LGS return flux: report on the Tenerife optimization experiments and comparison with the Toptica laser results at the VLT

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The ESO 'Wendelstein' transportable laser guide star unit and receiver telescope have been installed at OT and have complete the RF campaigns in Apr 2016.

The 20W CW, 589nm laser is based on the RFA technology, also present in the Toptica laser

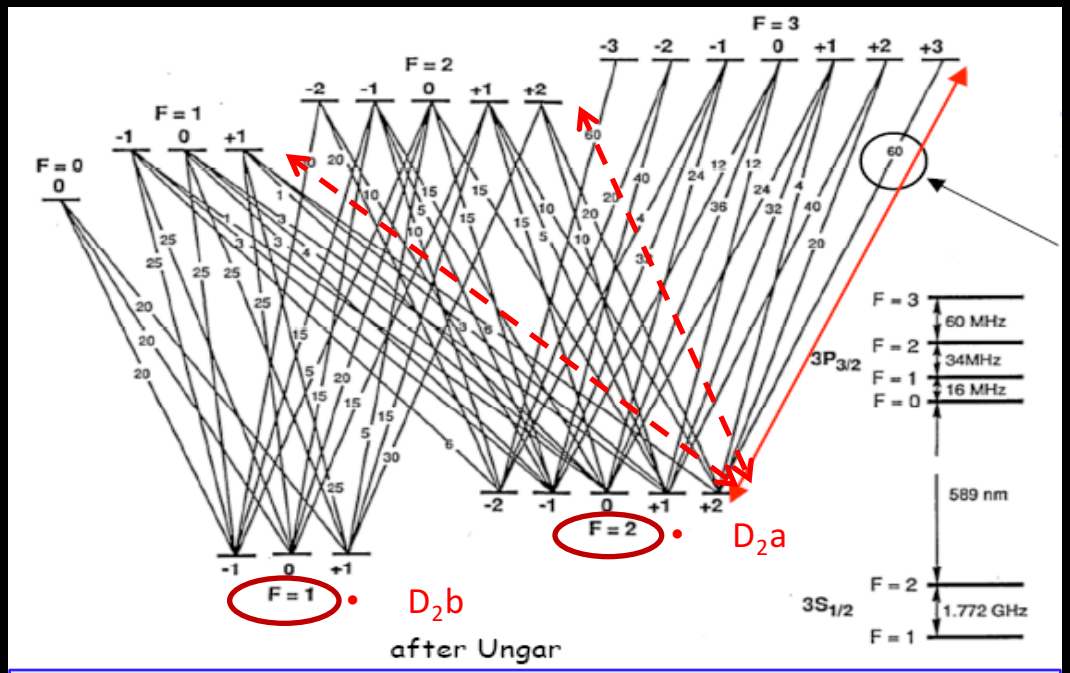
- Purpose
- Setup, HW/SW
- First operation results
- Outlook

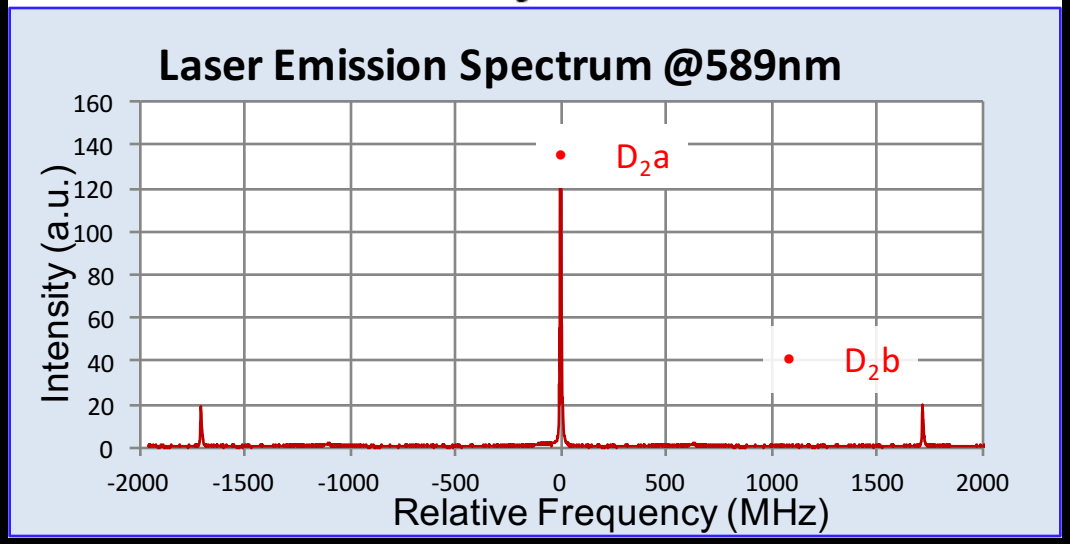
Rationale

R&D on LGS-AO technologies, toward mature LGS-AO systems for our telescopes

- Which is the best laser format for the LGS return flux ? (Holzlöhner et al. , 2010)
- Is the 22W laser meeting also the EELT LGS RF specifications ? (7.6Mph/s/m^2 at Zenith)
- Get statistically meaningful Return Flux data sets, to be taken in various seasons
- Sinergies, resources and efforts combined from different institutes (ESO, IAC, OAR, GTC)
- One week LGS photometry observations per quarter, until April 2016

Multiline laser spectrum: Repumper D_{2b} line





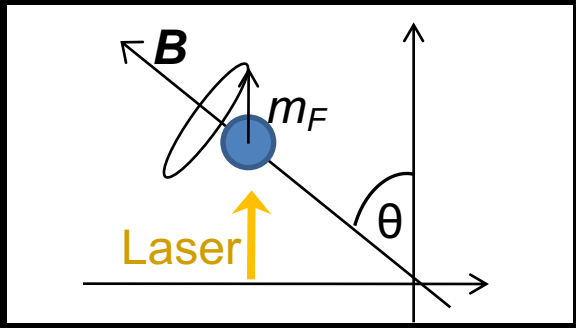
Downpumping: e^- falls at F=1: lost atom

Can be rescued to F=2 with D_{2b} phot.

The laser needs to be multi-line (1.718 GHz)

Which amplitude of D_{2b} is optimal?

Due to the Larmor precession,
does it depend on (ALT, AZ) – and how much?

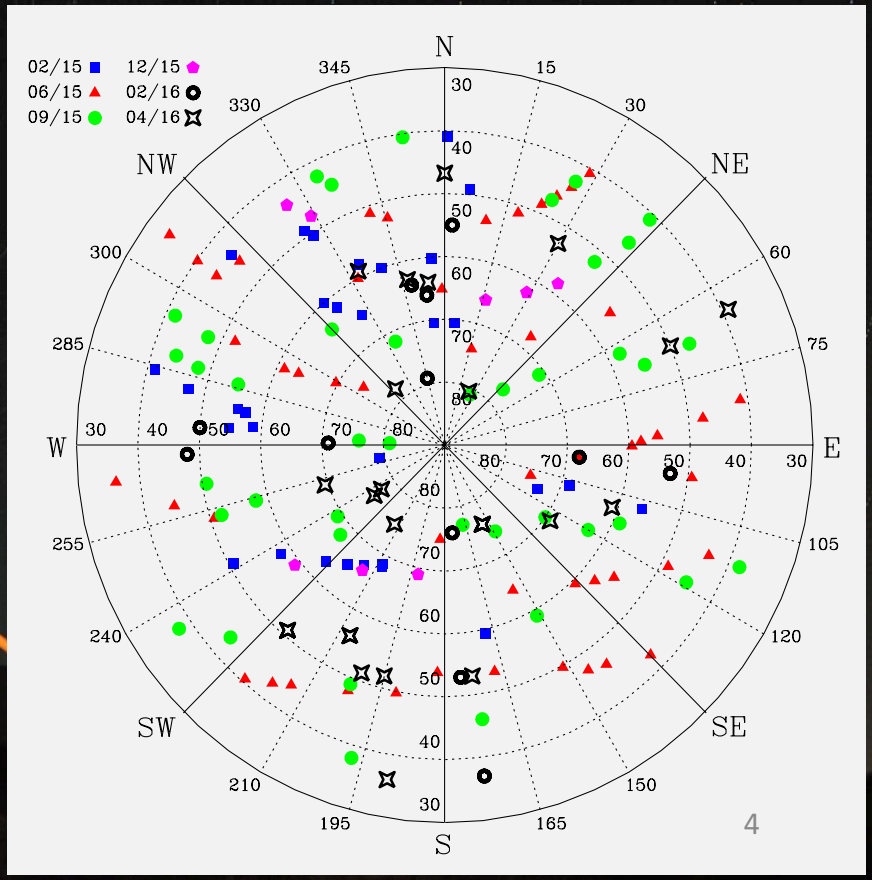


Optical Pumping: which gain ?

