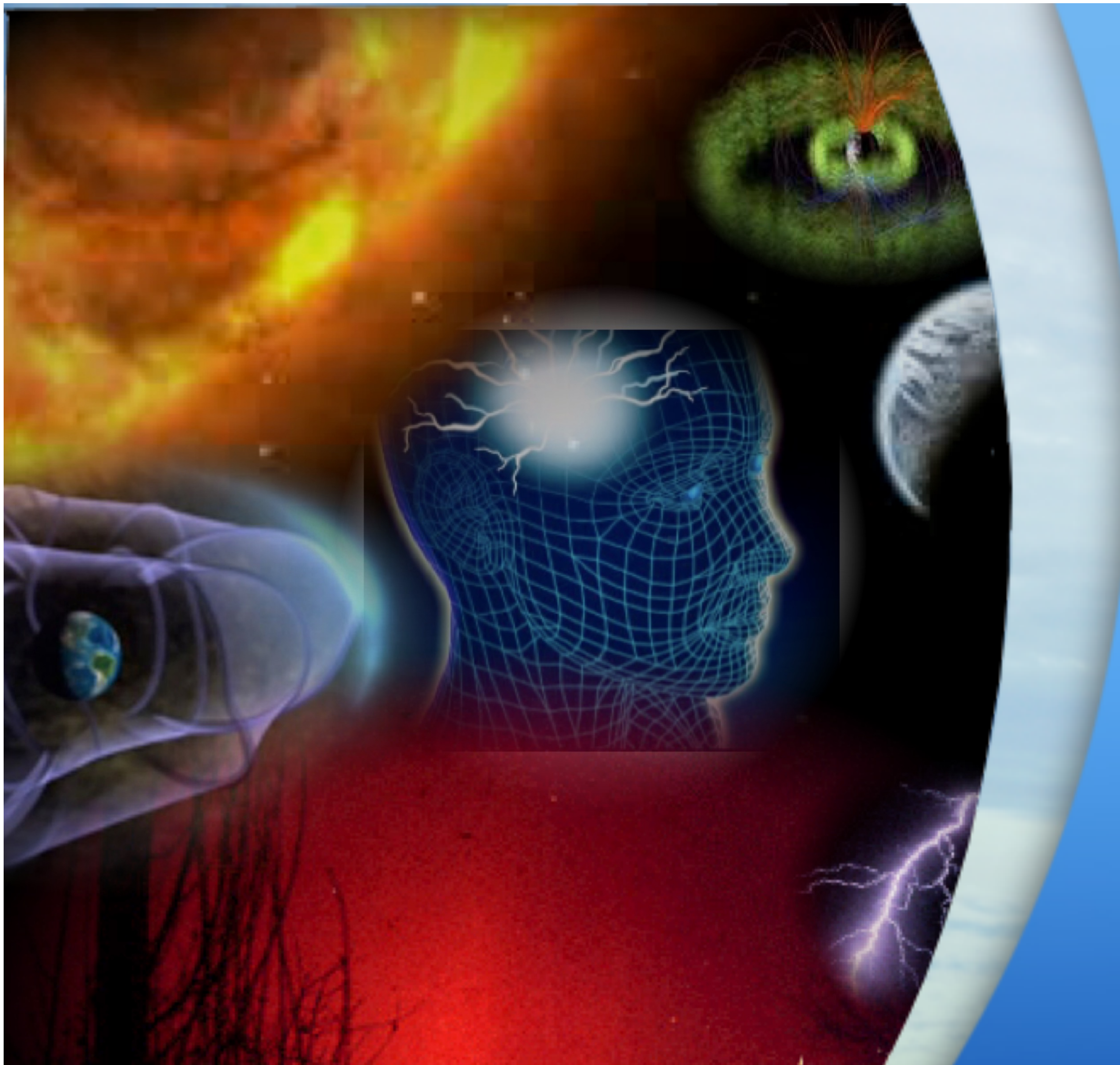


Moving forward on the most compelling science questions in Heliophysics

Drive Science Centers

Issues & Implementation

Janet Kozyra,
NASA Heliophysics

Expected NASA Drive Center Funding in Grand Challenges Research (GCR) program

2017	2018	2019	2020
$2M	$4M	$6M	$8M

**DRIVE Center solicitation may shift to early 2018. Funding profile may be adjusted from that shown here.

Out-year funds are expected to be flat at $8M/yr

Concept is to have multiple DRIVE centers in existence at any given time

Modest NSF contribution still TBD with delayed start.

NRC Decadal Survey recommends center budgets of $2-3M/yr over 4-6 years. Renewals?

