# Step onset from an initial uniform distribution of turbulent energy

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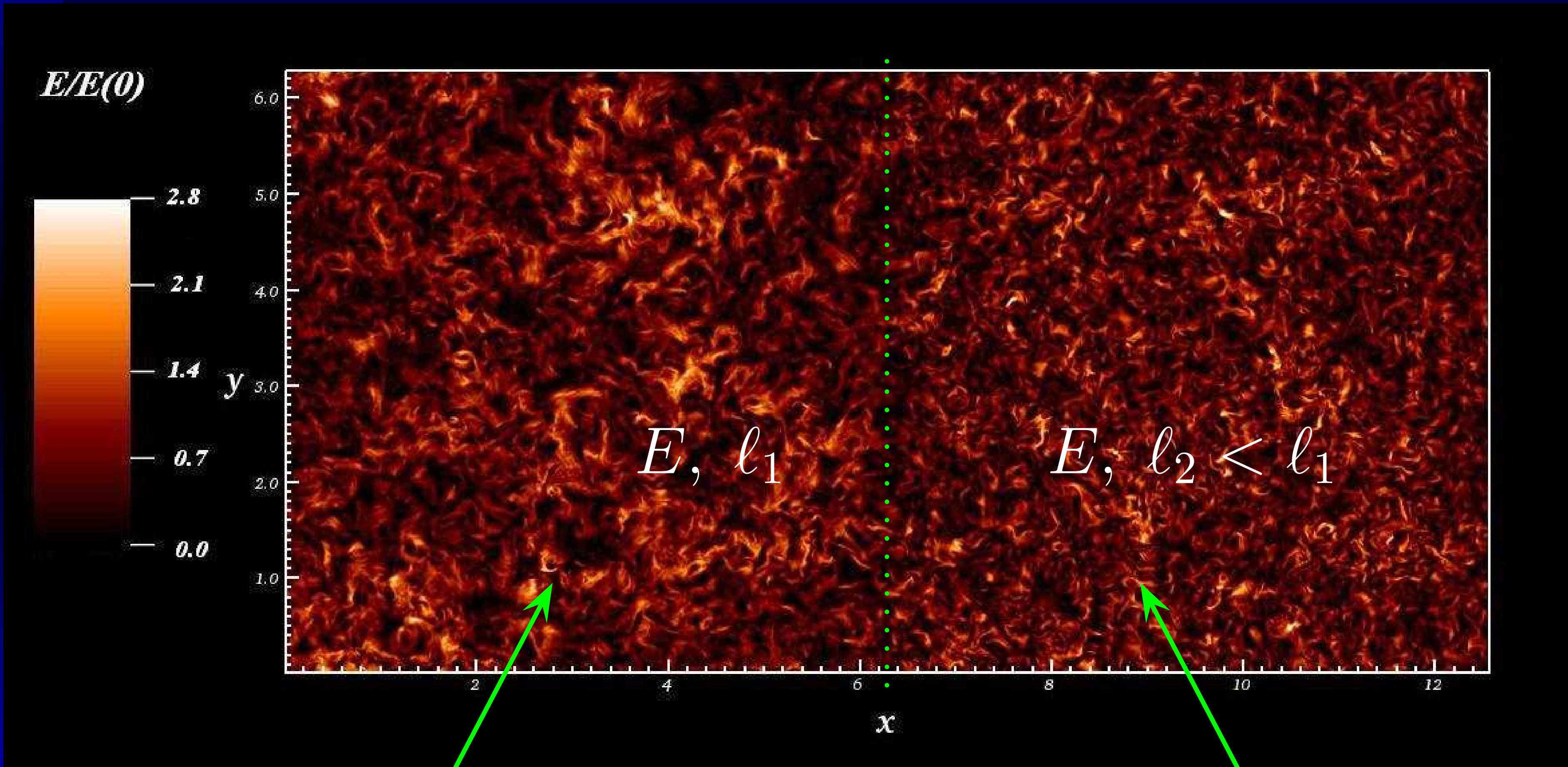
An integral scale gradient introduced in a uniform kinetic energy distribution can generate:

- an energy gradient
- a highly intermittent layer

# Flow Configuration

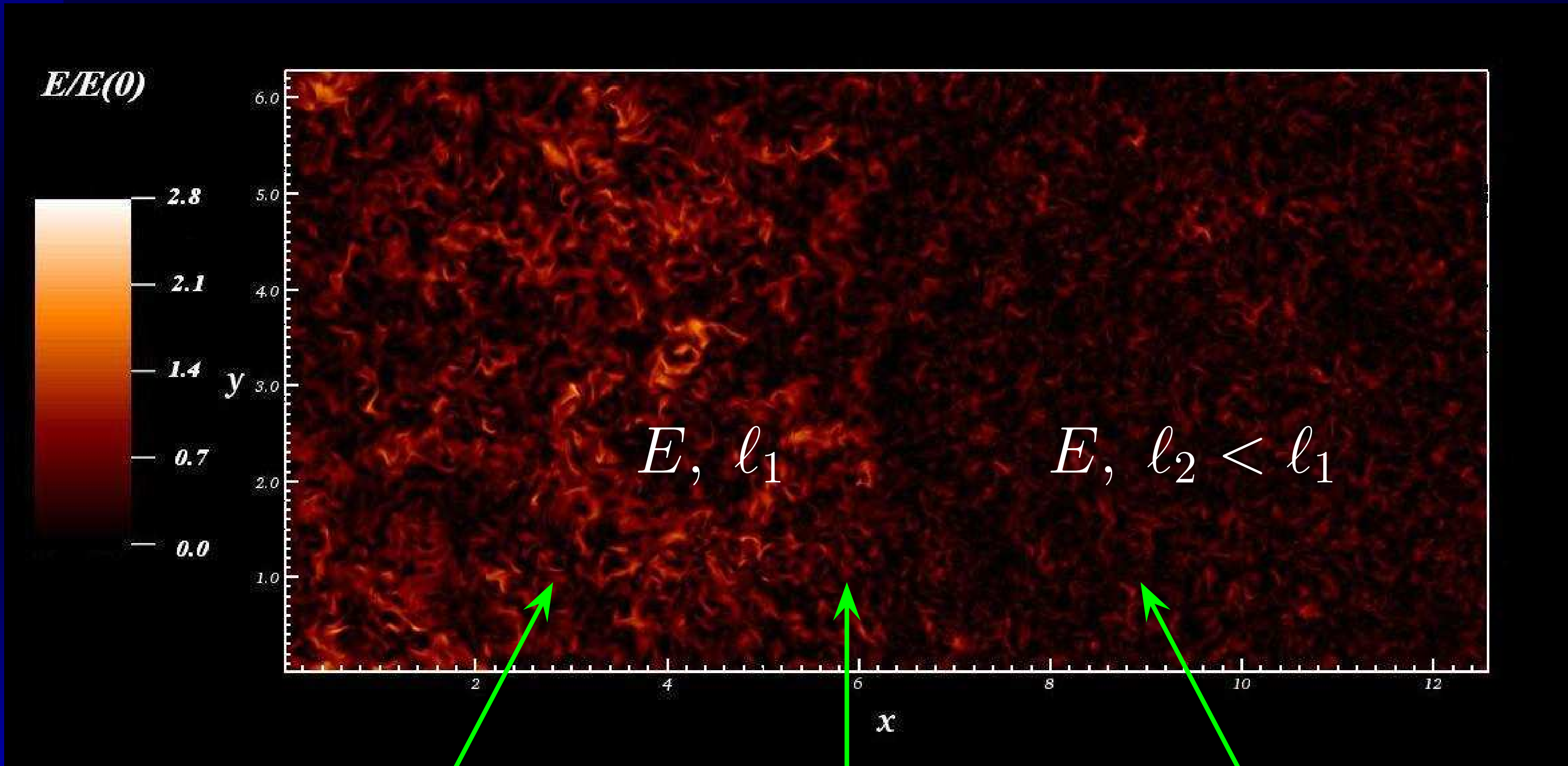
Initially uniform turbulent kinetic energy:




1-Larger scale turbulence 2-Smaller scale turbulence

# Flow Configuration

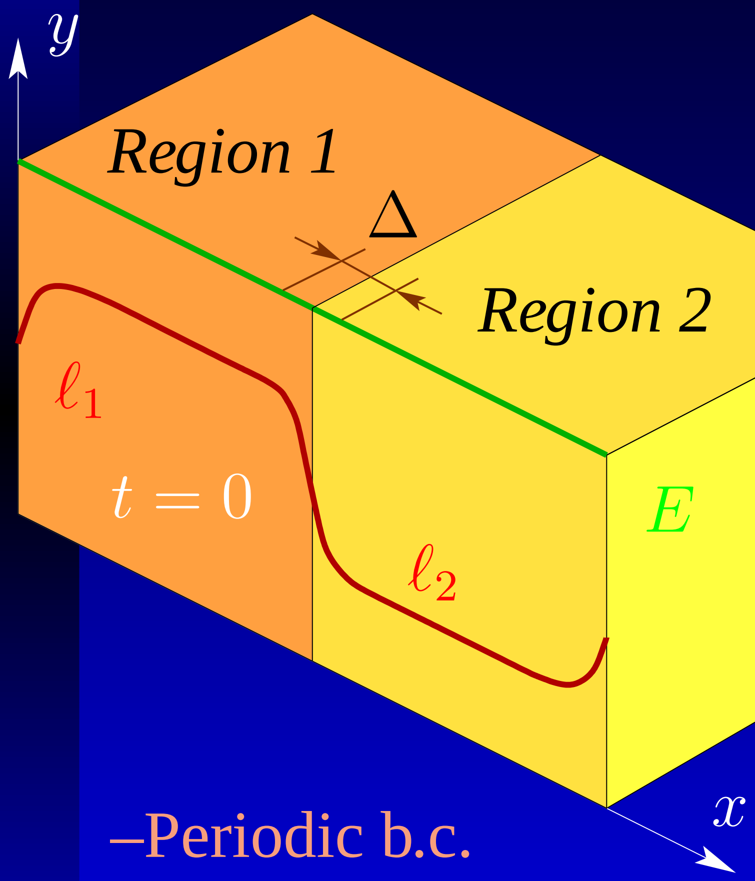
Initially uniform turbulent kinetic energy:




1-Larger scale turbulence 2-Smaller scale turbulence

*Shearless mixing layer*

# Method

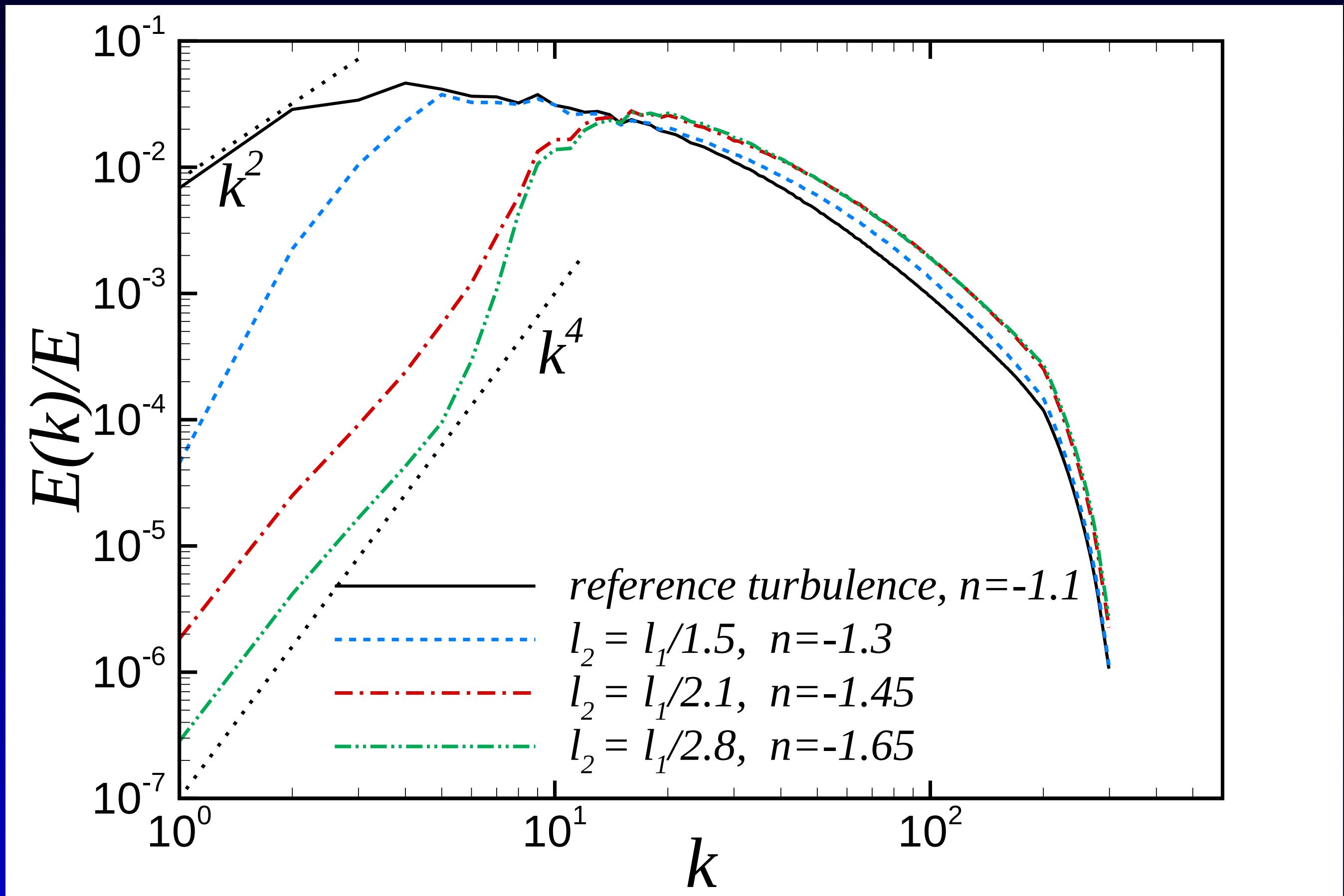



–Periodic b.c.

–Temporal decay

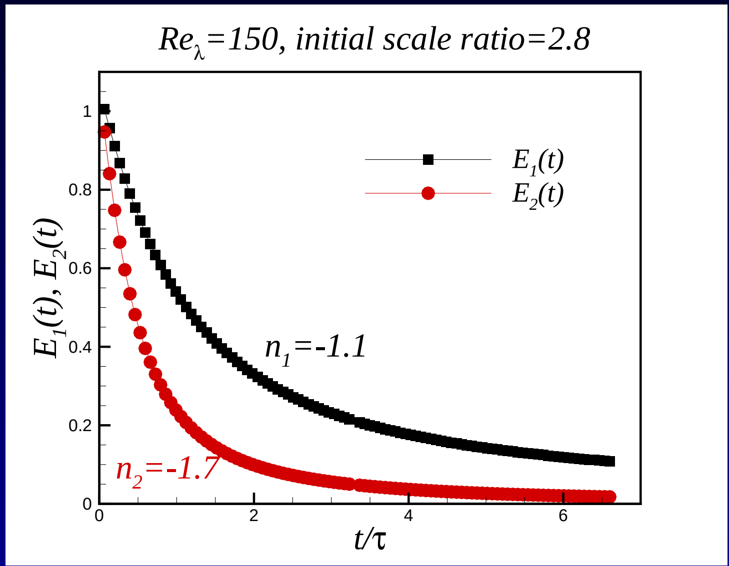
- **DNS**:
  - $Re_\lambda = 150$
  - parallelepiped domain, $2\pi \times 2\pi \times 4\pi$
  - $600^2 \times 1200$ grid points
  - Fourier-Galerkin pseudospectral space discretization
  - explicit RK-4 time integration

