Payload Options

for Future Entry Probe Missions

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Organization

- PSDS recommended entry probe missions
- Mission science objectives and instrumentation options
  - (With a couple of diversions for explanations)

PSDS Recommendations for Future Entry Probe Missions

- Saturn probe in NASA's New Frontiers Program
- Ice giant (Uranus or Neptune) orbiter with probe
- Orbiter and probe to the *other* ice giant; *next decade*
- Venus In-Situ Explorer (VISE) in New Frontiers Program
  - Holdover from previous PSDS
  - Primarily landed science, but measurements on the way down
- Venus Climate Mission (VCM), flagship
  - Includes "a balloon, a mini-probe, and two drop sondes"

Saturn Entry Probe Science Objectives and Instrumentation Options

- Tier 1 Objectives (measured to the 5-10 bar level)
  - Composition
    - Abundances of noble gases He, Ne, Ar, Kr, and Xe *(and their isotopes!)*
    - Isotopic ratios of H, C, N, and O
  - Atmospheric structure (T, P, and mass density vs. depth)

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      Wide, continuous mass range
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      Very high mass resolution
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    → Atmospheric Structure Instrument (ASI) package
    System of thermometers, barometers, & accelerometers
    Very lightweight, low power, low data volume

PSDS Draft Report
Saturn Entry Probe Science Objectives

- Tier 2 Objectives
  - Vertical profile of zonal winds at the probe entry location
  - Location, density, and composition of clouds as a function of depth
  - Variability of atmospheric structure and clouds in two locations
  - Vertical profile of water abundance at the probe entry location
  - Precision isotope measurements for light elements in simple molecules
    - Elements such as N, O, & S

Omits measurements of diagnostic species such as CO, PH_3, AsH_3, SiH_4, GeH_4

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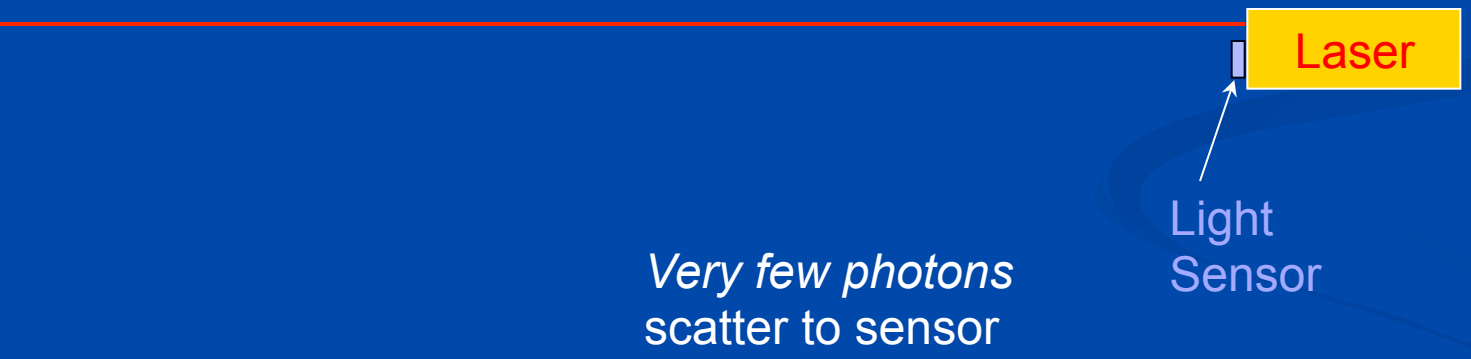

