PINPOINT

Precision Inertial Navigation & Positioning On an Integrated Tesseract

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Proposer's day

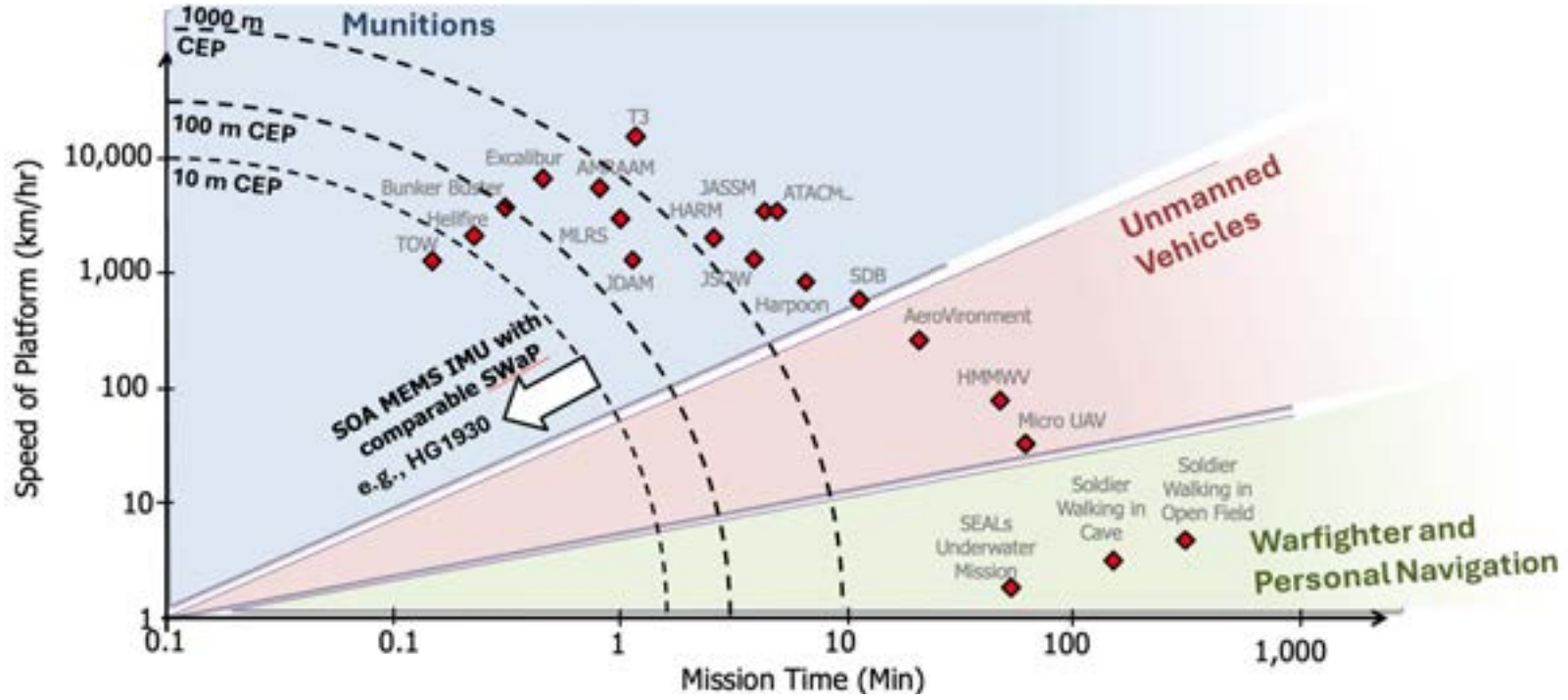
07/27/2026

Accurate positioning will be denied in future battles

- GPS denial already a problem in current conflicts
- Peer conflict threatens entire GPS constellation
- Other solutions such as visual/terrain-based navigation unreliable in dynamic conflict and over/under water

Approximate denial of GPS in Ukraine conflict

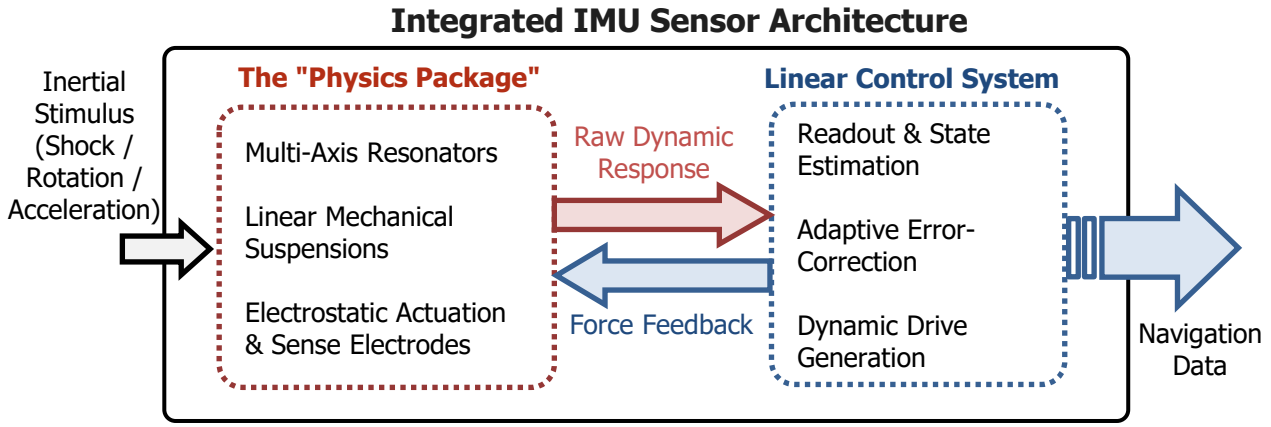
Estimated performance of current platforms in GPS denial

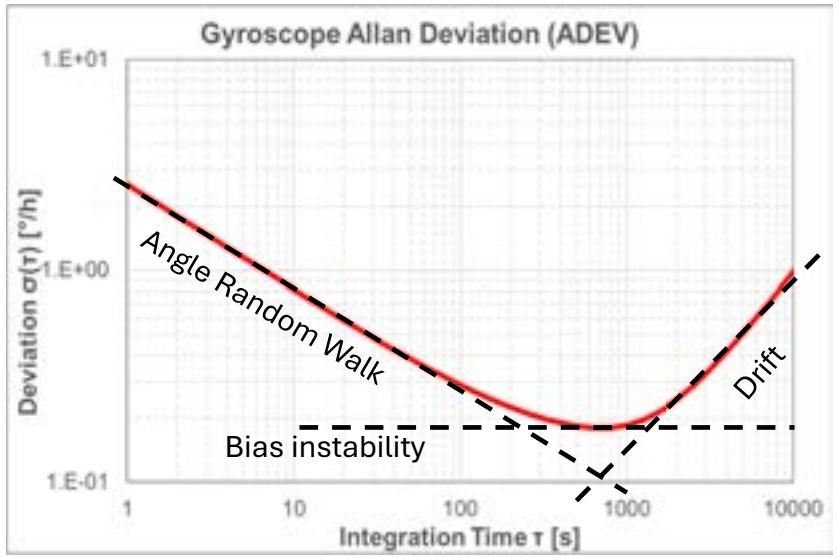


PINPOINT will provide the precision to execute missions without aid from external sources