May be augmented with space weather funding if there is a strong R2O center component

Timeline for DRIVE Center Program Implimentation & Solicitation

Dec 2017 — Gathering Inputs
- CSSP HSC Report, 2017
- RFIs deadline 9/5/17

Dec 2017 — Develop Program
- NASA HPD creates draft program
- Discussions with NSF
- LWS Town Hall

Jan 2018 — Solicitation
- Internal NASA approval process
- Ammendment to ROSES-17 (-18)**

Feb 2018 — Step 1 proposals due

April 2018 — Full Proposals Due

** Shift to ROSES-18 would cause 1 month delays in solicitation, STEP1, and Fulll proposal dates listed above.

Information guiding DRIVE Center planning

RFIs	35 RFIs: 7 proprietary & confidential, 16 discuss specific center ideas, 4 suggest strong R2O/O2R components. Will not discuss specific RFIs
NRC, CSSP	NRC Decadal Survey [2013]; NRC Science of Team Science [2015]; CSSP Report on DRIVE Center Implementation [2017]; NSF Portfolio Review [2016]

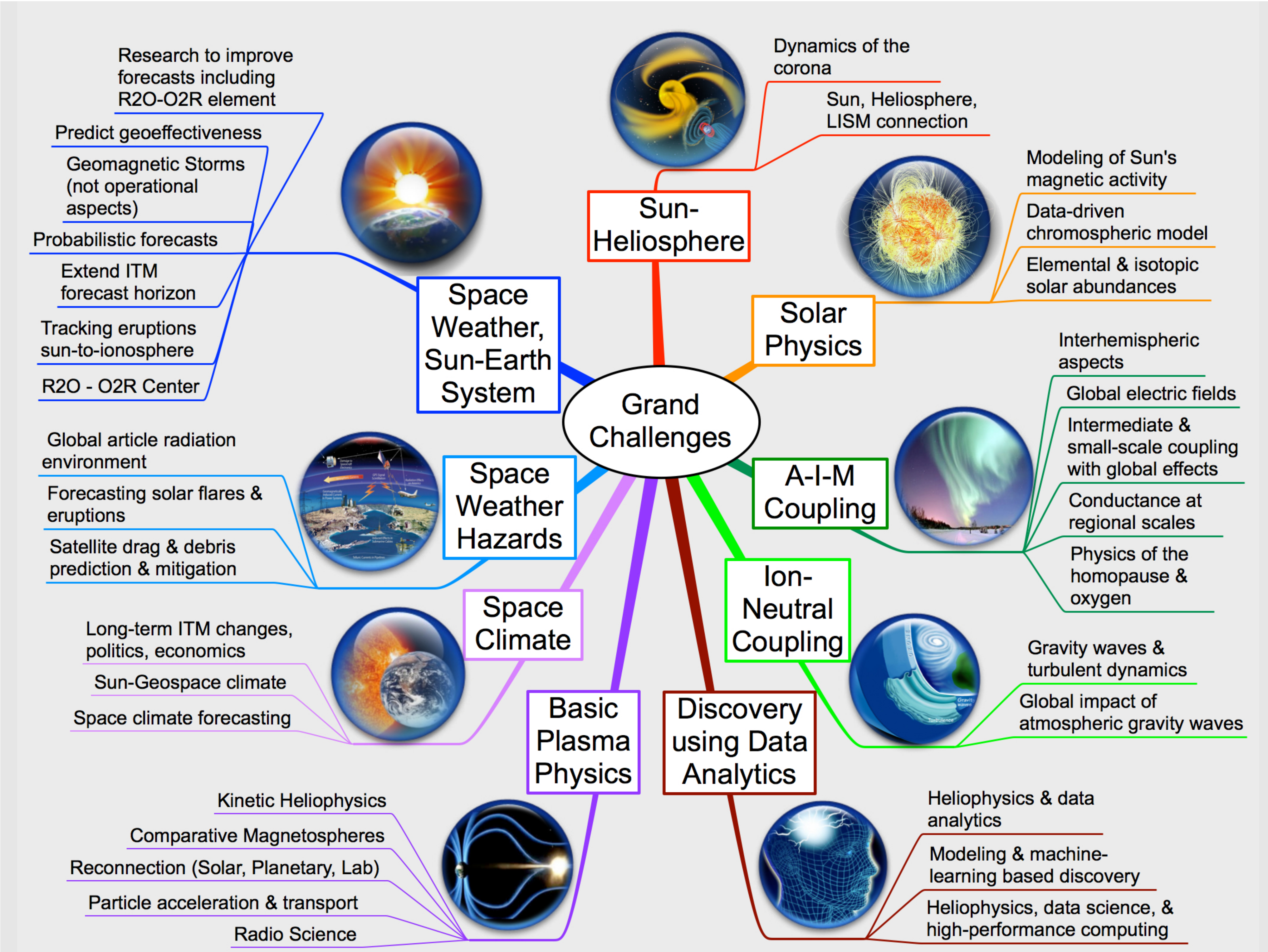
NSF Centers
** In 2005, 200 centers, $350 M/yr (7% NSF budget)*
	• **Centers for Chemical Innovation (CCI)** – now 15 centers
	  ○ Phase I = $1.8M over 3 yrs; Phase II = $4M/yr, 5 yrs
	• **Materials Research Science & Eng Ctrs (MRSEC)**– now 23
	  ○ $2.2-4M/yr for up to 6 yrs
	• **Science & Technology Centers (STC)**– now 12
	  ○ $4M/yr for 5 years with a possible renewal for 5 yrs
	• **Physics Frontier Centers (PFC)** – now 11
	  ○ $1-5M/yr for 5 years with potentially one renewal

