INSpIRe

Investigating Near-Space Interaction Regions: Developing a Remote Observatory

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INSpIRe OBJECTIVES

1. Establish an adaptable research station

capable of contributing to many areas of terrestrial and planetary aeronomy

2. Integrate high-throughput interference spectrometers into a remotely operable configuration

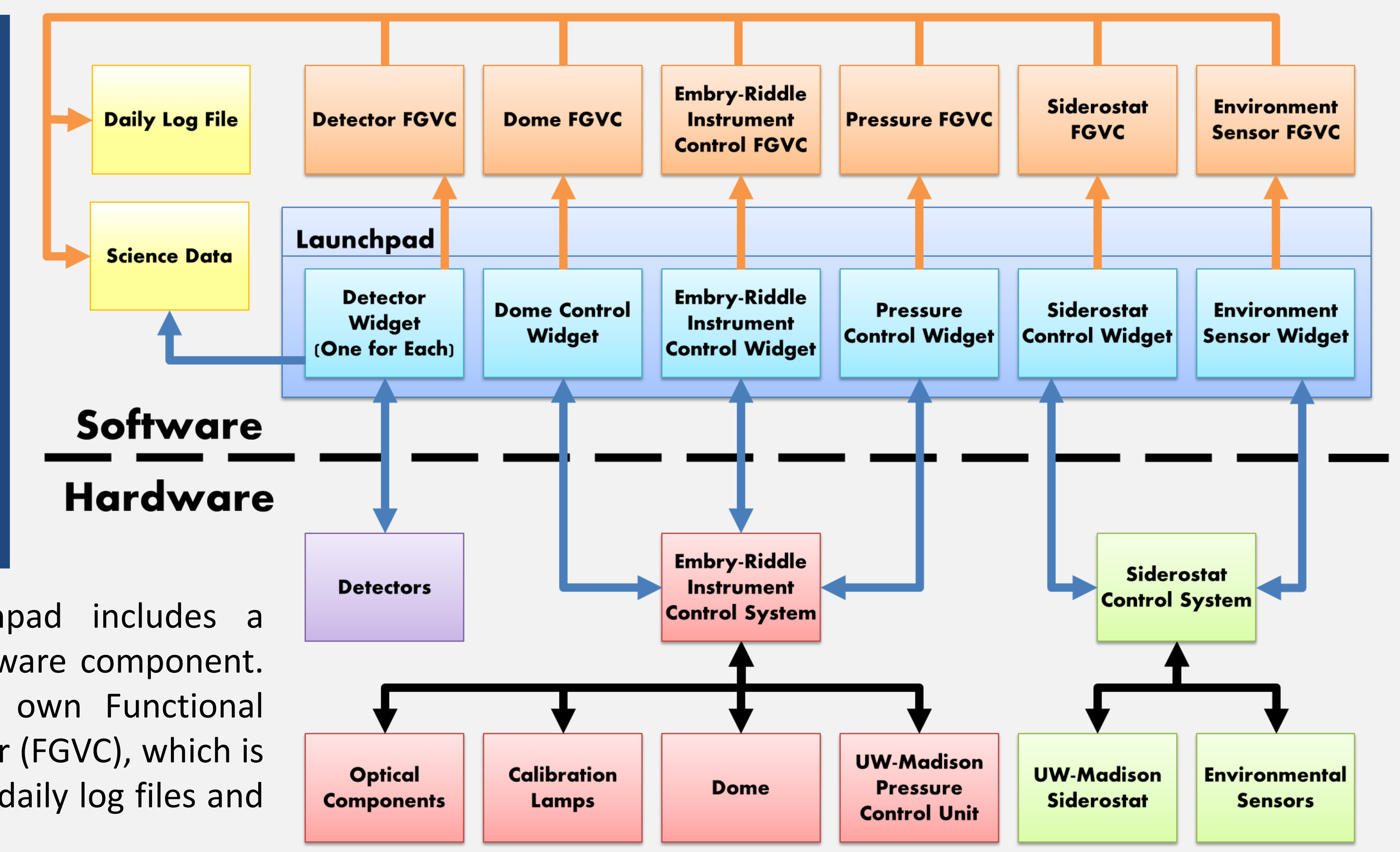
3. Deploy this instrumentation to a clear-air site,

establishing a stable, well-calibrated observing platform

4. Embark on a series of observations

specifically designed to contribute to three major areas of geocoronal research, i.e., geocoronal physics, structure/coupling, and variability

SYSTEMS BLOCK DIAGRAM



The INSpIRe Launchpad includes a widget for each hardware component. Each widget has its own Functional Global Variable Cluster (FGVC), which is used to populate the daily log files and science data headers.

