

The NASA Technical Consulting Team (NTCT) provides support to the B612 Sentinel project on behalf of, and funded by, NASA. The NTCT will support all phases of the mission, as linked by a series of progress assessment “Gates”. These “Gates” are broadly defined in the Space Act Agreement (SAA) between NASA and B612. Further assessment will be via the project and mission reviews, which the NTCT will support as a part of the Sentinel Special Review Team (SSRT). The NTCT will also provide independent science, engineering and operations’ assessment for NASA as requested by NASA, mostly on behalf of B612, on technical aspects of the Sentinel Project.

Members of the NASA Technical Consulting Team are:

Team Lead - Cheryl L. B. Reed is a Program Manager for the Johns Hopkins University Applied Physics Laboratory (APL), Space Department and is also the Civil Space Program Development Manager. Since joining APL in 1985, Ms. Reed has held major program and project management roles for more than 20 national and international civilian and national security space programs. Current project assignments’ include NASA’s Robotic Lunar Lander (RLL) (which recently received the NASA Silver Achievement Medal), Marco Polo-R Asteroid Sample Return Study, and the Missile Defense Agency’s Precision Tracking Space System (PTSS) Technical Advisor task. She has significant experience in managing technical teams and programs at the concept, subsystem, instrument, spacecraft and mission levels, and throughout all program phases. Ms. Reed routinely works with government sponsors and manages across diverse mission teams of U.S. and foreign academic institutions, industry, public agencies and government organizations. She often takes on special assignments, such as chairing proposal and concept study evaluations, serving on source selection boards, non-advocate review boards, and as lead on major program procurements such as commercial procurement of spacecraft buses. Most recently, Ms. Reed served as the NASA Standing Review Board (SRB) Chair for the GRAIL mission to the Moon, which received the NASA Group Achievement Award in 2012. Ms. Reed was appointed to the University’s Principal Professional Staff in 2004.

Paul Abell is the Lead Scientist for Planetary Small Bodies assigned to the Astromaterials Research and Exploration Science Directorate at the NASA Johnson Space Center. He has been studying potentially hazardous asteroids and near-Earth objects for over 15 years. Paul was a telemetry officer for the Near-Earth Asteroid Rendezvous (NEAR) spacecraft Near-Infrared Spectrometer team and was a science team member on the Japan Aerospace Exploration Agency (JAXA) Hayabusa near-Earth asteroid sample-return mission. He was also a member of the Hayabusa contingency recovery team and participated in the successful recovery of the spacecraft’s sample return capsule. Since 2006 he has been a member of an internal NASA team examining the possibility of sending astronauts to near-Earth asteroids and is the lead committee member of the Small Bodies Assessment Group chartered with identifying Human Exploration Opportunities for NEOs. Paul is a science team member of the Large Synoptic Survey Telescope (LSST) tasked with identifying NEOs for future robotic and human space missions, and is also the Science Lead for NEO analog activities and operations of the NASA Extreme Environment Mission Operations (NEEMO) and Research and Technology Studies (RATS) projects. Asteroid 8139 (1980 UM1) is named Paulabell in recognition of Paul's contributions to NEO research and exploration studies.

Arlin Bartels serves at NASA’s Goddard Space Flight Center as the Flight Manager for the OSIRIS-REx Asteroid Sample Return mission. Prior to OSIRIS-REx he has served for over twenty years developing space flight instrumentation and spacecraft hardware in industry and for NASA. He also served as the Payload Manager for the Lunar Reconnaissance Orbiter (LRO) launched in June 2009,

responsible for delivering the sensors and instruments used by NASA to identify potential landing spots for future manned missions, and that is now conducting a scientific research program. He also led the GSFC-inhouse development of the MESSENGER Laser Altimeter currently in operation at Mercury. Arlin received NASA's Exceptional Achievement Medal for his work on LRO.

Dr Steven Chesley is an expert in asteroid and comet orbit determination with NASA's NEO Program Office at the Jet Propulsion Laboratory. He led the development of JPL's Sentry system – an automatic process that updates the orbits of recently observed NEOs and assesses their hazard to Earth. He has been active in NASA studies relating to the asteroid impact hazard and in particular in evaluating the performance of potential asteroid search programs. Steve's spaceflight project experience includes NEAR-Shoemaker navigation and the comet ephemeris development for the last five NASA comet-spacecraft encounters, most recently the EPOXI mission to Comet Hartley 2 and the Stardust-NExT mission to Comet Tempel 1. He is presently a co-investigator on the OSIRIS-REx asteroid sample return mission, responsible for the target asteroid ephemeris development. Steve is a recipient of NASA's Exceptional Engineering Achievement Medal in recognition for his work on the Stardust-NExT mission. Asteroid 12104 Chesley is named in his honor.

