

# AIDA<sup>3</sup>

Artificial Intelligence for Digital,  
Autonomous, and Augmented Aviation



*Vision and plan for operational implementation*  
**Dr. Sabine Brunswicker, Professor, Founding Director**

An Interdisciplinary Center in Discovery Park District  
with **Purdue** and **Windracers** as founding partners

# What is AIDA<sup>3</sup>

## A NEW ERA IN PHYSICAL ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

The Purdue Center on AI for Digital, Autonomous and Augmented Aviation (AIDA<sup>3</sup>) is a hub of innovation, where cutting-edge research meets practical application. At AIDA<sup>3</sup>, we harness the power of artificial intelligence to revolutionize aviation and transportation. Our multidisciplinary team is pioneering AI and machine learning (ML) models to address industry challenges — from optimizing commercial logistics to enhancing safety in autonomous transportation.



On April 12, 2024 we unveiled Earhart, one of the key physical artifacts of the new center AIDA<sup>3</sup>

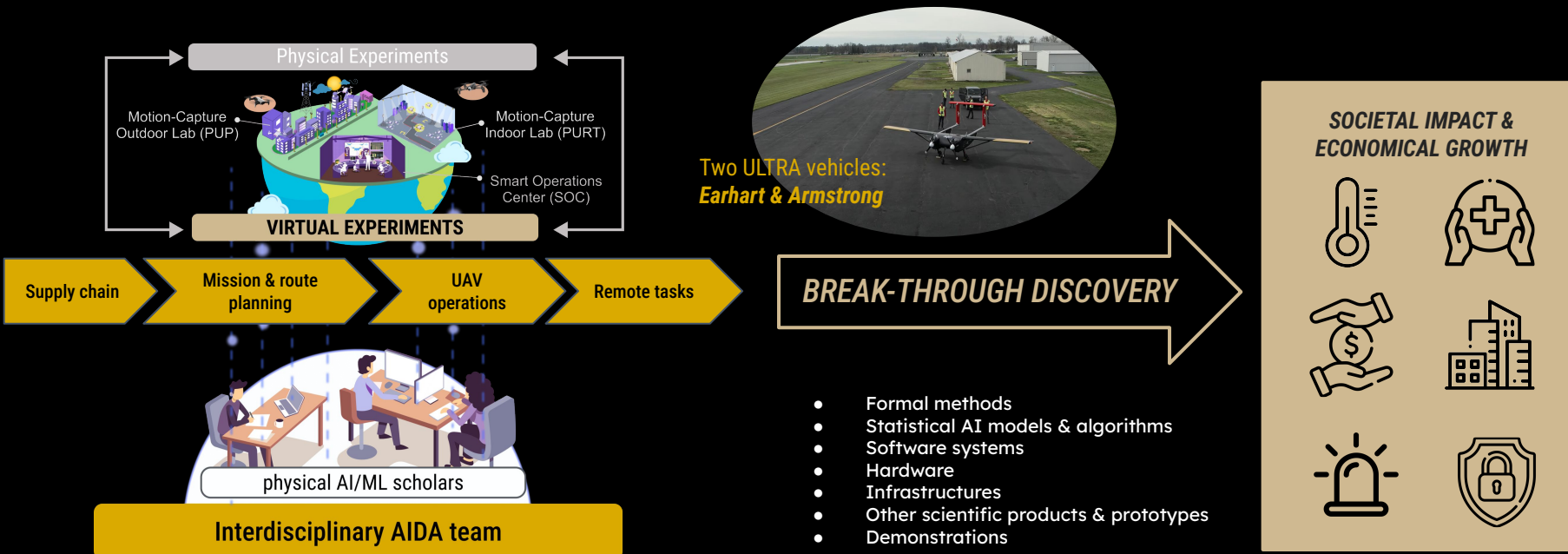


On April 9, 2024 Earhart performed its first flight in the US



# THE BOTTOM-LINE: IF AIDA<sup>3</sup> IS SUCCESSFUL, ITS BREAKTHROUGH DISCOVERIES HAVE THE OPPORTUNITY TO TRANSFORM SOCIETY AT SCALE

