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The Shielding Integral Benchmark Archive Database (SINBAD) Task Force

Reinvigorating SINBAD by Crowdsourcing

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Outline

I. Update on SINBAD Developments

II. SINBAD Migration to GitLab

SINBAD - Shielding Integral Benchmark Archive and Database

- **International archive for complex shielding benchmarks**
- 102 reactor, fusion neutronics, and accelerator shielding experiments
- Work jointly carried out by the United States' Radiation Safety Information Computational Center (RSICC) and the NEA.
- Started in 1992 by OECD/NEA Databank and ORNL/RSICC by E. Sartori, B. Kirk, I. Kodeli, and others

https://oe.cd/nea-sinbad

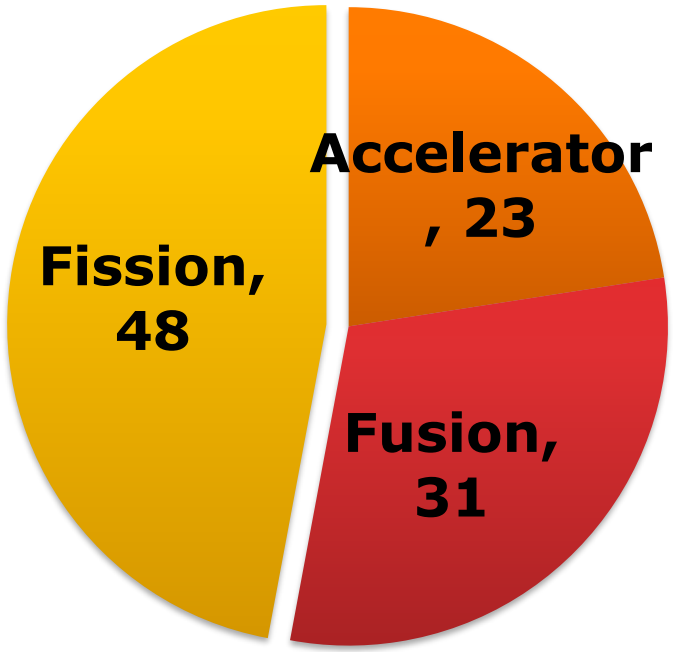


Figure: Sinbad entries per application domain

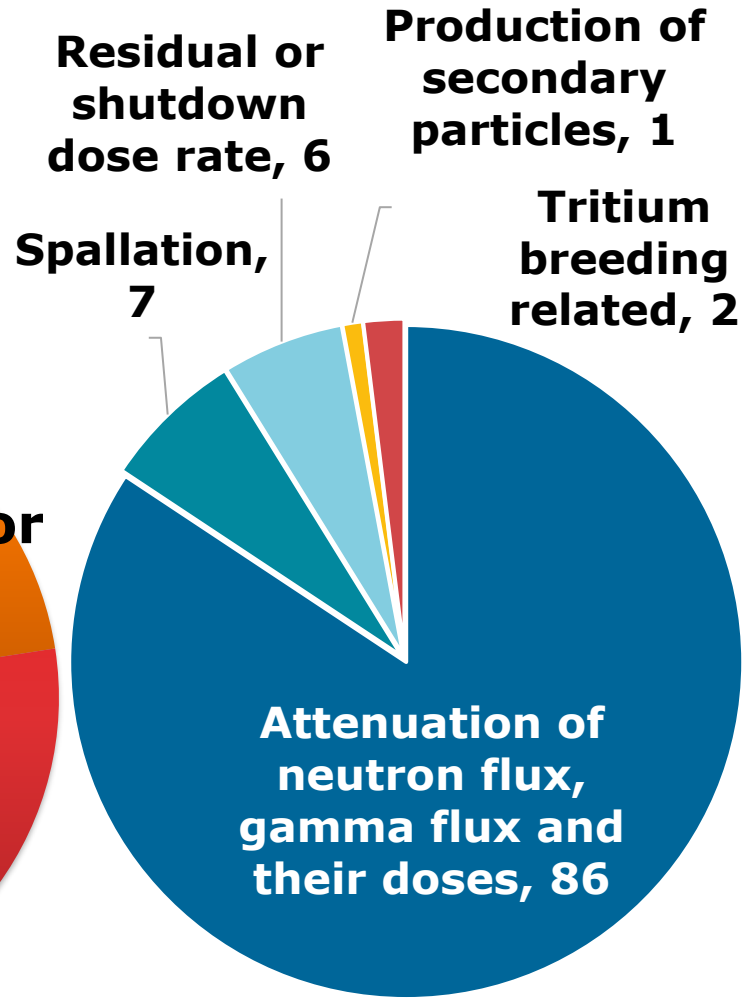


Figure: Sinbad entries per physical phenomenon

SINBAD: Motivation for Change

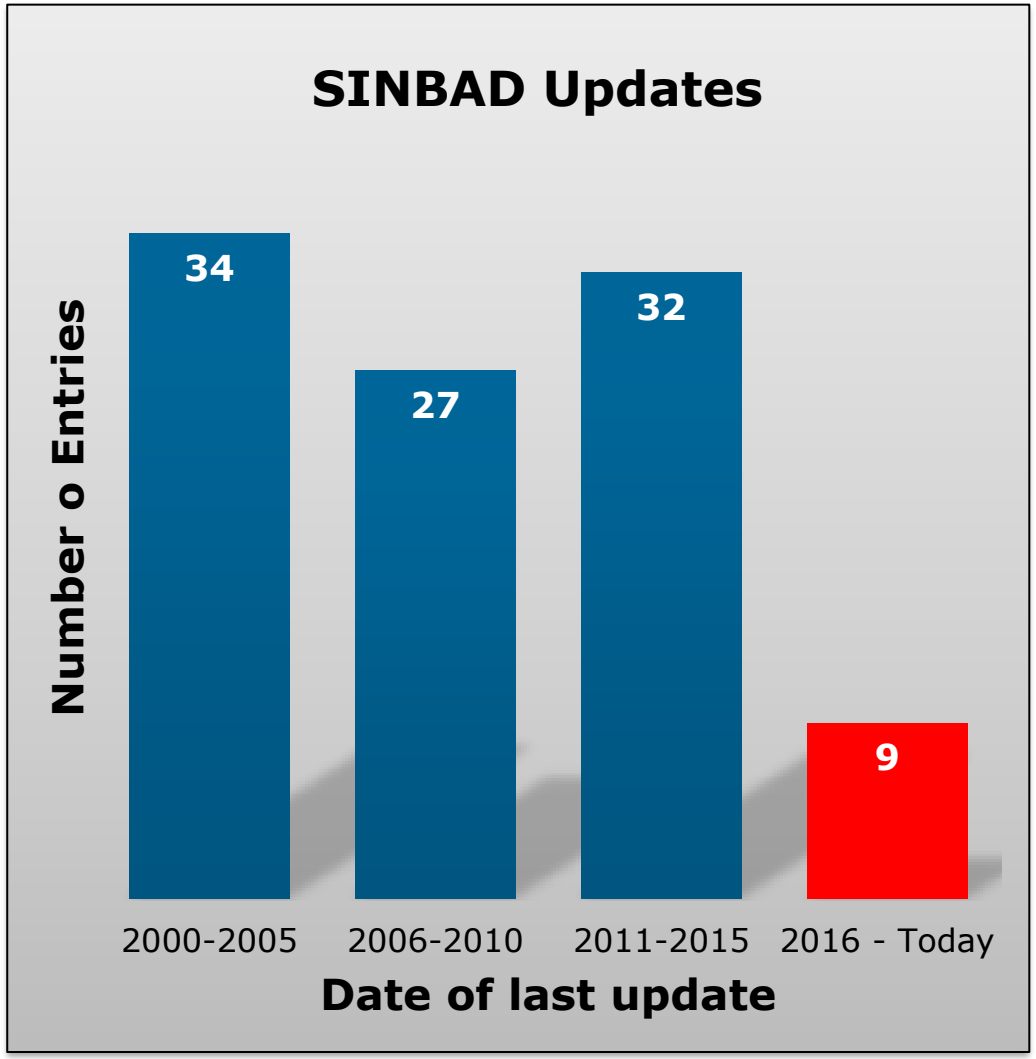
102 reactor, fusion neutronics, and accelerator shielding experiments

