Project Description

- **Note: 15-page limit**
- **Note: A separate, 2-page data management plan can include details on standards used for data and metadata, and policies for accessing, sharing, and re-using data**
- **Note: A separate resources and facilities section can include a "description of the internal and external resources (both physical and personnel)", and this may be a good place to discuss local expertise. We must also include biographical sketches that list education, professional preparation, and related "products", somewhat akin to a CV**

1 Overview

- **Section lead(s):** Ryan Lynch
- **Target length:** 3/4 page
- Brief description of:
  - Context within the development of the UWB Rx
  - Key ideas/goals of the project
  - Scientific and technical motivation
  - Innovative/transformative impact of the project
  - Benefits to the wider astronomical community
  - Broader impacts, including enhanced infrastructure for research and education and impact on STEM education

2 Intellectual Merit

2.1 Motivation

- **Section lead(s):** Ryan Lynch, digital group
- **Target length:** 3 pages
- **Note: Highlight "expected significance" here**
- **Note: Highlight "objectives" here**
- Scientific Motivation (Ryan Lynch and Scott Ransom)
  - Direct detection and characterization of low-frequency gravitational wave Universe (i.e., NANOGrav)
    - Brief explanation of pulsar emission and ISM effects
    - Expected impact of UWB Rx for GW detection, including mention of Michael Lam's works
  - Broadband spectral studies of transients
    - Brief description of magnetars and FRBs
    - Importance of wide instantaneous bandwidth
  - Additional science drivers (scientific staff; radio recombination lines? astrochemistry?)
- Technical Motivation (Digital group (+ BTL/CASPER?))
  - **Randy: please provide your thoughts on what best goes under this section**
  - Importance of digitizing at RF
    - RFI resistance (i.e. high dynamic range, reducing analog components)
      - Talk about limitations of existing IF system and VEGAS here
    - Improved stability, reliability?
  - "Sharing the spectrum" (i.e. RFI excision)

2.2 Innovation

- **Section lead(s):** Digital group (+ BTL/CASPER?)
- **Target length:** 4 pages
- **Note: Highlight "relationship to present state of knowledge" here**
- **Note: To the extent possible, explicitly describe work to be undertaken and/or major activities (can expand in §4 as needed)**
- **Randy: please provide your thoughts on what best goes under this section**
- New hardware?
- Firmware development
  - Fast sampling
  - Increased bit-depth/dynamic range
  - Dealing with bandpass slope/selecting significant bits?
- Protocols/formats for high data rates
  - Packetization
  - $10 \rightarrow 40 \rightarrow 100$ GbE
  - **Question for digital group: How would we break up band (i.e. subband the way GUPPI and VEGAS do in coherent DD modes) and transmit to HPCs?**
  - **Note: We should talk to Chris and computing group about network infrastructure**
- Active RFI excision
  - MAD and SK algorithms
  - Machine learning algorithms
    - Talk about new chips/architecture here?
- Interference compliance
  - Design of low-power, non-interfering electronics
  - Shielding (w/ input from Carla?)
- Cooling? (w/ input from mechanical/works divisions?)
- Commensal/multi-backend/multi-mode observing?
  - **Note: We should talk with software group about software backends**
- **Note: We could include impact on key science drivers here**

3 Broader Impacts

Note: We should decide if we want to support a postdoc, intern, or grad student. This would most likely be in engineering. If so, we can place this under sections for "Development of a Competitive Workforce"

Note: Ryan will talk to Sue Ann about whether we can naturally include any EPO components (within budget)

3.1 Commitment to the Public

- **Section lead(s):** Ryan Lynch
- **Target length**: 3/4 page
- Facility-supported, general-user, open-skies instrumentation
- Make all designs, firmware, software, and RFI excision algorithms publicly available

3.2 Enhanced Infrastructure for Research and Education

- **Section lead(s):** Ryan Lynch + scientific staff, digital group
- **Target length:** 2pages
- Reiterate importance to UWB Rx project
  - Include impact metrics for NANOGrav, pulsar, transient, and other science areas
- "Pilot program" for GBT IF system upgrades
  - Enable instantaneous use of full bandwidth for all existing (single-feed?) receivers
    - Focus on the science this would enable (e.g. astrochemistry, extragalactic surveys)
  - Provide maximum flexibility when balancing bandwidth vs number of pixels for camera program
    - Mention Argus+ and any other camera programs?
  - Incorporate active RFI excision at all frequencies
    - Mention car radar and any other new, high-frequency sources of RFI (w/ input from IPG)
  - Provide greater resistance to RFI through increased bit depth and by minimizing analog components
  - Improve reliability and reduce operational complexity by minimizing components in signal path
  - Update IF system with state-of-the-art technology
  - Create a model for fast, modular upgrades as new technology emerges
- Relevance for other instruments
  - Highlight ngVLA, SKA, and emphasize that all products of research will be shared freely
    - See if Jay and/or BTL/CASPER know of any existing plans for RF digitization at these or other observatories

4 Project Plan and Timeline

- **Section lead(s):** Laura Jensen
- **Target length:** 2 pages

4.1 Work to be Undertaken OR Key Milestones and Evaluation

- Should align with activities identified in §2.2
- Should also include metrics for success and a plan for evaluation

4.2 Proposed Timeline

- A graphical timeline, organized by year and work type
- A narrative description of the timeline

5 Results from Prior NSF Support

- **Section lead(s):** All (as needed)
- **Target length:** ? (must be < 5 pages)
- **Note: Only needed for PIs or co-PIs with a current NSF award or one with an end date in the past five years.**
- For each award:
  - NSF Award number, amount, and period of support
  - Title of project
  - Summary of completed/proposed work
    - Intellectual Merit
    - Broader Impacts
  - List of publications
  - Evidence of research projects and their availability
  - Relation of completed work to proposed work (for renewals only)