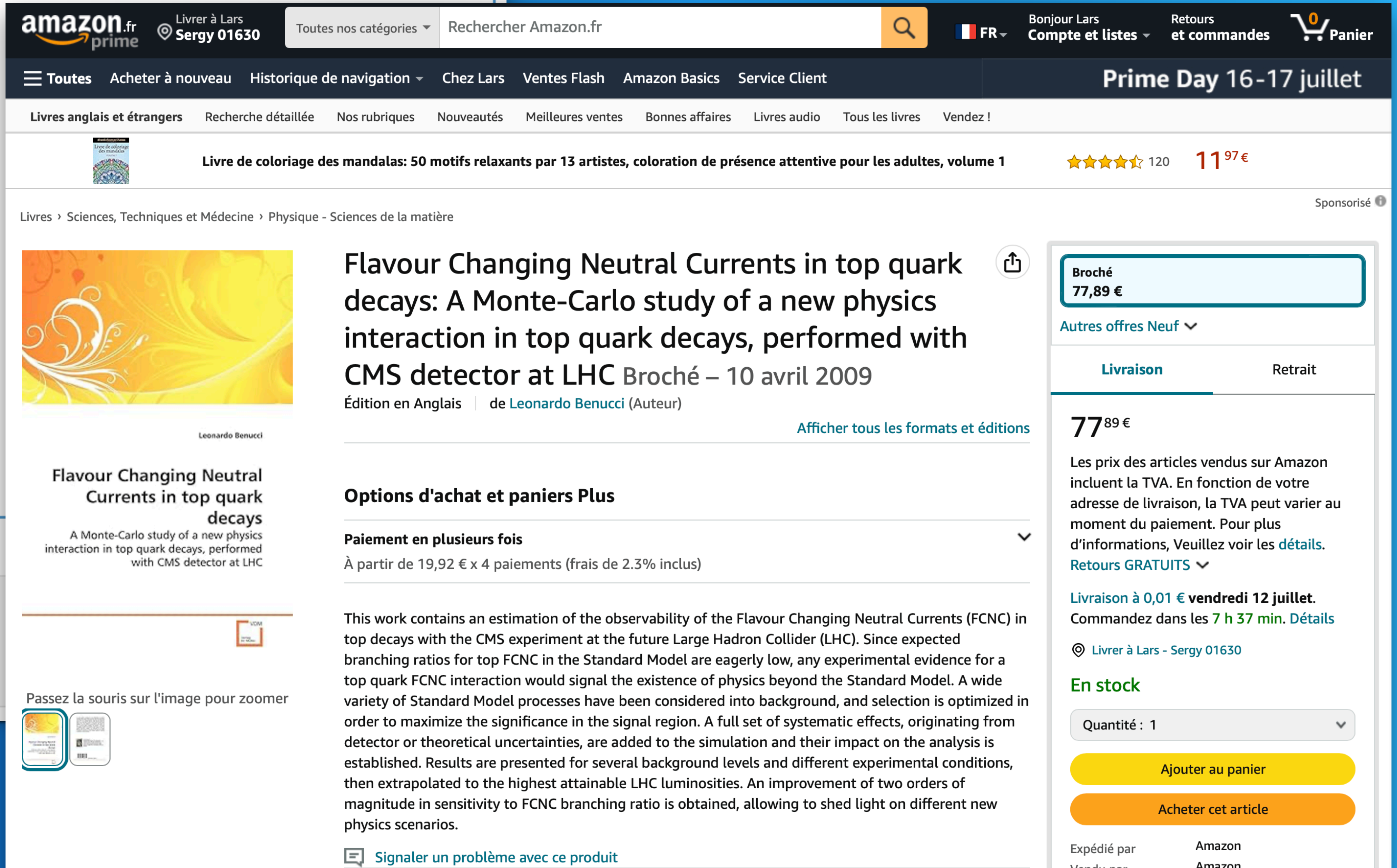

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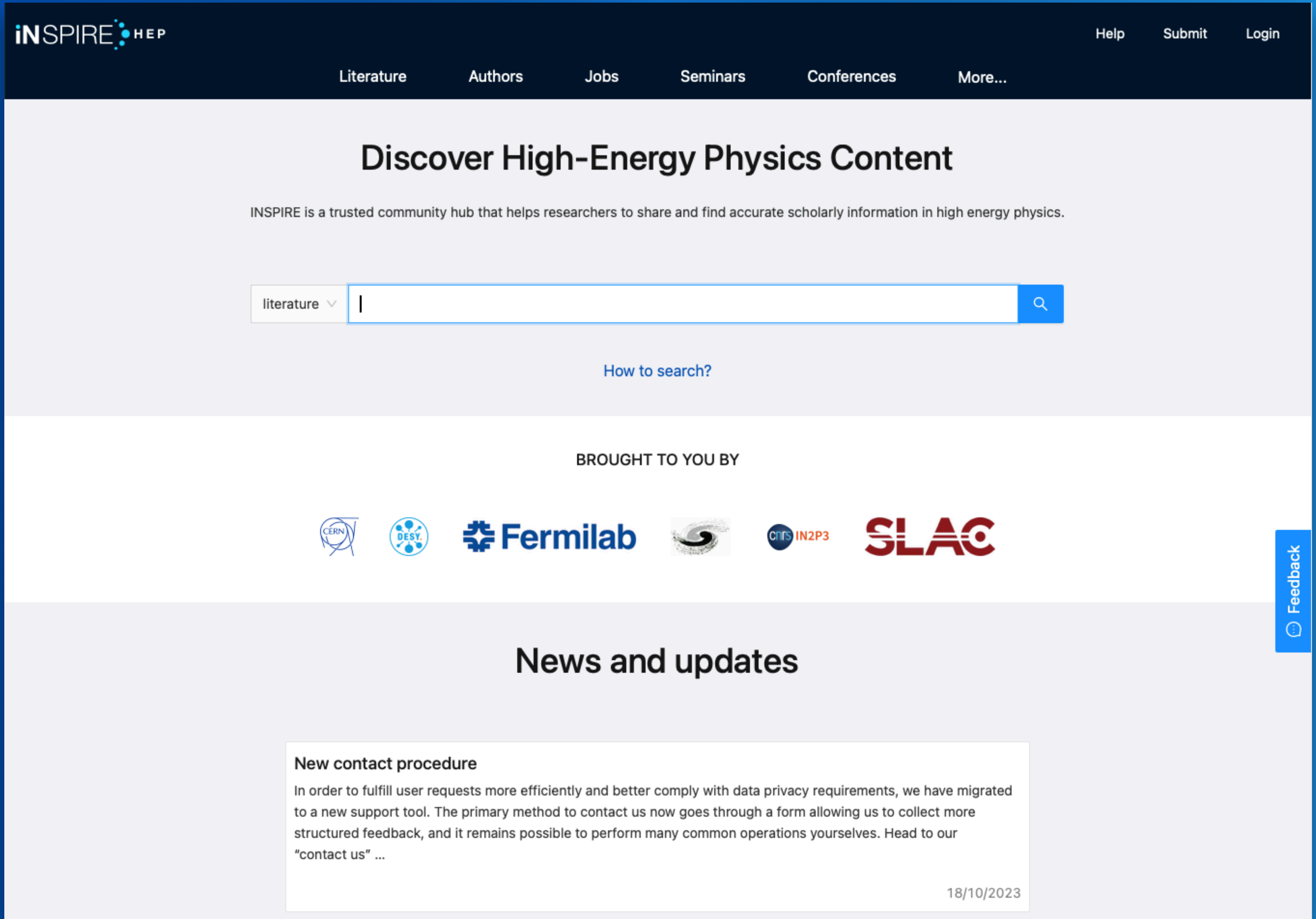

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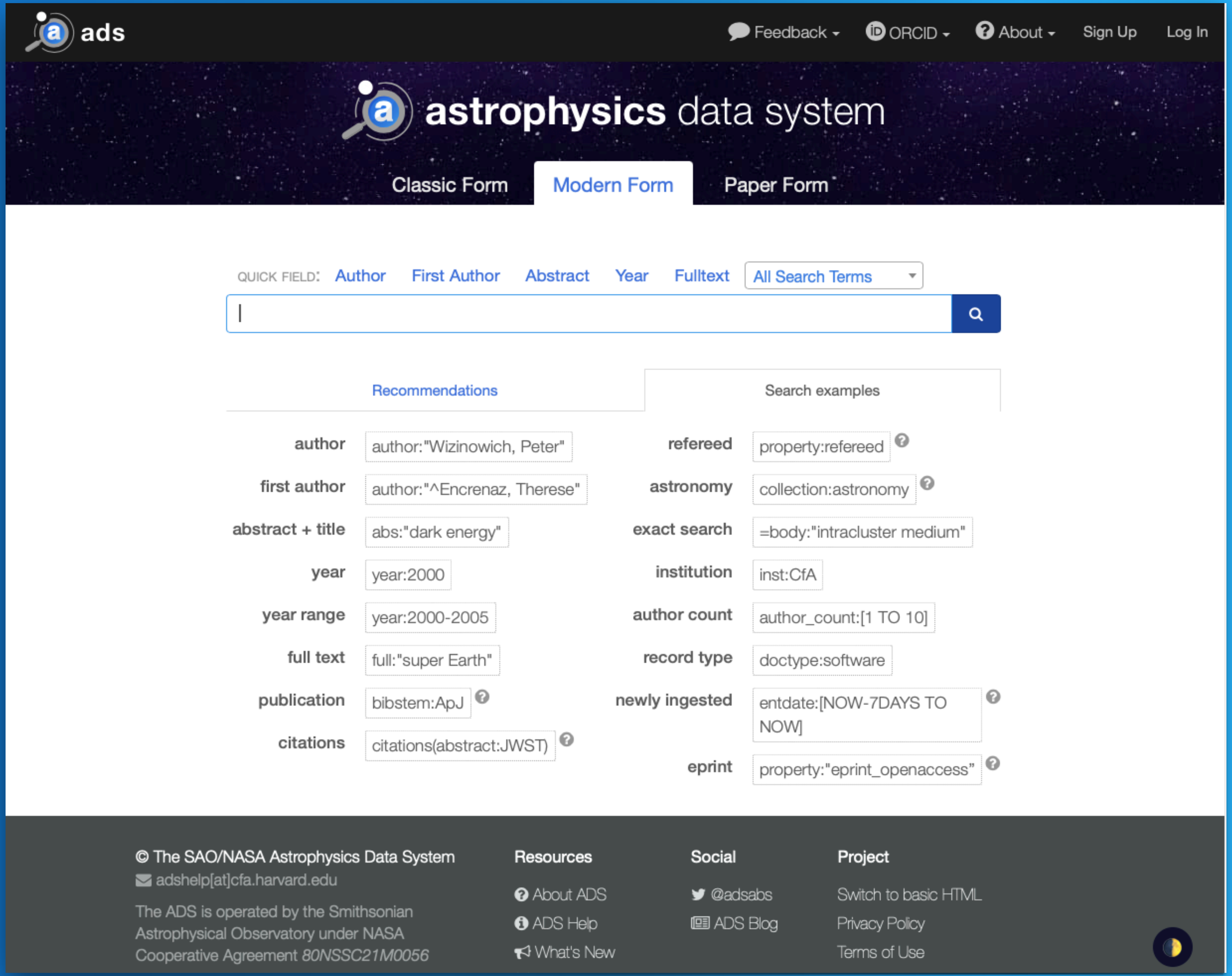

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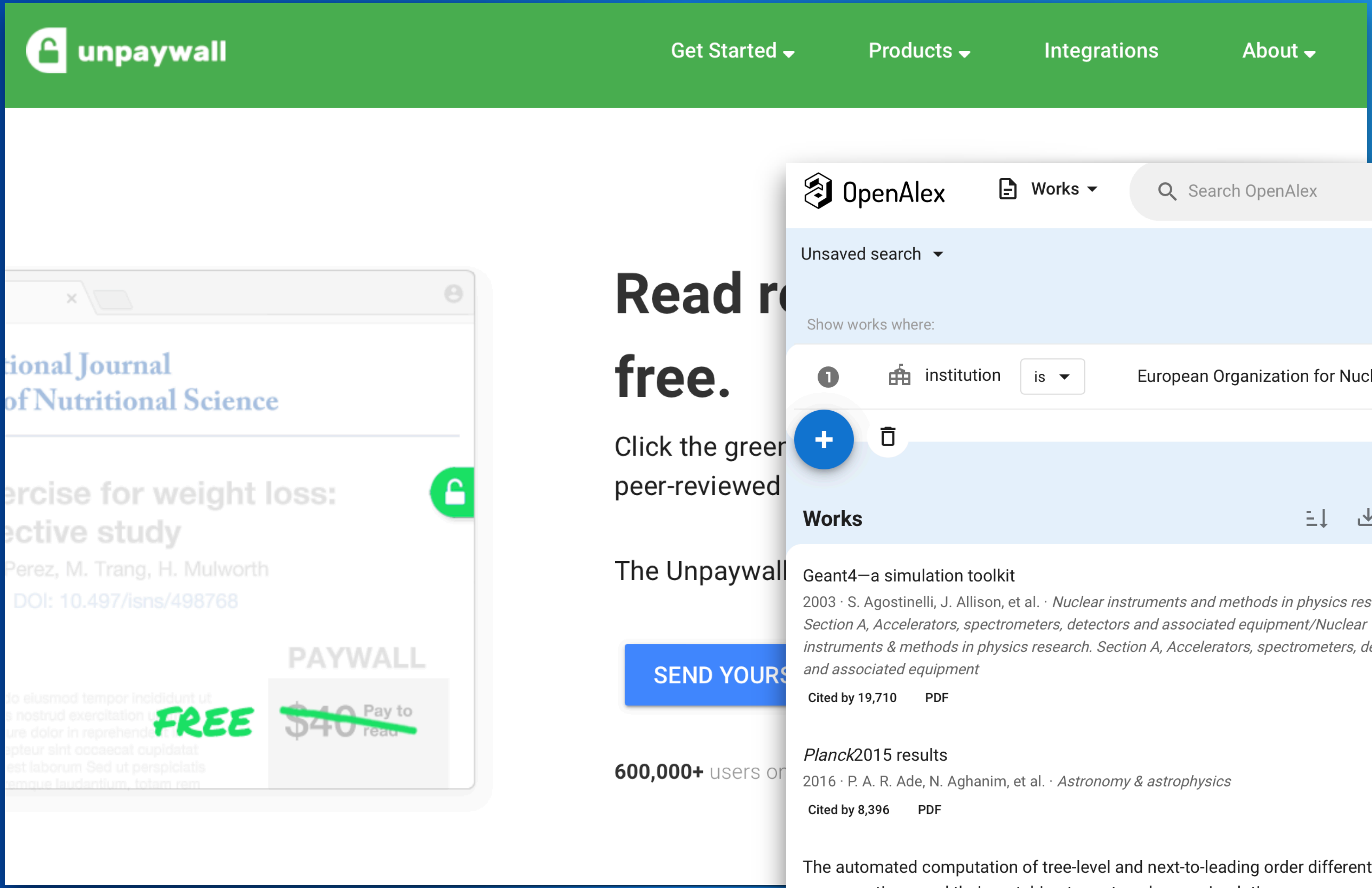

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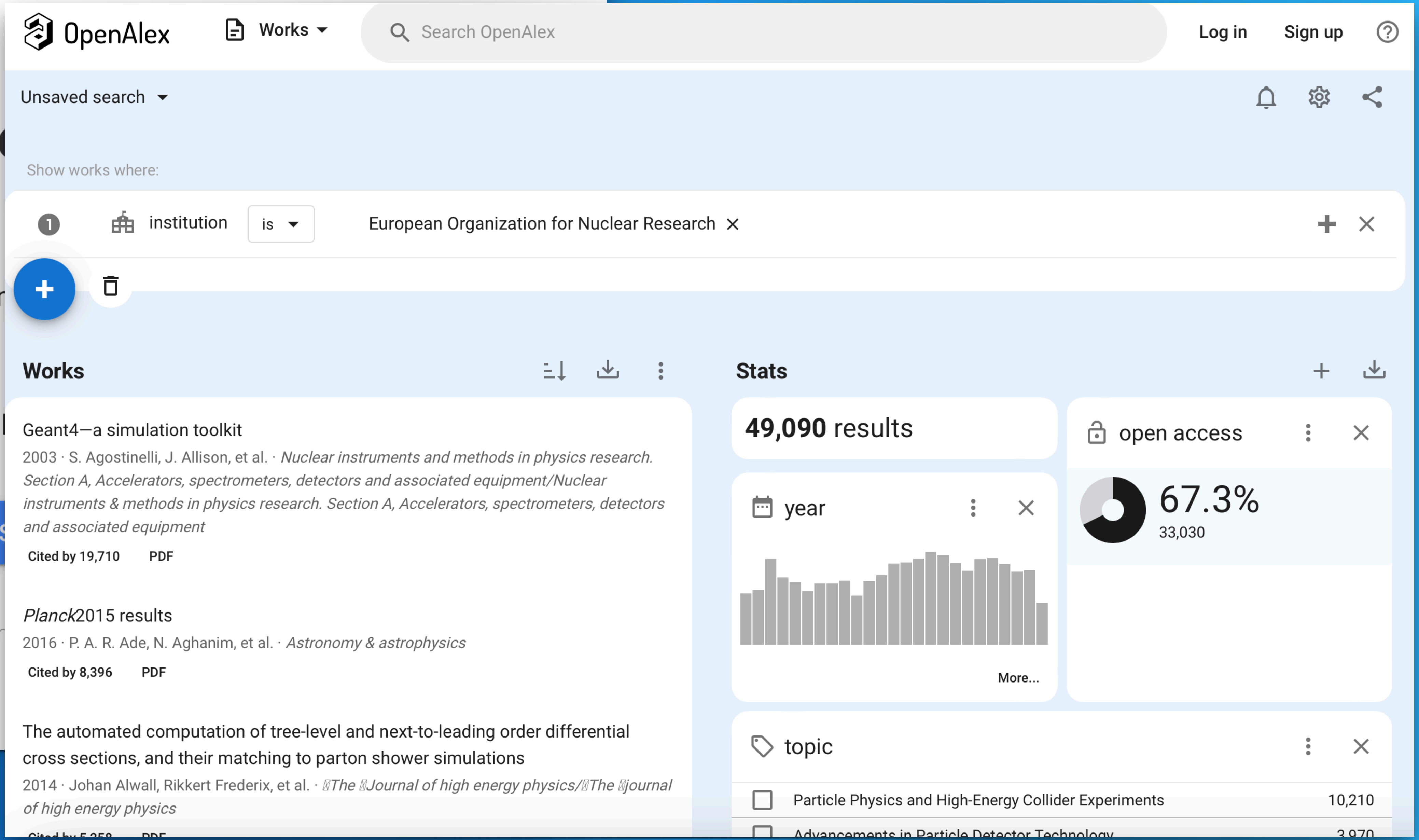

