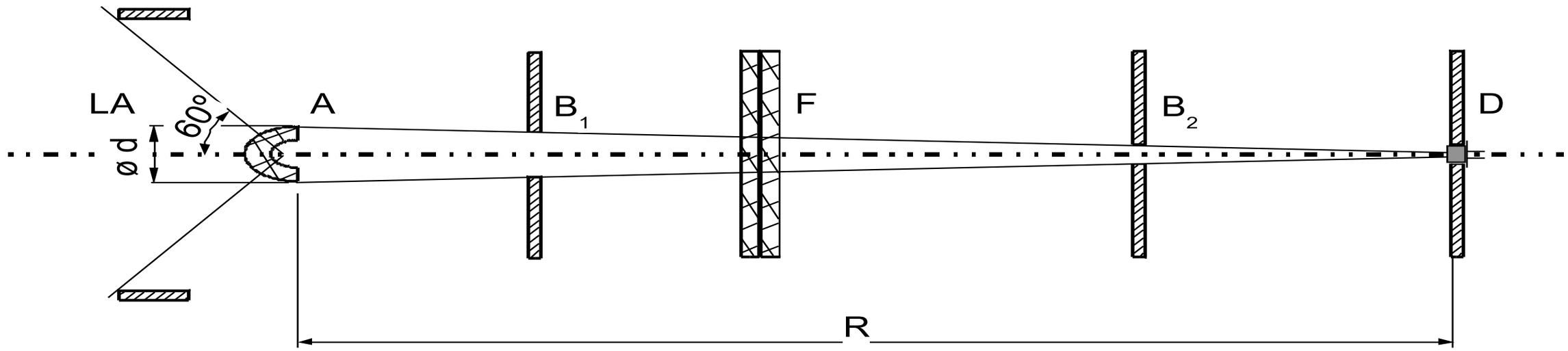
Laser Safety and Time distribution on Ground

T2L2/ELT - Workshop

20.3.2014 Wettzell



"Snow Flake" blocking filter

Diffusor Disc

Spectral Filter

Aperture

attenuation by separation

Laser Safety in SLR

- Local (operator) Safety: (HV, slewing telescopes, eye-safety) see poster LEB
- In-Sky-Safety: outside operator, tracking radar, aircraft transponder, camera, flight control radar data
- Target Safety (sensor integrity, operator)

Laser Safety in SLR

- Ranging Elevation Mask, beam power limitation, scheduling, Go/no-Go flag
- In-Sky-Safety: outside operator, tracking radar, aircraft transponder, camera, flight control radar data, no-flight zone (eg. ED-R 59 in Wettzell)
- Target Safety (sensor integrity, astronauts)

Example: WLRS (old laser)

Parameter	Quantity
Wavelength	532 nm
Laser Energy per shot (at laser output)	0.1 - **50** mJ
Pulse Width	80 ps
Transmission through telescope	0.63
Transmission through atmosphere (max)	0.75
Minimum Range to ISS	380 km
Laser Beam Divergence (half angle)	**25** - 200 μrad
Atmospheric turbulence induced beam Divergence (half angle) typical	15 μrad
Diameter of Laser Spot at ISS	19 m
Total area illuminated at ISS	284 m^2
Energy density	8.3e-9 J/cm^2
Interlock	Go/ no Go Flag (as defined by ILRS)
MPE (2^{nd} Harmon. Nd:YAG < 100 ps)	7.2e-8 J/cm^2

Target Safety in SLR

The WLRS is always eye-safe for the crew of the ISS with a safety margin of one order of magnitude

ELT requires a carefully balanced link budget, since we operate at single photon level both in space and on ground (ELT detector attenuation: ND6)

Parameter	**Quantity**
Laser Energy per shot	0.1 mJ
Laser Beam Divergence (half angle)	200 μrad
Energy density at Columbus Module (TCA)	2.3e-13 J/cm^2
MPE (2nd Harmon. Nd:YAG < 100 ps)	7.2e-8 J/cm^2

Target Safety in SLR

How to ensure mission objectives AND target eye safety?

