Description of project activities.

Each year over the next three years 20 high school science teachers and 30 high school students will be selected to become PSC Leaders. (Each teacher will select on-two high school students to participate) Professional development for 20 teachers will take place each year during online sessions and 12-day residential institutes at the NRAO in Green Bank, WV. Thirty high school students will join staff and teachers for a 5-day student-mentor institute each summer.

1. Preliminary online introduction to the PSC.

Once teachers have been selected to participate, project staff will lead online activities to:

- Introduce them to radio astronomy, and the discovery of pulsars.
- Introduce them to the Collaboratory website.
- Assess their readiness to incorporate IT into their core courses.

2. Summer Activities: PSC Research Institutes for Teachers at the NRAO.

PSC Research Institutes will involve teachers in pulsar research projects, instruction in relevant physics and astronomy content, and classroom applications. Teachers will be immersed in the research environment of the NRAO, interacting with astronomers, engineers and computer scientists as they learn how pulsar data are collected, analyzed, and reported. They will participate in many facets of pulsar research, help astronomers use the GBT to collect data and conduct data reduction and analysis using the IT tools developed for the PSC.

The Institute's activities can be broken down into 3 categories: team research projects, astronomy concepts and research skill development pedagogy and classroom transfer activities.

Teachers who complete the Research Institute will be awarded three hours of graduate credit in Physics from WVU. Teachers will also be eligible to receive 3 hours of graduate credit in Curriculum and Instruction after completing academic year activities. Tuition will be waived.

3. Summer Activities: Research Institutes for Students at the NRAO.

After a weekend break, our 20 participating teachers will return to NRAO with students for a five-day orientation to the PSC. These students will later become school-based team leaders as each school creates a team to assist astronomers with their pulsar data analysis.

4. Academic Year Activities.

Once the project begins, an initial set of background activities will be undertaken by an entire class. Those students who find themselves interested in these activities will apply to join the PSC. We envision that about 5-10 students from each school will become full members. PSC members will have access to proprietary GBT data which will be accessed online at WVU and then searched for new pulsars. Once students have confirmed a new pulsar they will estimate its distance, measure the spin-down rate to estimate its age and magnetic field, measure its position and correlate it with catalogs

from other telescopes and establish whether the pulsar has an orbiting companion. Re-discovering known pulsars will lead to comparisons of pulsar properties from past to present. Students will also diagnose and report patterns of RFI at the GBT.

While each dataset will be assigned primarily to one team, multiple PSC teams will analyze it, thereby fostering interschool collaboration. Only positive results confirmed by multiple teams will be flagged for examination by PSC staff. In addition to creating an online community between students across the state, this process will ensure rigorous confirmation of any discovery. Student teams will be responsible for communicating their results via scientific "papers" published on our website.

5. Capstone Activity—Annual PSC Seminar.

Each spring the PSC will convene a 3-day seminar at WVU. PSC teachers, students and school guidance counselors will be invited to attend. During the seminar, PSC student members will share their research via oral papers or posters. Professional astronomers will also be invited to report on their work. WVU undergraduate and graduate physics, computer science and engineering students will deliver short presentations on projects they are working on.

PSC students and guidance counselors will broaden their awareness of IT career pathways through tours of University science and engineering schools, and through participation in activities at the WVU Virtual Environments Laboratory (VEL). These activities will be based on the VEL's outreach program for teenagers called Creativity and Computing. (http://wvvel.csee.wvu.edu/creativity/)

Teachers, staff, evaluator and Advisory Committee members will participate in a capstone feed-back meeting at which the entire PSC community can reflect on successes and failures over the past year and share solutions with one another. During years two and three of the project, a limited number of teachers/students from prior years may elect to return and participate in subsequent seminars. These teachers/students will be selected based on interest and sustained (multi-year) involvement in the program.

6. Opportunities for Sustained Support of PSC Teachers and Students.

Long-term participation by teachers and students in the PSC will be encouraged. In addition to sustained support delivered online via the Collaboratory:

- Newly discovered pulsars will be re-observed with the GBT. Students who were part of both the discovery team and the confirmation teams will be invited to participate in the follow-up observations. They can participate either at the Green Bank Observatory or online.
- Teacher-mentors, selected from the pool of active PSC teachers, will assist new teachers during our Research Institutes
- PSC symposium—teachers and students who remain active will be eligible to participate in all PSC symposia.
- Mentorships at NRAO—exceptional students may apply to participate in 40-hour (one-week) career mentorships at NRAO. The Observatory hosts mentorships for students interested in exploring engineering, physics and computer science careers.

7. Relevance of the PSC to National and State Science Education Standards.

The Pulsar Search Collaboratory targets a subset of key science content goals and objectives:

a. Nature of Science/Science as Inquiry. The PSC provides teachers with experience in conducting scientific research, and collaboration in designing a classroom project that models scientific processes. At the same time, core content will be introduced within the context of scientific research. The PSC integrates the teaching of the facts of science with the practice of scientific research.

b. Content. Pulsars, rapidly spinning highly magnetized neutron stars, are fascinating objects for study. Research into their extreme properties has impacted most areas of fundamental physics. The PSC will allow students to gain first-hand insights into several areas of the new West Virginia Physical Science Content Standards:

- **Motions and forces:** Pulsars produce strong gravitational, electric and magnetic forces which impact their immediate surroundings. The most readily studied force within the framework of the PSC is gravity. Pulsars in binary or multiple systems causes the pulsars to orbit each other, and produce measurable doppler shifts in the pulsar signals. The orbital motion of binary pulsars found by PSC students can be precisely measured and permit measurements of the masses of the pulsars and orbiting bodies.
- **Conservation of energy**: Pulsars radiate electromagnetic waves at the expense of rotational kinetic energy. This energy balance is measurable over time. By measuring this, and the intensity of the radio emission from pulsars detected by the PSC, students can calculate what fraction of the pulsar's rotational kinetic energy is converted into radio emission. The period change also indicates that an external force is present, gradually braking the star over time. The dominant braking force is the pulsar's magnetic field. Students will be able to use their measurements to calculate the size of this magnetic field and the braking torque that this produces, again using basic physical principles. Such strong magnetic fields are far beyond anything that could be produced or investigated in a laboratory on Earth.
- **Interactions of energy with matter:** From their data, PSC students will be able to study the propagation of radio waves from pulsars as they traverse the interstellar medium, an ionized plasma of free electrons which exists throughout our Galaxy. The effect of this interaction is to slow down radio waves emitted at lower frequencies relative to ones emitted at higher frequencies. Students will be able to directly measure this delay and use it to infer properties of the interstellar medium and estimate the distance to the pulsar.

c. Information Technology. Meeting the goals of the WV Curriculum standards and the NSES requires WV students to use technology to improve their ability to do science. Last year, West Virginia published a detailed report about the state-of-the-state with regard to creating 21st century learners (WVBE, 2006). The outcome of this report is a call to integrate meaningful IT standards into all core subjects at all grade levels. This change in standards will take effect in September, 2009. The PSC will be a valuable IT application for science that will meet the new standards for IT integration.