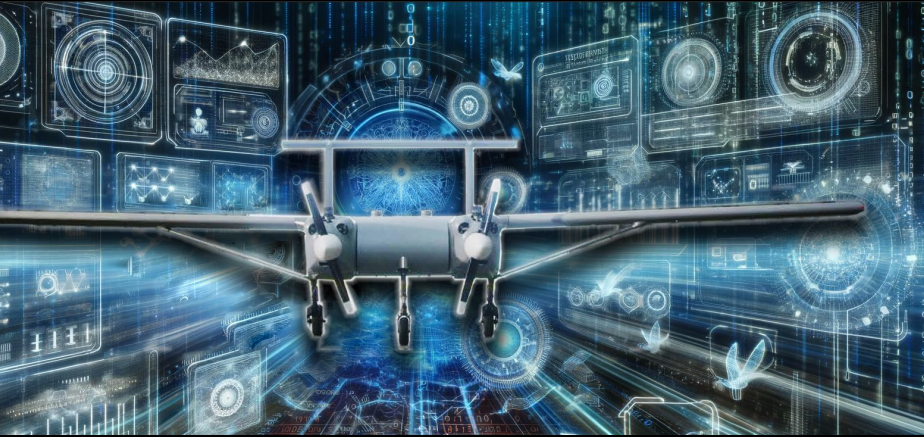
## AIDA<sup>3</sup> - AI for digital, autonomous, and augmented aviation



### BREAK-THROUGH DISCOVERY

- Formal methods
- Statistical AI models & algorithms
- Software systems
- Hardware
- Infrastructures
- Other scientific products & prototypes
- Demonstrations

**SOCIETAL IMPACT & ECONOMICAL GROWTH**



## The founding partners

# WHO IS AIDA<sup>3</sup>

We are a multidisciplinary consortium founded by Purdue University and Windracers, with opportunities for additional partners to join. Purdue brings together four esteemed colleges and one dedicated institute, along with a team of expert faculty. Windracers, developer and operator of the ULTRA unmanned aerial vehicle platform, provides extensive experience in parcel and humanitarian aid delivery services across the United Kingdom.



INSTITUTE FOR **PHYSICAL AI**

COLLEGE OF  
**ENGINEERING**

COLLEGE OF  
**LIBERAL ARTS**

COLLEGE OF  
**SCIENCE**

**POLYTECHNIC**  
INSTITUTE

*WINDRACERS' ULTRA Is the largest automated UAV currently available in the US for research (and commercial) purposes*

## ULTRA Design Parameters

### Air Cargo Transportation over Middle Mile (50-500 km)

- Focus on air cargo transportation using a high payload UAV – ULTRA
- Operates beyond visual line of sight (BVLOS)
- ULTRA UAV platform on 3<sup>rd</sup> iteration – with high reliability avionics system developed in-house
- Extensive operational experience across UK with established safety case with CAA
- FAA Waiver in US to operate out of Jasper County
- Manufacturing JV in India and in UK
- Contracts with UK Ministry of Defence for aircraft and training
- Currently used in Ukraine for supply delivery
- Used for meteorological research in the Antarctic
- Starting work with World Food Programme in Southern Africa for aid delivery

Parameter	Design Goal
Range	1,000 km (+45 min reserve)
Payload	100 kg+
Empty Weight	270 kg
Maximum Takeoff Weight	450 kg
Payload Volume	700 litres
Cruise Speed	135 km/h
Takeoff and landing	200 m (Nil wind)
Nominal Endurance	12+ hours
Electric Power	350W
Runway	Dirt, Grass, Tarmac, and Ice



# WHO IS AIDA<sup>3</sup>

## DIRECTOR:

Sabine Brunswicker (PPI)

## CORE FACULTY:

Inseok Hwang (AAE)

James Goppert (AAE)

Yung-Hsiang Lu (ECE)

Damon Lercel (PPI)

## AFFILIATED PURDUE FACULTY (ACTIVE)

Aniket Bera (CS)

Eugenio Culurciello (BME)

Dan Czisco (EAPS)

Mahsa Ghasemi (ECE)

