

WP3.1: 1D reduced model

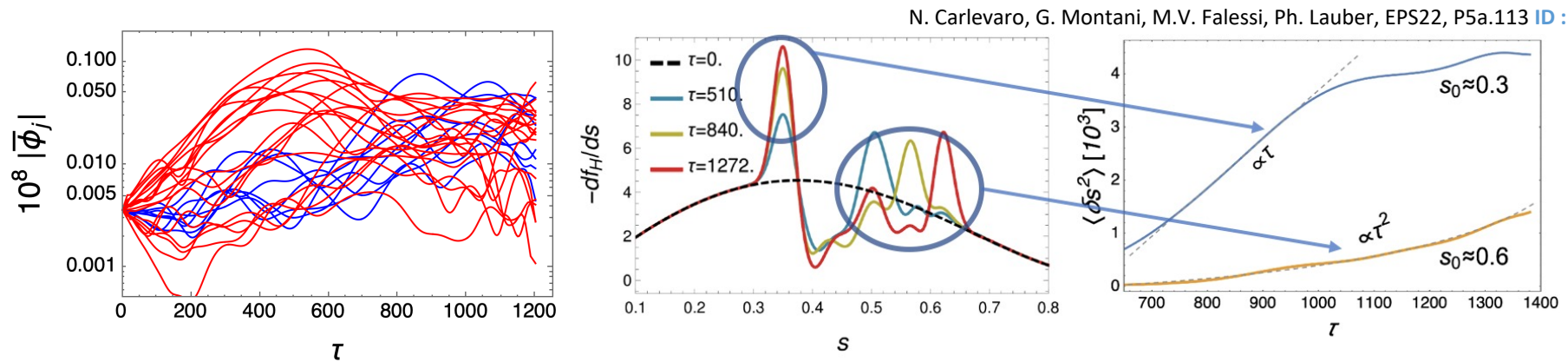
D2 - Updates

Nakia Carlevaro

ATEP Meeting 27/01/2023

WP3.1 – D2: Systematic statistical analysis of test particle transport and assessment of diffusive vs. non diffusive behaviors

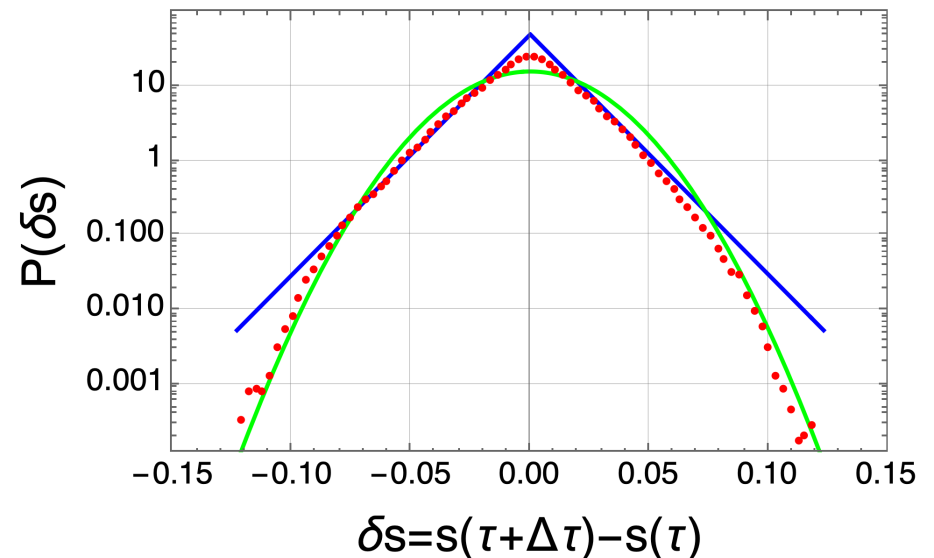
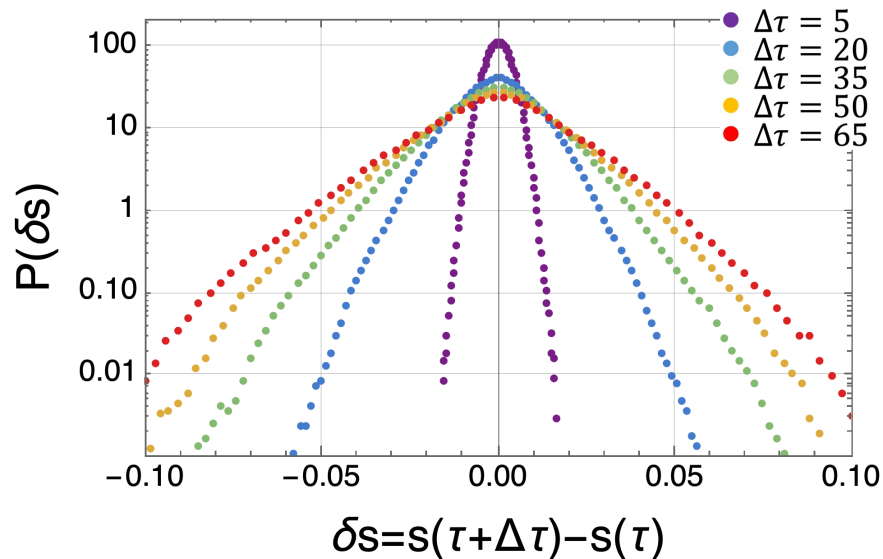
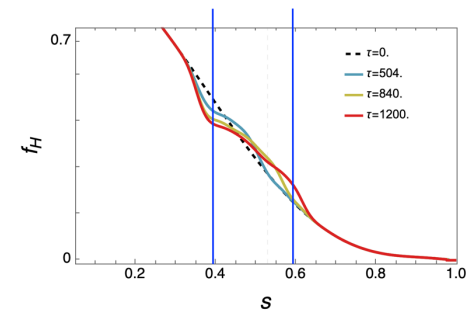
- Test particle transport is studied in the **1D reduced model**.
- **Local analysis** of mean square path already addressed for the ITER 15MA scenario
-> Avalanche excitation of the **low branch (linear stable)** yields to **convective transport** ($\sim \tau^2$).



