

Bridging research silos – How PIDs build a connected and open research landscape

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Open Science Week, October 22, 2026

Content

- Basics
 - What are PIDs, what are they used for, and how do they work?
 - Selected PID Types
 - Key Takeaways
- PIDs in the Context of the NFDI (PID4NFDI)
- PID Roadmap for Germany
(PID Network Germany)

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Persistent Identifiers (PIDs)

Basics

Why We need PIDs?

<https://doi.org/10.1103/PhysRevLett.114.191803>

Combined Measurement of the Higgs Boson Mass in pp Collisions at $\sqrt{s} = 7$ and 8 TeV with the ATLAS and CMS Experiments

G. Aad et al.

(ATLAS Collaboration)
(CMS Collaboration)
(Received 25 March 2015; published 14 May 2015)

A measurement of the Higgs boson mass is presented based on the combined data samples of the ATLAS and CMS experiments at the CLAS LHC in the $M = 7$ and 8 TeV pp collision channels. The results are obtained from a simultaneous fit to the reconstructed invariant mass peaks in the two channels and are found to be consistent among themselves. The combined measured mass of the Higgs boson is $m_H = 125.09 \pm 0.21$ (stat) ± 0.12 (sys) GeV.

M. Vranjes Milosavljevic,^{1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,34,35,36,37,38,39,40,41,42,43,44,45,46,47,48,49,50,51,52,53,54,55,56,57,58,59,60,61,62,63,64,65,66,67,68,69,70,71,72,73,74,75,76,77,78,79,80,81,82,83,84,85,86,87,88,89,90,91,92,93,94,95,96,97,98,99,100,101,102,103,104,105,106,107,108,109,110,111,112,113,114,115,116,117,118,119,120,121,122,123,124,125,126,127,128,129,130,131,132,133,134,135,136,137,138,139,140,141,142,143,144,145,146,147,148,149,150,151,152,153,154,155,156,157,158,159,160,161,162,163,164,165,166,167,168,169,170,171,172,173,174,175,176,177,178,179,180,181,182,183,184,185,186,187,188,189,190,191,192,193,194,195,196,197,198,199,200,201,202,203,204,205,206,207,208,209,210,211,212,213,214,215,216,217,218,219,220,221,222,223,224,225,226,227,228,229,230,231,232,233,234,235,236,237,238,239,240,241,242,243,244,245,246,247,248,249,250,251,252,253,254,255,256,257,258,259,260,261,262,263,264,265,266,267,268,269,270,271,272,273,274,275,276,277,278,279,280,281,282,283,284,285,286,287,288,289,290,291,292,293,294,295,296,297,298,299,300,301,302,303,304,305,306,307,308,309,310,311,312,313,314,315,316,317,318,319,320,321,322,323,324,325,326,327,328,329,330,331,332,333,334,335,336,337,338,339,340,341,342,343,344,345,346,347,348,349,350,351,352,353,354,355,356,357,358,359,360,361,362,363,364,365,366,367,368,369,370,371,372,373,374,375,376,377,378,379,380,381,382,383,384,385,386,387,388,389,390,391,392,393,394,395,396,397,398,399,400,401,402,403,404,405,406,407,408,409,410,411,412,413,414,415,416,417,418,419,420,421,422,423,424,425,426,427,428,429,430,431,432,433,434,435,436,437,438,439,440,441,442,443,444,445,446,447,448,449,450,451,452,453,454,455,456,457,458,459,460,461,462,463,464,465,466,467,468,469,470,471,472,473,474,475,476,477,478,479,480,481,482,483,484,485,486,487,488,489,490,491,492,493,494,495,496,497,498,499,500,501,502,503,504,505,506,507,508,509,510,511,512,513,514,515,516,517,518,519,520,521,522,523,524,525,526,527,528,529,530,531,532,533,534,535,536,537,538,539,540,541,542,543,544,545,546,547,548,549,550,551,552,553,554,555,556,557,558,559,560,561,562,563,564,565,566,567,568,569,570,571,572,573,574,575,576,577,578,579,580,581,582,583,584,585,586,587,588,589,590,591,592,593,594,595,596,597,598,599,600,601,602,603,604,605,606,607,608,609,610,611,612,613,614,615,616,617,618,619,620,621,622,623,624,625,626,627,628,629,630,631,632,633,634,635,636,637,638,639,640,641,642,643,644,645,646,647,648,649,650,651,652,653,654,655,656,657,658,659,660,661,662,663,664,665,666,667,668,669,670,671,672,673,674,675,676,677,678,679,680,681,682,683,684,685,686,687,688,689,690,691,692,693,694,695,696,697,698,699,700,701,702,703,704,705,706,707,708,709,710,711,712,713,714,715,716,717,718,719,720,721,722,723,724,725,726,727,728,729,730,731,732,733,734,735,736,737,738,739,740,741,742,743,744,745,746,747,748,749,750,751,752,753,754,755,756,757,758,759,760,761,762,763,764,765,766,767,768,769,770,771,772,773,774,775,776,777,778,779,780,781,782,783,784,785,786,787,788,789,790,791,792,793,794,795,796,797,798,799,800,801,802,803,804,805,806,807,808,809,810,811,812,813,814,815,816,817,818,819,820,821,822,823,824,825,826,827,828,829,830,831,832,833,834,835,836,837,838,839,840,841,842,843,844,845,846,847,848,849,850,851,852,853,854,855,856,857,858,859,860,861,862,863,864,865,866,867,868,869,870,871,872,873,874,875,876,877,878,879,880,881,882,883,884,885,886,887,888,889,890,891,892,893,894,895,896,897,898,899,900,901,902,903,904,905,906,907,908,909,910,911,912,913,914,915,916,917,918,919,920,921,922,923,924,925,926,927,928,929,930,931,932,933,934,935,936,937,938,939,940,941,942,943,944,945,946,947,948,949,950,951,952,953,954,955,956,957,958,959,960,961,962,963,964,965,966,967,968,969,970,971,972,973,974,975,976,977,978,979,980,981,982,983,984,985,986,987,988,989,990,991,992,993,994,995,996,997,998,999,1000,1001,1002,1003,1004,1005,1006,1007,1008,1009,1010,1011,1012,1013,1014,1015,1016,1017,1018,1019,1020,1021,1022,1023,1024,1025,1026,1027,1028,1029,1030,1031,1032,1033,1034,1035,1036,1037,1038,1039,1040,1041,1042,1043,1044,1045,1046,1047,1048,1049,1050,1051,1052,1053,1054,1055,1056,1057,1058,1059,1060,1061,1062,1063,1064,1065,1066,1067,1068,1069,1070,1071,1072,1073,1074,1075,1076,1077,1078,1079,1080,1081,1082,1083,1084,1085,1086,1087,1088,1089,1090,1091,1092,1093,1094,1095,1096,1097,1098,1099,1100,1101,1102,1103,1104,1105,1106,1107,1108,1109,1110,1111,1112,1113,1114,1115,1116,1117,1118,1119,1120,1121,1122,1123,1124,1125,1126,1127,1128,1129,1130,1131,1132,1133,1134,1135,1136,1137,1138,1139,1140,1141,1142,1143,1144,1145,1146,1147,1148,1149,1150,1151,1152,1153,1154,1155,1156,1157,1158,1159,1160,1161,1162,1163,1164,1165,1166,1167,1168,1169,1170,1171,1172,1173,1174,1175,1176,1177,1178,1179,1180,1181,1182,1183,1184,1185,1186,1187,1188,1189,1190,1191,1192,1193,1194,1195,1196,1197,1198,1199,1200,1201,1202,1203,1204,1205,1206,1207,1208,1209,1210,1211,1212,1213,1214,1215,1216,1217,1218,1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Basics