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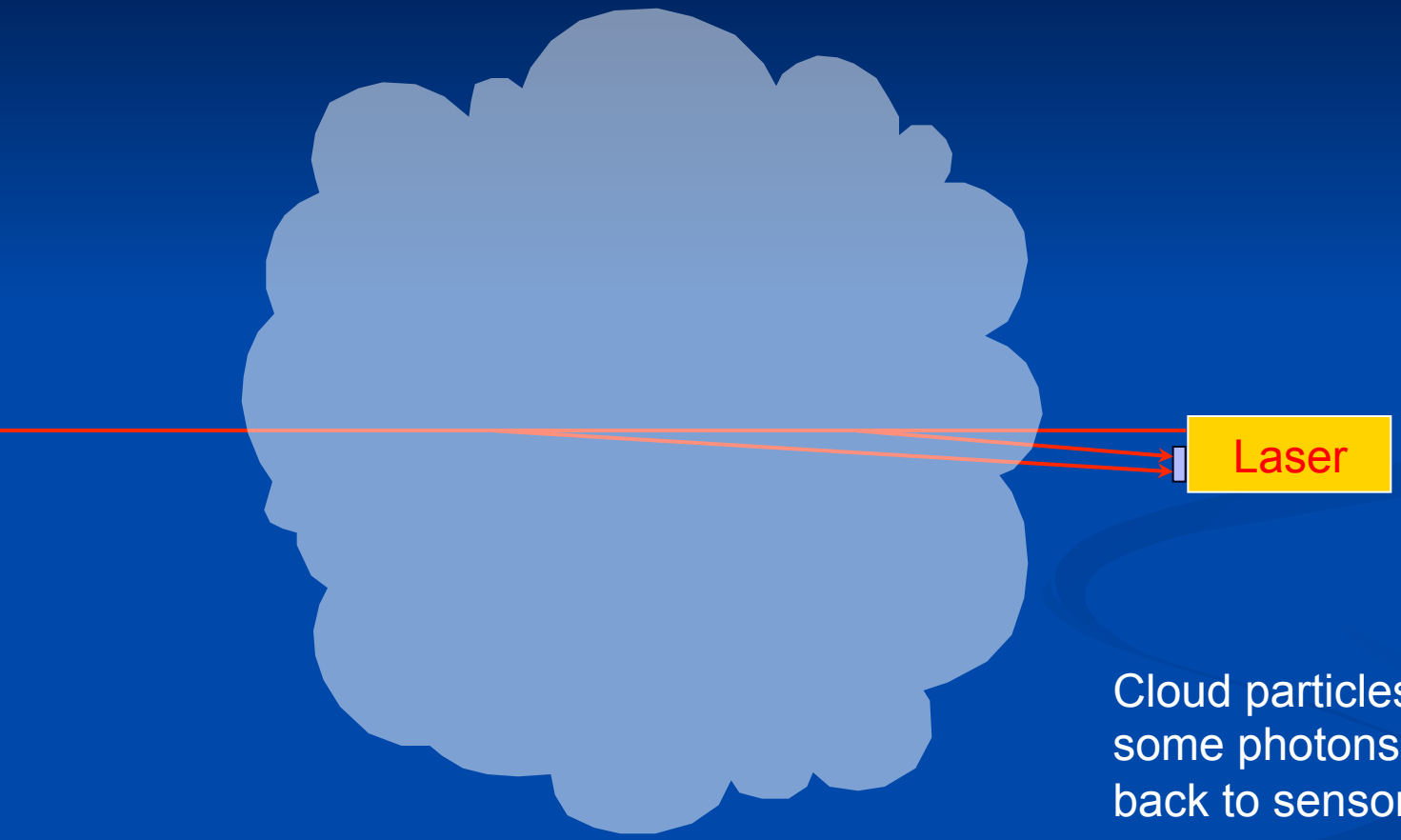