- Limited volume -> difficulty to go further on tests of power dependence of mean square path.
- Setup for advanced/global **statistical analysis** is ready (new tracer code using **mid-point scheme** - second order in time).
- First analysis of test particle trajectories evaluating $\delta s = s(\Delta\tau + \tau) - s(\tau)$.
- δs (for a given $\Delta\tau$) calculated for a single trajectory, then the **histograms** for all tracers/trajectories are built and normalized providing the **global PDF of spatial displacements**.

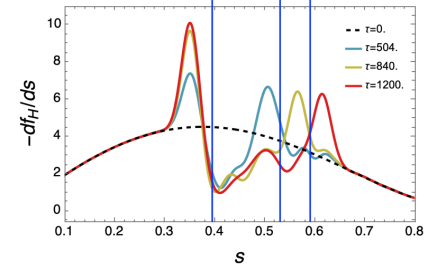
- **Preliminary results on diffusion**

- Comparison w/ **QLT (diffusive model)**
 - > trajectories defined by random walk
 - > PDF expected to be a **normal distribution** with expected value $\mu = 0$ and variance $\sigma = 2D\tau$
 - > also **exponential distribution** (memoryless random variables) can be addressed [Volokitin, Krafft, PPCF 54, 085002 (2012)].
- 10000 test particles initialized in the resonant region s_{r1} and s_{r2}

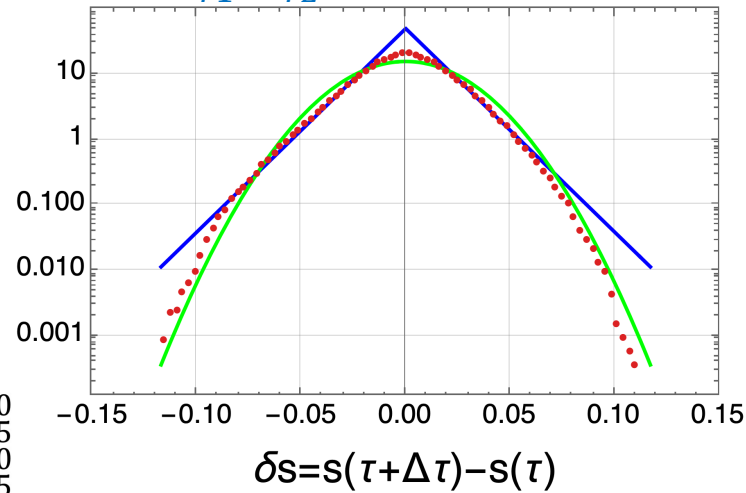
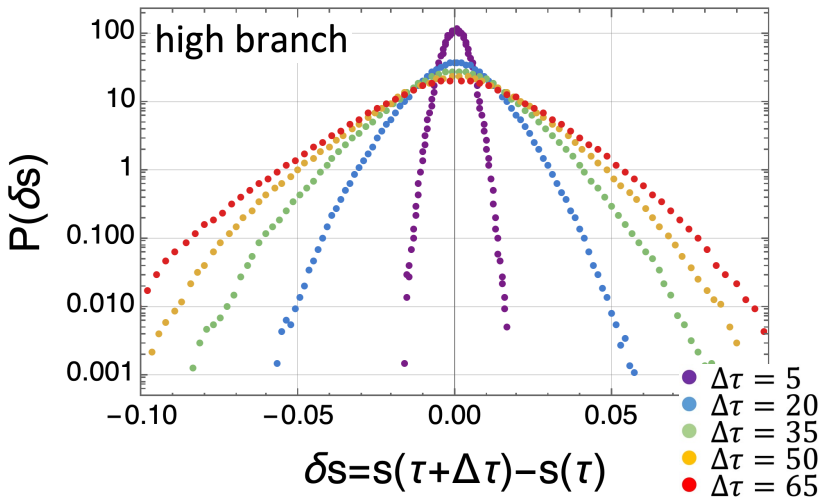


