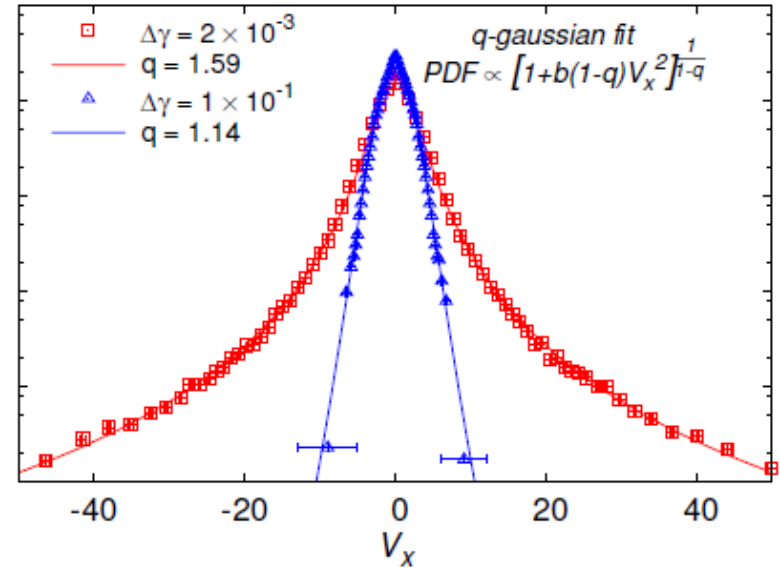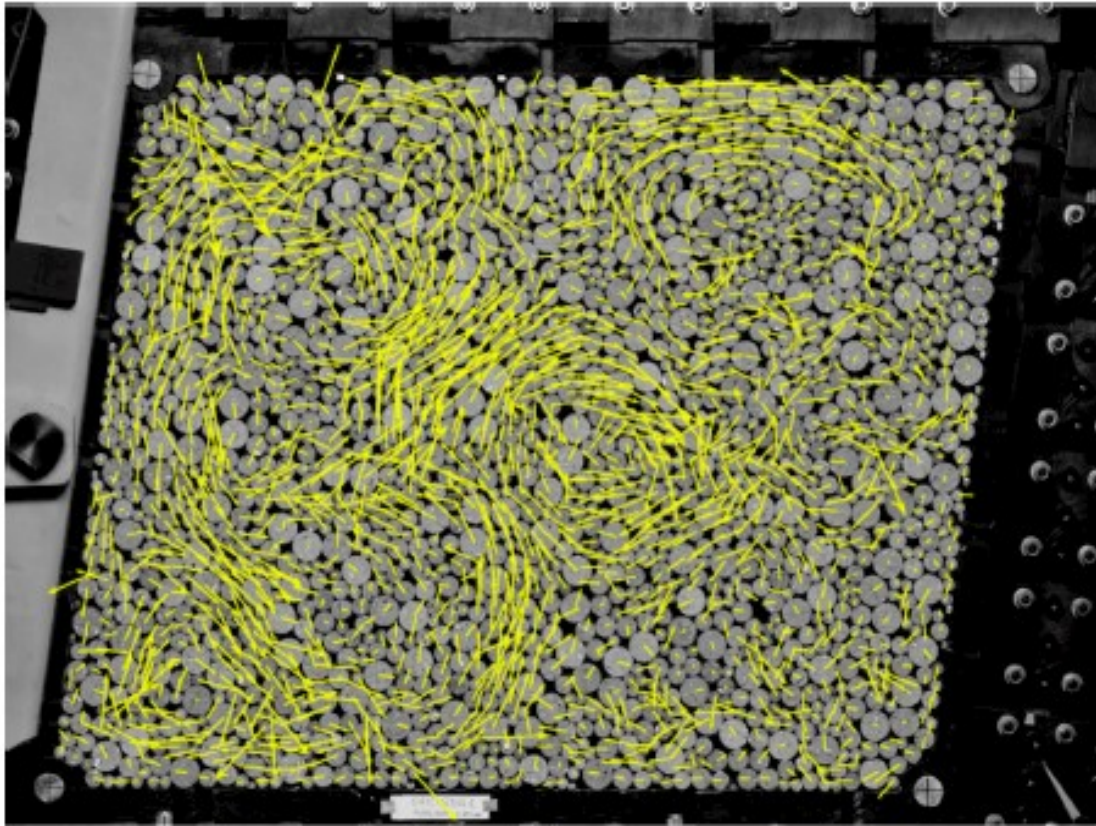# Experimental evidence of "Granulence":
non-gaussian displacement fluctuations in a 2D granular material close to unjamming transition

Allbens ATMAN Picardi Faria

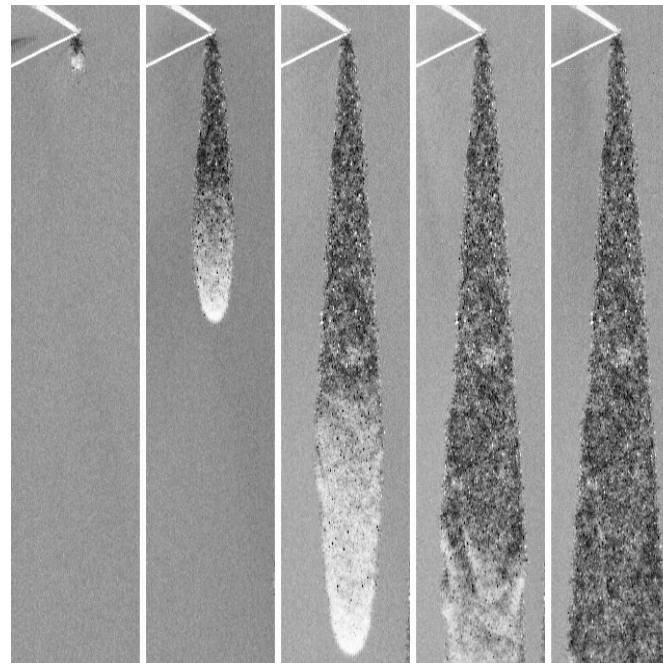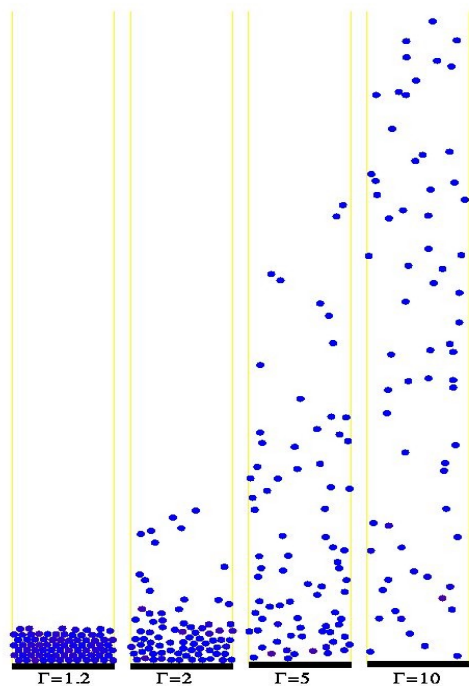**Departamento de Física e Matemática**
INCT – Sistemas Complexos
CEFET/MG

Basic Concepts

Classical states of the matter

Gas	Liquid	Solid

$\Gamma=1.2$ $\Gamma=2$ $\Gamma=5$ $\Gamma=10$

Granular sunder vibration:
Granular temperature

A.Daerr, S.Douady , NATURE **399** 241 (1999)
Avalanches in granular
displacements

Sandpiles
(J-B Métais)

