KISS Workshop on the

"*Science and Enabling Technologies for the Exploration of the Interstellar Medium*"

Post Workshop: Summary of Action Items

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Co-Organizers

Plan Towards Workshop #2 January 12th, 2015

- ALL: Next KISS workshop January 12th, 2015; mark your calendars; book your travel
  - Assume 3 full days.
- ALL: review Action Item list (in this presentation) and provide any comments back to Leon Alkalai cc: Nitin Arora.
- Science Team: Goals, Objectives due by November 17th, 2014
- Mission Team: Two Team X studies: Early December 2014
- Technology Team: updated briefings at the workshop January 12th, 2015
- Emerging Capabilities Team: present results at workshop January 12th, 2015
- ALL: KISS Final Study Report due March 15th, 2015
- ALL: Proposal for Technology Development Plan to KISS, April 1st, 2015
- ALL: KISS funding opportunity, October 1st, 2015

Overview of Action Items

1. Science
   - STM: Science Objectives, Measurements and Feasibility Assessment
   - Science / measurement Interactive Tool
2. Two Team X studies
   - 1) 100 AU in < 10 years; grand tour KBO + Centaurs; 2) Swarm of small probes into the LISM
3. Technology Assessment
   - Miniaturization: Impact of Cubesats on the future of Space Exploration; instruments
   - Propulsion: Solar Sails (dual use, material testing, new deployment)
   - Communications: Optical or RF communication systems
   - Thermal management: thermal shield for perihelion burn
   - Avionics: Reliability, miniaturization, re-configurability using FPGA
4. Engineering Feasibility Study
   - 1) Gravitational lensing; 2) Beamed energy; 3) Solar Sail scaling and perihelion burn
5. Public Outreach
   - Formulate Plan; Public engagement; Explore avenue for non-governmental funds
6. Develop Strategy to reach/influence Decadal Surveys

AI-1: Science action item team leads

- **In-Situ Science**:
  - Lead: Gary Zank
  - Members: Merav Opher, Dick Mewaldt, Seth Redfield, Ralph McNutt, Paul Goldsmith, Jamie Rankin, Elena P., Adam Michael
  - Topics: Plasma ISM, Neutral, Magnetic Field, Turbulence, Dust, ENA and backscatter Lyman-alpha
- **KB Science, Zodiacal Dust**:
  - Lead: Mike Brown
  - Members: Mark Swain, Mike Werner, Mike Shao
  - Topics: KBOs, Dust detection and characterization, Understand utility of KB in terms of planetary formation
- **Astrometry, Astrophysics**:
  - Lead: Mike Shao
  - Members: Mark Swain, Slava Turyshev, Claudio Maccone, Mike Werner, Jared Males, Seth Redfield, Freeman Dyson
  - Topics: Extra galactic parallaxes, masses of asteroids, centaurs, Exoplanets search, orphan planets search