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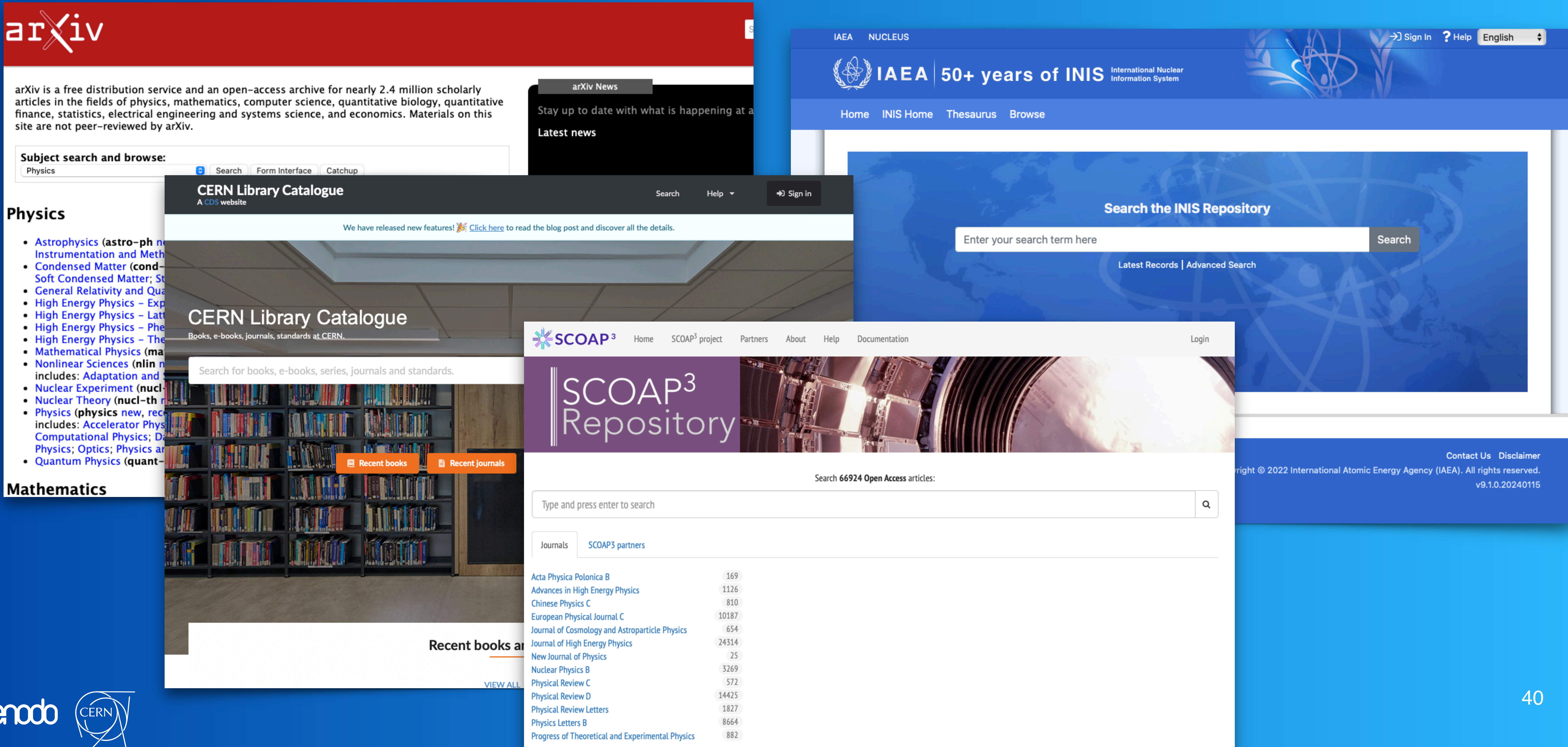
INIS, SCOAP3, arXiv, Library catalogue …



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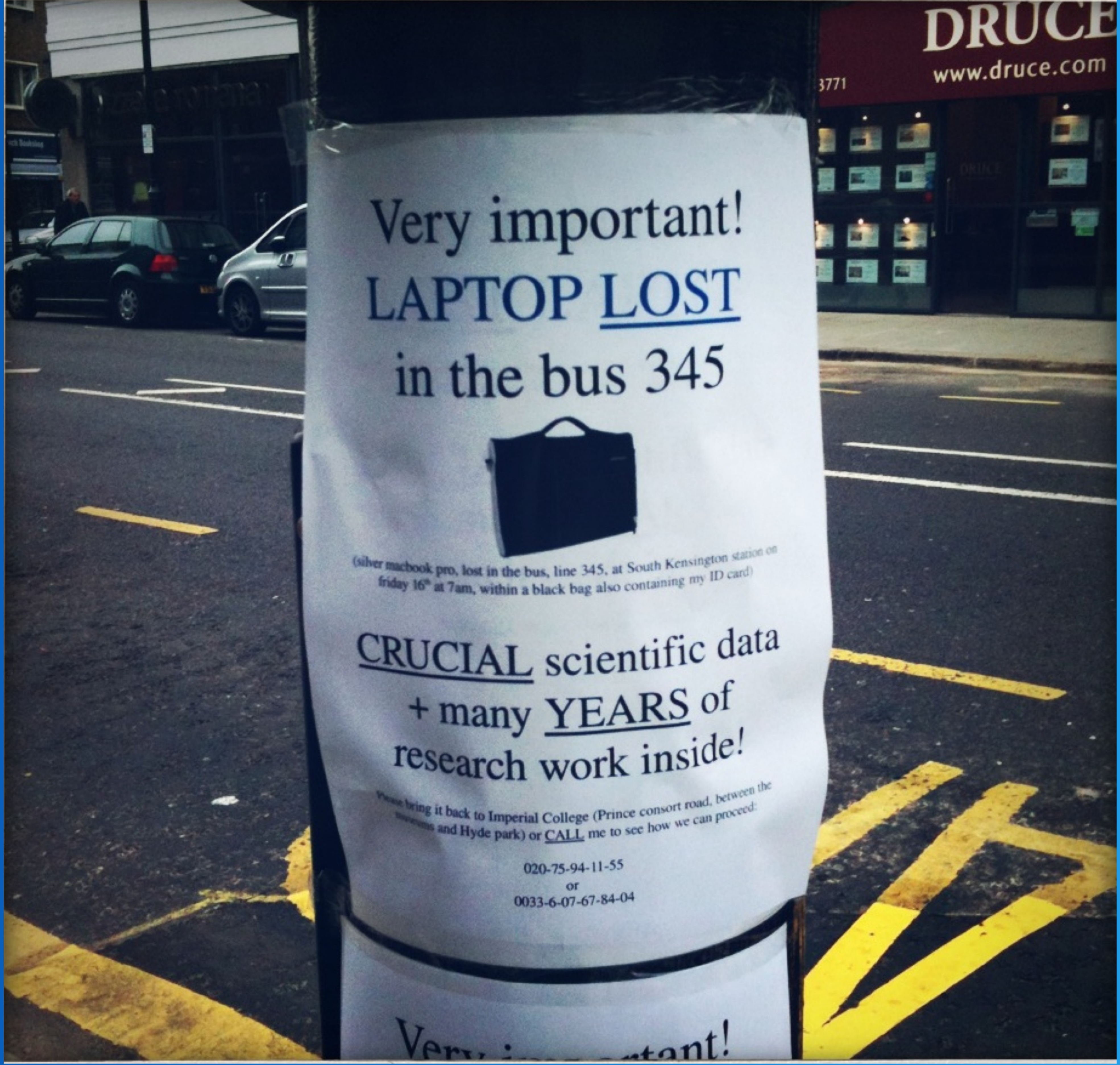
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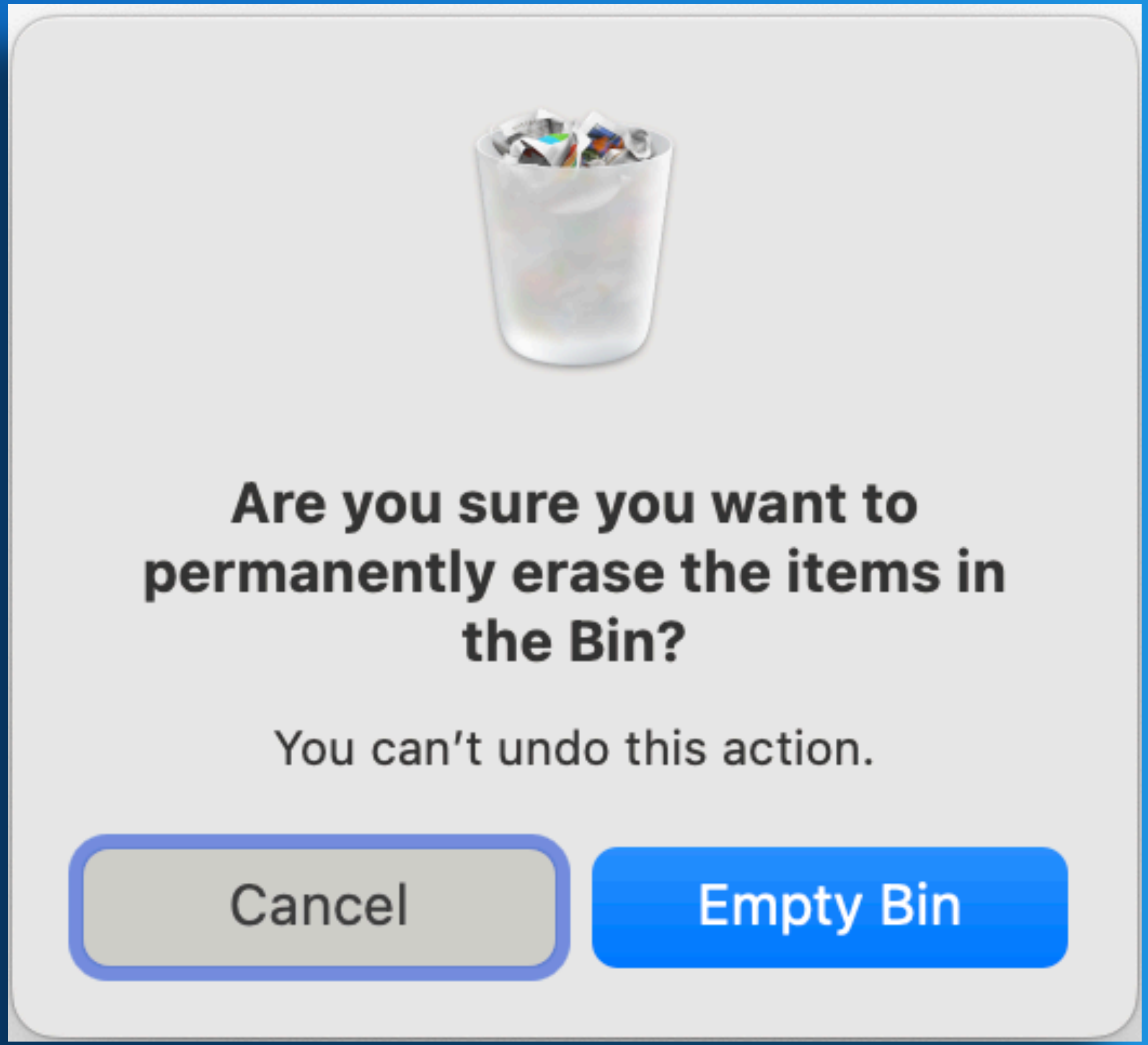
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Example 1

LHC Open Data

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• Data for outreach/education	Level 2	GB
• Reconstructed data	Level 3	PB
• Raw data	Level 4	EB

LHC Open Data

• Data behind plots in publications	Level 1	MB
• Data for outreach/education	Level 2	GB
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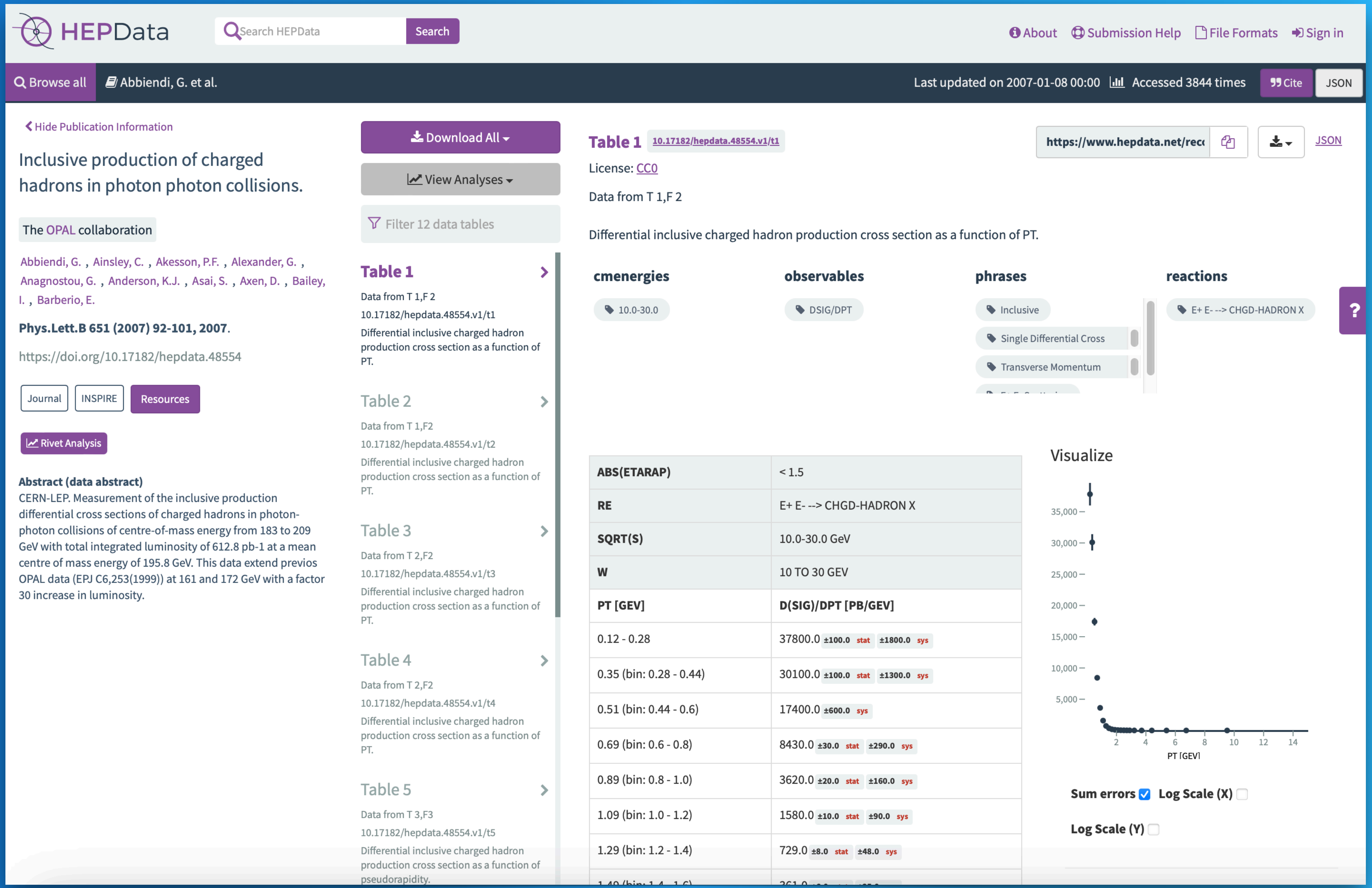
HEPData - Level 1

	$10 < W < 30$ GeV		$30 < W < 50$ GeV	
p_T [GeV]	$\langle p_T \rangle$ [GeV]	$d\sigma/dp_T$ [pb/GeV]	$\langle p_T \rangle$ [GeV]	$d\sigma/dp_T$ [pb/GeV]
0.12–0.28	0.20	$(3.78 \pm 0.01 \pm 0.18) \times 10^4$	0.20	$(1.15 \pm 0.00 \pm 0.03) \times 10^4$
0.28–0.44	0.35	$(3.01 \pm 0.01 \pm 0.13) \times 10^4$	0.35	$(9.01 \pm 0.02 \pm 0.21) \times 10^3$
0.44–0.60	0.51	$(1.74 \pm 0.00 \pm 0.06) \times 10^4$	0.51	$(5.26 \pm 0.02 \pm 0.13) \times 10^3$
0.60–0.80	0.69	$(8.43 \pm 0.03 \pm 0.29) \times 10^3$	0.69	$(2.69 \pm 0.01 \pm 0.07) \times 10^3$
0.80–1.00	0.89	$(3.62 \pm 0.02 \pm 0.16) \times 10^3$	0.89	$(1.22 \pm 0.01 \pm 0.03) \times 10^3$
1.00–1.20	1.09	$(1.58 \pm 0.01 \pm 0.09) \times 10^3$	1.09	$(5.85 \pm 0.05 \pm 0.19) \times 10^2$
1.20–1.40	1.29	$(7.29 \pm 0.08 \pm 0.48) \times 10^2$	1.29	$(2.94 \pm 0.04 \pm 0.11) \times 10^2$
1.40–1.60	1.49	$(3.61 \pm 0.06 \pm 0.25) \times 10^2$	1.49	$(1.59 \pm 0.03 \pm 0.06) \times 10^2$
1.60–1.80	1.69	$(1.92 \pm 0.04 \pm 0.13) \times 10^2$	1.69	$(9.13 \pm 0.21 \pm 0.32) \times 10^1$
1.80–2.00	1.89	$(1.13 \pm 0.03 \pm 0.08) \times 10^2$	1.89	$(5.32 \pm 0.15 \pm 0.19) \times 10^1$
2.00–2.20	2.09	$(6.68 \pm 0.23 \pm 0.44) \times 10^1$	2.09	$(3.34 \pm 0.12 \pm 0.11) \times 10^1$
2.20–2.40	2.29	$(4.17 \pm 0.19 \pm 0.26) \times 10^1$	2.29	$(2.22 \pm 0.10 \pm 0.07) \times 10^1$
2.40–2.60	2.50	$(2.85 \pm 0.16 \pm 0.17) \times 10^1$	2.50	$(1.47 \pm 0.08 \pm 0.04) \times 10^1$
2.60–2.80	2.70	$(1.98 \pm 0.13 \pm 0.12) \times 10^1$	2.70	$(1.00 \pm 0.06 \pm 0.03) \times 10^1$
2.80–3.00	2.90	$(1.45 \pm 0.12 \pm 0.09) \times 10^1$	2.90	$(7.48 \pm 0.54 \pm 0.26) \times 10^0$
3.00–3.50	3.21	$(7.93 \pm 0.56 \pm 0.50) \times 10^0$	3.23	$(4.33 \pm 0.26 \pm 0.15) \times 10^0$
3.50–4.00	3.71	$(3.87 \pm 0.42 \pm 0.27) \times 10^0$	3.73	$(2.32 \pm 0.19 \pm 0.08) \times 10^0$
4.00–5.00	4.40	$(1.63 \pm 0.22 \pm 0.15) \times 10^0$	4.42	$(1.12 \pm 0.09 \pm 0.04) \times 10^0$
5.00–6.00	5.40	$(5.16 \pm 0.78 \pm 0.55) \times 10^{-1}$	5.43	$(5.05 \pm 0.66 \pm 0.19) \times 10^{-1}$
6.00–8.00	6.74 ± 0.01	$(1.37 \pm 0.31 \pm 0.22) \times 10^{-1}$	6.74	$(2.10 \pm 0.33 \pm 0.12) \times 10^{-1}$
8.00–15.00	9.52 ± 0.12	$(1.90 \pm 0.86 \pm 0.33) \times 10^{-2}$	9.62 ± 0.03	$(2.23 \pm 0.60 \pm 0.36) \times 10^{-2}$