Cloud particles scatter some photons directly back to sensor

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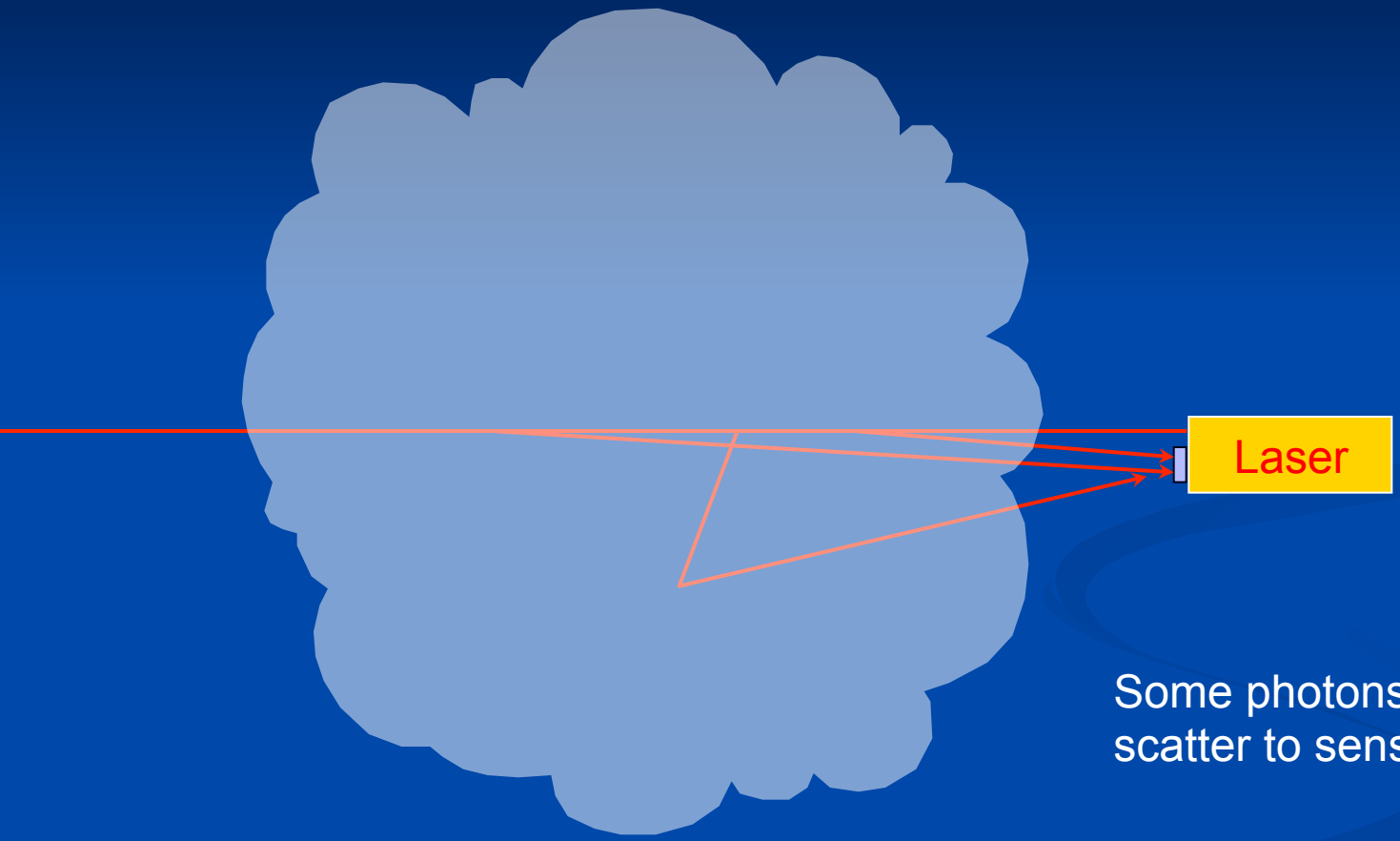