NASA Center	• **The NASA Astrobiology Institute (NAI)** – *Virtual* institute managed at AMES has 12 teams, 600 researchers, 100 institutions ○ Each team funded at $1M/yr for 5 yrs, can recompete

NSF Centers Comparison

	CCI	MRSEC	STC	PFC
Funding Level	Phase 1: $1.8M/3yrs Phase 2: $4M/yr for 5 yr	$2.2-4M/yr for up to 6 yrs contin-gent on progress	$4M/yr for 5 yrs, possibility of re-newal for 5 more.	$1-5M/yr for 5 yrs; optional 1 yr extension & renewal
Unique Aspect	Development phase before Full Center	Nat'l network providing access to experimental tools at MRSECs	Network of STC center directors	Allows to leverage existing grants
Other grants	No significant overlap with ongoing federally-funded research			Overlap in focus of existing grants provides leverag-ed benefits
# allowed PI/CO-I	only 1 Phase 1, and 1 Phase 2	PI/Co-I only 1 prelim proposal	Only 1 proposal in a competition	PI/Co-PIs on only 1 prelim & 1 full; Participate any #
Who can submit?	US Academic Institutions	US Academic Institutions	US Academic Institutions	US Academic Institutions

Structure recommended in CSSP report



Grand Challenges
Sun-Heliosphere
Dynamics of the corona
Sun, Heliosphere, LISM connection
Solar Physics
Modeling of Sun's magnetic activity
Data-driven chromospheric model
Elemental & isotopic solar abundances
A-I-M Coupling
Interhemispheric aspects
Global electric fields
Intermediate & small-scale coupling with global effects
Conductance at regional scales
Physics of the homopause & oxygen
Ion-Neutral Coupling
Gravity waves & turbulent dynamics
Global impact of atmospheric gravity waves
Discovery using Data Analytics
Heliophysics & data analytics
Modeling & machine-learning based discovery
Heliophysics, data science, & high-performance computing
Basic Plasma Physics
Kinetic Heliophysics
Comparative Magnetospheres
Reconnection (Solar, Planetary, Lab)
Particle acceleration & transport
Radio Science
Space Climate
Long-term ITM changes, politics, economics
Sun-Geospace climate
Space climate forecasting
Space Weather Hazards
Global article radiation environment
Forecasting solar flares & eruptions
Satellite drag & debris prediction & mitigation
Space Weather, Sun-Earth System
Research to improve forecasts including R2O-O2R element
Predict geoeffectiveness
Geomagnetic Storms (not operational aspects)
Probabilistic forecasts
Extend ITM forecast horizon
Tracking eruptions sun-to-ionosphere
R2O - O2R Center

RFI Recommendations

Personnel

- 8-10 senior researchers at 2-3 months each + 6 postdocs + 6 grad students + 10 part-time undergrads
- 10 senior researchers at 50% FTE + 12 grad students + 6 postdocs
- 15 Students + ~10 tenured faculty + 5-7 researchers with partial support
- 10-15 total including postdocs, researchers & grad students