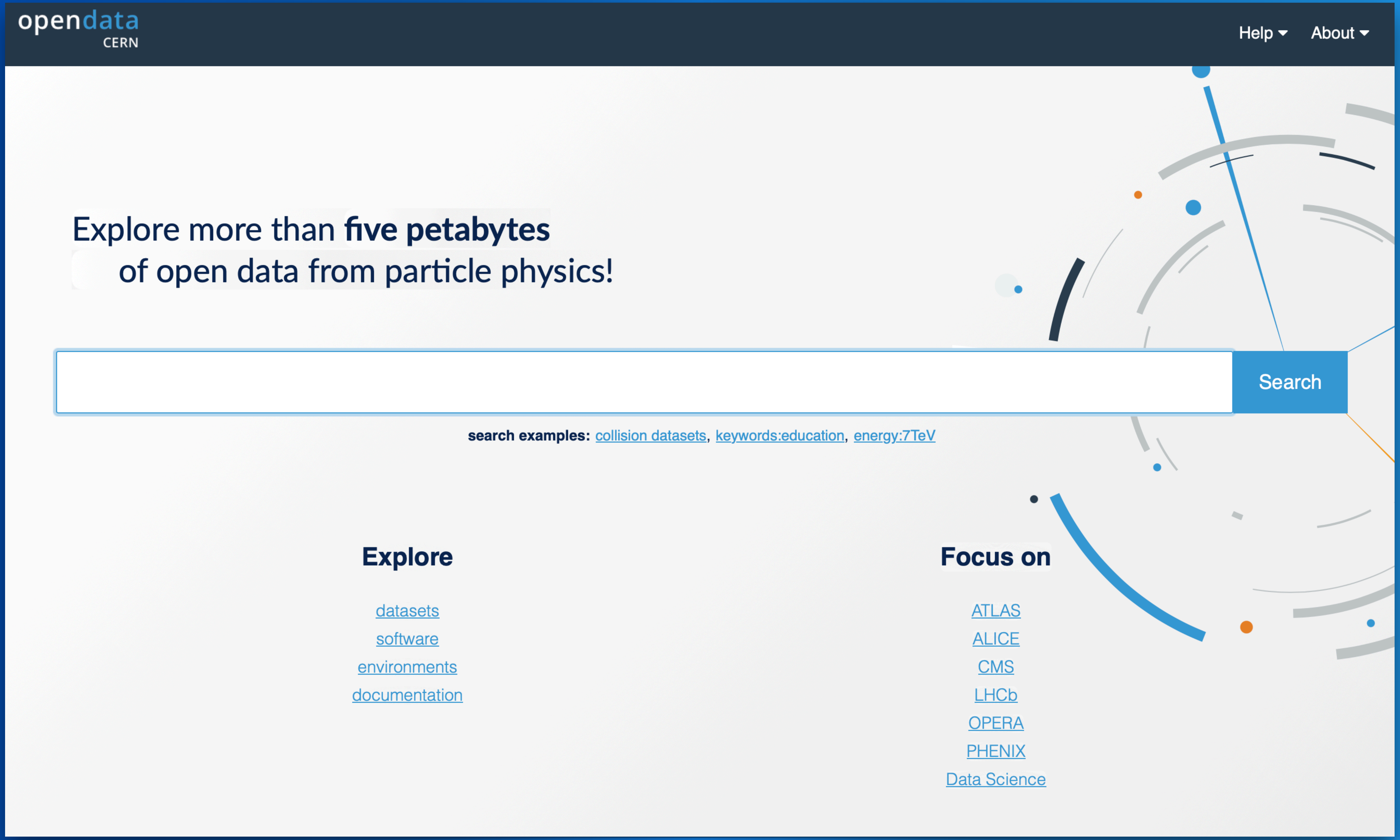
Table 1: Differential inclusive charged hadron production cross-sections $d\sigma/dp_T$ for $|\eta| < 1.5$ and in the W ranges $10 < W < 30$ GeV and $30 < W < 50$ GeV. The first uncertainty is the statistical uncertainty and the second uncertainty is the systematic uncertainty. No value is given if the error on $\langle p_T \rangle$ is less than 0.01.

Source: https://doi.org/10.48550/arXiv.hep-ex/0612045



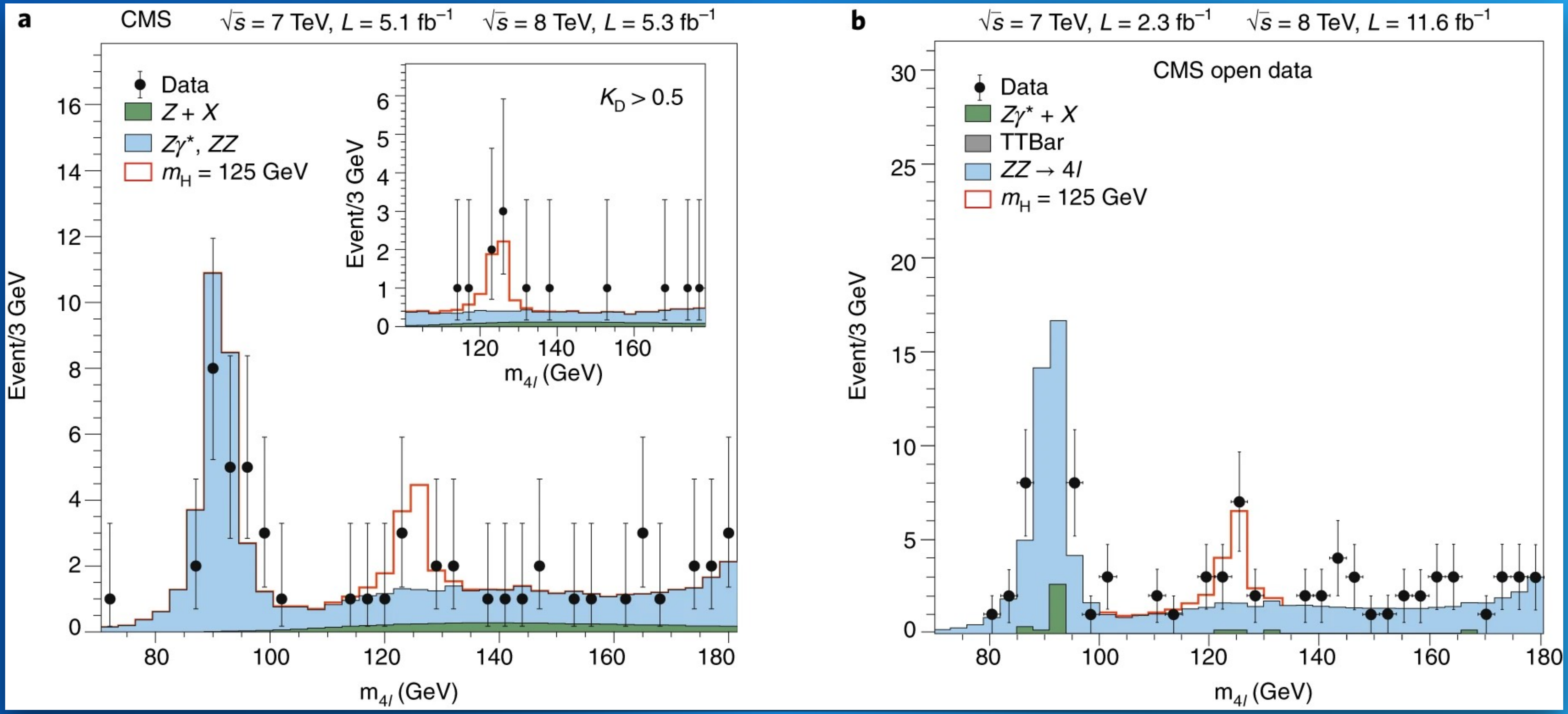
Source: https://doi.org/10.17182/hepdata.48554

CERN Open Data - Level 2/3



- Data + Software + Virtual Machines + Documentation
- 5 PB of data from all LHC experiments

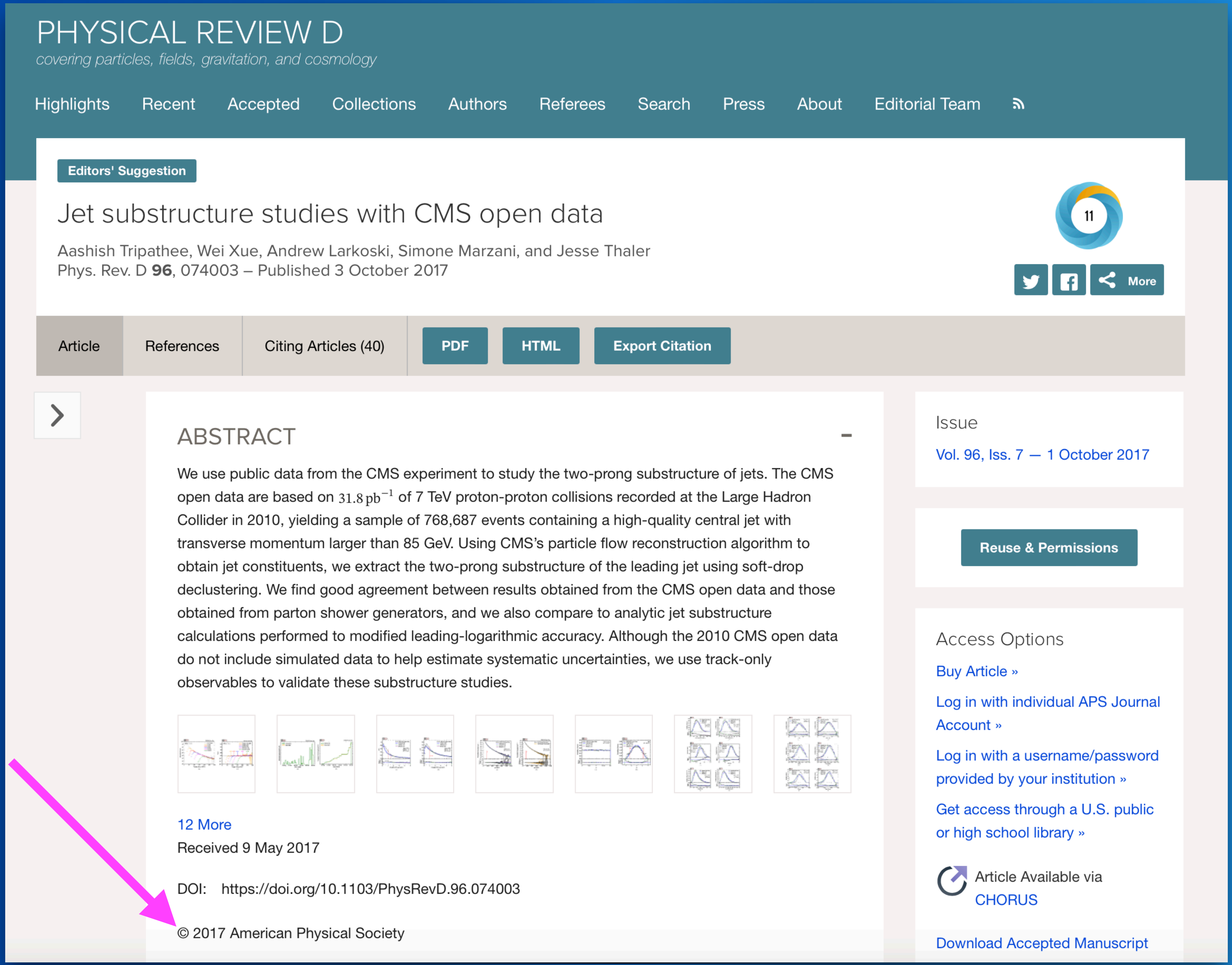
CERN Open Data - Level 2



The official CMS result   Researchers + students

Source: Chen, X., Dallmeier-Tiessen, S., Dasler, R. et al. Open is not enough. Nature Phys 15, 113–119 (2019). https://doi.org/10.1038/s41567-018-0342-2

CERN Open Data - Level 3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Editors' Suggestion

Jet substructure studies with CMS open data

Aashish Tripathee, Wei Xue, Andrew Larkoski, Simone Marzani, and Jesse Thaler
Phys. Rev. D **96**, 074003 – Published 3 October 2017

11

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ABSTRACT

We use public data from the CMS experiment to study the two-prong substructure of jets. The CMS open data are based on $31.8\,\mathrm{pb}^{-1}$ of 7 TeV proton-proton collisions recorded at the Large Hadron Collider in 2010, yielding a sample of 768,687 events containing a high-quality central jet with transverse momentum larger than 85 GeV. Using CMS's particle flow reconstruction algorithm to obtain jet constituents, we extract the two-prong substructure of the leading jet using soft-drop declustering. We find good agreement between results obtained from the CMS open data and those obtained from parton shower generators, and we also compare to analytic jet substructure calculations performed to modified leading-logarithmic accuracy. Although the 2010 CMS open data do not include simulated data to help estimate systematic uncertainties, we use track-only observables to validate these substructure studies.

12 More

Received 9 May 2017

DOI: https://doi.org/10.1103/PhysRevD.96.074003

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- Using released CMS open data from 2011-2012
- Confirmed their jet substructure model predictions

Source: https://doi.org/10.1103/PhysRevD.96.074003

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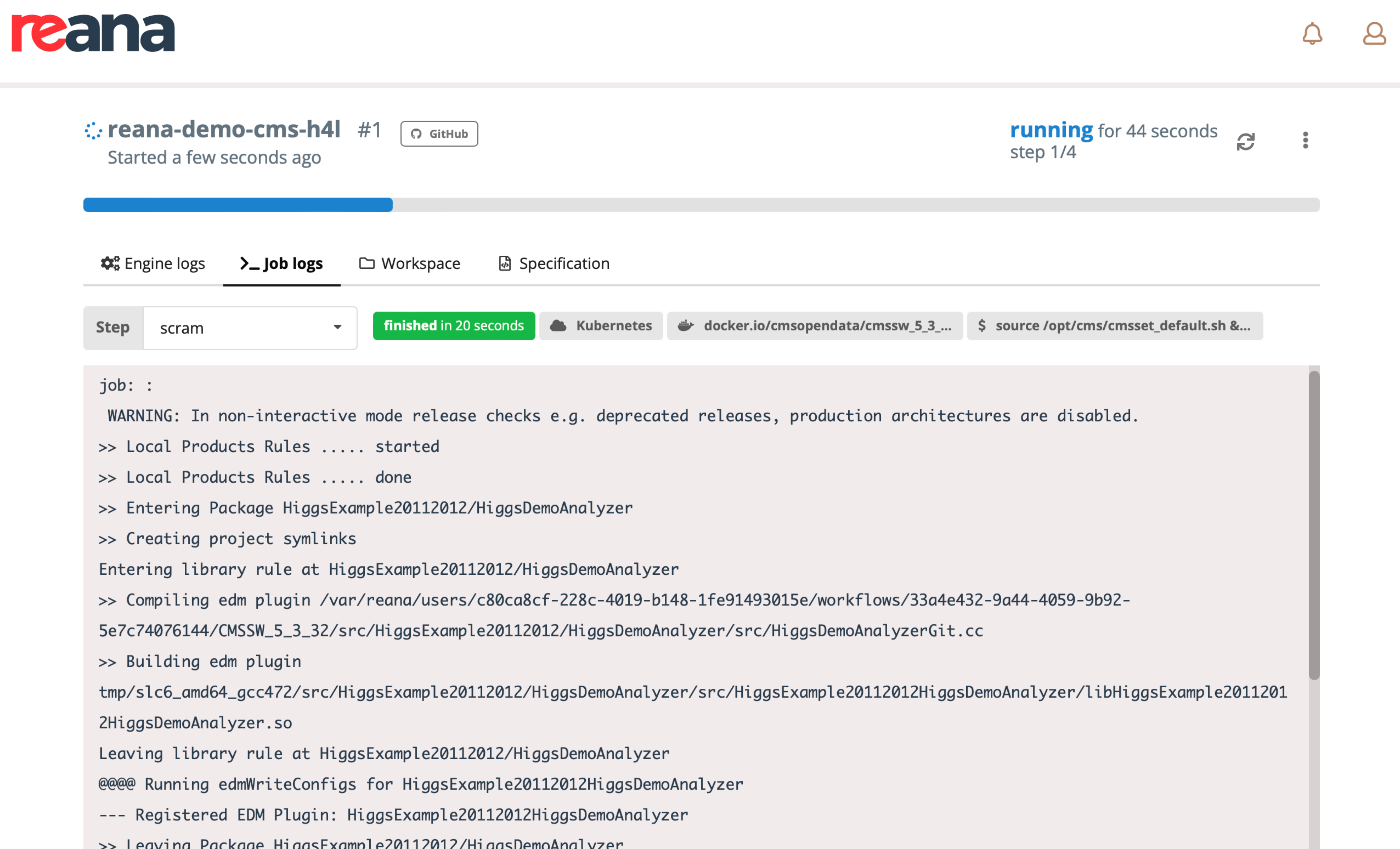
Reproducible research data analysis



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https://reana.io

Example 2

Taxonomic treatments

Describe the discovery of new biological species

Example:
Journal article describing 22 new millipedes, published in European Journal of Taxonomy


European Journal of Taxonomy 445: 1–90
https://doi.org/10.5852/ejt.2018.445

ISSN 2118-9773
www.europeanjournaloftaxonomy.eu
2018 · Enghoff H.

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Monograph

urn:lsid:zoobank.org:pub:852A3F68-B728-413A-B12E-56F306D56C35

A mountain of millipedes VII: The genus *Eviulisoma* Silvestri, 1910, in the Udzungwa Mountains, Tanzania, and related species from other Eastern Arc Mountains. With notes on *Eoseviulisoma* Brolemann, 1920, and *Suohelisoma* Hoffman, 1963 (Diplopoda, Polydesmida, Paradoxosomatidae)

Henrik ENGHOFF

Natural History Museum of Denmark, University of Copenhagen, Universitetsparken 15, DK-2100 København Ø, Denmark.

