



GNAO - an MCAO system for the Gemini North telescope

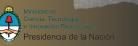
Gaetano Sivo, <u>Julia Scharwächter</u>, GNAO team, GNAO science team, Gemini AOWG









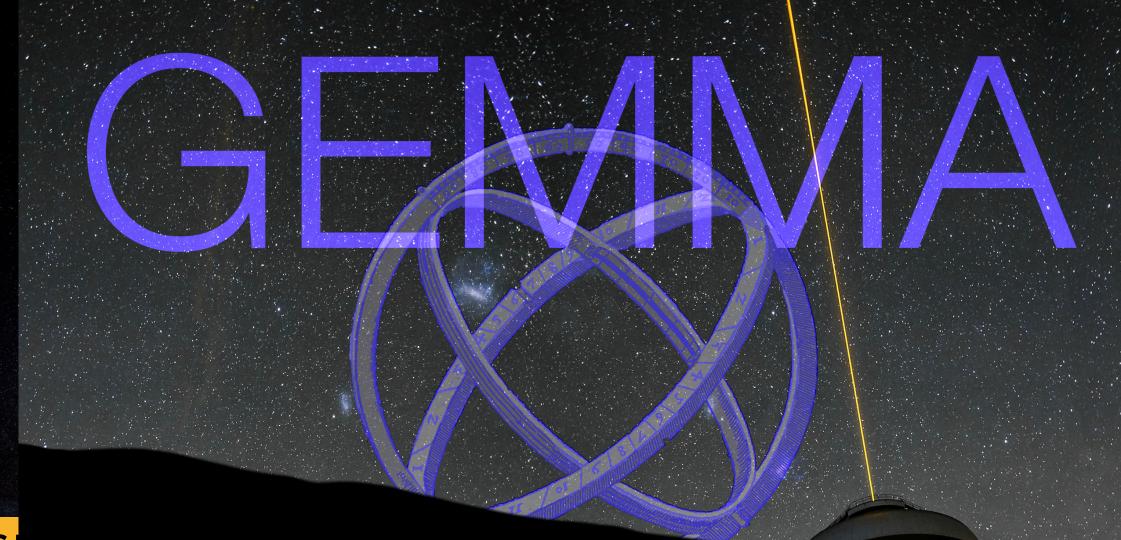






GEMMA Program







Gemini in the Era of Multi-Messenger Astronomy



GEMMA Program









Adaptive Optics

Time Domain

Outreach

More info about general GEMMA

https://www.gemini.edu/gemma/index.html















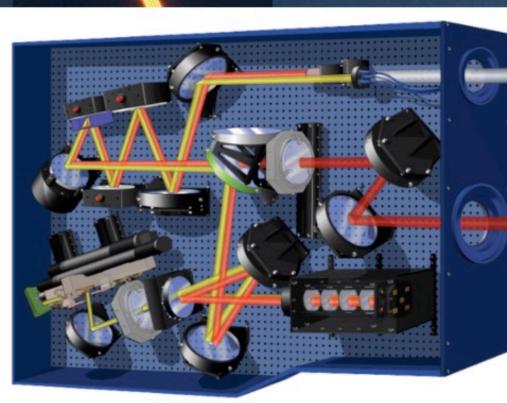
NSF's National Optical-Infrared

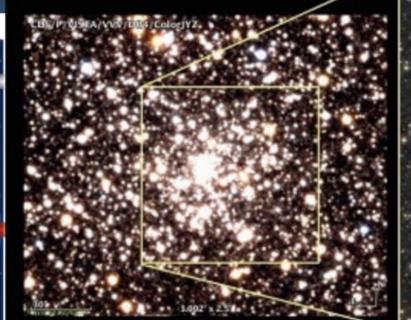


N2C.CN2C

What is GeMS ?