- Large $\Delta\tau$ indicate some diversion from normal distribution **towards exponential functions** (log scale).
- Nonetheless, the global PDF is reasonably normal: comparison wrt **diffusion coefficient predicted by the QLT**.

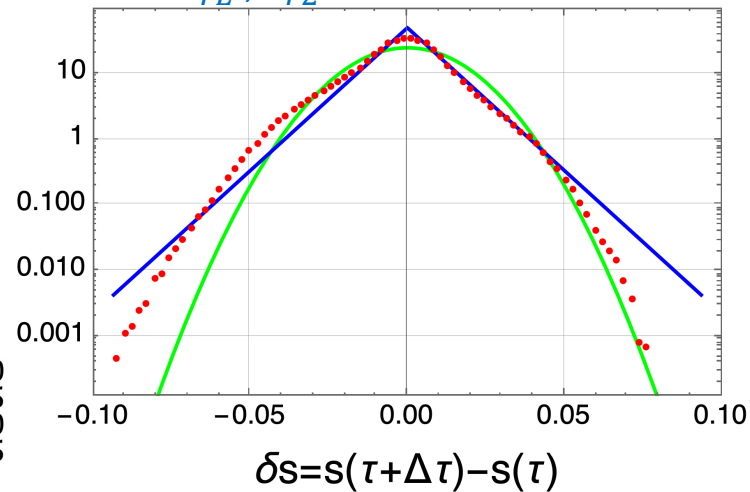
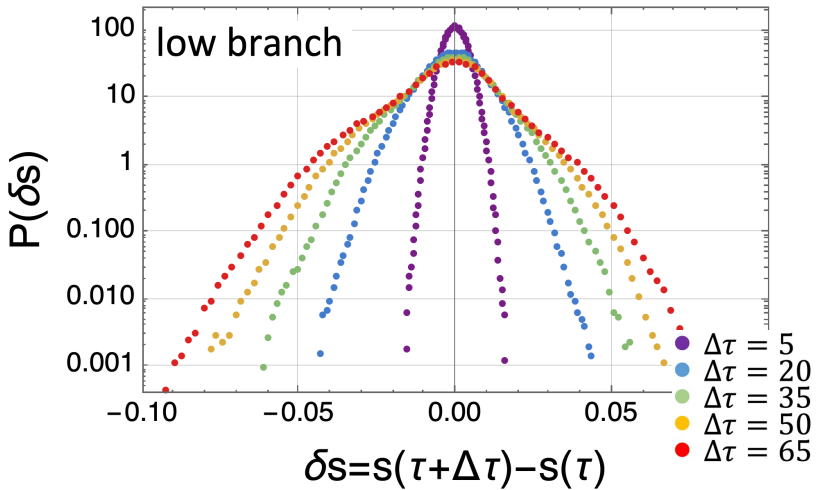
- Different tracer populations