Email: henghoff@snm.ku.dk

urn:lsid:zoobank.org:author:FB09A817-000D-43C3-BCC4-2BC1E5373635

Abstract. Twenty-two new species of the genus *Eviulisoma* Silvestri, 1910, from the Eastern Arc Mountains, Tanzania, are described: *E. acaciae* sp. nov., *E. aequilobatum* sp. nov., *E. akkariae* sp. nov., *E. angulatum* sp. nov., *E. articulatum* sp. nov., *E. biquintum* sp. nov., *E. breviscutum* sp. nov., *E. cetafi* sp. nov., *E. chitense* sp. nov., *E. commelina* sp. nov., *E. coxale* sp. nov., *E. ejti* sp. nov., *E. grumslingslak* sp. nov., *E. kalimbasiense* sp. nov., *E. navuncus* sp. nov., *E. nessiteras* sp. nov., *E. ottokrausi* sp. nov., *E. paradisiacum* sp. nov., *E. sternale* sp. nov. and *E. zebra* sp. nov. from the Udzungwa Mts, *E. culter* sp. nov. from the Rubeho Mts and *E. kangense* sp. nov. from the Kanga Mts. *Eviulisoma kwabuniense* Kraus, 1958, and *E. dabagaense* Kraus, 1958, both from the Udzungwa Mts, are redesribed based on new material. Notes are provided on *E. iuloideum* (Verhoeff, 1941) based on type material. *Eoseviulisoma* Brolemann, 1920, is synonymized under *Eviulisoma*, based on newly collected material of *E. julinum* (Attems, 1909), type species of *Eoseviulisoma*. New material of *Suohelisoma ulugurense* Hoffman, 1964, type species of *Suohelisoma* Hoffman, 1964, has revealed that the gonopod structure is more similar to that of *Eviulisoma* than originally thought, but *Suohelisoma* is retained as a valid genus. Four species groups are recognized among *Eviulisoma* species from the Udzungwa Mts, but the need for a revision of the entire genus is emphasized. Two types of epizootic fungi are recorded from *Eviulisoma* spp., and an enigmatic amorphous mass, which may be a kind of plugging substance, is recorded from the gonopod tips and excavated sixth sternum of several species.

Keywords. Taxonomy, new species, epizootic fungi, copulatory plug.

Enghoff H. 2018. A mountain of millipedes VII: The genus *Eviulisoma* Silvestri, 1910, in the Udzungwa Mountains, Tanzania, and related species from other Eastern Arc Mountains. With notes on *Eoseviulisoma* Brolemann, 1920, and *Suohelisoma* Hoffman, 1963 (Diplopoda, Polydesmida, Paradoxosomatidae). *European Journal of Taxonomy* 445: 1–90. https://doi.org/10.5852/ejt.2018.445

1

Enghoff H. 2018. A mountain of millipedes VII: The genus *Eviulisoma* Silvestri, 1910, in the Udzungwa Mountains, Tanzania, and related species from other Eastern Arc Mountains. With notes on *Eoseviulisoma* Brolemann, 1920, and *Suohelisoma* Hoffman, 1963 (Diplopoda, Polydesmida, Paradoxosomatidae). *European Journal of Taxonomy* 445: 1–90. https://doi.org/10.5852/ejt.2018.445

Treatments: Data in disguise

Geographic coordinates

Date of collection

Collector

Material (total: 3 ♂♂)

Holotype

TANZANIA: ♂, Mwanihana Forest, above Sanje, 1650 m a.s.l., pitfall trap, 18 Aug. 1982, M. Stoltze and N. Scharff leg. (ZMUC).

Paratypes

TANZANIA: 1 ♂, Morogoro Region, Kilombero District, Udzungwa Mts National Park, forest below Mwanihana Peak, 7°49′ S, 36°50′ E, 1800 m a.s.l., sifted from leaf litter, 20 Aug. 2017, T. Pape leg. (ZMUC); 1 ♂, Morogoro Region, Udzungwa Mts National Park, Mito Mitatu, above Mang'ula, 07°49′3″ S, 36°52′58″ E, 1487 m a.s.l., 16 Dec. 2016,

Host collection

EUROPEAN JOURNAL OF TAXONOMY

MATERIAL CITATIONS FORMATTING GUIDE

In accordance with the European Journal of Taxonomy's FAIR & Open Science policy, the formatting guide for entomology, zoology and palaeozoology material citations is provided below (guidelines for botany available soon). Authors are encouraged to prepare their manuscripts according to this model prior to submission, but they will also be given the opportunity to comply upon acceptance of the article.

While EJT strongly recommends that authors adhere to the guidelines given below, the fine-grain formatting of the material citations is not compulsory; if an author decides not to comply or the material is not appropriate

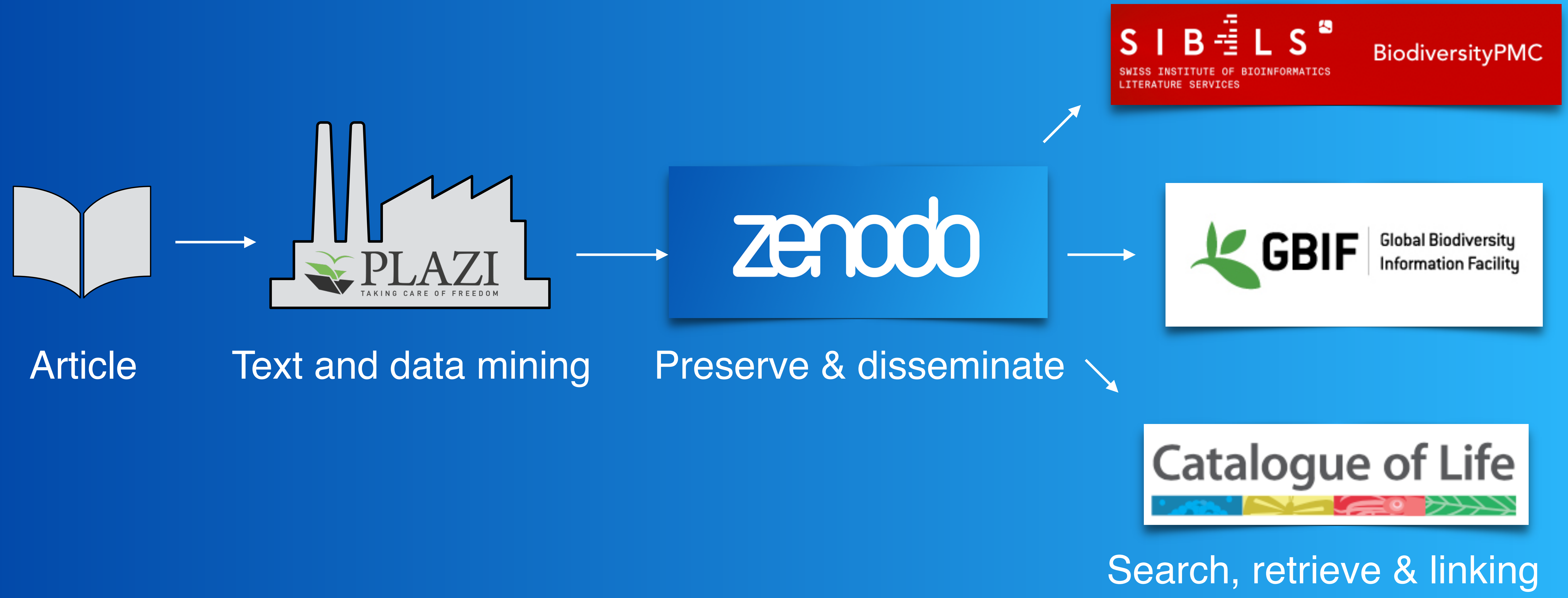
Locked up data

Unanswerable questions:

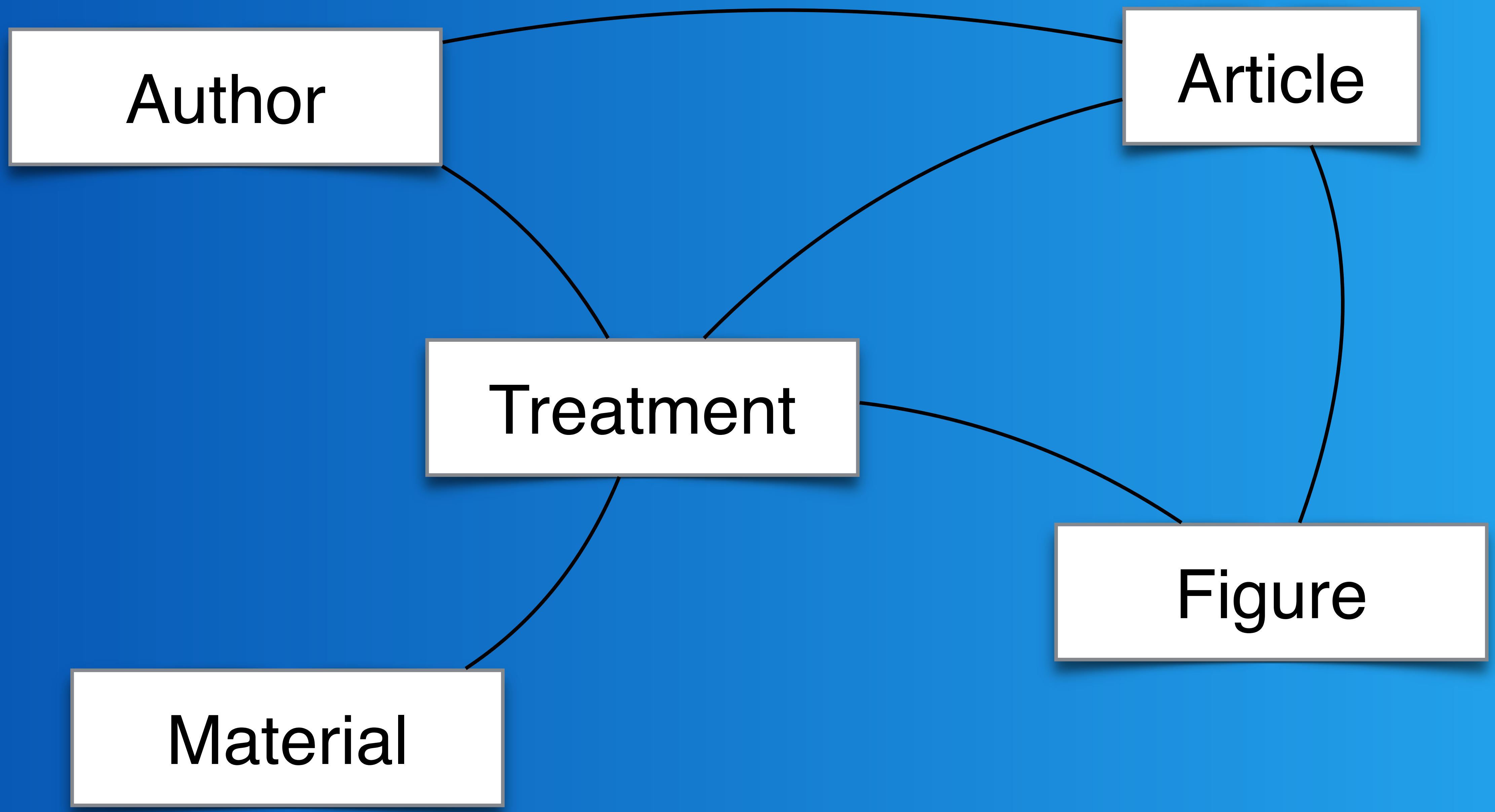
- How many species have been described by my collection?
- Give me a list of all new species?
- Retrieve all images for a given taxon?
- What’s known about a geographic region?

- **Treatments:**
  - Past 260 years: **~10+ millions** published
  - Every year: **~17k** new / **~130k** augmented

It takes an ecosystem



It takes an ecosystem



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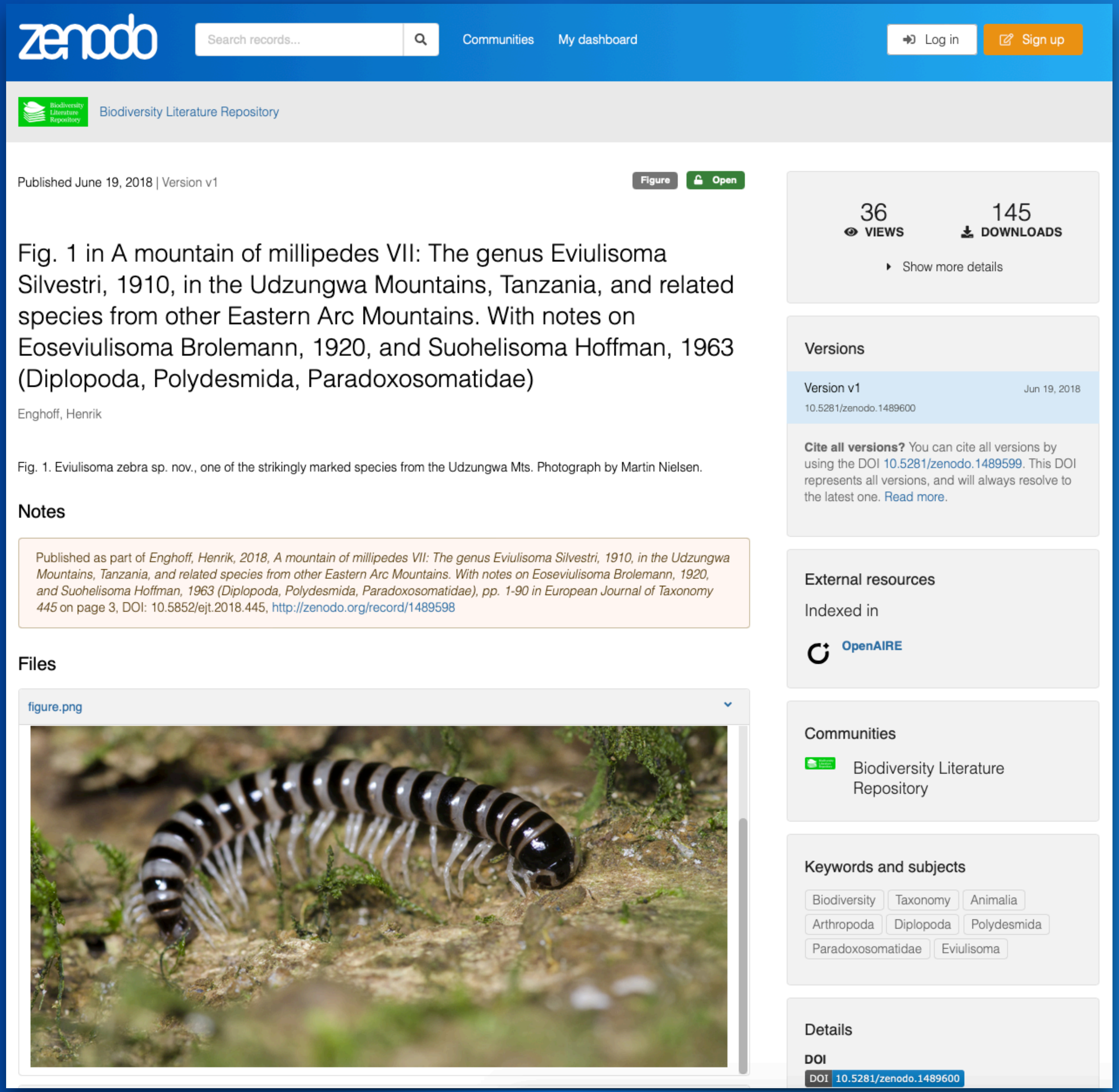
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Published June 19, 2018 | Version v1
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Enghoff, Henrik
Fig. 1. Eviulisoma zebra sp. nov., one of the strikingly marked species from the Udzungwa Mts. Photograph by Martin Nielsen.
Notes
Published as part of Enghoff, Henrik, 2018, A mountain of millipedes VII: The genus Eviulisoma Silvestri, 1910, in the Udzungwa Mountains, Tanzania, and related species from other Eastern Arc Mountains. With notes on Eoseviulisoma Brolemann, 1920, and Suohelisoma Hoffman, 1963 (Diplopoda, Polydesmida, Paradoxosomatidae), pp. 1-90 in European Journal of Taxonomy 445 on page 3, DOI: 10.5852/ejt.2018.445, http://zenodo.org/record/1489598
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100% With taxon match
49% With coordinates
83% With year
32 Accepted names
0 Synonyms
100% Overlap with GBIF Backbone
100% Overlap with Catalogue of Life
40 GEOREFERENCED RECORDS

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Findable, Accessible, Interoperable, Reusable

FAIR Principles

- **Findable:** Persistent identifier (id); Metadata; Registered
- **Accessible:** Retrieval by id using standard free protocols (e.g. web); Metadata survive data.
- **Interoperable:** (meta)data uses broadly applicable knowledge representation
- **Reusable:** (meta)data are richly described; clear and accessible data usage license; provenance

Wilkinson, M. D. et al. The FAIR Guiding Principles for scientific data management and stewardship. Sci. Data 3:160018 https://doi.org/10.1038/sdata.2016.18 (2016).