HP 1 - A Fossil Relic in the Galactic Bulge





VVV - VISTA (4m) FWHM~0.8", K_{tim} ~ 17 GSAOI+GeMS - Gemini-South (8m) FWHM~0.1", K_{im}~ 20





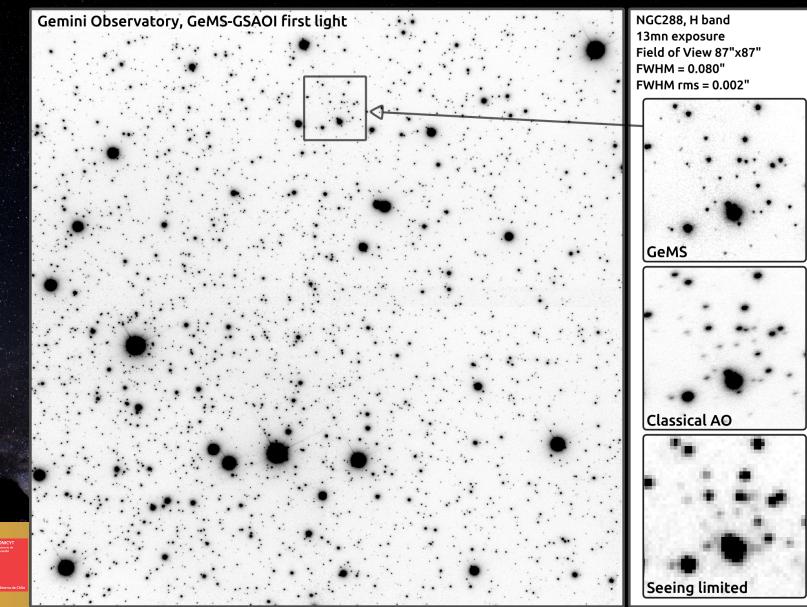
Rigaut et al., MNRAS 2014

NRC·CNRC

GEMINI OBSERVATORY

Why MCAO







Why GNAO



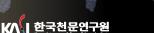
- Current Gemini-N single-conjugate AO (SCAO) system ALTAIR is aging
- SCAO limited to narrow field-ofview with AO-degradation off-axis
- Many science cases depend on wide-field AO compensation (e.g. photometry in crowded fields, accurate astrometry)











[Lawrence, Andersen et al., in prep.]

GeMS/GSAOI (K) 15" x 10"

Example: Embedded massive star clusters:

R136 in 30 Doradus



GNAO Overview

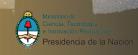


- MCAO @ Gemini North
- Designed to feed Imaging and Spectroscopic instrument
 - First light instrument GNAOI
 - Visiting instrument GIRMOS
- Needs to deliver uniform close to diffraction limit correction on 2' FoV in the NIR
- Keep open future upgrade
 - Laser GLAO using ASM













GNAO Org Chart

NRC · CNRC

GNAO Org Chart **GEMMA Executive Committee** Henry Roe (Chair) **Project Sponsor** Andy Adamson Henry Roe John Blakeslee Cathy Blough Inger Jørgensen Scot Kleinman Principal Investigator Rene Rutten Gaetano Sivo Project Scientist Scientific Julia Scharwächter **Project Manager** Adaptive Optics **GNAO** Science Team Suresh Sivanandam (Chair) Manuel Lazo Working Group Mark Ammons Julian Christou (Chair) Morten Andersen Mark Ammons Programmatic John Bally Scott Chapman John Blakeslee Mark Chun Deputy Rodrigo Carrasco Carlos Correia **Project Manager** Ruben Diaz Simone Esposito Trent Dupuy Celia Blain Thierry Fusco Anja Feldmeier-Krause Masen Lamb Wesley Fraser **Benoit Neichel** James Jee Francois Rigaut **Project Support** Hwihyun Kim Eric Steinbring Coordinator: Natalia Gonzalez Marie Lemoine-Busserolle Jean-Pierre Veran Franck Marchis Assistant: Courtney Bausman **Chris Packham** Michael Pierce Systems Engineering Team Thomas Puzia Lead: William Rambold Gaetano Sivo Co-Lead: Natalie Provost Julia Scharwächter Advisor: Manuel Lazo Chad Trujillo Paolo Turri Technical System Controller WP LGSF WP Team AOS Product Manager **RTC WP Team Manager** Manager Team Manager Celia Blain William Rambold Eduardo Marin William Rambold LGSF Team AOS Team System Controller **RTC Team** SysEng: John Bassett SysEng: Luc Boucher Sci:Paul Hirst Team Optics: Tom Schneider AO Sci: Laure Catala SysEng: William Rambold SysEng: Natalie Provost Mech: Chas Cavedoni AO Sci: M. van Dam (C) SW: Pedro Gigoux SW: Paul Hirst MechSup: Stacy Kang Opt: Emmanuel Chirre SW: Ricardo Cardenas SW: David Jenkins Elect: Stan Karewicz Opt: Cristian Moreno SW: William Rambold IT: ITS Team SW: Angelic Ebbers Opt: Andrew Rakich (C) IT: ITS Team SW: Ricardo Cardenes Mech: Brian Chinn SOS: Jesse Ball Electrical: John White IT: ITS Team SW: Angelic Ebbers SW: Pedro Gigoux SOS: Lindsay Magill Inst: John White V1.9 Dec 2, 2019 IT: ITS Team AO Sci: AO Scientist Instr: Instrumentation Engineer **Opt:** Optical Engineer **SOS:** Science Operations Specialist Electrical: Electrical Engineer IT: Information Technology RTC: Real Time Computer SW: Software Engineer HW/SW: Hardware/Software Eng Sci: Scientist SysEng: Systems Engineer Mech: Mechanical Engineer WP: Work Package Approval Line ---- Support/Advice Line