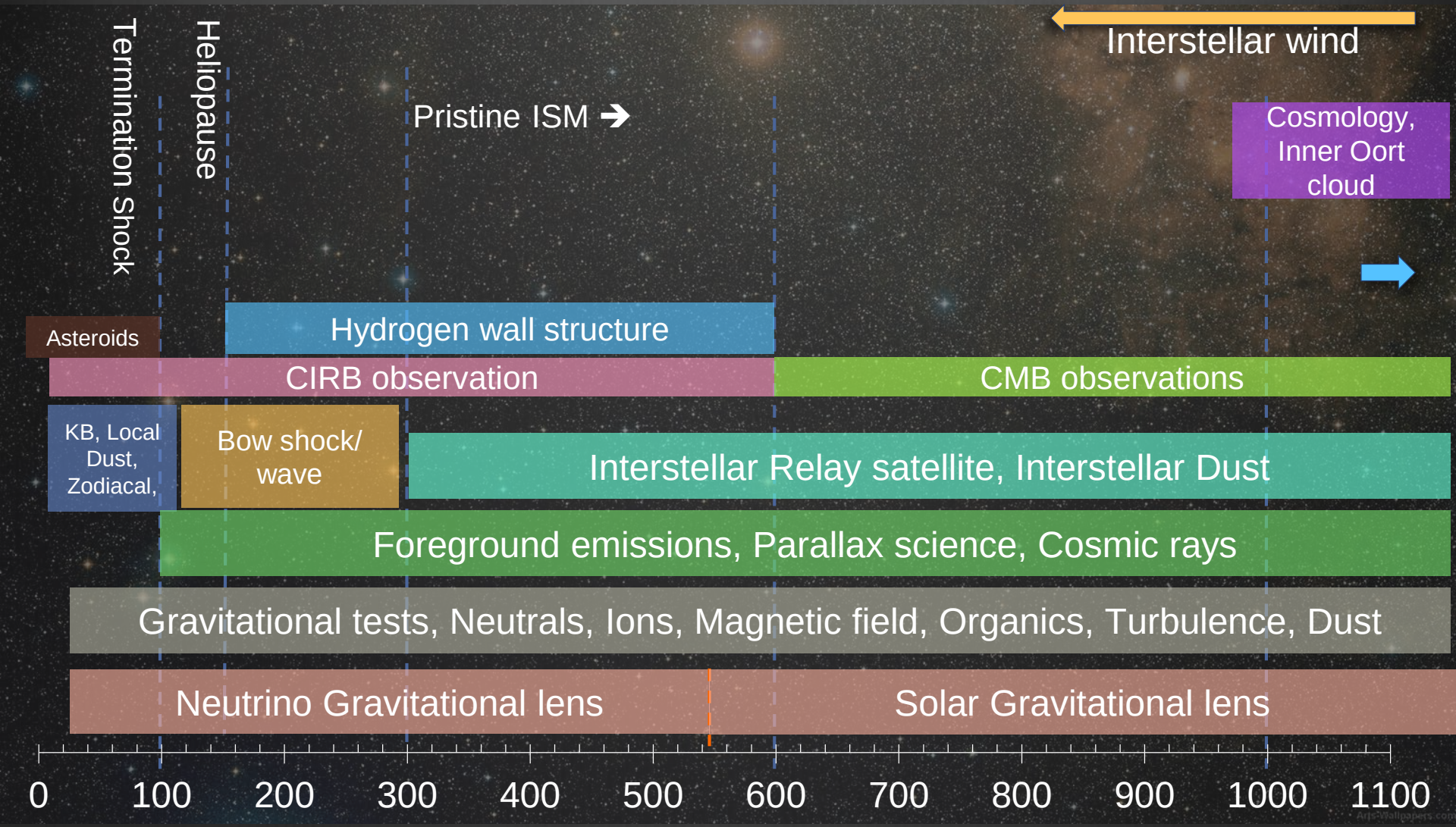
AI-1: Science action item: each team

- Define:
  - Science goals
  - STM: Science Traceability Matrix approach
- Quantify science objectives:
  - what is the value of science?
  - additional description requirements, how you meet them?
- Measurements and instrument requirements:
  - Miniaturization
  - Key performance parameters and system requirements
- Due date:
  - November 17th, 2014
  - Will be reviewed at workshop January 12th, 2015

AI-1: Science Visualization Tool

- Lead: Nitin Arora, Jamie, Elena, etc.
- Show log scale, linear scale (to and from)
- Show Voyager and other spacecraft
- Polar plot (top view) showing various local ISM regions
- Highlight various science disciplines (planetary, Heliophysics, astrophysics etc.)
- Include interactive behavior
- Understand and develop educational aspects of the tool
- Illustrate KBOs in some scientific detail
- Combined science case: Heliophysics, Astrophysics, Planetary Science
- Follow up with Ellan Stofan, NASA CS
- 3D navigation

AI-1: Science Visualization Tool (draft)