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Volume 506, Issue 3, 1 July 2003, Pages 250-303

GEANT4—a simulation toolkit

S. Agostinelli [ae], J. Allison [as], K. Amako [e], J. Apostolakis [a], H. Araujo [aj], P. Arce [l m x a], M. Asai [g ai], D. Axen [i t], S. Banerjee [bi l], G. Barrand [an], F. Behner [l], L. Bellagamba [c], J. Boudreau [bd], L. Broglia [ar], A. Brunengo [c], H. Burkhardt [a], S. Chauvie [bj bl], J. Chuma [h], R. Chytracek [a], G. Cooperman [az]...D. Zschiesche [af]

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Abstract

GEANT4 is a toolkit for simulating the passage of particles through matter. It includes a complete range of functionality including tracking, geometry, physics models and hits. The physics processes offered cover a comprehensive range, including electromagnetic, hadronic and optical processes, a large set of long-lived particles, materials and elements, over a wide energy range starting, in some cases, from 250 eV and extending in others to the TeV energy range. It has been designed and constructed to expose the physics models utilised, to handle complex geometries, and to enable its easy adaptation for optimal use in different sets of applications. The toolkit is the result of a worldwide collaboration of physicists and software engineers. It has been created exploiting software

https://doi.org/10.1016/S0168-9002(03)01368-8 (Hint: Use unpaywall.org to access)

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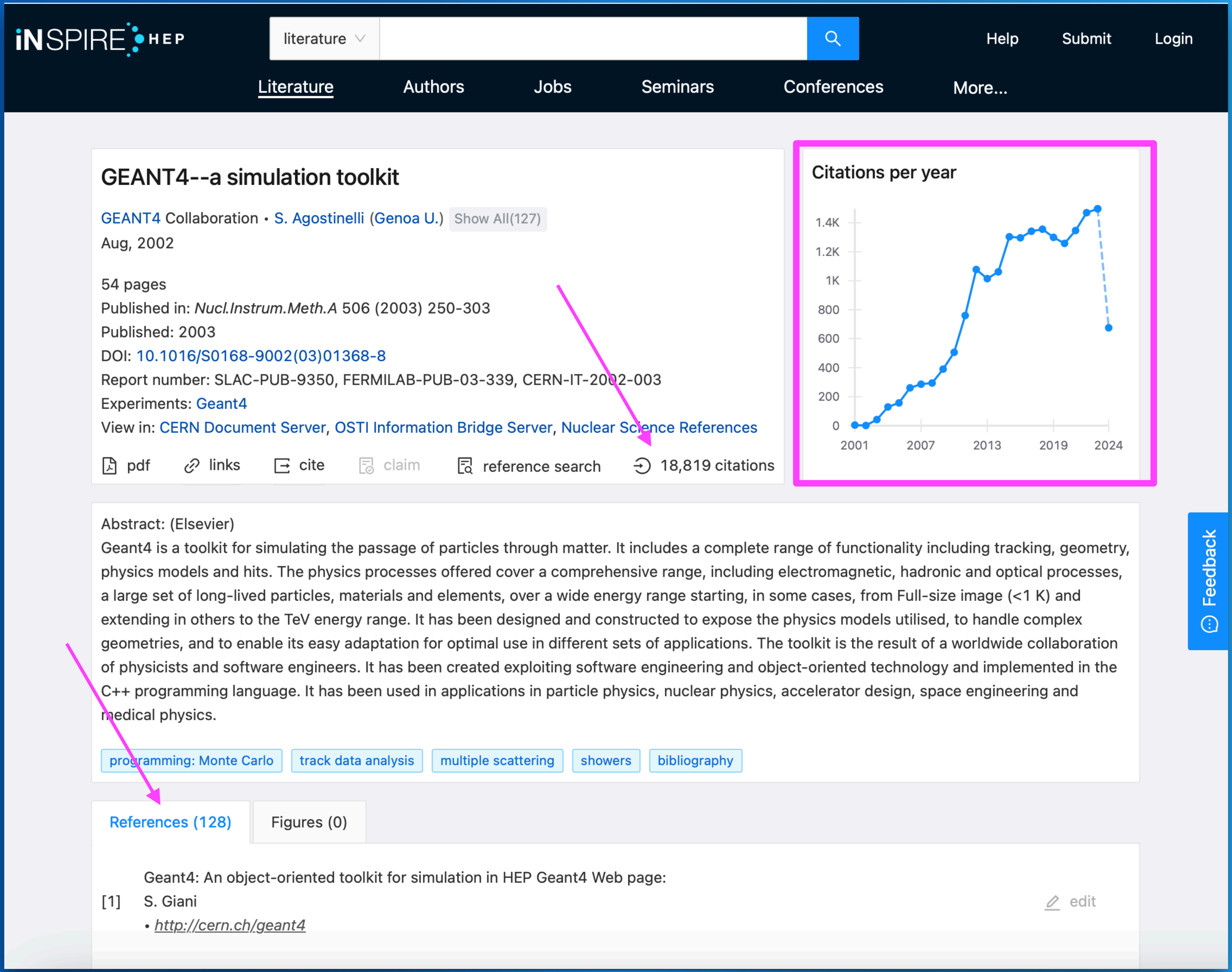

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GEANT4--a simulation toolkit

GEANT4 Collaboration • S. Agostinelli (Genoa U.) Show All(127)

Aug, 2002

54 pages

Published in: *Nucl.Instrum.Meth.A* 506 (2003) 250-303

Published: 2003

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Report number: SLAC-PUB-9350, FERMILAB-PUB-03-339, CERN-IT-2002-003

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Abstract: (Elsevier)

Geant4 is a toolkit for simulating the passage of particles through matter. It includes a complete range of functionality including tracking, geometry, physics models and hits. The physics processes offered cover a comprehensive range, including electromagnetic, hadronic and optical processes, a large set of long-lived particles, materials and elements, over a wide energy range starting, in some cases, from Full-size image (<1 K) and extending in others to the TeV energy range. It has been designed and constructed to expose the physics models utilised, to handle complex geometries, and to enable its easy adaptation for optimal use in different sets of applications. The toolkit is the result of a worldwide collaboration of physicists and software engineers. It has been created exploiting software engineering and object-oriented technology and implemented in the C++ programming language. It has been used in applications in particle physics, nuclear physics, accelerator design, space engineering and medical physics.

programming: Monte Carlo | track data analysis | multiple scattering | showers | bibliography

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[1] Geant4: An object-oriented toolkit for simulation in HEP Geant4 Web page:
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How Do Astronomers Share Data? Reliability and Persistence of Datasets Linked in AAS Publications and a Qualitative Study of Data Practices among US Astronomers

Alberto Pepe[1,2]*, Alyssa Goodman[1,2], August Muench[1], Merce Crosas[2], Christopher Erdmann[1]

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Abstract

We analyze data sharing practices of astronomers over the past fifteen years. An analysis of URL links embedded in papers published by the American Astronomical Society reveals that the total number of links included in the literature rose dramatically from 1997 until 2005, when it leveled off at around 1500 per year. The analysis also shows that the availability of linked material decays with time: in 2011, 44% of links published a decade earlier, in 2001, were broken. A rough analysis of link types reveals that links to data hosted on astronomers' personal websites become unreachable much faster than links to datasets on curated institutional sites. To gauge astronomers' current data sharing practices and preferences further, we performed in-depth interviews with 12 scientists and online surveys with 173 scientists, all at a large astrophysical research institute in the United States: the Harvard-Smithsonian Center for Astrophysics, in Cambridge, MA. Both the in-depth interviews and the online survey indicate that, in principle, there is no philosophical objection to data-sharing among astronomers at this institution. Key reasons that more data are not presently shared more efficiently in astronomy include: the difficulty of sharing large data sets; over reliance on non-robust, non-reproducible mechanisms for sharing data (e.g. emailing it); unfamiliarity with options that make data-sharing easier (faster) and/or more robust; and, lastly, a sense that other researchers would not want the data to be shared. We conclude with a short discussion of a new effort to implement an easy-to-use, robust, system for data sharing in astronomy, at theastrodata.org, and we analyze the uptake of that system to-date.

Citation: Pepe A, Goodman A, Muench A, Crosas M, Erdmann C (2014) How Do Astronomers Share Data? Reliability and Persistence of Datasets Linked in AAS Publications and a Qualitative Study of Data Practices among US Astronomers. PLoS ONE 9(8): e104798. doi:10.1371/journal.pone.0104798

Editor: Aaron Alain-Jon Golden, Albert Einstein College of Medicine, United States of America

Received November 20, 2013; **Accepted** July 18, 2014; **Published** August 28, 2014

Funding: This material is based upon work supported by the National Aeronautics and Space Administration under Grant/Contract/Agreement No. NNX12AE11G issued through the Astrophysical Data Analysis Program (ADAP). The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

Competing Interests: The authors have declared that no competing interests exist.

* Email: alberto.pepe@gmail.com

Introduction

> No, I don't have a website where I store these data. Most of it is in various stages of mess. —An Astronomer

Astronomical observations can generate very large volumes of data, and observations taken at a particular time are by definition irreplaceable and unrepeatable. As such, making astronomical data publicly available in a structured, intelligible format is of fundamental importance to enable scientific transparency and long term data curation and preservation, facilitating data re-use [1].

To date, some of the most systemically planned data sharing in astronomical research has focused on the preservation and dissemination of observations created in so-called ''sky surveys.'' The purpose of these surveys is to collect and measure data from extended regions of the Sky, in a systematic and controlled fashion. Modern optical sky surveys, such as the Sloan Digital Sky Survey (SDSS), the 2-Micron All-Sky Survey (2MASS), and the future Large Synoptic Survey Telescope (LSST) generate massive databases, ranging in size from hundreds of terabytes to hundreds of petabytes [2]. Surveys that rely on spectrally-resolved observations, often made with radio-wavelength interferometers, generate ''3D Data Cubes'' rather than ''2D images,'' and they are already so large that it is not possible to keep all the raw data after analysis is complete.

Despite their sheer volume, the data collected in the context of large surveys represent only a portion of all the data generated in Astronomy. Most discoveries rely upon smaller studies, and/or are based on heavily-processed subsets of many surveys. In any field of scientific endeavor, many different levels of data exist [3]: from ''raw'' data to ''processed'' data, from ''calibration'' data to ''published'' data. If we imagine all data in Astronomy to be a pyramid, **primary** data from large sky surveys occupies the bottom half of the pyramid. But, as we just mentioned, these primary data are used by astronomers all over the world to produce more specific studies, where astronomers analyze and process primary data in many ways producing **derived** data.

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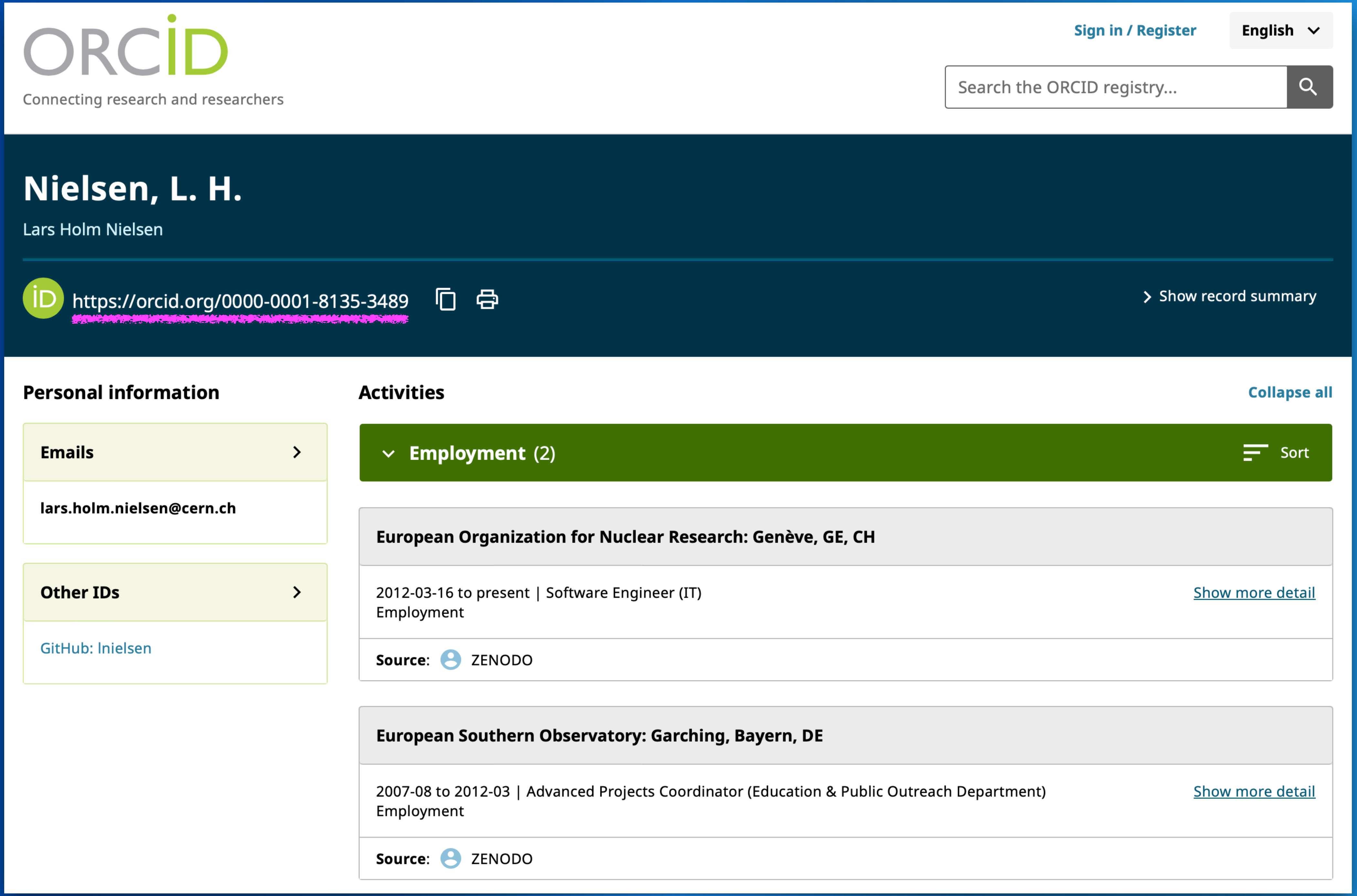

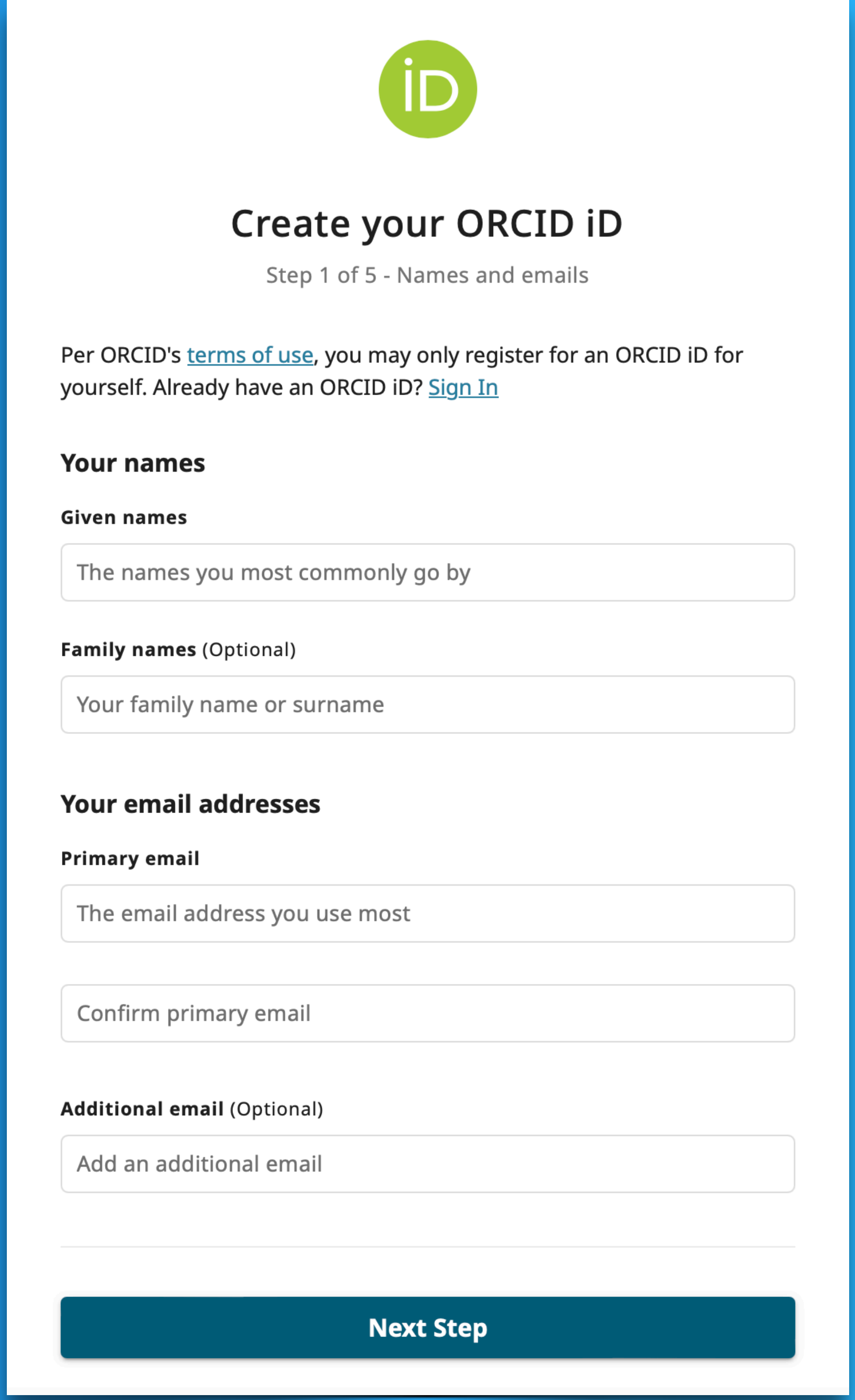

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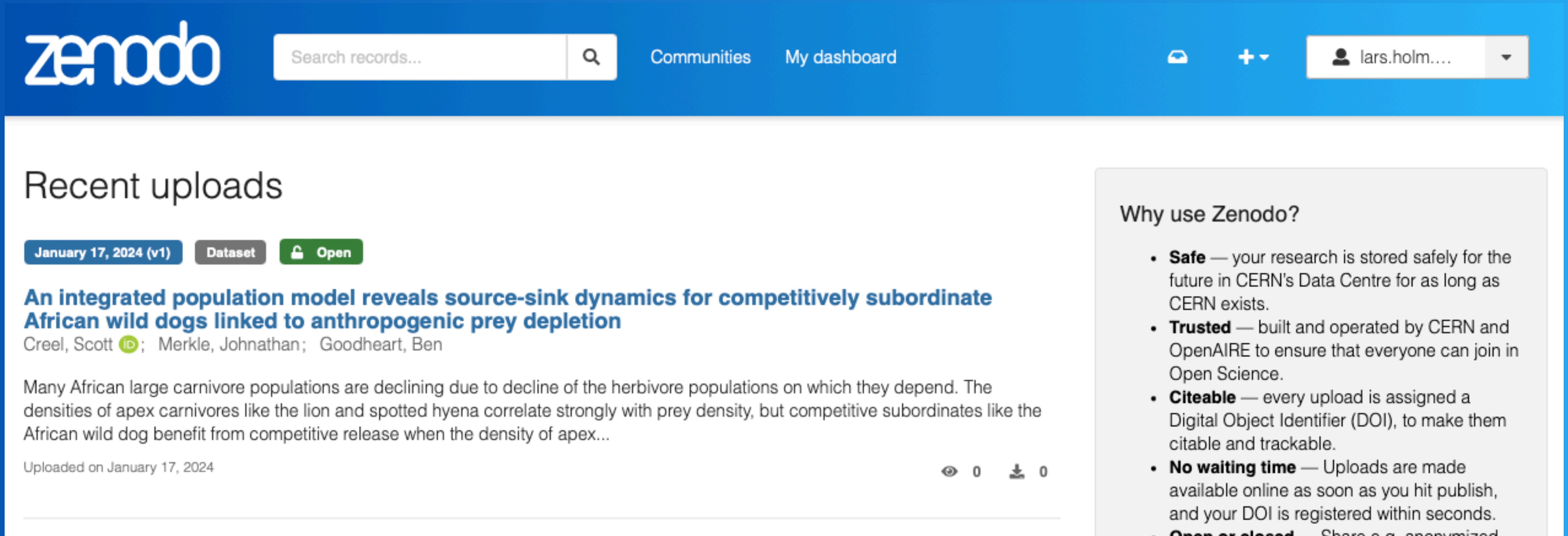