RF Observations - LGS Photometry

Vary laser parameters

- Linewidth (2-32 MHz)
- Polarization (lin ver,hor,+45,-45, LHC, RHC)
- D2b intensity (0-30% of D2a)
- Power at 589nm (2-20 W)
- D2b frequency (1673-1753 MHz)



Acquire LGS Photometry
Use OB observing blocks
Use Data Pipeline

Model results from Holzlöhner et al. (A&A, 2010)

Timeline OT LGS experiments:

Apr2016
Spring Obs run

Dec2015
Winter obs. run

Jun2015
Summer obs. run

Jan2015
Commissioning run

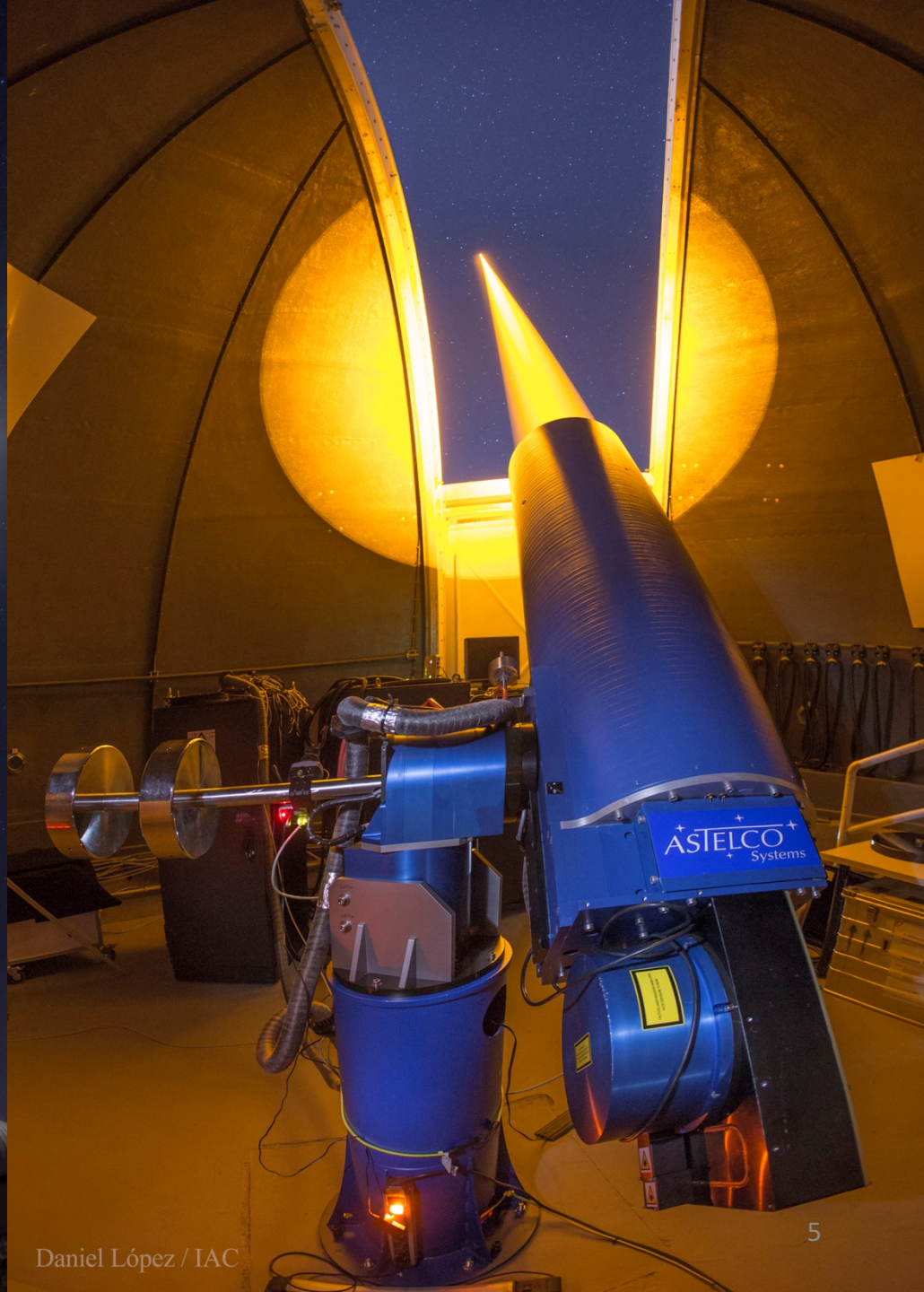
May-Dec2014
WLSU OT installation

Feb2016
Winter obs. run

Sep2015
Autumn obs. run

Feb2015
Winter obs. run

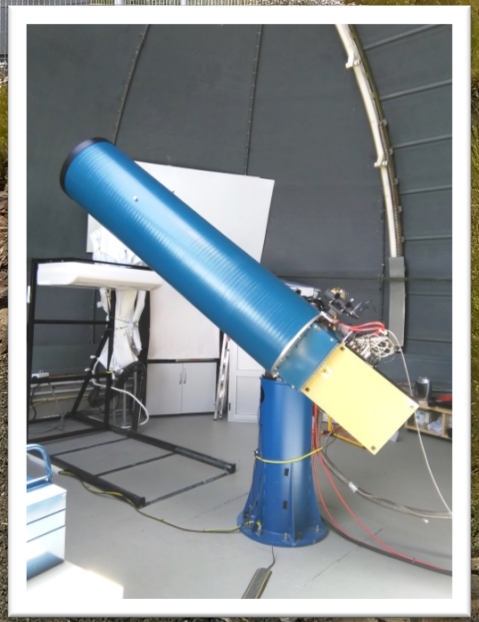
Dec2014
Rx Commiss. run

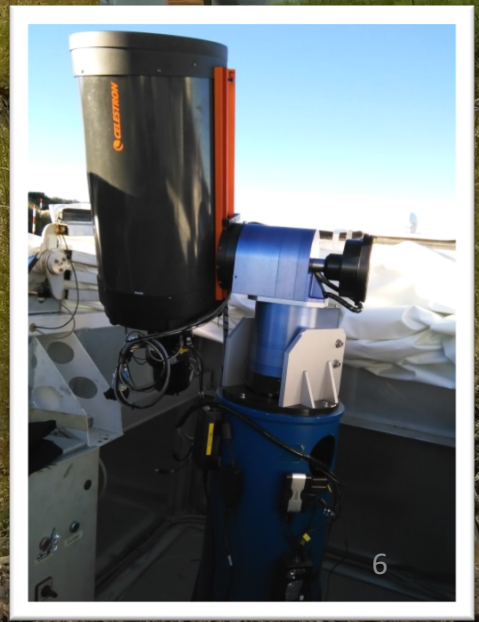


Main dome:
350mm diam. Tx telescope + laser head
Tx electronics, Rx electronics and laser cabinets
Heat pump
Transportable Clean tent

Rx dome:
400mm diam Rx telescope with focuser, derotator, CCD
Astelco dome + controller

