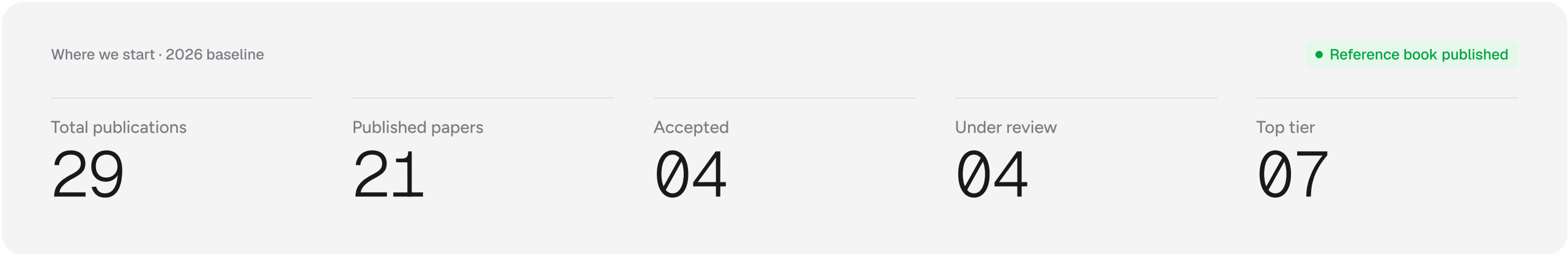


From pore-scale physics to planetary-scale observation.

Our 2026–2030 plan for research direction, publication targets, infrastructure, and partnerships.

Period	2026 – 2030
Published	April 2026
Owner	Dr. Irwan Ary Dharmawan
Department	Geophysics, FMIPA Unpad



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Lab members · Team profile

The team behind the plan.

17 active members and 10 alumni, led by Dr. Irwan Ary Dharmawan, Head of Laboratory, Department of Geophysics, Universitas Padjadjaran. He founded the lab, oversees its research in digital rock physics and remote sensing, supervises postgraduate students, and works with partners in Indonesia and abroad.

See all members →

Researchers	Research associates	PhD student	Master students	Undergraduates	Alumni
3	3	1	8	2	10

01 · Context

Where the lab stands today.

What we have built

- ✓ Mature LBM workflow on RockExplorer (Xeon Gold, 128 GB)
- ✓ Hybrid LBM + ML pipeline (CNN, U-Net, RA-UNet)
- ✓ Open datasets: Digital Rocks Portal, NETL, DPM
- ✓ 10 landmark papers (2023–2026) in a reference book
- ✓ Two research streams: Rock Physics (18) and Remote Sensing (8)
- ✓ Active work with UI (ML/DL) and industry

What still needs work

- Synthetic-to-real generalization gap
- Little Indonesian volcanoclastic data
- 3-D model training is still too costly
- No standard national DRP benchmark yet
- Multi-phase flow and reactive transport not yet covered
- Real-time wellsite deployment is still a goal

A lab built around Indonesian reservoirs.

Our reference points for the 2026–2030 plan.

Vision 2030

A digital rock physics and remote sensing lab for Indonesian reservoirs (volcaniclastic, carbonate, geothermal), with regular Q1 papers and active industry and university partnerships.

Five missions

- 01 Keep developing the hybrid LBM + ML pipeline.
- 02 Publish Q1 and top-tier papers regularly.
- 03 Train graduate students in computational geophysics.
- 04 Support Indonesian oil & gas, geothermal, and CCS.
- 05 Keep international partnerships active.

Core values

- Scientific rigor
- Open science
- Transparency
- Collaboration
- Mentorship
- Indonesia-first
- Global outlook

Our tagline

“We bridge pore-scale physics and planetary-scale observation.”

03 · Lab mandate

Our mandate and strategic position.

Three strategic objectives frame our 2026–2030 work.

Lab focus

Combine physics-based simulation (LBM), machine learning, and remote sensing to characterize Indonesian reservoirs, from pore scale to surface observation.

Objective 01

 Hybrid LBM + ML pipeline

Strengthen the LBM + ML workflow as the lab’s main research tool.