Tracer initialization in $s_{r1} ; s_{rL}$



Tracer initialization in $s_{rL} ; s_{r2}$



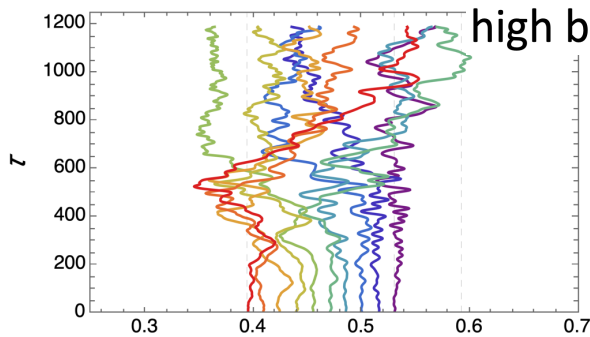
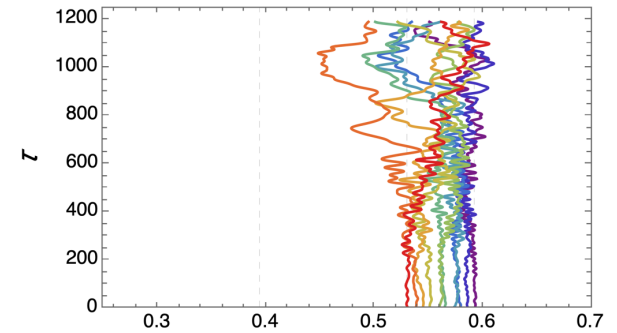
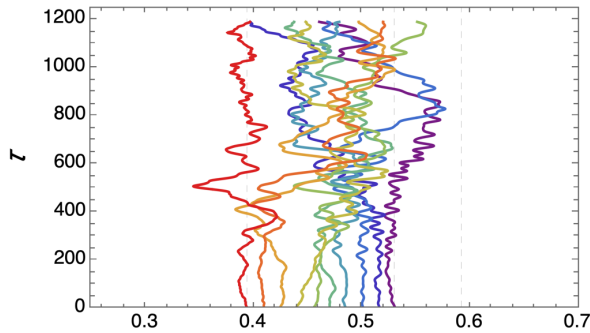
Marked deviation from normal distribution.

Asymmetry of the PDF

Non diffusive transport

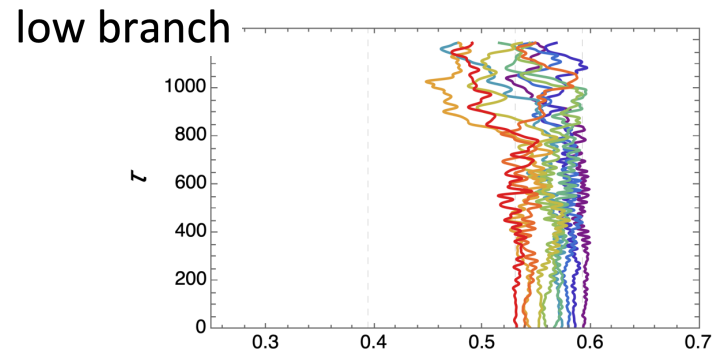
• Simple analysis of single trajectories

(Different behavior depending on the initial phase)

