An instrument to determine the coherence time of atmospheric turbulence:

The fast defocus monitor (FADE)

Aglaé Kellerer*, Andrei Tokovinin**

* European Southern Observatory, Germany

** Cerro Tololo Inter-American Observatory, Chile

$r_0^{-5/3}$	$= 0.423\ k^2 \int C_n^2\, dh$	Fried parameter
τ_0	$= 0.314\ r_0 / V_{5/3}$	coherence time
$V_{5/3}^{5/3}$	$= \int V^{5/3} C_n^2\, dh \,/ \int C_n^2\, dh$	

Current methods of coherence time measurement

Method	Measured quantities	Mirror diameter /m	Problems
SCIDAR	$C_n^2(h)$, $V(h)$	>1	Needs large telescope
Balloons	$C_n^2(h)$, $V(h)$	none	Expensive, no monitoring
AO system	r_0, τ_0	>1	Needs working adaptive-optics system
SSS	$C_n^2(h)$, $V(h)$	>0.4	Low height resolution
GSM	r_0, $V(h)$, τ_{AA}	0.1 (4 telescopes)	No obvious relation to τ_0
MASS	τ_0*	0.02	Biased (low layers ignored)
DIMM	r_0	0.25	Indirect τ_0 estimate
FADE	r_0, τ_0	0.35	Might be discovered in: Kellerer, A., Tokovinin, A., A&A (2007)

