

# Efficient distance computation for ellipsoids in dilute and dense particle-laden flows

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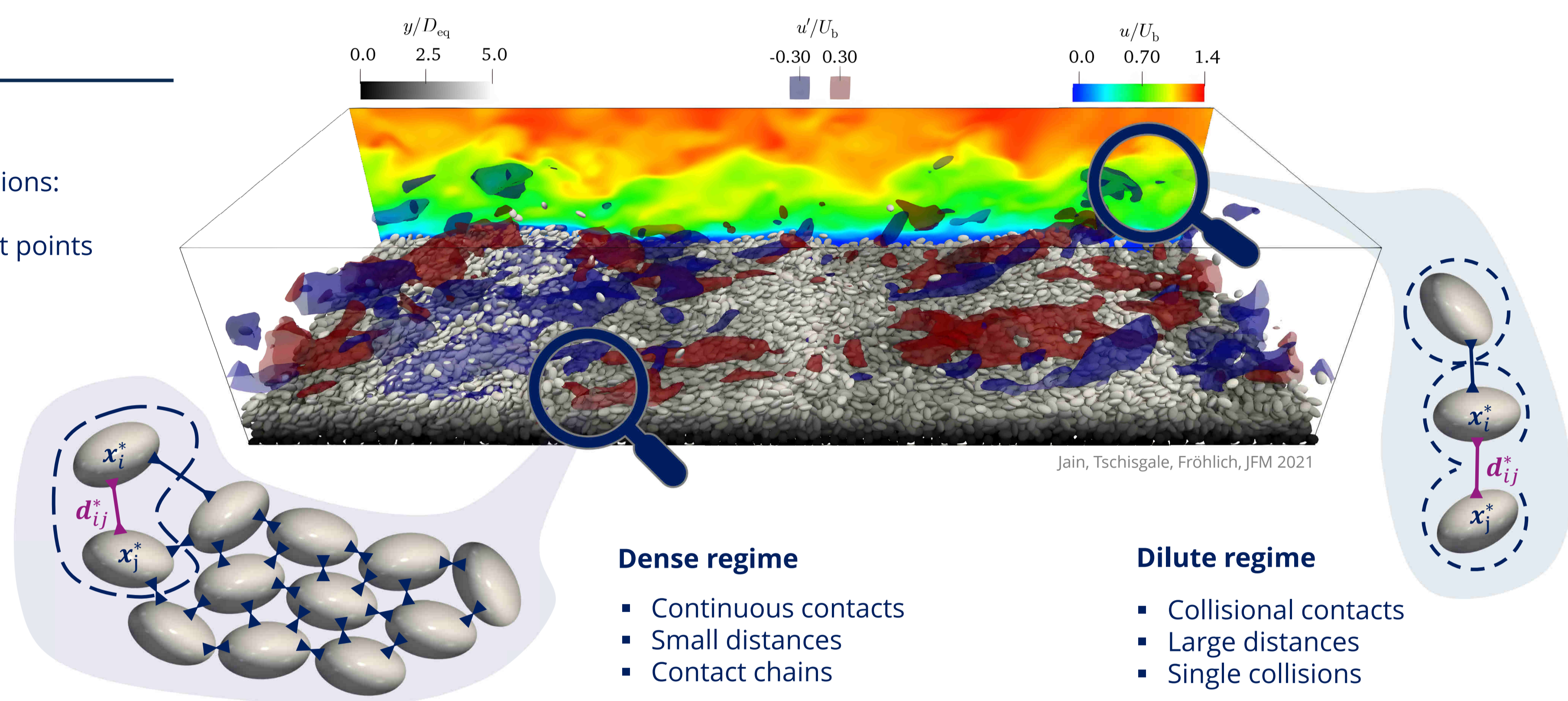
## Contact detection

### Particle-particle interactions

- Unresolved particle-particle interactions: collision and lubrication
- Models require distance and contact points
  - Collision model  $|d_{ij}^*| \leq d_{col}$
  - Lubrication model  $|d_{ij}^*| \leq d_{lub}$