Complex fluid *x* soft matter

Gas
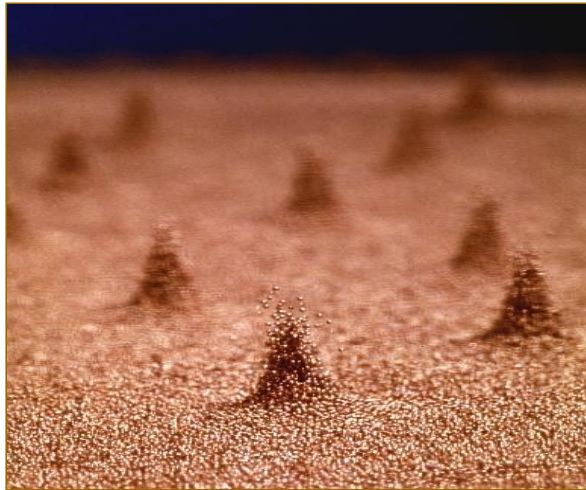
Liquid

Solid
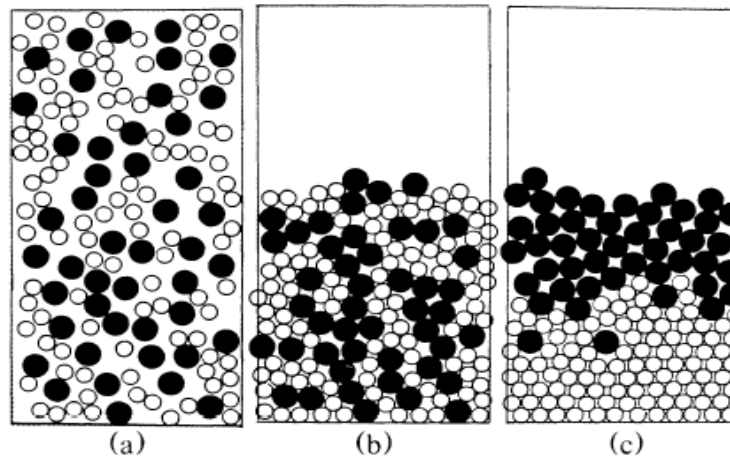

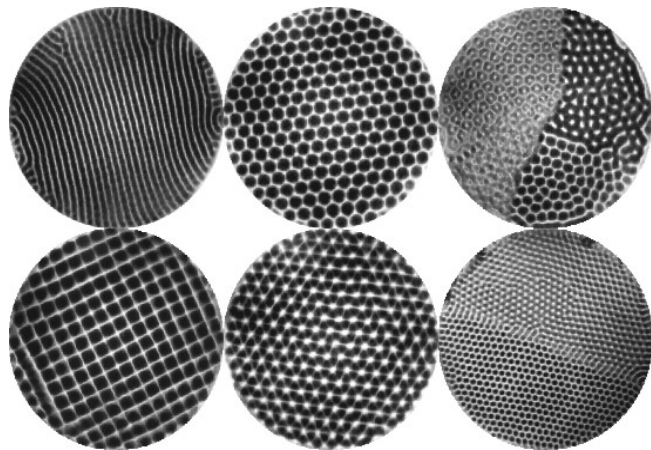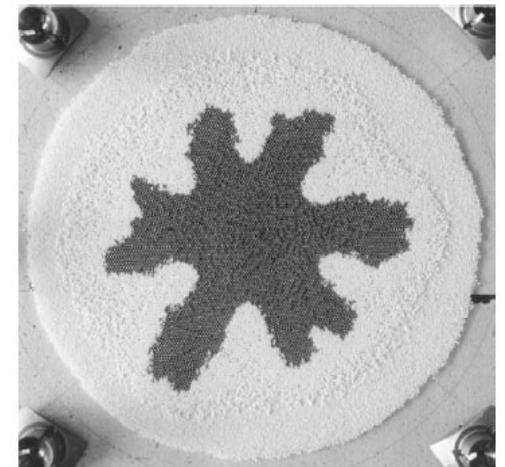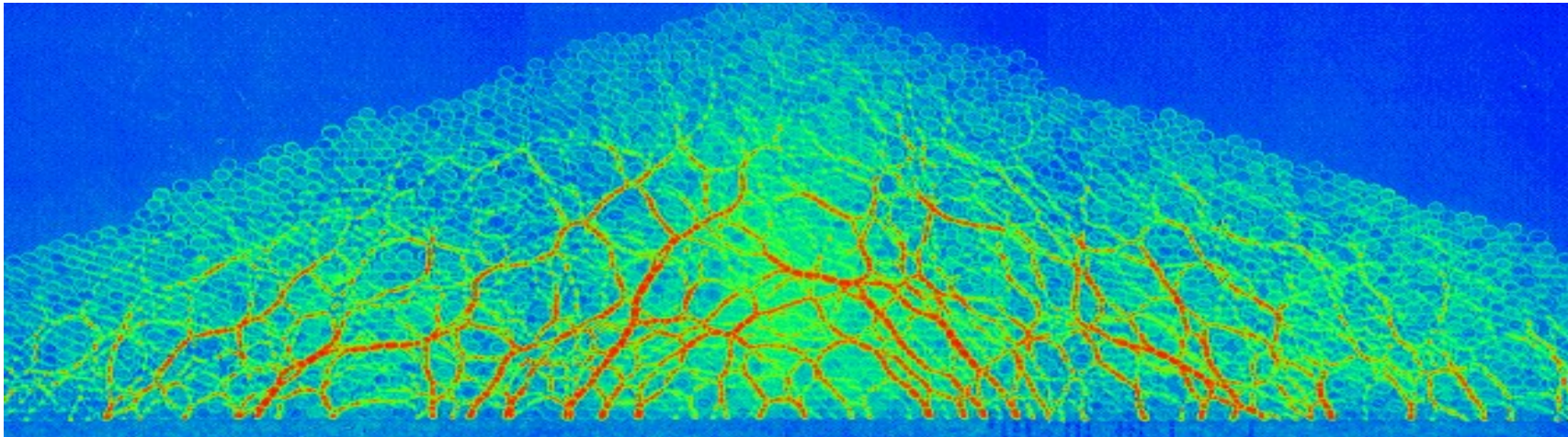F. Melo et al, PRL **75** 3838 (1995).
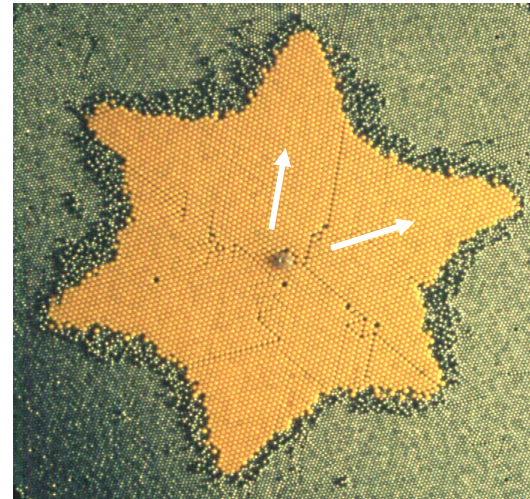
S.F. Pinto, M. S. Couto, **A.P.F. Atman** et al, *PRL*, **99**, 068001 (2007)
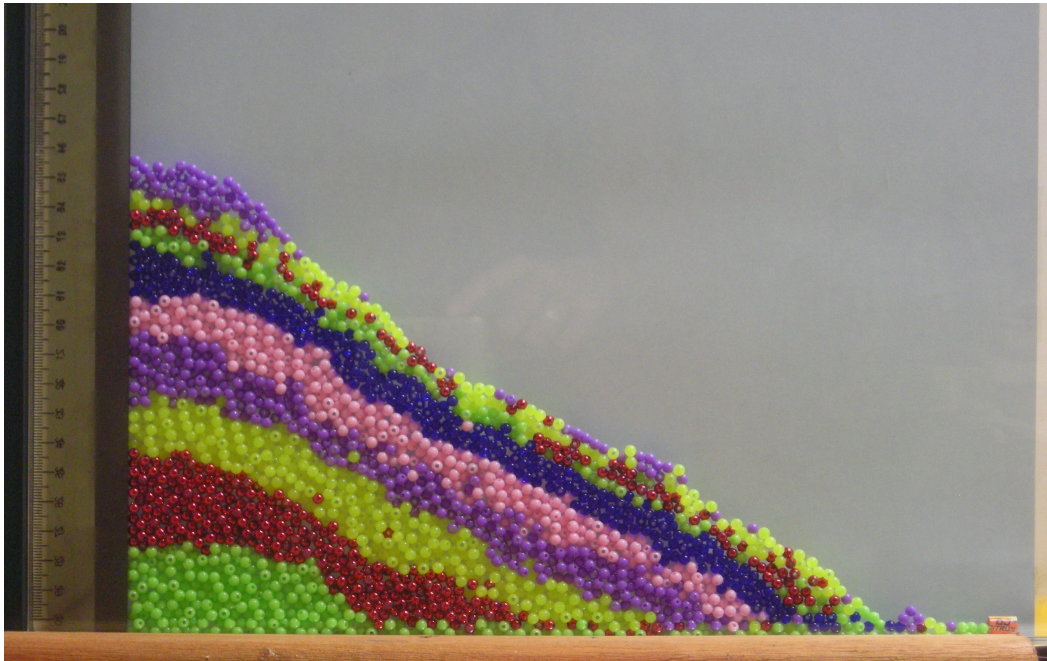

(a)   (b)   (c)
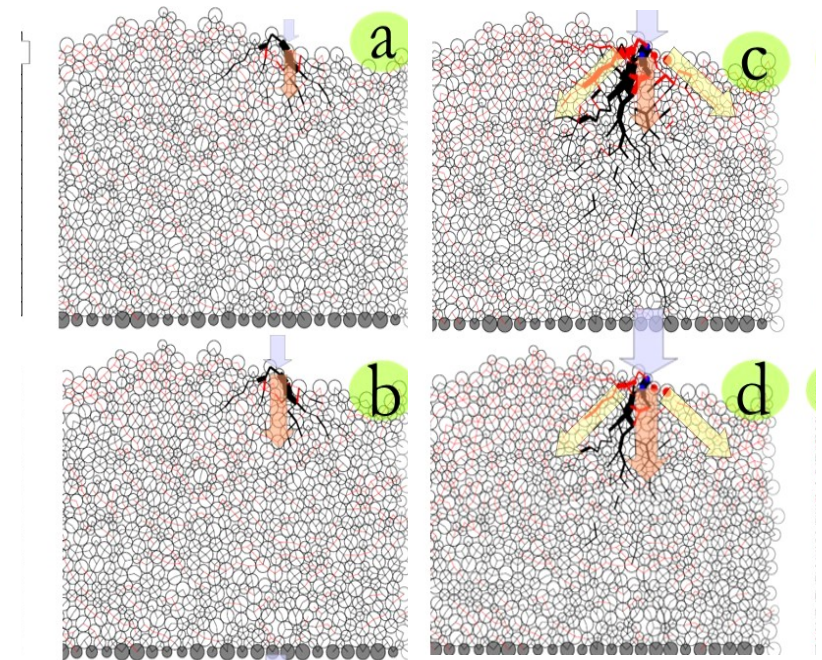
A. Rosatto et al., PRL **58**, 1038 (1987)

Unjamming transition

Geng et al
PhysicaD
182, 274
(2003)

A. C. Oliveira, A.P.F. Atman and J.G. Moreira,
unpublished.

ATMAN, A. P. F. , GOLDHIRSCH, Isaac et al. In: Proceedings of the 6th
International Conference on Micromechanics of Granular Media.: AI P, 2009.
p. 492-495.