GPS: Global Positioning System

Current tactical systems limited by linear operating regime





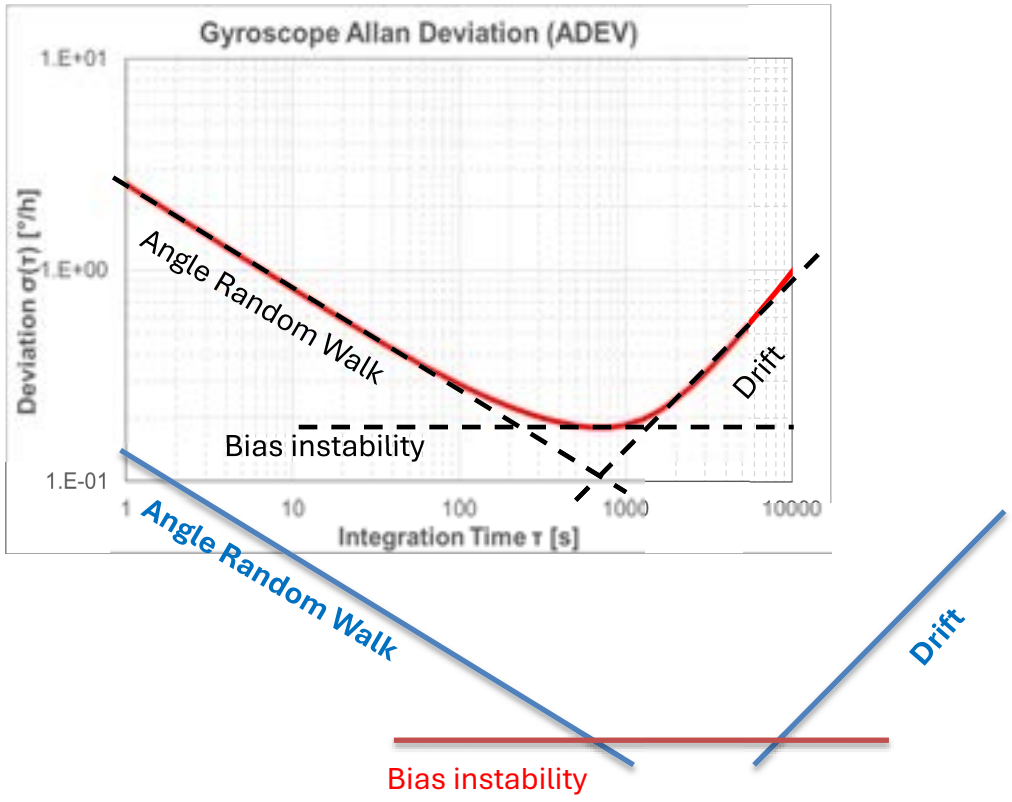
State of Art: 6 tethered, linear-range operating, MEMS sensors – 3 rotation rate sensing gyroscopes and 3 acceleration sensing accelerometers

- **Sensor Physics Package:** Tethered mechanical system operates in linear range of vibration
  - Driving down ADEV requires increasing momentum (mass x velocity) of proof mass
- **Sensor Control System:** Oscillation sustaining drive circuits, transimpedance amplifier readout, misalignment correction circuits
  - Untethering and high-velocity masses pushes system into nonlinear regime

Advancing small-ꝺ zed IMU ꝺ ate-of-the-art requires leaping to nonlinear operation and control

MEMS: Micro-electromechanical system
ADEV: Allan Deviation
IMU: Inertial measurement unit

PINPOINT will research Nonlinear Sensor Package, Control Systems and their interplay



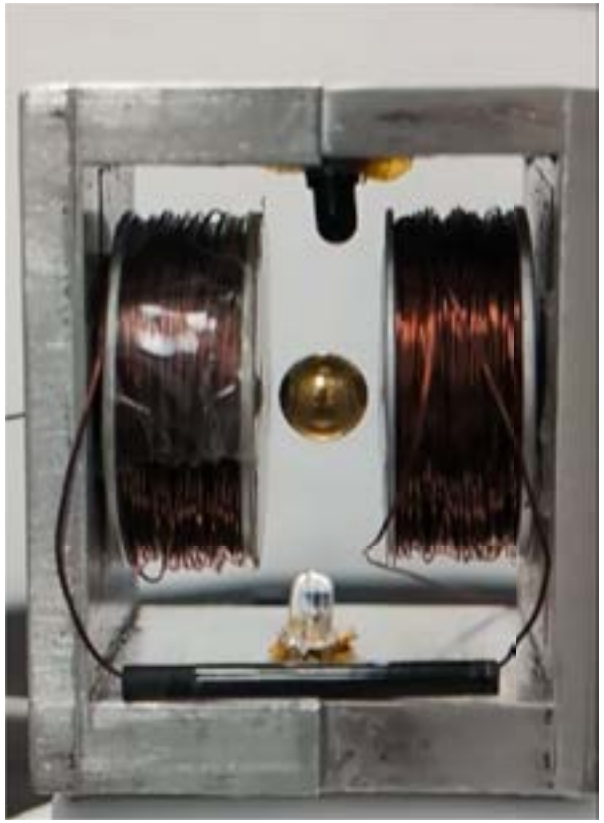
PINPOINT Vision: Develop a 6 degree-of-freedom IMU. For each sensing axis we will leverage

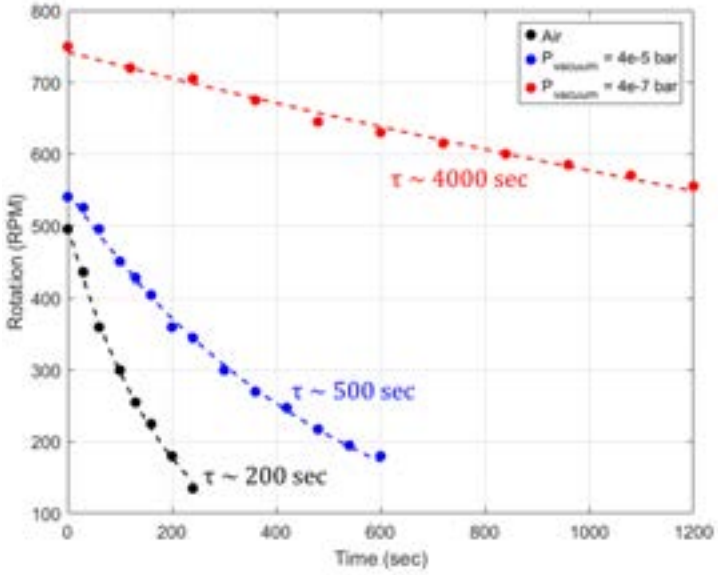
- **Levitated Microsystem:**
  - All 6 trap potentials are extremely nonlinear
  - Spinning or oscillating the trapped mass will involve overcoming these nonlinear potentials
- **High Velocity Microsystem:**
  - Operates in the mechanical spring's nonlinear range
- **Low-noise, Nonlinear Control Systems:**
  - Oscillation driver
  - Sensing without back-action
  - Phase-coherent mechanical combs