Why We need PIDs?

- There are challenges in publication management related to
 - Homonyms
 - Name changes
 - Different spellings and abbreviations
 - ...
- The central importance of publications for research evaluation.
 - This makes the correct and unambiguous identification, naming, and linking of all contributors, infrastructures, and funding organizations with their research results essential.
 - A broad view of research output to recognize research products such as data, software, samples, etc., in addition to traditional text-based publications

Basics

What are PIDs?

- Persistent Identifier: “unique, universal, and permanent identifiers” ([Koster, 2020](#))
- “Identifier” = a string of characters that refers to an object
- “Unique” = refers to only one object (within the known universe)
- “Universal” = applies to the entire world (or the World Wide Web)
- “Persistent” = remains available regardless of individual institutions, systems, or system implementations
- Can refer to all types of objects, not just digital ones
- Most often “actionable”: Can be represented as a URL that leads to the identified source or to a landing page with metadata information
- Serve to link objects across platforms
- They can be resolved by users free of charge (“They’re free to resolve.”).



Basics

How do PIDs work?

- PIDs are typically organized within institutionally managed systems.
- Persistence is a matter of the service!
→ There must always be stakeholders who reliably operate the PID service, both technically and organizationally.
- PIDs incur costs (similar to publication costs), even though resolving them is free for users.
 - Mostly through (consortium) membership (e.g., DataCite Germany Consortium, ORCID Germany Consortium...)
- The PID string is structured according to a uniform schema.
 - Example: DOIs have the format prefix/suffix
 - A DOI formatted as a URL: <https://doi.org/10.2312/40943a34kjinho3>