Unjamming in sandpiles:
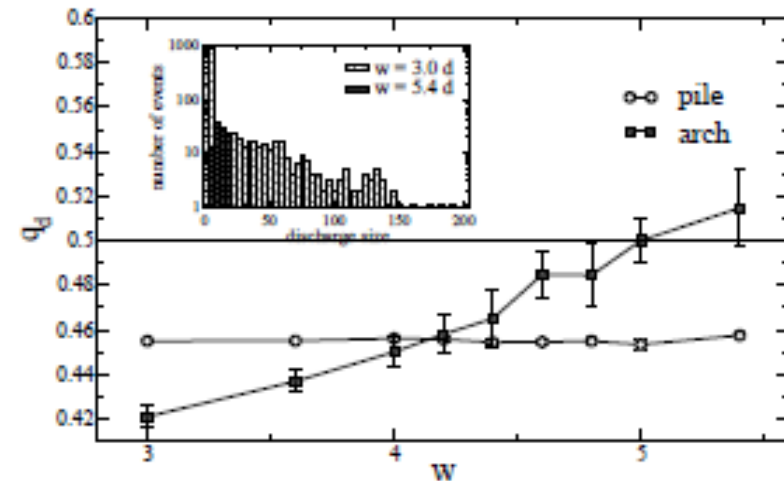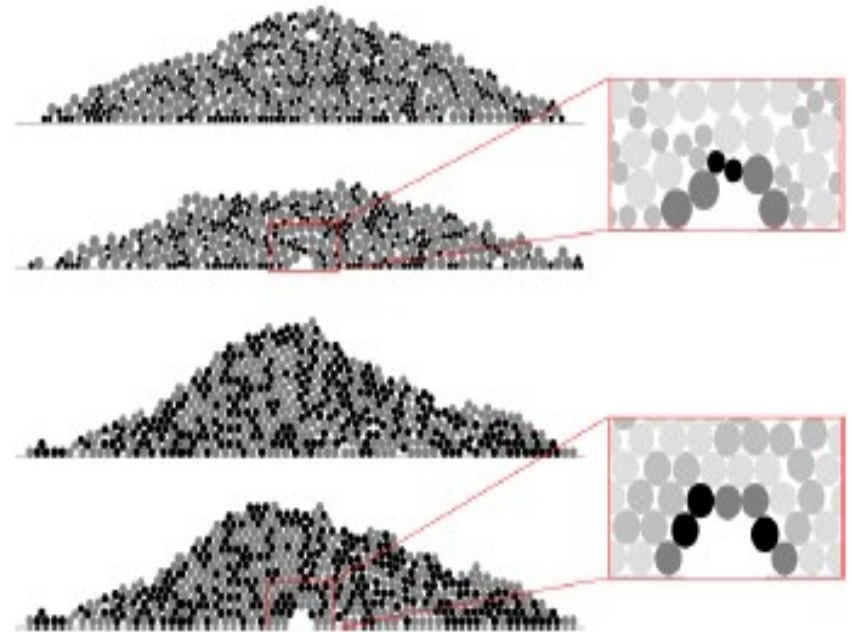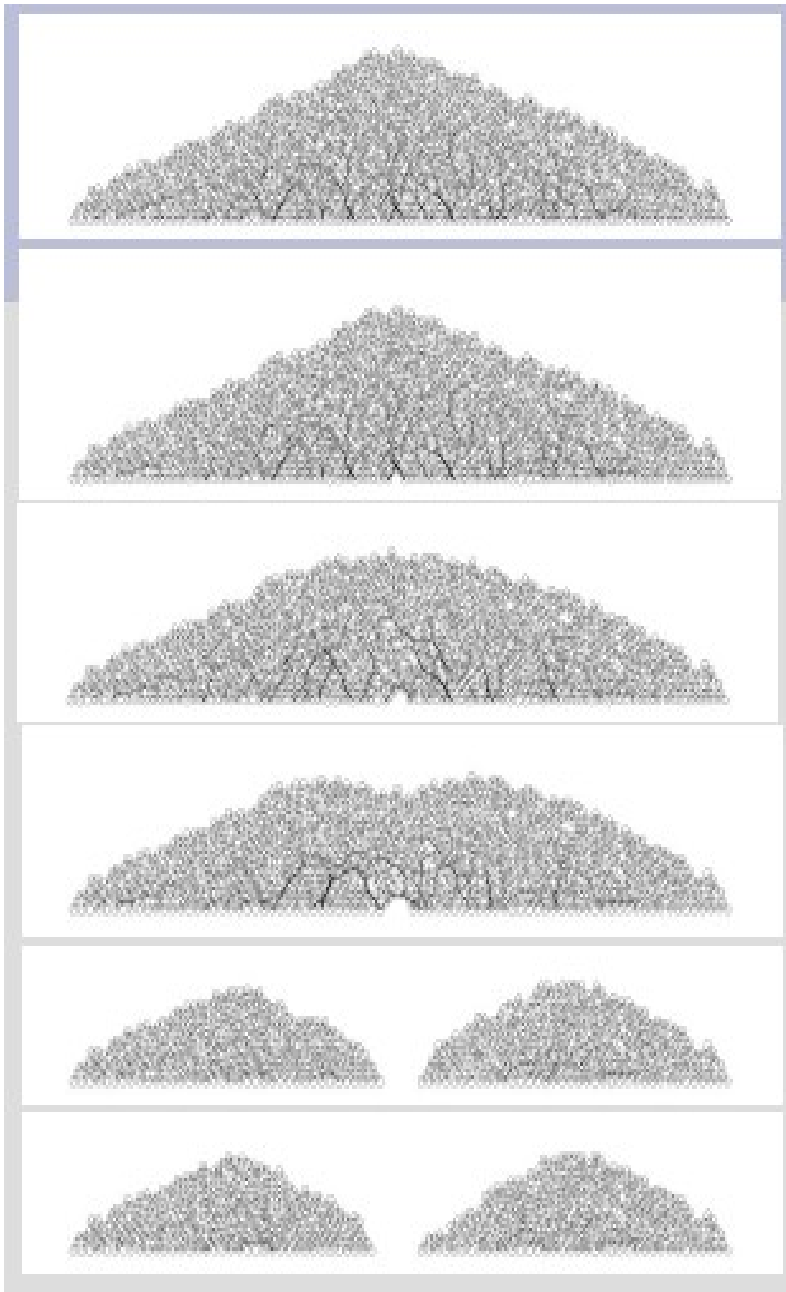
MAGALHÃES, Caio Franca Merelim ; MOREIRA, J. G. ; ATMAN, A. P. F. .
Segregation in arch formation. EPJ E, v. 35, p. 38, 2012.

MAGALHÃES, Caio Franca Merelim ; MOREIRA, J. G. ; ATMAN, A. P. F. .
Catastrophic regime in the discharge of a granular pile. PRE, v. 82, p. 051303, 2010.

Departure from elasticity

A.P.F. Atman, P. Claudin, G. Combe.,
*Departure from elasticity in granular layers:
investigation of a crossover overload force, .*
Computer Physics Communications, v. 180,
p. 612-615, 2009.
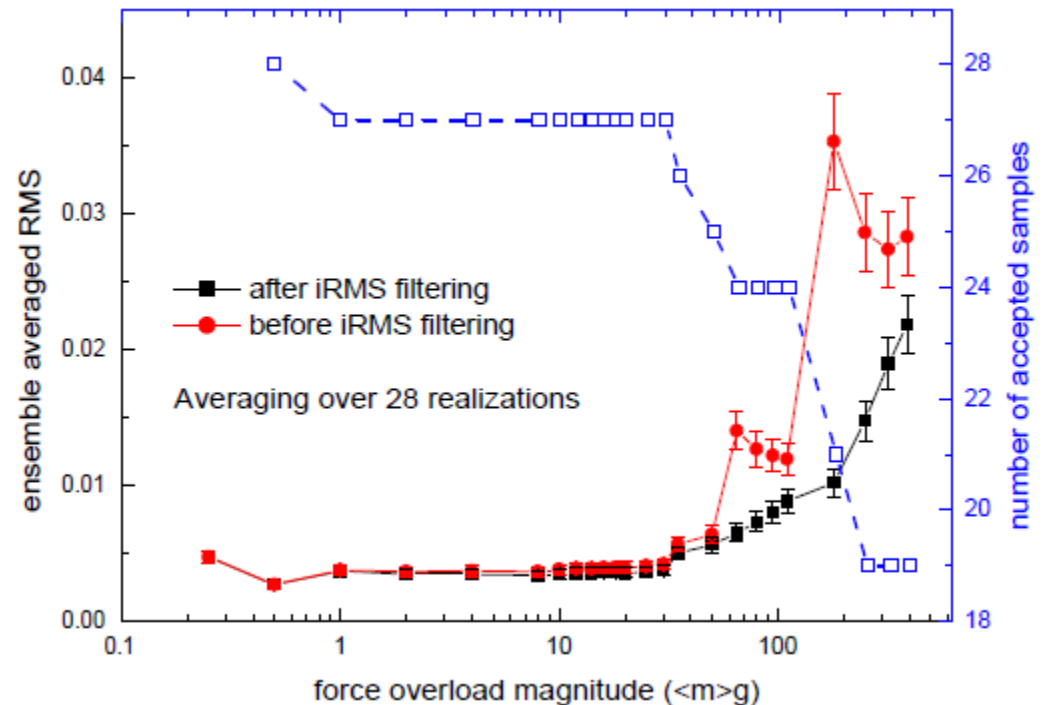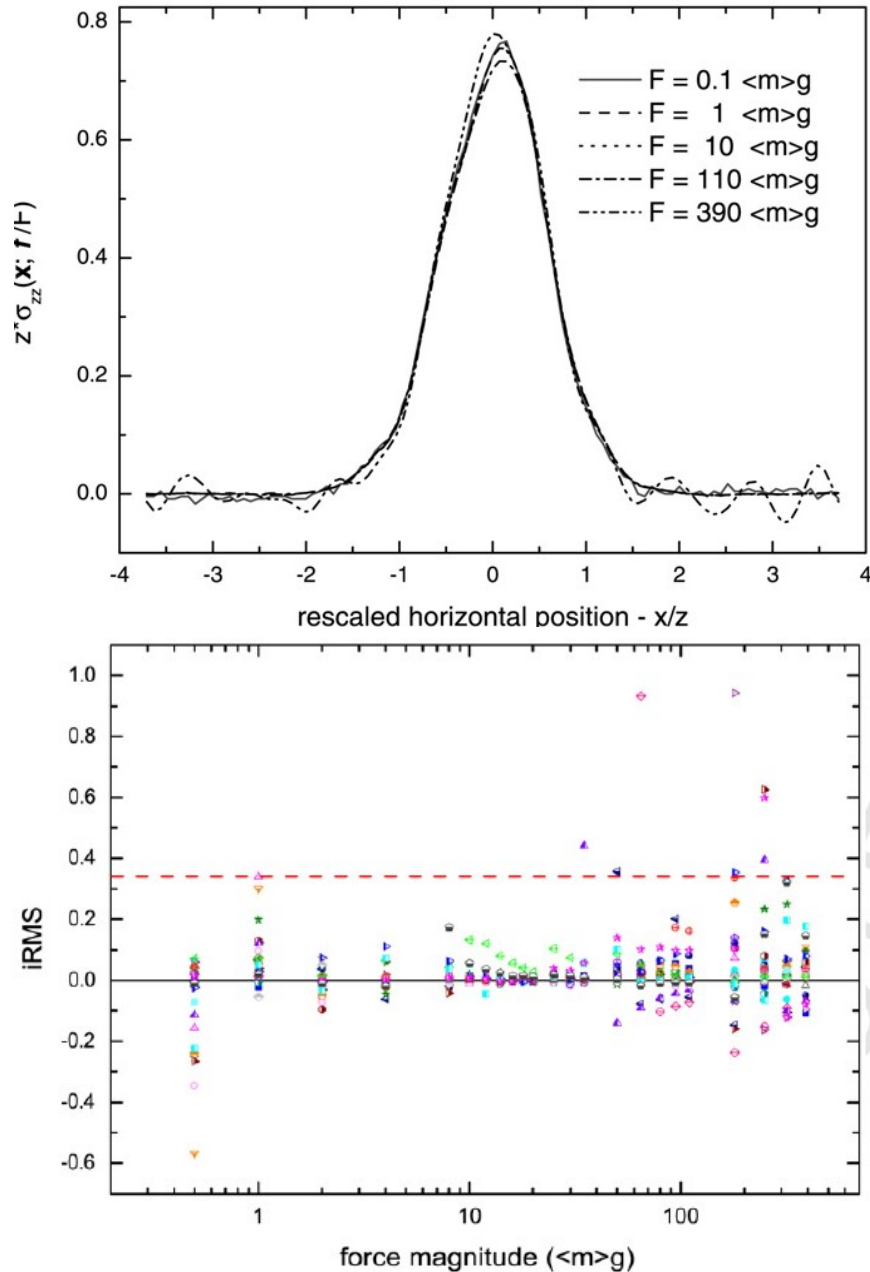
Approaching to unjamming