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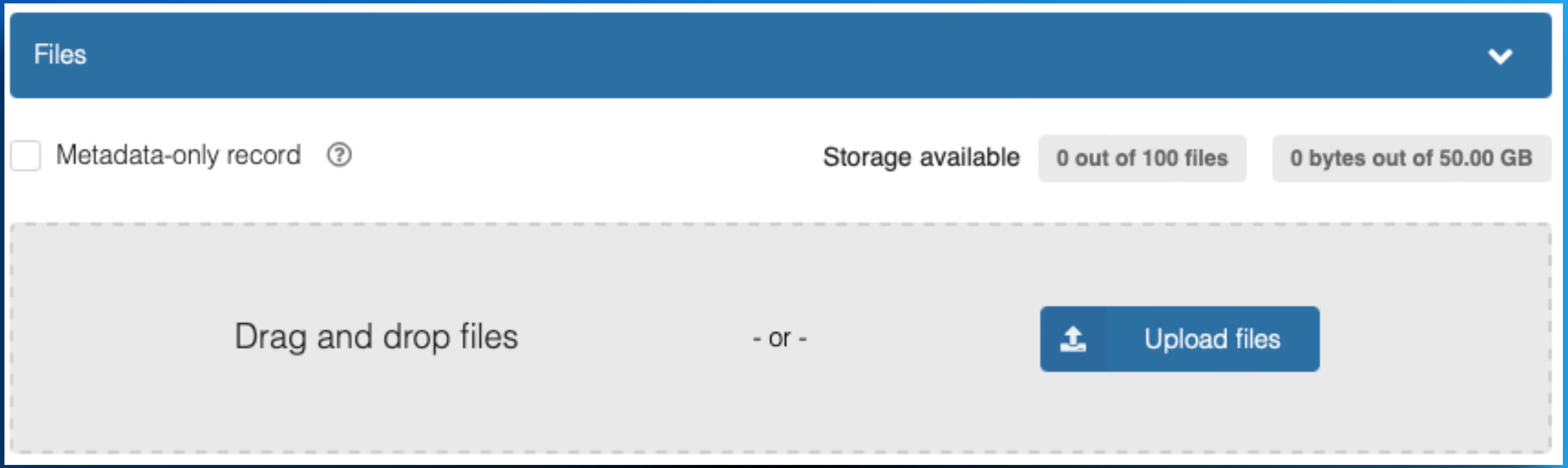

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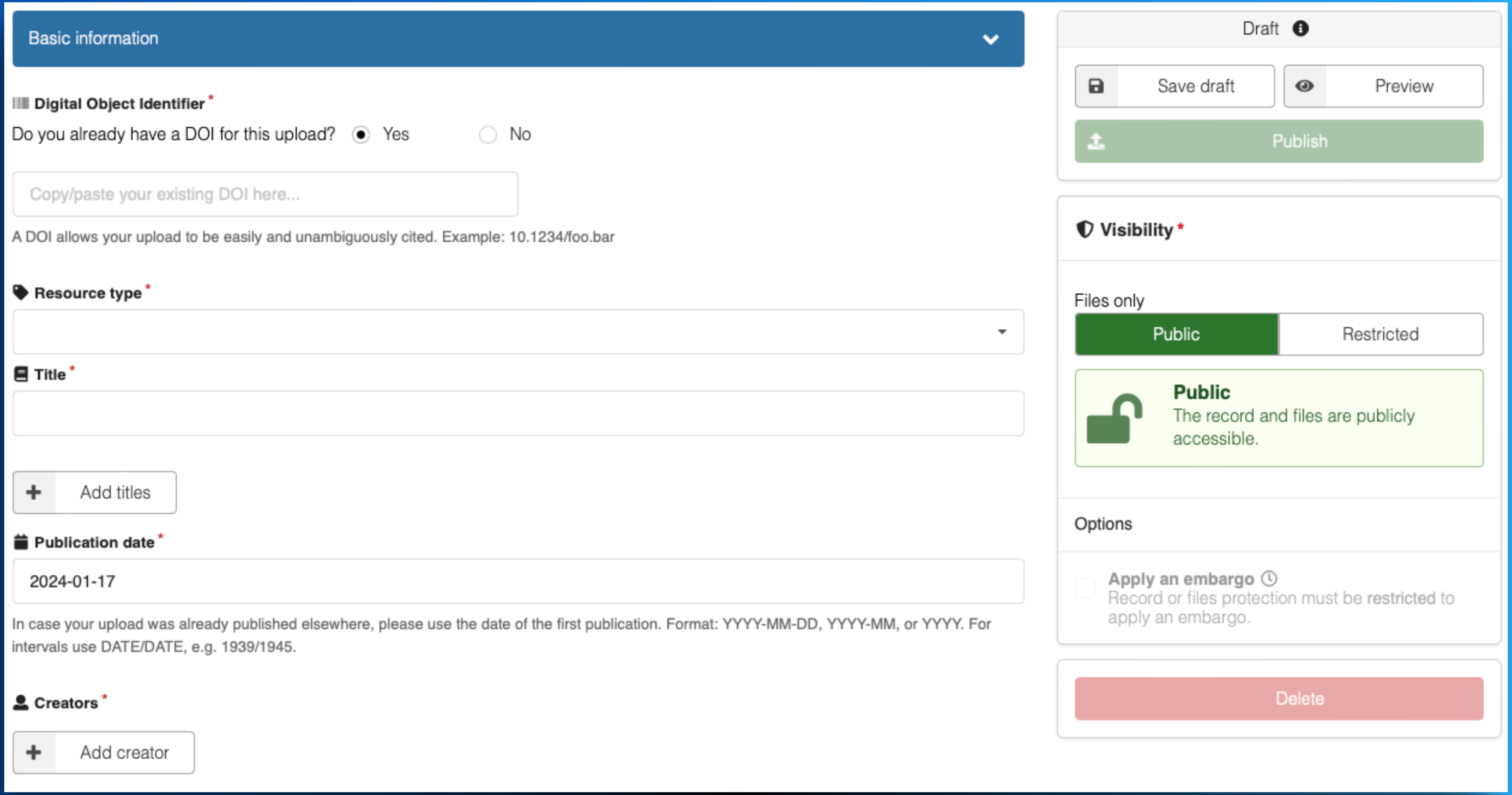

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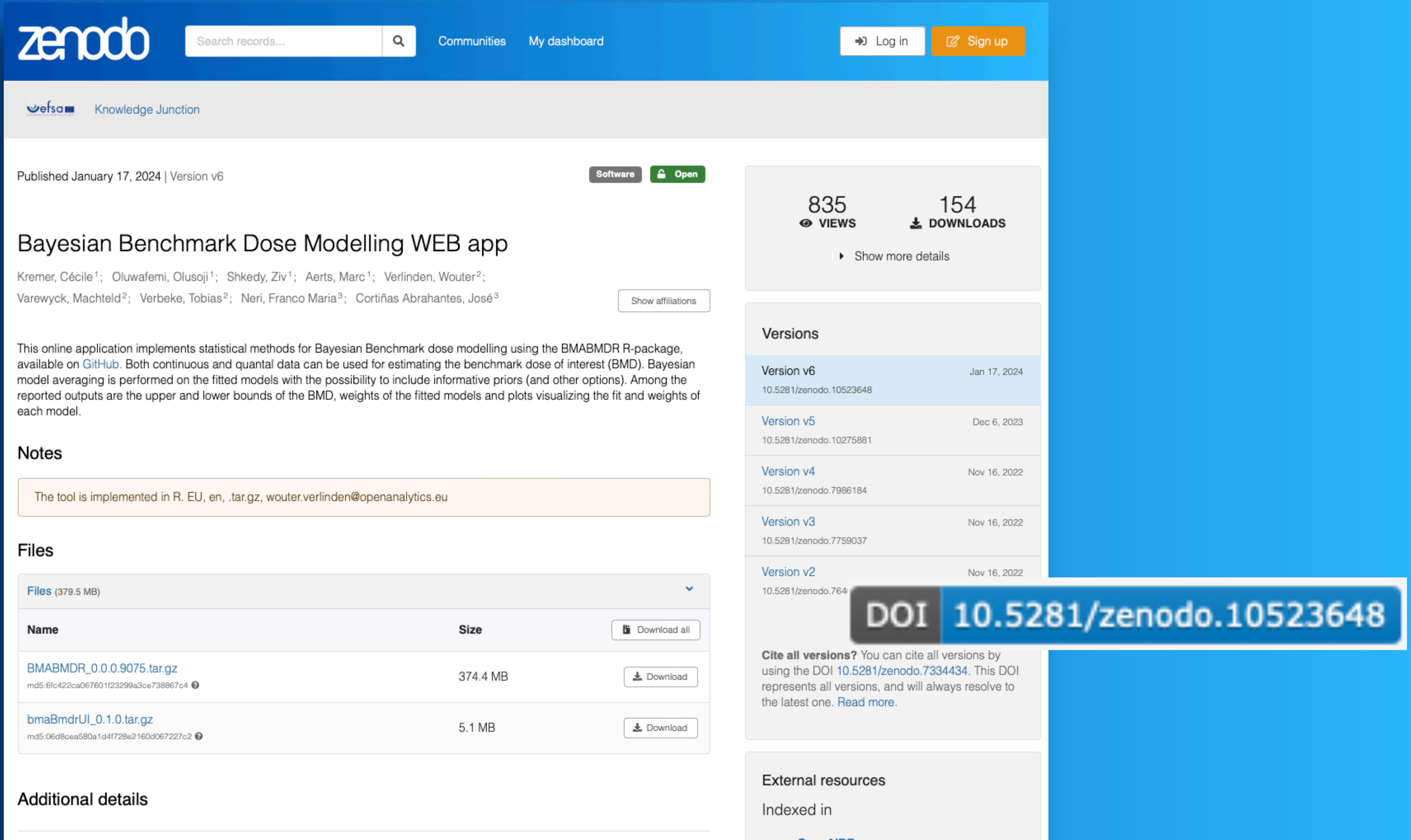
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This online application implements statistical methods for Bayesian Benchmark dose modelling using the BMABMDR R-package, available on GitHub. Both continuous and quantal data can be used for estimating the benchmark dose of interest (BMD). Bayesian model averaging is performed on the fitted models with the possibility to include informative priors (and other options). Among the reported outputs are the upper and lower bounds of the BMD, weights of the fitted models and plots visualizing the fit and weights of each model.
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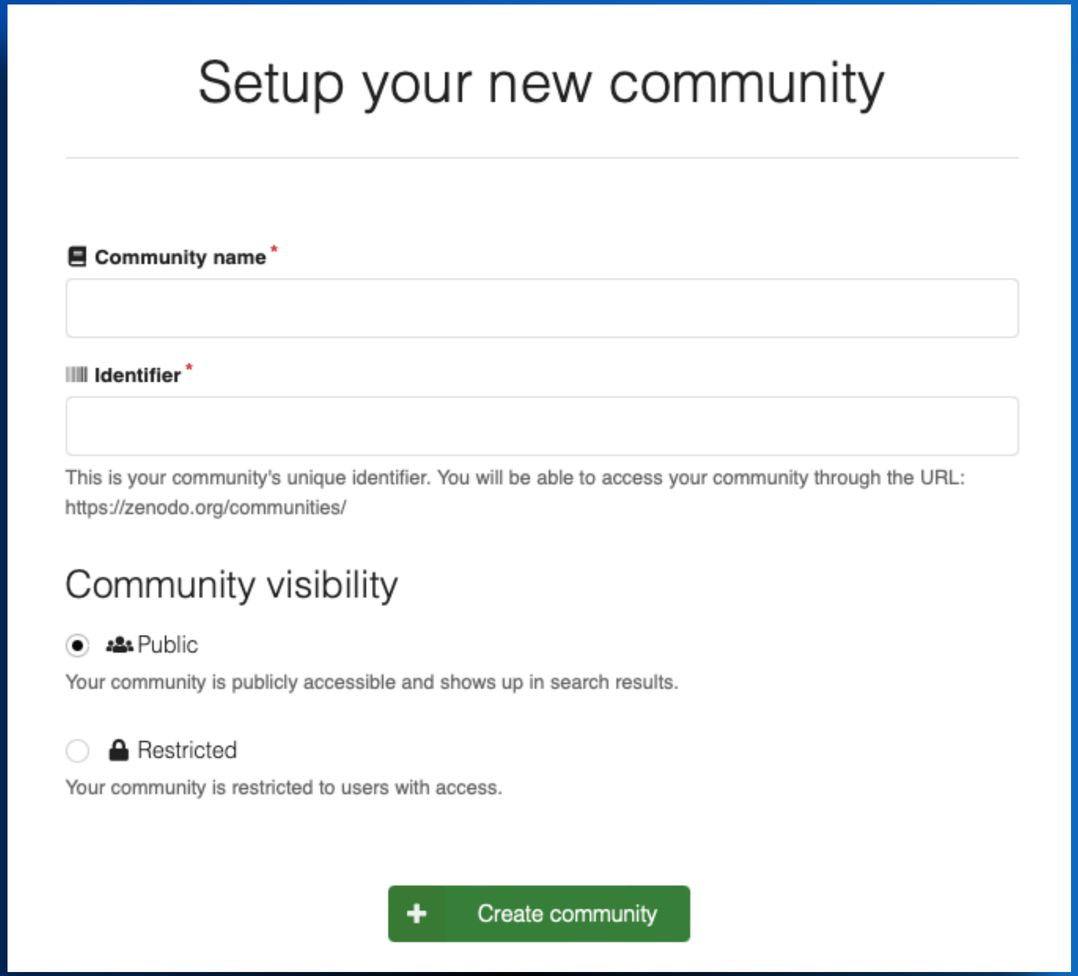

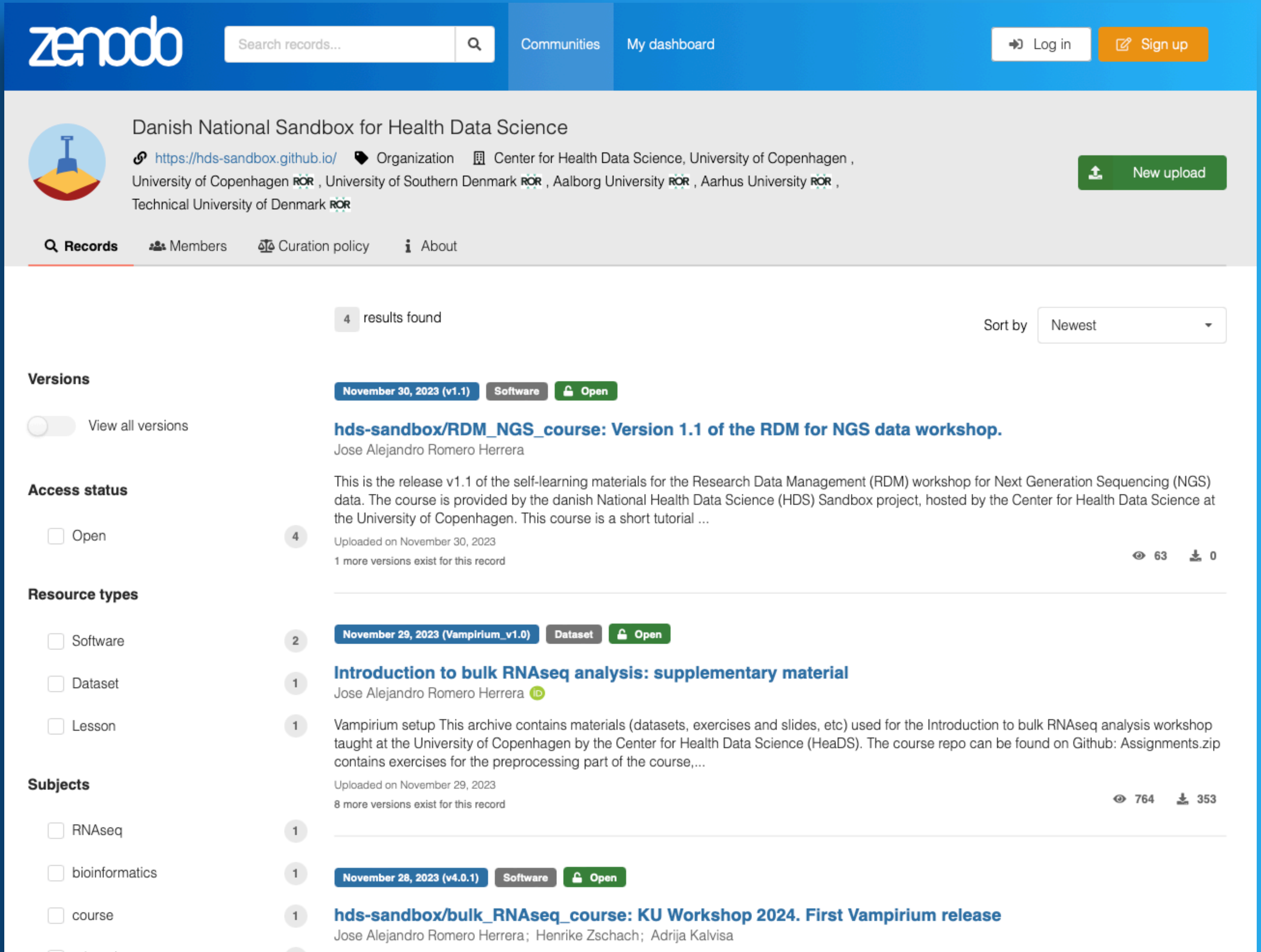

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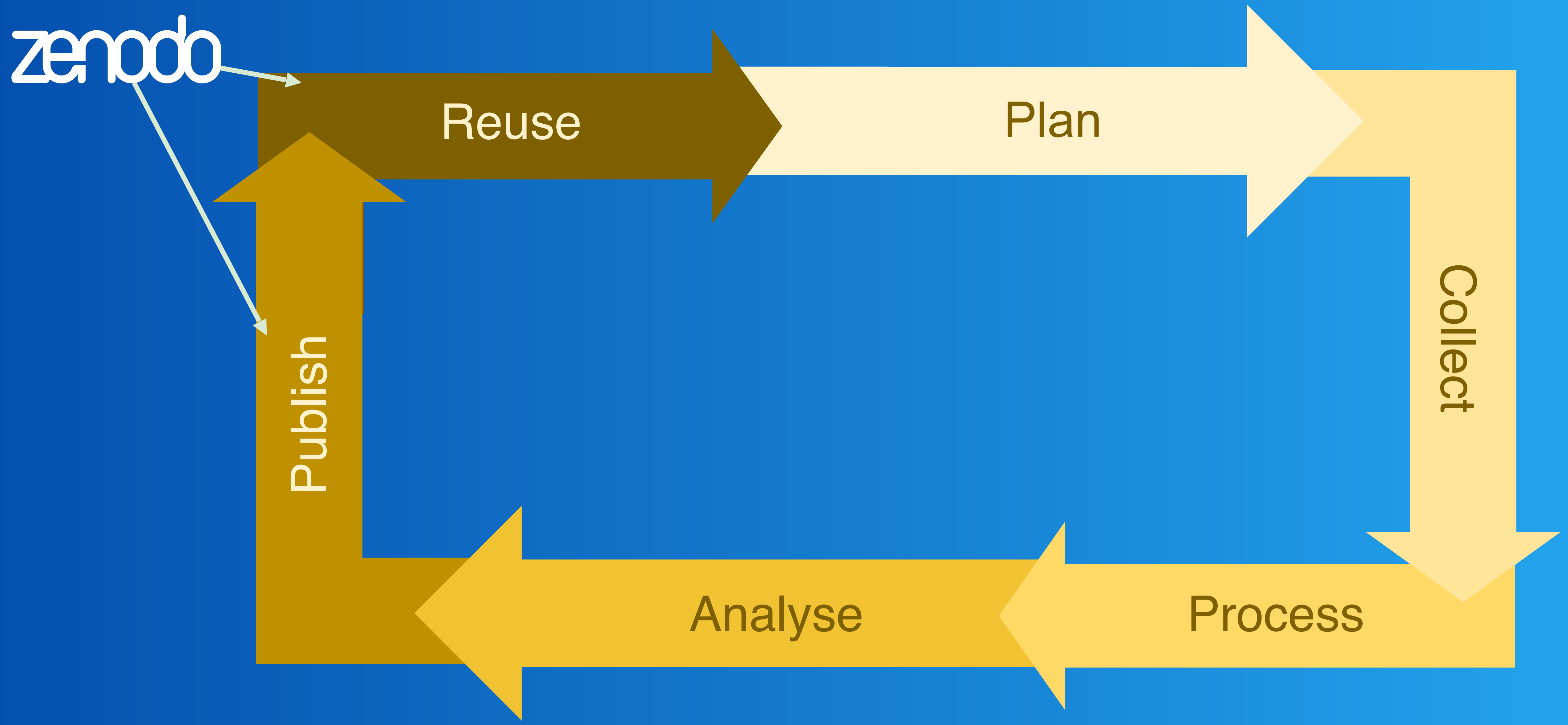