1. IR part of laser power is measured continuously

2. Measurement voltage is inverted, causing high power values and power failure to give similar (low) voltage readings

3. Low voltages are considered unsuitable for the mission objectives and potentially unsafe

4. Ranging activities are suspended

5. A mechanical switch senses actual beam divergence settings and ranging cannot commence when the switch is not activated (hardware inhibit)

Summary

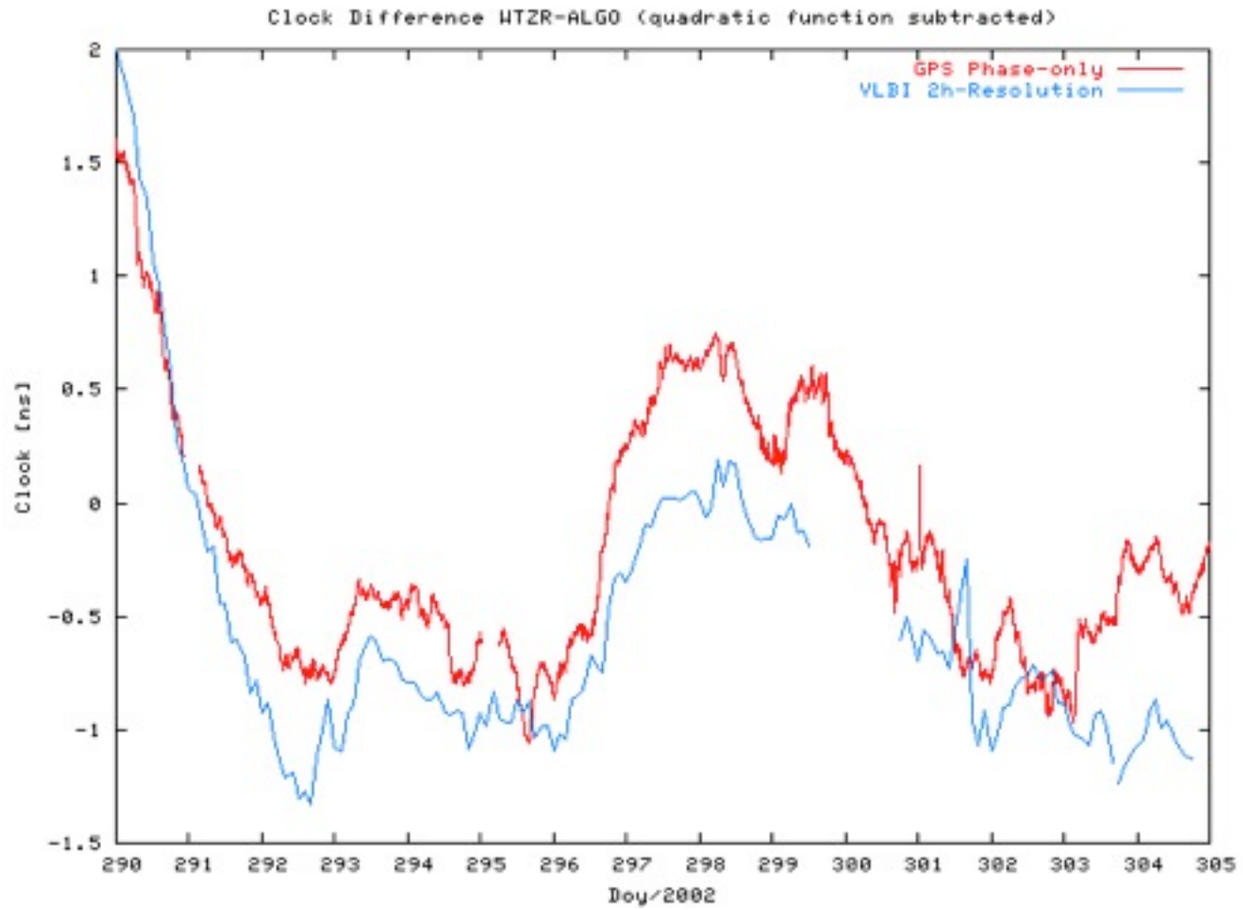
- ELT for ACES builds on the success story of T2L2 and was adjusted to fit into payload margins

- ELT system requirements make it an interesting but also challenging target

- Ground segment (good clock) and safety requirements make it a target for only a few SLR stations

- The ILRS needs to develop a procedure to properly handle the ranging restrictions

Motivation



Observation: Clocks accumulate all sorts of systematics (Delays) of the various techniques.

