Understanding the Kinetics of Protein–Nanoparticle Corona Formation

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Obra Social Fundación "la Caixa"

Seventh Framework Programme

Generalitat de Catalunya

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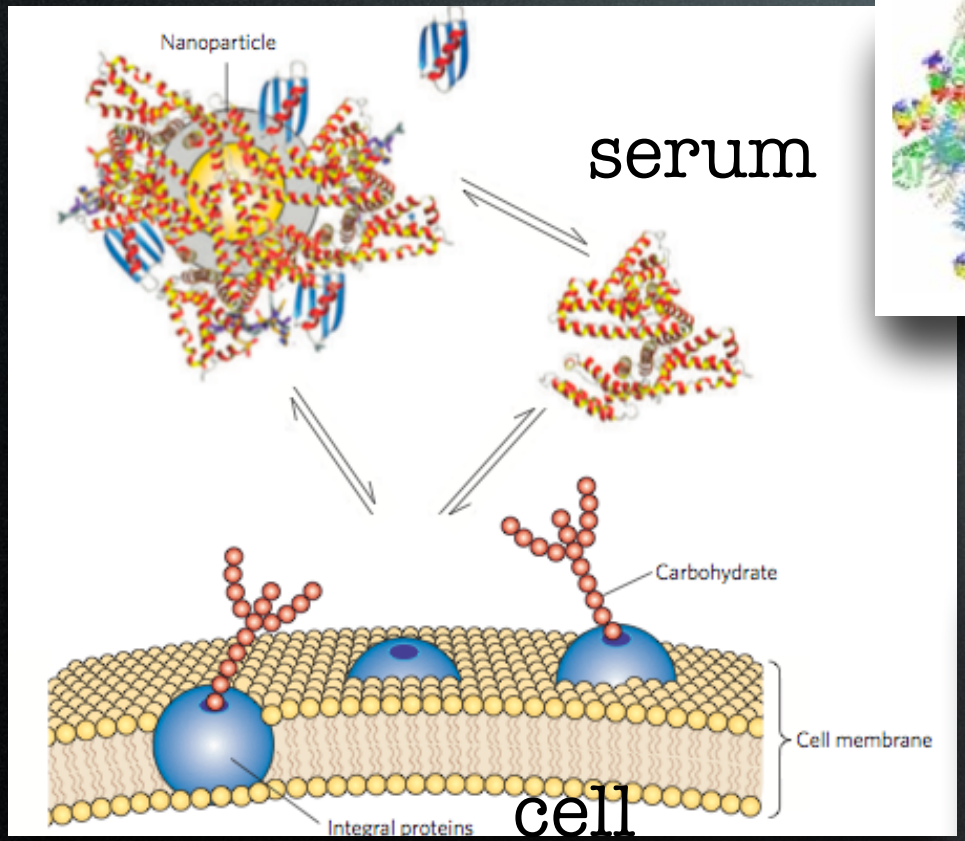
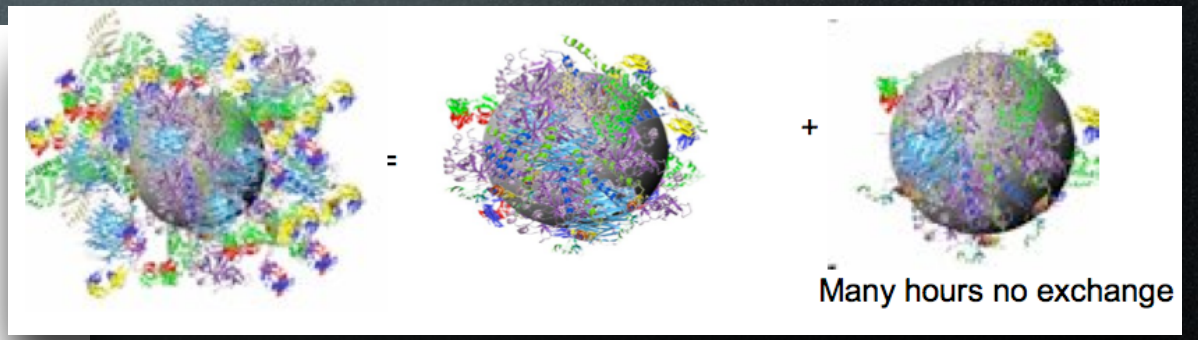
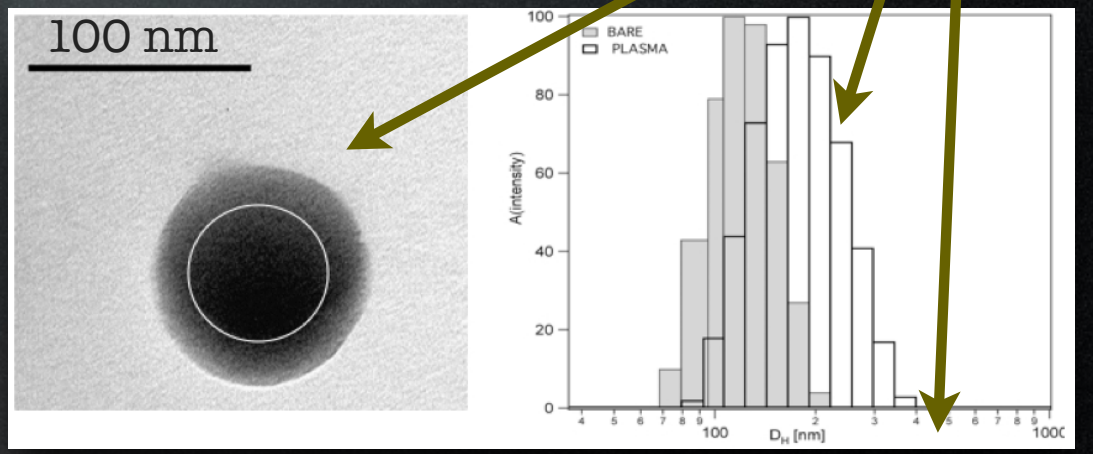
Gobierno de España · Ministerio de Economía y Competitividad