Elastic parameters estimation in granular layers close to unjamming: the critical repose angle limit
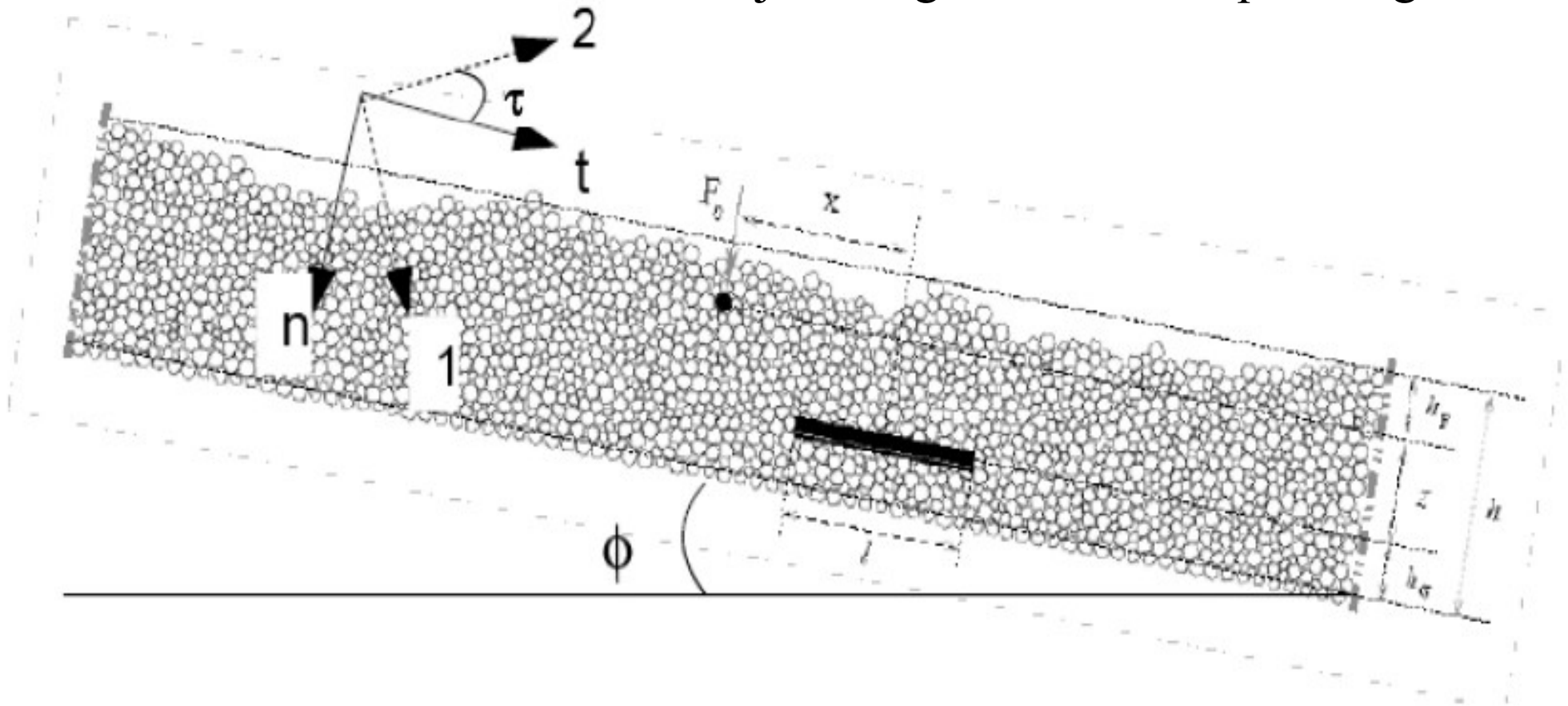
ATMAN, A. P. F. ; Combe, G. ; Claudin, P. *Mechanical response of an inclined frictional granular layer approaching unjamming*. Europhysics Letters (Print), v. 101, p. 44006, 2013.

Skewness of stress response function due to shear:

2D cell shear: $\phi=5$

Interior: photoelastic pentagons

Change in the contact force network orientation due to shear: $\Delta = 45^o$

Skewness in stress response function:
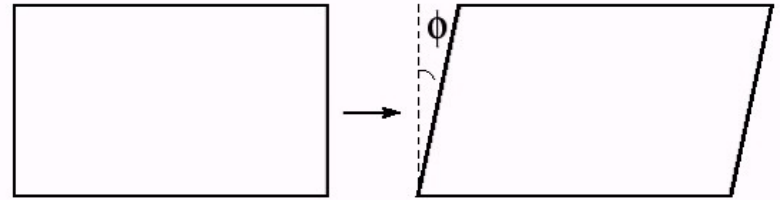
$\beta=22°$ (2D)

$\beta = 8^o$ (3D)

Geng et al., PHYSICA D **182**, 274 (2003)
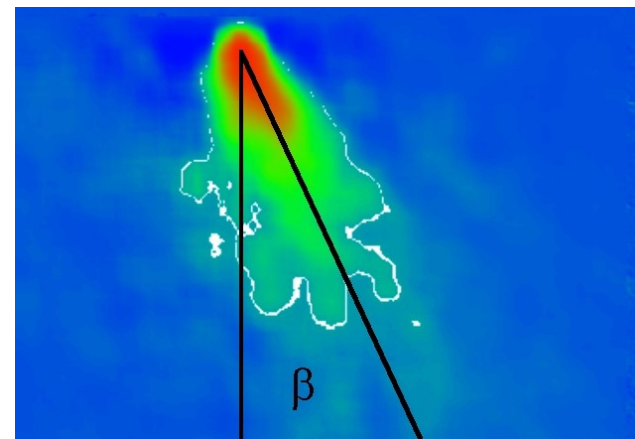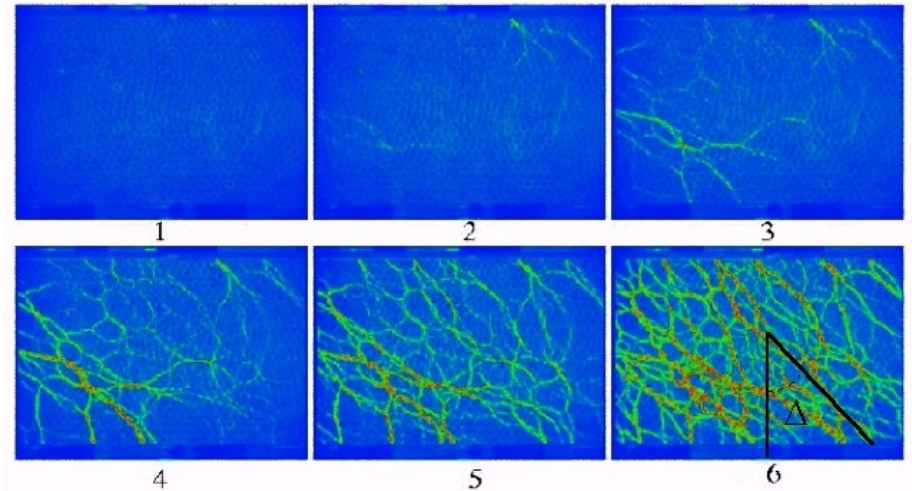
Simple **E**lastic **M**odel:

ATMAN, A. P. F. et al. *From the stress response function (back) to the sandpile 'dip'.* The European Physical Journal. E, Soft Matter, Berlin, v. 17, n.1, p. 93-100, 2005.
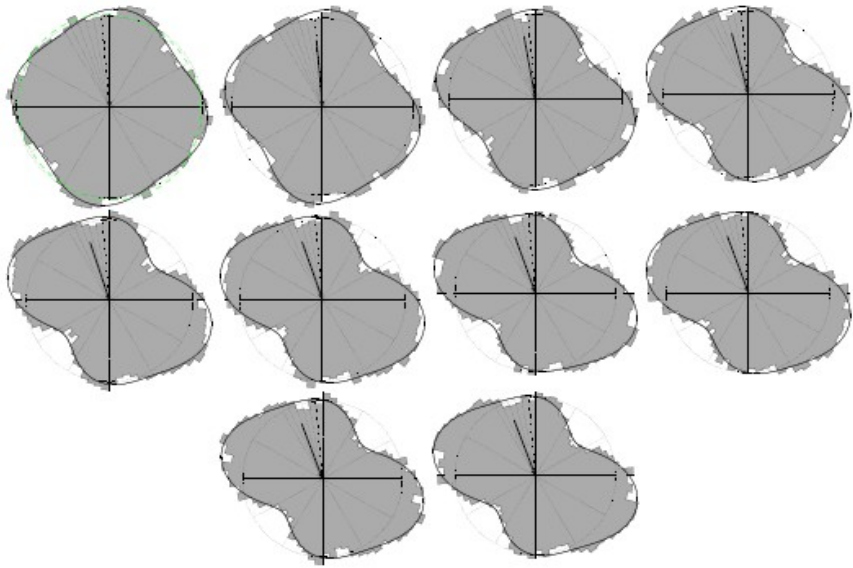
Parameters: $r,\ t,\ \tau,\ \theta$ and ν_x

In: $h,\ z,\ \theta_0$ from experimental or simulation data;

Out: stresses and elastic parameters!

Tool: stress response function.