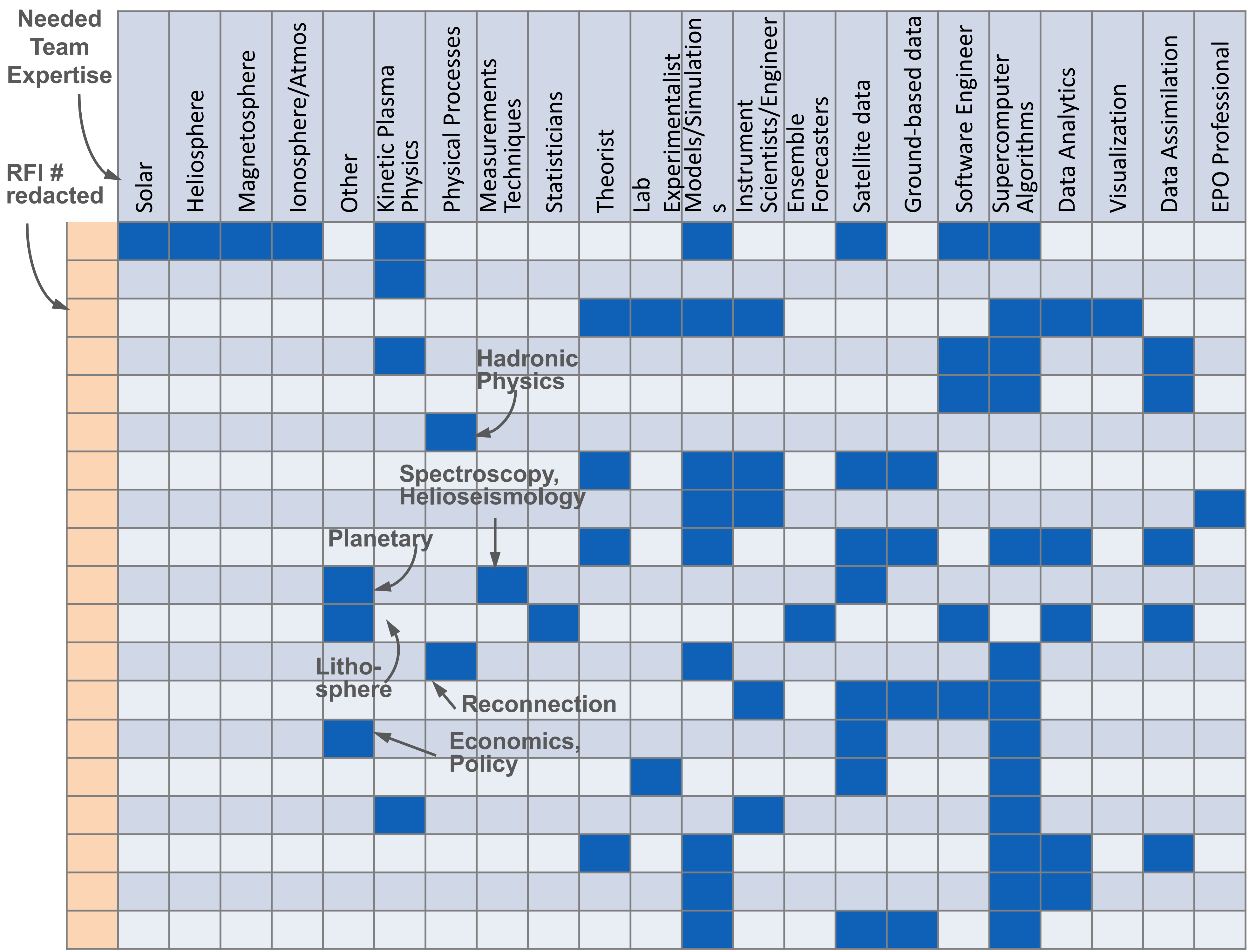
Resources Needed

- 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 efforts

Note: LWS focus science teams are currently funded at ~$1M/yr for 4 yrs



Needed Team Expertise
RFI # redacted
Solar
Heliosphere
Magnetosphere
Ionosphere/Atmos
Other
Kinetic Plasma Physics
Physical Processes
Measurements Techniques
Statisticians
Theorist
Lab Experimentalist
Models/Simulations
Instrument Scientists/Engineer
Ensemble Forecasters
Satellite data
Ground-based data
Software Engineer
Supercomputer Algorithms
Data Analytics
Visualization
Data Assimilation
EPO Professional
Hadronic Physics
Spectroscopy, Helioseismology
Planetary
Litho-sphere
Reconnection
Economics, Policy