Protein Corona





Complete corona = Dynamic corona + Hard corona

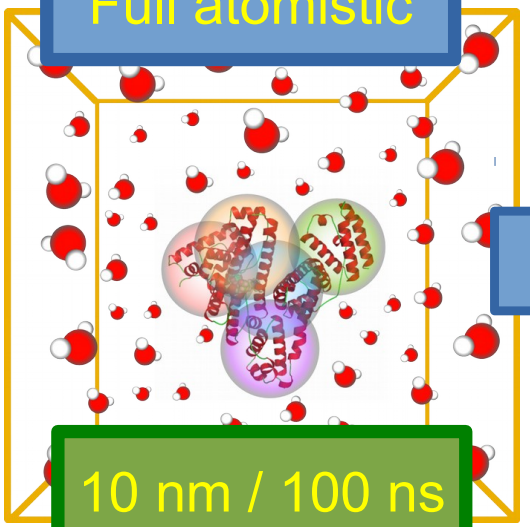


Stable: characterizes the uptake

I. Lynch, & K. A. Dawson, Nano Today 3, 40 (2008)
I. Lynch, A. Salvati & K. A. Dawson, Nature Nanotechnology (2009)
D. Walczyk, F.B. Bombelli, M.P. Monopoli, I. Lynch & K. A. Dawson JACS 132, 5761 (2010)

Multi-scale approach for Proteins & Nanoparticles

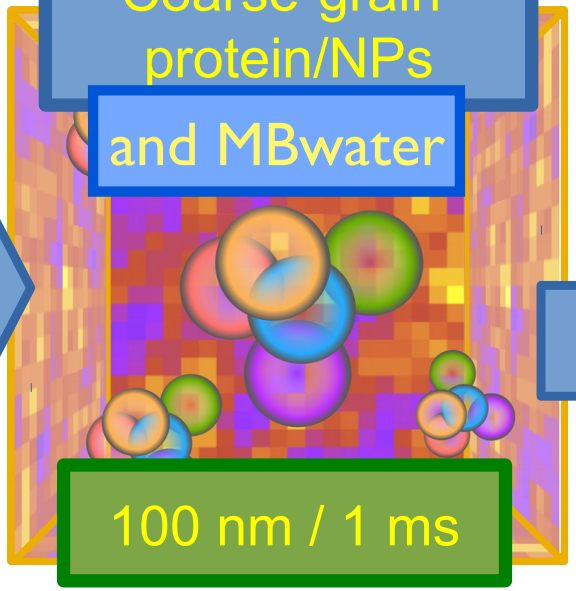
Full atomistic



10 nm / 100 ns

!

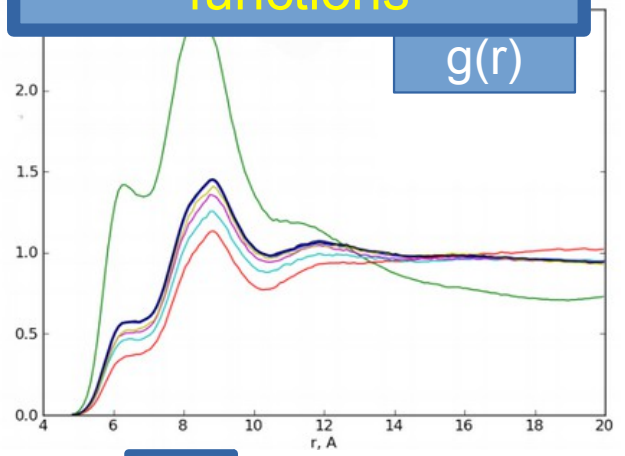
Coarse-grain protein/NPs and MBwater



100 nm / 1 ms

...

