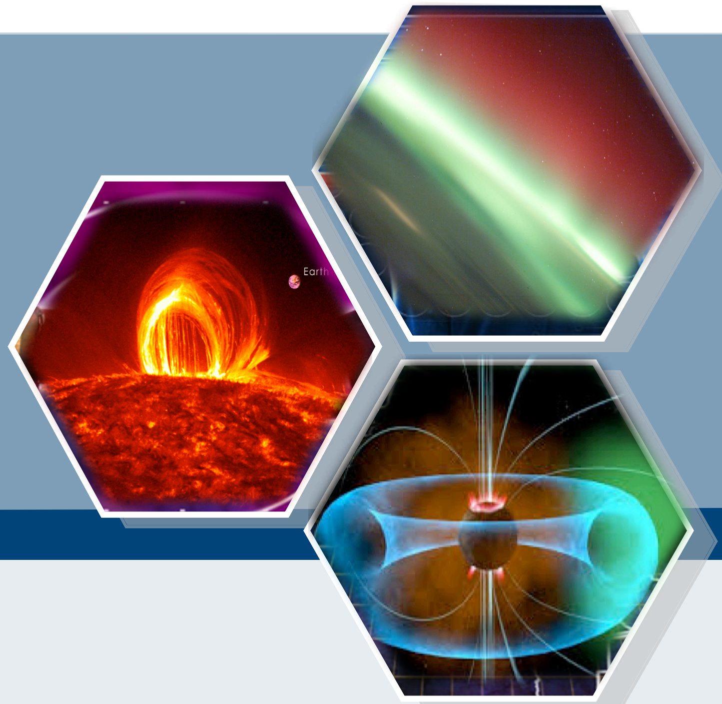
Update on DRIVE Science Centers Program



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HPAC Member's Individual Responses

1 *Comments about,* "an O2R-R2O component and shared funding with other programs/agencies"

- Delay until more commitment from NOAA's upper management
- Add an "R2O Enhancement Option" funded by NOAA, for example. Potentially needs a separate pool of reviewers

2 *Comments about,* "# of co-existing Centers. budget & lifetime, funding profile needed"

- **Lifetime:** 5 years at minimum, but funding for the last 2 years contingent on a successful comprehensive review. After 5 years, propose R2O as an optional extension of the center. 4-year lifetime with possible extension. Four years is the lifetime of LWS FST teams
- **Number:** Ideally, more than one Center at any one time constrained by the budget situation
- **Funding:** $3M/yr, bare minimum of $2M/yr.

2 Question raised: What is the optimum center size to get high performance? Is it a better use of resources to have more smaller centers or fewer larger ones?

"Understanding the relationship between scientific productivity and research group size is important for deciding how science should be funded."