atory GNAO Main Requirements



Science field of view	2' diameter (performance spec. in 85"x85")
Wavelength	0.830 μm ≤ λ ≤ 2.5 μm
Zenith angle	50° (operational up to 60°)
K-band Strehl ratio H and J-band	>= 0.3 (with <10% variation) in median conditions >=0.14 and >=0.05
Rel. photometric accuracy	<= 2%
Rel. astrometric accuracy (3 NGS, K-band)	<= 0.2 mas
PSF uniformity/temporal stability	10% or better (excellent conditions)
Optimized on-axis correction	Enhanced on-axis Strehl for narrow-field science
AO telemetry	Storage for post-processing by science user
Non-sidereal tracking	Rates of <= 450 "/hr
Operability	Nominal queue operations, 2-person night crew
Stability	Closed loop Ops up to 1.2" seeing @0.5µm
Sky Coverage	20% with 3NGSs @ Galactic Pole 60% with 1NGS @ Galactic Pole



GNAO subsystems



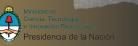
- Laser Guide Star Facility
- Adaptive Optics Subsystem
- Real Time Controller
- Control System









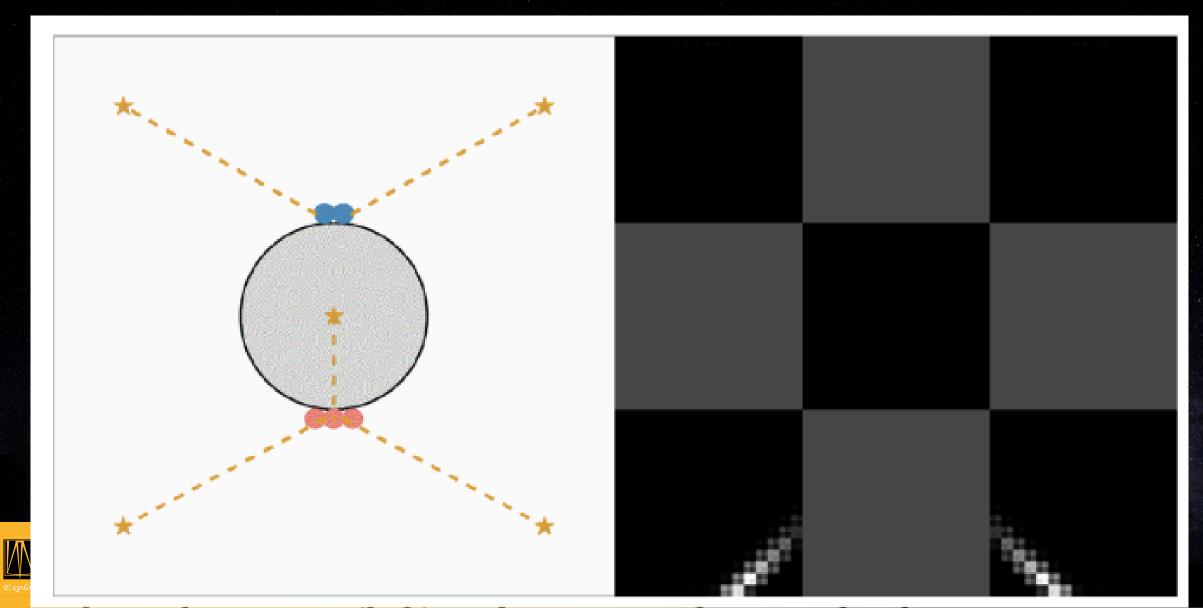






Astronomy Research Laboratory Laser Guide Star Facility

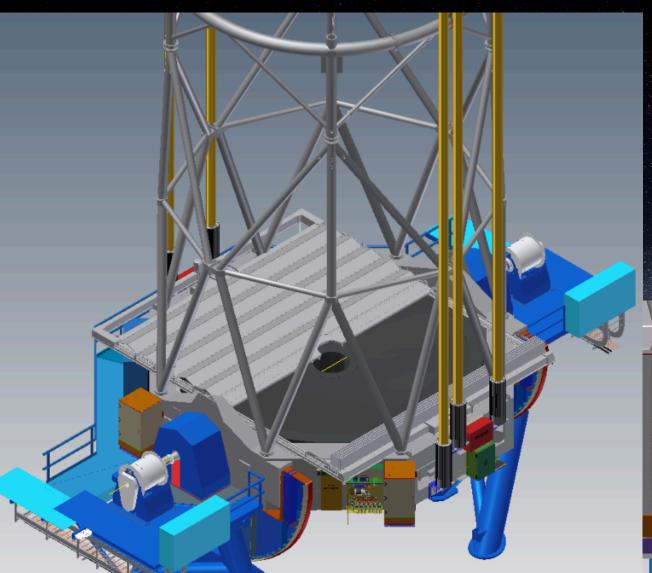






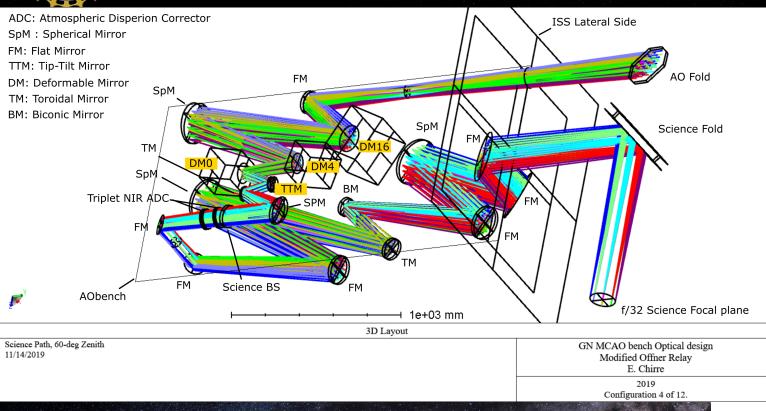
Astronomy Research Laboratory Laser Guide Star Facility