Radial distribution functions



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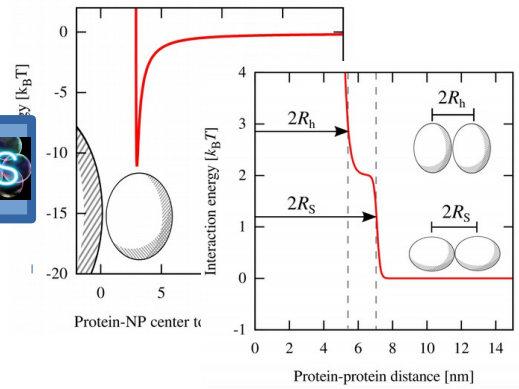
Effective potentials



Experiments

BUBBLES

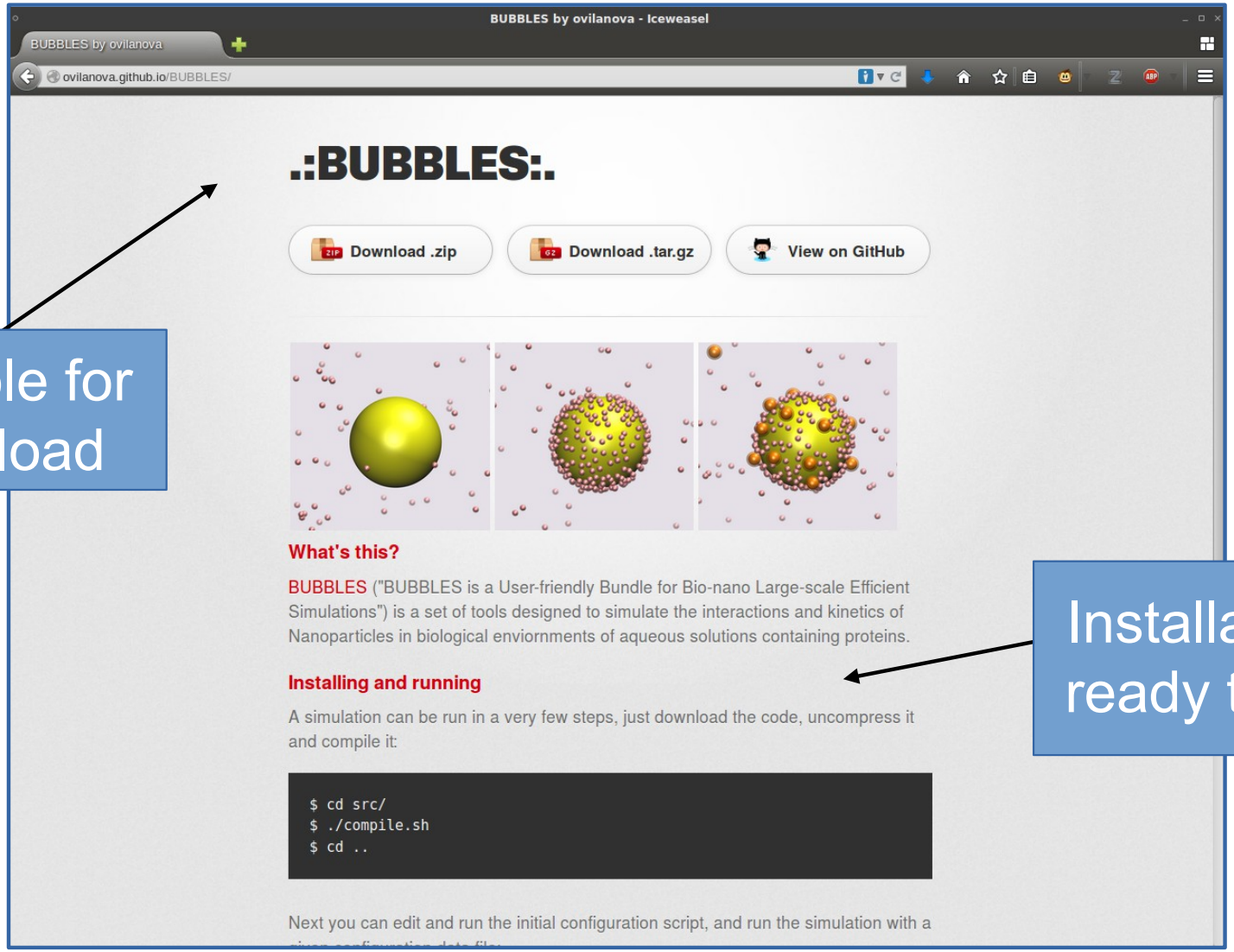
NPs in protein solutions

1 μm / 1 min

How can we extract model parameters from experiments and make a predictive model?