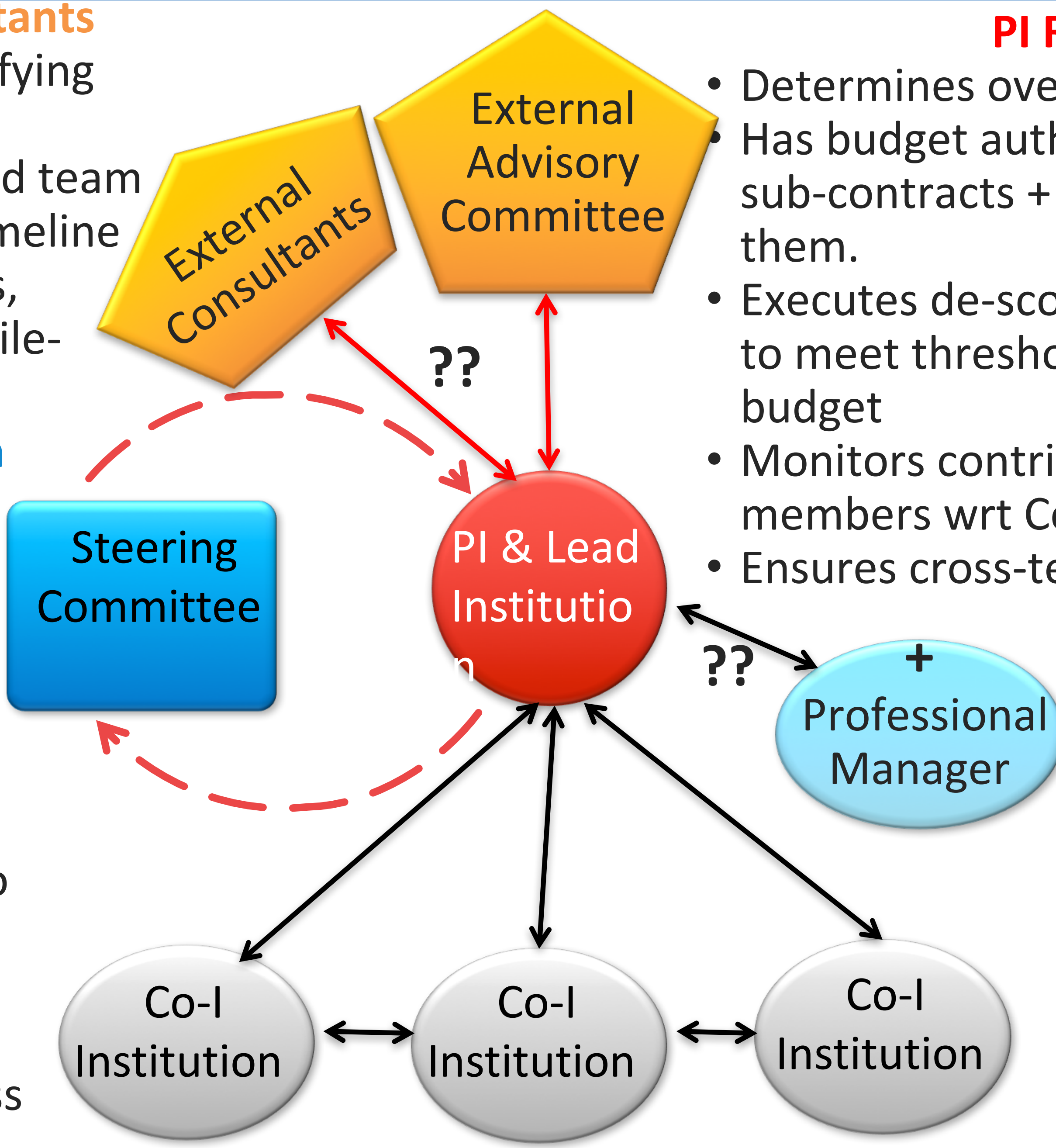
Most common management structure with some variations

External Consultants

- Assist in identifying elements for:
  - An integrated team
  - A mission timeline of objectives,
  - Metrics & mile-stones

Steering Comm

- Composed of leads at Co-I institutions
- Charged to:
  - Evaluate progress
  - Create strategies to enhance progress
  - Evaluate effectiveness of teams



PI Role

- Determines overarching goals
- Has budget authority through sub-contracts + can change them.
- Executes de-scope plan if needed to meet threshold mission within budget
- Monitors contributions of team members wrt Center goals
- Ensures cross-team interaction

Lead Institution

- Undergrad & Postdoc mentoring
- Executes EPO
- Organize workshops
- maintain software & data
- Support profes-sional code development

Issues Raised in the RFIs (Pros and Cons)

R2O-O2R

- Grand Challenge: System Science
- Response to national priorities & mandates on NASA, NSF, NOAA, DoD, with a high probability of producing civil & military benefits. Consistent with recent SWAP actions. Shared cost <$!M per agency.
- Inclusion of commercial and industrial partners viewed as a strength
- Science enjoys funding success because it can deliver societal benefits. An emphasis on forecasting in the HSCs brings enormous benefits.