Chiller

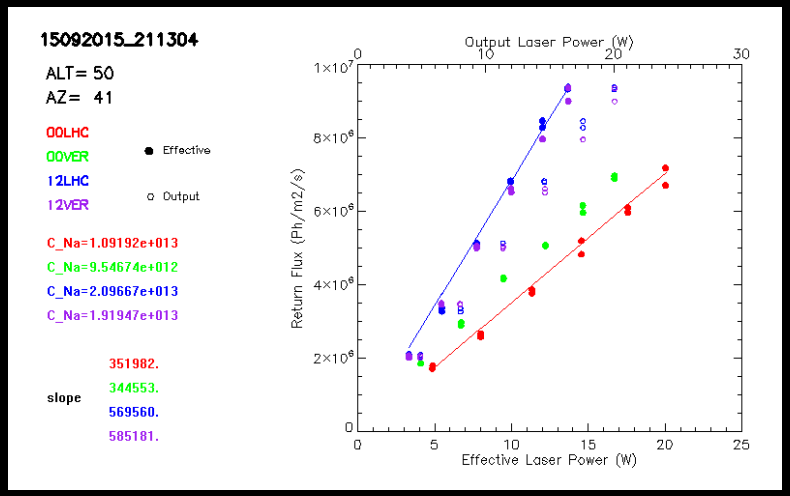


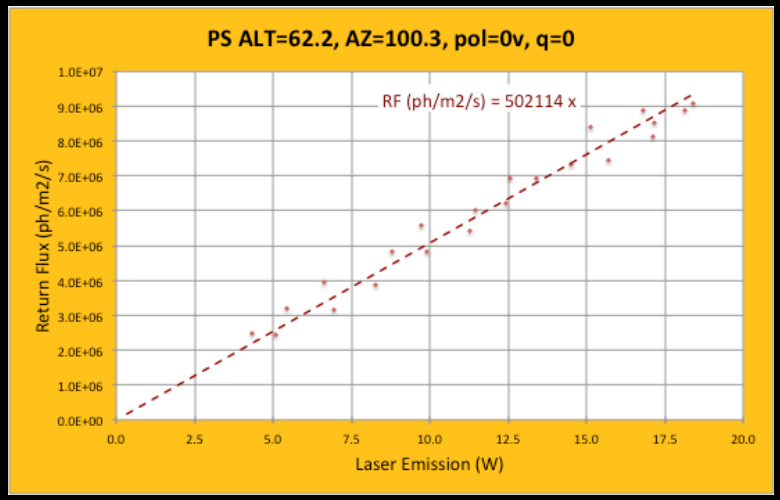


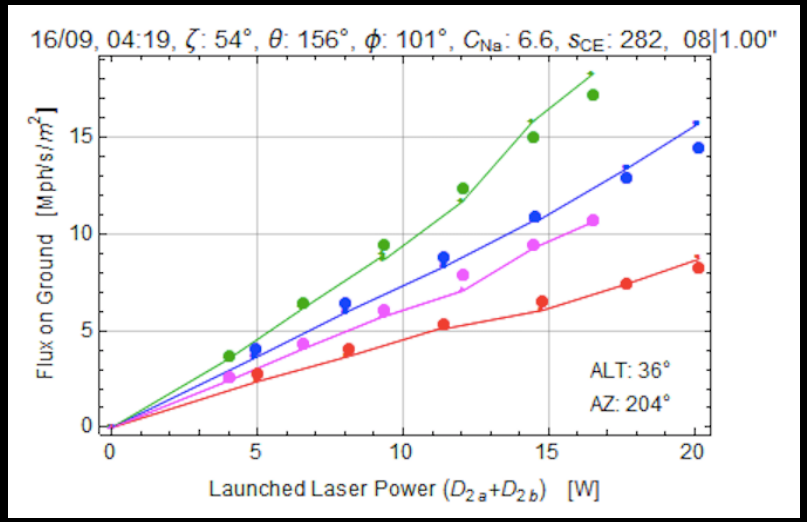
Inside the Tx Dome

Laser Launch Telescope - Apr 2016

LGS RetFlux Power Scans and C_Na

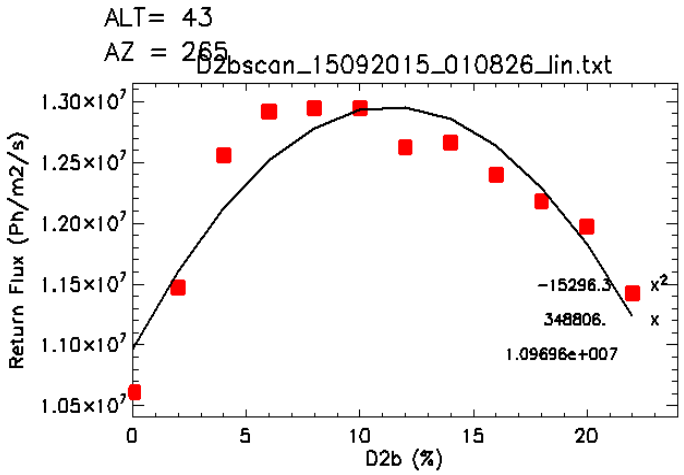


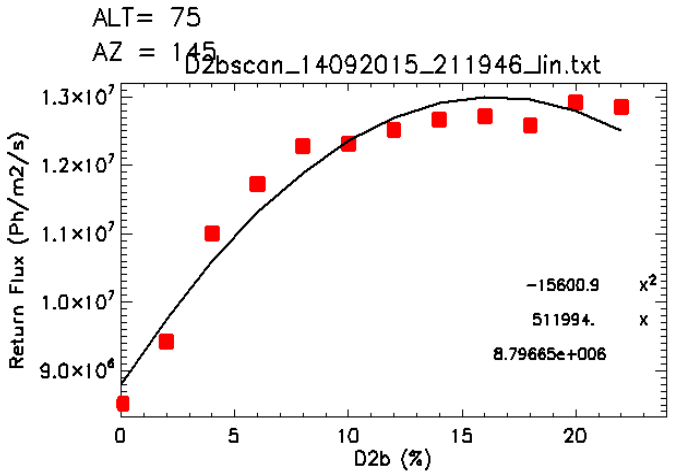


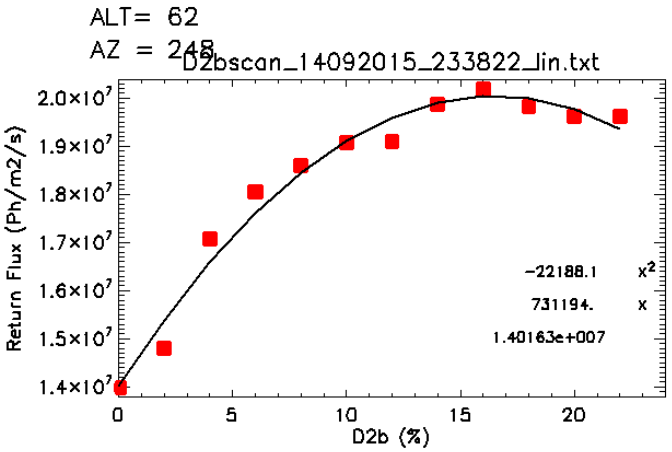


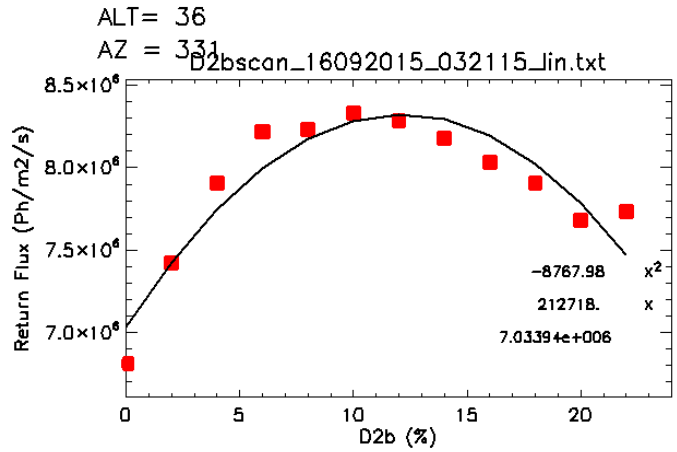
- Power Scans taken in D2b 12%,0%, LinPol, CircPol
- Ron model fitting allows to derive seeing, LGS size, C_{Na}, S_{ce}
- Wendelstein laser power ranges 2-20W