Application Suite Website

Bubbles is a User-friendly Bundle for Bio-nano Large-scale Efficient Simulations



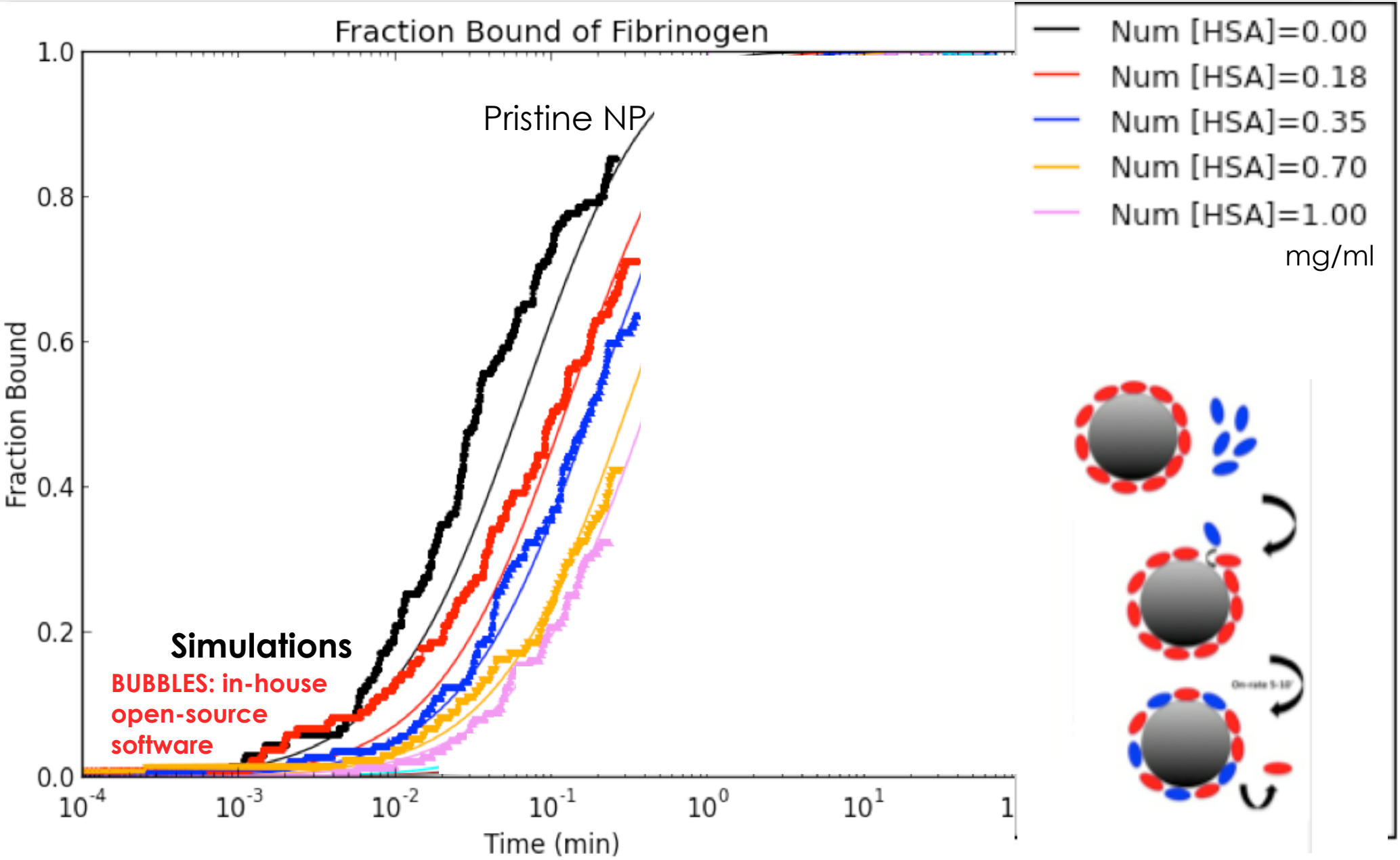
Available for download

Installable & ready to use

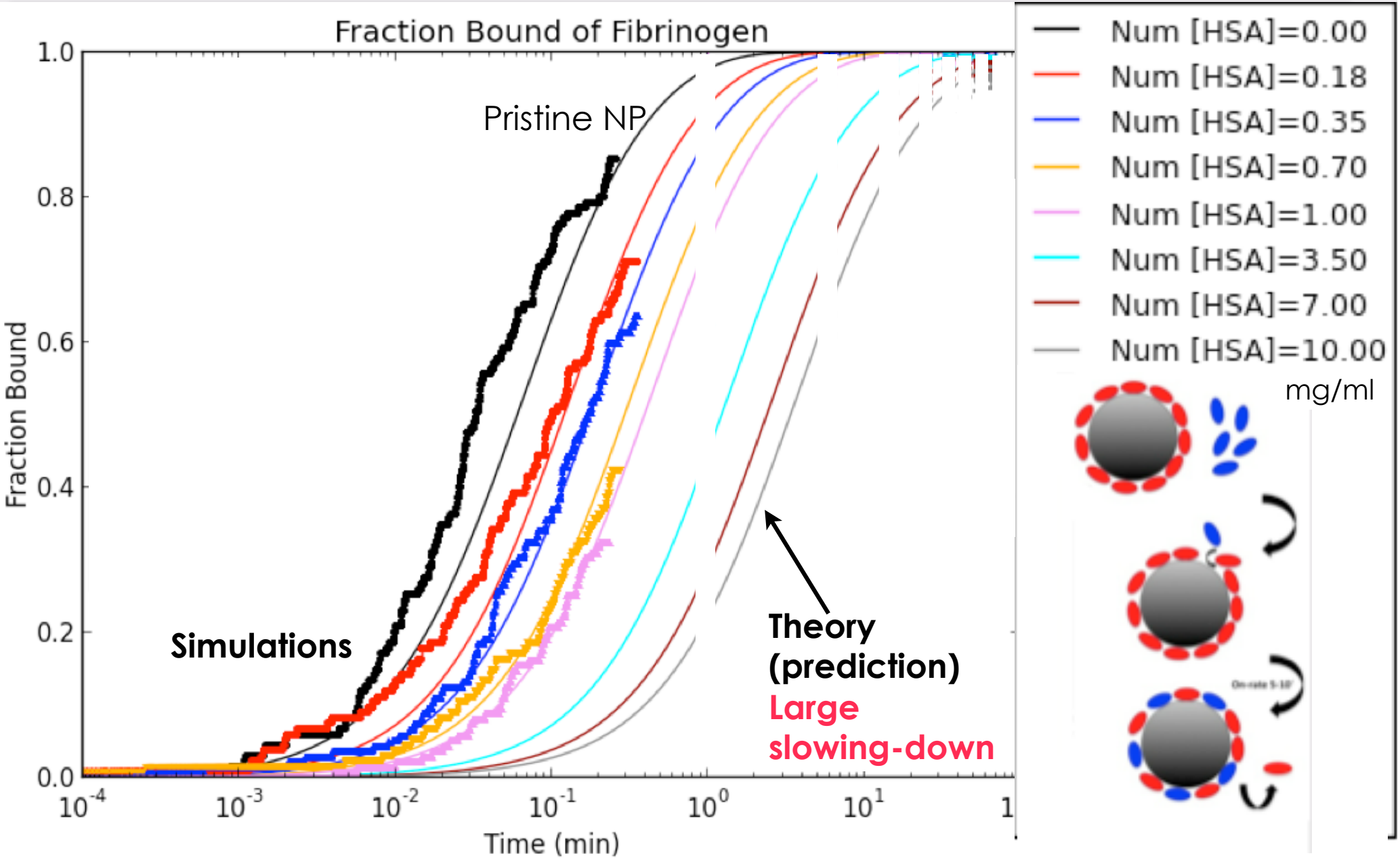
https://github.com/bubbles-suite/BUBBLES