INSpIRe STATUS UPDATE

Before this year, the initiative installed the dome and siderostat and started developing independent control software for several subsystems.

- **Developments in 2016 included** the install of INSpIRe's first science instrument REDDI, the addition of lightning protection, and a more cohesive graphical user interface
- **This year,** we will install the Embry-Riddle Instrument Control System, alongside many mechanical-optical components, and a Fabry-Perot spectrometer to start remote observations.

INSpIRe Control Room (Siderostat Control System, above)

CORE SCIENCE

A **limited number** of direct determinations of

Vertical Distribution

&

Vertical Transport Flux

of Atomic Hydrogen in the Upper Atmosphere

Leads to Questions

- What is the distribution of atomic hydrogen in the **thermosphere** and **exosphere**?
- How does that distribution respond to **external forcing**?
- Is the upward flux of hydrogen from the mesosphere **constant or variable**?
- What are the exospheric particle populations and velocity distributions **(satellite, ballistic and escaping components)**?

The unique capabilities of INSpIRe will provide key information to address these questions and may extend aeronomical research into planetary aeronomy.

NEW OPPORTUNITES

REDDI in its new home inside the INSpIRe instrument room.

The INSpIRe research station has capability for aeronomical research beyond the core science objectives, including day- and night-sky winds, sodium in the lunar exosphere, and diffuse galactic targets, like the interstellar medium. REDDI is using this unique observing platform to observe night-time thermospheric winds, which could be complemented by daytime thermospheric wind measurements from FP2 in the future. The two "Visiting Instrument" ports are also useful for high-throughput instruments with research goals other than geocoronal research.

ACKNOWLEDGEMENTS

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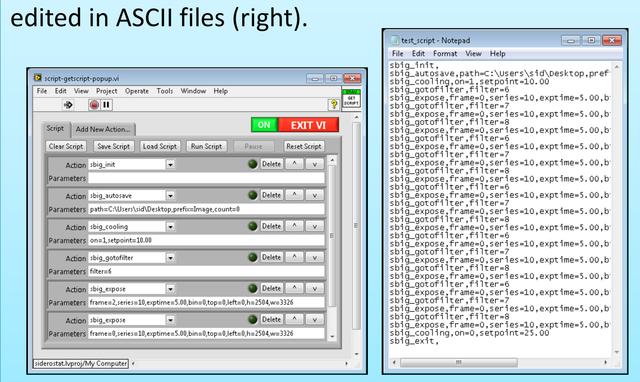
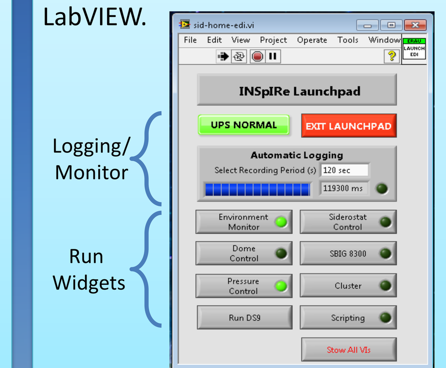
SCRIPTING

Remote users of INSpIRe may want to build re-usable scripts for completing recurring tasks, such as tuning the Fabry-Perot. The scripting widget (left) allows users to build, save, load, and run such scripts. Scripts can be edited in ASCII files (right).

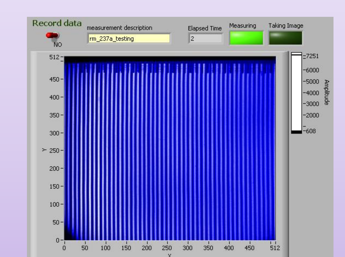


CONTROL CPU

Users may Remote Desktop into the computer and securely control the entire observatory with the INSpIRe Launchpad, written in LabVIEW.



SPATIAL HETERODYNE SPECTROMETER(S)



A REDDI fringe from a Ne Lamp.

REd-line DASH Demonstration Instrument (REDDI), using Doppler Asymmetric Spatial Heterodyne (DASH) spectroscopy, joined INSpIRe in 2016. Additionally, two Field-Widened SHSs plan to observe at the INSpIRe research station as visiting instruments at the VI-1 port under the siderostat.