Investigate possibility of LOG scale

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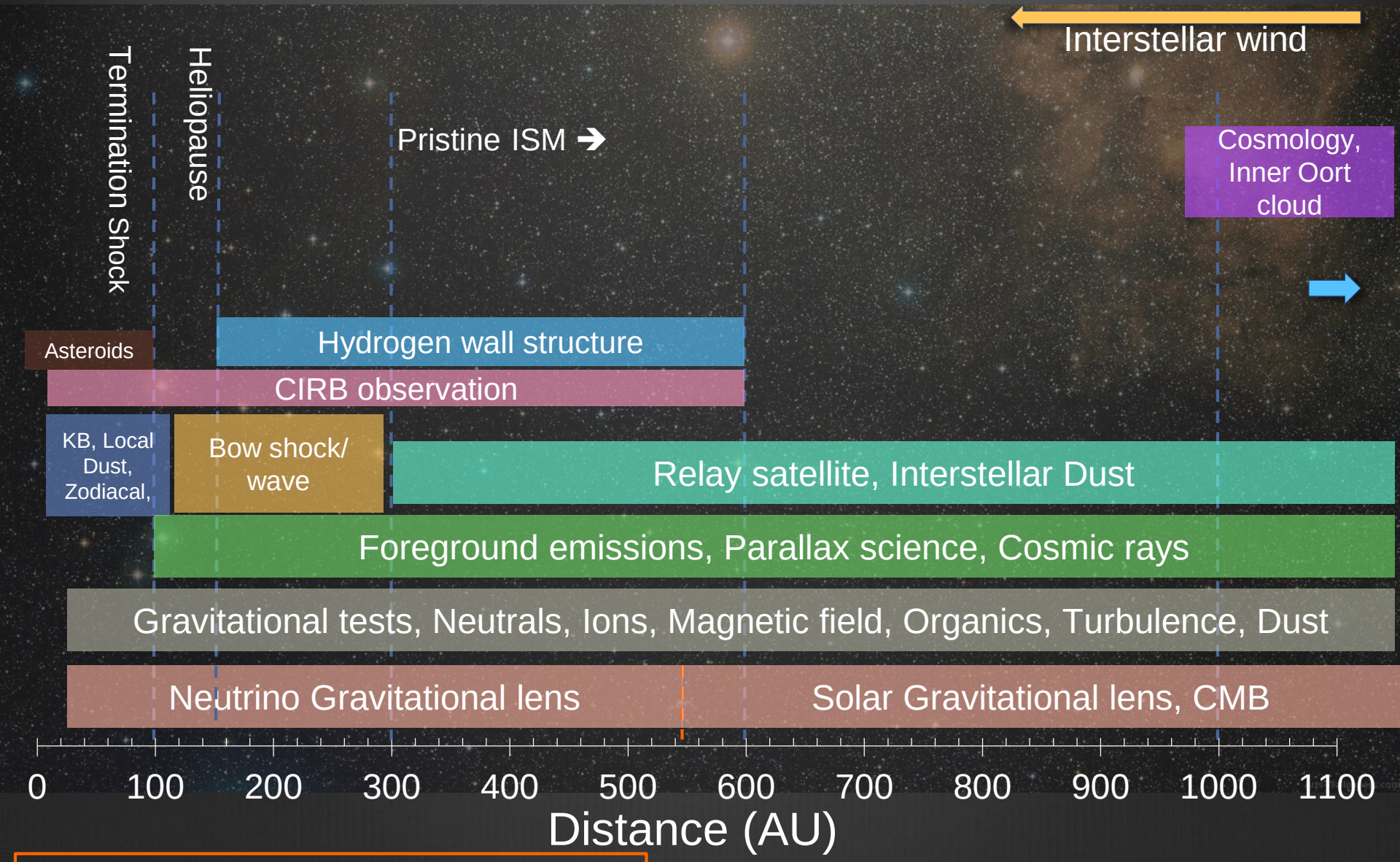

Investigate possibility of LOG scale

AI-2: Team-X Mission Study 1

100 AU in ~10 years

- Assume SLS lift capability
- Investigate Trajectory options: Jupiter flyby to achieve perihelion; Direct Jupiter flyby escape
- Analogy to Grand tour: Centaur and KBO flyby
- Critical event analysis: Perihelion burn:
- Cruise phase science team: Mark Swain, Mike Shao, Seth, Jarred, Mike W., Phil Lubin
- Credible design for a 2-3 stage solid (SRM) with heat shield
  - Thermal Protection System scaling