We will define a new paradigm in small-sized IMUs by building on nonlinear and adaptive control, early measurements of noise sources, and iterative modeling-measurement

ADEV: Allan Deviation
IMU: Inertial measurement unit

Levitated microsystems show strong potential for 100-1000x improvement in ARW/VRW and bias drift



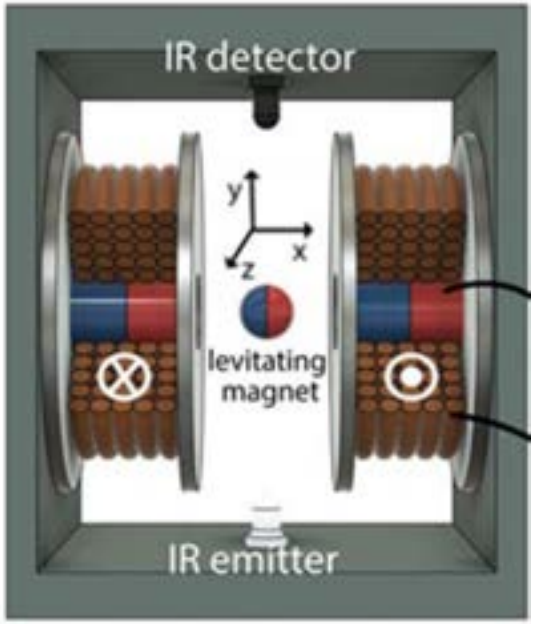


- **Levitated Mass:**
  - All 6 trap potentials are extremely nonlinear
  - Spinning or oscillating the trapped mass will involve overcoming these nonlinear potentials
- **Low-noise, Nonlinear Control Systems:**
  - Cross-axis error correction
  - Sensing without back-action with clever schemes adapted from the Optomechanics and Squeezed-light community

A ring-down time of 1 hour (1000X better than SOA); enabling longer free inertial navigation for missions

ARW: Ange Random Walk
VRW: Vector Random Walk
SOA: State of the Art

Challenges of designing levitated multi-axis sensors



acceleration

Permanent magnets: Passive stabilization in (y, z) directions

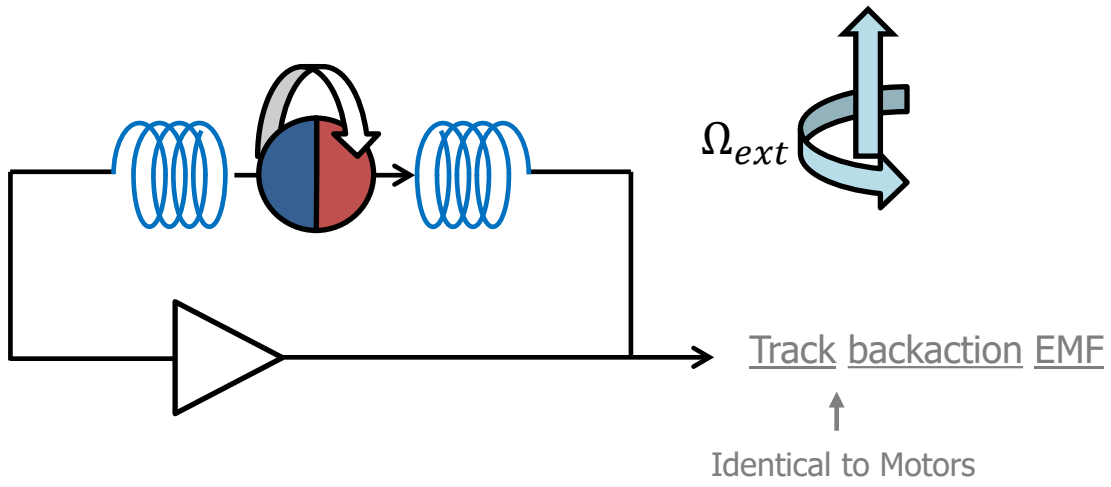
Electromagnets: Active feedback stabilization in (x) direction

MEASURING ACCELERATION

- **X-axis acceleration:** Magnetic force changes to keep mass in place
  - Feedback force can be used to measure acceleration
- **Y/Z-axis acceleration? Option:** Use multiple coils
  - Change in each magnetic field measures acceleration along different axes

MEASURING ROTATION

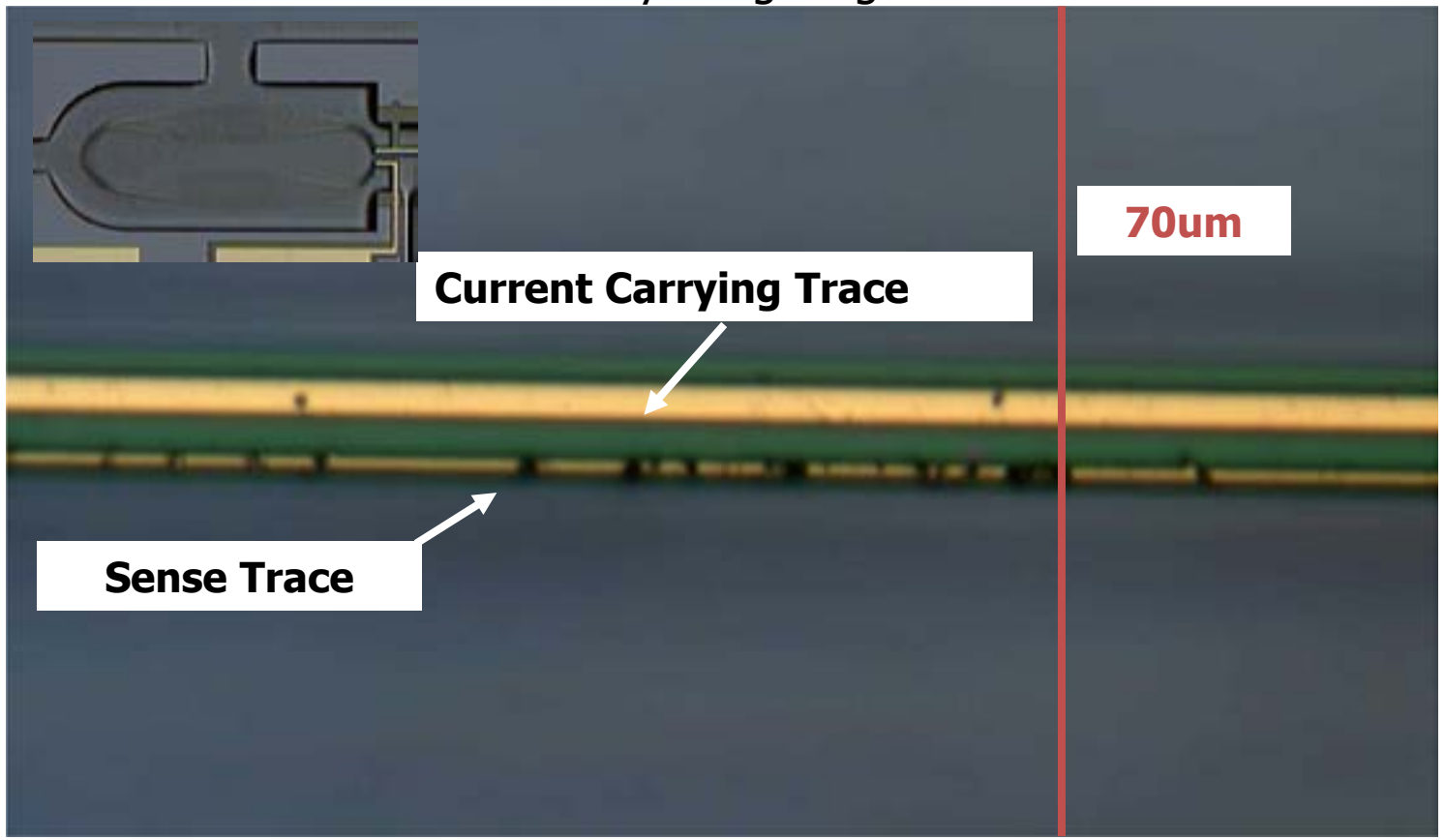
- Levitated mass is trapped about the (y, z) rotational axes
- But it is free to rotate about x axis
- In presence of **Z-rotation**, Electromagnets maintain spin direction
  - Back-action can be used to measure rate
- Multiple coils can measure rotation along other axes (y, z)