h height of turbulent layer

C_n^2 refractive index constant

V speed of turbulent layer

r_0 Fried parameter

τ_0 coherence time

τ_{AA} coherence time of angle-of-arrival fluctuations

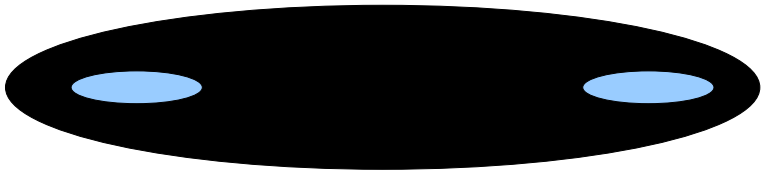
DIMM

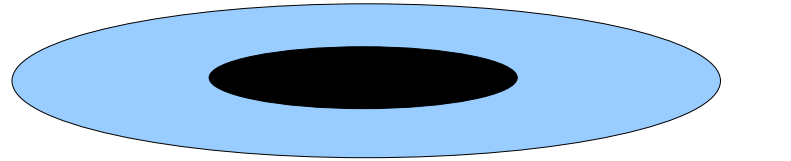
non isotropic

FADE

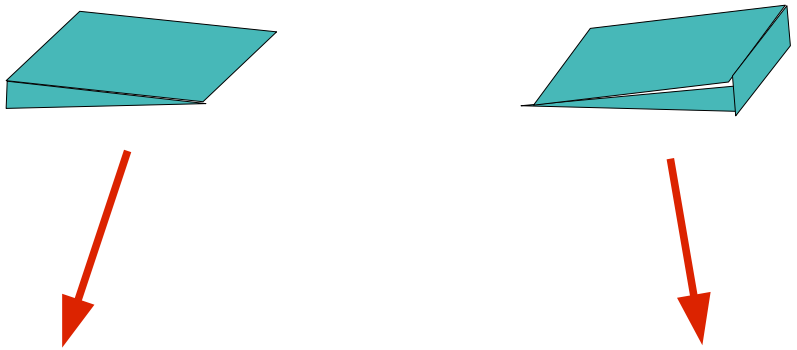
isotropic

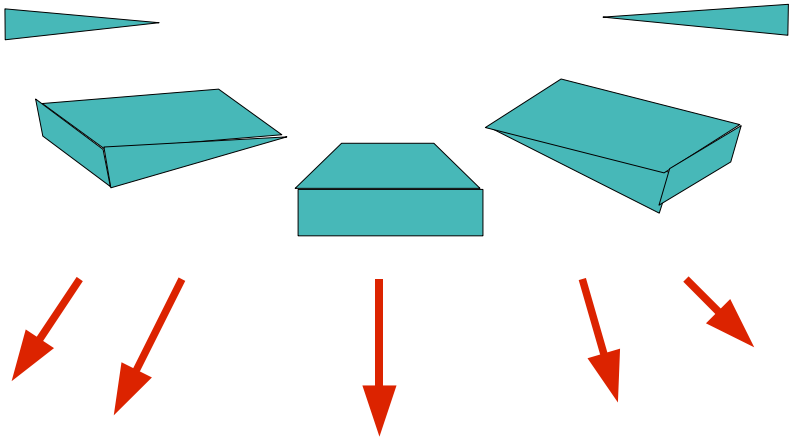
Mask



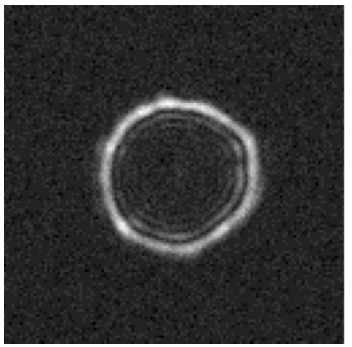


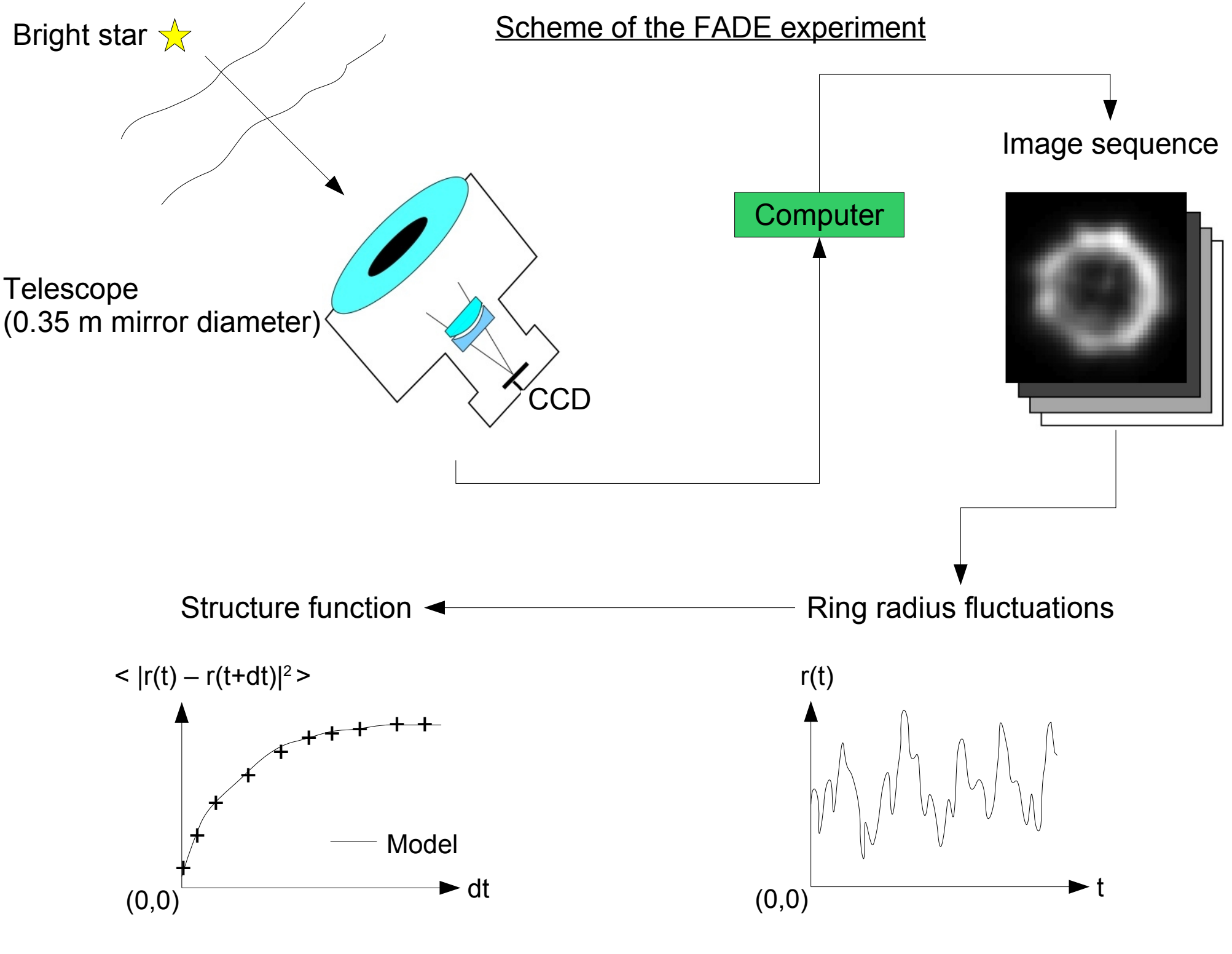
Conic aberration





Resulting image




Scheme of the FADE experiment
Bright star
Telescope
(0.35 m mirror diameter)
CCD
Computer
Image sequence
Ring radius fluctuations
Structure function
< |r(t) – r(t+dt)|² >
Model
dt
(0,0)
r(t)
t
(0,0)

Observations at Cerro Tololo, Chile

October 29th - November 2nd 2006

FADE prototype

Component	Description
Telescope	*Celestron* C14 D=356mm f=3860m
Central obstruction	Circular mask 150mm diameter
Aberrator	2 *Linos* lenses, f=+/-50mm
Detector	*Prosilica* 640x480 pixels, frame rate up to 740Hz