REDDI

- Thermospheric wind studies
- 20 m s^{-1} wind precision, given a signal of 20 R for 5 min integrations
- Centered at 6300Å

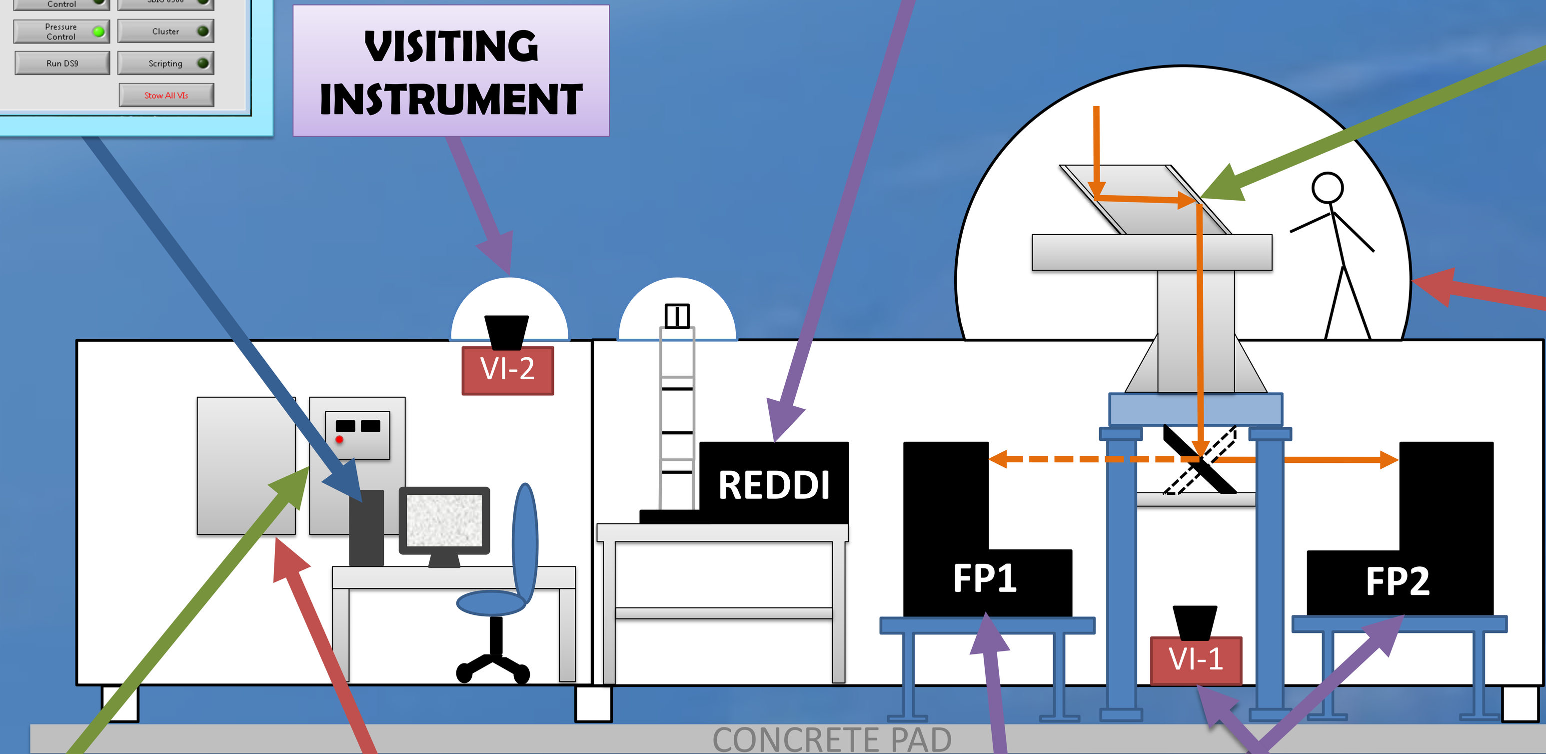
O^+ Field-Widened SHS

- Thermosphere and galactic research
- Resolving Power of 37,000
- Bandpass of 12Å centered at 3727Å

Hα Field-Widened SHS

- Geocoronal research
- Resolving Power of 67,000
- Bandpass of 12Å centered at 6563Å