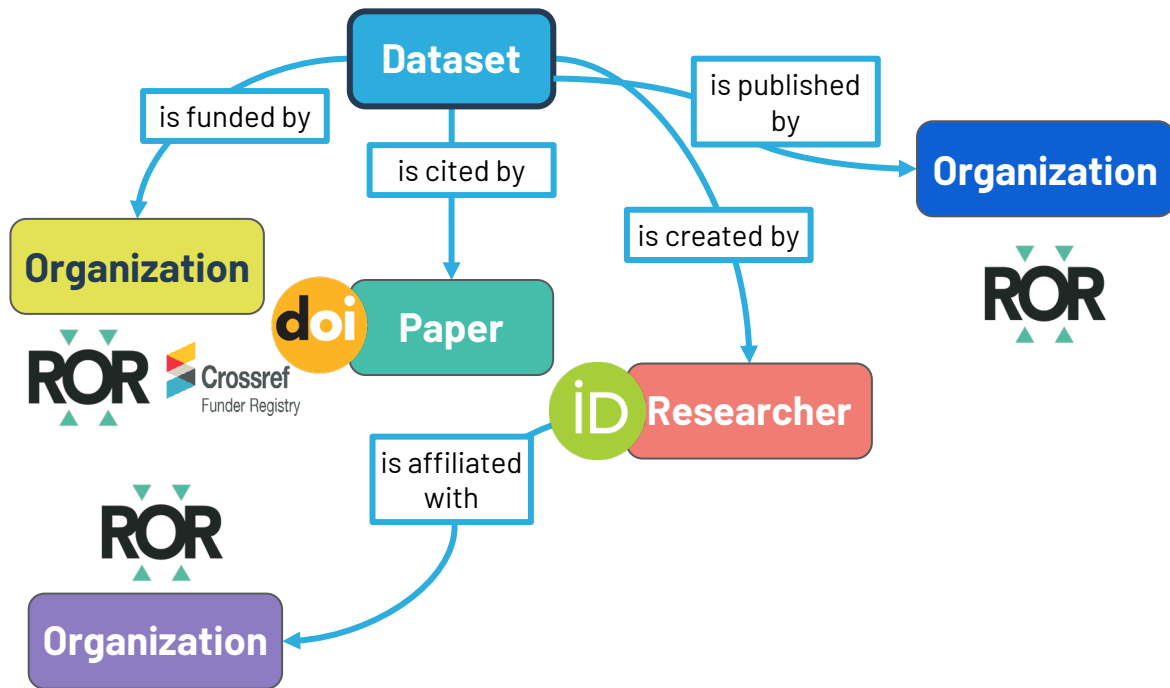
Basics

How do PIDs work? PIDs and Metadata

Closely linked to PIDs are the associated metadata for the entity.

They not only describe but also define how research objects are related to one another, for example:

- A journal article that cites a dataset,
- a person who authors a publication,
- an institution that funds a project,
- or software that generates data.



Source: El-Gebali, S. (2025). Interoperability through Persistent Identifiers Metadata. PID4NFDI. <https://doi.org/10.5281/zenodo.17864643>

Basics

Use Case: PIDs for Research Data

<https://marine-data.de/>

The screenshots show the following content:

- Top Left:** A map view of the Arctic region with various data points and trajectories. A red box highlights a specific area on the map.
- Top Right:** A list view of data entries. A red box highlights a specific entry: "PS122/5 Polarsen 2020-08-12 Ar... 2020-10-12 Br...".
- Bottom Left:** A detailed view of the selected entry. A red box highlights the entry details, including the title "Drift trajectories of the main sites of the Distributed Network of MOSAIC 2019/2020 (2021)" and the authors "Nicolau, Marcel; Hermann-Campe, Kathrin; Blas, Angela; Hoppmann, Mario; Kanow, Torsten; Krähfeld, Richard A.; Le, Lu; Rabe, Benjamin (2021)".
- Bottom Right:** A citation page for the entry. A red box highlights the citation information, including the title "Drift trajectories of the main sites of the Distributed Network of MOSAIC 2019/2020" and the authors "Nicolau, Marcel; Hermann-Campe, Kathrin; Blas, Angela; Hoppmann, Mario; Kanow, Torsten; Krähfeld, Richard A.; Le, Lu; Rabe, Benjamin (2021)".

<https://www.pangaea.de/>

Best-Practices-Report on ORCID Integration in PANGAEA

Selected PID Types

Overview

 Zeitschrift Gesamtperiodika oder Ausgabe/Heft    	 Artikel Einzelbeitrag in einer Zeitschrift oder einem Buch   	 Buch Monografie, Sammelband, u.ä.    	 Person I.d.R. in der Wissenschaft tätige Person    
 Forschungsdaten I.d.R. in einen Repositorium abgelegt  	 Publikationsdienst Repositorium, Publikationsplattform, Forschungsinformationssystem, ...   IDs aus OpenDOAR, DRIS, FAIRsharing, re3data, ...	 Instrument Messinstrument, Supercomputer, Forschungsgrößgerät, ... 	 kulturelles Objekt Eigenschaft durch Metadaten beschrieben und mit PIDs verlinkt    
 phisches Objekt Probe, Material, ...  	 Software I.d.R. Forschungssoftware    Software Heritage Identifier (SWHID)	 Projekt I.d.R. Forschungsprojekt 	 Organisation I.d.R. Forschungseinrichtung   

Source: Lange, M., Genderjahn, S., & Czerniak, A. (2024). Persistente Identifikatoren für offene und FAIRe Wissenschaft. Open-Access-Tage 2024 (OAT24), Cologne. Zenodo. <https://doi.org/10.5281/zenodo.12167372>, lizenziert unter CC BY 4.0 International

Selected PID Types

Handle System

Explanation:

- An organization can acquire its own Handle prefix and assign Handle PIDs within this namespace.
- Handle metadata can be freely chosen.