EMF: Electromotive Force

High-Velocity microsystems show potential for >200x improvement in ARW/VRW

Lorentz force actuators actively mitigating Si fracture and material fatigue



$$Coriolis\ Force\ F_c = (\boldsymbol{2mv}) \times \Omega$$
$$= Scale\ Factor \times angular\ velocity$$

$$m \equiv mass$$
$$v \equiv linear\ velocity$$

Proof-mass and velocity drive scale factor to reduce angle random walk and velocity random walk

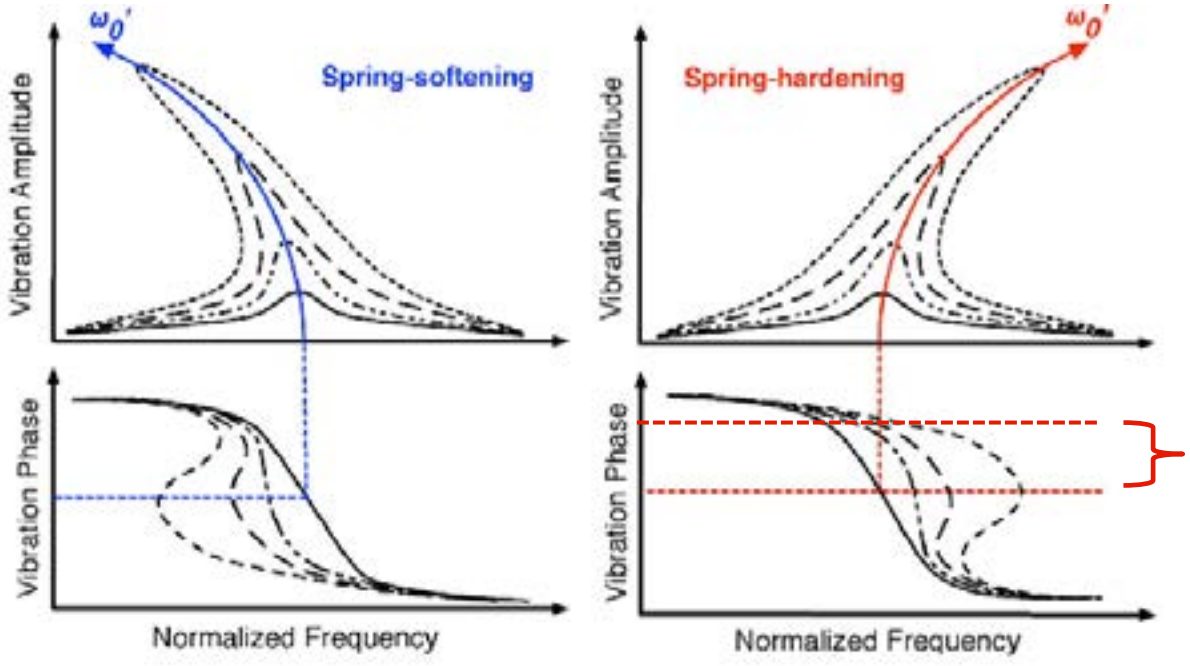
Increasing maximum velocity from 1 m/s to 70 m/s enables

- 200x improvement in gyroscope Scale Factor and Noise
- 20x improvement in oscillator jitter in resonant accelerometer
- Materials such as AlN and Diamond have now reached **182 m/s and 400 m/s** respectively!!

AlN: Aluminum Nitride, a piezoelectric material, commonly used in our cellphones' radio filters

ARW: Ange Random Walk
VRW: Vector Random Walk

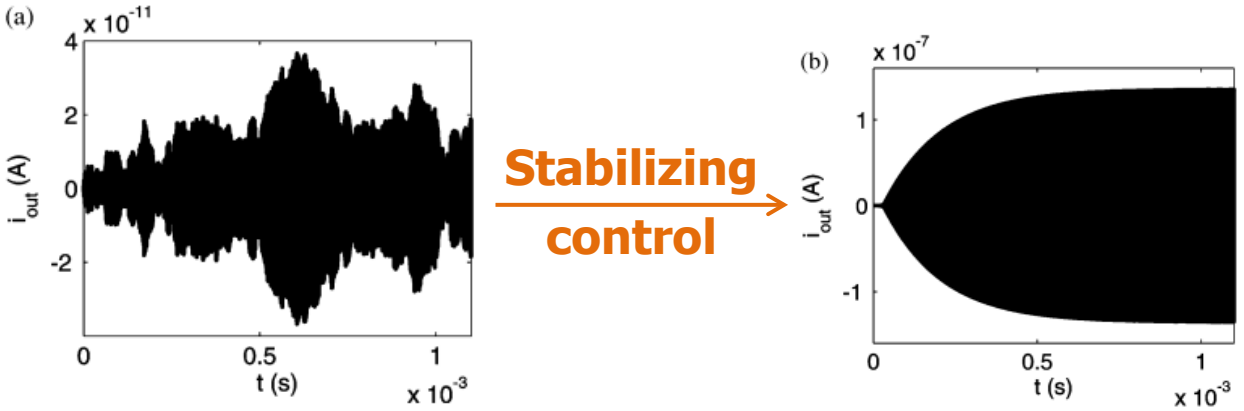
Challenges of operating high-velocity oscillators



- High Velocity Sensors require large excitation of mechanical resonators
- This can drive devices into nonlinear regime

Challenge:

- Resonator can have two stable points of operation
- Sophisticated Control System must be designed to guarantee there is no phase-hopping