Dominant Face-to-Face; Supplementary Virtual

- With low center funding, advisable to make use of physical proximity for management & knowledge integration; virtual collaboration tools as supplement-ary. Too expensive & time consuming for effective implementation unless additional resources available.
- Most efficient way to make progress is still face-to-face contact with access to data, analysis tools, simu-lations, and theoretical ideas
- Collaborations that involve telecons (or Skype) are helpful on occasion, but do not lead to the same amount of progress
- Experience shows that key element for success is the amount of face time between team members

R2O-O2R

- DRIVE HSCs provide an ideal vehicle for achieving essential basic science breakthroughs, consistent with DS and CSSP recommendations.
- *Building infrastructure for space weather operations (including software) while timely and important, should be funded via other mechanisms*

Dominant Face-to-Face; Supplementary Virtual

- The most efficient way to advance multi-disciplinary research & ensure ground-breaking progress is to organize a virtual center.
- Propose a virtual Institute managing entity that is removed from parochial disciplinary or programmatic interests, and facilitates a self-directing community.
- The DRIVE centers could benefit from already-developed productivity & collaboration tools

Other Issues Raised in RFIs

Two views of knowledge integration/ team interaction

View1: Achieved through network of graduate students & postdocs. Senior co-investigators too busy for this but provide broad perspective & guidance.

View 2: Sustained & active participation from all team members is needed to achieve center-level goals. This requires substantial salary support (~50%) for all senior personnel

Center management issues

- Based on personal experience, management structures of major projects lack authority & accountability. Need PI grant-subcontract funding.
- Considering the budget, professional management not an option.
- Take lessons from successful Silicon Valley startups. They utilize a strong core that sets a high-level vision, identifies the best teams to carry out the vision, and then gives autonomy to the teams in choosing "how" to accomplish their parts of the puzzle.

Need more computational resources

- Ensemble forecasts need massive computational resources. Tropospheric weather has ~10,000 allocated processors. SWPC has dedicated 64 processors to run one simulation continuously.
- Reducing & mapping terabytes or petabytes of data into meaningful visualization will require processing near to where the data are and indexing techniques for real-time data exploration
- Visualization of 3D computer results is critical for both interpreting simulation data & EPO. Recommend access to a professional visualization team

Data Analytics

NASA's Frontier Development Lab, an 8-week accelerator program for applying machine learning techniques to planetary & Heliophysics problems, is a prototype for public/private partnership [in the Centers]

Leveraging host institution

Take advantage of synergies with host institution facilities & programs for: 1) education & workforce development , 2) mechanisms & support for effective team science.

Getting the most out of diverse science teams – Crucial element for success (the Human Element)

- Issue: Conducting research collaboratively increases the time required for communication and coordination of work. If these challenges are not recognized & addressed, then projects *may fail to achieve their scientific goals*.
- Science of Team Science: Reviewed by NRC to provide recommendations
- Key challenges for teams:
  - High diversity of membership
  - Deep knowledge integrations
  - Large size
  - Goal misalignment with other teams
  - Permeable boundaries
  - Geographic dispersion
  - High task interdependence
- Recommendation to Funders
  - Require a communication plan for all geographically dispersed teams
  - Require a deep knowledge integration plan for centers with interdisciplinary teams
- Provided a table of recommendations for: (1) Leaders of science teams & groups, (2) Leaders of geographically-dispersed science teams, (3) Universities and other scientific organizations, (4) Public and private funders, (5) Researchers, and (6) the Scientific community

Proposal Review Process for Single-Phase Center

1

Preliminary Proposal

- Evaluated by review panel with ad hoc reviews as needed
- Reviewed based on science merit mostly
- Invitation to submit full proposal if selected.

2

Full Proposal

- By invitation only
- Evaluated by ad hoc reviews
- Besides merit review, include program-specific criteria
- Finalists invited to make presentation of proposal to panel (reverse-site visit for **MRSEC**; site visit for **STC**)
- Panel report to NSF to use in selection

- MRSEC: Annual and final reports
- STC: Annual reports on progress & plans, as a basis for performance review & determining continued funding. STCs are also required to develop a set of management & performance indicators for submission annually to NSF via an NSF evaluation technical assistance contractor.

Proposal Review Process for 2 Phase Center

1 Preliminary proposal Phase I

- Evaluated by review panel with ad hoc reviews as needed
- Determines whether invited to submit full phase 1 proposal.