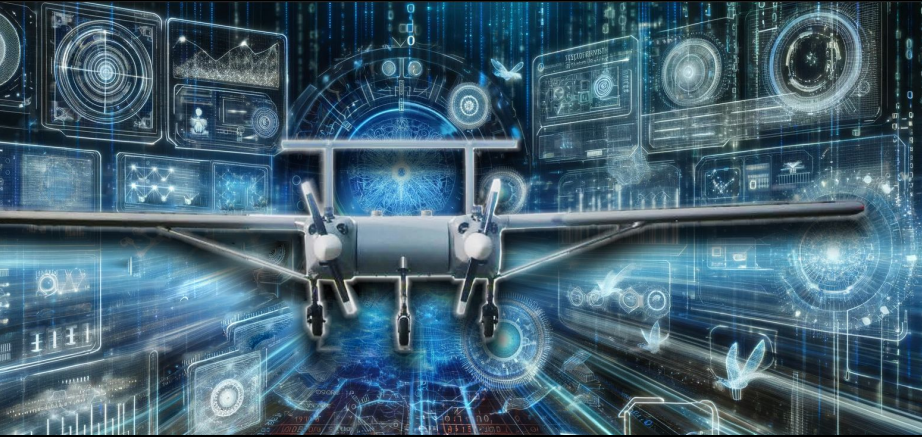
Nan Kong (BME)

Santiago Torres-Arias (ECE)

Stacey Connaughton (CLA)






Philip E. Paré (ECE)

And we hope that  
more ECE faculty  
get involved!








## Key research areas & organizational set-up

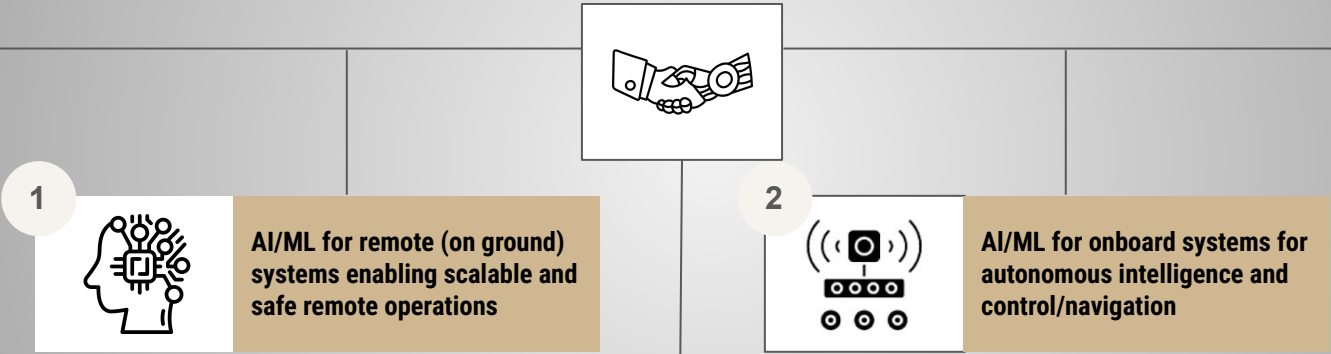
*AIDA's research is organized in 5 major pillars; discoveries made in those pillars translate into solutions that solve problems in different impact areas*


Key R&D Pillars	
	Remote AI/ML systems for safe & trustworthy human-autonomy teaming in m:n architectures
	AI for onboard AI-systems for autonomous sensing/intelligence and control
	AI for supply-chain innovation and optimization
	AI for meteorological sensing and weather hazards
	Cybersecurity for AI in digital aviation





Key impact areas	
Multi-modal cargo & transportation	
Emergency response & public safety	
Humanitarian aid	
Defense	
Healthcare	

**Pillar 1 and 2 are currently in focus (with ECE faculty involved): Solving the problem of safe and scalable remote operations is a grand challenge**