### Contact points

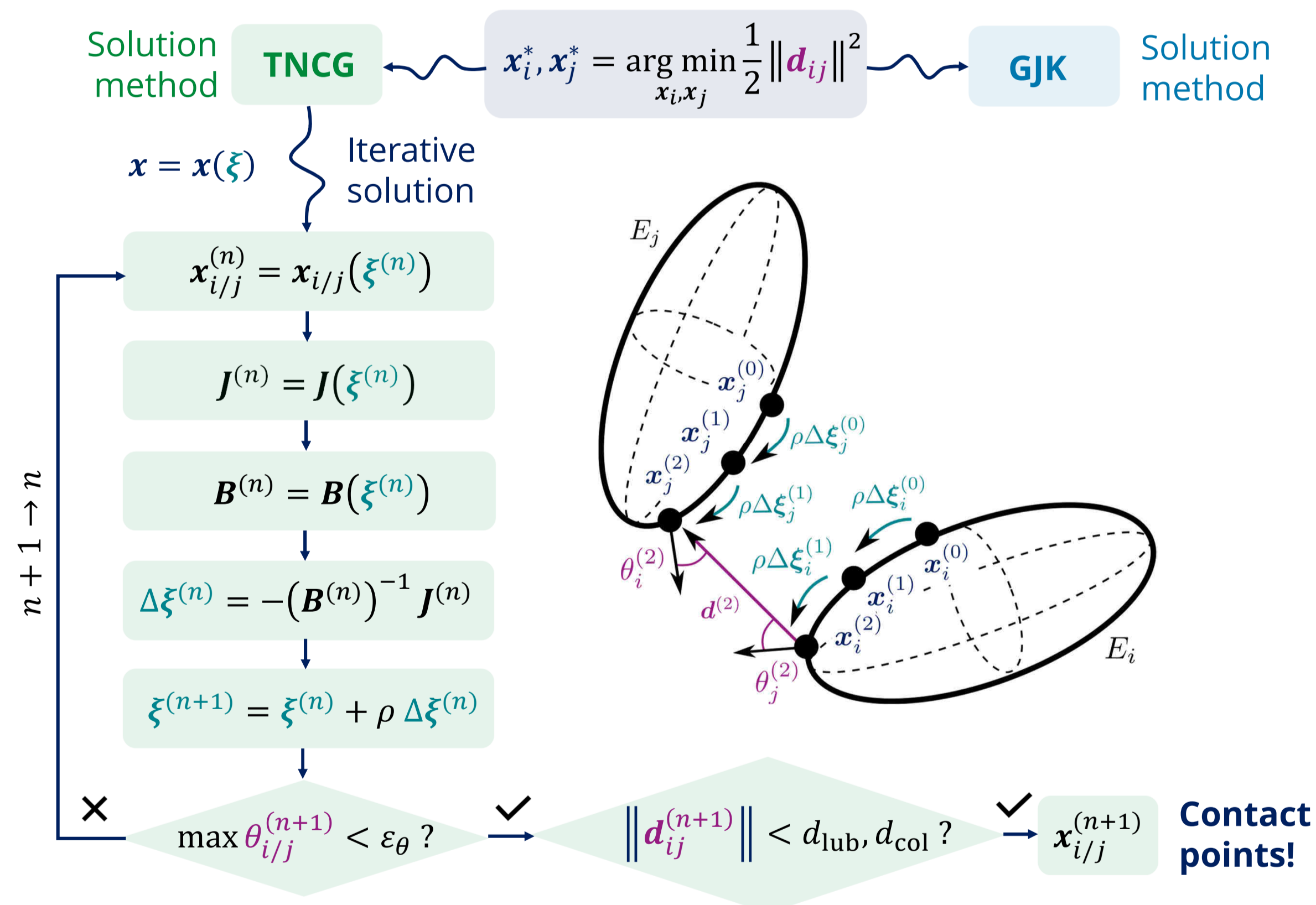
- State of the art algorithm: Gilbert-Johnson-Keerthi (GJK)
- New approach: Formulate as optimization problem and solve with Trust-Region Newton-Conjugate-Gradient (TNCG)