(For example, it is not bound by the guidelines of a specific DOI agency.)

(Typical) Areas of Application:

- Any type of digital or physical object

Infrastructure:

- a. Administration: DONA Foundation (nonprofit organization)
- b. Provider:
 - a. GWDG (as a member of the Persistent Identifier Consortium for eResearch (ePIC))
 - b. Infrastructure hosting provided either by the provider or by the PID-registering organization



Böhm, J. (2025). Persistent Identifier Consortium for eResearch (ePIC). Zenodo. <https://doi.org/10.5281/zenodo.17136458>



Explanation:

- Based on the Handle System
- [Certified to ISO Standard 26324](#)
- Globally interoperable and unique identification

(Typical) Areas of Application:

- Journal Article & Research Data
- Increasingly: software code, data management, and software management plans

Infrastructure

- a. Administration: International DOI Foundation (IDF) (nonprofit)
- b. PID Providers/Registration Agencies: [CrossRef](#), [DataCite](#)



Selected PID Types

ORCID – Open Researcher and Contributor iD



Explanation:

The ORCID iD is an alphanumeric code used to uniquely identify individuals working in academia.

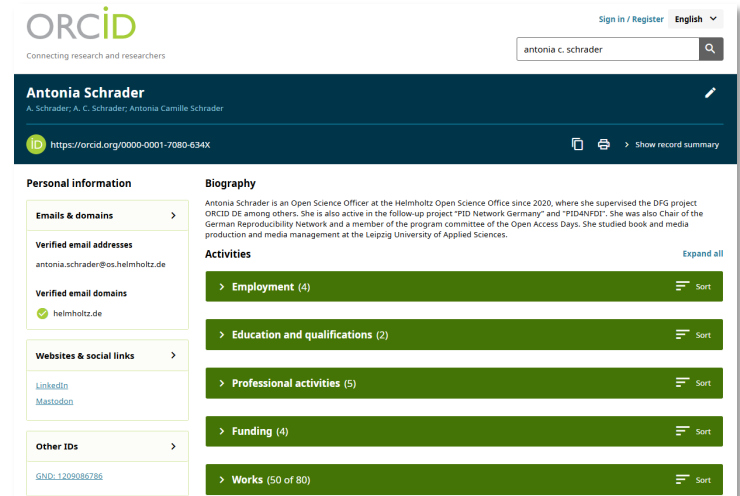
- Anyone can register for an ORCID iD free of charge.
- The personal ORCID iD is linked to the ORCID profile, the ORCID record.
- Data protection: EU and UK GDPR as well as U.S. data protection laws; see Privacy Policy

(Typical) Areas of Application:

- Individuals

Infrastructure:

- PID provider/registration agency:
ORCID Inc. (non-profit organization)



ORCID Record of Antonia:
<https://orcid.org/0000-0001-7080-634X>

Selected PID Types

GND-ID – Gemeinsame Normdatei (The Integrated Authority File)

Explanation:

- Identifier in the Gemeinsame Normdatei—a service for the collaborative use and management of authority data
- Used primarily in the DACH region

(Typical) Areas of Application:

- Used primarily in librarianship to identify persons, organizations, geographical entities, works, terms, and events
- Cataloging of publications

Infrastructure:

a. Administration: German National Library

Assignment: Qualified GND partner institutions (e.g., libraries, museums, archives)



Selected PID Types

ROR ID – Research Organization Registry



Explanation:

A global registry of open identifiers for research and funding organizations, operated by the PID community.

The registry contains records for the corresponding ROR ID under CC 0.

(Typical) Areas of Application:

- Organizations in the scientific community

Infrastructure:

- PID Provider/Registration Agency:
California Digital Library, Crossref, and DataCite

The screenshot shows the ROR record for the Helmholtz Association of German Research Centres. At the top, the URL <https://ror.org/0281dp749> is displayed. Below this, the organization's name is listed. The record is organized into several sections: 'OTHER NAMES' (Helmholtz-Gemeinschaft Deutscher Forschungszentren (de)), 'ORGANIZATION TYPES' (Funder, Government), 'LOCATIONS' (Berlin (GeoNames ID 2950159), Germany), 'WEBSITE' (<https://www.helmholtz.de>), and 'OTHER IDENTIFIERS' (GRID grid.211011.2, ISNI 0000 0001 1942 5154, Crossref Funder ID 501100001656, Wikidata Q679913). A 'RELATIONSHIPS (25)' section is also present at the bottom, with a 'View details' button.