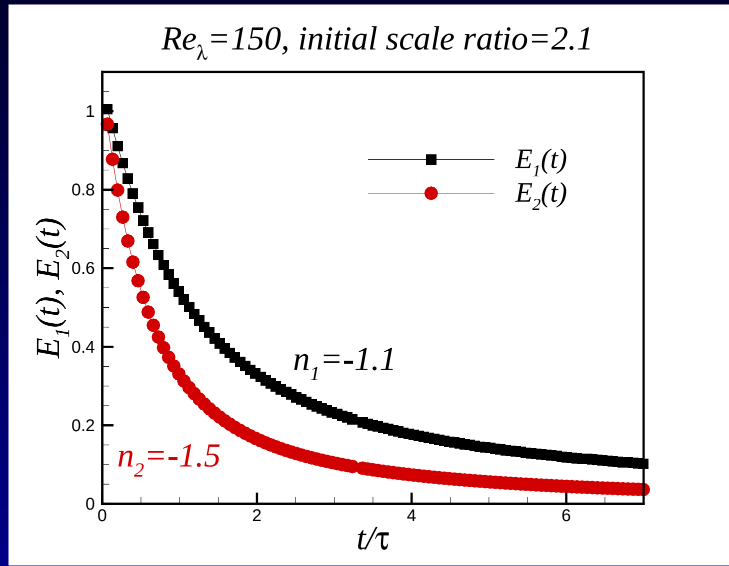
# Initial energy spectra

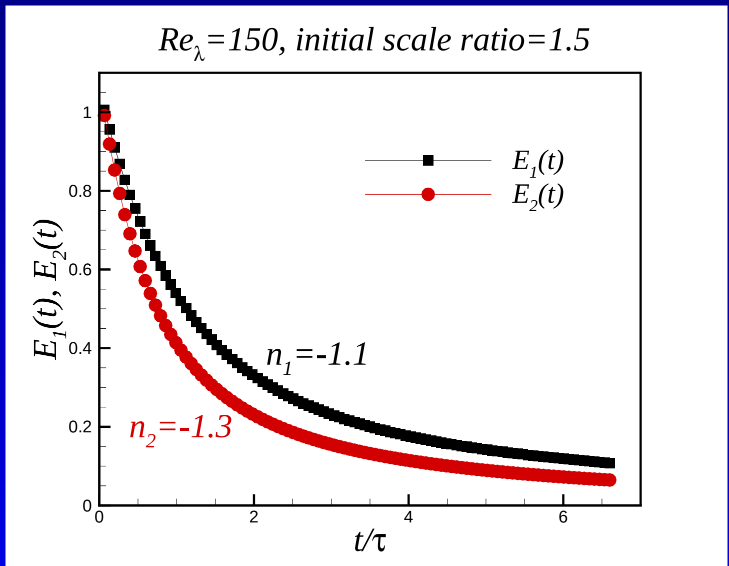



Field 1 → larger integral scale
Field 2 → smaller integral scale

# Turbulent kinetic energy decay

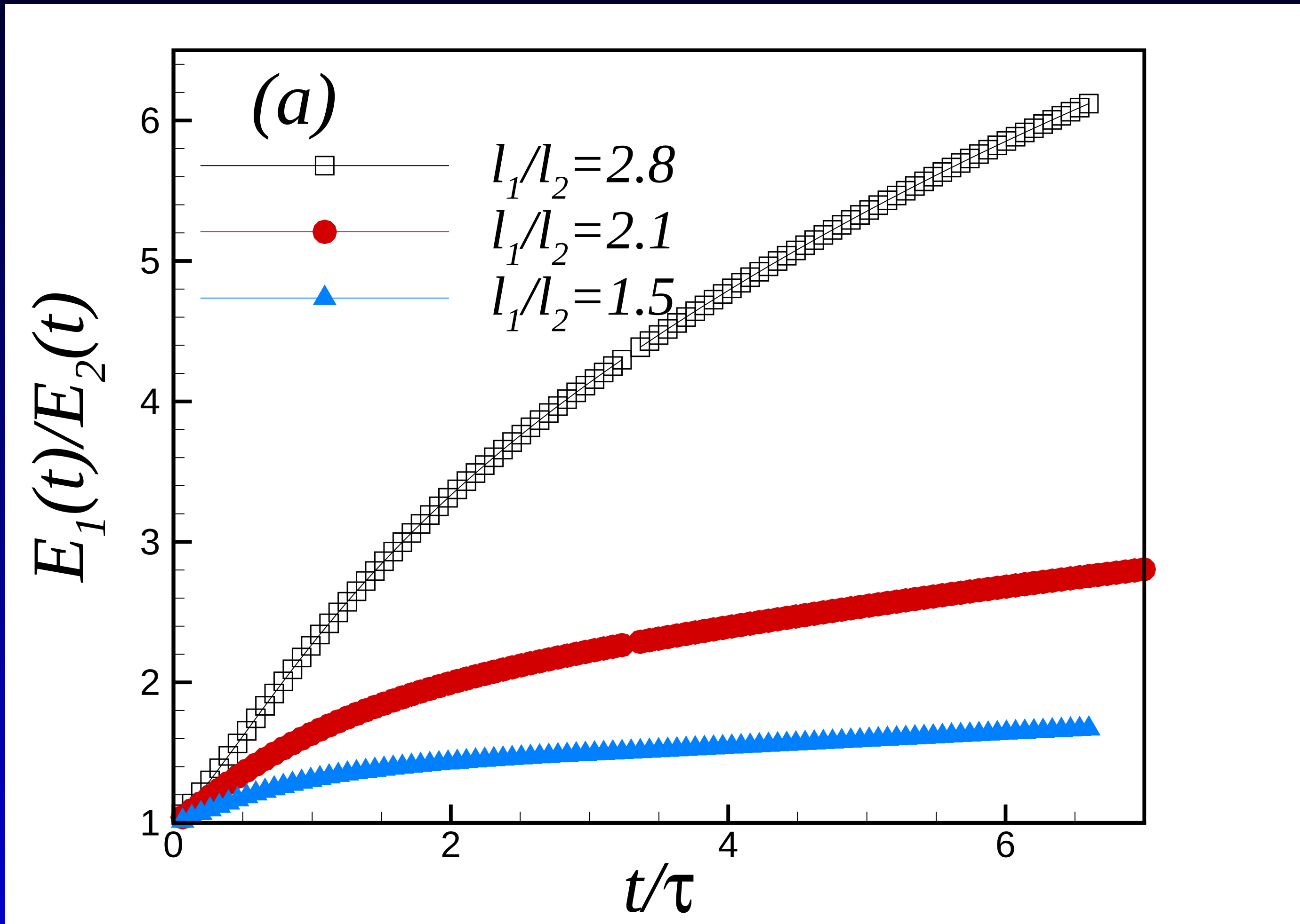