Micro-macro mechanical analysis.
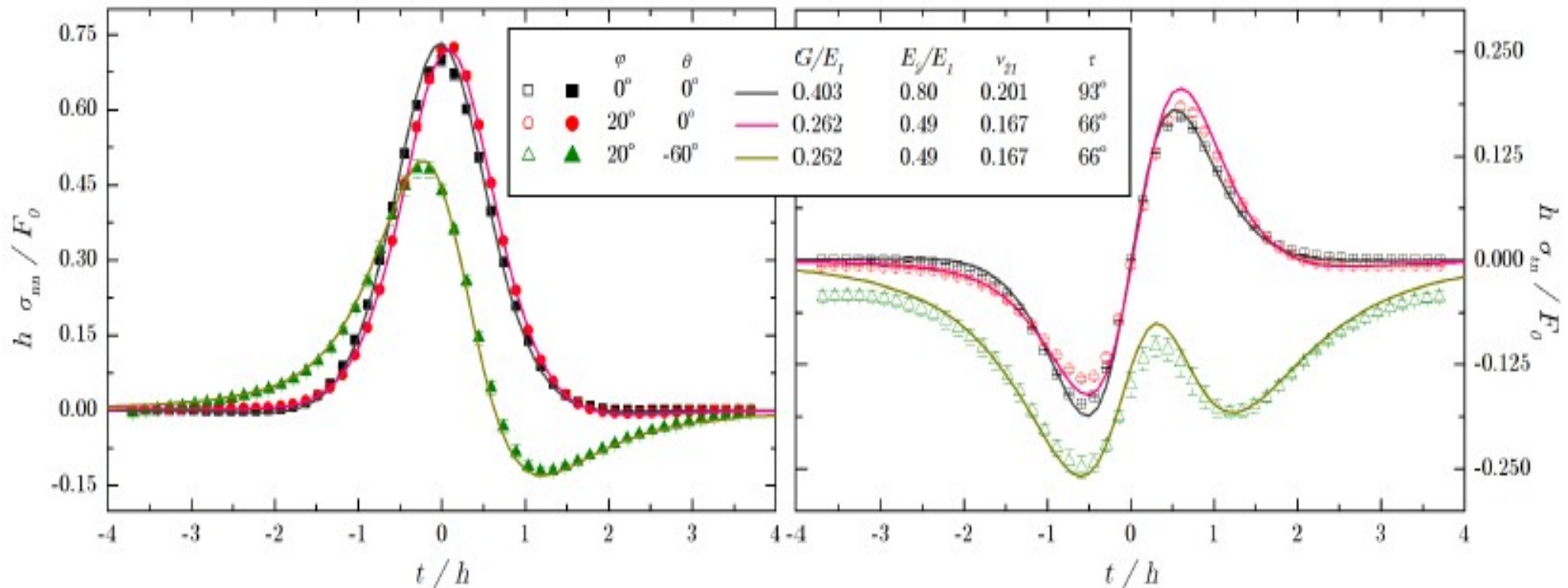
Results
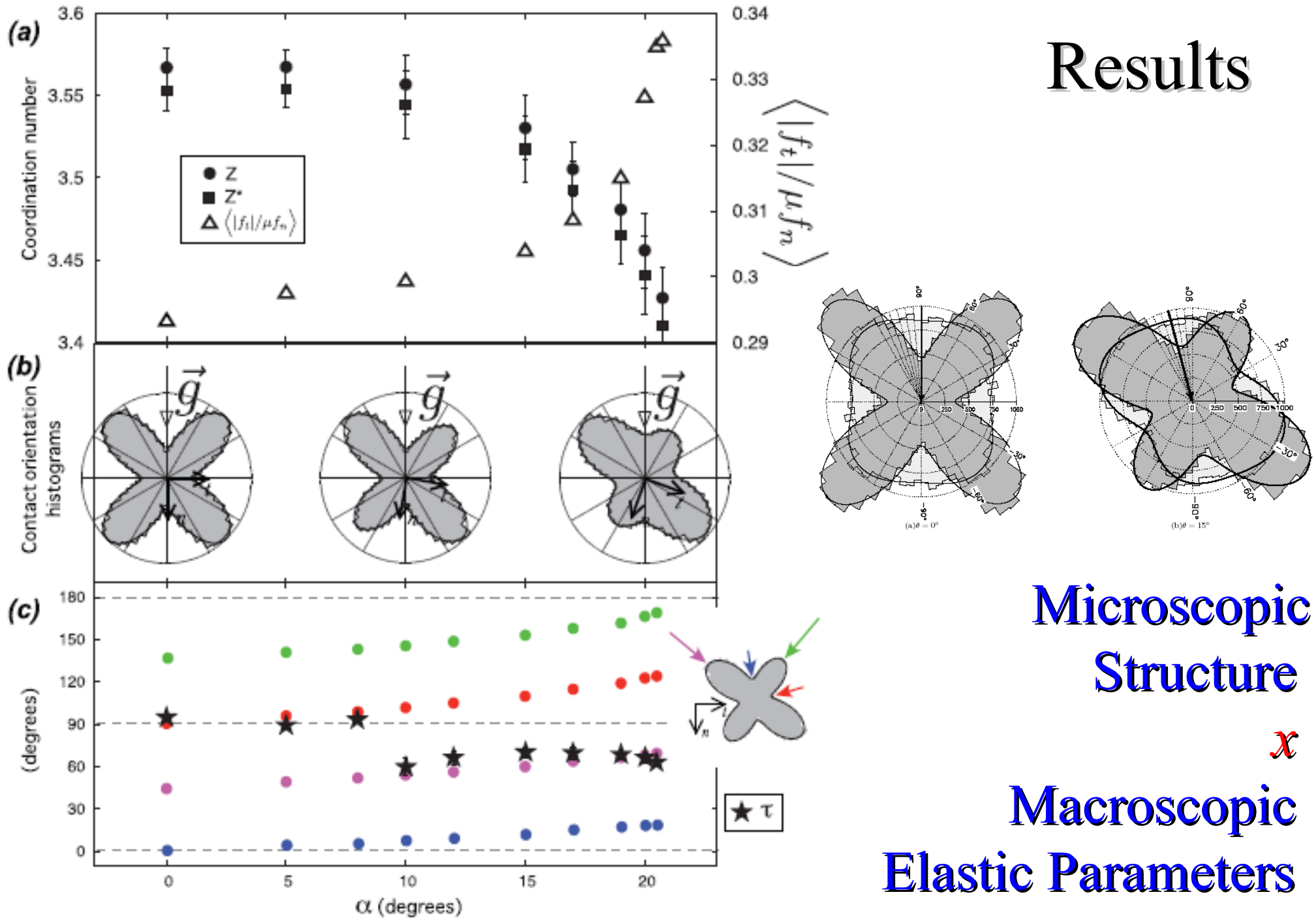
Microscopic Structure

x

Macroscopic Elastic Parameters

Shear Modulus
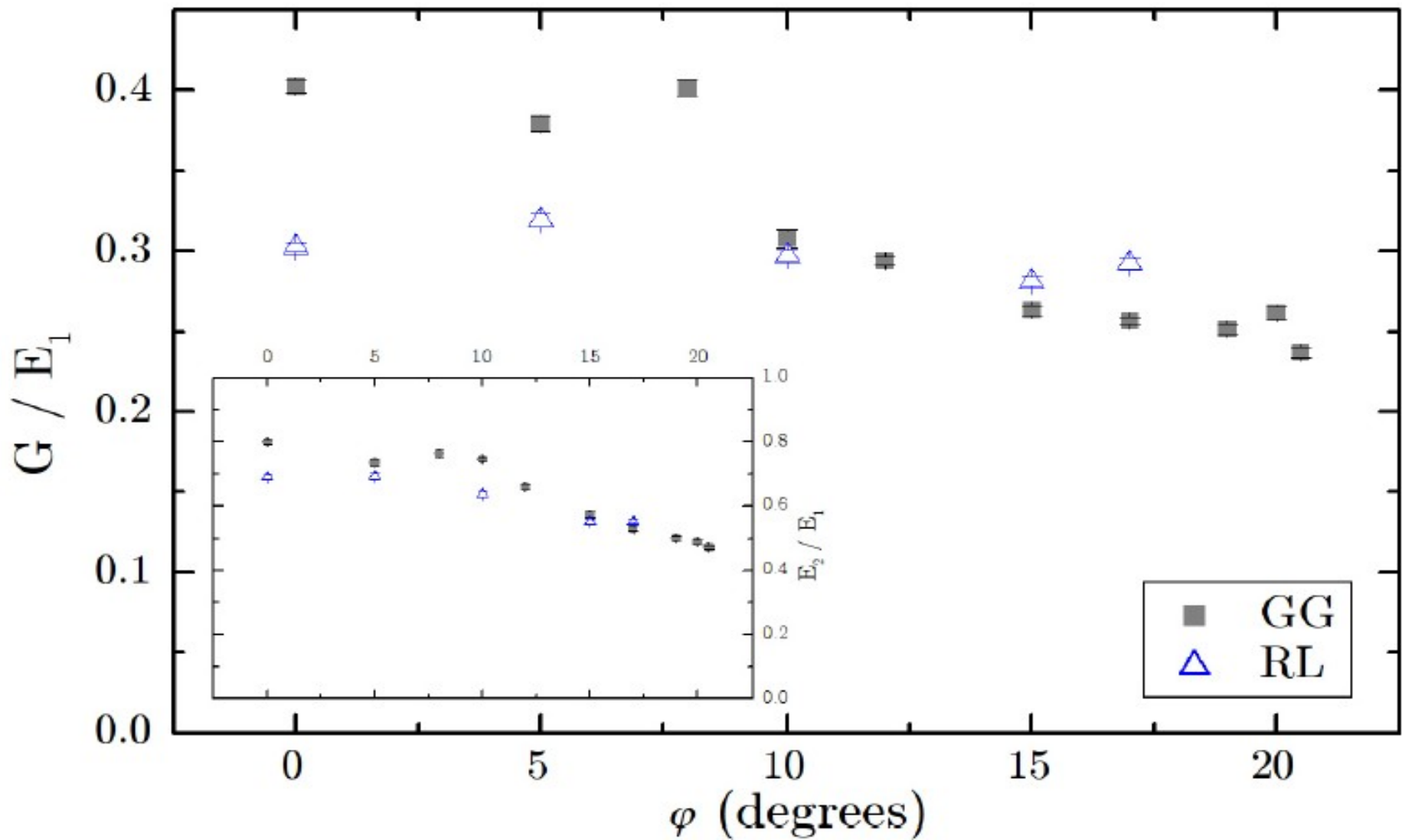
Mechanical response of an inclined frictional granular layer approaching unjamming

A. P. F. Atman[1], P. Claudin[2], G. Combe[3] and R. Mari[2]

[1] *Departamento de Física e Matemática and National Institute of Science and Technology for Complex Systems,*

A.P.F.Atman, *Simulações em Sistemas Complexos, INCT-SC, Rio de Janeiro , 22-24 abril de 2013.*