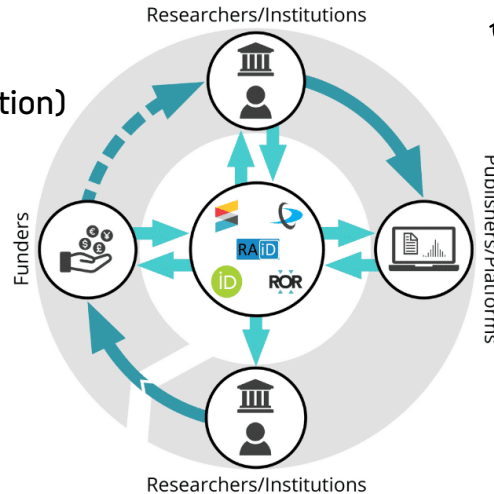
ROR Record of the Helmholtz Association:
<https://ror.org/0281dp749>

Key Takeaways

The Importance of PIDs for the Research Lifecycle

Researchers

- Unambiguous assignment (disambiguation)
- Citation eligibility
- Visibility and reach
- Recognition
- Less administrative effort



Research Lifecycle

- Reproducibility
- Scientific integrity and quality assurance
- A fundamental building block for FAIR

Source: Brown, J., Jones, P., Meadows, A., & Murphy, F. (2021). The PID-optimised Research Lifecycle. Zenodo. <https://doi.org/10.5281/zenodo.4991733>

PIDs in the Context of NFDI



Basic service for the NFDI

PID4NFDI

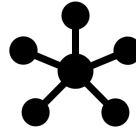
PID4NFDI is currently being funded during the integration phase as part of Base4NFDI.

- Goal: To consolidate and further develop PID services within the NFDI at all levels: technical, organizational, methodological, and in terms of communication.
 - Integration of existing PID infrastructures
 - Improvement of metadata quality and mapping
 - Training and public outreach
 - Support for PID integration in consortia in accordance with requirements
 - Alignment with national and international PID strategies and guidelines
- Close collaboration between PID4NFDI and PID Network Germany



HELMHOLTZ
Open Science

Service components

 PID Coordination Hub ✓ continuously updated (link)	 PID Cookbook ✓ continuously extended (collection)	 PID provider selection tool ✓ operational (PID Selection Tool)	 ePIC prefix registration ✓ operational (request form)
 Focus groups for PID integration in ELNs, DMPs ✓ completed	 Use Cases for instruments, physical objects, high granular/warm data, projects & grants ✓ continuously extended (i.a. KonsortSWD, Text+)	 Support for PID integration ✓ operational (contact form, FAQs)	 Training materials on PIDs (fundamental/advanced/expert) ✓ continuously updated (collection)