Some photons multiple-scatter to sensor

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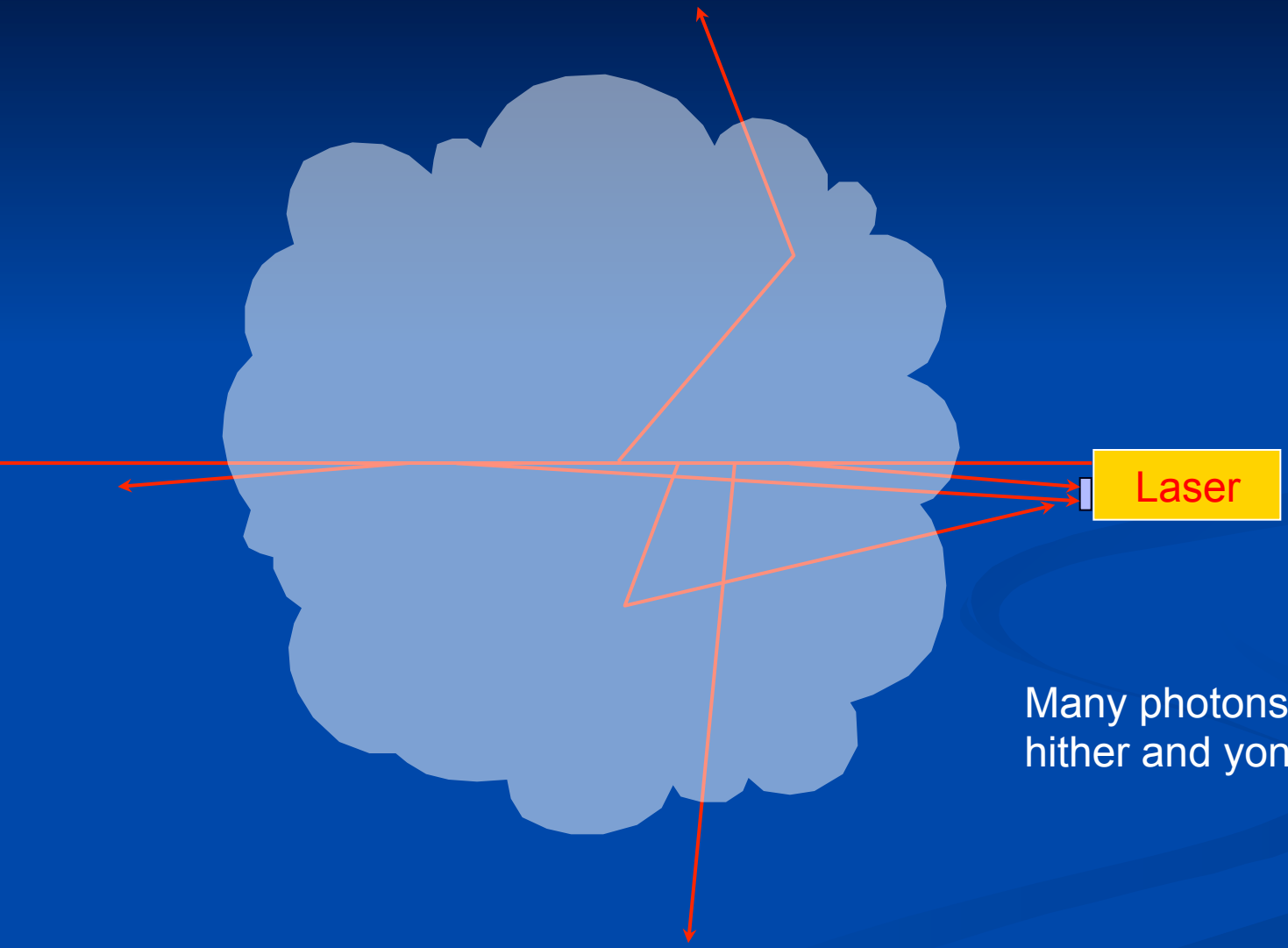

Many photons scatter hither and yon

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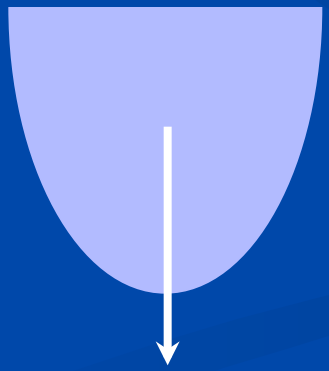

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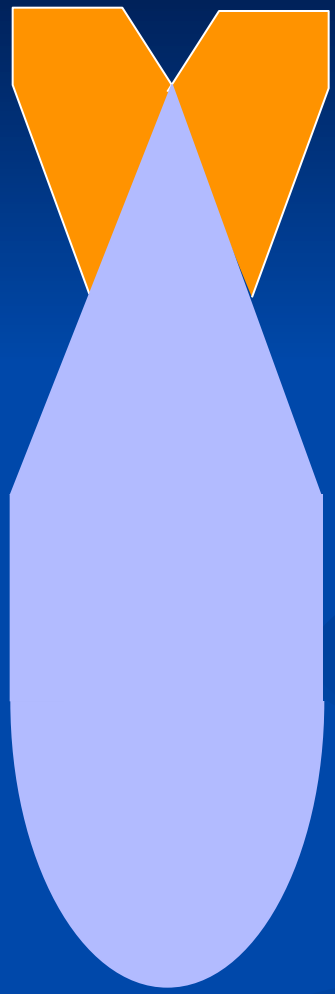