- **BUT: only 9 updates since 2016 and only 4 new experiments added in the last 10 years**

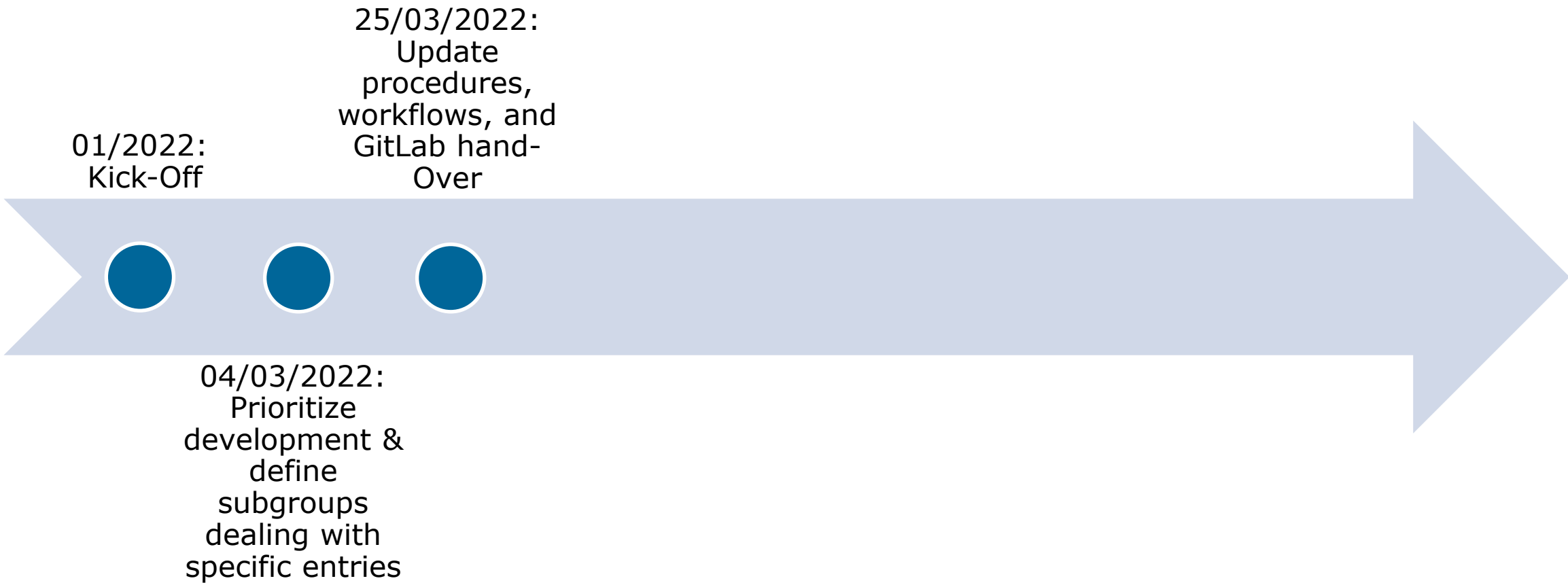
➔ Initiated NEW EGPRS Task Force on SINBAD in 2022

Targets:

- Modernize the database building upon previous work
- Implement new software tools for database maintenance based on new NEA Data Bank infrastructure
- (Re-)Build community of database developers
- Adopt standardized format agreed in 2019 for SINBAD
- **Improve the quality of the existing database entries**
- **Provide new database entries**



Status SINBAD Task Force



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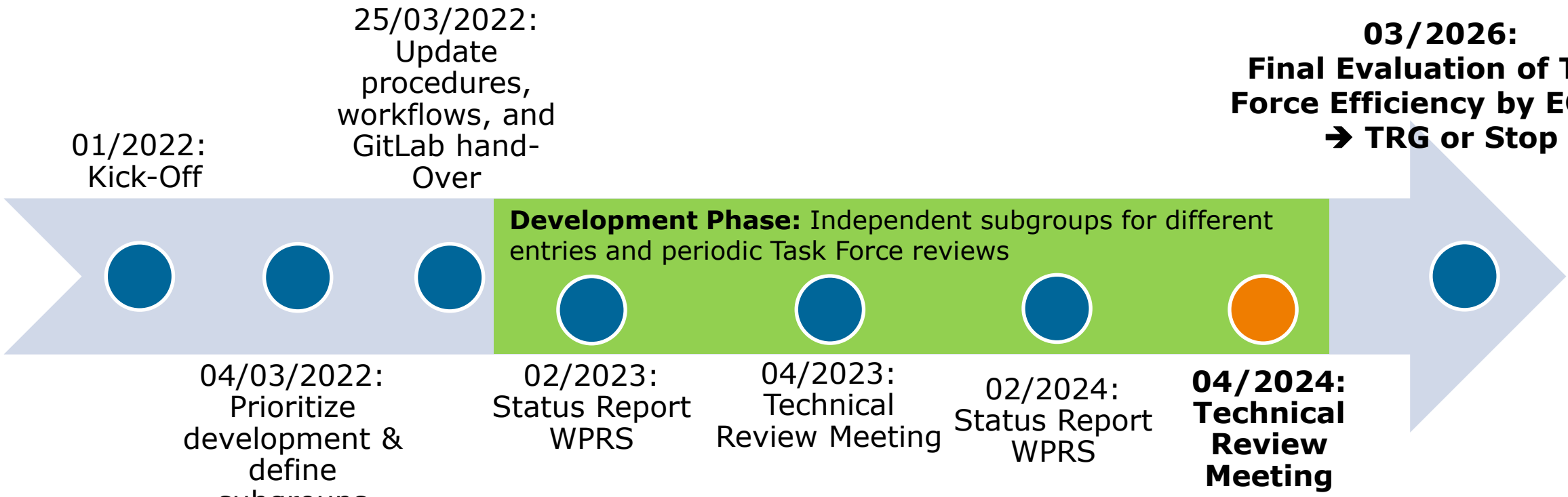