LGS RetFlux D2b Scans LinPol

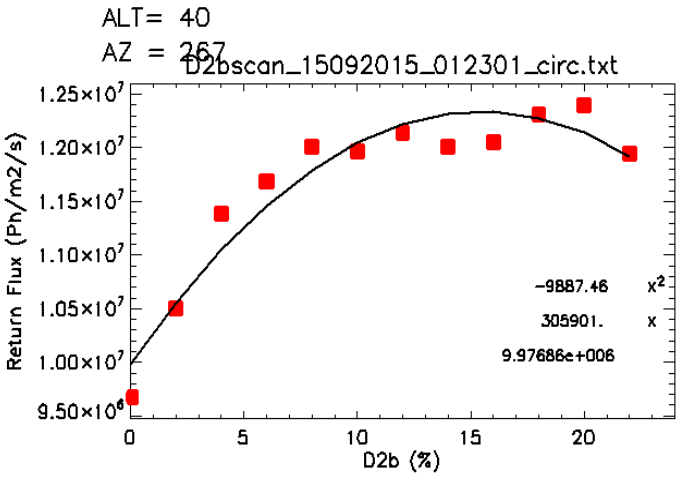


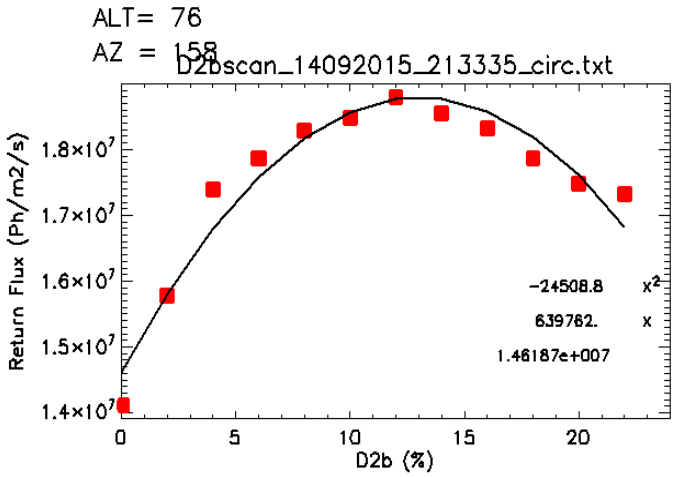


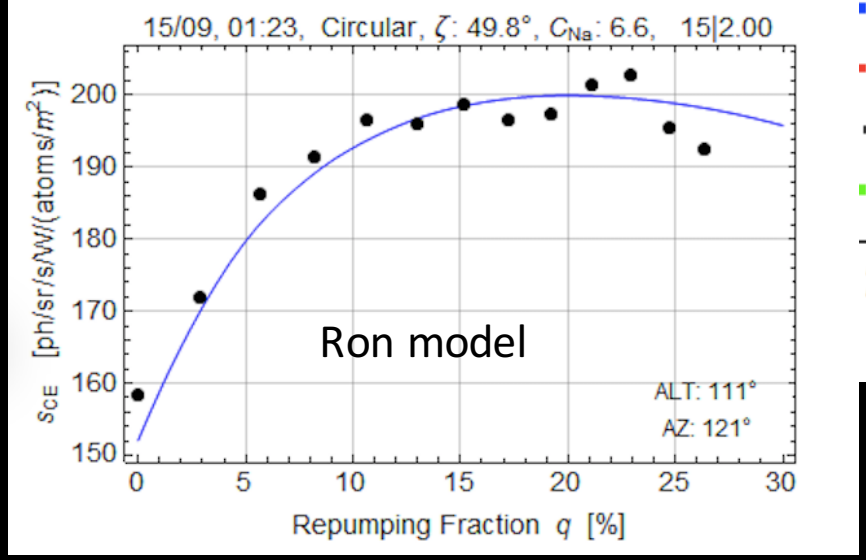


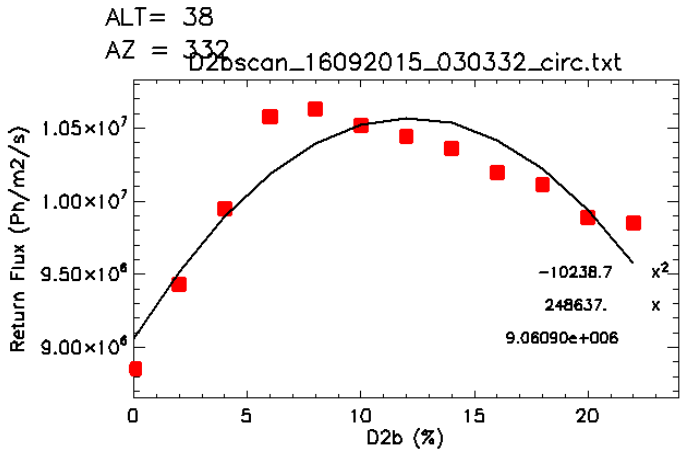


LGS RetFlux D2b Scans CircPol

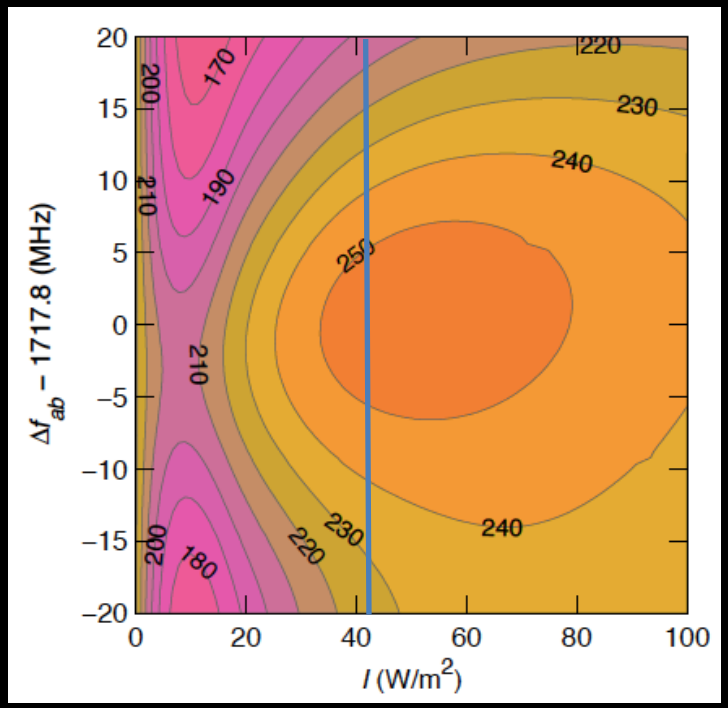




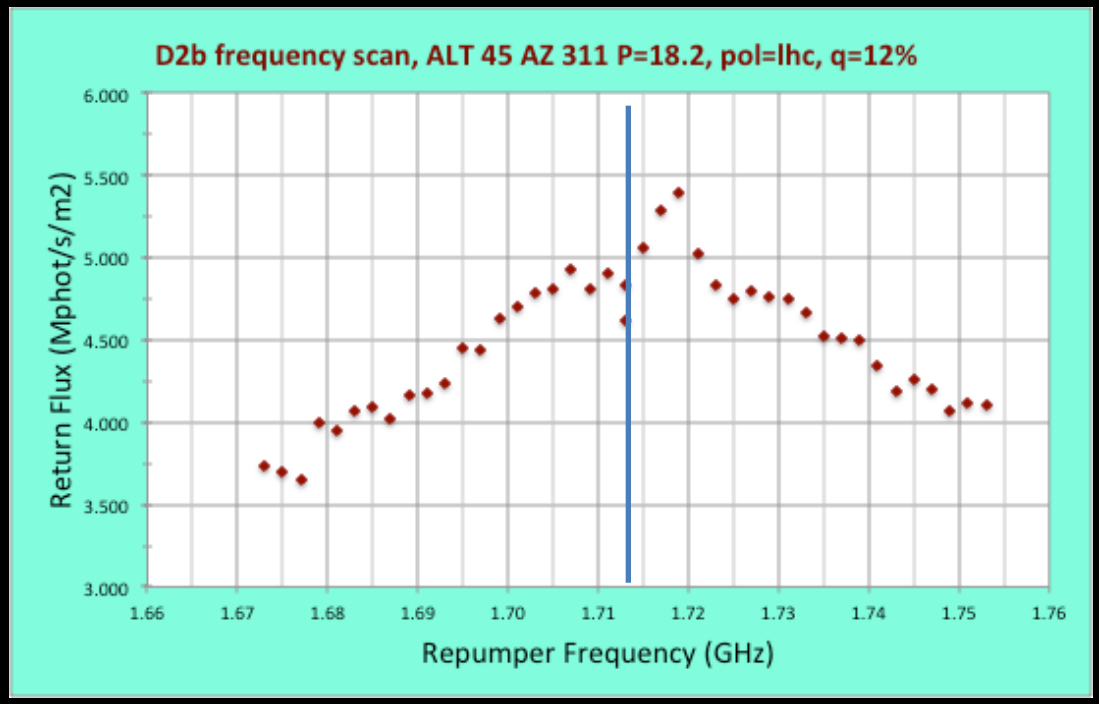




Laser Repumper Frequency