AI-2: Team-X Mission Study 2

- Members: Paullette, Dick M., Merav Opher, Manan, Darrell, Jamie, Freeman, Leon, Nitin, Adam
- Swarm of probes to cross the heliopause
- How small can you make the probe?
- How many?
- How fast can they escape ?
- Miniaturization ‘revolution’
- CubeSat analogy for interstellar missions

AI-2: Possible Tech Demo missions

- Solar Reflector to simulate Low Perihelion
  - Test solar heat shield
  - Test SRM inside the shield at elevated temperatures
  - Solar sail material testing
  - Increase sail loading (g/m^2) and sail specific weight
    - Packaging, origami deployment
  - Part of the test in Earth orbit
  - Some ground testing possible (France)
- Small Spacecraft Lifetime Mission
  - Long distance Com.
  - Kuiper Belt and beyond (target 100 AU in 10 years)
  - Small instruments when possible
  - REP
  - SRM at Jupiter
  - Hibernation
- Laser-Sail / Beam propulsion Demo
  - Small Sail + Laser from earth or small-sat

AI-3: Technology Assessment Update

- Miniaturization update, Rob Staehle
  - Update on CubeSats, integrated avionics and instruments
- Propulsion, Les Johnson
  - Solid rocket motor lifetime qualification and near perihelion burn
  - Light weight, Dual use sails; Sail material testing for close solar pass
  - Radio Isotope based Electric Propulsion/ Low power long life Thrusters
- Telecommunications, Abhi Biswas
  - Deployable / Inflatables antennas; Sail as an antenna; Solid state Optical comm.
- Thermal / Shield, Ralph McNutt
  - Solar heat shield (test Carbon-Carbon shield with new configurations)
  - Magnetic and Electro static Shielding; Thermal management
- Avionics: G&NC, Reliability and Resilience, Leon Alkalai
  - FPGAs, Hibernation, Wafer scale systems; Systems on a chip; Radiation tolerance

AI-4: Engineering Feasibility Study: Beamed Energy Engineering Study

- Members: Phil Lubin, Lou Friedman
- Provide a reasonable engineering implementation concept
- Propose a technology demonstration concept
- Present results at the January workshop

AI-4: Engineering Feasibility Study: Gravitational Lensing

- Members: Jared, Slava, Caludio, Mike (Shao), Mark Swain
- Define science objectives?
- Can it be done and how?
- What would the image of the Earth look like?
- Identify other engineering constraints.

AI-4: Engineering Feasibility Study Solar Sail Trade Study

- Members: Lou, Les, Darren, Nathan Barnes, Manan
- How close to the Sun can you go?
- What is the best sail density or sail specific weight possible?
- What would it take to design a 150 m (radius) Sail ? How much would the sail + sail sub-system weigh ?
- Dual use question: other uses of Solar Sail ?

AI-5: Public Outreach Plan

- Study lead: Mae Jemison, Lou Friedman, Leon Alkalai
- Public outreach: crossing of Voyager, Scientific American, National Geographic, NPR
- Work with JPL Blaine Baggett to come up with ideas,
- Minute Physics outreach – a series of lectures on youtube
- Target and work with existing groups like 100YSS program and others
- Ideas for Crowdsourcing a first mission or tech demo mission
- Present ideas at the January workshop

AI-6: Develop a plan to (inform) Influence the Decadal Surveys

Study Lead: Paul Goldsmith, Mike Werner

Target Decadal Surveys:

- Astrophysics
- Planetary
- Heliophysics

AI-6: Grand Vision of a Grand Challenge Interstellar Exploration Program

Technology Demonstration, Science Discovery

Technology Demonstration Missions	Small Explorers LISM and Heliosphere Multi-Probes	Medium Scale Missions	Large Scale Missions	Thousand AU challenge
1 – 10 AU	5 – 100 AU	200 – 300 AU	500 - 600 AU	1000 AU 50 years

Advanced Studies, Technology Maturation, Technology Development