NEW: SINBAD Maturity Level Scheme

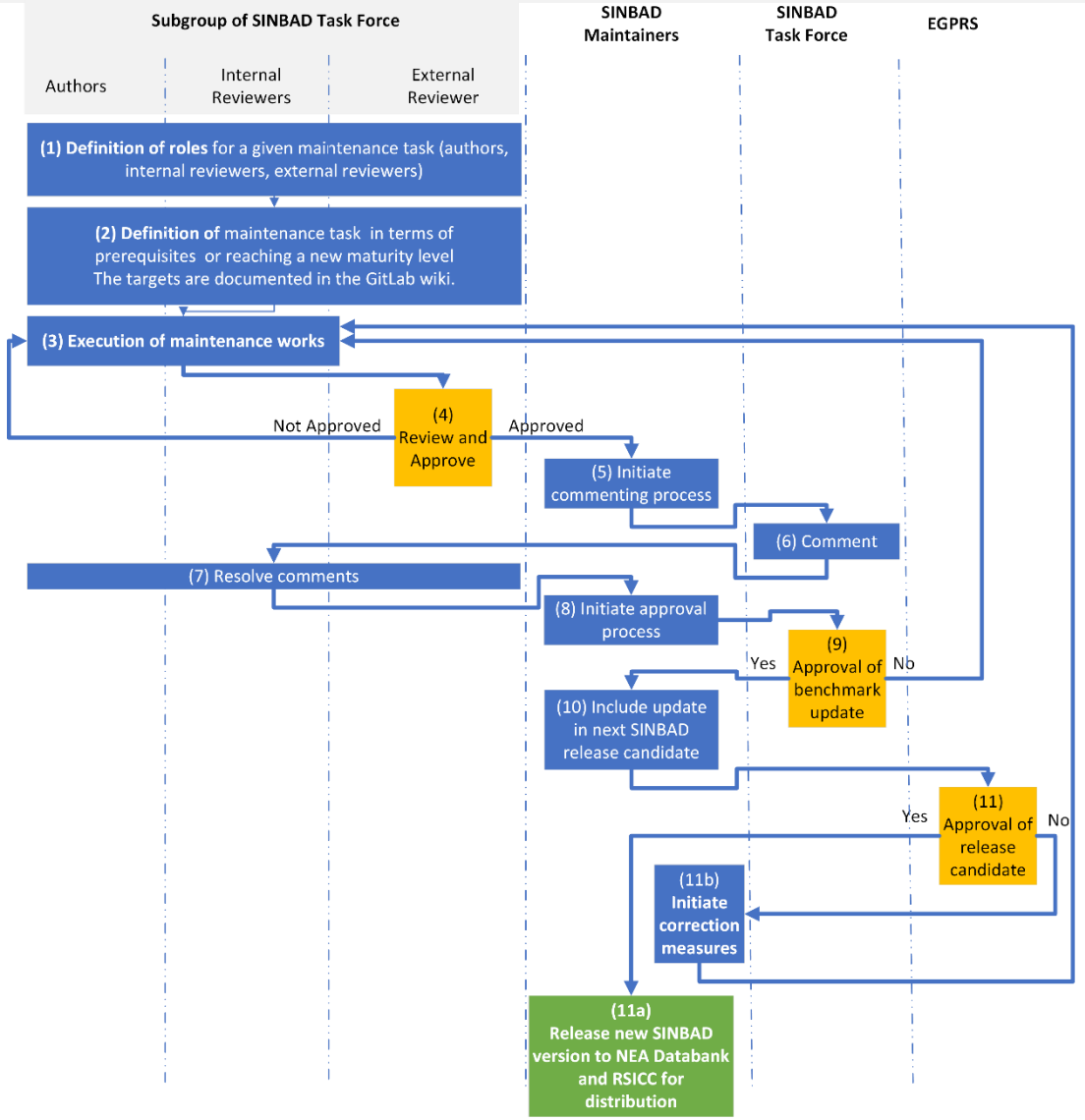
- 5 Maturity Levels
- Level 4 corresponds roughly to ICSBEP requirements

- Iterative maintenance efforts to reach specific maturity levels and/or prerequisites

Prerequistes	Maturity Level				
	1	2	3	4	5
Re-distribution rights for experimental data and documentation has been obtained	☒				
Experiment documentation according to Section 1 of Evaluation Guide (SINBAD TRG, 2019[3])					
• Description of the measurement facility		☒			
• Description of each measurement configuration		☒			
• Description of materials		☒			
• Description of radiation sources		☒			
• Measurement of input and output variables		☒			
• Data in basic machine-readable format (e.g. CSV)		☒			
Evaluation of measurement data (Section 2 of Evaluation Guide (SINBAD TRG, 2019[3]))					
• Evaluation of measurement configuration			☒		
• Evaluation of radiation source			☒		
• Evaluation of the measured data			☒		
• Provision of computation models which have been used for evaluations			☒		
• Sensitivity and uncertainty analysis (including provision of computation models)				☒	
• Definition of scientific relevance based on 1*-3* scheme				☒	
Benchmark model (Section 3 of Evaluation Guide (SINBAD TRG, 2019[3]))				☒	
Sample case results and input files for related computational models (Section 4 of Evaluation Guide (SINBAD TRG, 2019[3]))				☒	
Geometry as CAD model					☒
Data in hierarchical machine readable data format (e.g. HDF5)[1]					☒
Provision of automatic pre- & post-processing chain for the benchmark models					☒

Other Process Updates

- Report templates follow ICSBEP standard (based on TRG 2019 recommendations)
- Standardized hierarchical directory structures
- Word and Latex Templates
- Two processes:
  - Maintenance effort driven by subgroup
  - Simplified merge request workflow for small changes (Maintainers consult former subgroups)



Active TF Subgroups

Subgroup Title	Coordinator	Application Domain
Vessel fluence	A. Alpan (USA)	V&V for RPV aging studies
LLNL pulsed spheres	A. Tamashiro (USA)	Attenuation of 14MeV neutrons
FNG Copper	I. Kodeli (UK)	Attenuation of 14MeV neutrons in Cu
KFK – n gamma	S. Simakov (GER) O. Buss (NEA)	Neutron and gamma attenuation in Fe and the associated (n,γ) reactions
FNG HCLL	P. Ortego (SPN)	Tritium breeding in He cooled Pb-Li
Broomstick ^{16}O	S. Simakov (GER) O. Buss (NEA)	Attenuation of fission neutrons in ^{16}O
CERN-EU high-energy Reference Field (CERF)	R. Froeschl (CERN)	Accelerator activation and residual dose rate + neutron shielding at CERN with a hadron beam
Health Physics Research Reactor (HPRR) **NEW**	M. Dupont (USA)	Neutron fluence, neutron dose, and gamma dose from a HEU fast burst reactor
ASPIS Cranked Duct **NEW**	D. HANLON (UK)	Neutron streaming in a configurable duct

Health Physics Research Reactor (HPRR)