Therefore clock parameters are showing technique specific discrepancies. This applies for inter- and intra-technique comparisons.

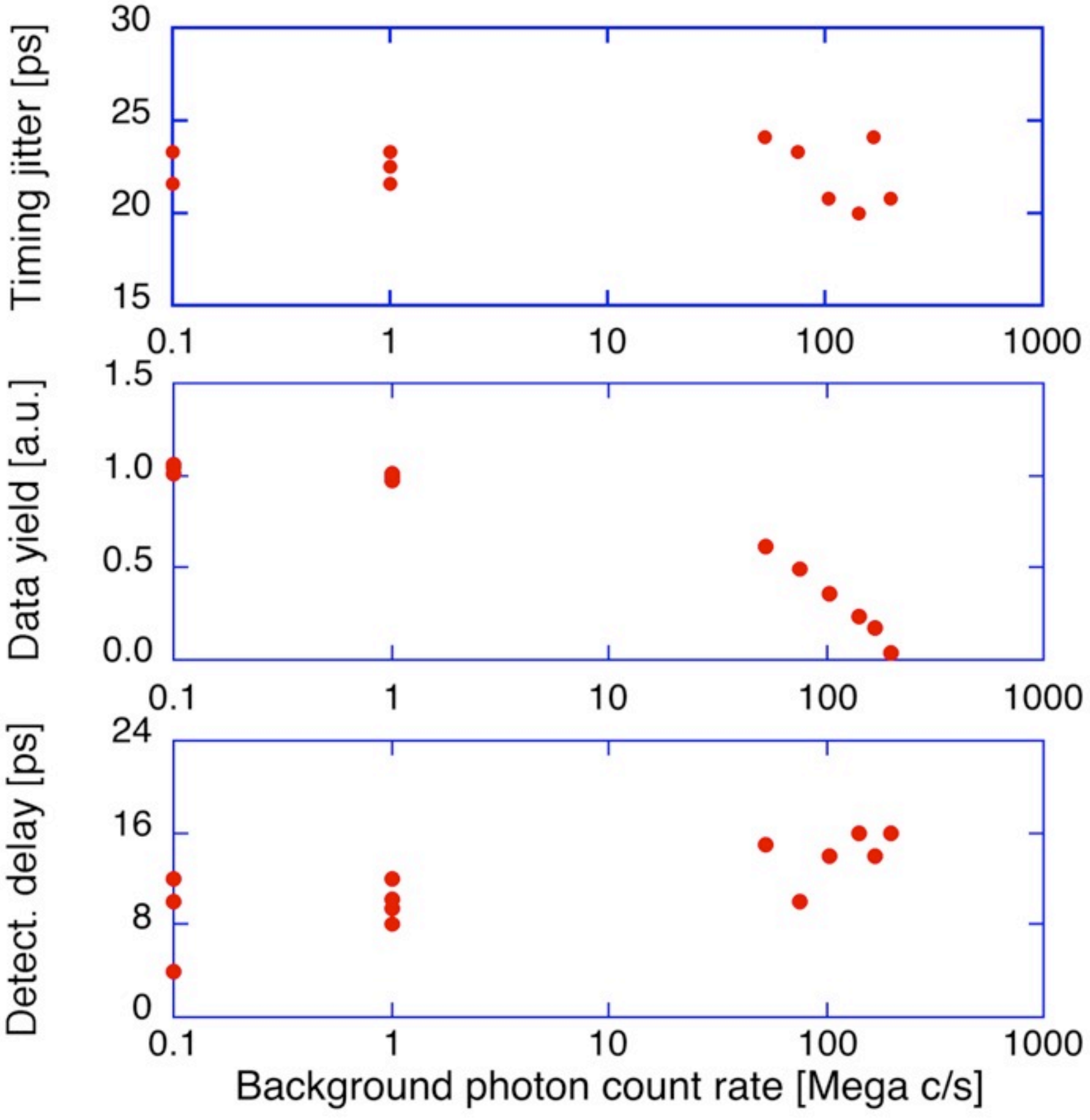
Consequence: Can we gain by aiming for a Common Clock for all techniques within an observatory

Method: Optical 2-way time transfer (via fiber)...