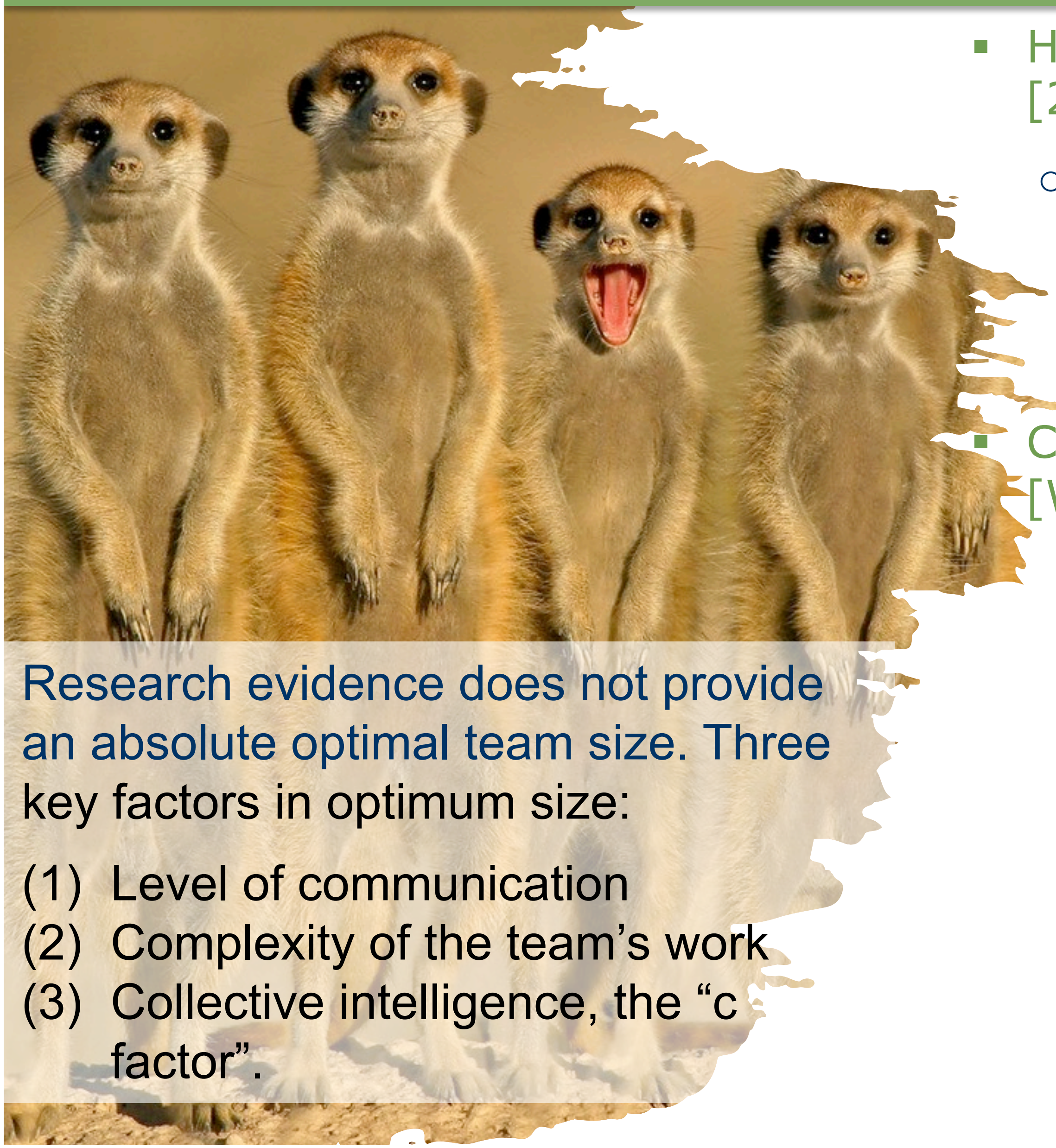
-- Cooke et al., Research Groups: How big should they be?, PeerJ. 2015; 3: e989.

The reason teams are formed is to enhance communication and to apply collective intelligence to solve problems. As team size increases:

- More difficult for members to contribute to their full potential
- Hinders balanced contributions
- In interdisciplinary teams, full contributions from all members are essential.