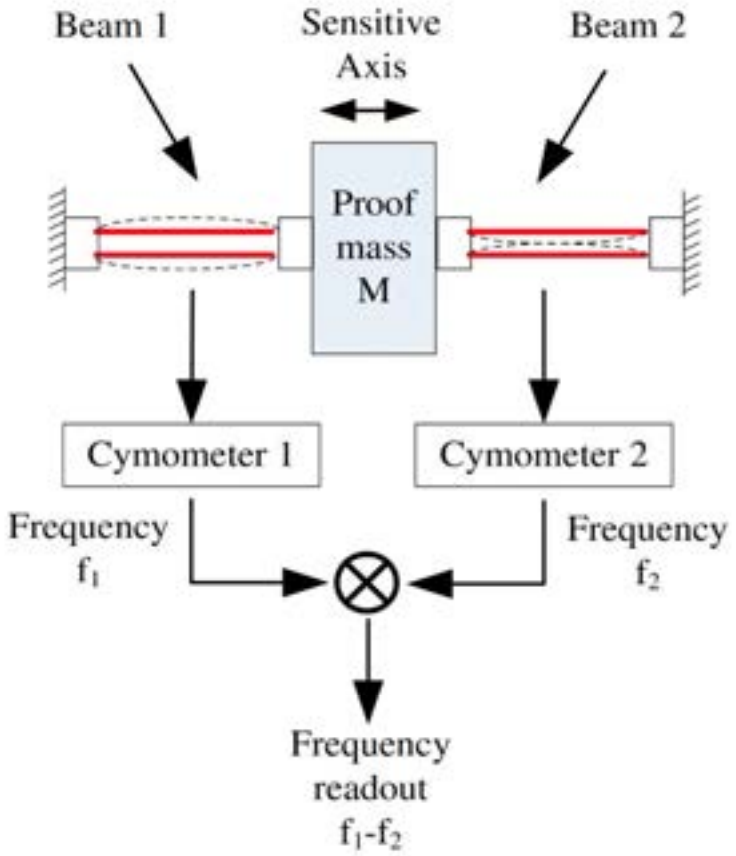


- Control must take system from unstable behavior to linear/predictable response
- Inertial sensors must rely on stable oscillating reference

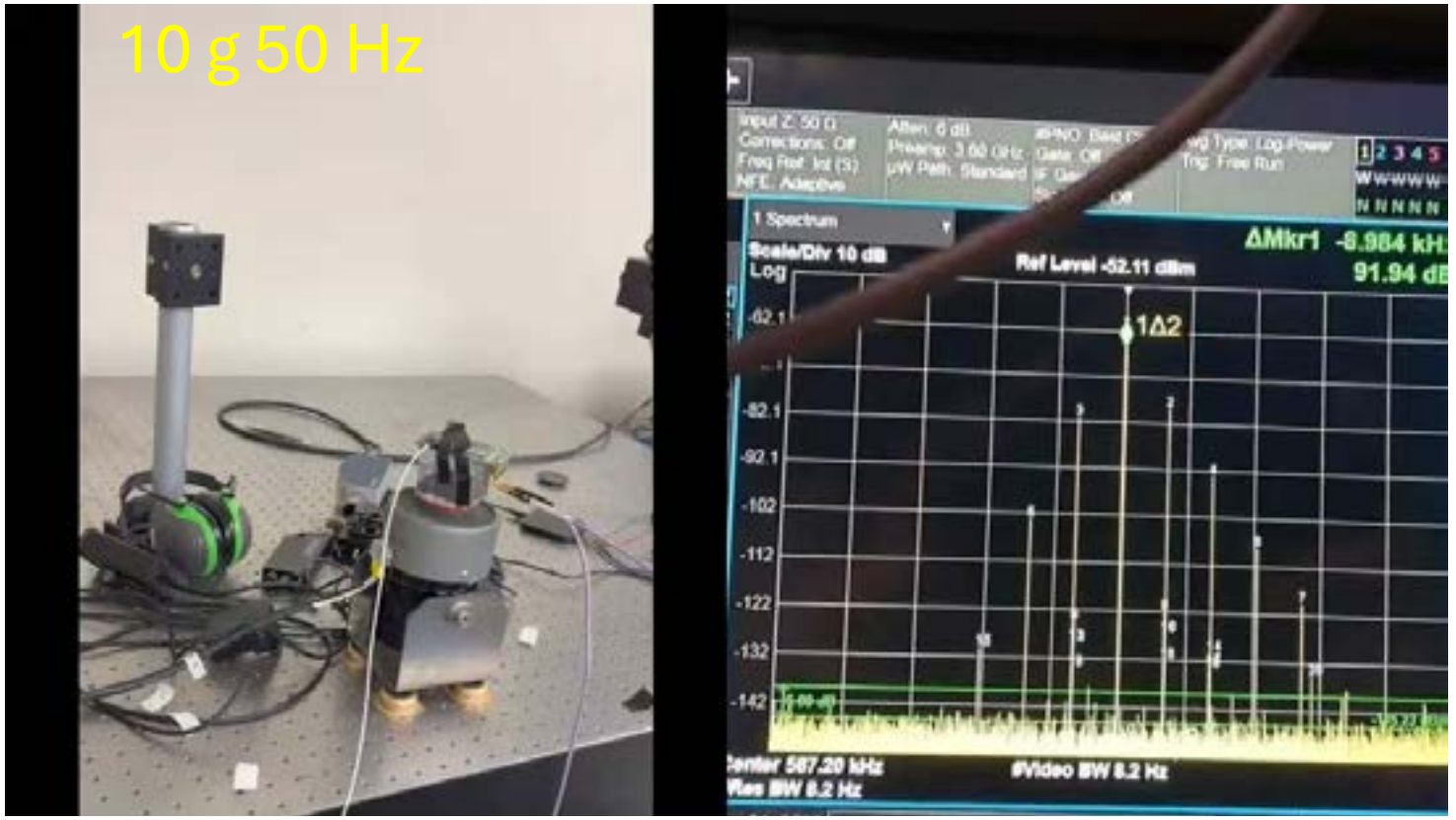
Mestrom, R. M., Fey, R. H., & Nijmeijer, H. (2009). IEEE/ASME Transactions on Mechatronics, 14(4), 423-433.

Potential for shock immunity using mechanical frequency combs

High frequency ensures shock immunity while frequency comb beat tracks acceleration