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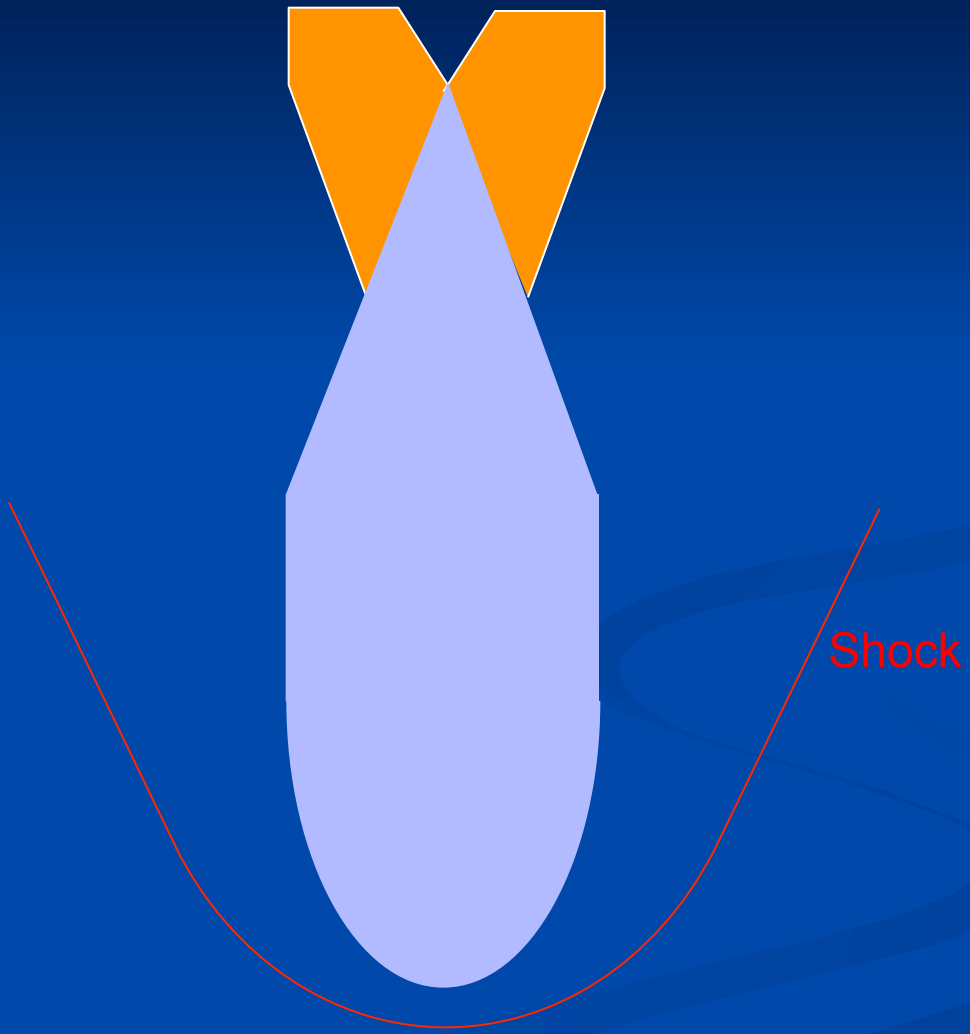