Fried parameter, coherence time

DIMM

Installed on a 6m high tower

at 10m distance from FADE

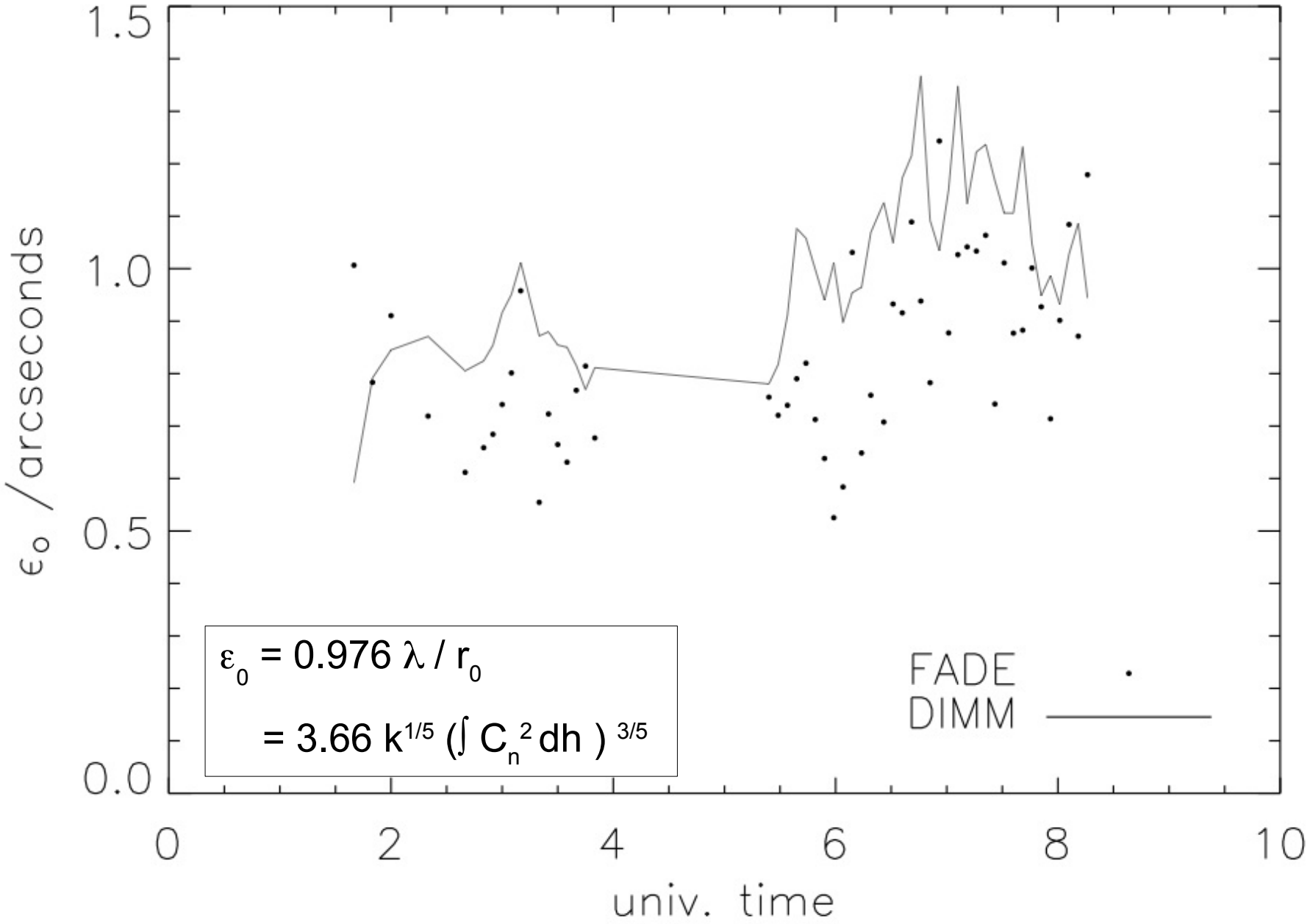
Fried parameter

MASS

Coherence time

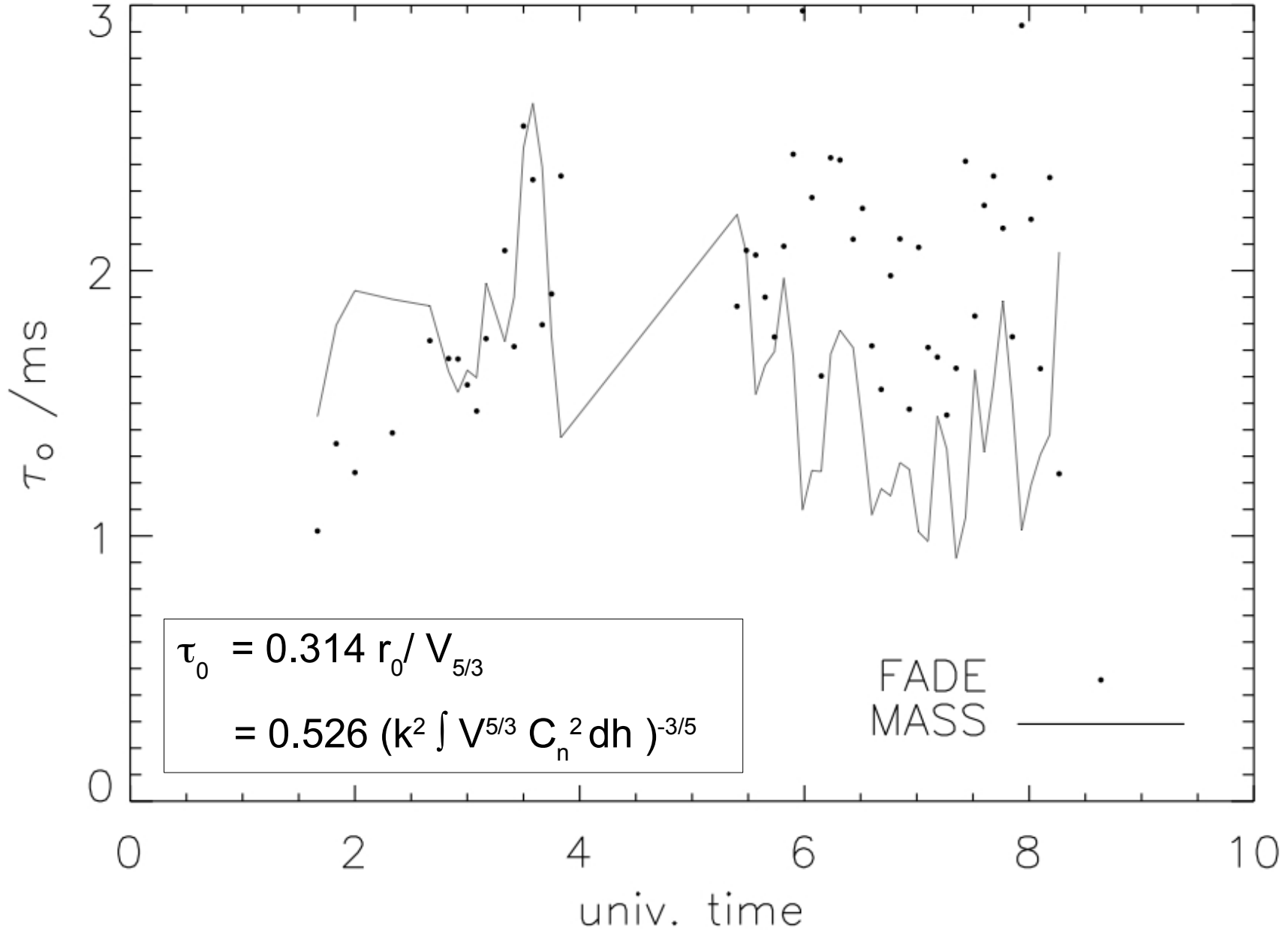
Seeing derived in terms of FADE and DIMM