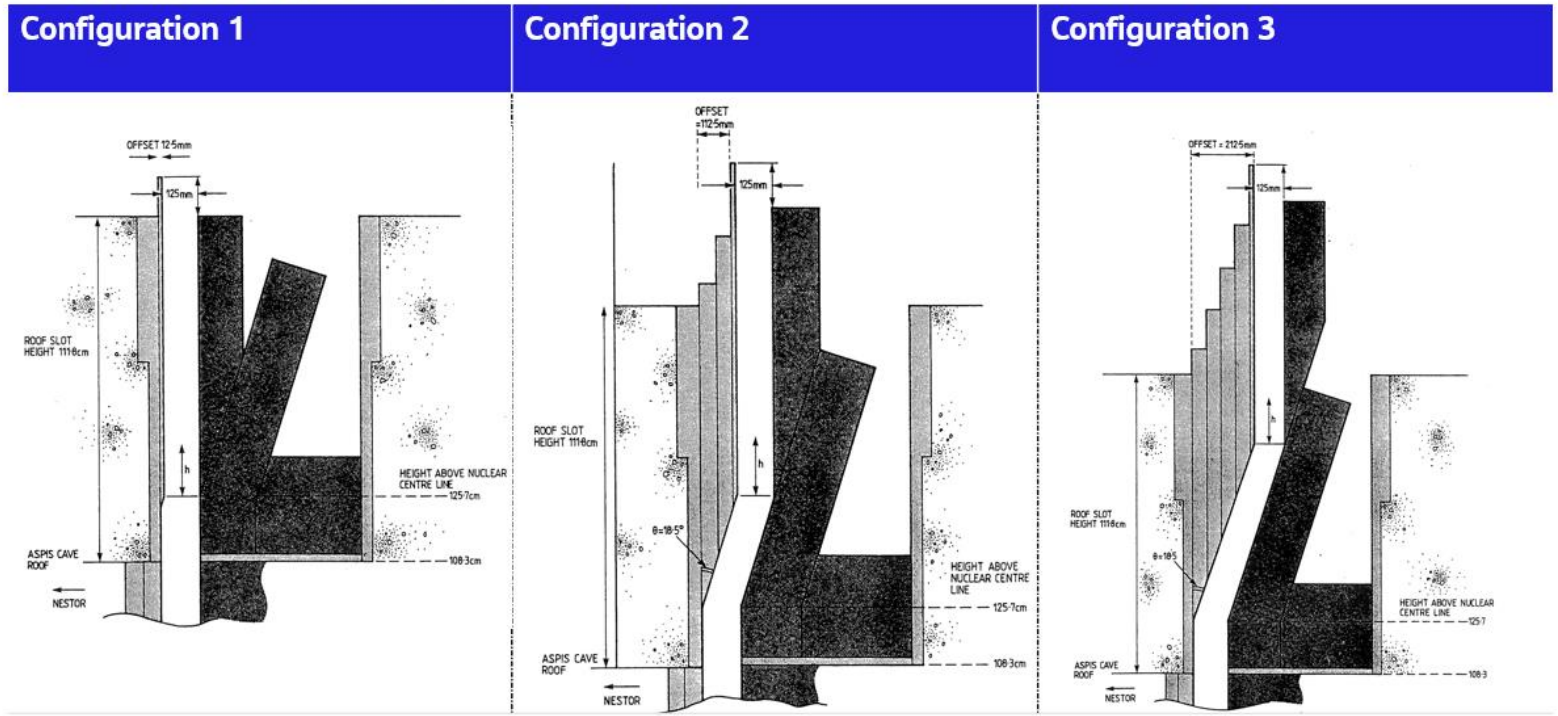
- Evaluation work focused only on experimental data from ORNL-6240, the latest report available with the newest reactor configuration
- SINBAD evaluation will contain benchmarks from four 4 experiment categories:
  - **Total neutron fluence** from a steady-state operation of the HPRR measured by Bonner sphere spectrometry, shielded and unshielded
  - Derived **neutron kerma** results
  - **Sulfur pellet activation** at different distances from an HPRR pulse, shielded and unshielded
  - **Gamma dose** from an HPRR pulse measured by G-M counter and TLD

Figure 53: HPRR

ASPIS Cranked Duct

- NESTOR = Argonaut type reactor with caves in which shielding experiments could be performed.
- One of the caves is referred to as the ASPIS cave, in which experiments of the NESTOR Shielding and Dosimetry Improvement Programme (NESDIP) were performed by inserting a trolley containing different arrangements of materials.
- These source fission neutrons then penetrate a configurable neutron shield and entered a polythene backed cavity from where they could stream up through a roof slot into a three-legged "cranked" (kinked) duct.
- Neutron measurements were performed in the final leg of the duct with both BF3 and SP2 Hydrogen gas counters

Cranked Duct in Roof Slot



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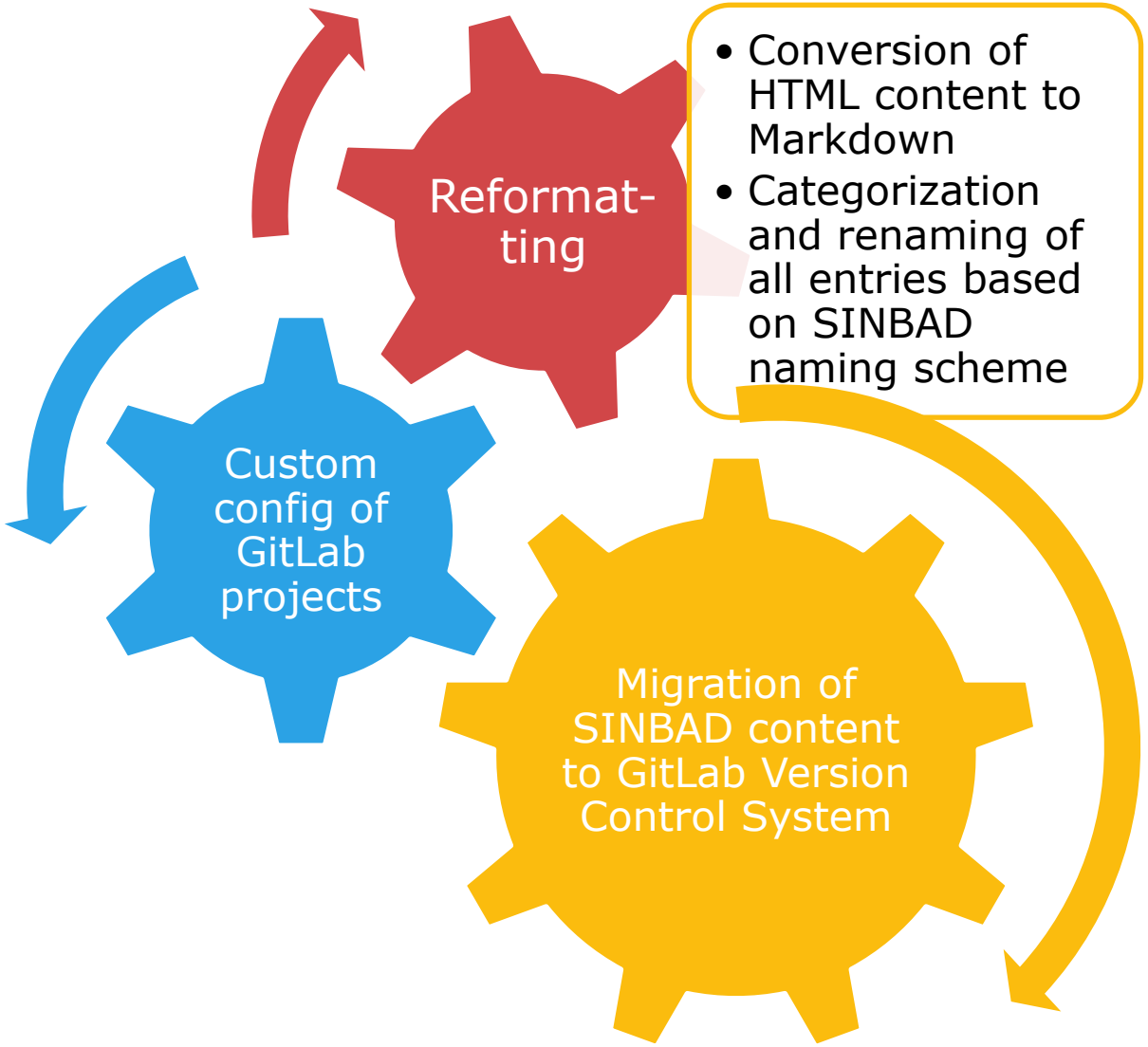
SINBAD Migration to GitLab