Traditional tuning fork accelerometer

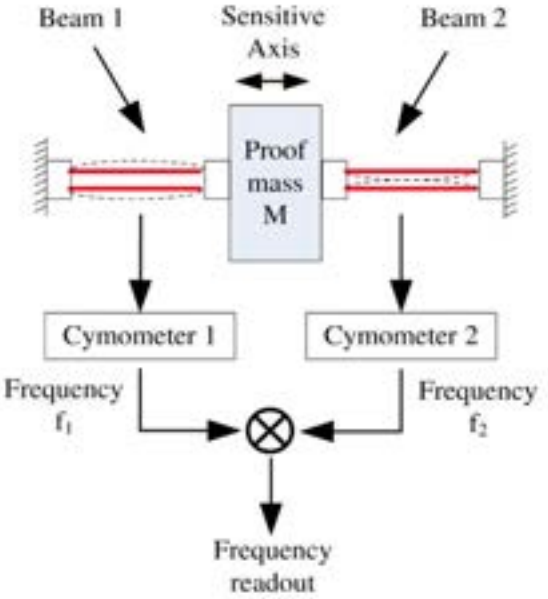


Mechanical frequency comb accelerometer

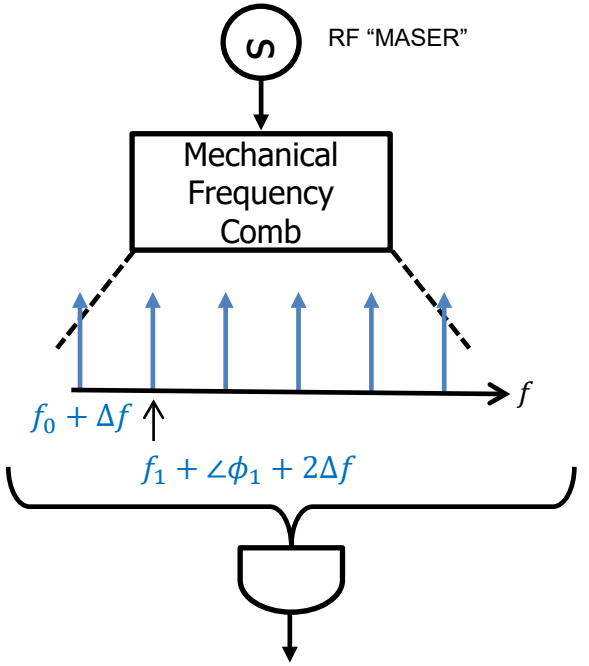
The frequency comb readout shifts operation to shock insensitive higher frequency while coherent beat notes encode sensor's Dynamic Range at minimal increase in SWaP

Beat note: the result of mixing two or more frequencies. Beating can be implemented by using a mixer circuit, diode or equivalent element

Mechanical frequency combs enable high dynamic range and coherent acceleration sensing (large SNR)



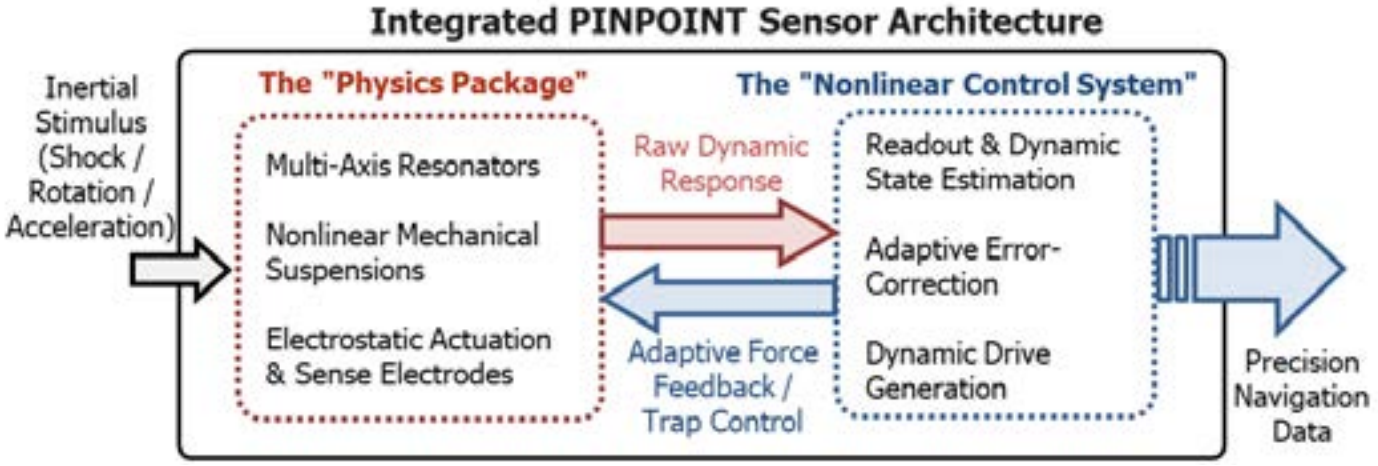
Two oscillators drift and age independently

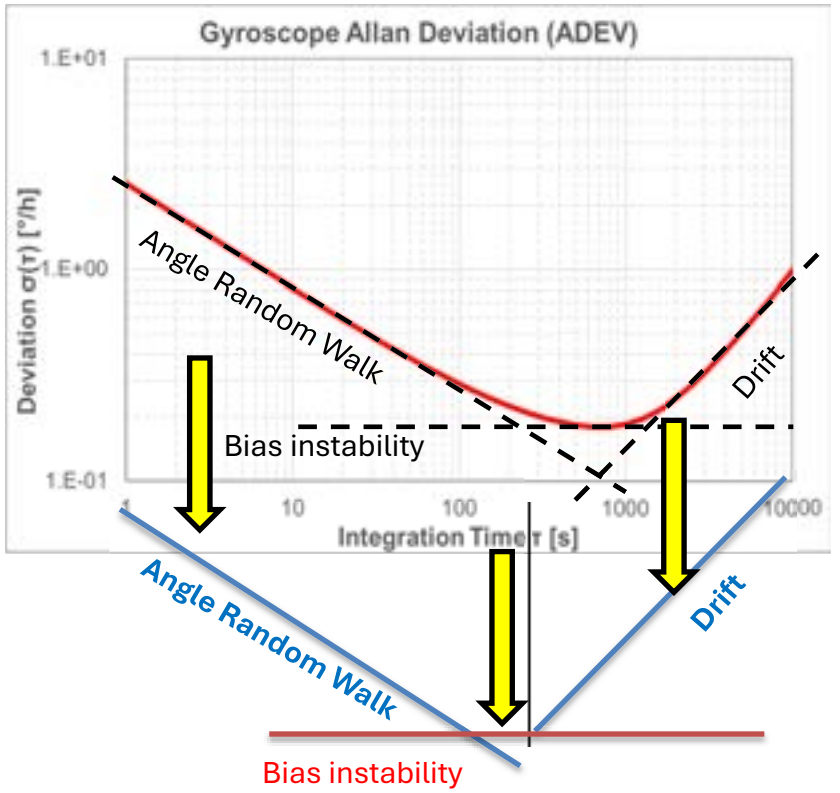


- Mechanical Combs will be a superior long-term sensor solution provided all oscillators are phase coherent and drift together **(at low pump frequency)**
- Combs generate at extreme mechanical nonlinearity. CLOAKing or anti-aging schemes are critical to ensure long-term, long-life operation

Zhou, Z., *et al.* Theoretical investigation of the mechanical coupling in a differential vibrating beam accelerometer. *Microsyst Technol* **21**, 1459–1464 (2015).

Nonlinear electro-mechanical dynamics coupled to nonlinear control systems improve sensor performance at all time-scales





- Demonstrate Nonlinear Control that transduces the physics package while taking advantage of the new insights in Sensor nonlinearity
- The resulting PINPOINT Sensor will drive the Allan Deviation curves by > 10X across all time-scales!