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- Start early!
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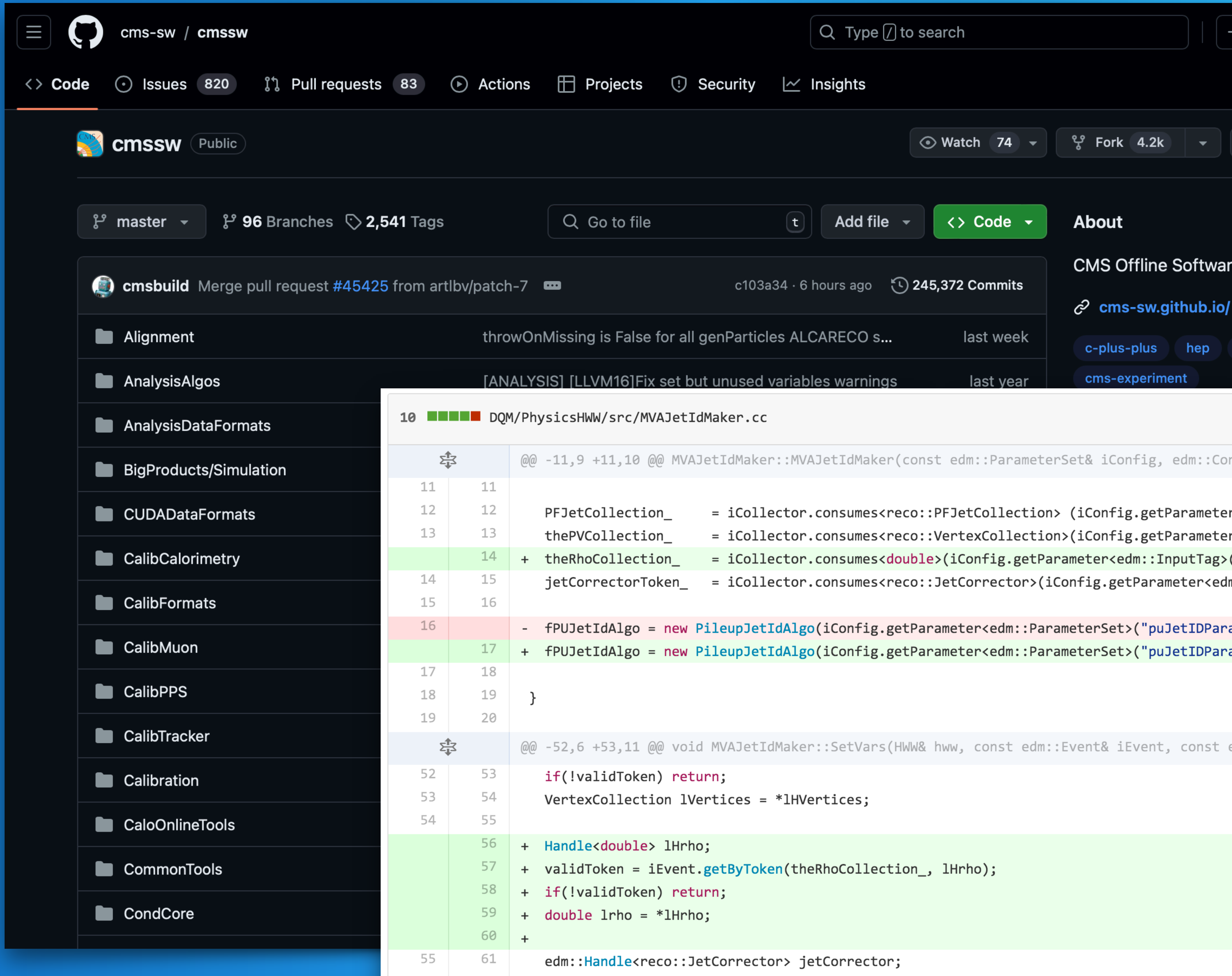

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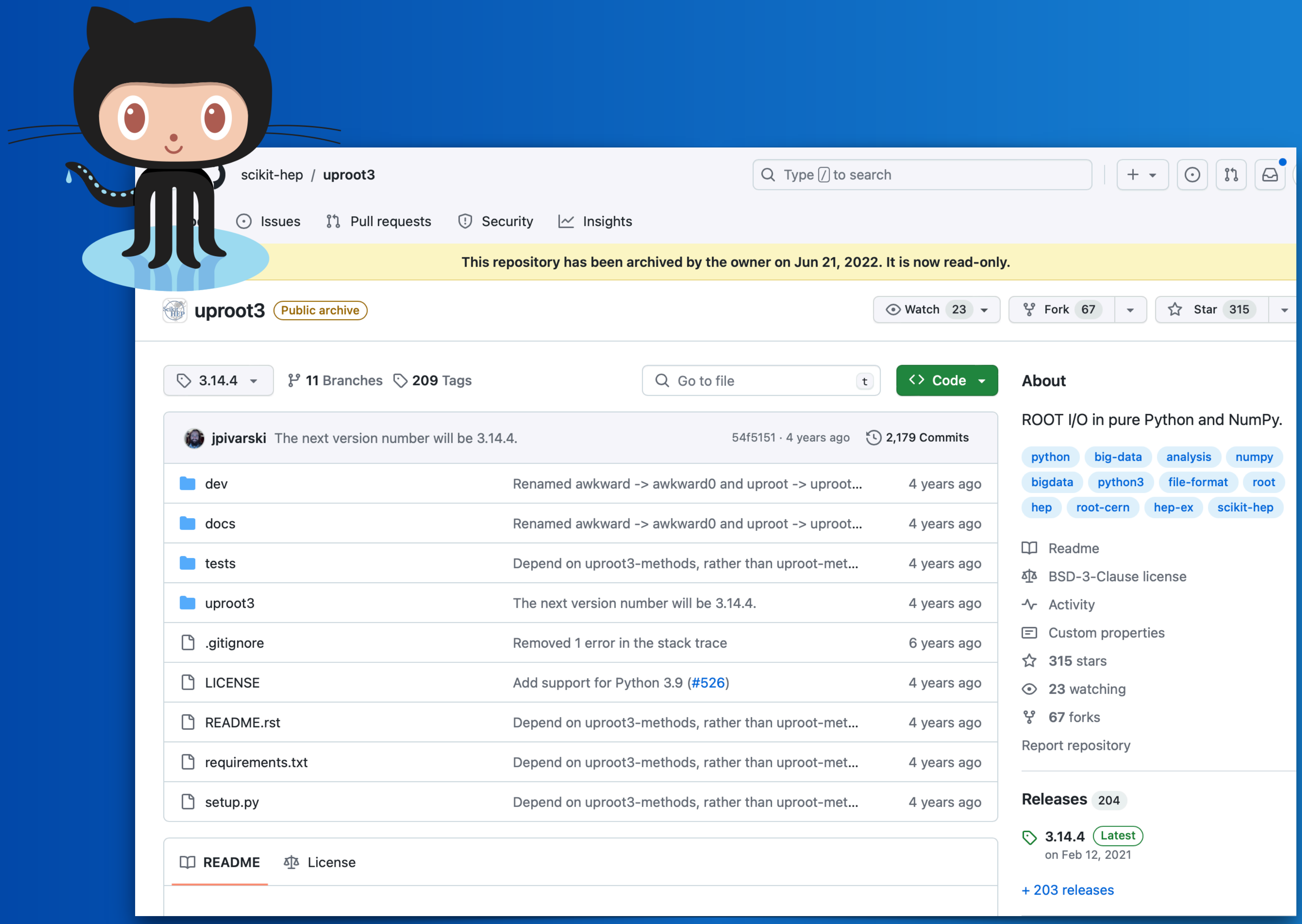

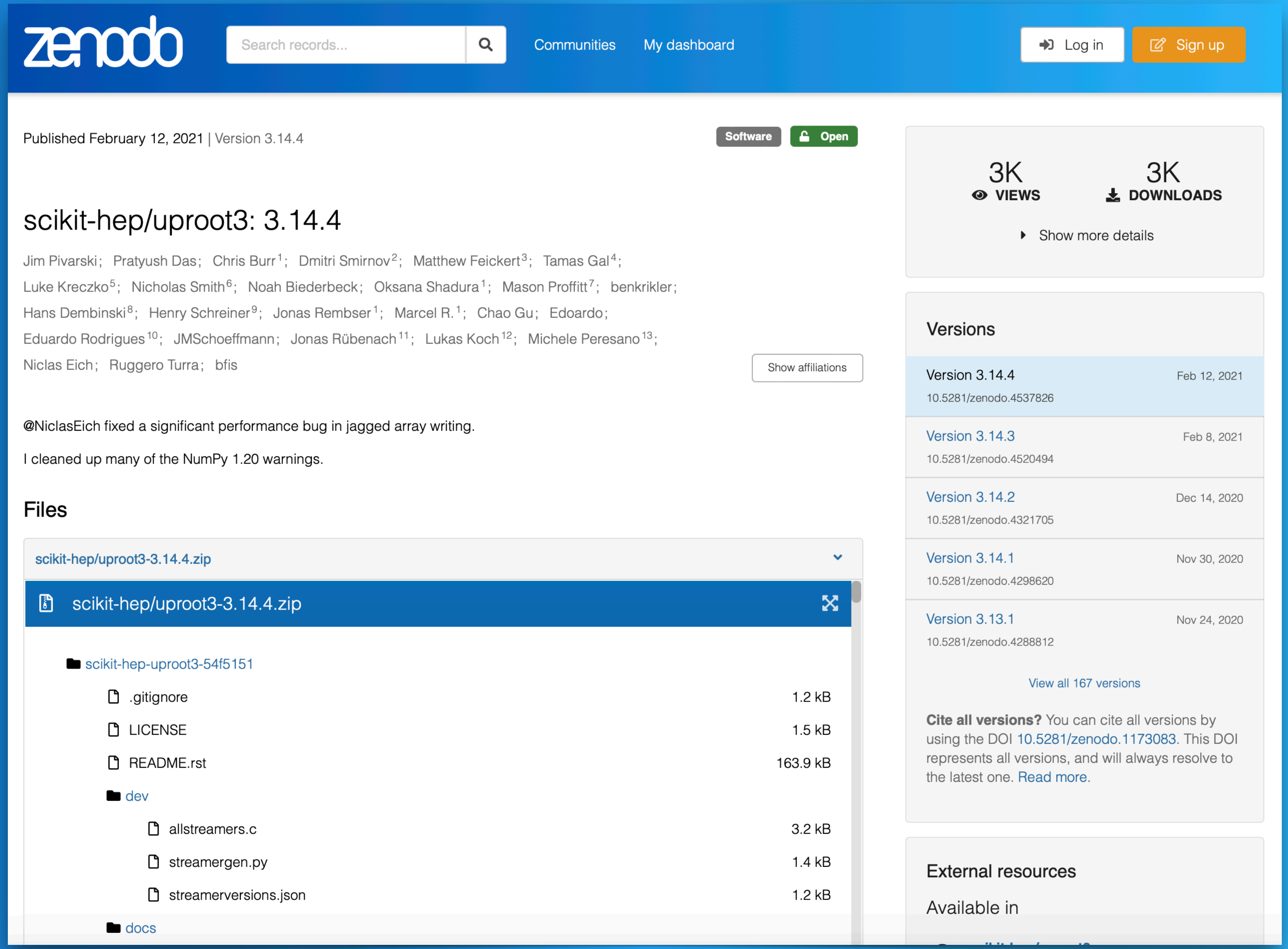

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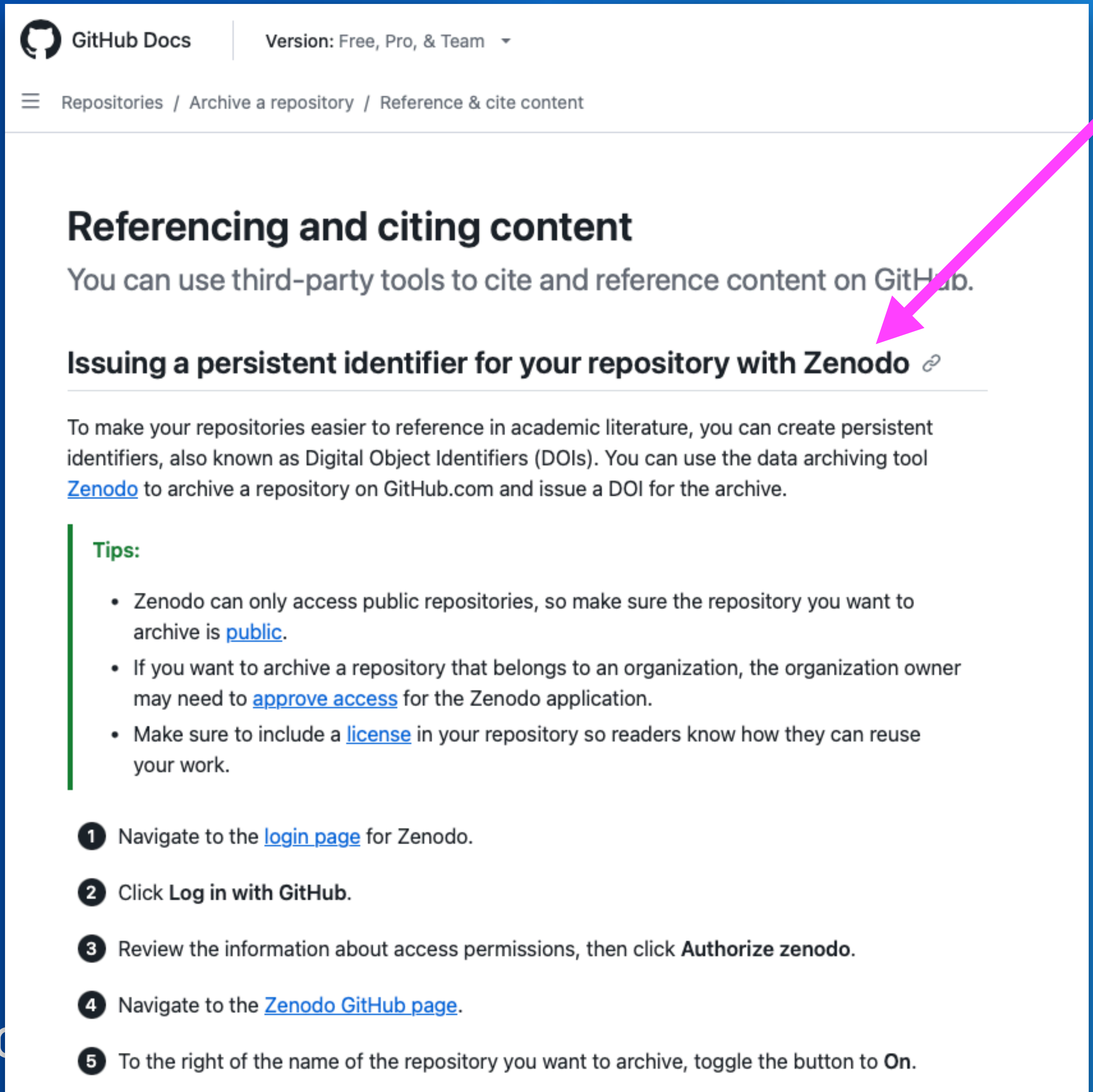
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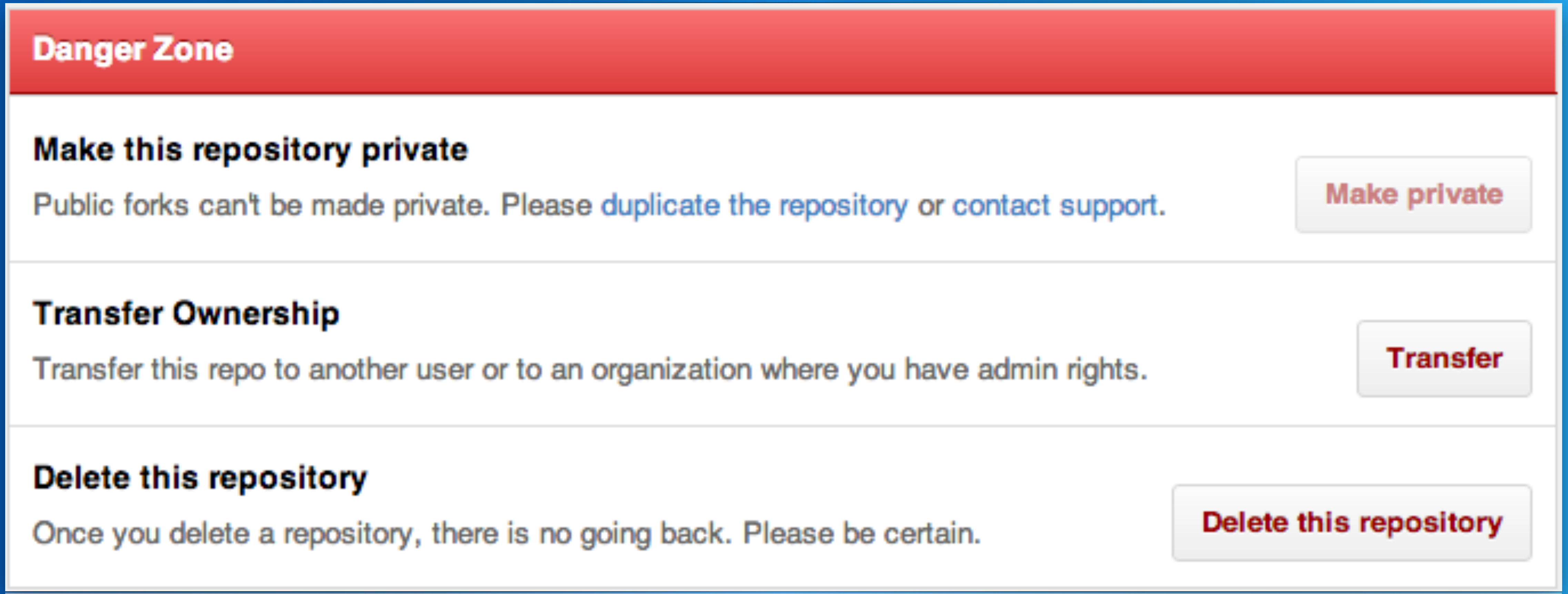
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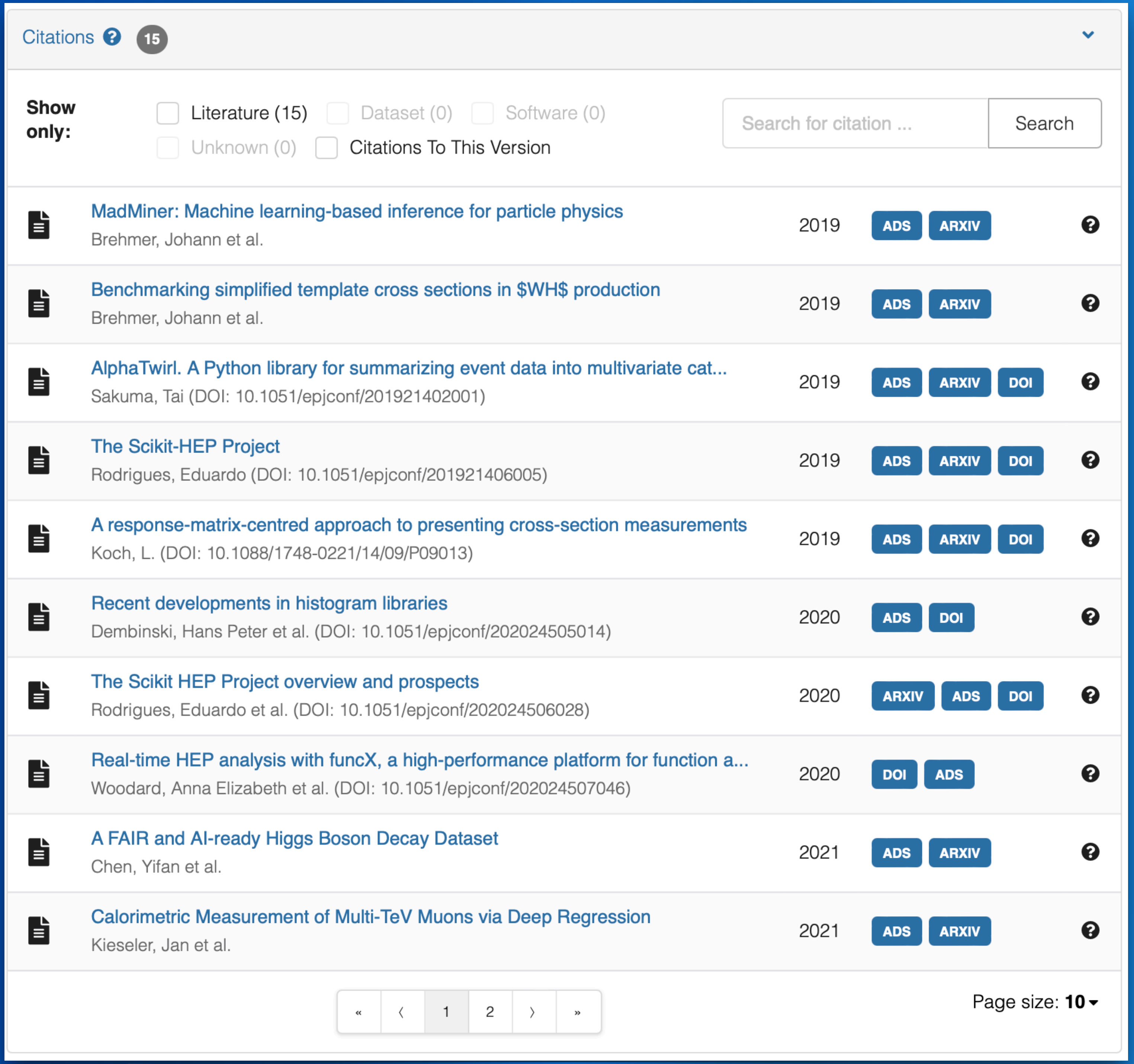