SINBAD Migration to NEA GitLab

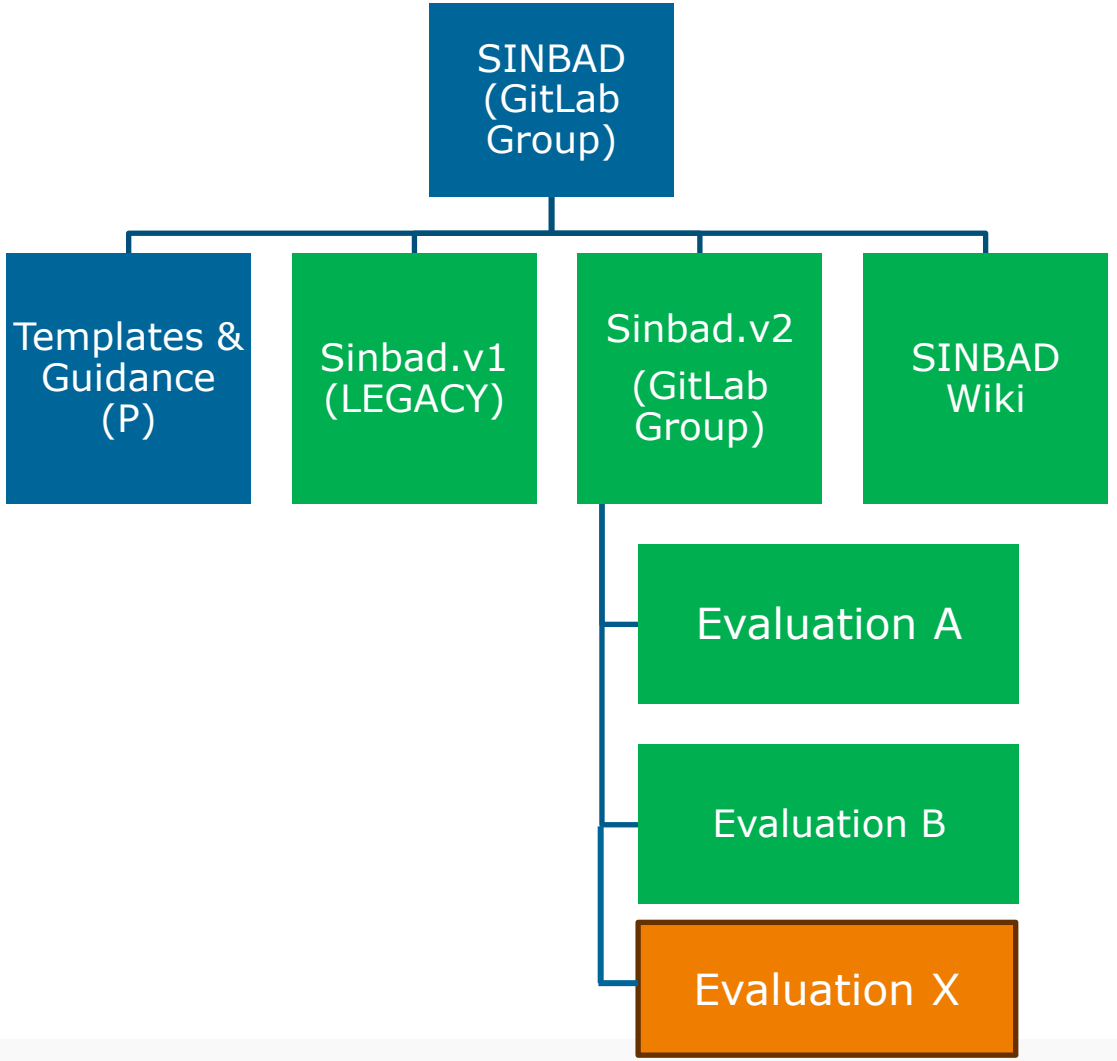
- WHY?
  - Provide platform for simple user feedback
  - Quick & traceable change workflows
  - Enable users to upload proposed corrections and additional data
  - Full version control and control of main version by the SINBAD Task Force



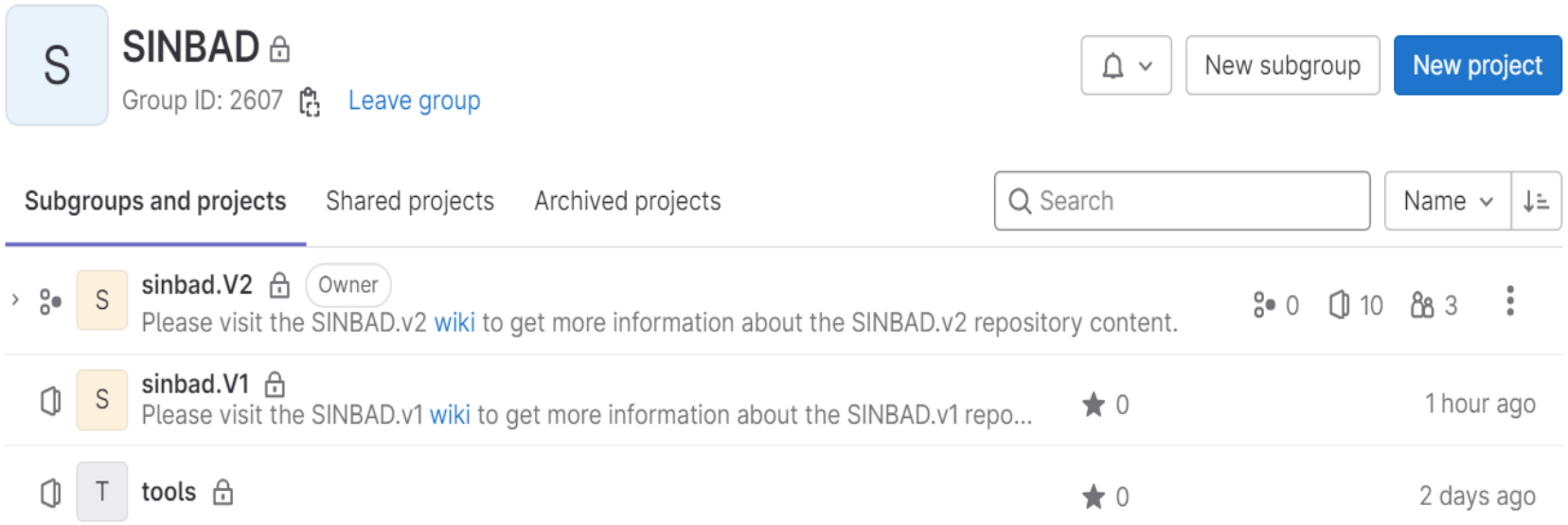
SINBAD Platform

- **SINBAD hosted on NEA GitLab by OECD NEA Data Bank** (on-premises)
  - GitLab access **for all licensees**
  - Subgroups work in branches & issue merge requests to maintainers (NEA & Task Force Chair)
- **New evaluations added as new projects ➔ modular**
- **Issue Tracking:**
  - Transparent issue tracking for development within GitLab
  - Users are asked to report issues directly on GitLab
- **Future SINBAD distribution only via NEA GitLab**

GitLab Group/Project Structure:



SINBAD Versions



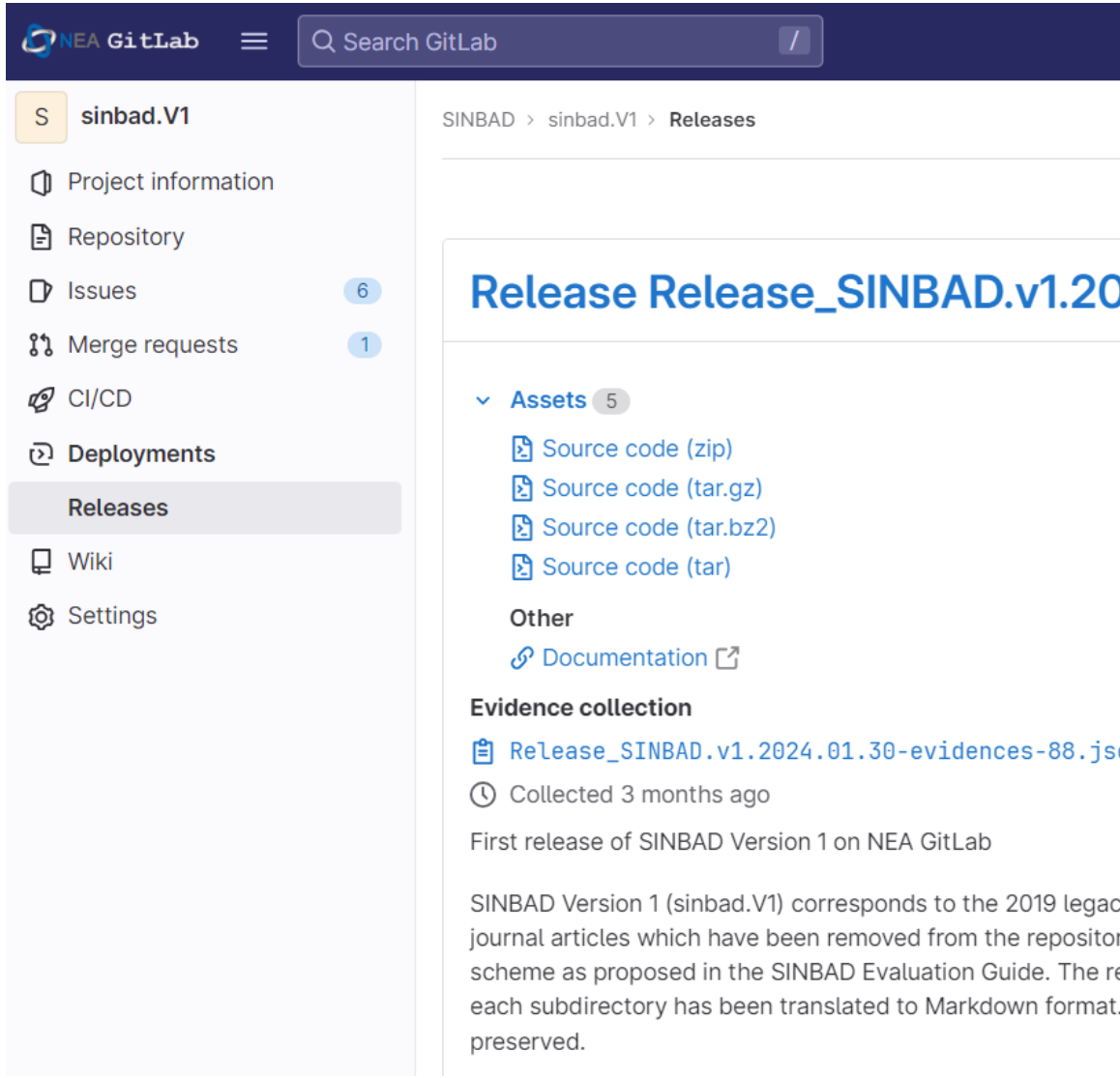
2 versions of SINBAD on GitLab

- **Sinbad.V1**:containing the **original** entries (updated to GitLab)
- **Sinbad.v2**:**current version,** designed for maintenance, allowing contributors to work on this version

SINBAD Distribution Process

1. Users request licenses at NEA-DB or RSICC
2. All licensed users (also RSICC licensees) are given access to the NEA GitLab system by NEA DB
3. Licensees will also have access to all future revisions of a SINBAD Version

➔Users have always access to most up-to-date information



Outlook and Conclusions

- **Successful migration of SINBAD to NEA GitLab**
- **GitLab system supports crowdsourcing to drive the future SINBAD development: users can easily provide feedback and get involved in development process**
- **Transparent maintenance & development process**
- **Ready to acquire experimental data in “Maturity Level 1”**

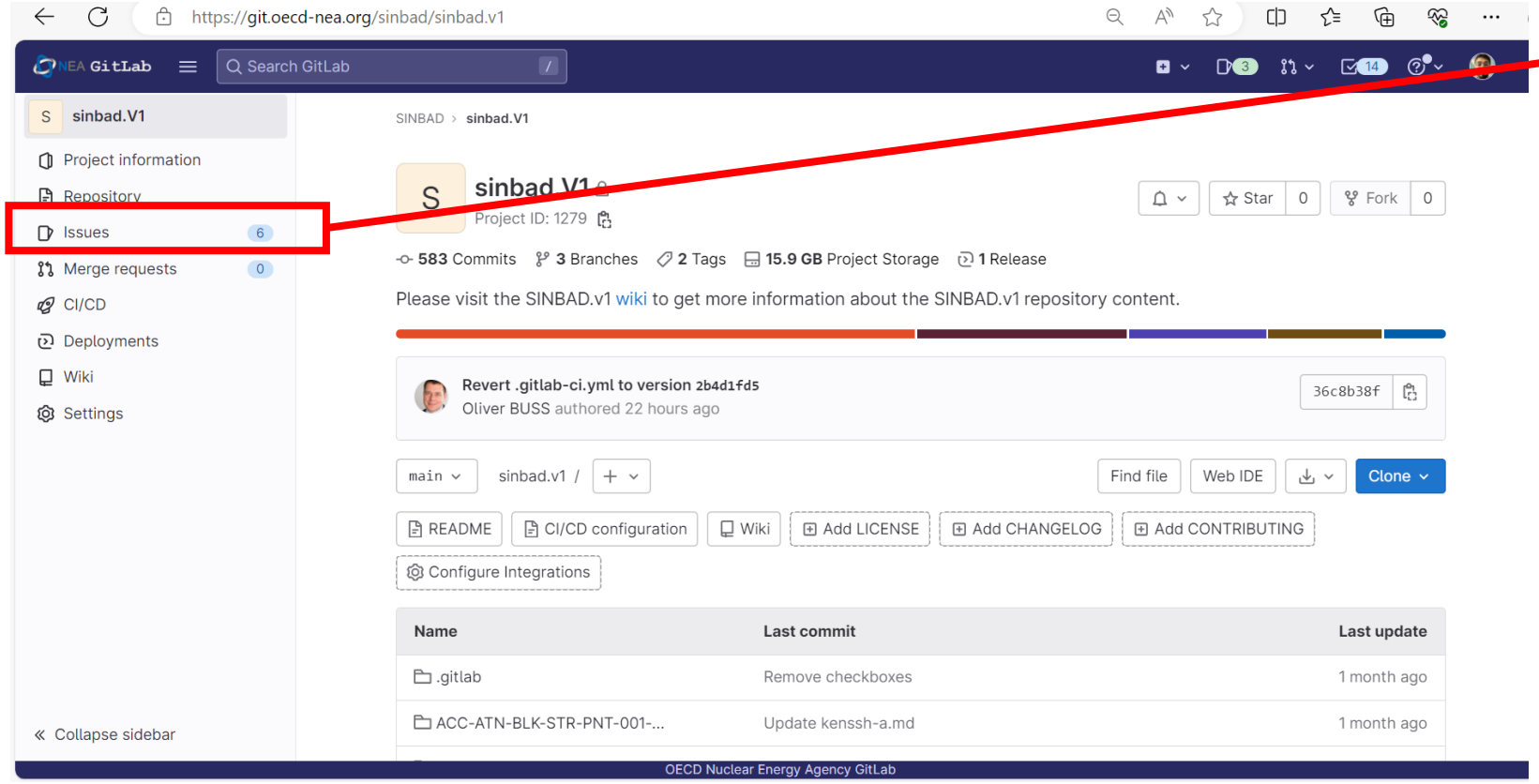
- **SINBAD licensing by RSICC and NEA DB**
- **SINBAD distribution in future only via NEA GitLab**