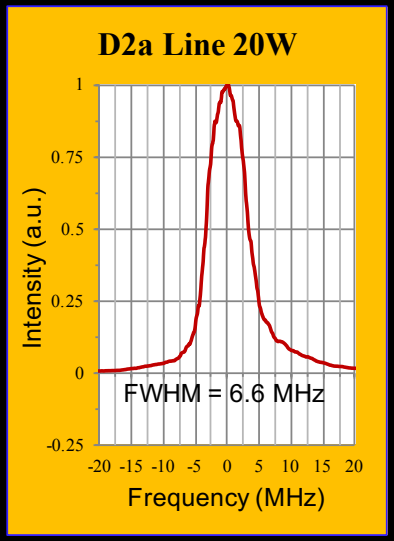


Repumper Freq Scan

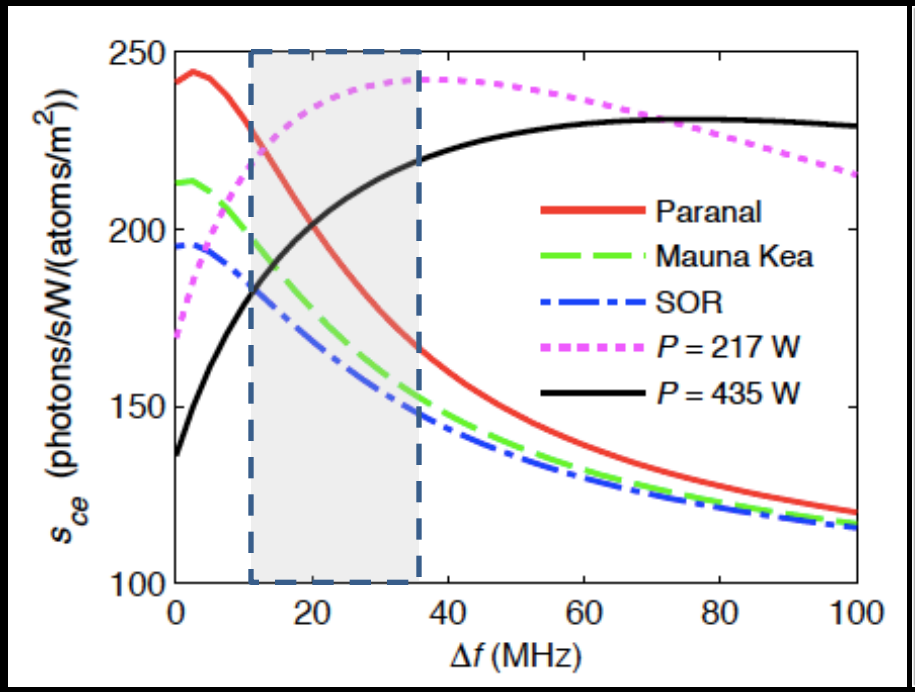


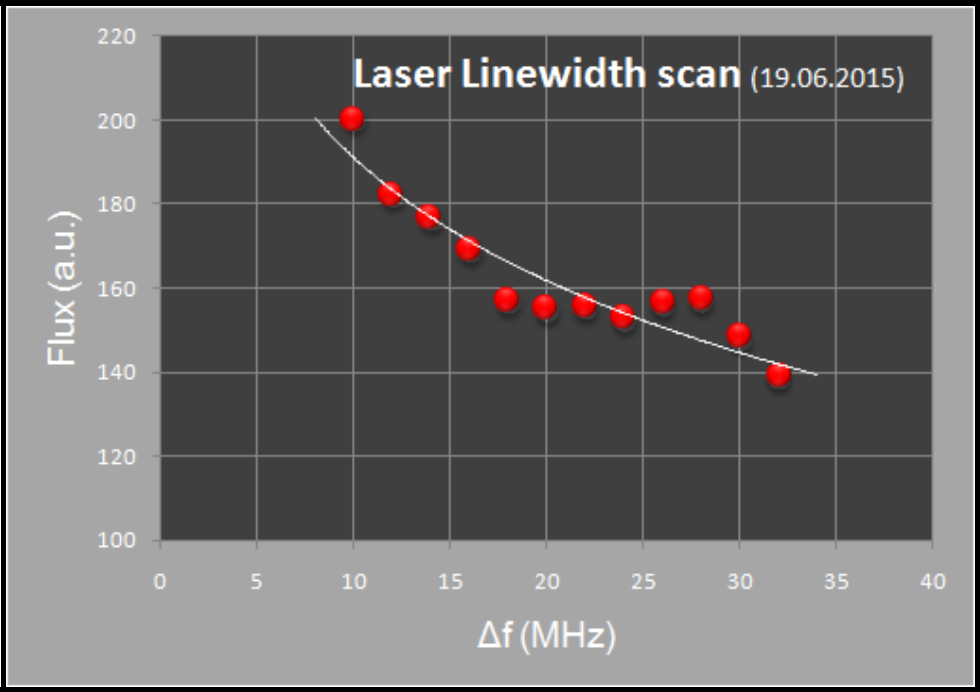
Best Frequency 1.719+/-0.002 GHz

Laser Linewidth

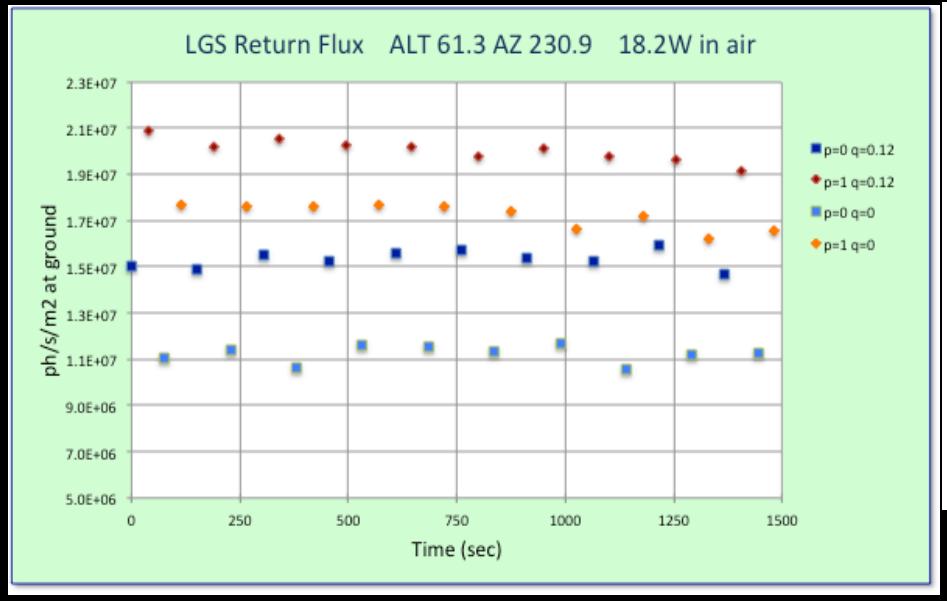


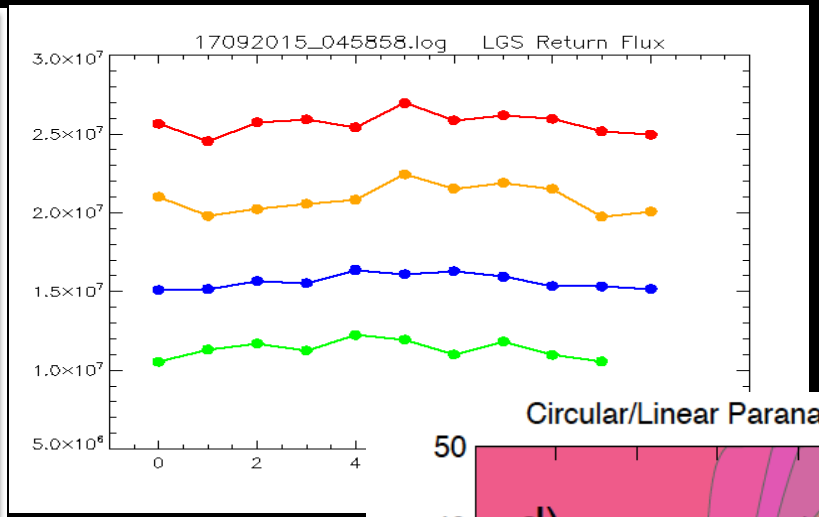
Optimal laser linewidth at few MHz (<10 MHz)