NSF's National Optical-Infrared Astronomy Research Laboratory AOO SUBSYSTEMS



 Science Path, 60-deg Zenith

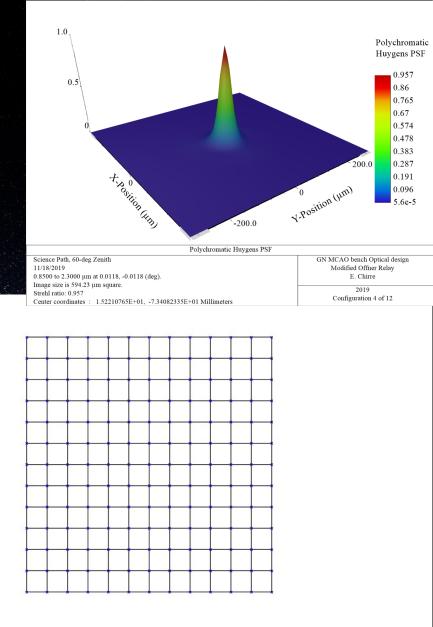
 11/14/2019

 Field: 0.0236 w 0.0236 h Degrees

 Image: 102.57 w 106.66 h Millimeters

 Maximum distortion: -0.1705% SMIA TV distortion: 0.0000%

 Scale: 1.000X, Wavelength: 1.6000 μm



GN MCAO bench Optical design Modified Offner Relay E. Chirre 2019 Configuration 4 of 12