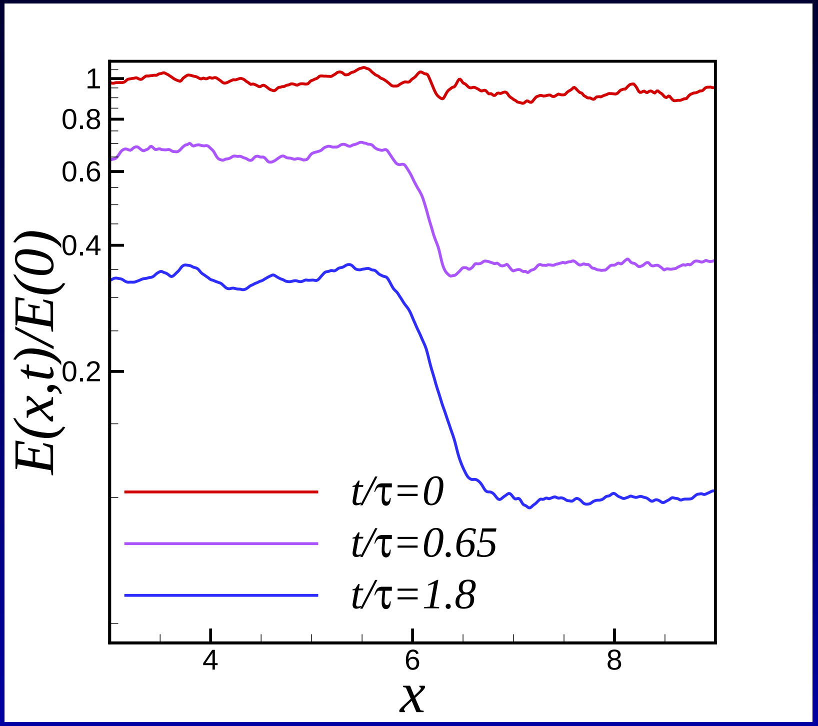

Homogenous turbulence with smaller scale decays faster
$\Rightarrow$ a kinetic energy gradient is generated

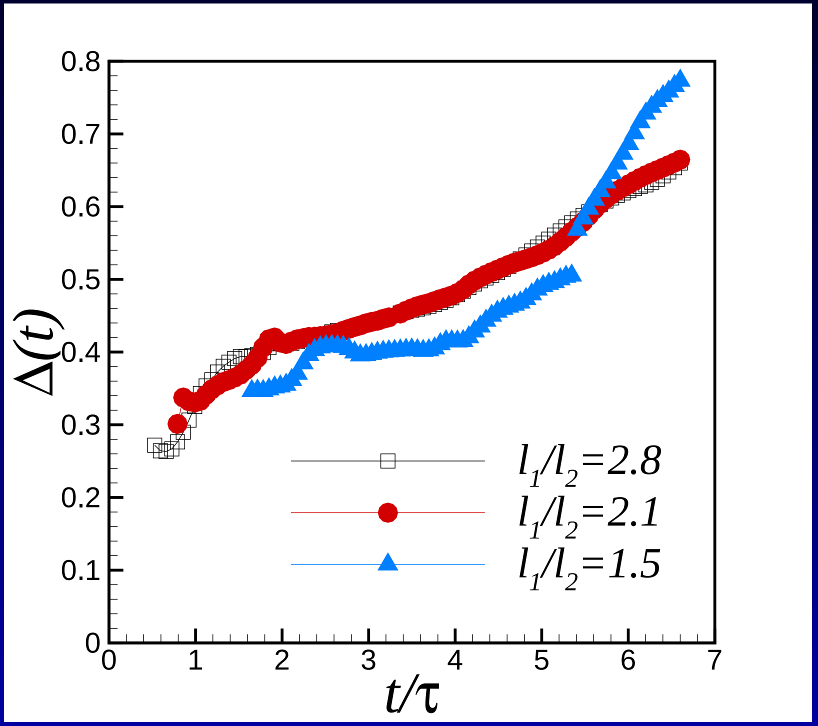
# Energy Ratio




Time evolution of the energy ratio $E_1/E_2$.