LGS RetFlux Toggles results





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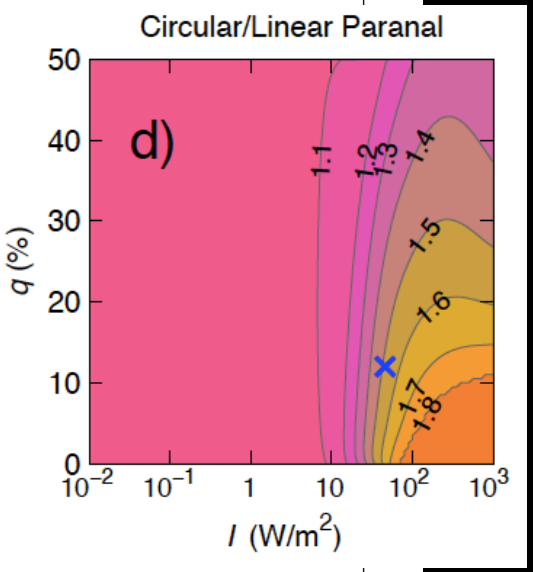
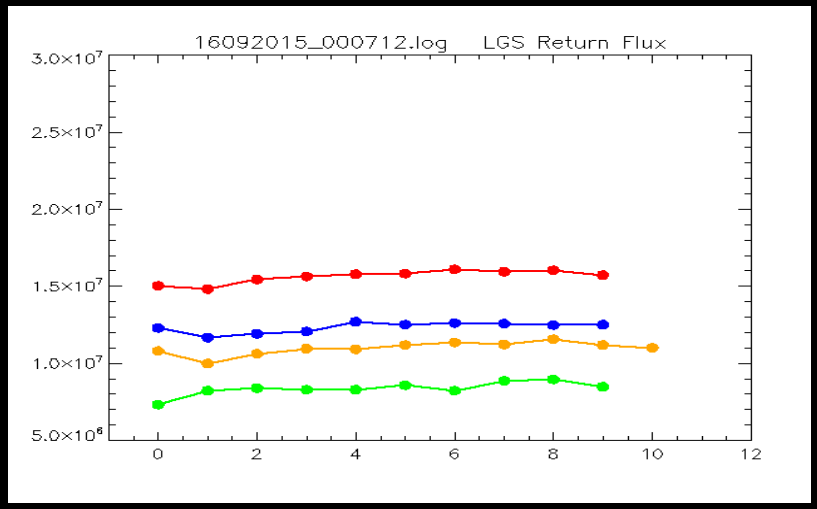
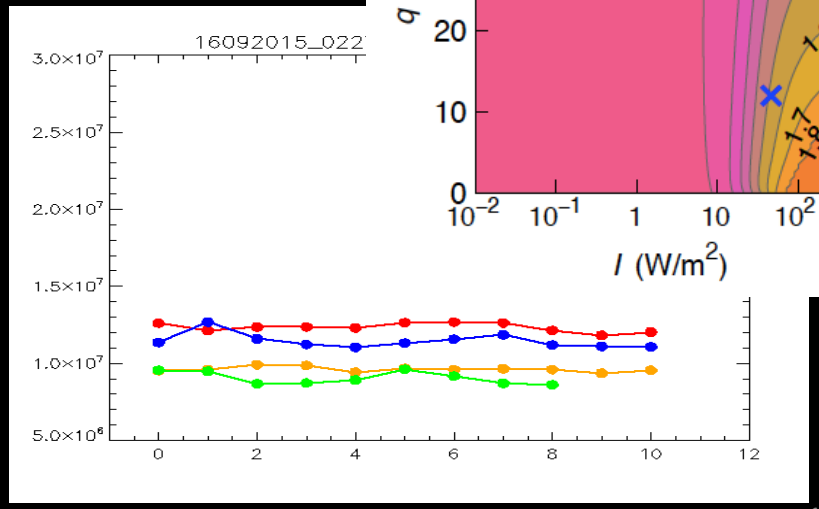
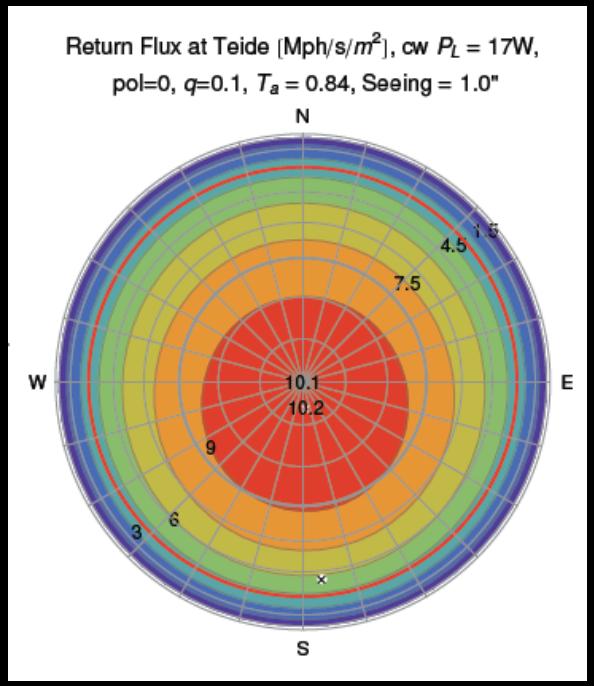
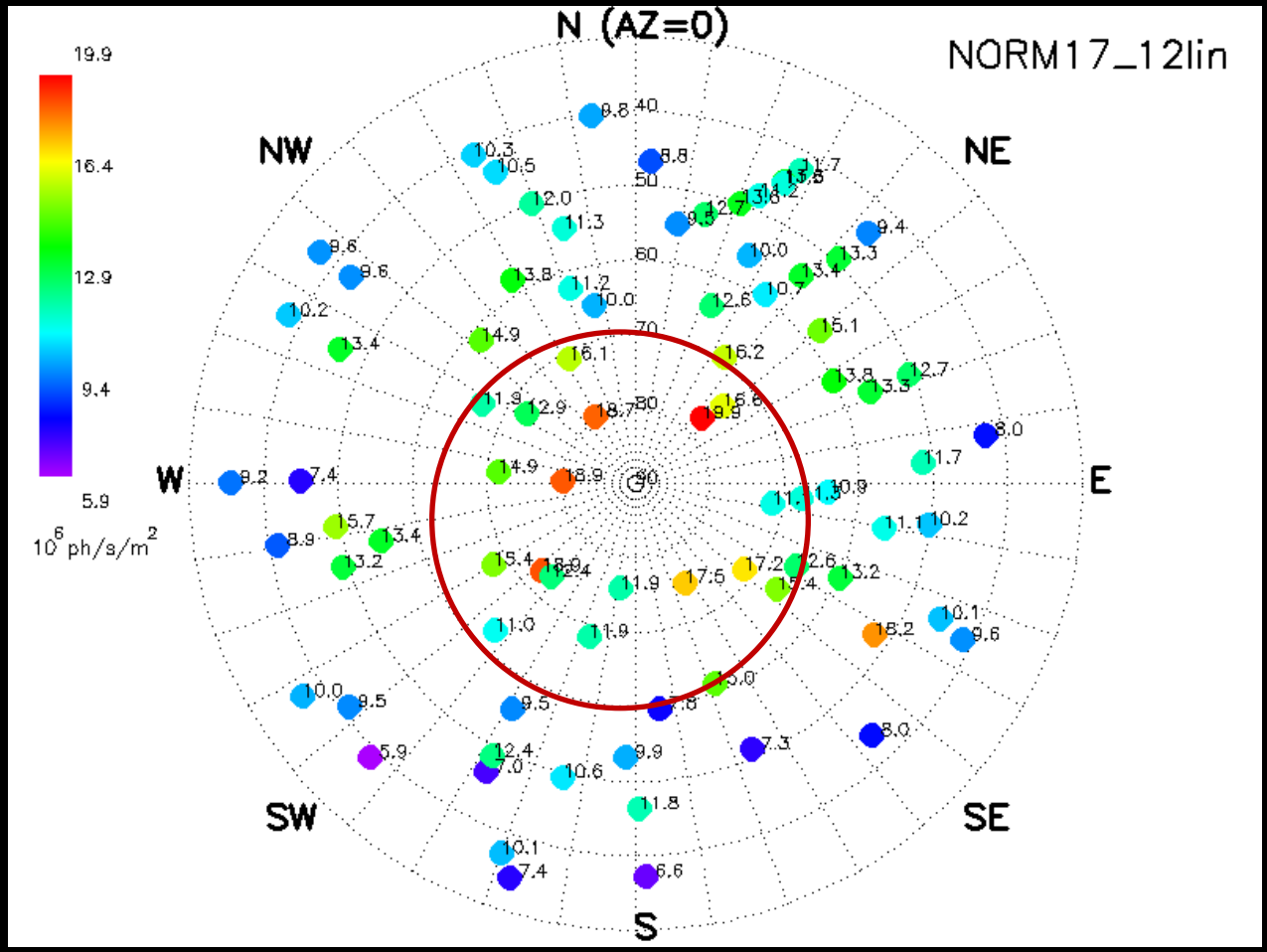