Jamming-Unjamming transition
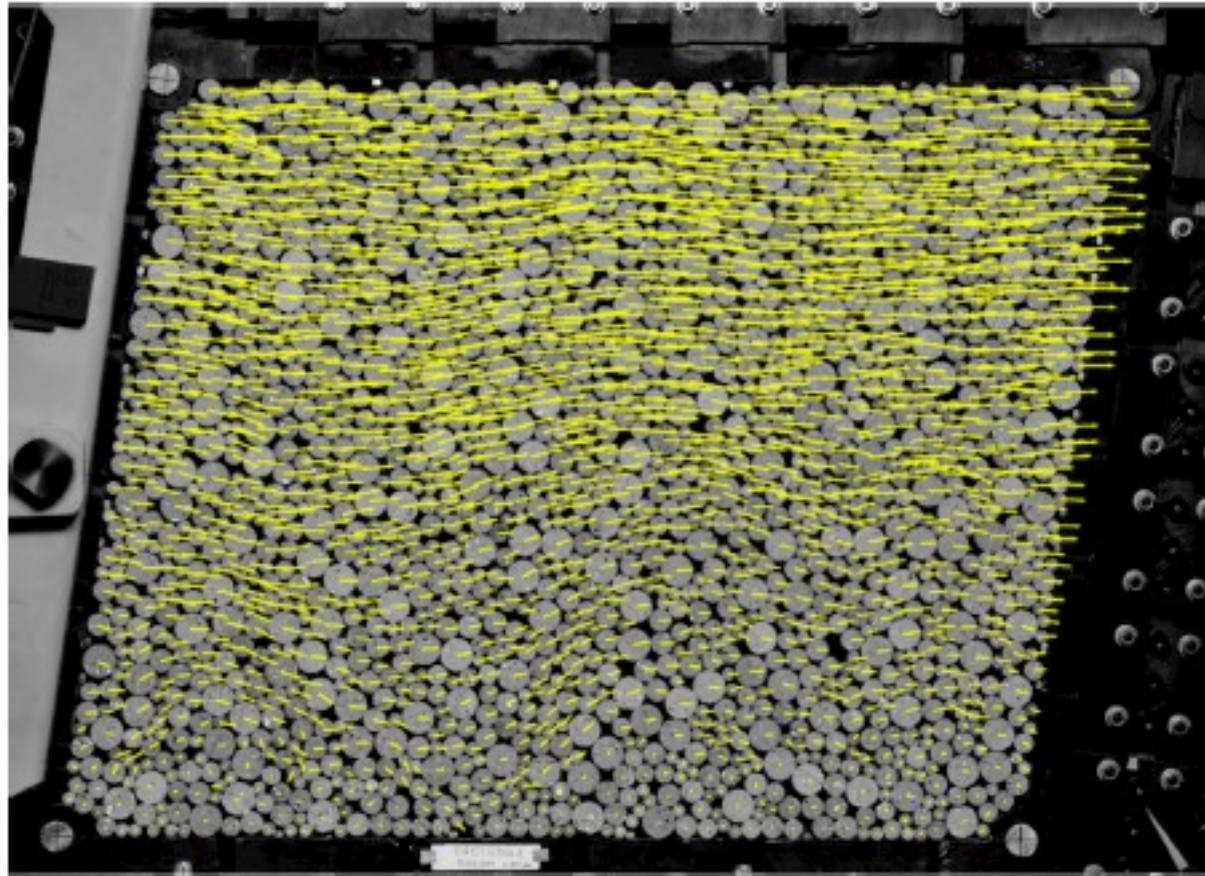
G. Combe, V. Richefeu, G. Viggiani, S.A. Hall, A. Tengattini, **A.P.F. Atman**
Experimental evidence of ``granulence''
Powders and Grains 2013, July 8-12, UNSW, Sydney, Australia, pp xxx-xxx, 2013.

Control parameters
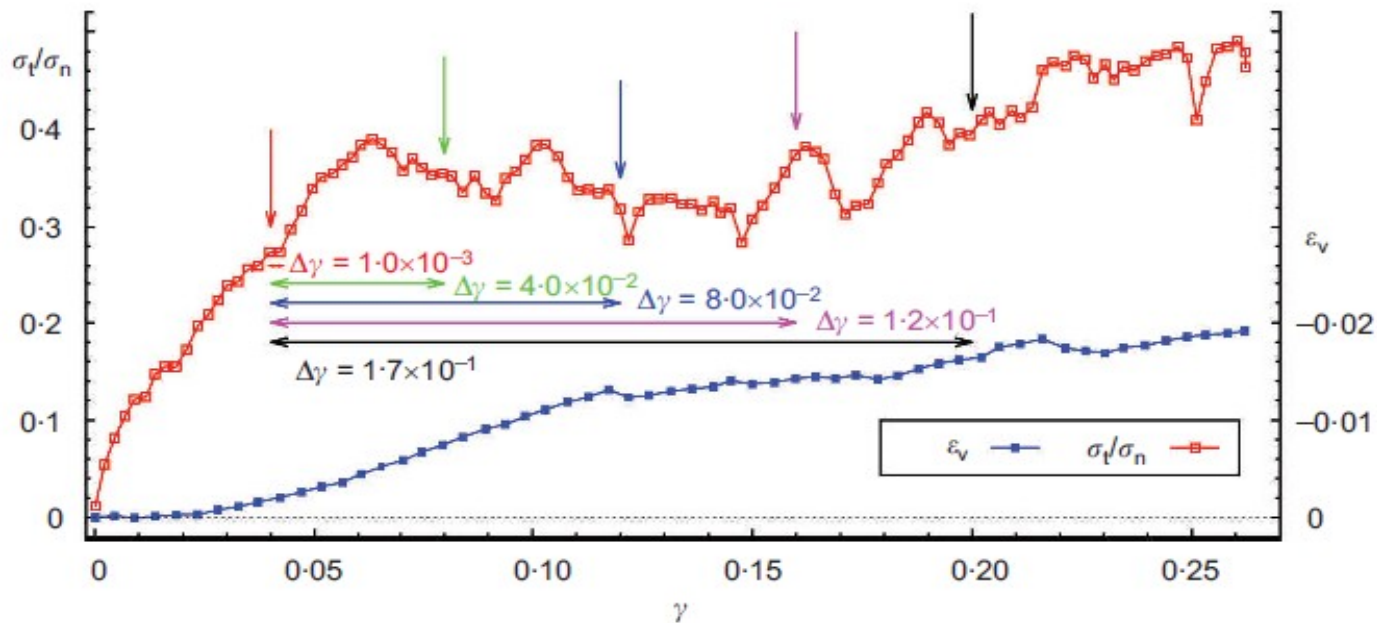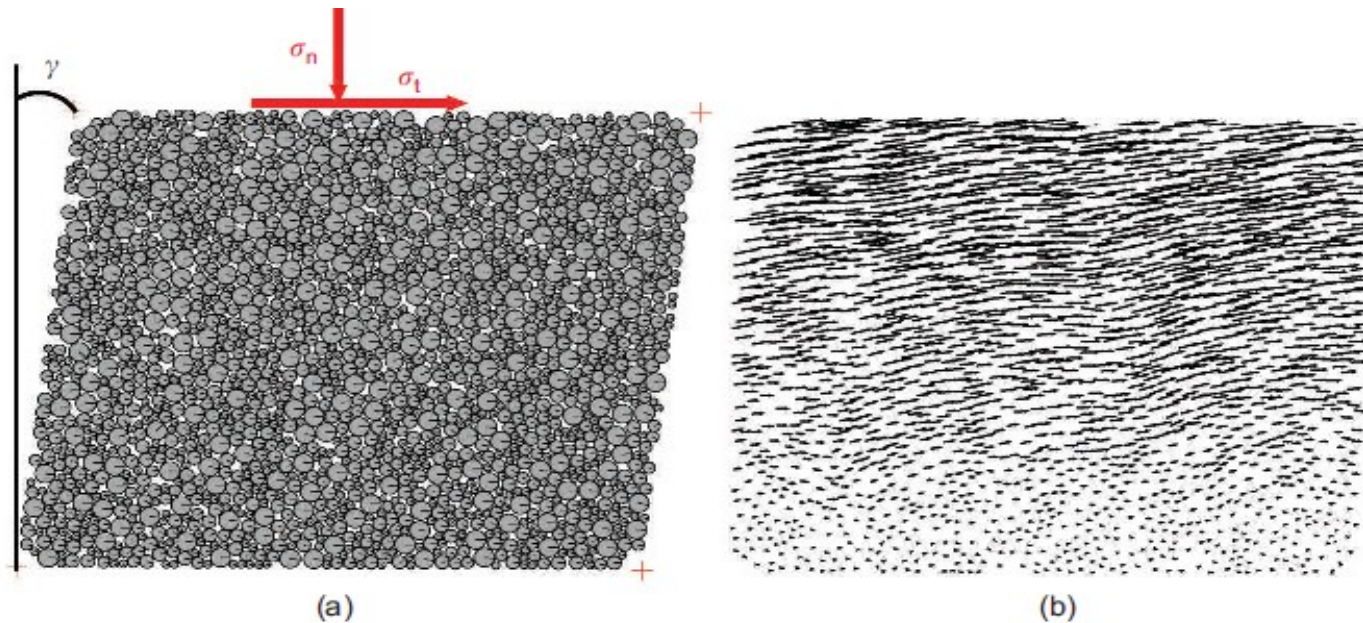
Accuracy
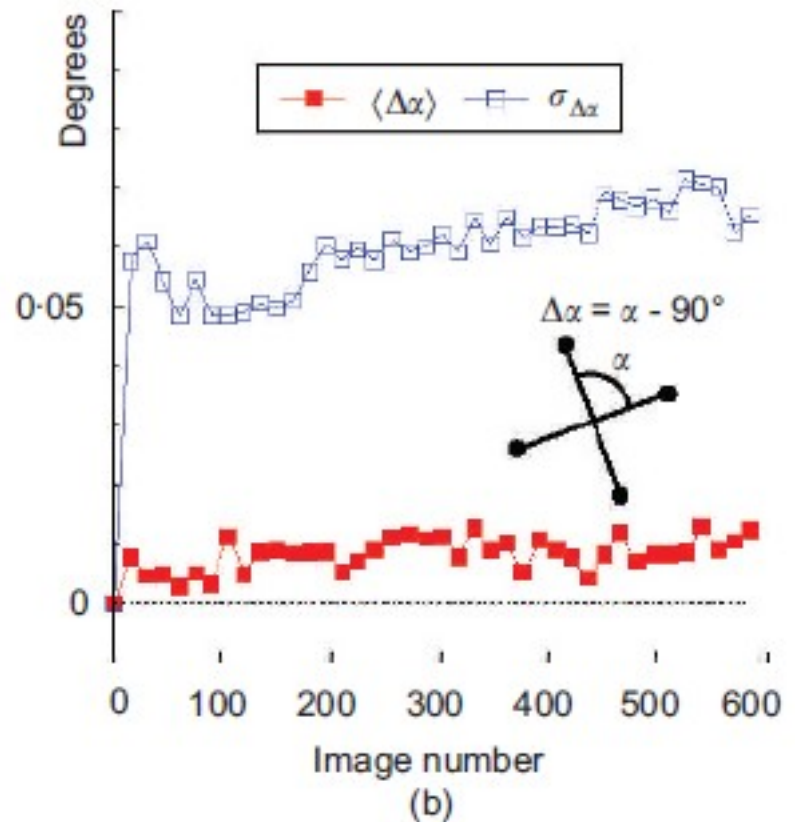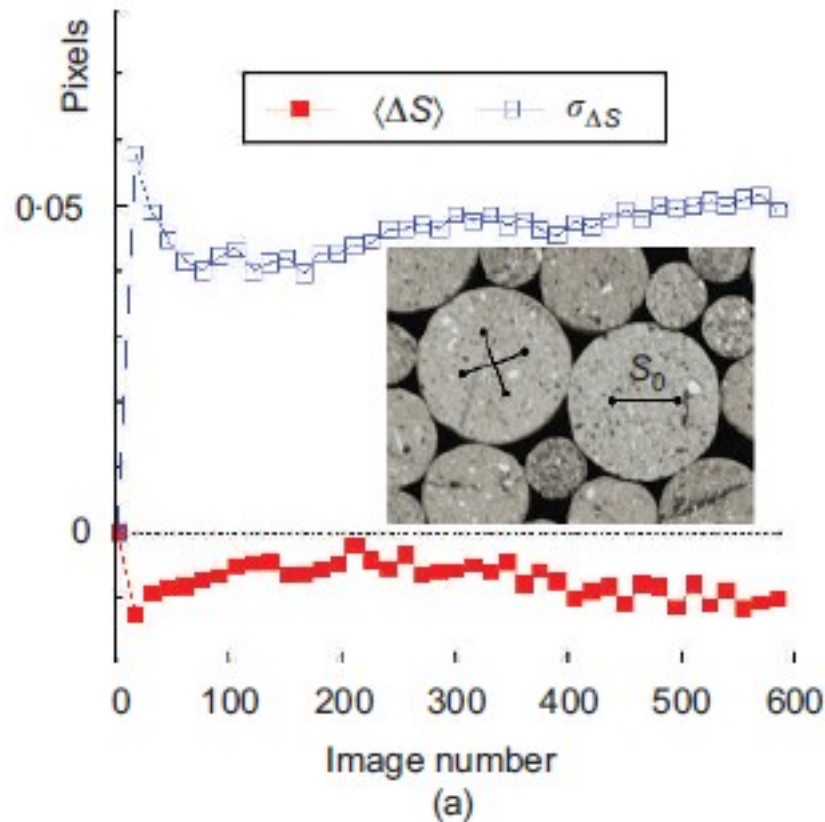
V. Richefeu, G. Combe, G. Viggiani
An experimental assessment of displacement fluctuations in a 2D granular material subjected to shear,
Géotechnique Letters, Vol. 2, pp 113-118, 2012.