Observations at Cerro Tololo, November 2nd 2006



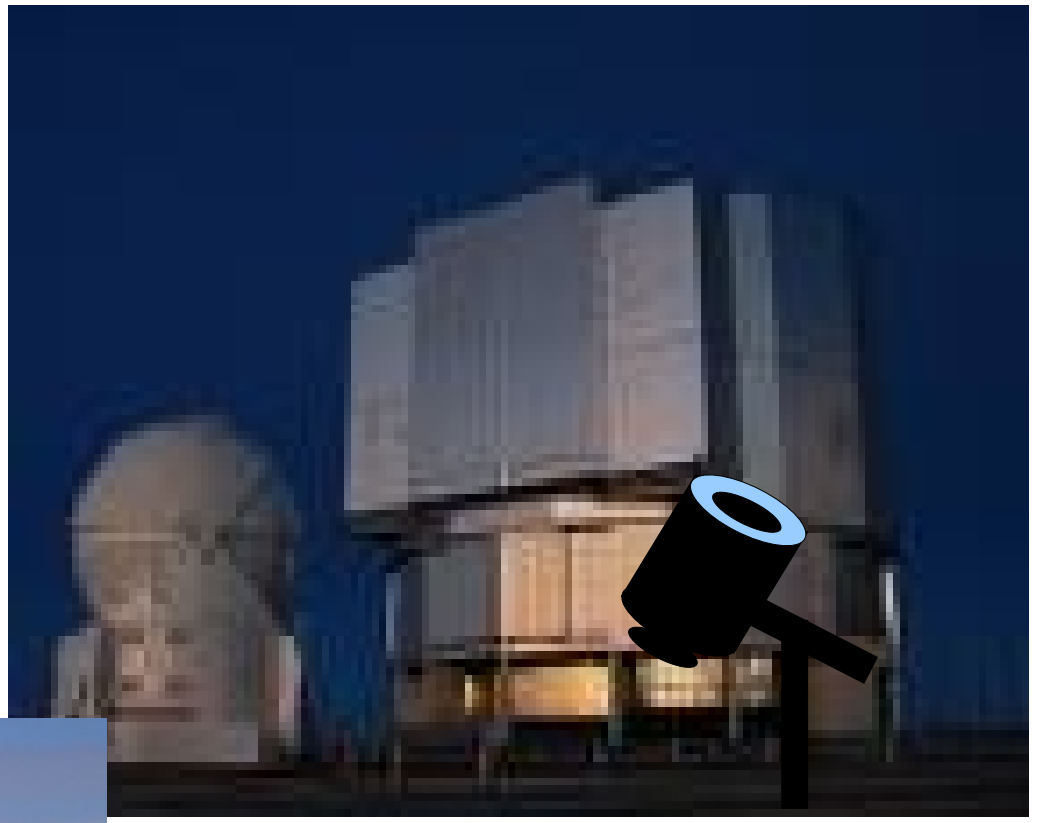
Coherence time derived in terms of FADE and MASS

Observations at Cerro Tololo, November 2nd 2006



Perspectives:

- Test the validity of FADE estimates: Simultaneous observations with an adaptive optics system or an interferometer



- Measure τ_0 at potential observatory sites such as Dome C, Antarctica.

Kellerer, A., Tokovinin, A., A&A (2007)
« Atmospheric coherence time in interferometry: definition and measurement »