Kinetics for competing proteins adsorbing on a NP?
Comparison with experiments?

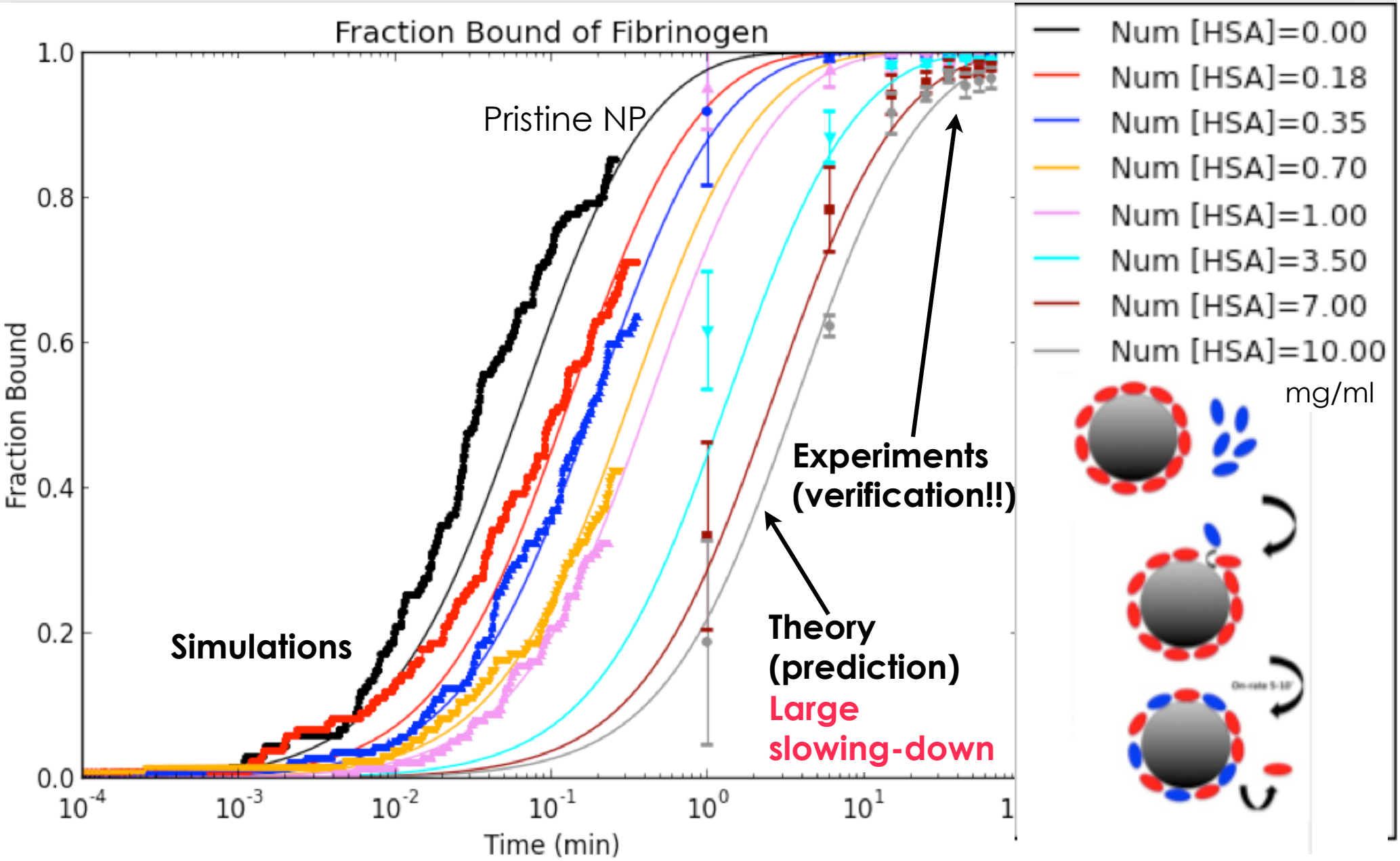
Prediction for Fib competing with HSA (precoated on NP) for increasing [HSA]