PINN integration with Darcy and conservation laws

Generative methods for image reconstruction

Reduce the synthetic-to-real performance gap

Multiscale connectivity (pore to reservoir)

Open-source release of the pipeline

Objective 02

 Indonesian datasets

Build a curated dataset of Indonesian rocks for ML training.

Volcaniclastic reservoirs (geothermal)

Pre-salt and tight carbonates

Fractured sandstones (EOR targets)

Coal-bed methane and shale gas

National DRP benchmark suite

Objective 03

 Industry deployment

Move from research code to tools that industry partners can use.

Edge inference for wellsite use

Software licensing and consulting

Industry partnerships (Pertamina, Star Energy)

CCS reservoir characterization

Training and certification programs

Three priorities, five research pillars.

Each pillar links to ongoing PhD projects, expected papers, and industry pilots.

Academic excellence

Priority 01

Q1 and top-tier papers, doctoral graduates, and reference textbooks.

Impact

Priority 02

Industry consulting, CCS support, geothermal characterization, and NDC contribution.

Innovation

Priority 03

Hybrid LBM + AI, PINN, generative AI, edge deployment, and software patents.

Five pillars, built in parallel

2026 – 2030

	P1		P2		P3		P4		P5
Physics-informed AI		Generative imaging		Multiscale modeling		Multi-phase & reactive		Edge AI & deployment	
PINN, conservation-law constraints, and hybrid LBM-ML losses.		GAN and diffusion models for super-resolution and data augmentation.		Pore to core to reservoir, with MS-Net and GNN connectivity.		Shan-Chen LBM, CCS, EOR, and two-phase flow simulation.		Real-time wellsite DRP, model distillation, and INT8 inference.	

How we work

Open science, reproducible workflows, Indonesian datasets, mentorship for graduate students, and results before claims.

Four enablers

01 Talent & mentorship

02 Compute & data infrastructure
The foundation: all other enablers depend on it

03 Funding & partnerships

04 Outreach & branding

One theme per year.

Three phases, from consolidation to deployment.

Phase 1 · Consolidation2026 – 2027		Phase 2 · Expansion2028 – 2029		Phase 3 · Deployment2030
Finish current outputs and address the synthetic-to-real gap.		Multiscale and generative methods; grow international work.		First edge-inference deployment; plan the next five-year cycle.
2026Y1	2027Y2	2028Y3	2029Y4	2030Y5
Consolidation	Hybrid AI	Multiscale & PINN	Generative & multi-phase	Edge inference & field
- Reference book published - Systematic review (Q1) - Talent pipeline expansion - National benchmark draft 8 papers in pipeline (4 accepted, 4 under review)	- PINN prototype - Domain adaptation methods - Indonesian volcanoclastic dataset 4–5 Q1 papers - First industry pilot	- MS-Net + GNN models - Pore to reservoir bridge - Generative super-resolution - Top-tier targets 2 doctoral defenses	- Diffusion models for rocks - Shan-Chen 2-phase LBM - CCS reservoir suite - International grant secured - Software patent filed	- Wellsite edge inference trial - Industry licensing live 15+ cumulative papers 5+ top-tier papers 2031+ plan published

What each year delivers.

2026

Consolidation & book launch

Stabilize the 10-paper output, publish the reference book, and draft the national DRP benchmark.

• Focus · Foundation & visibility

🧪 Research & publications

- Systematic review published (Results in Engineering)
- Reference book “Advancing Digital Rock Physics” launched
- Process 8 papers in the pipeline (4 accepted, 4 under review)
- Start the national DRP benchmark dataset
- First volcanoclastic micro-CT acquisition

🤝 Capacity & partnerships

- Recruit 2 doctoral candidates
- MoU with Pertamina and Star Energy
- First workshop with the UI ML team
- Apply for 1 international grant
- Open-source release: LBM utilities

🎯 Output targets

- 3–4 Q1 papers
- 1 reference book (done)
- 2 international conference talks

📦 Infrastructure

- RockExplorer GPU upgrade
- Storage expansion (+50 TB)
- CI/CD for the ML pipeline

⚠️ Risk watch

- Reviewer-2 capacity
- Mid-year funding gap
- Talent retention

2027

Hybrid AI & the generalization gap

Tackle the synthetic-to-real gap, build the first PINN prototype, and launch the Indonesian dataset.