## Contact point calculation

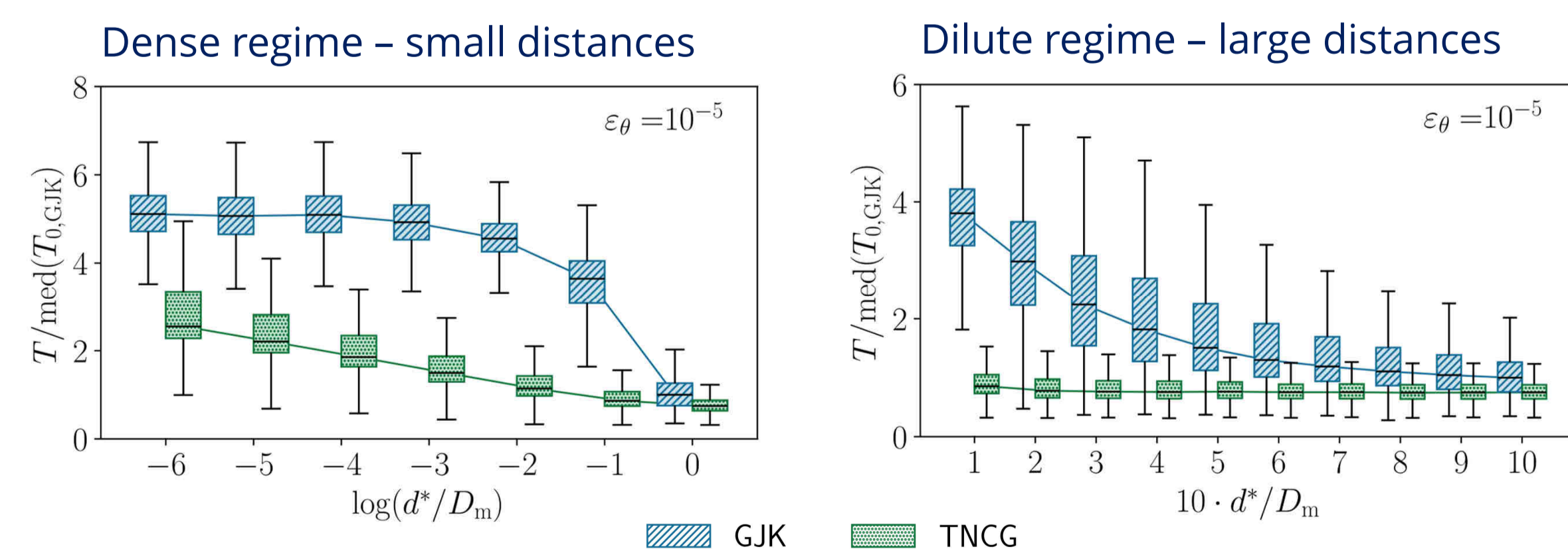
### Contact points: Minimum distance

Formulation of contact detection as minimum distance problem  
Iterative solution of minimum distance problem with TNCG