VISITING INSTRUMENT

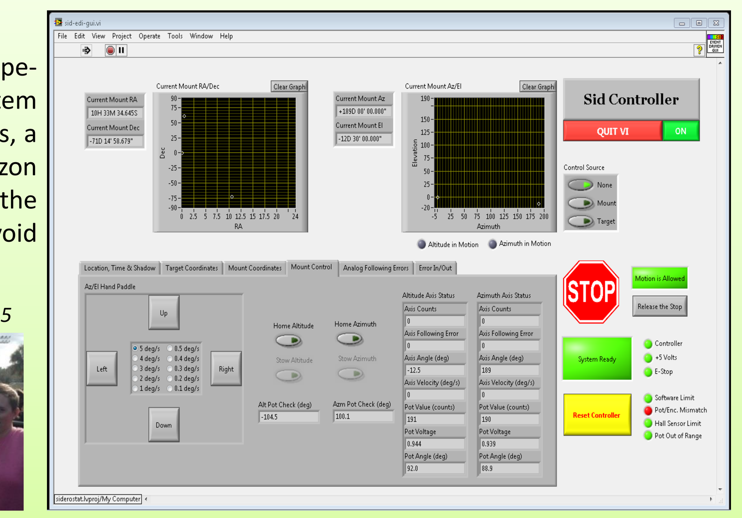


VISITING INSTRUMENT

SIDEROSTAT

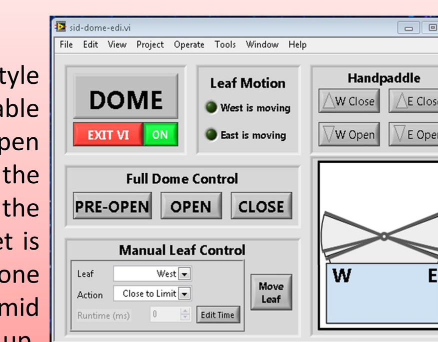
The siderostat is a periscope-like light collection system with two slanted mirrors, a 2° FOV, and horizon-to-horizon visibility. It is anchored to the concrete pad to avoid vibrations.

Jaehnig, Sid & Gallant, install 2015



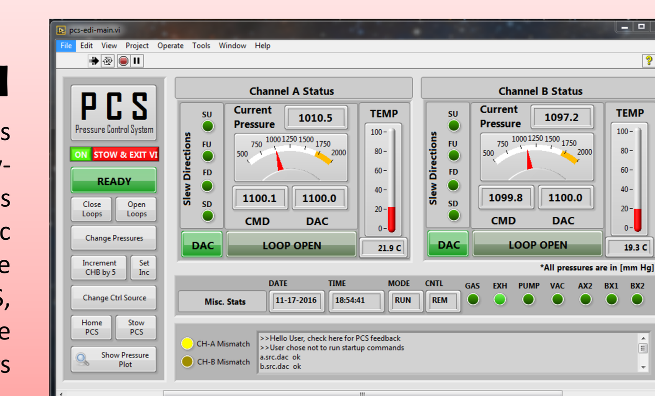
DOME

The 12-foot AstroHaven Enterprises clamshell-style dome protects the siderostat from undesirable weather. The clamshell design allows the user to open half of the dome at a time, if it is desired to block the wind or sources of light pollution on one side or the other. An extra feature of the dome control widget is the "pre-open" function. This opens the dome by one step, forcing the rubber seal to break apart in humid conditions, while letting the slack in the belts catch up.



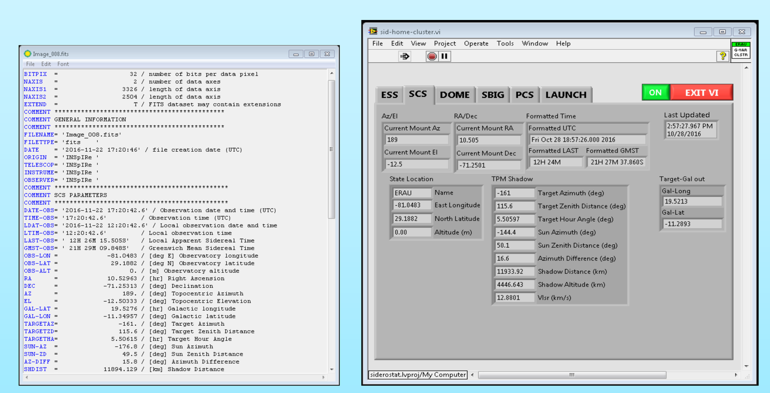
PRESSURE CONTROL SYSTEM

Our Fabry-Perot Spectrometers each use two independently-controlled pressurized gas chambers to tune to a specific wavelength. The Pressure Control System interface (PCS, right) send commands to the pressure regulator and monitors current pressure.