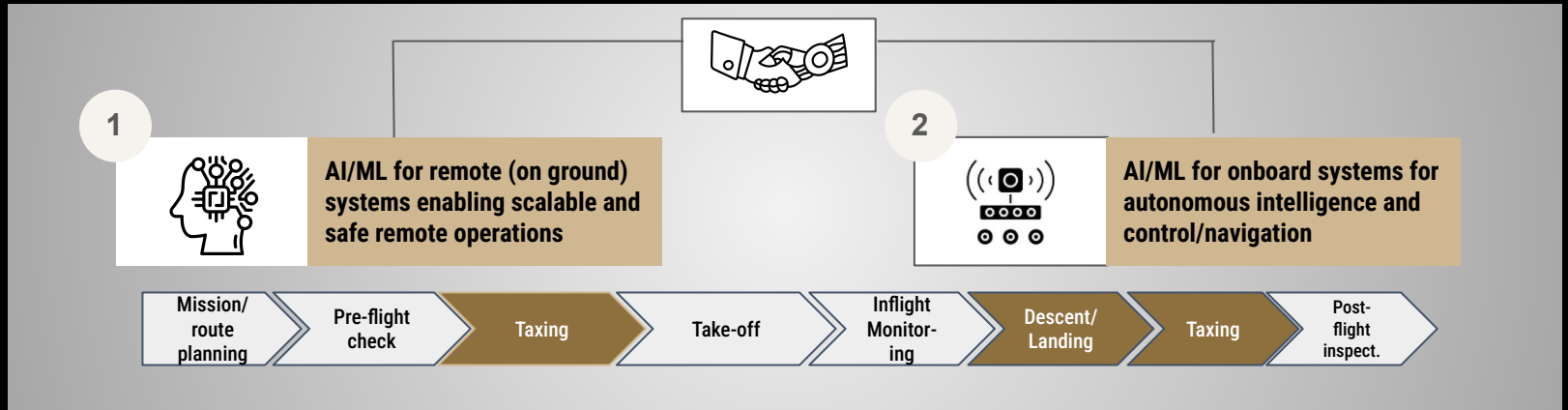


3  AI for supply-chain innovation and optimization

4  AI for meteorological sensing and weather prediction

5  Cybersecurity for AI in digital aviation

After workshops with Windracers' in UK and our own industry analysis we identified two critical "problems to solve" guiding research in pillar 1 and 2;



### High priority "Problems to solve"

**#1: 1:100**  
One human "operating" 100 Ultras @ same time

**#2: Simple to use**  
"Standard" human operator 100% proficient after two hours training

# These problems should be solved in ongoing and future seed-funded projects



## Problems to solve

### #1: 1:100

One human "operating" 100 Ultras @ same time

### #2: Simple to use

"Standard" human operator 100% proficient after two hours training



## R&D projects (seed funded)



AI/ML for remote real-time human sensing (e.g. cognitive load, situation awareness)



AI/ML for real-time shared intelligence & shared control



Verification of automated landing



Dynamic path-planning



Multi-modal sensing and AI/ML autonomous taxiing



AI/ML enabled taxiing using ATC/language-based navigation



AI/ML for training optimization & real-time expertise modeling



Deep AI/ML for optimized autopilot and aerodynamics prediction



AI/ML for real-time health monitoring and reporting by exception

*Problems to solve in pillar 2 to 5 go beyond remote operations and capture broader business problems of autonomous aviation*