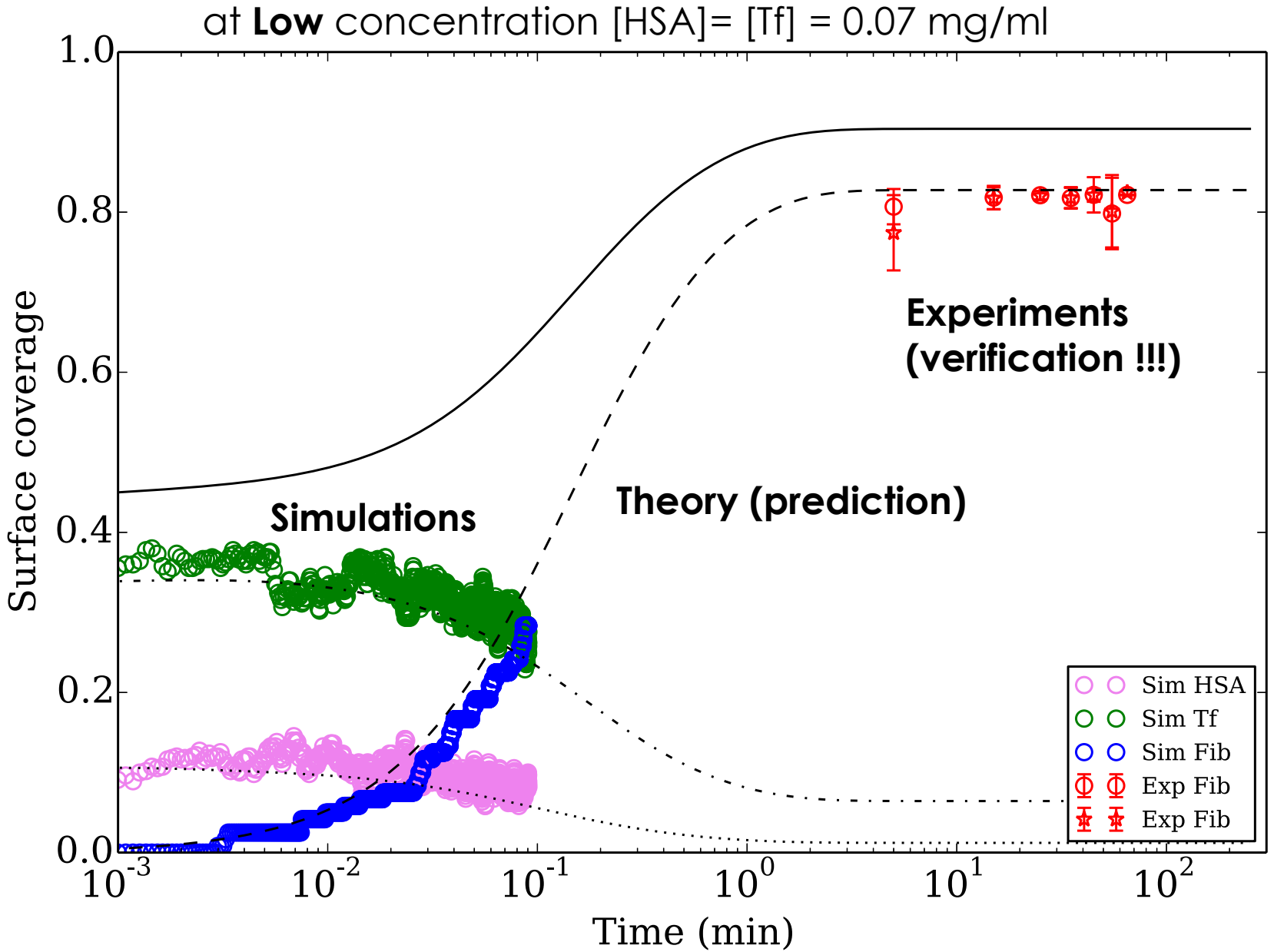
Prediction for Fib competing with HSA (precoated on NP) for increasing [HSA]



Verification for Fib competing with HSA (precoated on NP) for increasing [HSA]