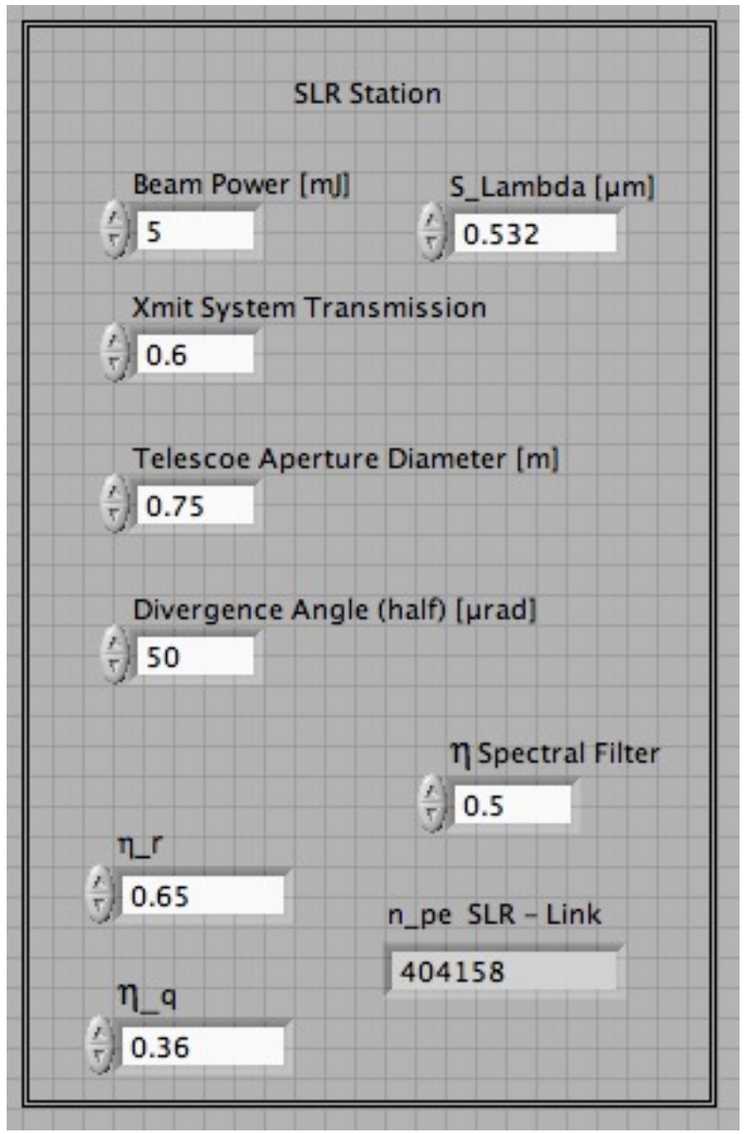
(Access to time (space time definition) requirese a pulsed system.)

The frequency source (for the time being) is a Maser @ 100 MHz (10 GHz), eventually we aim for a link to an optical clock (PTB).