### Problem solution: Comparison of CPU time

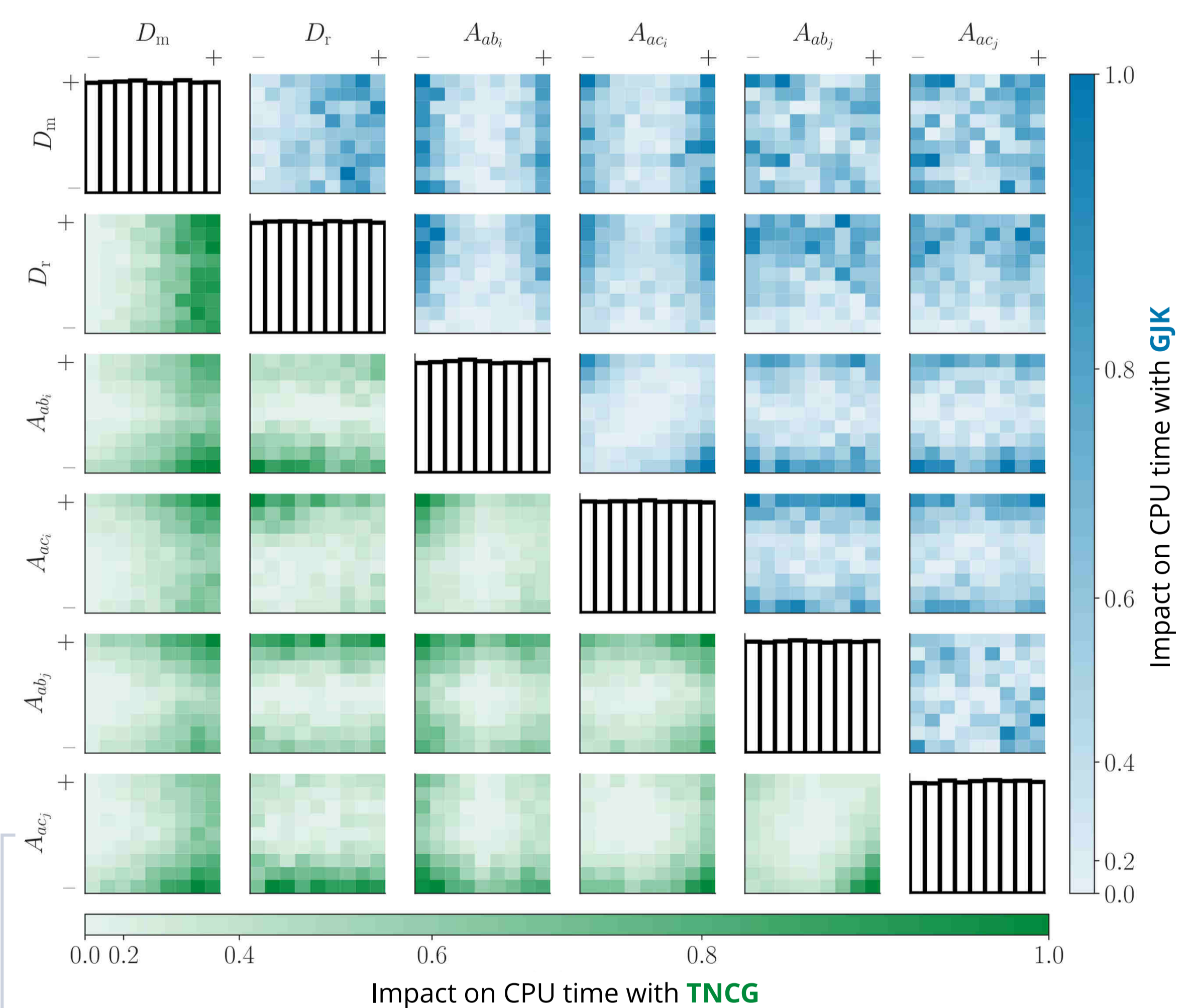
Comparison of TNCG and GJK for small and large distances between ellipsoids



## Performance analysis

### Performance: Impact of collision configuration

Impact of parameters on CPU time evaluated with  $7 \cdot 10^5$  pairs of ellipsoids  
Histograms of parameter distributions on main diagonal



### Parameters investigated

Diameters	Axis ratios $E_i$	Axis ratios $E_j$
$D_m = 0.5(D_i + D_j)$	$A_{ab_i} = a_i/b_i$	$A_{ab_j} = a_j/b_j$
$D_r = D_i/D_j$	$A_{ac_i} = a_i/c_i$	$A_{ac_j} = a_j/c_j$

## Achievements

- Formulation and solution of contact detection as 4D optimization problem
- Implementation of adapted TNCG algorithm
- Detailed analysis of factors influencing performance
- Improved performance and robustness compared to GJK