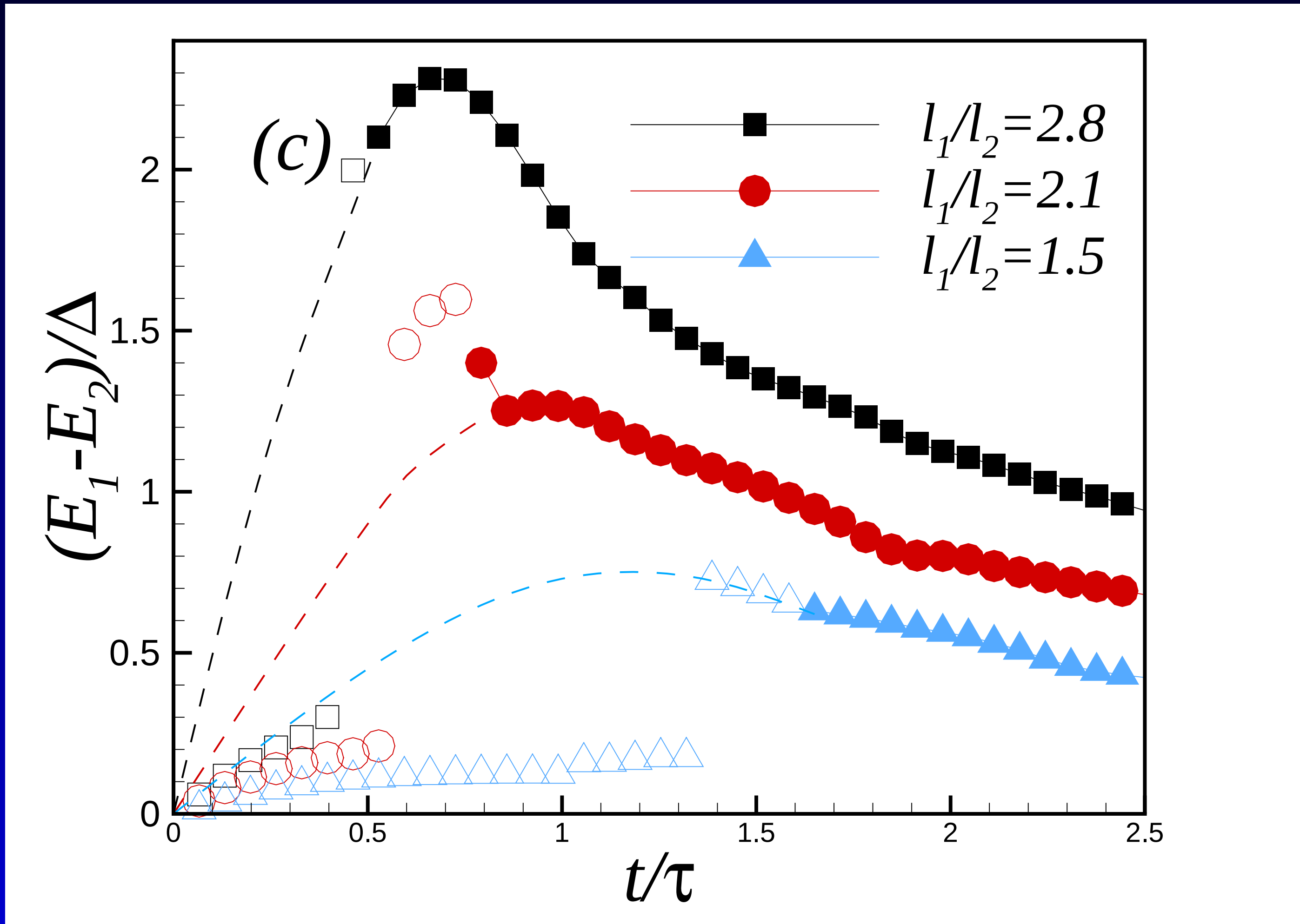
# Mixing layer thickness $\Delta(t)$



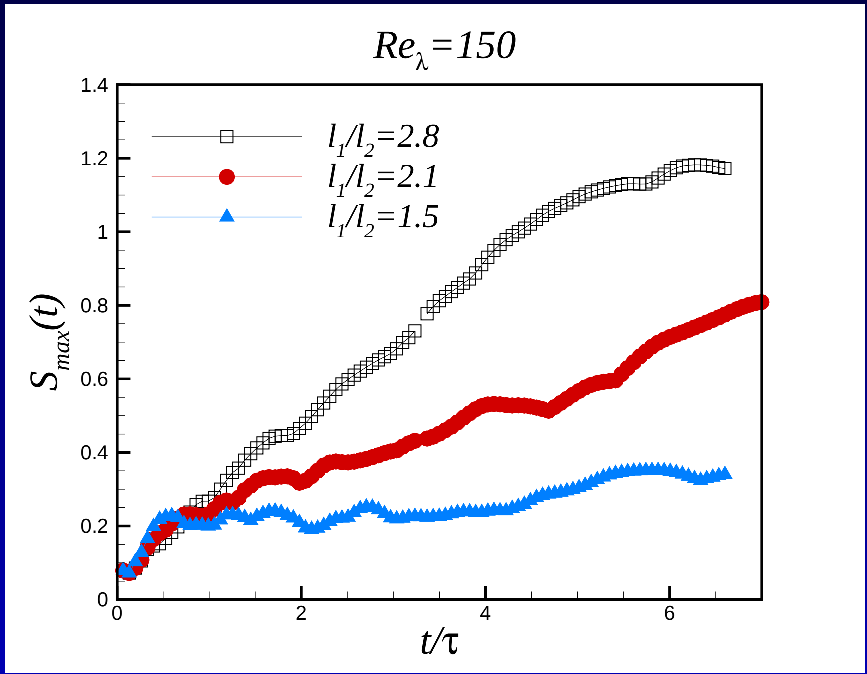

$\tau$ = initial eddy turnover time

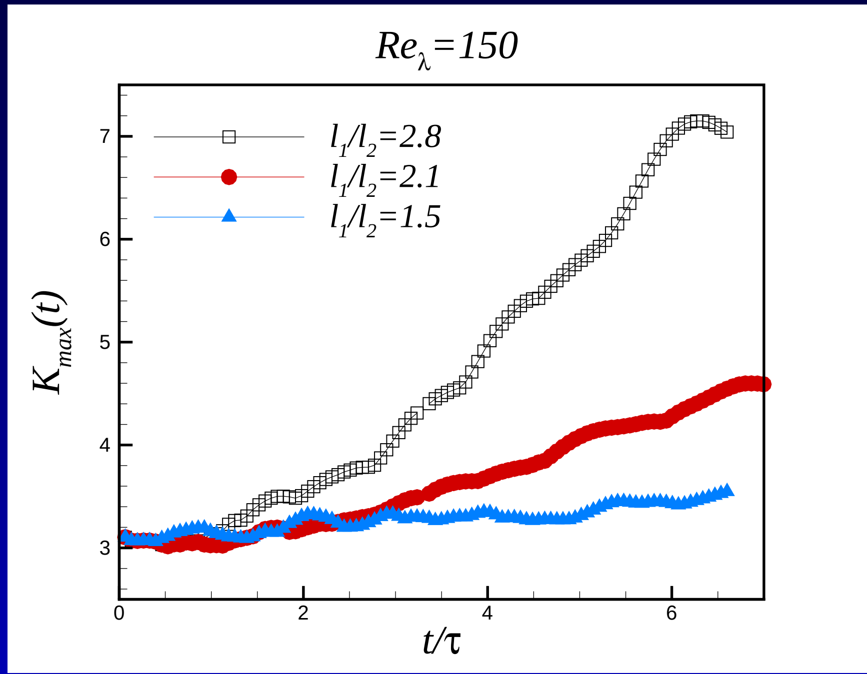
# Kinetic energy gradient



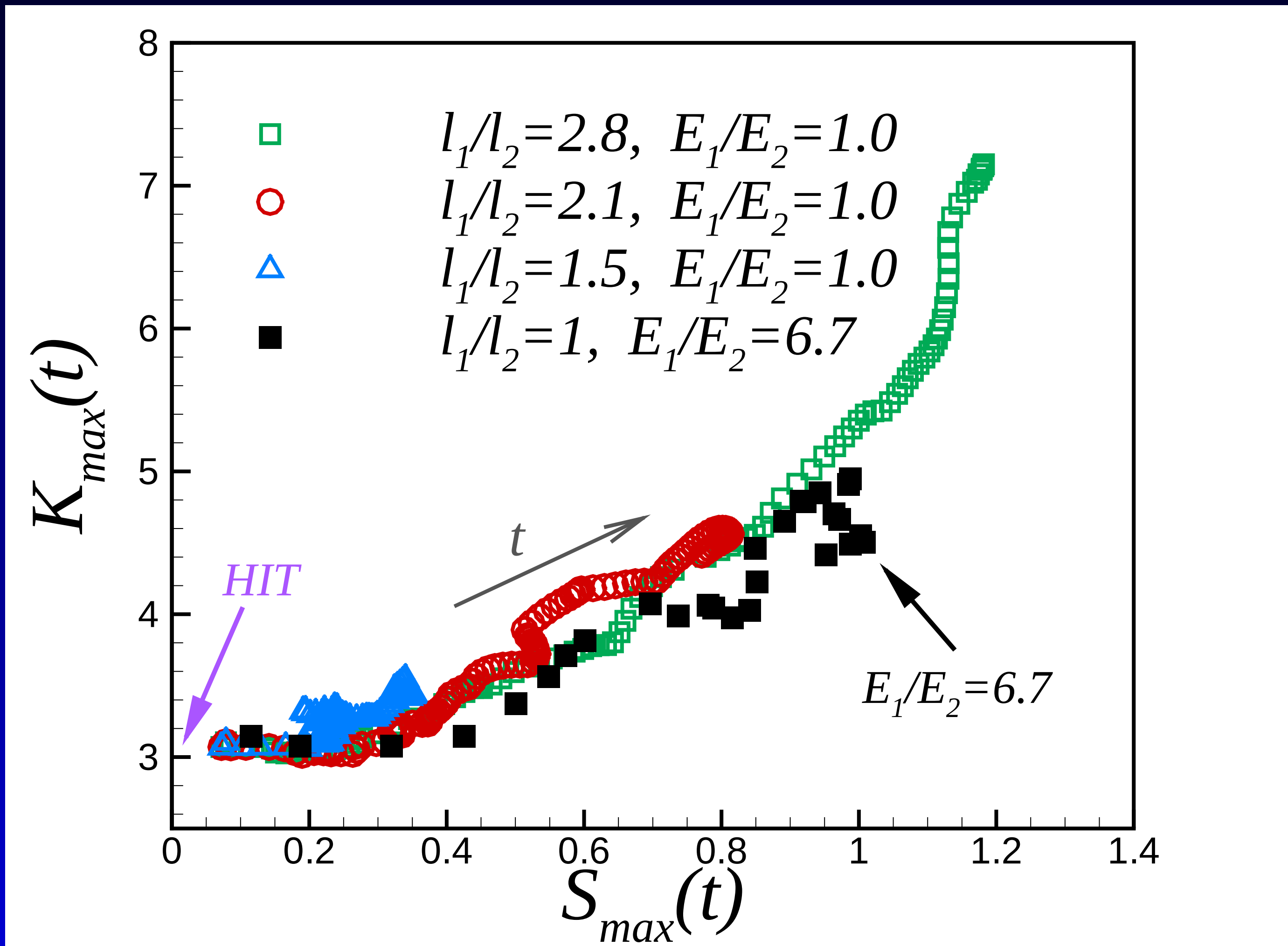