- **RTS 2024: need for unified results format, need exchange of numerical benchmark results, exchange input decks, identify synergies in geometry converter projects**

For more information please contact:

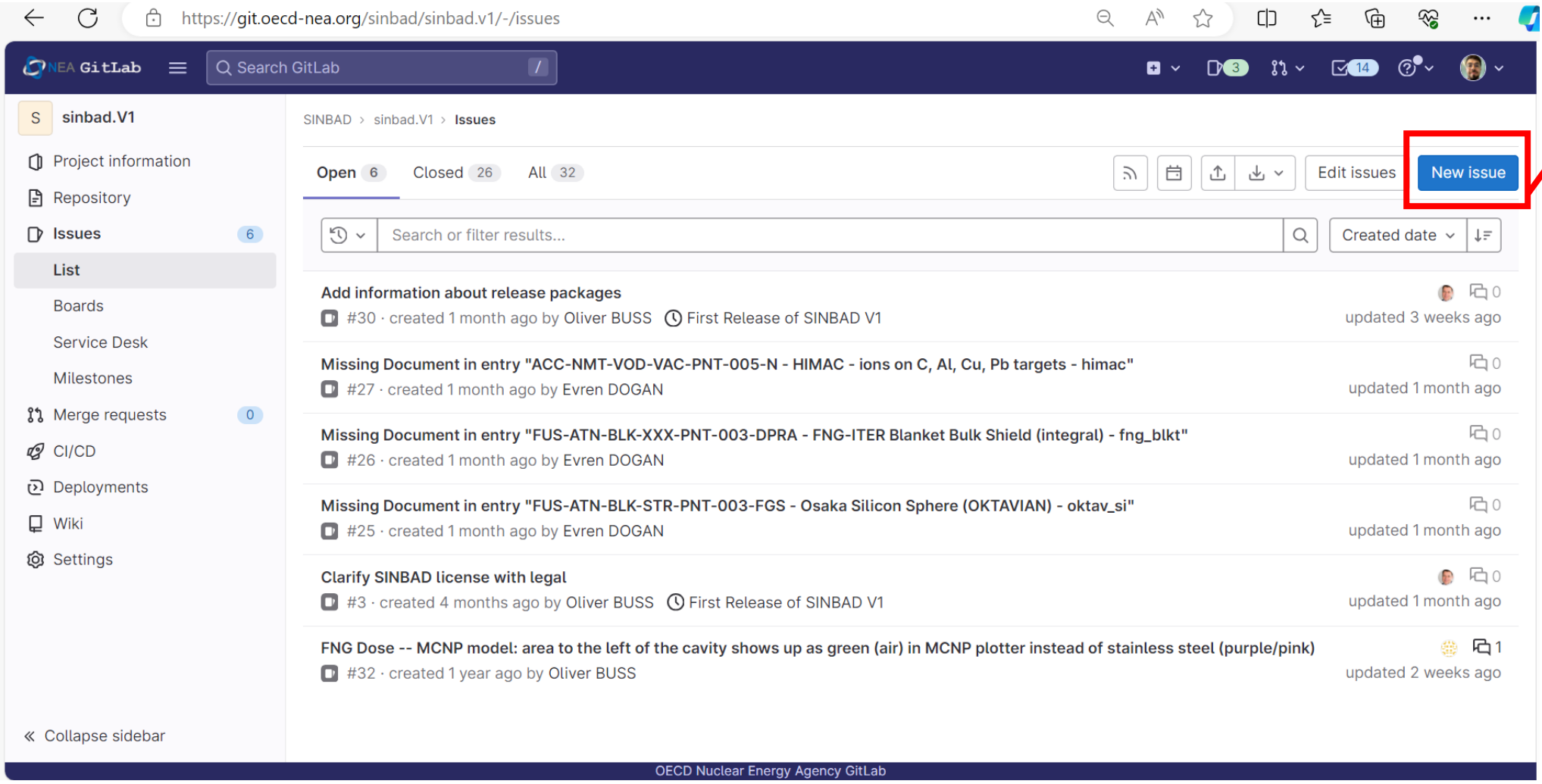
wprs@oecd-nea.org

Issue System



- GitLab's issue system efficiently **tracks tasks** in one central location.

Issue System

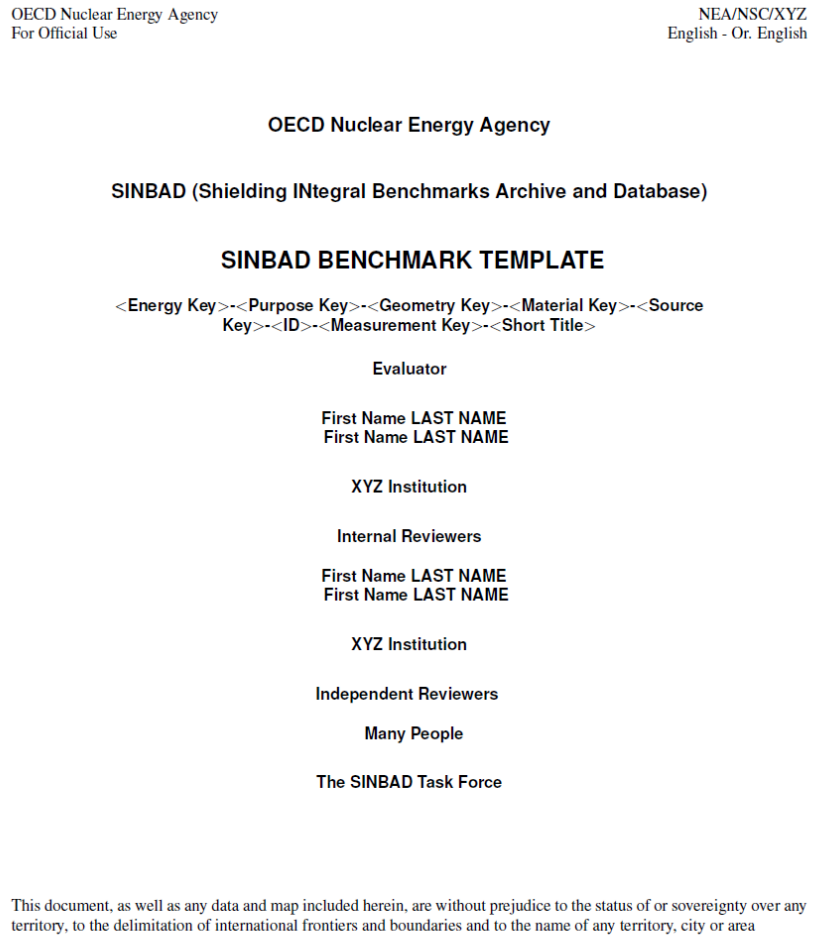


Creating New Issue

Updates to Templates

- **Word Template:**
  - Added scientific relevance rating, updated maturity level table
- **New LATEX templates** based on ICSBEP templates proposed by Alex McSpaden, Kelsey Amundson, Jesson Hutchinson, Geordie McKenzie, Kristin Stolte, Nicholas Thompson, and Robert Weldon.

https://git.oecd-nea.org/sinbad/templates-and-guidance



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SINBAD (Shielding INtegral Benchmarks Archive and Database)

SINBAD BENCHMARK TEMPLATE

<Energy Key>-<Purpose Key>-<Geometry Key>-<Material Key>-<Source Key>-<ID>-<Measurement Key>-<Short Title>

Evaluator

First Name LAST NAME
First Name LAST NAME

XYZ Institution

Internal Reviewers

First Name LAST NAME
First Name LAST NAME

XYZ Institution

Independent Reviewers

Many People

The SINBAD Task Force

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New Licences for SINBAD v1 and v2