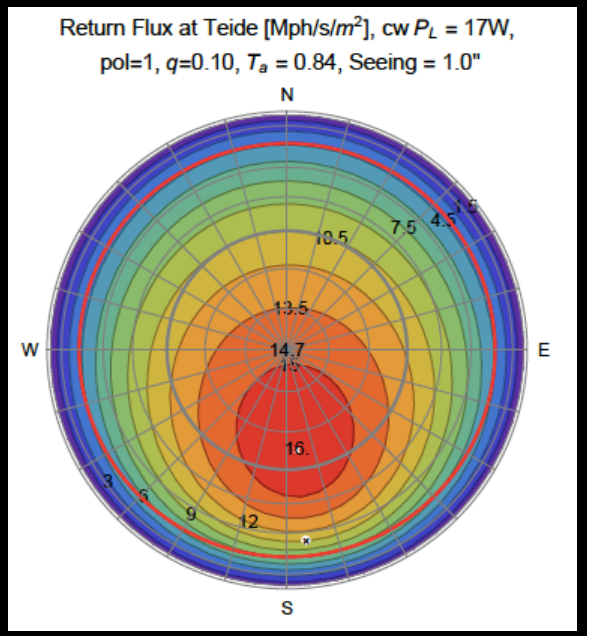
LGS Polar Maps: Linear with D2b

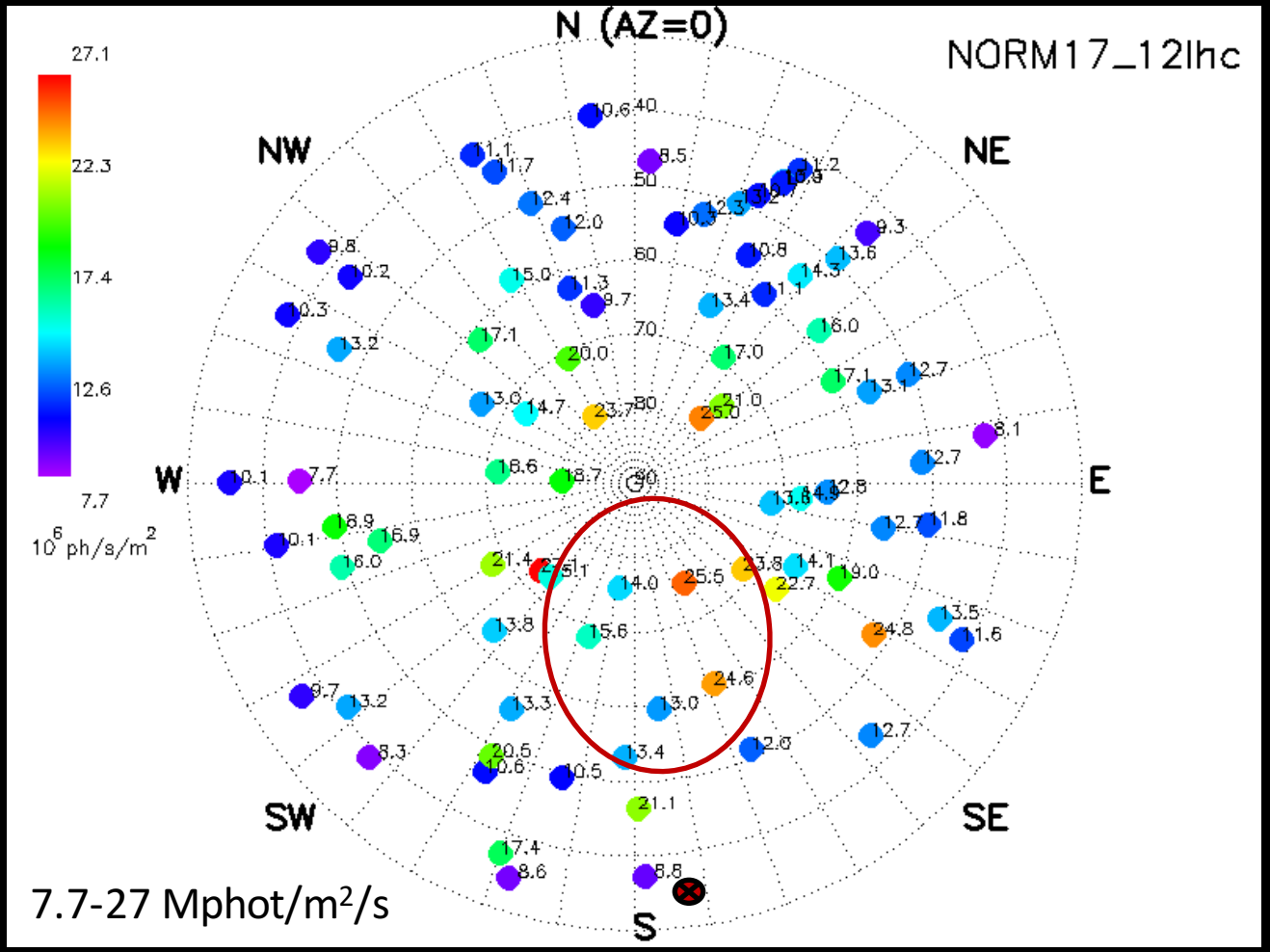




Throughput normalized - Laser power normalized - No normalization to C_Na

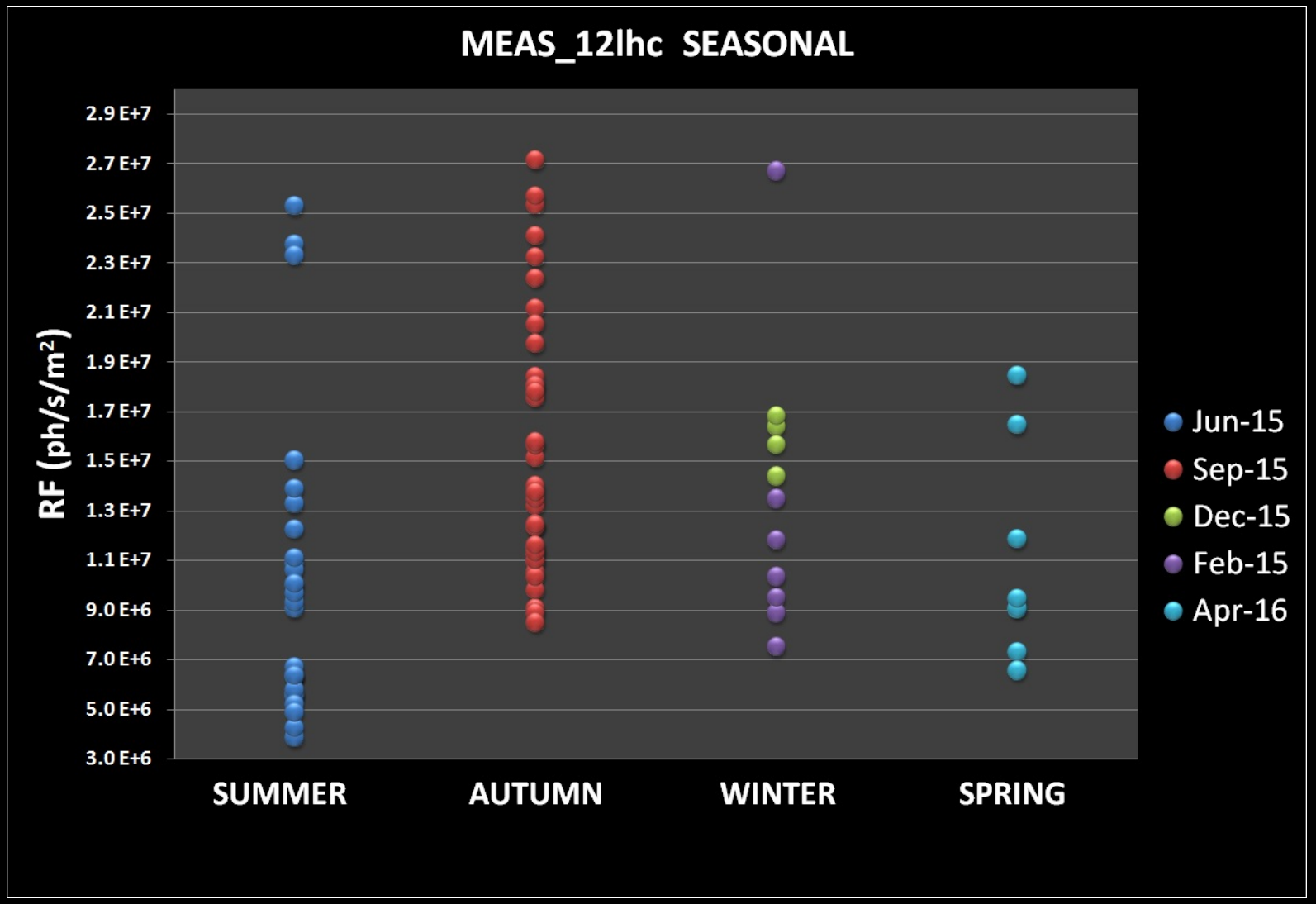
LGS Polar Maps: Circ with D2b



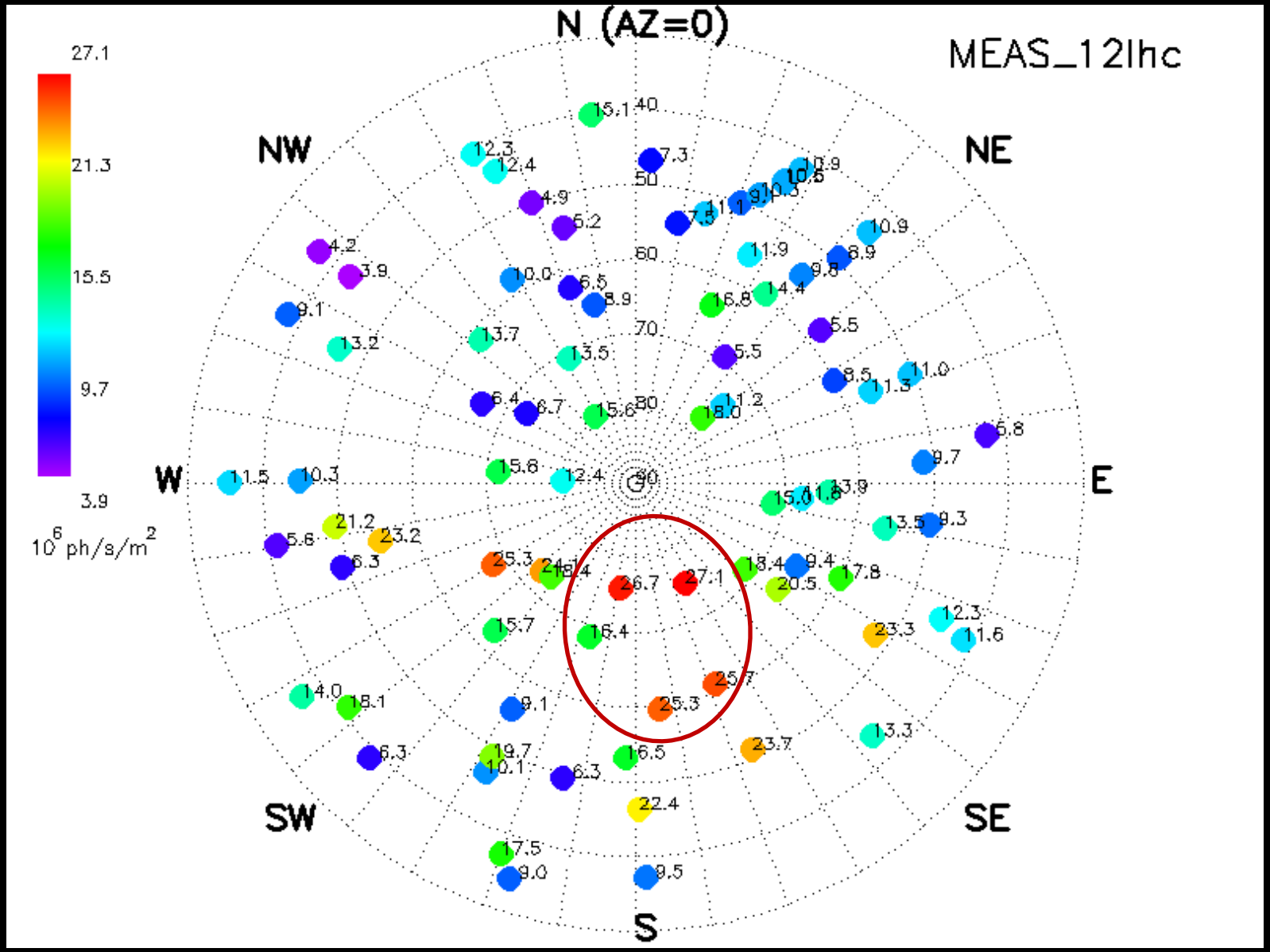


Throughput normalized
Laser power normalized
No normalization to C_Na

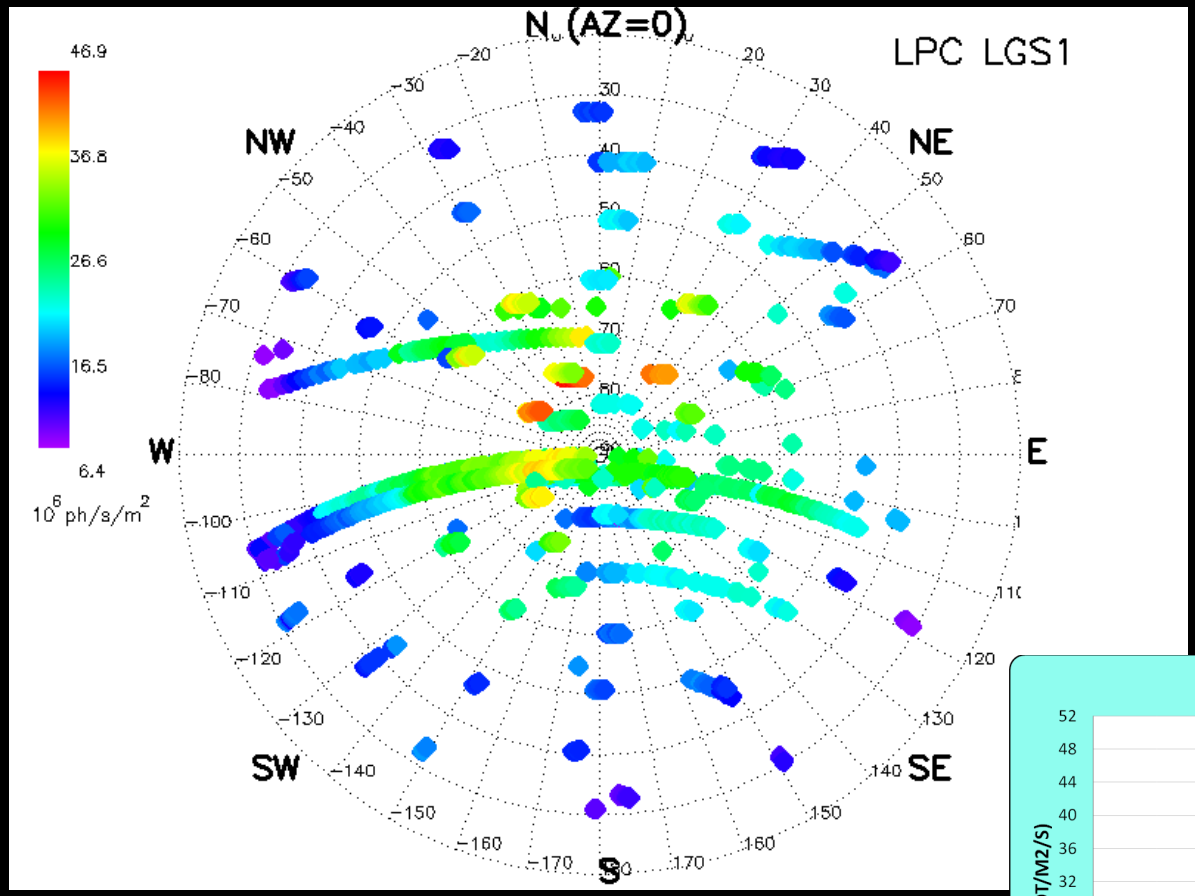
Measured Return Fluxes (this is what you get, no normalizations to compare with simulations)

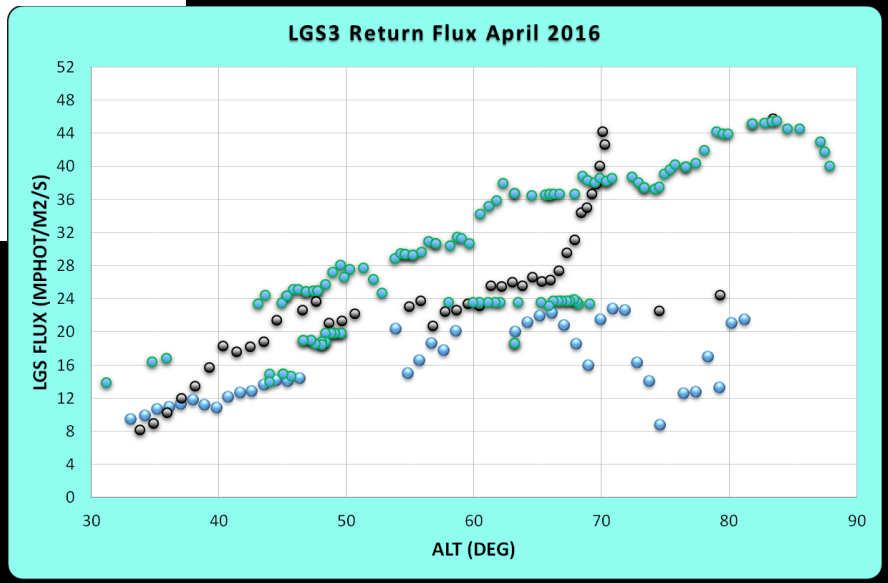


OT Measured Return Fluxes (this is what we got)



VLT Measured Return Fluxes (Commissioning April-June)





Summary

- OT return flux measuement campaign completed. Hard winter.
- Factor ~3 change in the return flux across the (alt,az) plane due to Larmoor precession
- No large seasonal variation (as expected)
- Optimal D_{2b} amplitude varies with (Alt,Az) – 8-20% of D_{2a}
- Optimal polarization: Circular polarization, in all cases
- Optimal D2b Frequency is 1.719 GHz
- Optimal CW Laser Linewidth: 2-6 MHz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THANK YOU FOR YOUR ATTENTION !