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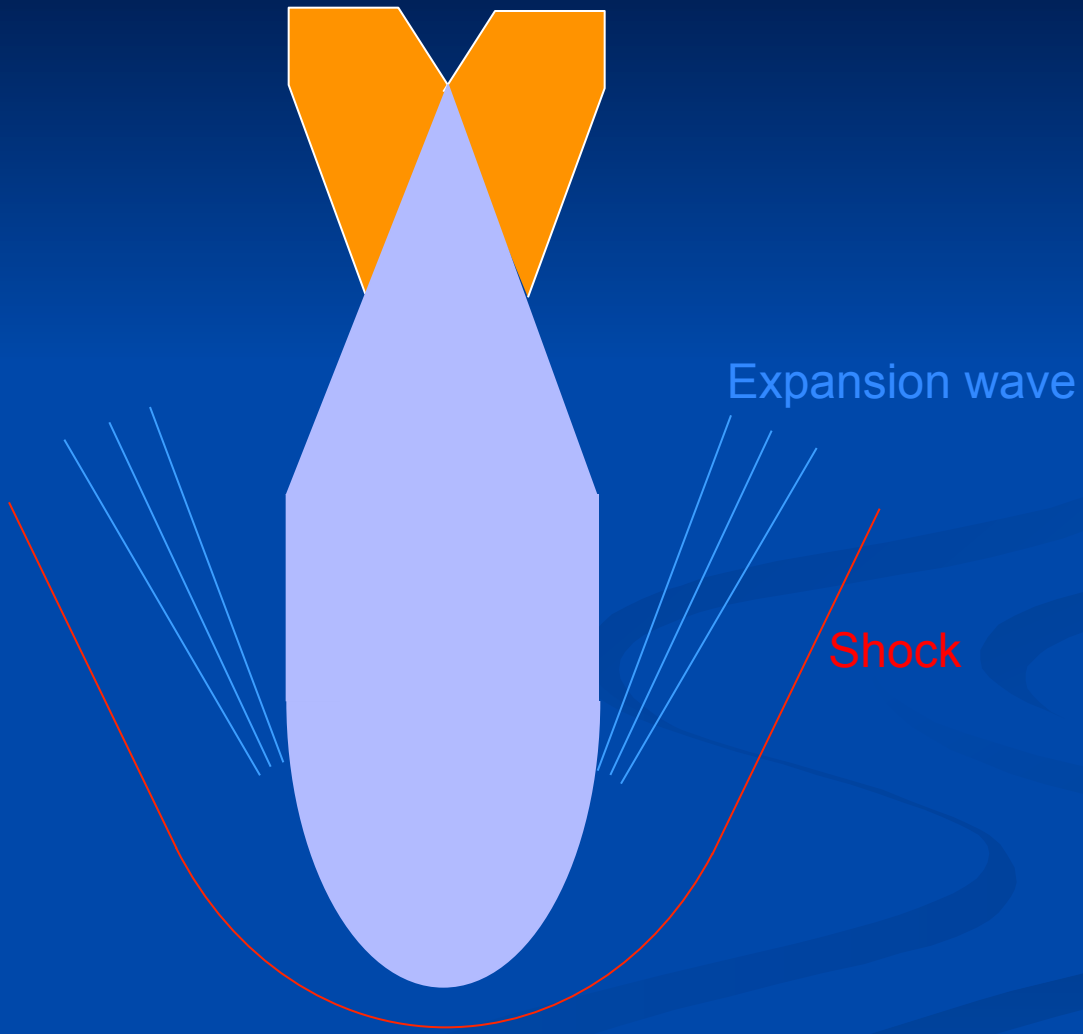

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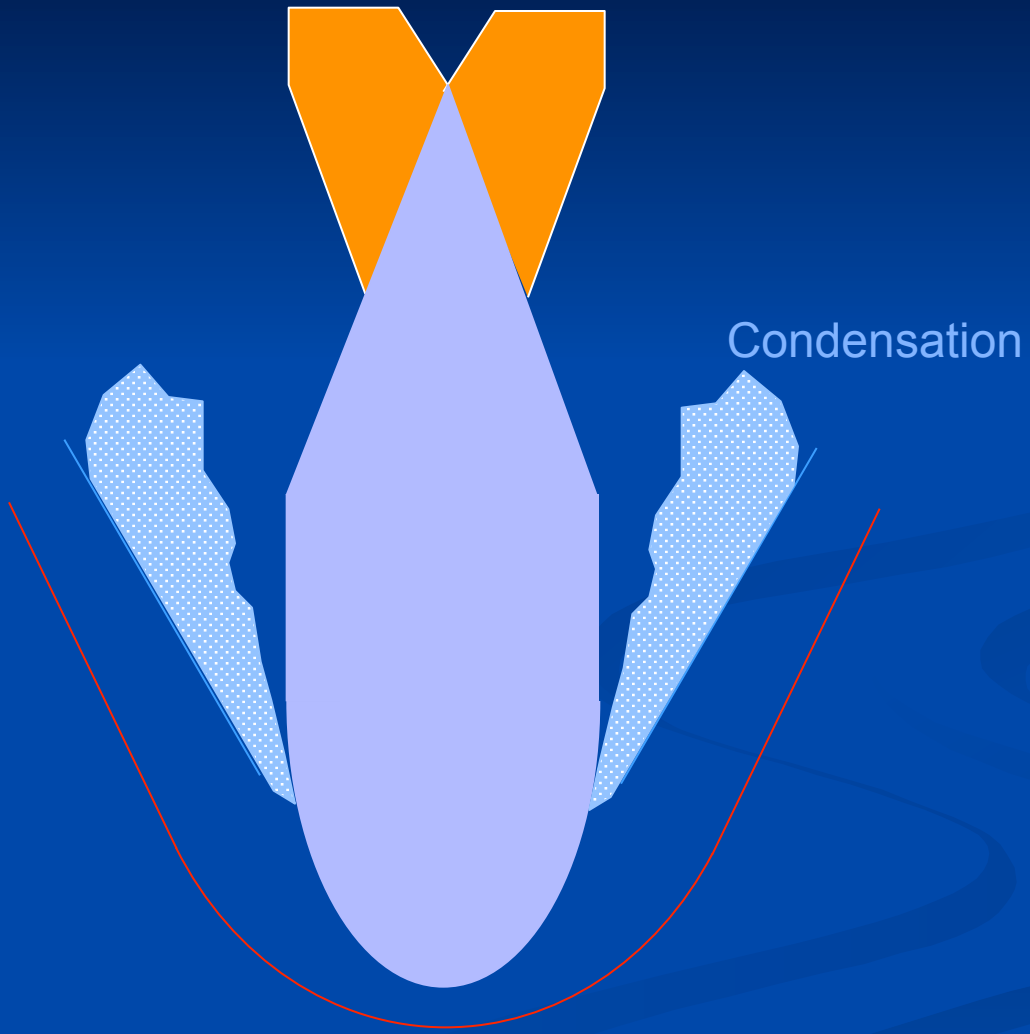