3



AI for supply-chain innovation and optimization

4



AI for meteorological sensing and weather prediction

5



Cybersecurity for AI in digital aviation

**High priority “Problems to solve”**

**#3: Always flying**  
70% asset utilization

**#4: Sensing dynamically**  
Without constraints

**#5: Attack resilience**  
No outsider can take control

*These problems should be solved in ongoing and future seed-funded projects*



### Problems to solve

**#3: Always flying**  
70% asset utilization

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Without constraints

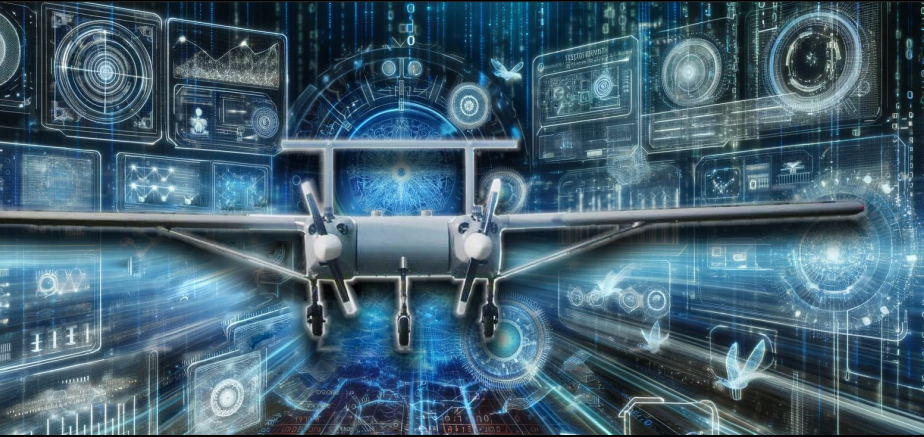
**#5: Attack resilience**  
No outsider can take control



### Future R&D projects (seed funded)

- AI/ML for real-time dynamic network optimization
- AI/ML for onboard systems enabling real-time migration sensing
- AI/ML for real-time weather prediction
- AI/ML for dynamic demand analytics and automatic dispatch
- AI/ML for preventive maintenance
- AI/ML for system identification ....
- ....
- ....





## Our facilities and infrastructure

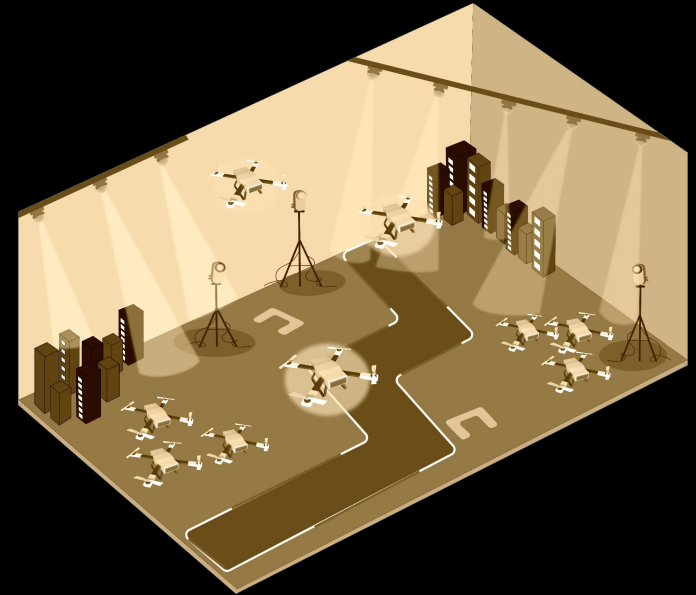
*PURT is an essential component of AIDA3*

In the beginning we would use a downscaled fixed-wing drone using Windracers sensors to run experiments until we have FAA approval for flying the ULTRA outdoors

#### Purdue UAV Research and Test (PURT)

The Purdue UAV Research and Test facility houses the largest indoor motion-capture environment in the world with an area of 20,000 sq ft and a ceiling 30 ft high. The motion-capture system provides ground truth data for algorithm development and enables virtual and augmented reality.

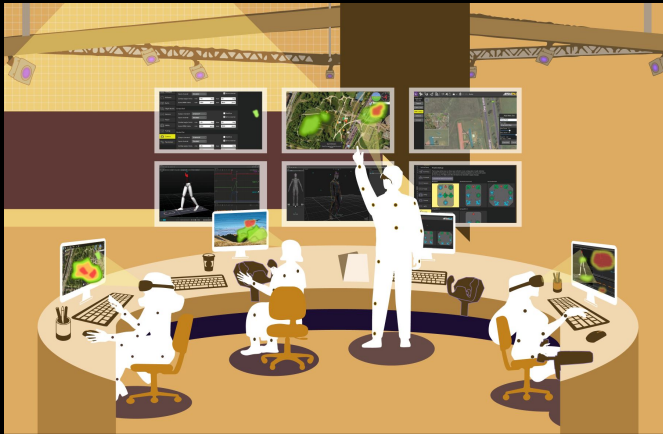
The virtual and augmented reality utilizes the position and attitude data from the motion capture system to stream video to both autonomous vehicles and humans wearing virtual reality headsets in the facility.