See PDFs

1. SINBAD v1: https://mynea.oecd-nea.org/sites/WPRS/EGPRS/SINBAD/Meetings/SINBAD%20Task%20Force%20Meeting%2C%2018%20April%202024%2004-18-2024%2009h00/Meeting%20material/10_License%20SINBAD%20V1.pdf

2. SINBAD v2: https://mynea.oecd-nea.org/sites/WPRS/EGPRS/SINBAD/Meetings/SINBAD%20Task%20Force%20Meeting%2C%2018%20April%202024%2004-18-2024%2009h00/Meeting%20material/10_Licence%20SINBAD%20%20V2.pdf

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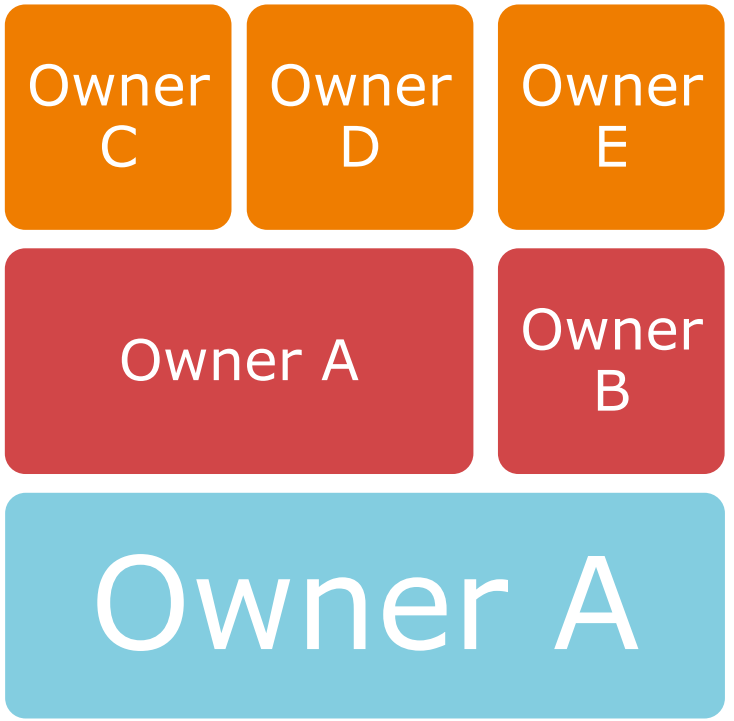

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BACK-UP

Naming Scheme

<Energy Key>-<Purpose Key>-<Geometry Key>-<Material Key>-<Source Key>-<ID>-<Measurement Key>-<Short Title>

☐ **FIS:** experiments relevant for the fission energy range, including spontaneous fission and neutron sources based on (α,n) reaction.

☐ **FUS:** the FUS identifier shall be used for experiment in the Fusion energy range, and should be used with DT reactions. This key also applies to DD reactions if they are mixed with DT reactions, otherwise DD reactions should be classified as fission.

☐ **ACC:** Accelerator experiments are those with energy close to the nucleus binding energy and much higher and are frequently far off being properly a shielding experiment, therefore most of the subsequent identifiers are not applicable.

Naming Scheme

<Energy Key>-**<Purpose Key>**-<Geometry Key>-<Material Key>-<Source Key>-<ID>-<Measurement Key>-<Short Title>

The following purpose keys are defined:

- ☐ **ATN:** Attenuation of neutron flux, gamma flux and their doses
- ☐ **ACT:** Activation of samples of materials for measuring activity and residual heat
- ☐ **HOT:** Heating rate during the irradiation process
- ☐ **SDR:** Residual or shutdown dose rate originated in a part of the shielding
- ☐ **TBR:** Tritium breeding or production of tritium in breeding materials
- ☐ **RES:** Production of residual nuclides
- ☐ **SEC:** Production of secondary particles in number, energy or angle
- ☐ **NMT:** Production of multiple neutrons by high energy particles (spallation)

Naming Scheme

<Energy Key>-<Purpose Key>-**<Geometry Key>**-<Material Key>-<Source Key>-<ID>-<Measurement Key>-<Short Title>

The following geometries are categorized:

☐ **BLK:** The geometry of most of shielding blocks is a solid parallelepiped made of a single material or of a set of plates of different materials including water in a closed container or simulated by plastics. This case is defined as BLK.

☐ **GAP:** In other cases, the main purpose is to measure the streaming of neutrons and gammas along a narrow gap between close bulky elements or along a human size labyrinth in a concrete building. These cases are defined as GAP.

☐ **VOD:** In many cases there is no shielding at all because the purpose is to detect and measure secondary particles, measure cross sections or produce residuals by high energy particles generated in an accelerator, so the shield part is void and is identified as VOD.

☐ **SKY:** The special case where the objective is to measure the scattering of particles in the air located over the facility, i.e. the skyshine radiation. This is defined as SKY.

Naming Scheme

<Energy Key>-<Purpose Key>-<Geometry Key>-**<Material Key>**-<Source Key>-<ID>-<Measurement Key>-<Short Title>

Concerning the material of the shielding the following groups are defined:

- **STR:** Structural materials as steel, iron, concrete, etc.
- **MOD:** Materials with capability to moderate neutrons such as water, polymers, light materials in general. Lead is included because of function similarity if this is its main purpose (fission energy range).
- **BRE:** Breeder materials such as lithium.
- **MUL:** Neutron multiplier materials such as Berylium and Lead when this is its main purpose (fusion energy range).
- **VAC:** In all those cases with accelerators where only vacuum is present in the space between target and detectors.
- **XXX:** Various material groups.

Naming Scheme

<Energy Key>-<Purpose Key>-<Geometry Key>-<Material Key>-**<Source Key>**-<ID>-<Measurement Key>-<Short Title>

The following types of radiation sources are defined:

- ☐ **PNT:** Point source
- ☐ **LIN:** Linear source
- ☐ **SUR:** Surface source
- ☐ **VOL:** Volume source

Naming Scheme

<Energy Key>-<Purpose Key>-<Geometry Key>-<Material Key>-<Source Key>-**<ID>**-<Measurement Key>-<Short Title>

The **<ID>** is an integer identifier. It is an integer identifier if the first 5 identifiers are the same.

Naming Scheme

<Energy Key>-<Purpose Key>-<Geometry Key>-<Material Key>-<Source Key>-<ID>-**<Measurement Key>**-<Short Title>

The identifier letters for the different measuring techniques are the following:

- ☐ **N:** Total neutron flux and neutron flux spectrum
- ☐ **G:** Total gamma flux and gamma flux spectrum
- ☐ **R:** Reaction rate in activation foils
- ☐ **A:** Activity
- ☐ **F:** Time of neutron flight if directly available, otherwise as spectrum would be N
- ☐ **D:** Neutron dose
- ☐ **P:** Photon dose
- ☐ **T:** Tritium activity in a breeder material or in a TLD
- ☐ **B:** Bonner sphere signal if directly available, otherwise D or P
- ☐ **L:** Linear transfer dose if directly available, otherwise D or P
- ☐ **S:** Scintillator light pulses if directly available, otherwise D or P

Naming Scheme

<Energy Key>-<Purpose Key>-<Geometry Key>-<Material Key>-<Source Key>-<ID>-<Measurement Key>-**<Short Title>**

This part should contain short title of the entry and the legacy directory name if the entry was already distributed before the implementation of this naming scheme (e.g. "**KEK-KENS-p-500-MeV-with-4m-Concrete-kens500**" or "FNG-ITER-Blanket-Bulk-Shield-integral-fng_blkt").