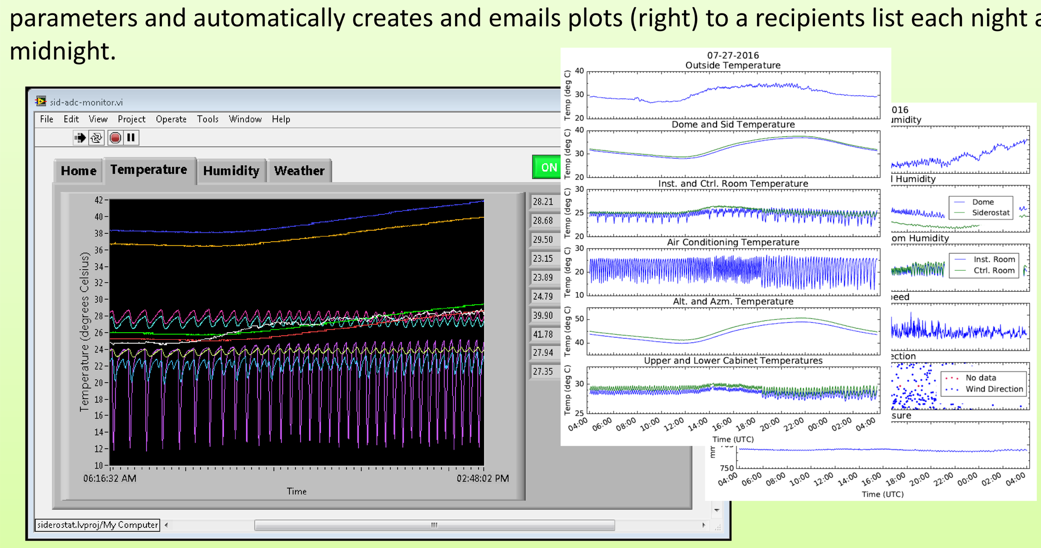
INTEGRATED MONITORING

INSpIRe has many subsystems that need monitoring. Using global variable clusters, the INSpIRe software control system can access monitoring information and populate daily logs (ESS), the Cluster widget (right), and any generated FITS file headers (left) with information from any of the subsystems that are currently running.



SIDEROSTAT CONTROL SYSTEM & ENVIRONMENTAL SENSOR SYSTEM

The Siderostat Control System (SCS) is responsible for siderostat movements and the Environmental Sensor System (ESS, left), which monitors the temperature, humidity, pressure, and weather inside and outside of the trailer. The ESS keeps a daily log of these parameters and automatically creates and emails plots (right) to a recipients list each night at midnight.



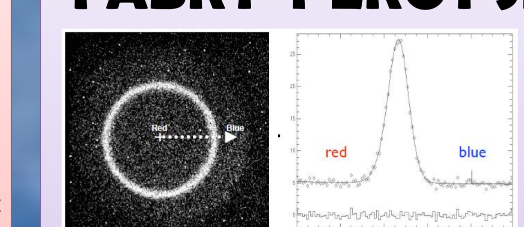
EMBRY-RIDDLE INSTRUMENT CONTROL SYSTEM

The Embry-Riddle Instrument Control System (ERICS) is responsible for routing all mechanical and optical subsystem control to the main computer.

Subsystems include

- dome operations
- calibration lamps
- filter wheels
- focusers and fold mirrors
- gas pumps and gas valves

FABRY-PEROT SPECTROMETERS



An example of annular-summing FP data. Each spectral data point (right) corresponds to an equal area annuli-bin in the ring image (left).

The main port feeds two second-generation, annular-summing Fabry-Perot (FP) Spectrometers, each well-suited for high-resolution studies of faint, diffuse targets. Both FPs sit on tables that are independent from the trailer to avoid vibrations and have at least two etalons, useful for minimizing ghosts, thus increasing free spectral range, and increasing contrast.

Fabry-Perot 1 (FP1)

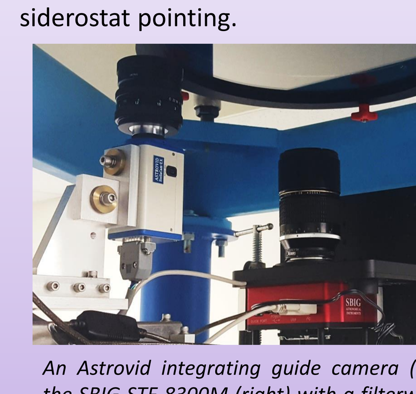
- Double etalon configuration with a tunable range of 4500Å to 10,830Å and 75 km s^{-1} spectral window
- 3.75 km s^{-1} spectral resolution
- Resolving Power of 80,000
- Bandpass of 1.2Å

Fabry-Perot 2 (FP2)

- Double and triple etalon configuration
- Resolving Power of 25,000-300,000

DETECTORS

The SBIG STF-8300M is used to develop and test a user interface (right) and FITS header population code to be ported to other detectors. We expect to use an Andor iKon-M934 as a data collection CCD. The SBIG detector will eventually be re-used as guide camera for siderostat pointing.



An Astrovid integrating guide camera (left) and the SBIG STF-8300M (right) with a filterwheel and Nikor 180mm lens, both temporarily mounted beneath the window to the siderostat.