*AIDA3 will also set-up the first smart operations center (SOC) supporting research and real-world implementation related to remote operations and air traffic control*

## Smart Operations Center (SOC)

- An **immersive smart operations center** for real-world remote operations as well as ground-breaking research.
- Equipped with gridded wall of screens along with motion capture cameras (ala PURT) and sensors and VR/AR technologies
- Operators using smart wearable devices (eye-tracking glasses, biometric sensors, EEG, fMIR, smart watch & cloths etc.) to optimize operations

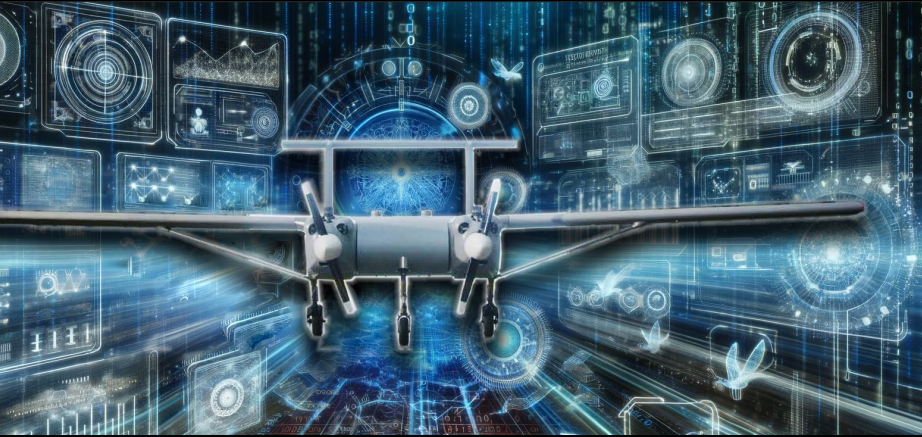


*AIDA is the driving force behind the PUP*



## Purdue Urban Proving Ground (PUP)

- The world's first and largest urban motion-capture outdoor facility
- Size of 475m \* 110m (approx 12 acres) with the goal to increase
- Capable of **motion capture** allowing for real time sensing at a centimeter level accuracy in an outdoor setting.
- Motion capture system is essential to creating digital twin simulations of physical systems.
- Integrated UTM with 4 system components: GBSAA, LAWN, Remote ID, and 3-D real-time weather.
- Potential for mixed-reality environments, and sensor emulation.



## Partnership model & Fundraising plan

*Our goal is to add two additional partners to the consortium within 13 months*

Tier	Tier III: Bronze	Tier II: Silver	Tier I: Gold	Founding Member (Windracers)
<b>Fee</b>	\$20,000/Y	\$80,000/Y	\$1,000,000/Y1	\$2,600,000/Year 1 and \$1,000,000 there after
<b>Benefits</b>	<ul style="list-style-type: none"> <li>- Member logo on website.</li> <li>- Ability for researchers from member organization to attend seminars.</li> <li>- Access to research outcomes.</li> </ul>	<ul style="list-style-type: none"> <li>- On-campus recruitment and workshops.</li> <li>- Active engagement and partnership to seek large-scale, external funding on strategic research at national levels.</li> <li>- Right to name member in Technical Liaison Team</li> <li>- Tier III benefits.</li> <li>- Funding will typically go directly to seed funding for doctoral researchers/faculty.</li> </ul>	<ul style="list-style-type: none"> <li>- Right to name a member in Technical Steering Committee.</li> <li>- Rights to intellectual property.</li> <li>- Tier II benefits.</li> </ul>	<ul style="list-style-type: none"> <li>- Co-Chair the Technical Steering Committee together with Director.</li> <li>- Tier I benefits.</li> </ul>

**Partners for consideration**

Crane (Navy Base Indiana), Ag Alumni Seed, Saab, ....(Lockheed Martin ...)