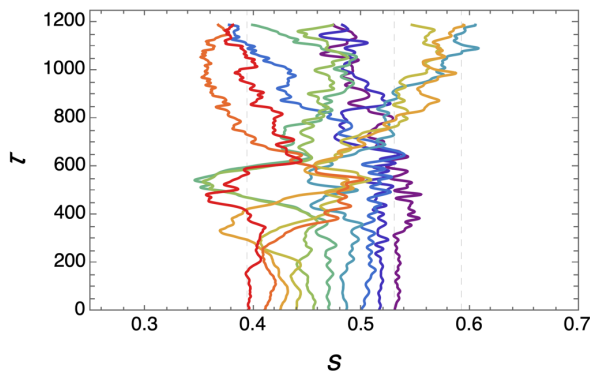


high branch

Drag of inner particles to the edge

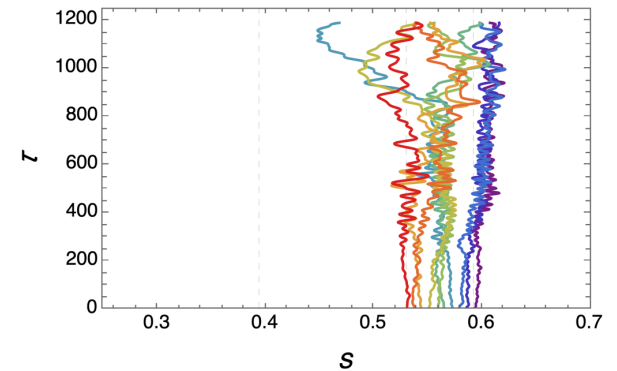


low branch



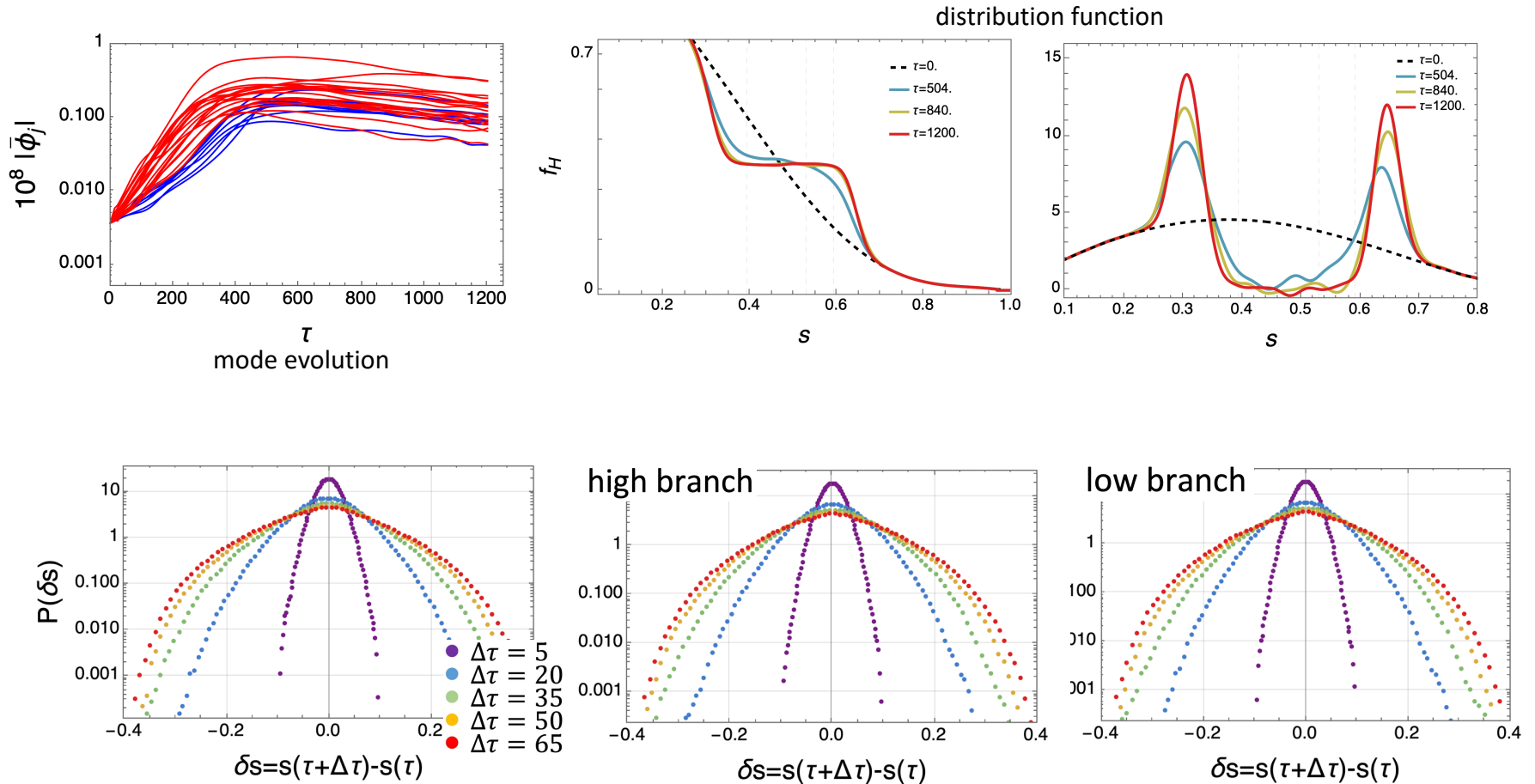
Excitation of linear stable modes

Motion towards the inner plasma



- Comparison wrt QL diffusion

Ad hoc QL set up -> reduced damping (now the low branch (blue) is linear unstable).



- The PDF are reasonably normal distribution.
- No differences between the high/low branch dynamics.
- Symmetry is preserved.

Concluding remarks

- These are **preliminary** results.
- The set up for the **advanced statistical analysis** is ready and fast.
- Parallel comparison wrt FTLE in the phase space and wave-particle trapping (transport barriers).
- Comparison of diffusion coefficients

$$D_{QL} \propto |\phi_k|^2$$

$$D_{tp} \propto \sigma_{PDF}$$

to quantify **discrepancy wrt QLT**.