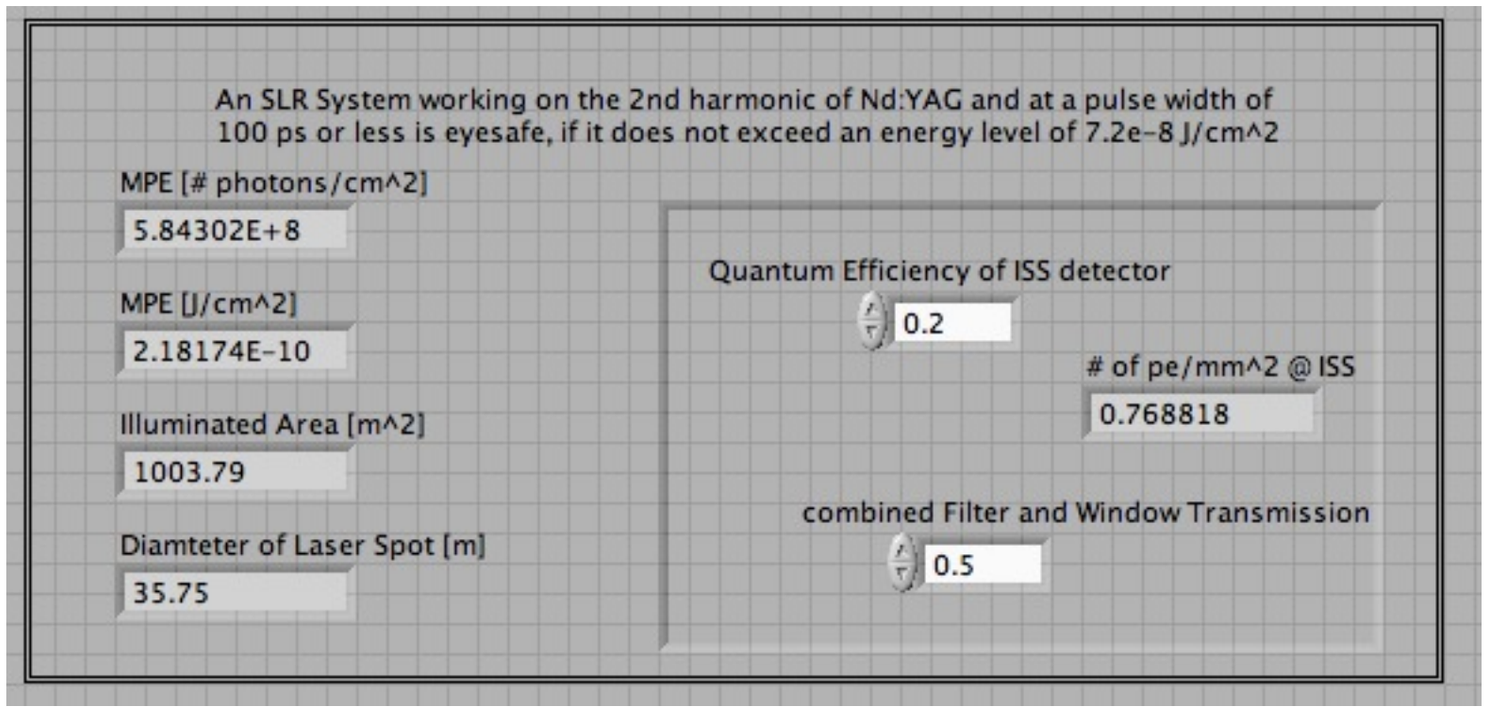
The frequency source is driving an optical master oszillator (OMO); pulses in the fs regime are distributed via a splitter box. There are 8 compensated links available.


Timing jitter [ps]
30
25
20
15
0.1
1
10
100
1000
Data yield [a.u.]
1.5
1.0
0.5
0.0
0.1
1
10
100
1000
Detect. delay [ps]
24
16
8
0
0.1
1
10
100
1000
Background photon count rate [Mega c/s]

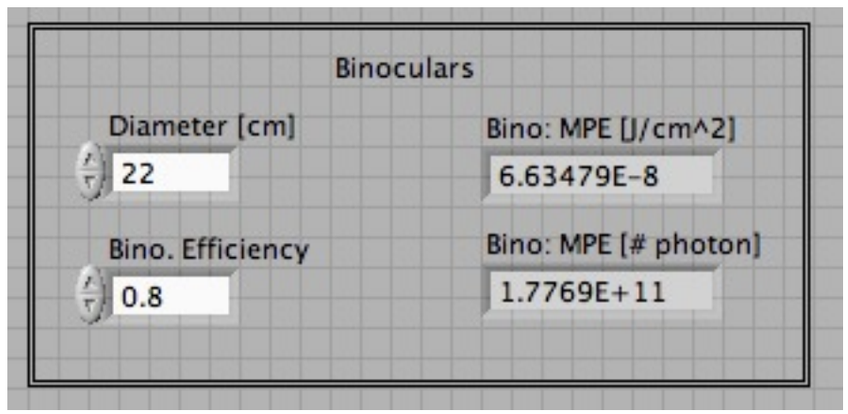
WLRS System Simulator



SLR operations



ELT link margin



… and In-Sky-Laser Safety

Known Issues (WLRS)

- Higher rep. rate to get within ISS range (blind region) ✓
- pulse width reduction on laser ✓
- better control of laser fire needed ✓
- modification of timing system to obtain ps-accuracy for comparison ✓

Experimental Simulation: Ajisai