**The CENTER'S RESOURCES WILL SEED and SUPPORT AN AMBITIOUS FUNDRAISING GOAL OF \$20M within ~5 years**

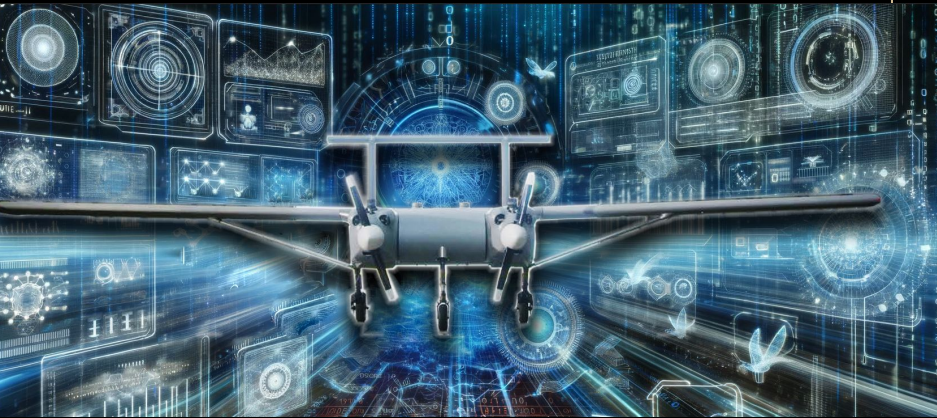
Funding source	Program/title	Timeline, Status,	institutions, PIs	Total Budget
NSF Midscale R1	Mid-scale RI-1 (M1:IP): AirTonomy: A Cyber-Physical Research Infrastructure for Next-Generation Autonomous Aerial Vehicles	After successful reverse site visit in July 2023 workshop in april 20224; Jan 2025	AIDA+ 8 US academic institutions PI Brunswicker Co-PIs: Lu, Hwang, Lercel, Song, Goppert; 22 faculty members	~\$18 M
NSF CISE	CISE Medium: HCC: Human-autonomy teams (HAT) for UAVs (HAT4U)	October 2023; awaiting decision	AIDA Co-Pis: Lu, Hwang, Lercel	~ \$1.2 M
NSF/EPSRC	U-SAFE: Trustworthy shared intelligence for safe human-autonomy teaming with UAVs	Pre-proposal sent and accepted; full proposal due April 24, 2024	AIDA/Sheffield PI Brunswicker	~ \$500 K USA
USAID	USAID Grants: A cost-effective UAV-based humanitarian logistics model for increased resilience in East Africa	Response to RFI	AIDA/Windracer USA	up to \$ 20 M
DoD	Battlefield medicine and UAV-based medical delivery (e.g. blood supply)	2023; PI white paper sent	AIDA: PI PI Brunswicker, Kong	~ \$1 M
NSF CPS	Brain-human interfaces for real human-autonomy teaming	for spring 2024	AIDA: PI Brunswicker Co-PIs: Hwang, Ghemasi, Hiele, Sereno	~ \$2 M
NASA ULI	Realizing m:n architectures for UAV operations	Pro-proposal May 2024	AIDA PI: Brunswicker	~ \$8 M
FAA	Workforce Development for AAV operations	Spring 2024	AIDA, Damon	?
DoD/Crane	Foreign Competitive Testing	May 2024	AIDA, Windracers USA	?
NSF PDM	AI for UAV-based weather forecasting and dynamic path planning	May 2024	AIDA, Dan Czizco,	?