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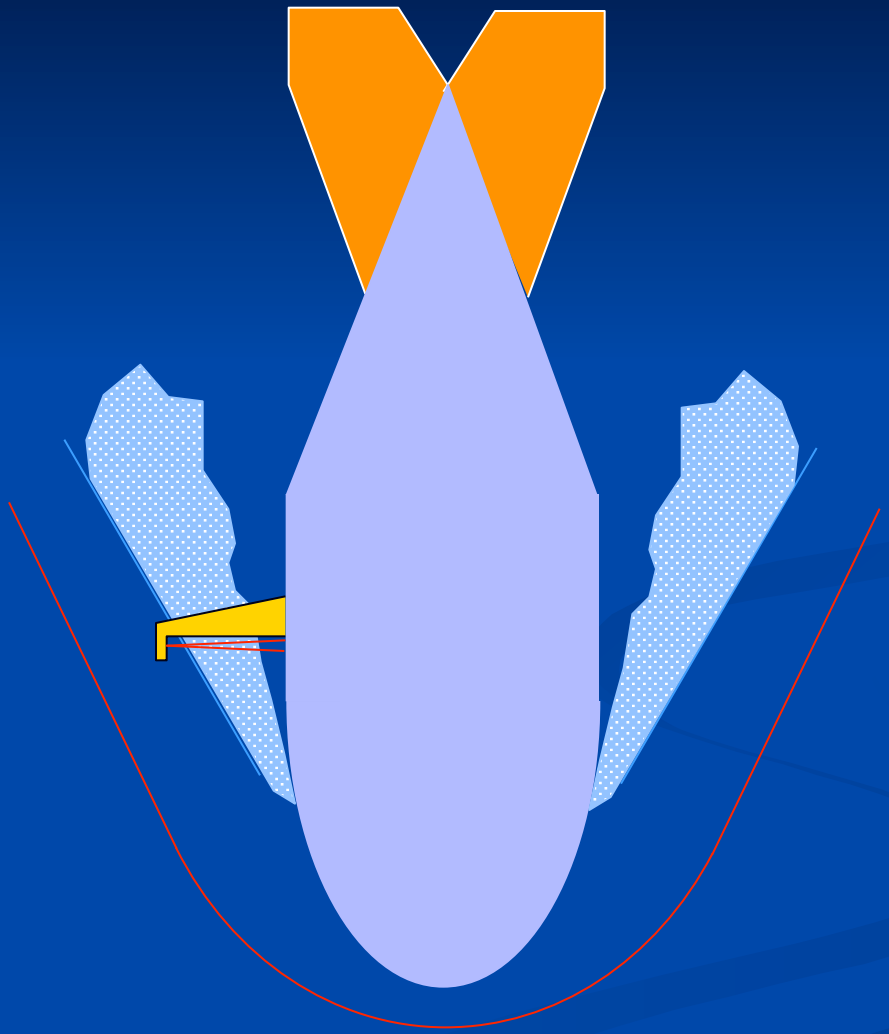

Flow-Induced Nephelometer Error

- Instruments can be fooled!
- Not just nephelometers: thermometers, barometers -- anything looking at the gas flowing by the descent module
- When designing descent module configuration and payload mounting, *you must consider the dynamics of the airflow*!