End to End Simulations



 Monte-Carlo simulations run using YAO

open-source, general purpose AO simulation tool developed by Francois Rigaut

 Used extensively on GeMS











Big Bang Theory, Season 4 Episode 9

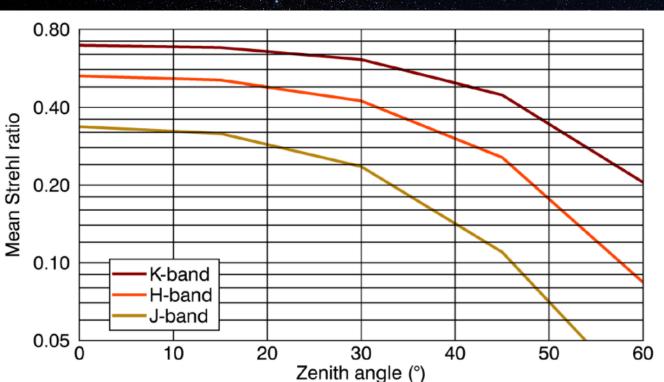
🎔 Presidencia de la Nación

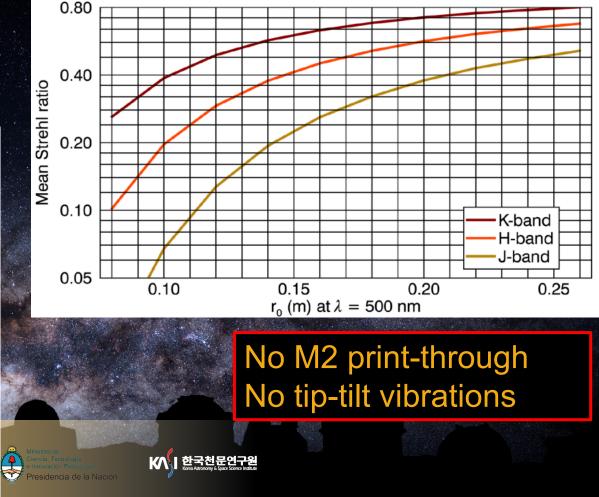


Simulations Results



bright guide stars, zenith, median seeing







