



## Laser Requirements and Prospects for Gemini LGS AO program

### MCAO Conceptual Design Review Material

Prepared by: Céline d'Orgeville,  
Gemini Laser Systems Engineer



## CP multi-LGS MCAO System parameters

- MCAO
  - 3 DMs, 5 WFSs
  - 16x16 subapertures
  - 800 Hz frame rate
  - 250 to 400 photodetection events/subap.(16x16)/frame
  - 12-1 to 17-1 SNR
  - 0.05 to 0.07 arcsec tilt measurement accuracy
  - 0.08 to 0.11  $\mu\text{m}$  rms WF through servo
- LGS
  - 5 Laser Guide Stars
  - 50-W-class laser or 5x10-W-class laser



## Laser systems power & beam quality calculations

- MK LGS AO system

- (1) Simulation of 12x12 subap. Shack Hartmann WFS performances with LGS (F. Rigaut's AO modeling code) for an ideal gaussian beam at zenith
- (2) Multiply by coeff. 2 (resp. 3) to set the power requirements (resp. goal) while taking real laser beam and additional wavefront aberrations into account
- (3) Derive power requirements for different laser formats using J. Telle's "slope efficiency" numbers at zenith and 45°
- (4) Adjust for saturation



## Laser systems power & beam quality calculations

- CP multi-LGS MCAO system

- (1) Optimal estimator calculations with Brent Ellerbroek's AO modeling code, using MTF-based approach to model LGS shape and WFS measurement accuracy  
(0 and 45 degree calculations, beam quality, lenslet and CCD degradations included)
- (2) Same power requirement per LGS as the MK LGS power requirement --> 5 times as much power required



## Promising laser design approaches

- Compact and potentially reliable sources like diode-pumped solid-state lasers and fiber lasers
  - Sum-frequency solid state lasers
    - › Nd:YAG zig-zag slabs (Lincoln Lab - UoChicago & Lite Cycles...)
    - › Nd:YAG end-pumped rods (Coherent Technologies Inc. - LLNL...)
    - › Direct-coupled-pumped technology (AFRL & Lightwave Electronics)
    - › Thin disk technology (Nanolase, France - UoStuttgart, Germany...)
  - Raman laser (UoArizona...)
  - Raman fiber laser (INO, Quebec - Q-peak - IRE-POLUS Group, Germany...)
  - OPO-based technologies (EOS, Australia - SAIC)



## Gemini laser R&D program

- Gemini issued an RFP for laser R&D last January
  - R&D activities purpose is to focus on key components for operational high power lasers (risk-reduction activities)
- We are currently (May 2000) in the final phase of 2 laser R&D contract negotiations with:
  - UoChicago (plan is to refurbish Lincoln Lab's micro-macro-pulse sum-frequency laser and incorporate Lite Cycles' gain modules to demonstrate a 40 W sodium laser in early 2001—joint funding with CfAO, NSF)
  - Coherent Technologies Inc. (plan is to demonstrate a 10-W CW mode-locked 1.32  $\mu\text{m}$  laser in early 2001 and make design studies for a brassboard system)



## Gemini laser R&D program (cont'd)

- + CRDA in preparation with AFRL
  - Intent is to boost AFRL's schedule in building a 50-W class CW sum-frequency laser
  - Goal is to demonstrate a 25 W sodium laser in early 2001
- Required development schedule
  - 9 months to a year, starting this month (May 2000)
  - related to the MCAO laser systems delivery dates (June 2003)