pid4nfdi@lists.nfdi.de



pid4nfdi.bsky.social



<https://www.linkedin.com/showcase/pid4nfdi/>



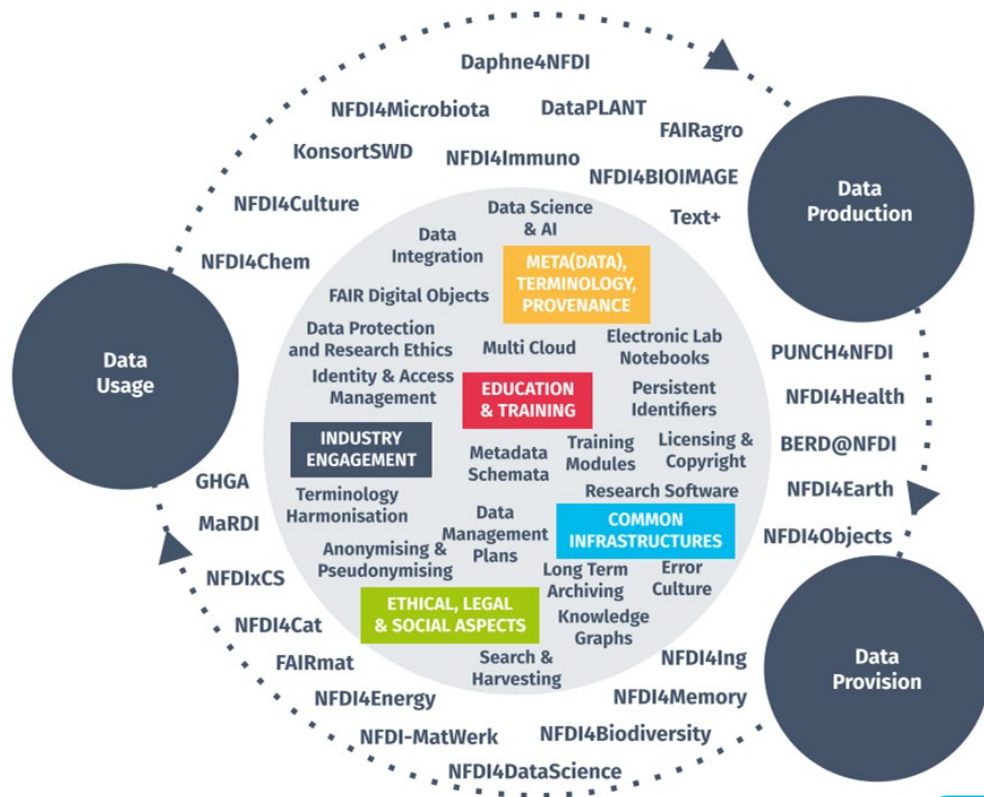
@pid4nfdi@nfdi.social



<https://pid.services.base4nfdi.de/>

Funded by the DFG as part of the NFDI.
Funding number: 521453681

Project members: Jana Böhm, Sara El-Gebali, Steffi Genderjahn, Stephanie Hagemann-Wilholt, Torsten Kahlert, Antonia Schrader, Frederik Springer, Sonja Sternkopf, Markus Stocker



National PID Roadmap for Germany



<https://doi.org/10.5281/zenodo.21713802>

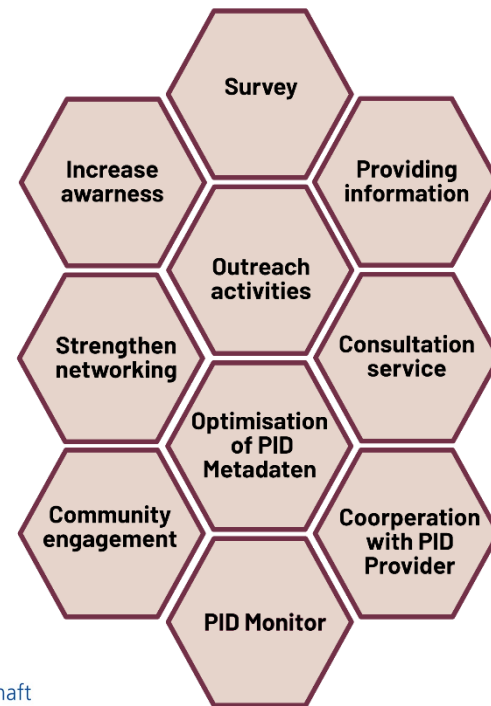
PID related projects

PID Network Germany (2023-2026)



Goals:

- Establishment of a **network** in science and culture
- **Promotion** and standardization of the use of PIDs
- **PIDs as a tool**: Highlighting their importance for the unique identification and linking of digital objects
- Support the **dissemination** and **linking** of PID systems and their **integration** into infrastructures
- Development of a **national PID roadmap**



Outcomes of PID Network Germany

Community Engagement



Workshops focusing on implementation scenarios as well as opportunities and challenges in the use and integration of PIDs



- Strengthening the network
- Promoting exchange
- Raising awareness
- Sharing information and use cases

All workshops are documented both in English and German on the project website under [“Events”](#).

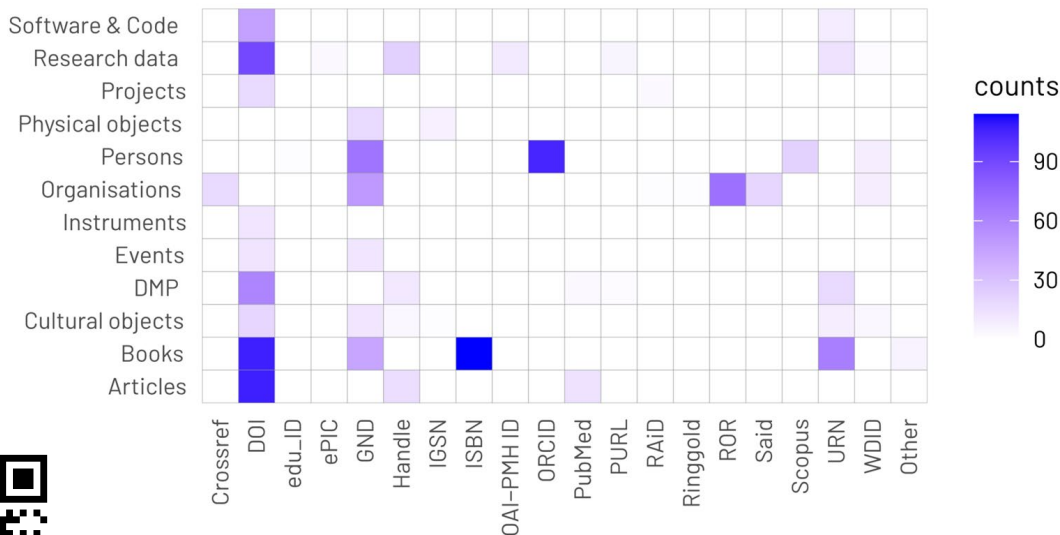
Outcomes of PID Network Germany Survey & Landscape Analysis



Quantitative Survey

- Survey period: March–May 2024
- Target group: Universities, universities of applied sciences, non-university research institutions, and department-specific research institutions
- 126 complete responses
- Covered over 20 PID types and entities

Which PIDs does your institution use for different entities?