2 Full Phase I

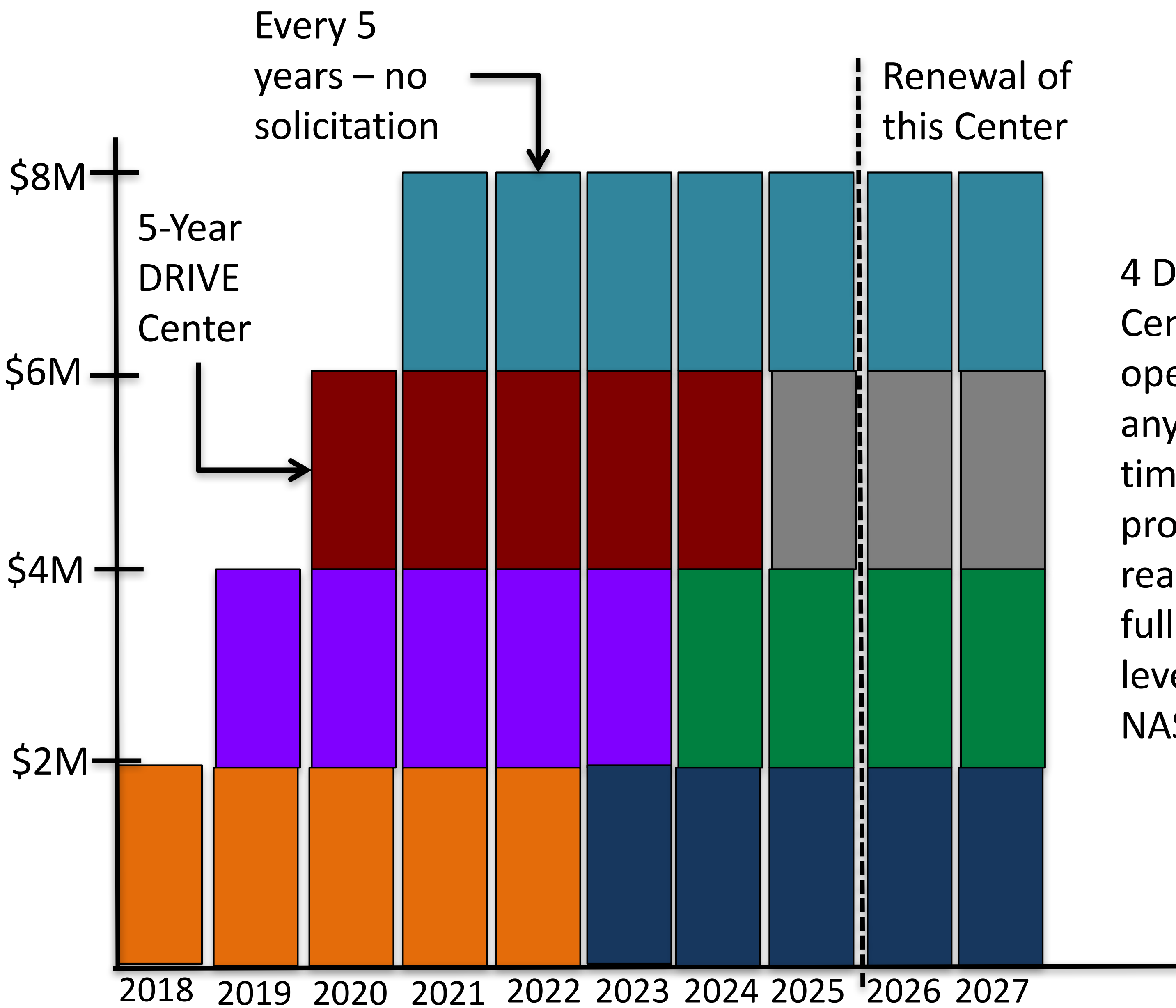
- By invitation only
- Evaluated by a combination of ad hoc and panel reviews
- Besides merit review, include program-specific criteria as well

3 Full Phase II

- Eligible after 3 -4 yrs as Phase 1 center; by invitation
- Ad Hoc reviews
- Sent to PI-option to respond
- Reverse site visit: PI presents proposal to panel & responds to questions
- Selections are made based on inputs from panel & other considerations