3 Proteins (HSA 1st + Tf 2nd + Fib 3rd) competition on SiO2 100 nm NPs



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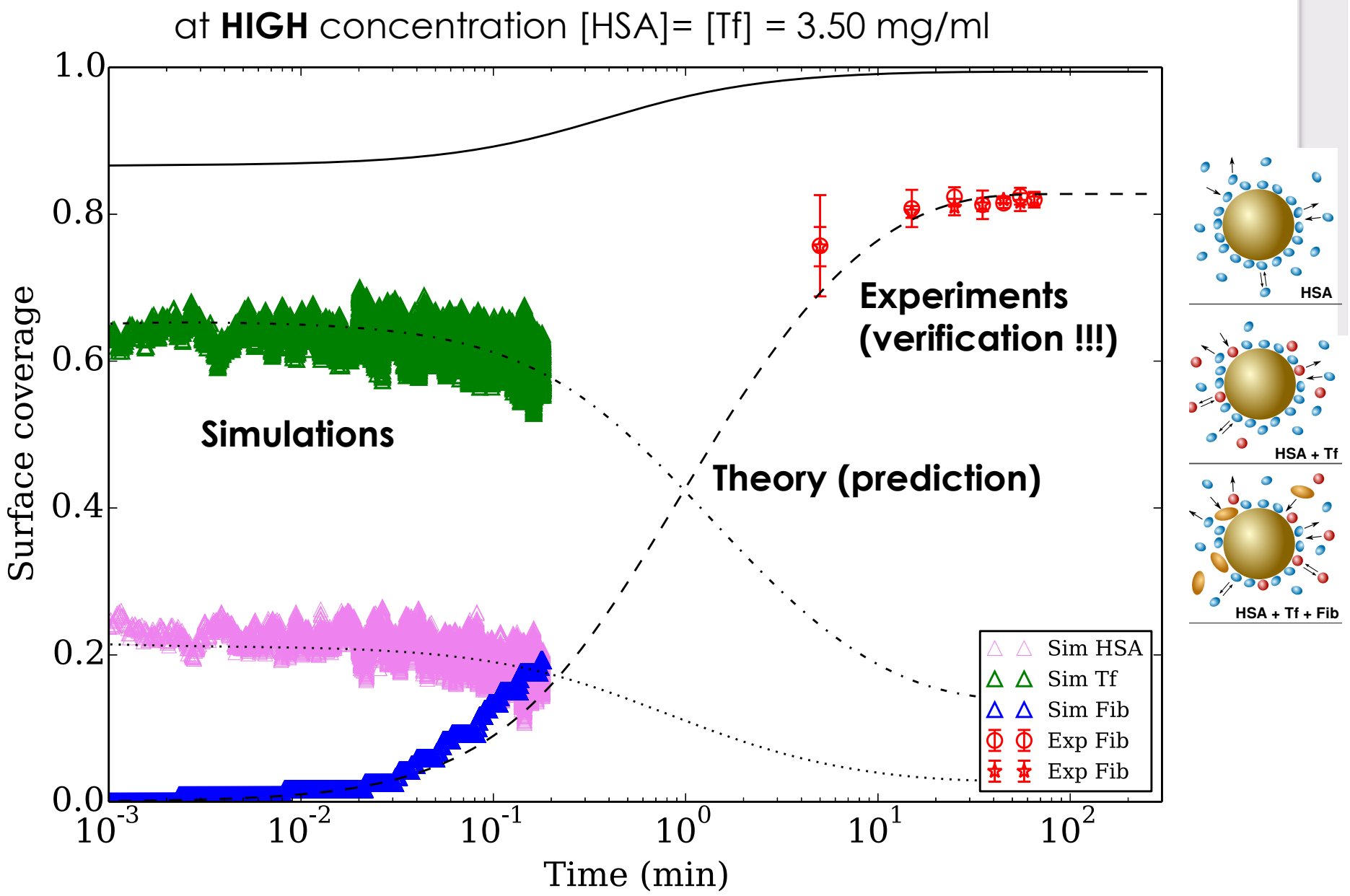
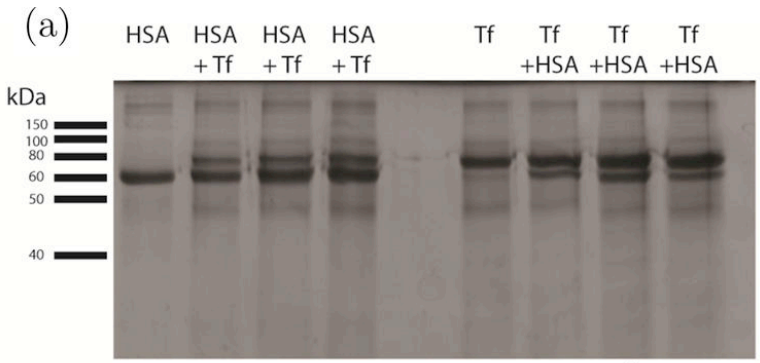
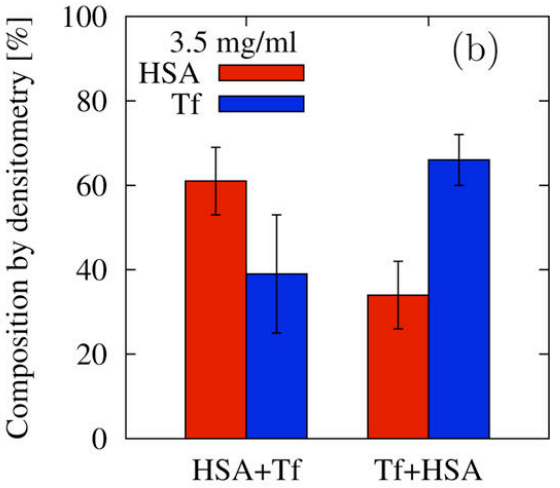