• Focus · PINN & domain adaptation

🧪 Research highlights

- PINN-RA-UNet (Darcy + continuity loss)
- Domain adaptation: synthetic to real fractures
- Indonesian volcanoclastic dataset (geothermal)
- Tortuosity benchmark on Brazilian carbonates
- Uncertainty quantification (MC Dropout, ensembles)

🤝 Industry & international

- First industry pilot (Pertamina): Cepu reservoir
- Visiting researcher exchange (Imperial College / Kyushu University)
- Joint workshop on PINN and geosciences
- International grant secured (such as AUN/SEED-Net)
- Attend Interpore, AGU, and EAGE

🎯 Output targets

- 4–5 Q1 papers (1 top tier)
- 1 doctoral graduation
- 3 conference papers

🛠️ Software output

- DRPRS-PINN v0.1 (public beta)
- Volcanoclastic dataset v1
- Benchmark suite v1

⚠️ Risk watch

- PINN convergence challenges
- Field acquisition delays
- GPU bottleneck

2028

PINN & multiscale modeling

Bridge pore scale to reservoir scale, deploy MS-Net + GNN, and deepen physics-informed AI.

• Focus · Multiscale connectivity

🧪 Research highlights

- MS-Net for multiscale flow prediction
- GNN for pore-network connectivity
- PINN v2: full Navier-Stokes residuals
- Generative super-resolution (low-res to high-res CT)
- Pore to core to reservoir upscaling pipeline

🎓 Education & outreach

- 2 doctoral defenses
- MOOC on Computational Geophysics (Unpad)
- 3 international PhD co-supervisions
- Annual DRPRS Symposium launched
- Industry training certificate program

🎯 Output targets

- 5–6 Q1 papers (2 top tier)
- 2 doctoral graduations
- 1 software patent applied

🛠 Software output

- DRPRS-MultiScale v1.0
- DRPRS-PINN v1.0 (stable)
- Public benchmark v2

⚠ Risk watch

- Multiscale validation difficulty
- GPU cost escalation
- Talent competition (industry)

2029

Generative AI & multi-phase flow

Diffusion models for rocks, Shan-Chen 2-phase LBM, and a CCS reservoir suite, as international visibility peaks.

• Focus · Diffusion + 2-phase

🧪 Research highlights

- Diffusion models for rock image synthesis
- Shan-Chen 2-phase LBM (oil-water, CO2-water)
- Reactive transport simulation (mineral dissolution)
- CCS-ready reservoir characterization suite
- Geothermal multi-phase modeling (Wayang Windu pilot)

📄 Industry & patents

- Software patent: DRPRS-Hybrid (filed)
- Industry licensing: 1 commercial contract
- Second Pertamina pilot expanded
- BPMA Aceh carbonate project kickoff
- International grant renewal secured

🎯 Output targets

- 5–6 Q1 papers (2–3 top 10%)
- 1 doctoral graduation
- 1 software license signed

🛠 Software output

- DRPRS-Generative v0.5
- DRPRS-2Phase v1.0
- CCS Toolkit v1.0

⚠ Risk watch

- Diffusion training compute
- Patent process delays
- Industry timing misalignment

2030

Edge inference & field deployment

First wellsite trial of edge inference, close the five-year cycle, and plan 2031–2035.

• Focus · Field deployment

🧪 Research highlights

- Edge inference: model distillation, INT8 quantization
- Mobile-DRPRS: smartphone-based field acquisition
- Wellsite analytics dashboard prototype
- Federated learning across industry partners
- 2031–2035 work plan published

📊 Cumulative outputs (2026–2030)

- 15+ new papers
- 5+ top-tier publications
- 3 software releases in industry use
- 1 national DRP benchmark suite
- 2 software patents filed

🎯 Output targets

- 4–5 papers, retrospective reviews
- 2 doctoral graduations
- Second software patent

🛠 Software output

- DRPRS-Edge v1.0
- Mobile-DRPRS app (beta)
- Federated learning toolkit

📖 Legacy

- Roadmap 2031–2035
- Second reference book
- Lab succession planning

Work that never stops.