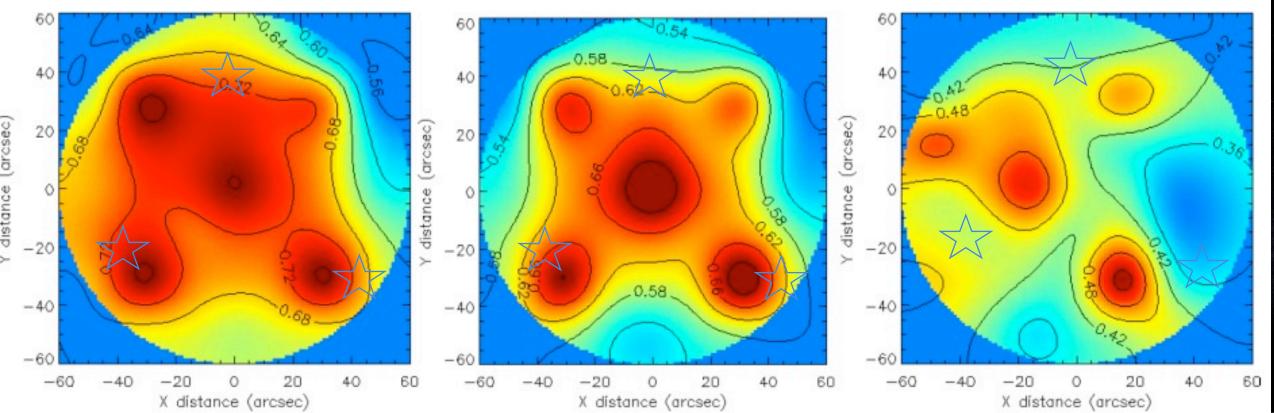
Simulations Results

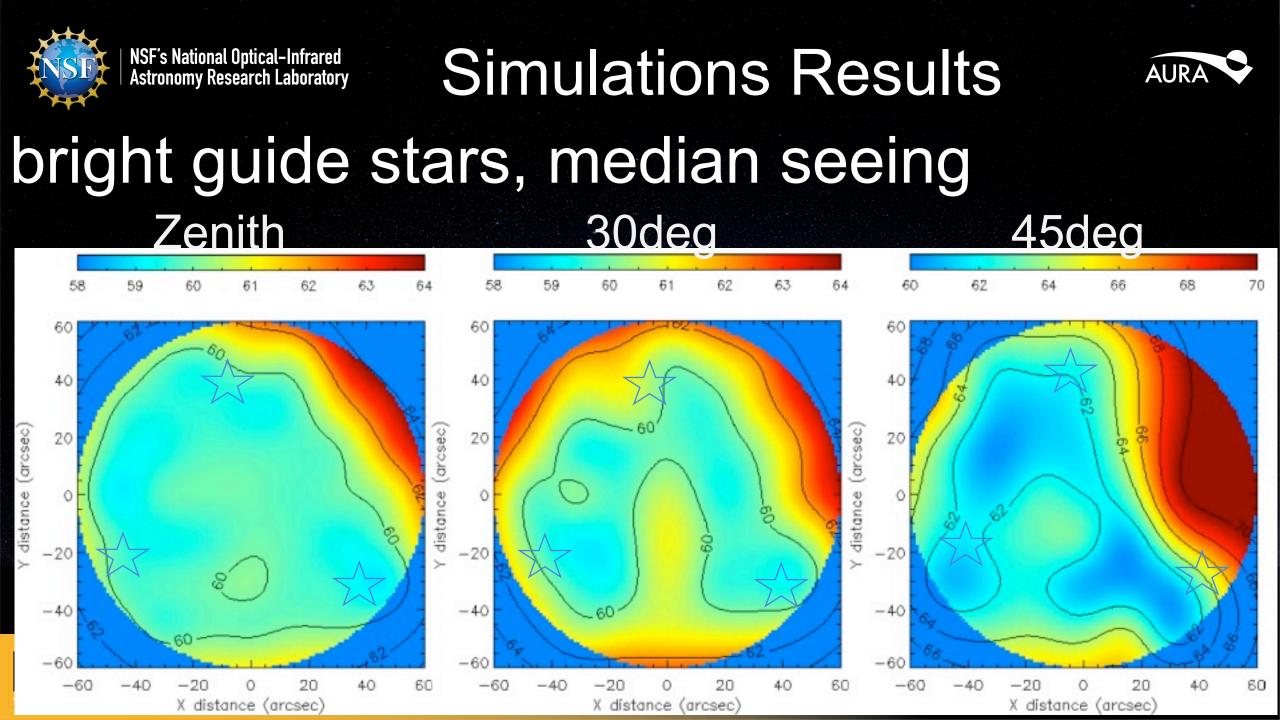


45deq

bright guide stars, median seeing Zenith <u>30deg</u>

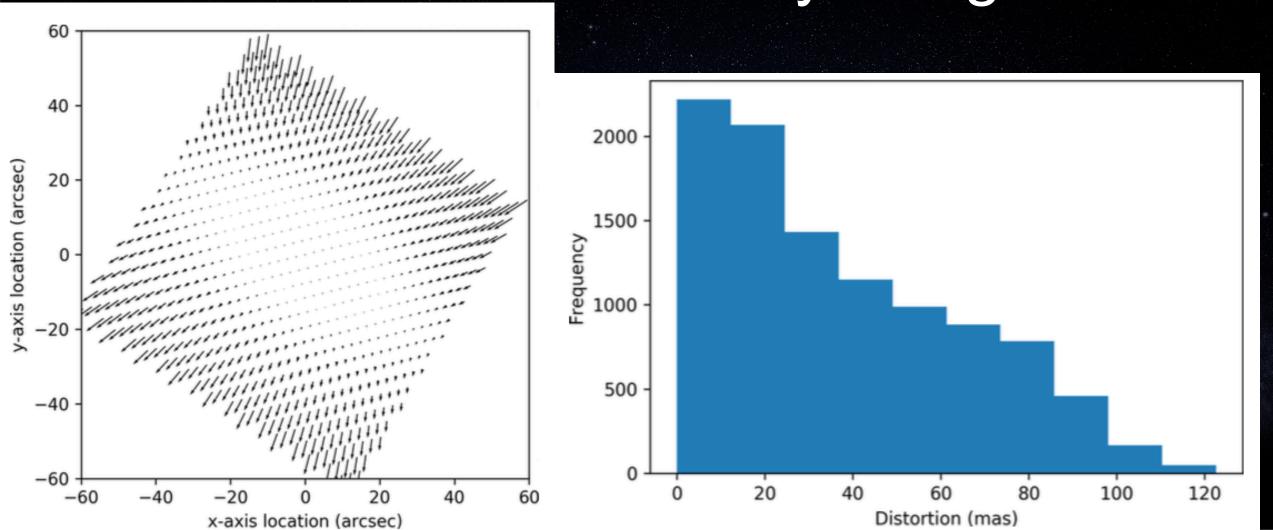








NSF's National Optical-Infrared Astronomy Research Laboratory Distortions Performance GNAO modified Offner relay design



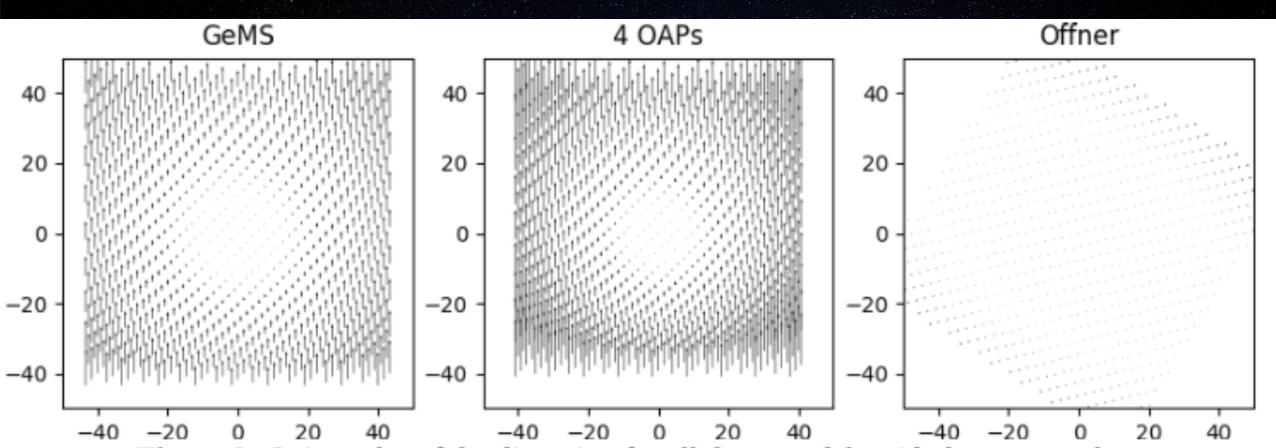
AURA



Astronomy Research Laboratory Comparison to GeNS



GNAO modified Offner relay design 10 times better than GeMS





GNAO next step



- RTC RFP out, review + selection process ongoing
- AOB RFP will be out VERY SOON, AoO already out
- GNAO passed CoDR in late September 2019
- GNAO first light for all subsystems by July 2024, full onsky commissioning after