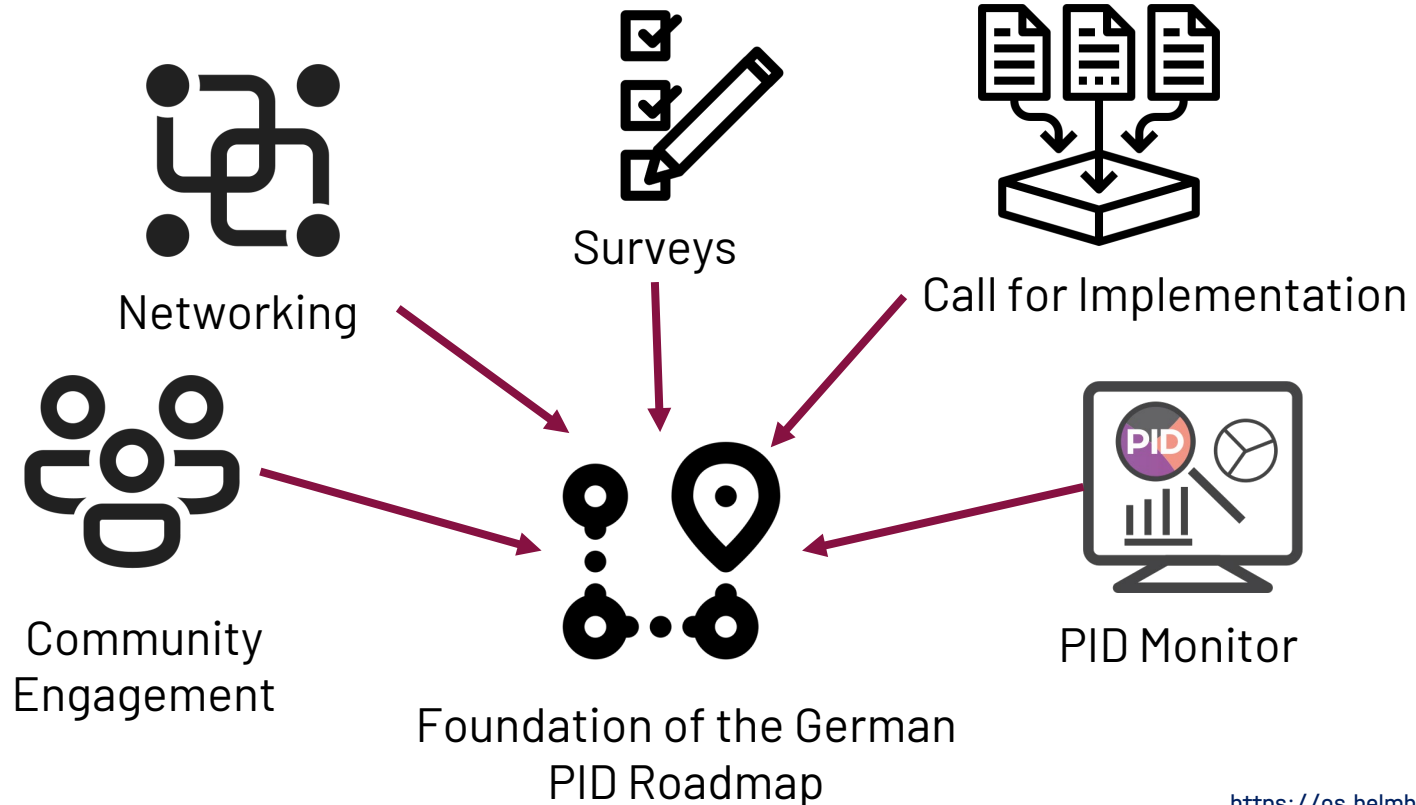


Persistent Identifiers in Germany:
Key Findings of a Nationwide Survey
(<https://doi.org/10.5334/dsj-2026-028>)