# Mixing layer intermittency

Velocity skewness and kurtosis, component in the inhomogeneous direction: maximum in the mixing layer



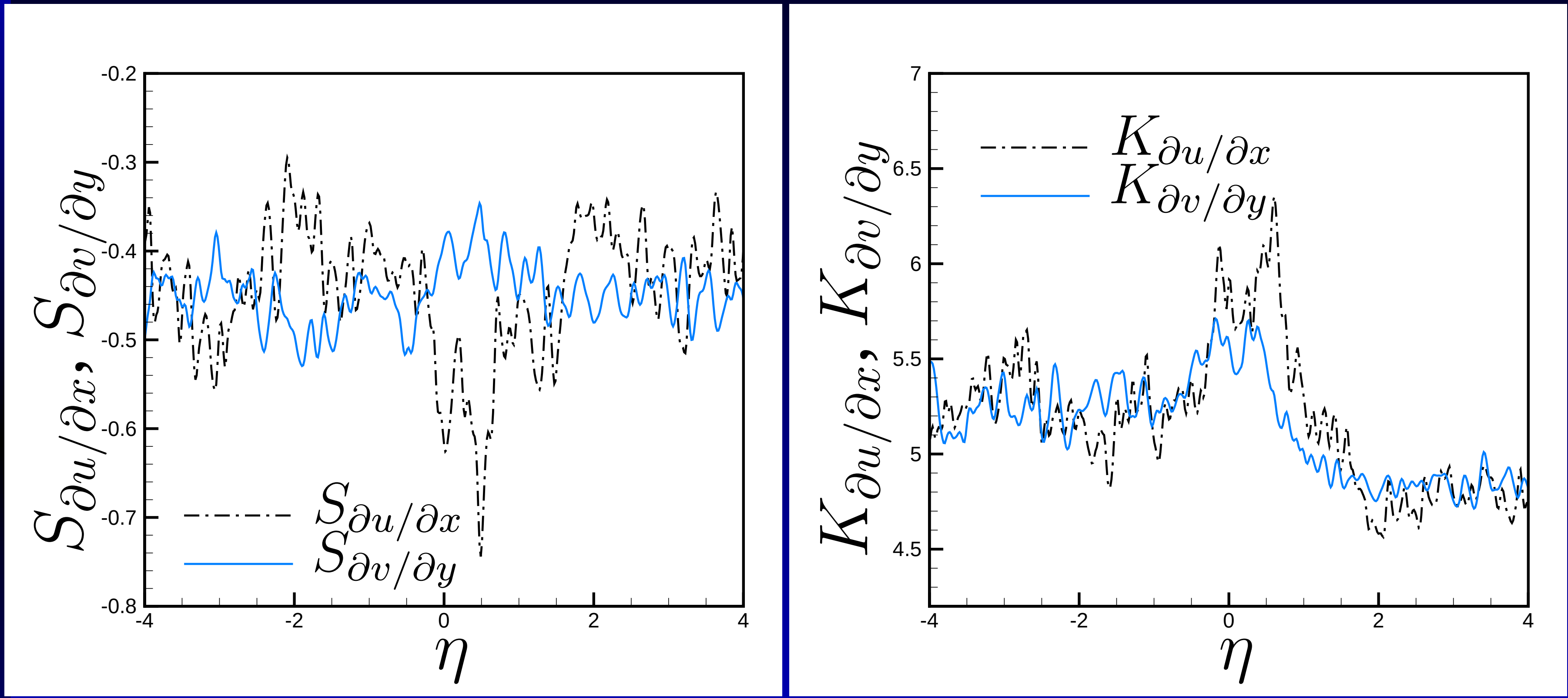



# Intermittency




A scale gradient can generate more intermittency than an energy gradient in presence of a uniform scale