2

Optimum Size of Team

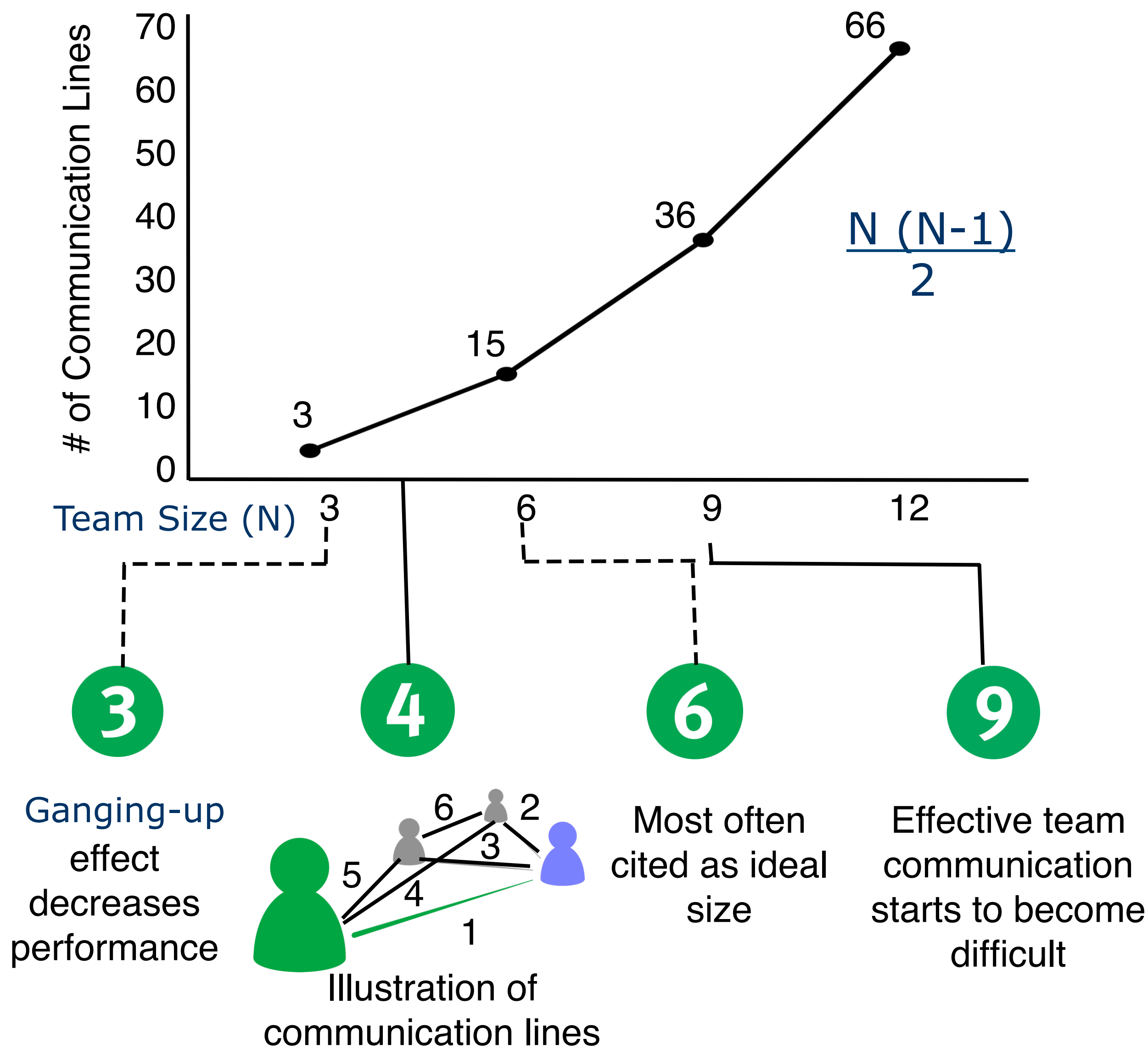


Research evidence does not provide an absolute optimal team size. Three key factors in optimum size:

(1) Level of communication
(2) Complexity of the team's work
(3) Collective intelligence, the "c factor".

- Hoegl [2005]; Blenko & Mankins, [2010] and many others found:
  - As size increases, good communication requires increasing resources (time, attention, etc.).
- Collective intelligence of a group [Woolley, et al., Science, 2010]:
  - Not strongly correlated with member intelligence (average or maximum)
  - Correlated with member's:
    - ✓ Average social sensitivity
    - ✓ Equality in conversational turn-taking
    - ✓ Proportion of females

Optimum Size of Team



4-9 members

Is thought to be the **"Sweet Spot"** for teams.

- lower end for highly collaborative work
- upper end for work with little collaboration.

One mitigation strategy [*Hoegl*,2005] :

- Multiple small teams with 6-7 members
- Team of team leaders also 6-7 members
- So by this measure, 36-49 center members in 6-7 institutions is in the sweet spot.
- Most communication takes place locally

Revisit RFI Recommendations

Personnel

8-10 senior researchers at 2-**3** months each + 6 postdocs + 6 grad students + 10 part-time undergrads

Total cost salaries + overhead ~ $2.5M (32 researchers) + 2 admin+ 2 techs = 36 people

5-6 institutions, ~6-7 people each

10 senior researchers at 50% FTE + 12 grad students + 6 postdocs

Total cost salaries + overhead ~ $3.95M (28 researchers) + 2 techs & 2 admin = 32 people

5-6 institutions, ~5-6 people each

Note: Annual cost assumes: GRA + tuition ~$100K; Postdoc ~$125K; Researcher @ 100% = $400K; undergrads ~$10K ea

Resources Needed

- Allocations on Pleiades, Blue Waters, petaflop-level computers (5M node-hours/ year; 4M SBU per year)
- Visualization & advanced computer graphics
- Mass storage, work stations, graphical processing units
- Heavily leverage other grants & institutional resources
- Leverage NASA-NSF strategic capabilities

Cost/Lifetime

- $3M/yr, $2M/yr, $4M/yr for **5 yrs**
- $1-2M/yr for **5-6 yrs**
- $1-3M/yr, $2-2.5M/yr, $2.5-3M/yr for **6 yrs**
- $1M/yr to join together & enhance several major funded

** $2M-$4M annually may be consistent with literature on optimum team size – if multiple institutions

HPAC Member's Individual Responses

3 Use 2-Phase center model (example CCI)? Minimize cost & duplication between Centers with shared resources model (example: MRSEC)?

- 2-phase center - if budget more than $2M/year
- Helpful to share system engineers to support the effective use of NASA's High-Performance Computers

- Single-Phase Center removes uncertainty of down-select. Speeds things up. Maximizes amount of money to the Centers.
- A steering committee of Center PIs could provide venue for sharing.