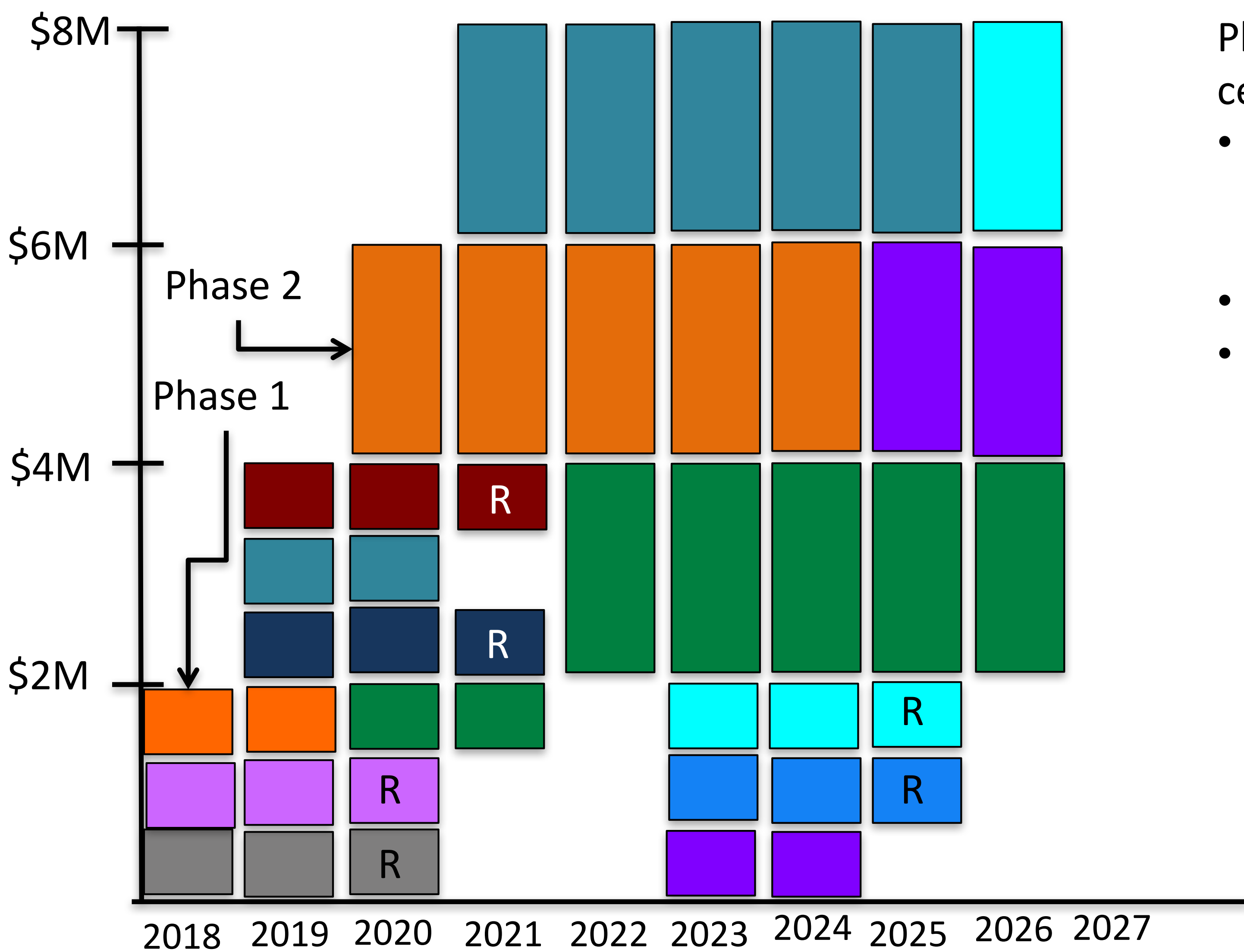
- Phase I post-award conditions: Complete strategic plans, including a diversity plan & data management plan, within 15 months of the start date. Plans will be provided to the NSF Program Director & evaluated during post-award review.

Notional profile for multiple centers



4 DRIVE Centers operating at any given time once program reaches its full funding level at NASA.

Notional profile for 2-Phase Centers



Phase 1 pre-centers:

- 2 year lifetime + 1 year ramp down **(R)**.
- ~$700K/yr
- Eligible to propose for Phase 2 center in 2nd and 3rd years

3-6 Phase 1 Pre-Centers + 3 Phase 2 DRIVE Centers at any given time.

Questions under discussion

1. Consider O2R-R2O component & shared funding with other programs/agencies?
2. What should be # of co-existing Centers? Budget & center lifetime? Program funding profile needed?
3. Use 2-Phase center model (example CCI)? Minimize cost & duplication between Centers with shared resources model (example: MRSEC)?
4. Adopt reverse site-visit model (ex: CCI, MRSEC, PFC) or site-visit model (ex STC) for proposal review? Add program-specific review criteria?
5. How to address the increased computational demands generated by multiple centers? How to support deep knowledge integration & efficient virtual communication?
6. Post-award reviews? Metrics for success?