Memory Effect: invert the incubation order (>1h) changes the hard-corona

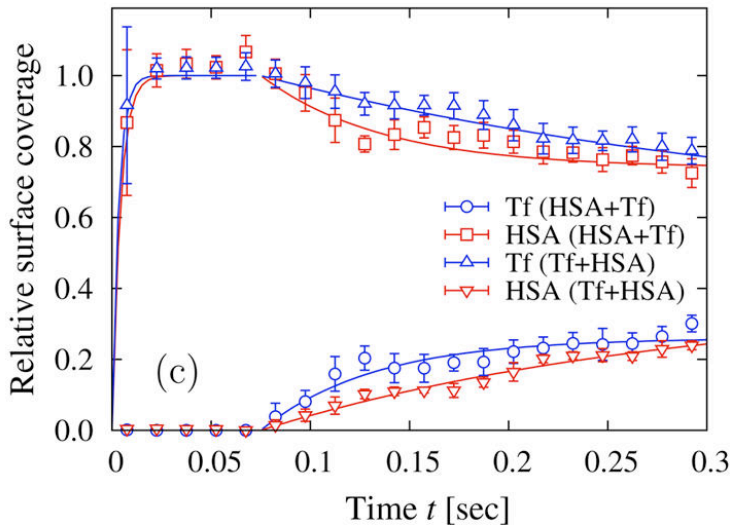


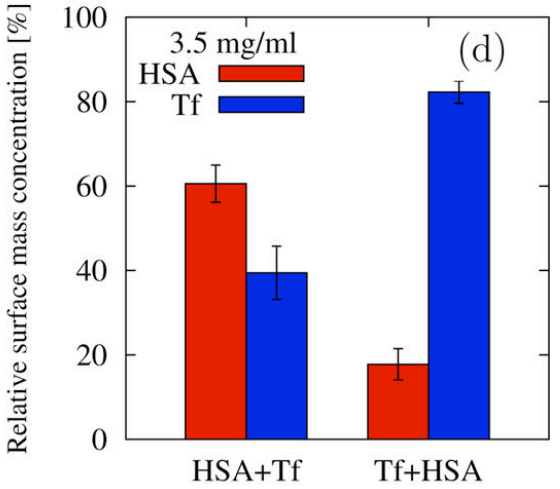
SDS-PAGE gel

[HSA] = [Tf]= 3.5 mg/mL



- need of **3-body interactions** to reproduce the effect
- interpretation: **irreversible degeneration of adsorbed proteins**





Conclusions

- **TAKE HOME MESSAGE**: We can predict the **multicomponents NP-protein corona kinetics & composition** from **experiments of monocomponent** solutions.
- We understand **kinetics of hard and soft NP-corona** (Open-source software: Bubbles "Bubbles is a User-friendly Bundle for Bio-nano Large-scale Efficient Simulations" https://github.com/bubbles-suite/BUBBLES).
- **Memory Effect**: possible indication of **irreversible degeneration of adsorbed proteins.**
- **Size Effect:** Protein **corona composition changes with NP-size**;

  Total adsorbed proteins increase with NP-size.
- **Case study**: ternary "plasma" (at low and HIGH concentration)
- **Which is the biologically relevant part of the corona?**

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Understanding the Kinetics of Protein–Nanoparticle Corona Formation

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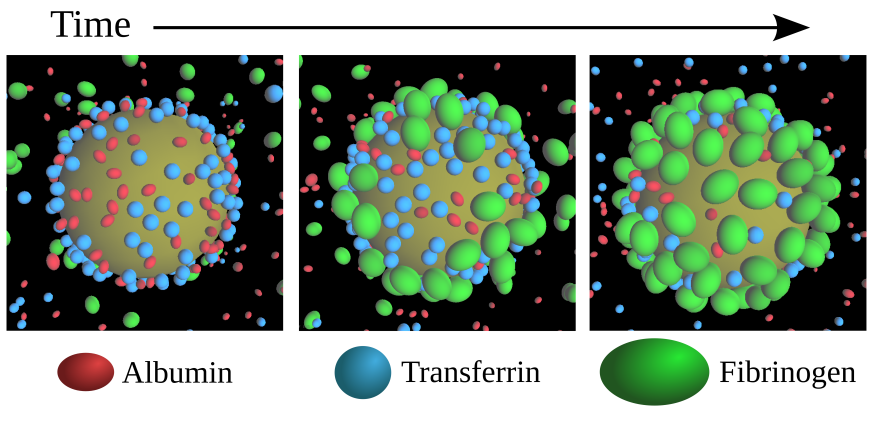

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Universitat de Barcelona

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http://www.ffn.ub.es/gfranzese

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SEVENTH FRAMEWORK PROGRAMME

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