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  - Vertical profile of water abundance at the probe entry location
    - → Deep probe, penetrating to 50-100 bar level, with NMS or TLS
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    - → *Two* probes, each with ASI and nephelometer *(et al.)*
  - Vertical profile of water abundance at the probe entry location
    - → Deep probe, penetrating to 50-100 bar level, with NMS or TLS
  - Precision isotope measurements for light elements in simple molecules
    - Elements such as N, O, & S
    - → Carefully designed TLS or very high-performance NMS

Omits measurements of diagnostic species such as CO, PH_3, AsH_3, SiH_4, GeH_4

Uranus Entry Probe Science Objectives and Instrumentation Options

- "Medium Priority Science Objectives"
  - Determine the noble gas abundances and isotopic ratios of H, C, N, and O *(and their isotopes!)*
  - Measure atmospheric structure at the probe descent location

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- "Medium Priority Science Objectives"
  - Determine the noble gas abundances and isotopic ratios of H, C, N, and O *(and their isotopes!)*
    - → Neutral Mass Spectrometer (NMS)
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      - Low to medium mass resolution
    - → Tunable Laser Spectrometer (TLS)
      - Small number of predetermined species
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    - → Atmospheric Structure Instrument (ASI) package
      - System of thermometers, barometers, & accelerometers
      - Very lightweight, low power, low data volume

Uranus Entry Probe Science Objectives and Instrumentation Options

- "Lower Priority Science Objectives"
  - Determine the vertical profile of zonal winds
  - Determine the presence of clouds as a function of depth in the atmosphere

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Venus Entry Probe Science Objectives and Instrumentation Options

VISE

- Science Objectives
  - Understand the physics and chemistry of Venus's atmosphere, "especially the abundances of trace gases, sulfur, light stable isotopes, and noble gas isotopes"
  - Understand the properties of Venus's atmosphere down to the surface and improve our understanding of Venus's zonal cloud-level winds
  - Constrain the coupling of thermochemical, photochemical, and dynamical processes in the atmosphere and between the atmosphere and the surface
  - Look for planetary-scale evidence of past hydrologic cycles, oceans, and life and for constraints on the evolution of Venus's atmosphere

Venus Entry Probe Science Objectives and Instrumentation Options

VISE

- Measurements
  - Composition
    - → NMS and/or TLS
  - Atmospheric structure
    - → ASI
  - Winds, dynamics
    - → Doppler Wind Experiment (2 USOs)

BUT... these instruments will encounter a harsher environment than those on 10-bar-level probes at Saturn or Uranus

Venus Entry Probe Science Objectives and Instrumentation Options

VCM

- Science Objectives
  - Characterize the strong CO_2 greenhouse atmosphere
  - Characterize the nature and variability of Venus's superrotating atmospheric dynamics
  - Constrain surface/atmosphere chemical exchange in the lower atmosphere
  - Determine the origin of Venus's atmosphere
  - Search for atmospheric evidence of recent climate change

Venus Entry Probe Science Objectives and Instrumentation Options

VCM

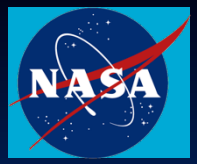
- Measurements
  - Composition
    - → NMS or TLS
  - Atmospheric structure
    - → ASI
  - Winds, dynamics
    - → Doppler Wind Experiment (2 USOs)
  - Cloud properties
    - → Capable nephelometer

Again, a harsher environment than for 10-bar-level probes at Saturn or Uranus

Results of PSDS Recommendations?

We'll see what NASA's response to the PSDS is!

We'll see what the Mid-Term Review (2016? 2017?) brings!



JPL

Questions?