PINPOINT performers will develop the Nonlinear control systems for the Nonlinear Sensor elements, and work symbiotically to drive Allan Deviation down across all time-scales

PINPOINT Program Execution Plan: From new theory to operational mission performance

FY 2027	FY 2028	FY 2029	FY 2030	FY 2031

Phase 1: Nonlinear IMU Theory and Lab Validation

Phase 2: Partner Mission Custom Designs

IV&V

Validate system architectures

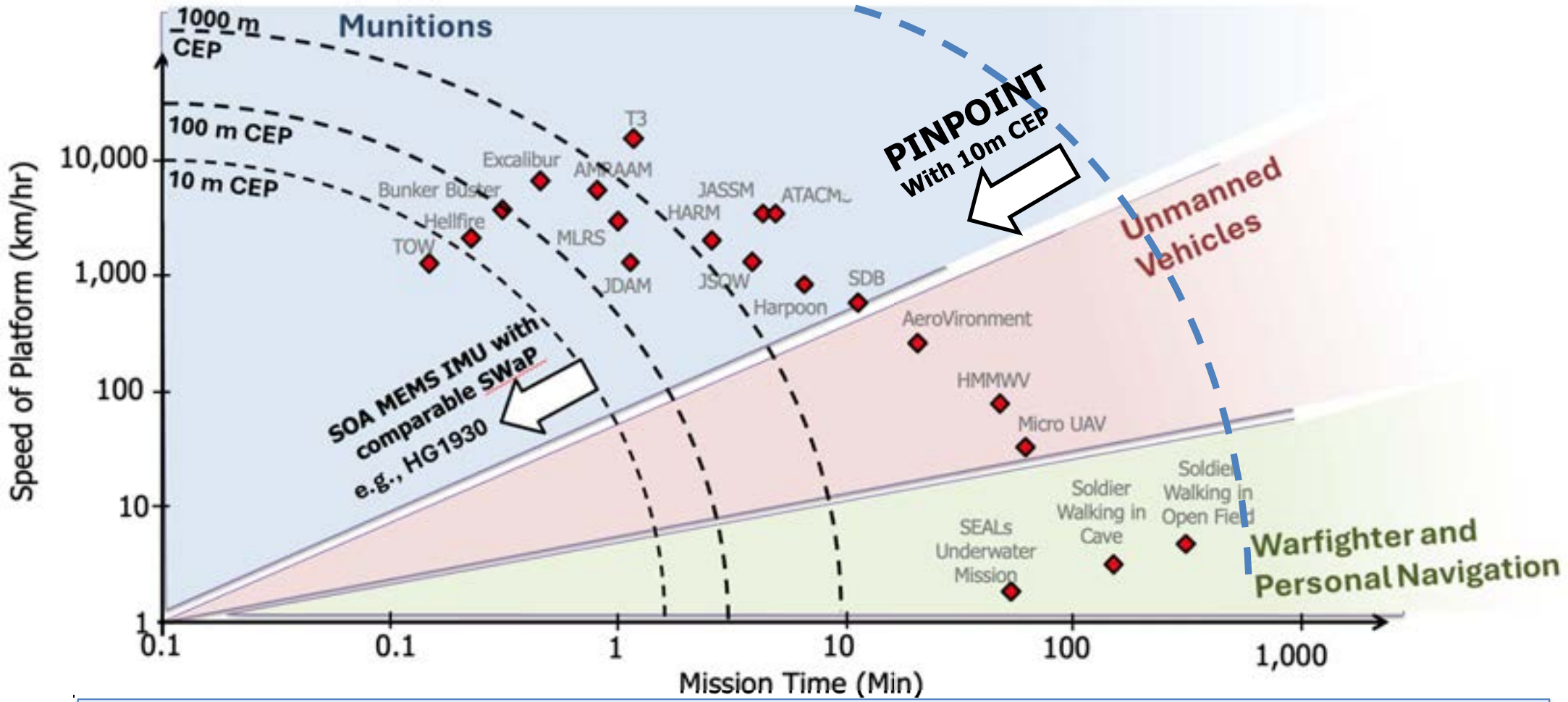
Government lab verification

Transition Partner-driven field testing

PINPOINT teams comprise mix of control systems theory and MEMS/device experts to develop and test the design space for customizing IMUs to partner missions

IV&V: Independent Verification and Validation
MEMS: micro-electromechanical systems

PINPOINT will enable GPS-free Precision Positioning and Navigation across the whole range of guided vehicles



PINPOINT IMUs will enable Munitions and Unmanned Vehicles to execute their missions with 10m CEP in GPS-denied locations over extended mission times.

CEP: Circular Error Probable
GPS: Global Positioning System
IMU: Inertial Measurement Unit
SOA state-of-the-art
SWaP: Size, Weight, and Power

www.darpa.mil

Precision Inertial Navigation & Positioning On an Integrated Tesseract (PINPOINT)
SPECIAL NOTICE DARPA-SN-26-98
Doing Business with DARPA

Phuongthao Phan
Contracting / Grants / Agreements Officer
DARPA Contracts Management Office

July 27, 2026

Edit 8/3/26 slide 2

PINPOINT - Doing Business with DARPA

- **BAA HR001126S0016** is pending to be posted at SAM.gov and grants.gov websites
- Award Instrument Type
  - Contract, Cooperative Agreement (CA), or Other Transaction (OT) for Prototype Agreement
- DARPA expects the proposed solutions to be either **fundamental** or **nonfundamental research**
- Important Dates:
  - **Proposers Day Teaming profiles due:** Aug 7, 2026 (extension from date in SN)
  - **BAA Posted:** Aug 6, 2026 (anticipated)
  - **Proposers Day:** July 27, 2026
  - **Abstracts Due:** August 27, 2026 at 4:00 p.m ET (anticipated)
  - **Submit questions by:** September 15, 2026 at 4:00 p.m. ET (anticipated)
  - **Proposal Due Date:** September 25, 2026 at 4:00 p.m. ET (anticipated)

NOTE: If there is any discrepancy between what is presented today and the BAA, the BAA takes precedence.

Acquisition Strategy

- Multiple awards are anticipated.
  - The number of awards will be based on the quality of the proposals.
- PINPOINT is a **48-month**, two-phases program.
  - Only Solicitating Phase 1 – 24 months – for negotiation & award
  - Notes: Not Solicitation Phase 2 – 24 months – request draft SOW and ROM for planning purposes
- Abstracts are **required**.
  - Attachments A and B are **required** for abstract submission.
  - Due Date: Must submit by **August 27, 2026 at 4:00 p.m ET** through BAAT.
  - Abstract feedbacks are to assist with proposal development and will not the evaluation process.
  - NOTE: Proposers who do not submit an abstract will not be able to submit a full proposal.

NOTE: If there is any discrepancy between what is presented today and the BAA, the BAA takes precedence.

Full Proposal Tips

Proposal Due Date: September 25, 2026 at 4:00 p.m. ET (anticipated)

- Read the BAA carefully
  - Non-conforming proposals may be rejected without review.
  - Proposals with no abstract will be rejected without review.
- Please ensure review of eligibility and statutory requirements when requesting an **OT for Prototype**
- Proposal Submissions:
  - Procurement contract and OT Prototype Agreement are submitted through BAAT.
  - Cooperative Agreements are submitted through grants.gov.
- Please submit questions to PINPOINT@darpa.mil by no later than **September 15, 2026 at 4:00 p.m. ET.**
- Monitor SAM.gov for BAA publication/amendments & PINPOINT website for Frequently Asked Questions (FAQs).
- Carefully read DARPA Fundamental Research Risk-Based Security (FRRBS) Review Process & CMMC requirement.

NOTE: If there is any discrepancy between what is presented today and the BAA, the BAA takes precedence.