Douglas Eng is currently the Group Supervisor of the Space Systems Applications Group at the Johns Hopkins Applied Physics Laboratory (APL) where he supervises a large number of the Systems Engineer for the APL Space Department. Doug was previously the Mission Systems Engineer for the Radiation Belt Storms Probe (RBSP) Mission which has recently been successfully launched and will study the relationship between the Sun and Earth's radiation belts and resulting space weather. Doug was also the Deputy Systems Engineer for NASA's STEREO Mission, which is currently in an extended mission to study Coronal Mass Ejections and to map the Sun in 3D. Doug has served as the advanced concepts manager for the Space Department where he was involved with several projects and proposals including, technically leading concept studies for the NRC Planetary Decadal Survey, lunar missions such as the International Lunar Network (ILN), NASA Planetary Proposal Efforts, and robotic asteroid mission concepts. Doug was also the Mission Systems Engineer in support of NASA's Science Definition Team for the Solar Probe Mission which ultimately led the start of the Solar Probe Plus Mission currently in Phase B with an objective to fly to the Sun's Corona to help understand the source of the Solar Wind scheduled to launch in 2018. Prior to working in the APL Space Department, Doug played a technical leadership role in the development of the technology and early development of the SM-3 missile defense system for the Missile Defense Agency and the Navy.

Robert McMurray, Jr., PhD, has been a physicist in the Instrument Technology Branch at NASA Ames Research Center for over 24 years. His expertise is in condensed matter physics, as well as low temperature and radiation effects on materials. He has worked on the development and testing of Infra-Red detectors for many NASA satellites, including Spitzer, WISE and JWST. The technology needed for these applications includes ultra-low noise cryogenic electronics and ultra-low background light levels in the mid-IR wavelengths during laboratory testing of sensitive detector arrays. He has been performing proton radiation tests on detectors, cryo-CMOS multiplexers, and other electronics at ARC since 1989. Prior to coming to NASA he worked at the Lawrence Berkeley Laboratory, now LBNL, in the nuclear engineering department in the capacity of a solid-state radiation detector physicist, including performing tests at other facilities such as SSRL. He concurrently worked in the Materials Sciences Department on the UC Berkeley campus. He received his Ph.D. in 1984 from the UC Berkeley Physics Department.

Ronak Shah serves at MIT Lincoln Laboratory, in the Space Control Systems Group and Aerospace Division. He works as the a co-principal investigator on the long-running LINEAR (Lincoln Near Earth

Asteroid Research) program, a significant contributor to NASA's Near Earth Object Observations Program. He has worked as an observational astronomer for nearly 20 years, using ground and space based instruments across the electromagnetic spectrum, concentrating on radio (including interferometry), infrared, optical, and X-ray. He has contributed or written refereed publications on a number of diverse subjects in astrophysics including star formation, chemical evolution of the interstellar medium, gravitational lensing, and Milky Way structure and evolution. Since joining Lincoln Laboratory, Ronak has contributed to both flight and ground missions serving the US Air Force's space situational awareness mission. He is currently one of the team scientists on the DARPA Space Surveillance Telescope, a next generation prototype that greatly improves the US capability to survey objects in deep space.

Terry Smith is a civil service employee at NASA's Goddard Space Flight Center, in its Avionics and Electrical Systems Engineering Branch. He has 28 years of experience in the design and development of Spacecraft Avionics and Flight Instrument Electrical Systems. He is a consultant to the NASA Avionics Steering Committee, and a standing member of the NASA Avionics Community of Practice. He has received two NASA Agency Exceptional Achievement Medals for his work on advanced avionics systems and products. He has recently architected avionics systems and/or products on the following projects: The NASA Crew Exploration Vehicle (CEV), the James Webb Space Telescope (JWST), the Magnetospheric MultiScale Mission (MMS), and the Global Precipitation Measurement (GPM) Mission. One of his premier achievements was leading the design and development of the Wideband Advanced Recorder and Processor (WARP) on the Earth Observing 1 (EO-1) Spacecraft. The WARP is a very high performance data acquisition, storage, processing, and downlink unit that collects instrument data at almost 1 Gbps, processes the data, and then autonomously commands the EO-1 spacecraft based on the instrument data. EO-1 is a single string spacecraft that launched in November 2000, with a 1 year mission life requirement. It is still operating flawlessly after almost 12 years. Terry's first job was designing microprocessor based digital electronics for the MILSTAR Air Force Terminal Program. It was that experience that led him to his passion for system engineering thereafter.

