VASAO

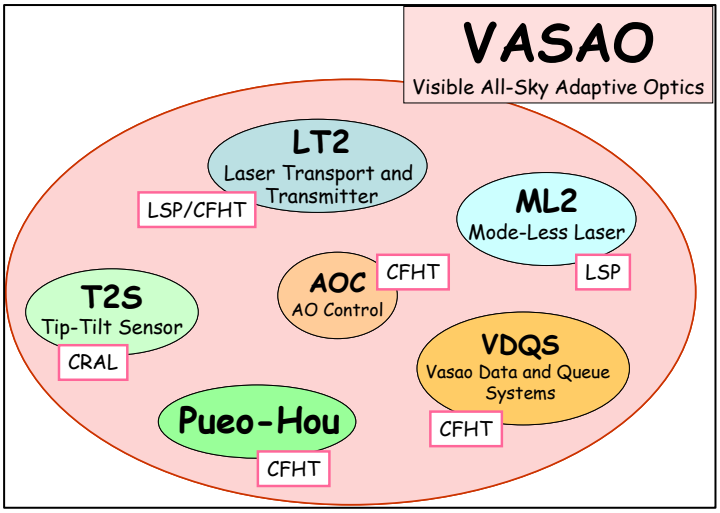
Visible All Sky Adaptive Optics

V1.0 - 10/20/2005

Building on an extensive and successful experience in Adaptive Optics (AO) and on recent developments made in its funding nations, the Canada-France-Hawaii-Telescope Corporation (CFHT) is studying the VASAO concept: an integrated AO system that would allow diffraction limited imaging of the whole sky in the visible, thanks to a polychromatic mode-less laser guide star coupled to a specially designed tip-tilt sensor used with Pueo-Hou, a refurbished and improved AO bonnette based on Pueo, the current CFHT AO system.

VASAO will open a new era in astronomical observations in the visible, providing a 100% coverage of the Mauna Kea sky at a resolution twice better than the Hubble Space Telescope and similar in the visible to what larger telescopes can obtain in the near-infrared.

Conceptually, **VASAO** is made of **four** main modules:



- **ML2**, the Mode-Less Laser, developed by LSP (*Laboratoire de Spectrométrie Physique* - Grenoble, France). ML2 will be the light source for the guide stars. Being mode-less, it will be more efficient than a single- or multi-mode laser of the same power, bringing more retro-diffused photons without saturating the Sodium layer. In the current concept, the laser is actually made of two lasers at 569nm and 589nm, opening the possibility of simultaneous laser guide stars (LGS) at 589nm and 330nm.

- **LT2**, the Laser Transport and Transmitter, is a joint development between LSP and CFHT. Through mirrors and/or hollow-core photonic crystal fibers, the laser output is projected in the pointing direction of the CFHT 3.6-m telescope through a specially designed "small" telescope, likely located at the back of the secondary mirror of the telescope, to create the laser guide star.

- **T2S**, the Tip-Tilt Sensor, is developed at CRAL (*Centre de Recherche Astronomique de Lyo*n, France). By looking at the light coming back from the laser guide stars at both 330nm and 589nm, T2S can retrieve the tip-tilt of the wave front, thus avoiding the need for a natural guide star that current LSG systems have to face. Looking at tiny relative angular distances between the two guide stars, T2S is very sensitive to vibrations and much care has to be paid to avoid most of them and monitor those which can't be removed.

- **Pueo-Hou** (the new Pueo), at the core of VASAO, is built on Pueo, the current CFHT AO bonnette: One of the first AO systems on a 4-m class telescope, and one of the most successful, thanks to its ease of use and robustness and to the Mauna Kea image quality. Pueo will be refurbished and improved to be able to image the isoplanetic field at 700 nm with Strehl ratios of 30% or better, making possible imaging with a resolution of 50 milli-arcseconds between 500 and 700nm, and at the limit diffraction of the telescope above.

Two modules will allow the integration of the VASAO components and of VASAO itself in CFHT's observing environment:

- **AOC**, the AO Control module, will take care of the operation of VASAO by carefully monitoring and phasing the operation of the four main components.

- **VDQS**, the VASAO Data and Queue System, will insure the smooth operation of VASAO in the Queued Service Observing (QSO) mode under which VASAO will be operated.

Pueo-Hou, AOC and VDQS will be CFHT's direct responsibility.

The feasibility of VASAO will be studied from the end of 2005 to the end of 2006. First light is anticipated in **2011/2012**. Demonstration of the **L2S** and **T2S** modules should be completed in France by the end of 2009.