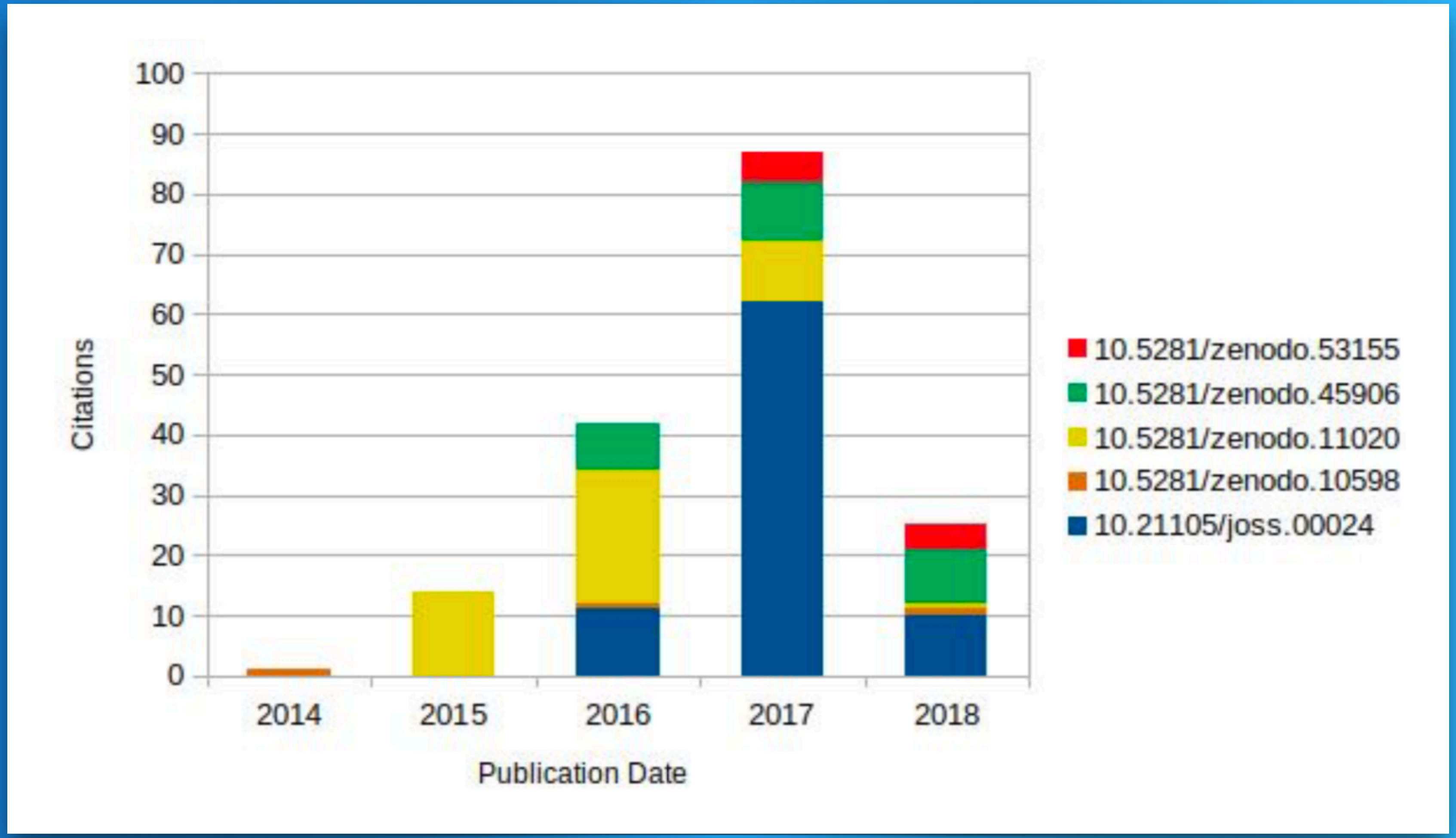

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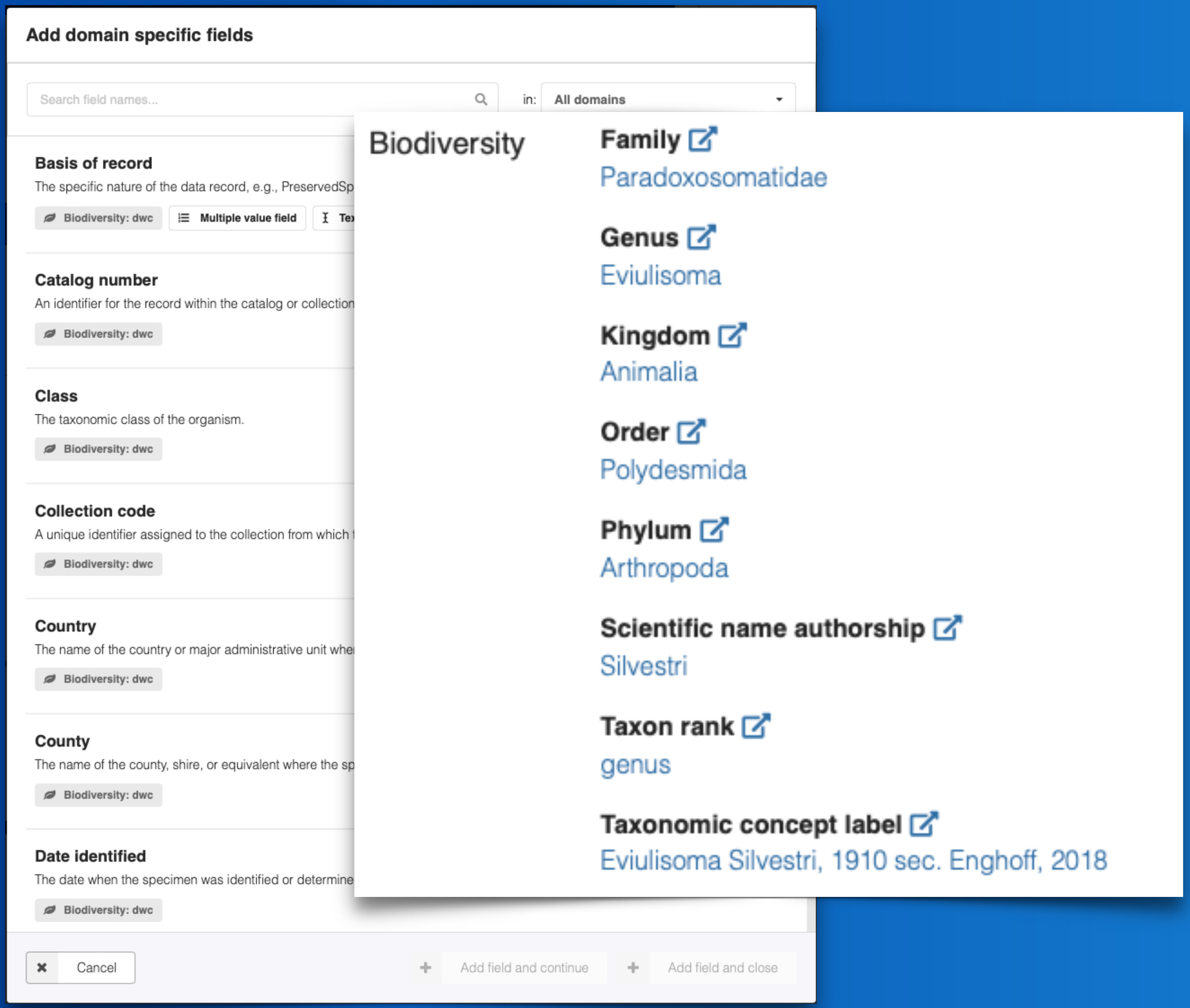

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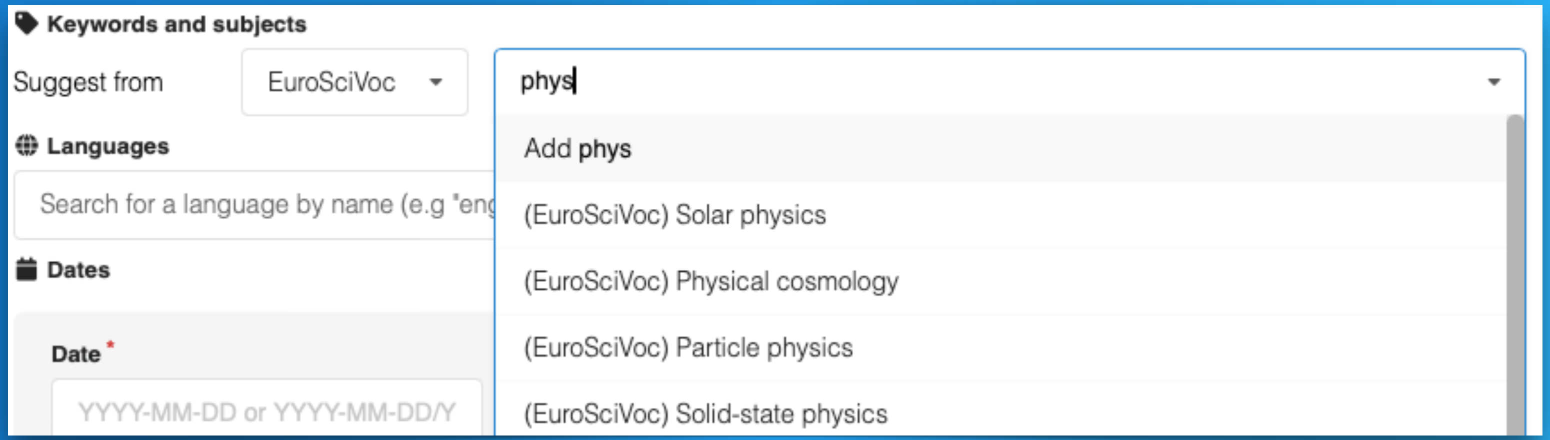

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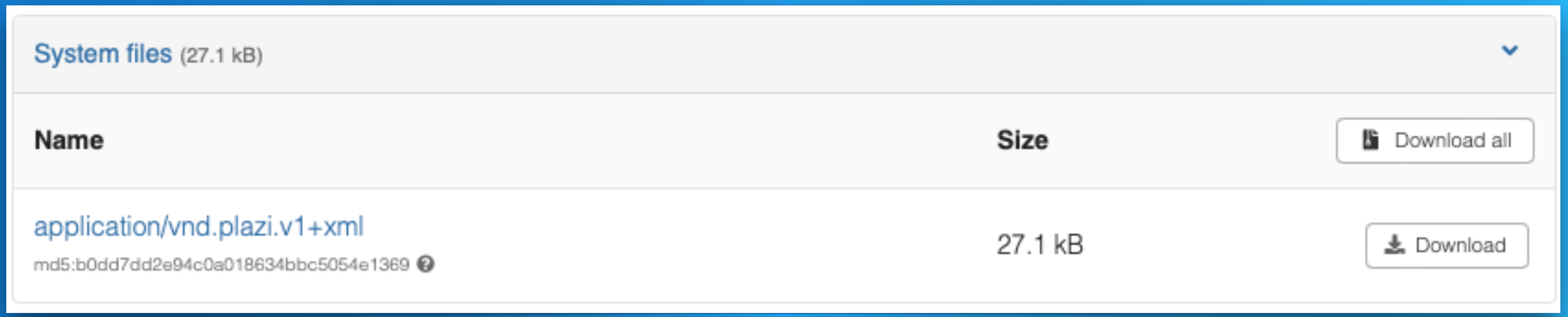

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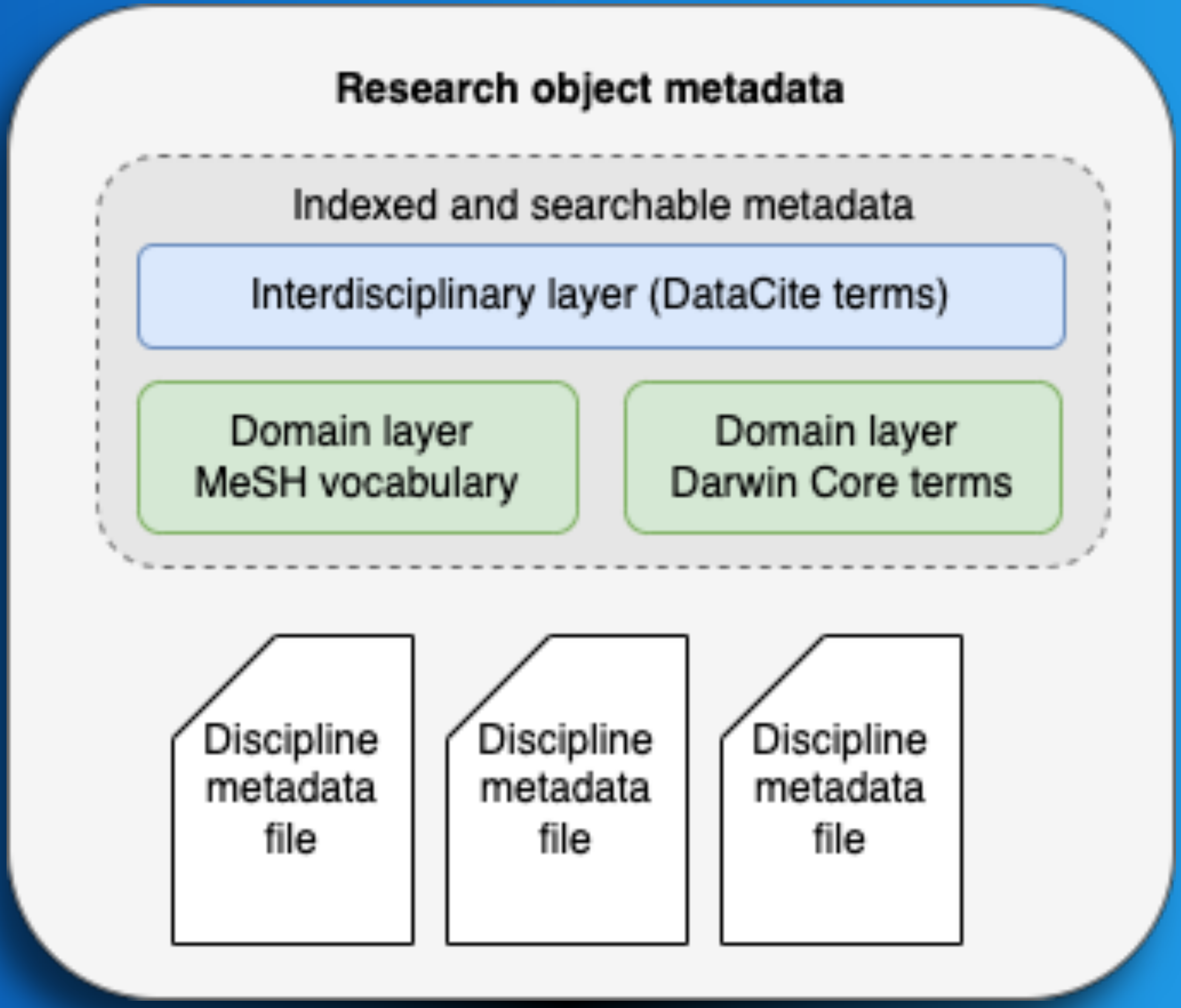

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