# Longitudinal derivatives



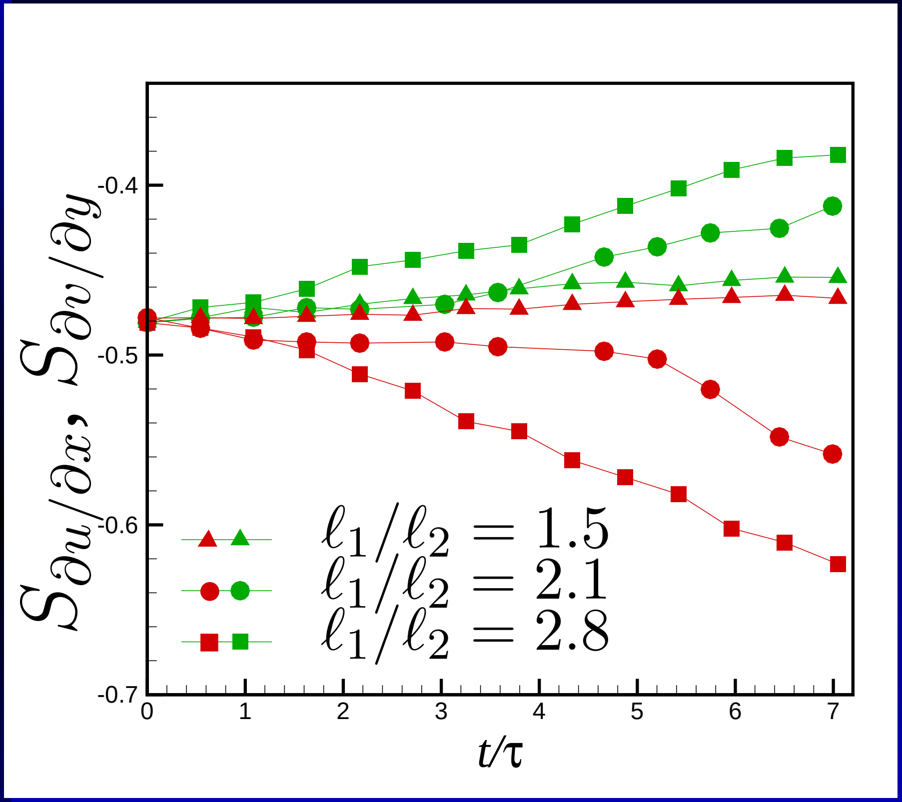

Spatial distribution of longitudinal moments,

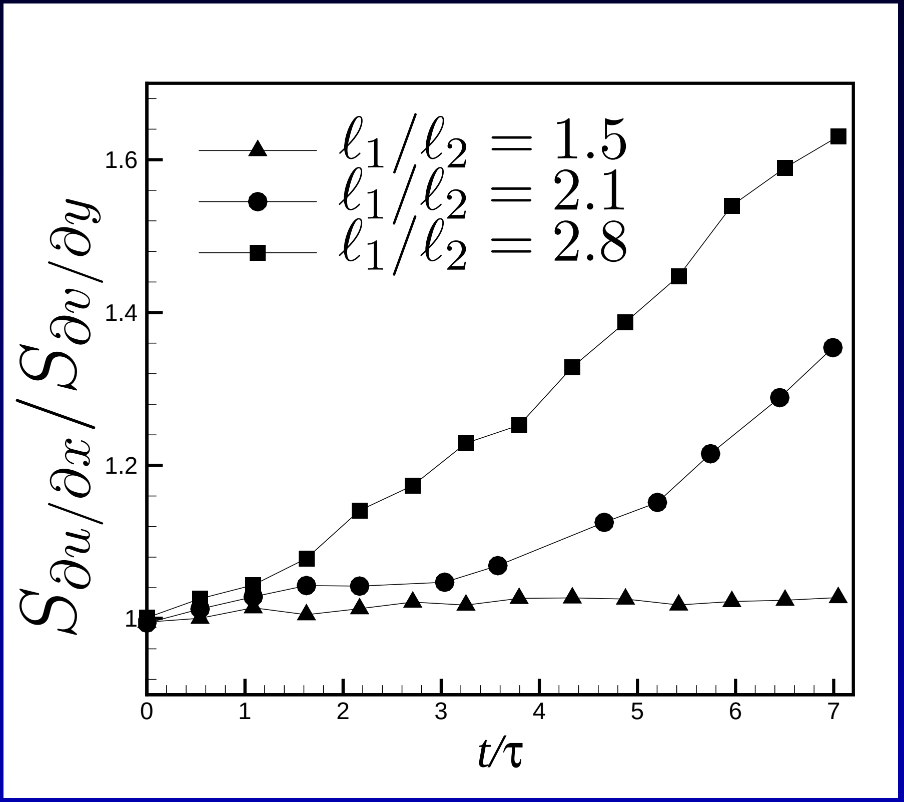
$\eta = x/\Delta$,

$x$, $u$ in the inhomogenous direction,

$y$, $v$ in homogenous directions.

# Longitudinal derivatives




Anisotropy is propagated to small scales.

# Conclusions

Simulations of a flow with an homogenous energy and an integral scale gradient show:

- an integral scale inhomogeneity generates an energy gradient
- the decay exponent of turbulent flow with the same initial energy depends on their integral scale $\Rightarrow$ the smaller the scale, the faster the decay.
- intermittency can be higher than that generated by an energy gradient and a uniform scale
- anisotropy and intermittency quickly spread to small scales.