4 Reverse site-visit model or site-visit model for proposal review? Add program- specific review criteria?

- Program-specific to assess relevance to the DRIVE initiative vision.

- External advisory committee is necessary to maintain focus.
- Annual 2-3 days meeting for all the teams to get together and present their work (similar to a design review).

HPAC Member's Individual Responses

5 How to address increased computational demands of centers? How to support deep knowledge integration & efficient virtual communication?

- HPD needs to increase HEC support. Request HEC budgeted in proposals
- Center communication plan needed. Center should be run as an open diversified institute instead of just a few senior people making the decisions. Should train the next generation modelers.
- NASA HPC is oversubscribed. Use model similar to NCAR climate supercomputing: a portion of HPC yearly allocations reserved for priority use by selected HSC teams. Leverage combined NASA HPC and NSF XSEDE resources.

6 Post-award reviews? Metrics for success?

- Post-award reviews by a combination of the advisory committee, ad-hoc panels and NASA/NSF program managers track and evaluate progress. Checks if the center has achieved the DRIVE initiative objectives
- Deliverables will depend on each proposal. Broad community benefit and engagement (e.g., if a model is built, develop scenarios for community use.

DRIVE Centers Plan Forward

- Drive Center plans that follow, take into account:
  - NRC, *Solar and Space Physics: A Science for a Technological Society*, 2013
  - NAS, *Enhancing the Effectiveness of Team Science*, 2015
  - NAS, *Report Series: Committee on Solar and Space Physics: Heliophysics Science Centers.* CSSP, 2017 & 2018 discussion with CSSP
  - RFI input from scientific community, 2017
  - 2017 HPAC discussion & individual inputs
  - 2017-2018 Discussions with NSF
  - Research into 6+ other NASA & NSF Center programs
  - Discussions within NASA HPD

- Learning from 2016 LWS FST team formation activities
  - Guided by recommendations from the NAS 2015 Team Science report

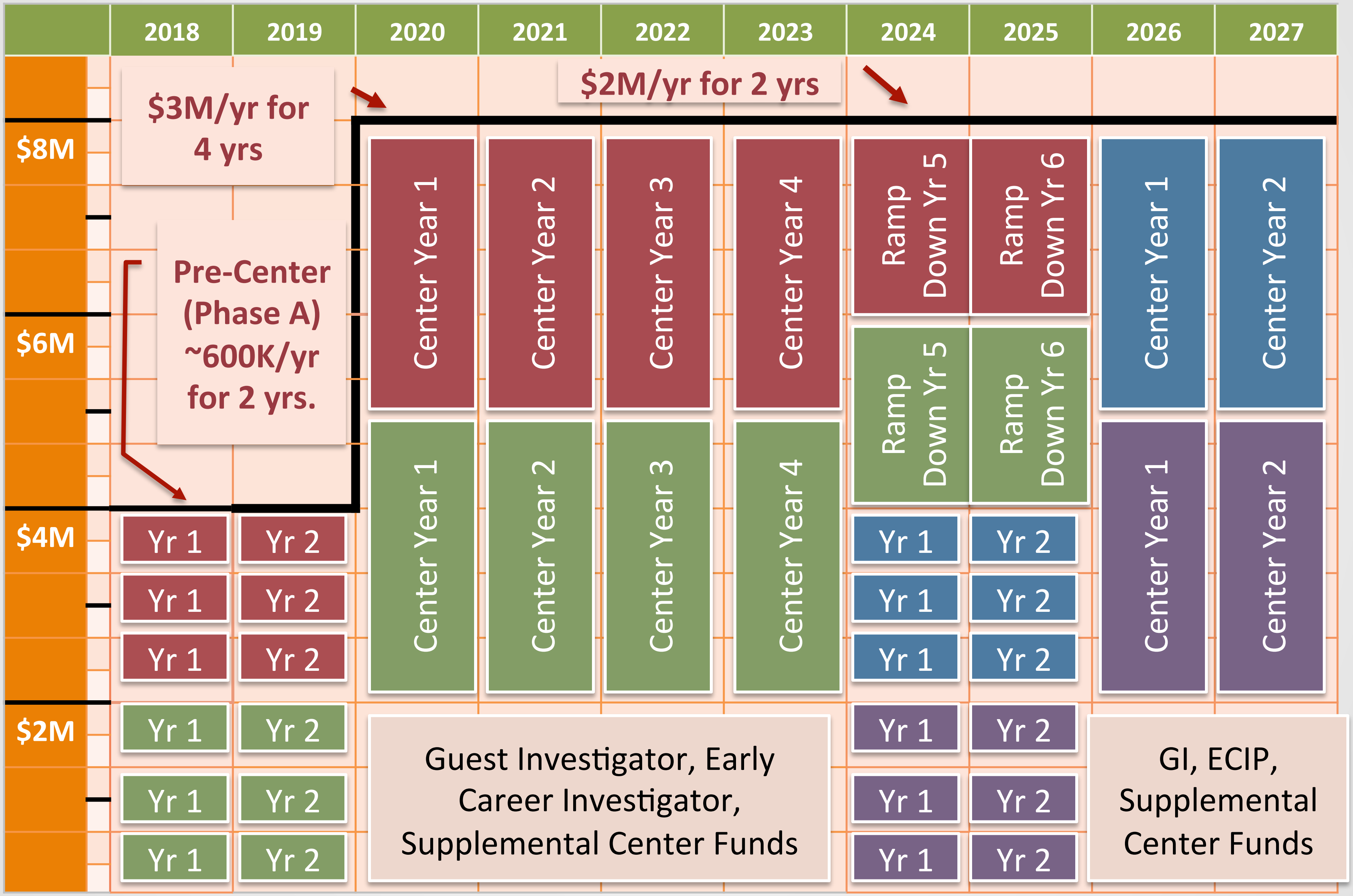
Basic Principles for DRIVE Center Program