Full Proposal Submission – Anticipated Documents

1. **Technical Approach & Management (Volume I) – 20 pages**
   - Attachment C: Proposal Summary Slide Template - **REQUIRED**
   - Attachment D: Proposal Instructions and Volume I Template - **REQUIRED**
2. **Cost Proposal (Volume II) - No page limit**
   - Attachment F: DARPA Cost Spreadsheet – **REQUIRED -** Both Prime and Subs are required to prepare their own Attachment F
3. **Additional Documents**
   - ❑ **Procurement contracts**
     - Attachment E: Proposal Instructions and Volume II Template – **REQUIRED**
     - CMMC Level 1 Requirement
   - ❑ **OT Prototype Agreement**
     - Attachment E: Proposal Instructions and Volume II Template – **REQUIRED**
     - Attachment G: Model Other Transaction for Prototype Agreement - **REQUIRED**
   - ❑ **Cooperative Agreements:**
     - SF424 (R&R) Budget forms through Grants.gov – **REQUIRED**
   - ❑ **Fundamental Research**
     - FRRBS

REMINDERS

Procurement Contract - ***Attachments C, D, E, and F***

OT for Prototype - ***Attachments C, D, E, F, and G***

Cooperative ***Agreement -*** ***Attachments C, D, F and SF424 (R&R) Budget forms through Grants.gov***

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Teaming & Eligibility Information

- **Non-U.S. organizations and/or individuals:** MAY participate in accordance with applicable laws, regulations, and policies, including those pertaining to export controls and security.
- **FFRDC, UARCs and Government agencies/labs:** Due to their long-term relationship with the Government, there are potential conflicts and advantages that would compromise fair and open competition if these entities propose for performer works. As such, these entities typically my only receive funding through existing awards that they hold with their sponsoring agencies. If these entities are proposed as subcontractors/subawardees, they must clearly demonstrate that the proposed work is not available from the private sector. If the proposal is scientifically merited and meets the criteria, DARPA may fund work proposed by these entities as highlighted within the BAA. **Refer to the BAA for details.**
- **Organizational Conflicts of Interest**. An organization cannot simultaneously provide scientific, engineering, technical assistance (SETA), advisory and assistance services (A&AS), or similar support to DARPA, and also be a performer on a DARPA research program. If a prospective proposer believes a conflict of interest exists or may exist or has questions on what constitutes a conflict of interest, the proposer **must send their contact information and a summary of the potential conflict** to the PINPOINT inbox.

NOTE: If there is any discrepancy between what is presented today and the BAA, the BAA takes precedence.

DARPA's Fundamental Research Risk-Based Security Review Process (FRRBS)

- DARPA's Fundamental Research Risk-Based Security Review Process (FRRBS) is an adaptive risk management security program designed to help protect the critical technology and performer intellectual property associated with DARPA's research projects by identifying the possible vectors of undue foreign influence. DARPA will create risk assessments of all proposed Senior/Key Personnel selected for negotiation of fundamental research awards (to include cooperative agreements and Other Transactions). The DARPA risk assessment process will be conducted separately from the DARPA scientific review process and adjudicated prior to final award.

- Applicable to fundamental research efforts, awarded using Cooperative Agreement or Other Transaction for Prototype Agreement.

- For additional information on this process, please visit Proposer Instructions links below.

  - Other Transaction agreements: https://www.darpa.mil/about/offices/contracts-management/proposer-transactions

  - Cooperative Agreements: https://www.darpa.mil/about/offices/contracts-management/proposer-grants

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Cybersecurity Maturity Model Certification (CMMC) Requirements

Applicable to awards under this Broad Agency Announcement that will result in procurement contracts

- General Applicability

a) Awards resulting from this Broad Agency Announcement (BAA) that take the form of procurement contracts are subject to the Cybersecurity Maturity Model Certification (CMMC) requirements prescribed in 32 CFR Part 170 and DFARS 252.204-7021, Cybersecurity Maturity Model Certification Requirements.

b) The Government will designate the required CMMC level (1, 2, or 3) in each resulting contract based on the sensitivity of the information involved—Federal Contract Information (FCI) or Controlled Unclassified Information (CUI).

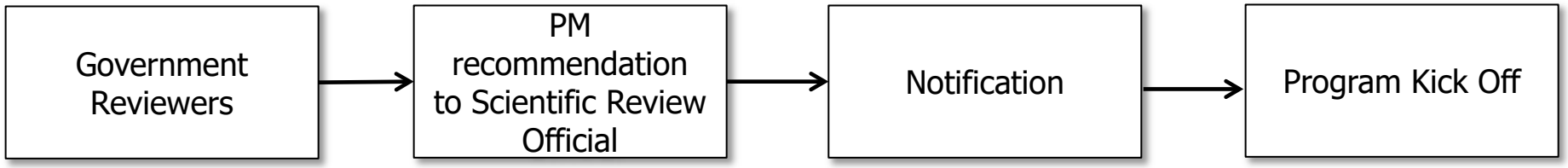
c) Offerors must demonstrate compliance with the applicable CMMC level at the time of contract award and maintain that level for the duration of contract performance.

d) CMMC requirements must be flowed down to all subcontractors whose performance involves processing, storing, or transmitting FCI or CUI.

✓ **It is anticipated that Procurement Contracts resulting from this BAA will require CMMC Level 1 compliance (not applicable to Cooperative Agreements or Other Transactions at this time).**

NOTE: If there is any discrepancy between what is presented today and the BAA, the BAA takes precedence.

Proposal Review-Awards Process



- No common Statement of Work – Proposals are evaluated on individual merit and relevance as it relates to the stated research goals/objectives rather than against each other.
- Proposals are evaluated for strengths and weaknesses relative to the criteria published in the BAA, *listed in descending order of importance:*
    1. **Overall Scientific and Technical Merit**
    2. **Potential Contribution and Relevance to the DARPA Mission**
    3. **Cost and Schedule Realism**
    4. **Proposer's Capabilities or Related Experience**
- Refer to the BAA for details regarding proposal evaluation.
- The DARPA contracting office will contact the selected performers and begin the negotiation process.
- Government reserves the right to select for award all, some (partial selection), or none of the proposals received.

NOTE: If there is any discrepancy between what is presented today and the BAA, the BAA takes precedence.

Procurement Sensitive Information

DARPA policy is to treat all submissions as procurement sensitive, and to disclose their contents only for the purpose of scientific review & source selection.

- Restrictive notices notwithstanding, during the evaluation process, submissions may be handled by support contractors for administrative purposes and/or to assist with technical evaluation.
- All DARPA support contractors performing this role are expressly prohibited from performing DARPA sponsored technical research and are bound by appropriate nondisclosure agreements.
- Input on technical aspects of the proposals may be solicited by DARPA from non-Government consultants/experts who are strictly bound by the appropriate non-disclosure requirements.

NOTE: If there is any discrepancy between what is presented today and the BAA, the BAA takes precedence.

Award Information

DARPA reserves the right(s) to:

- Fund proposals in phases and may or may not exercise the option period for continued work at the end of one or more of the phases
- Remove proposers from award consideration should the parties fail to reach agreement on award terms, conditions and cost/price

NOTE: If there is any discrepancy between what is presented today and the BAA, the BAA takes precedence.

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