 Talent pipeline

2 new doctoral candidates per year

Yearly undergraduate summer school

Postdoc fellowships (from year 3)

Industry–academia exchange

Mentorship: 1 senior per 3 juniors

 Open science

All code on GitHub, permissive license

Datasets on Zenodo with DOIs

CI/CD for reproducible pipelines

Yearly code-review hackathons

Public lab notebooks

 International engagement

3+ active international collaborations by 2028

Yearly international DRPRS Symposium

Visiting researcher exchanges

PhDs co-supervised with EU, US, and Japan

Interpore, AGU, EAGE, and SEG presence

 Indonesia-first datasets

Goal: the largest curated, AI-ready set of Indonesian rocks, covering volcanioclastic (geothermal), pre-salt and tight carbonates, fractured sandstones (EOR), coal-bed methane, and shale gas.

 Industry partnership program

Shared benchmarks, joint pilots, and consulting with Pertamina, Star Energy, BPMA Aceh, and geothermal operators, to turn research into reservoir-scale impact.

How we will measure progress.

Each chart shows today (2026), the 2028 plan, and the 2030 target.



Clear rhythm, named risks.

Decision & review rhythm

Weekly	Lab stand-up and PhD check-ins
Monthly	Publication pipeline review
Quarterly	Roadmap KPI review with the Faculty
Twice a year	Industry partner roundtable
Yearly	External advisory board and strategy refresh

Oversight bodies

- FMIPA Research Committee
- Department academic council
- External advisory board (industry + academia)
- Internal ethics & data-stewardship committee
- Joint LPDP / national grant oversight

Risk	Likelihood	Impact	Mitigation
Talent retention (industry pull)	● High	● High	Competitive stipends, postdoc track, software IP equity
Compute / GPU bottleneck	● Medium	● High	Shared HPC, cloud burst, and model distillation
Funding gaps mid-cycle	● Medium	● Medium	Mixed industry, national, and international grants
Reproducibility issues	● Low	● High	CI/CD, code review, public datasets, documentation standards
Scope creep / publication pressure	● Medium	● Medium	Yearly scope check and clear pipeline gates

What it takes to deliver.

Compute

~Rp 1–2 bn / year

2 GPU nodes (8× A100 / H100) by 2027

Storage up to ~100 TB by 2028

Cloud burst budget for diffusion models

Mobile and edge dev kits (year 4)

Yearly lifecycle cost: ~Rp 1–2 bn

People

8 PhDs over 5 years

Lab head + 2 senior co-investigators

2–3 postdocs (from year 3)

4–6 MSc students per year

2 visiting researcher slots per year

Funding mix

5 sources

National: LPDP, BRIN, Riset Inovasi

International: AUN/SEED-Net, JSPS, Royal Society

Industry pilots and consulting

Software licensing royalties (year 4+)

University internal seed grants

Critical success factors

01 Talent

Keep top PhD candidates with mentorship and a software IP share.

02 Discipline

Hold quarterly KPI reviews and avoid scope creep.

03 Industry alignment

Co-design pilots early and deliver value often.

04 Open science

Reproducibility is required, and all major outputs are public.

11 · Partners

Partners who share the plan.

Active research in Europe, the Middle East, and Southeast Asia on digital rock physics, AI for reservoir characterization, remote-sensing geophysics, and geophysical computation, with shared PhD supervision. UTP (Malaysia) is our newest partner in Southeast Asia.

5

Universities

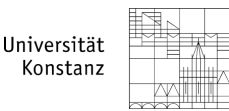
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Countries



Karlsruhe Institute of Technology

GERMANY



Universität Konstanz

GERMANY



Ghent University

BELGIUM



United Arab Emirates University

UAE



Universiti Teknologi PETRONAS

MALAYSIA

OPEN TO NEW PARTNERS

Work with us on rock physics and remote sensing.

Get in touch →

Europe

KIT: computational geosciences, HPC

UGent: pore-scale imaging

Univ. Konstanz: statistical physics, ML

Middle East

UAEU: carbonate reservoir characterization

Joint workshops and data sharing

Doctoral co-supervision

Southeast Asia

New

UTP: reservoir and petroleum geoscience

Joint Indonesia–Malaysia DRP benchmarks

Shared geothermal and volcanoclastic agenda

Questions, feedback, or a proposal?

Help build the next five years of Indonesian rock physics.

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