**Status Jan 2024**

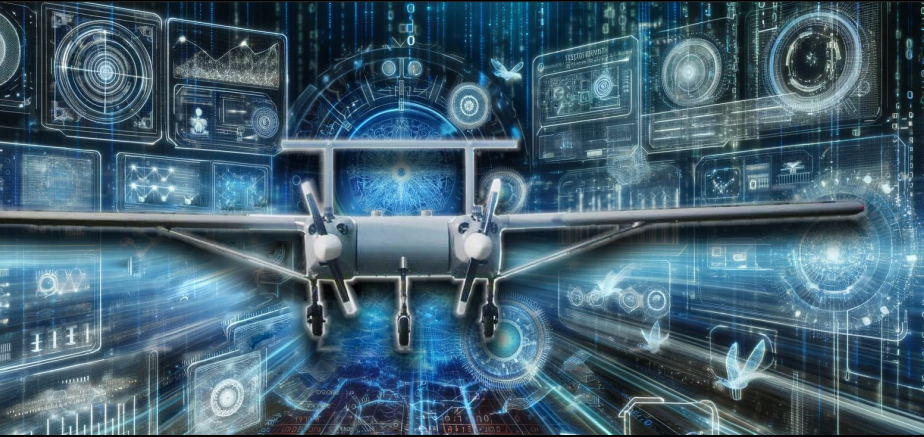
*Thank you for supporting  
the vision!*

**Sabine Brunswicker**  
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[go.purdue.edu/aida3](http://go.purdue.edu/aida3)

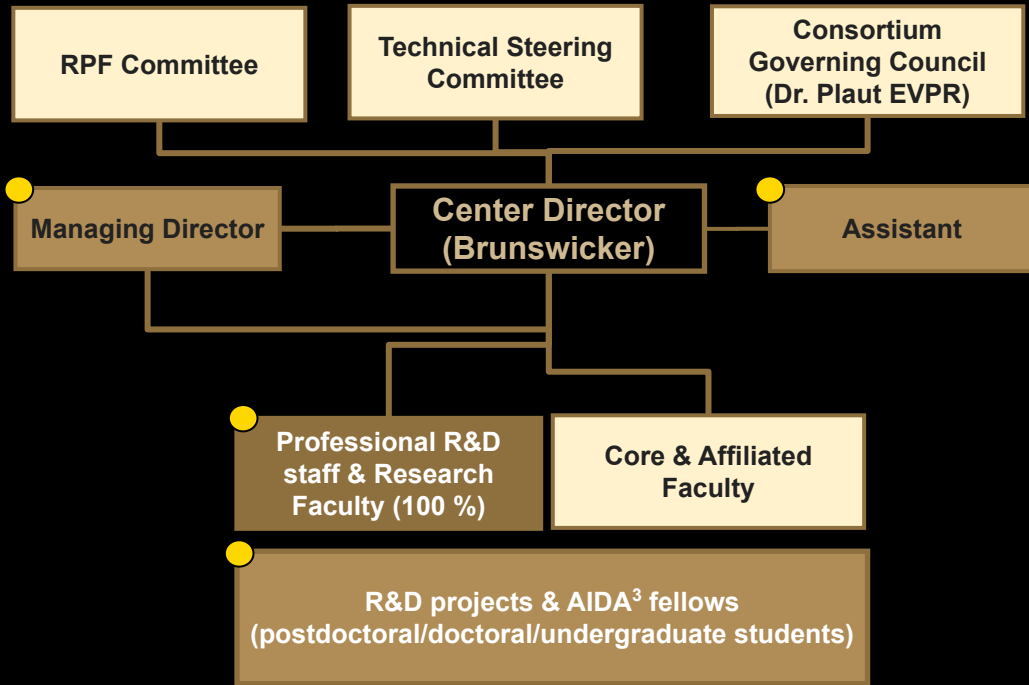






**Back-up**

To be successful, we need to finalize the hiring of fully dedicated R&D staff and faculty



Funded by Center Funds (Windracers & Colleges Costshare)

### Consortium Members



### Center funding for human resources

Managerial staff/admin	<ul style="list-style-type: none"> <li>Managing director</li> <li>Lead administrative assistant</li> </ul>
Professional R&D and operations staff	<ul style="list-style-type: none"> <li>Research faculty</li> <li>Junior AI/ML software engineer</li> <li>UAV pilot (tbd)</li> </ul>
Seed funds	<ul style="list-style-type: none"> <li>Post-doctoral/Doctoral AIDA<sup>3</sup> fellows</li> <li>Graduate AIDA<sup>3</sup> fellows</li> <li>AIDA<sup>3</sup> Internships</li> <li>AIDA<sup>3</sup> faculty summer support</li> </ul>