Dr Tim Spahr is currently the Director of the Minor Planet Center (MPC), located at the Harvard-Smithsonian Center for Astrophysics in Cambridge, Massachusetts. The NASA/NEOO-funded MPC is the world's clearing house for all astrometric observations and orbits of asteroids and comets, accepting and processing all data from all observatories worldwide. The MPC focuses attention on Near-Earth Objects (NEOs), and pays special attention to objects that might impact the Earth in the near future. The impact of small asteroid 2008 TC3 over the Sudan in October 1998 was correctly predicted by the MPC in near real time, and allowed scientists and authorities a few hours to prepare. Prior to working at the MPC, he wrote detection and astrometric software for the Catalina Sky Survey, which is now the world's most productive NEO and comet survey. He obtained his PhD studying celestial mechanics and the observational bias present in asteroid surveys under Stan Dermott at the University of Florida in 1998. During graduate school he conducted an asteroid survey using film (the precursor to the Catalina Sky Survey). This survey discovered 1996 JA1, an NEO that passed less than 250,000 km from the surface of the Earth in May 1996.

NASA HQ personnel managing the B612 Sentinel Space Act Agreement effort are:

Agreement Manager – Dr Michele Gates serves as Senior Technical Advisor to the Associate Administrator for Human Exploration and Operations at NASA Headquarters. In this role, she provides overall advice and support to the Associate Administrator across a broad array of strategic and tactical issues affecting the mission directorate. She provided critical programmatic support to the Associate Administrator in the implementation of a flexible, sustainable human space flight program portfolio, including both government and commercially owned and operated elements, during the transition from the Space Shuttle Program. Dr. Gates serves on the Agency's Mars Program Planning Group and as the lead in the development and negotiation of the first non-reimbursable Space Act Agreement with a non-profit organization for their deep space mission. Prior to this role, Dr. Gates served in a temporary assignment as the Deputy Associate Director for Earth Science Projects Continuity Missions at the Goddard Space Flight Center, where she provided overall programmatic guidance during the formulation and baseline of several earth science missions. Dr. Gates began her career 20 years ago in space radiation effects engineering at the Goddard Space Flight Center. She has a Bachelor's, Master's and PhD in aerospace engineering and lives in Alexandria, VA.

Program Executive - Lindley Johnson serves at NASA Headquarters Science Mission Directorate, Planetary Science Division, as the Lead Program Executive for the Discovery Program of mid-class Solar System exploration missions, and the Program Executive for the Near Earth Object Observations Program. Prior to NASA he served 23 years of Air Force active duty, obtained the rank of lieutenant colonel while working a variety of national security space systems, and received 15 major individual or unit awards. He is a nationally acknowledged expert in Space Control systems, and in particular space situational awareness operations. He was the lead Air Force orbital analyst to set up collision avoidance support for the Space Shuttle Program when it began operations in 1981. After joining NASA, he was the Program Executive for NASA's Deep Impact mission to comet Tempel 1, launched in January 2005 to deliver an impact probe to the comet's surface on July 4, 2005, and explore the composition and interior structure of short-period comets. NASA's NEO Observations program has discovered over 7,000 near-Earth asteroids and comets since Lindley became its manager, about 80% of the total known. Lindley has received NASA's Exceptional Achievement Medal for his work on comet and asteroid missions. He holds a BA in Astronomy from the University of Kansas and an MS in Engineering Management from the University of Southern California. Asteroid 5905 (1989 CJ1) is named Johnson to recognize Lindley's efforts for detecting Near Earth Objects.

HEOMD Lead - Victoria Pidgeon Friedensen is the Robotic Precursor Domain Lead for the Advanced Exploration Systems (AES) Division of the Human Exploration and Operations Mission Directorate (HEOMD), NASA Headquarters. As Domain Lead, she is responsible for planning and development of robotic instruments and missions that provide strategic information required for human missions to potential destinations beyond low-Earth orbit. Ms. Friedensen is also the Manager of the Joint Robotic Precursor Activity (JRPA) office. Jointly funded by NASA's Science Mission Directorate and HEOMD, these robotic precursor activities are intended to reduce the risk of human space exploration while maximizing benefit to both science and exploration. In addition to these two responsibilities, she is also the near-Earth asteroid destination lead for the Human spaceflight Architecture Team (HAT), and serves on a HEOMD strategic integration working group. Prior to 2011, Ms. Friedensen was the HQ program executive for the Lunar Precursor Robotics Program and was responsible for the Lunar Reconnaissance Orbiter (LRO) and Lunar CRater Observation and Sensing Satellite (LCROSS) missions. Previous responsibilities include serving as risk manager for the Prometheus Project to develop a space fission power system. Before joining NASA Ms. Friedensen

served as a Program Director at the National Academy of Engineering where she managed the Committee on Diversity in the Engineering Workforce and led early studies on Earth-systems engineering. She holds a B.A. from the University of North Carolina, and a M.S. from Virginia Polytechnic Institute and State University.