- The transformative nature of DRIVE Centers is best supported by:
  - Openly competing science objectives (not defining beforehand)
  - Giving proposers the freedom to define tools, methods, team composition and management
  - Requiring metrics and making their evaluation part of the proposal selection process
  - Limiting renewals, expecting significant progress or solutions in the Center primary lifetime. Enables Centers to be used as agile tools for addressing pressing strategic research problems as they emerge.
- Uniquely configured to support interdisciplinary science and innovative approaches.
- Supply valuable research and educational experiences for the broader community (visiting scientist programs, workshops, summer schools, etc.)
- Present a very real potential for positive societal impacts
- Augment not replace existing research elements
- Multiple centers provide opportunities for enriching cross-center interactions

Features of DRIVE Center Program

- ✓ NASA – NSF collaboration under a MOU agreement. Ensures that science goals and eligibility criteria and metrics for proposal selections are consistent with each agencies priorities
- ✓ Focused on key science problems of solar and space physics that have a “compelling justification for a center approach” – Science objectives, center structure, and metrics selected through open competition
- ✓ Multidisciplinary teams of theorists, observers, modelers, and computer scientists
- ✓ $1M-$3M per year for 6 years,
- ✓ Program ramping to $8 million per year
- ✓ Required elements evaluated in selection process:
  - Communications plan
  - Deep knowledge integration plan
  - Management plan
- ✓ Two phase structure: Six pre-centers, with downselect to two 6-yr Centers after two years. Funding for the last 2 years possibly contingent on a successful comprehensive review
- ✓ Considering possible supplemental center funding, GI program, Early Career Program, R2O-O2R enhancement or extension options, etc.

DRIVE Pre-Center–>Center *Draft* Plan



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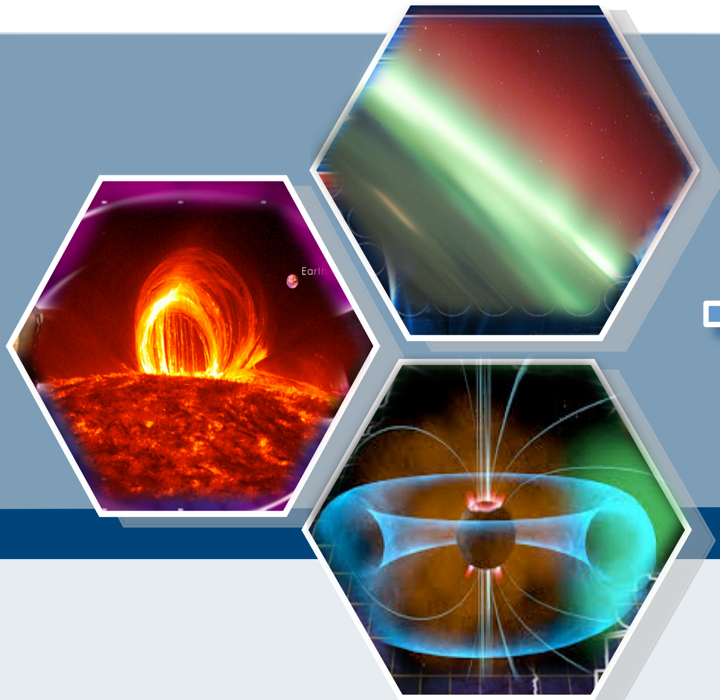

Thank You!