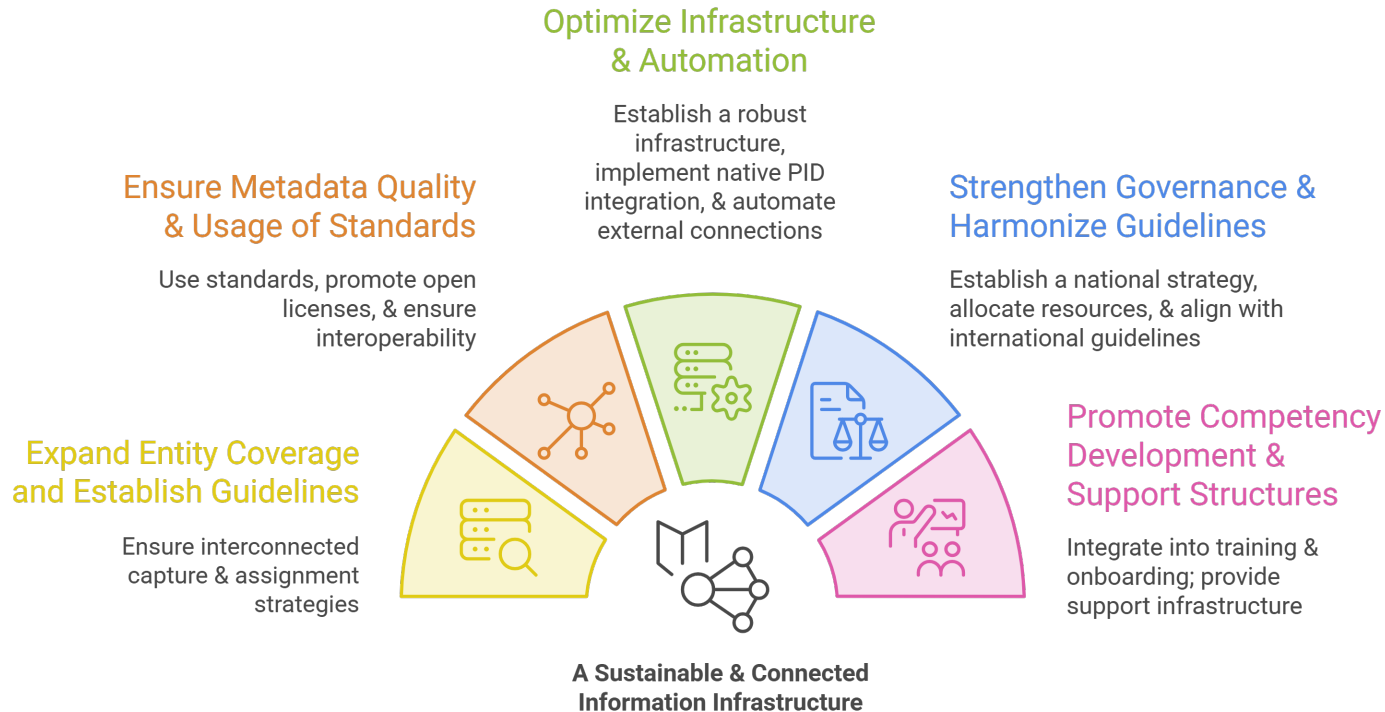
Outcomes of PID Network Germany

National PID-Roadmap for Germany



National PID Roadmap for Germany

5 Recommendations



<https://doi.org/10.5281/zenodo.21713802>

National PID Roadmap for Germany

Recommendations & Measures

Recommendations	R1: Systematically expand entity coverage and establish guidelines	R2: Ensure metadata quality and the use of standards	R3: Establish a robust technical infrastructure and optimize workflow automation	R4: Strengthen governance and harmonize guidelines	R5: Promote competency development and support structures
Measures	1.1. Ensure comprehensive PID assignment and interconnected metadata 1.2. Establish consistent assignment strategies	2.1. Consistently use standards and authority data 2.2. Demand open licenses and barrier-free access 2.3. Ensure interoperability and AI readiness	3.1. Establish native PID integration and interface standards 3.2. Automate external connections	4.1. Establish a national strategy and anchor it institutionally 4.2. Ensure sustainable allocation of resources 4.3. Harmonize with international guidelines	5.1. Integrate PIDs into training and onboarding processes 5.2. Provide best practices and support infrastructure
Relevant Stakeholders	  	    	    	  	   



Libraries, repositories, & p. services



FDM & data services



RFO



IT & information infrastructure



PID provider & standardization initiatives



Research & cultural heritage institutions

PID NETWORK DEUTSCHLAND

Contact

Website: www.pid-network.de

Email: info.pidnetwork@listserv.dfn.de

Mailing list: [PID Dialog](#)

 openbiblio.social/@PIDNetworkDE

 linkedin.com/showcase/pid-network-de/

 pidnetworkde.bsky.social

Project members: Andreas Czerniak, Barbara Fischer, Steffi Genderjahn,
Stephanie Hagemann-Wilholt, Antonia Schrader, Paul Vierkant, Frauke
Ziedorn

DFG funding number: [506475377](#)
Proposal <https://doi.org/10.48440/os.helmholtz.059>

Recommended Reading

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Thank you very much for your attention!

Any Questions?

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