Results:
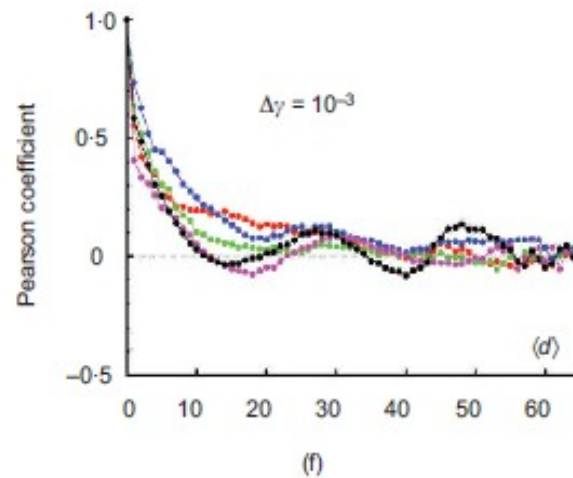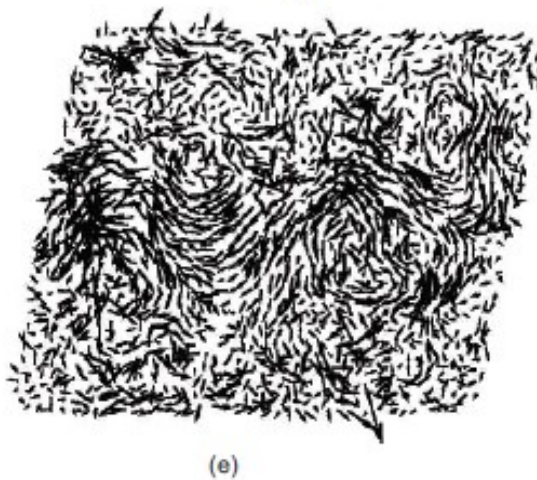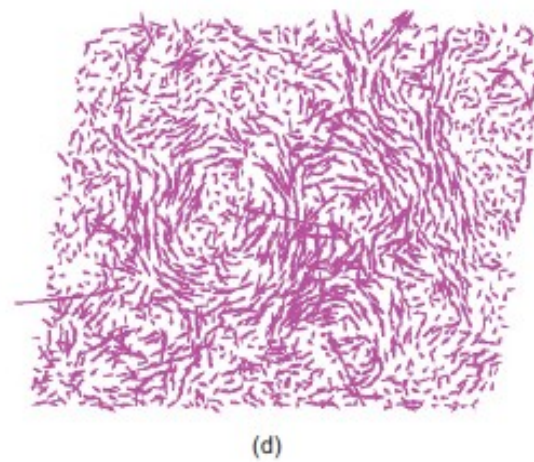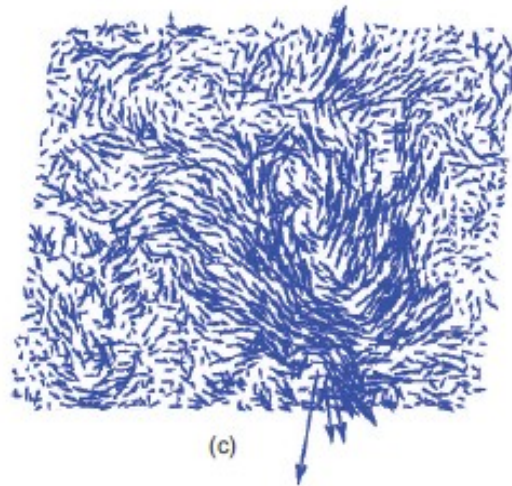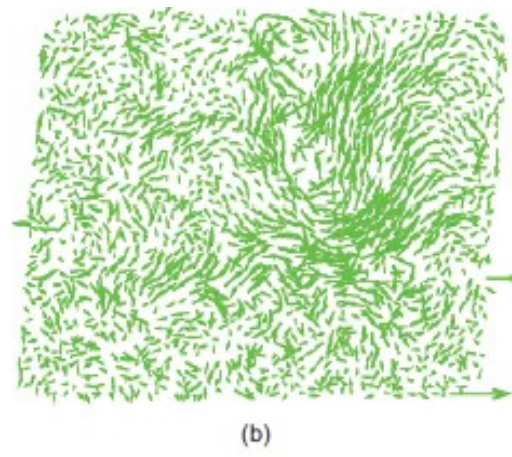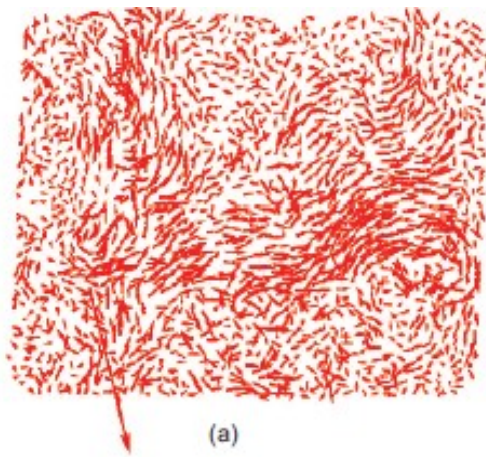
Dependence on strain displacement

Results:

Dependence on strain window

(a) (b) (c) (d) (e) (f)

Results:

Q-gaussian Fit

A.P.F.Atman, *Simulações em Sistemas Complexos, INCT-SC, Rio de Janeiro , 22-24 abril de 2013.*
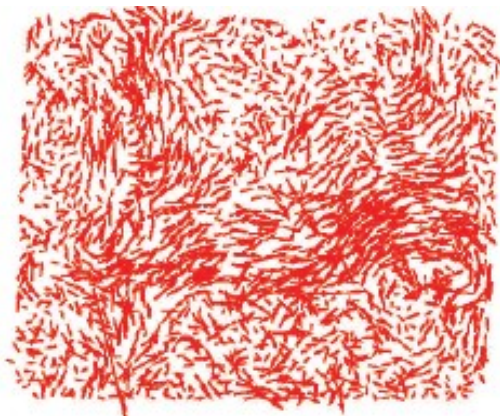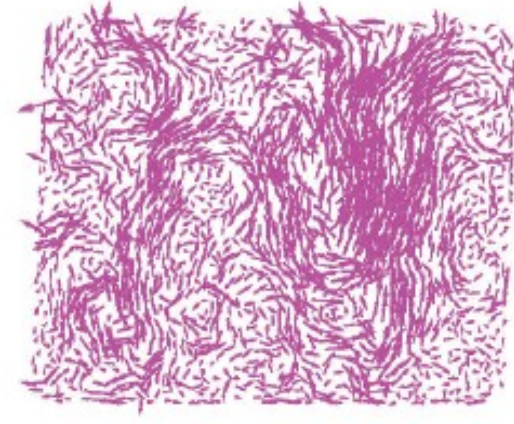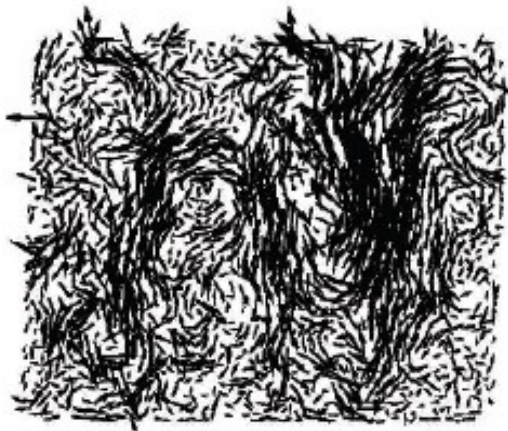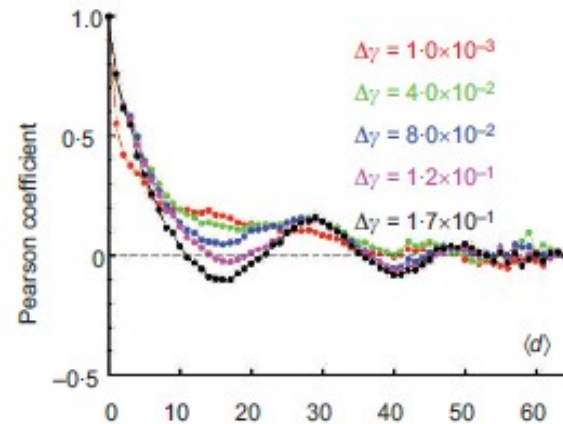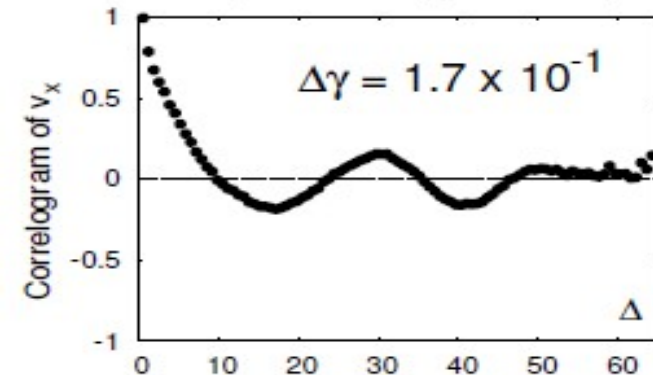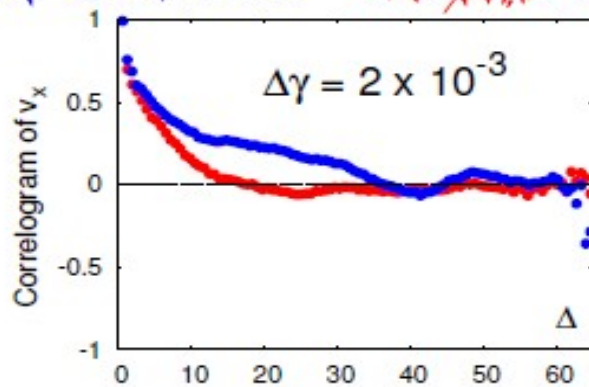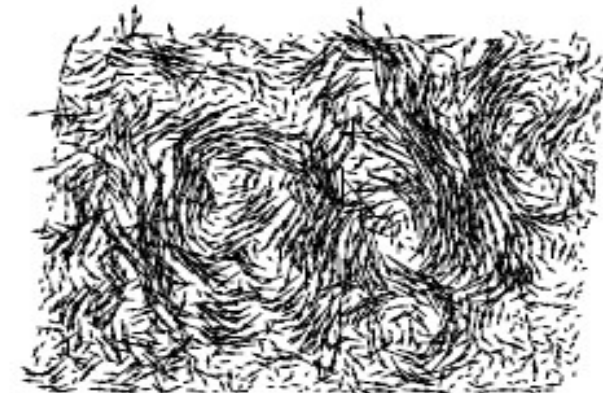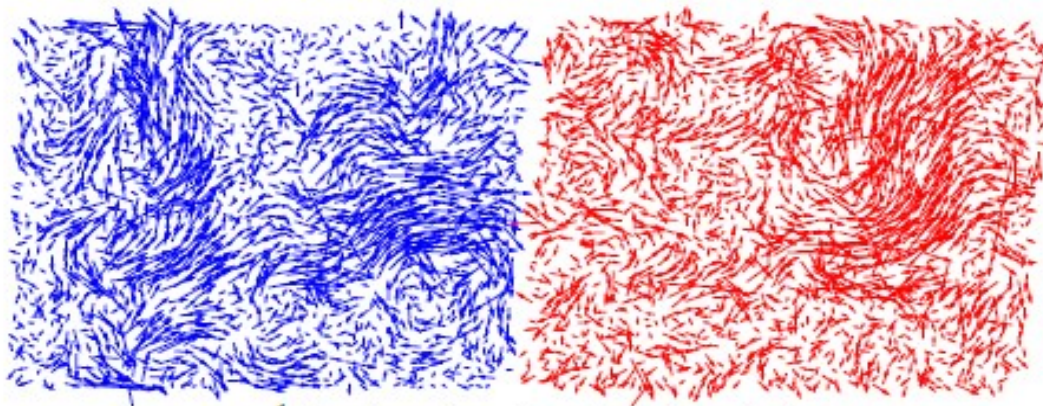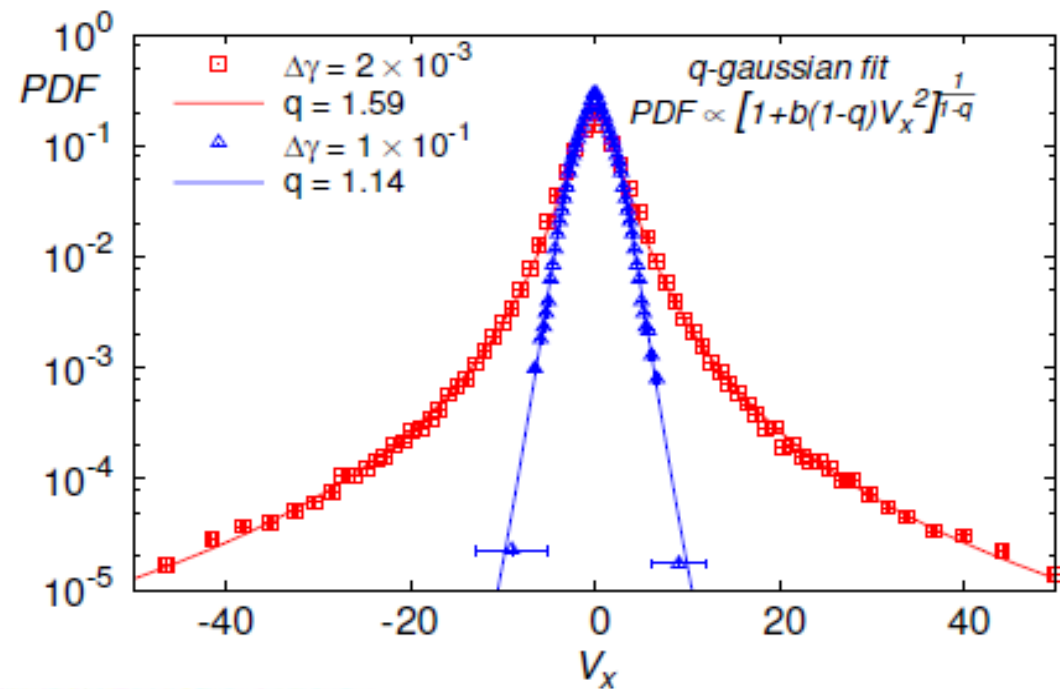
Granular displacement around an intruder
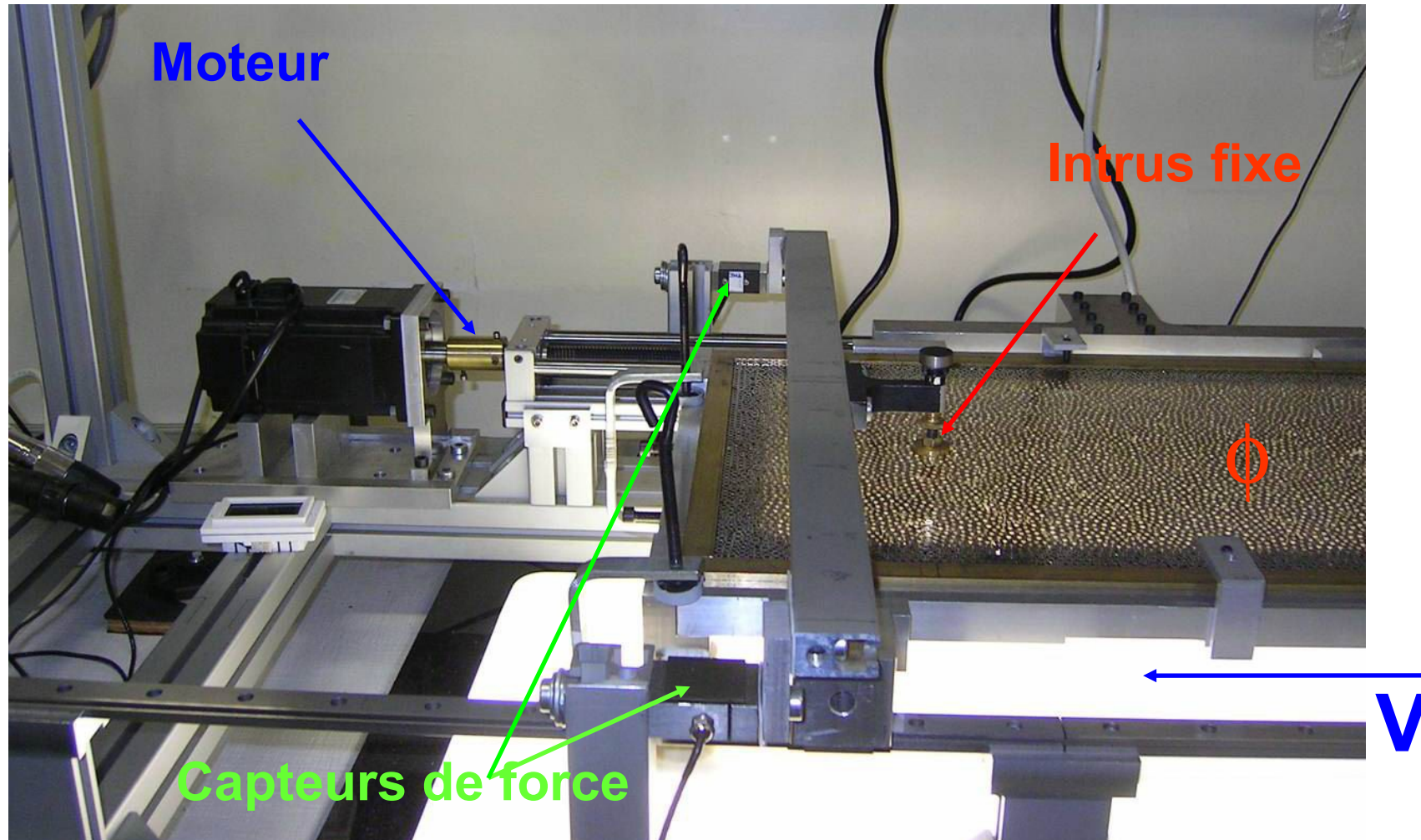
Experimental apparattus – Evelyne Kolb – PMMH/ESPCI – Université Paris 6&7

Jamming / unjamming transition
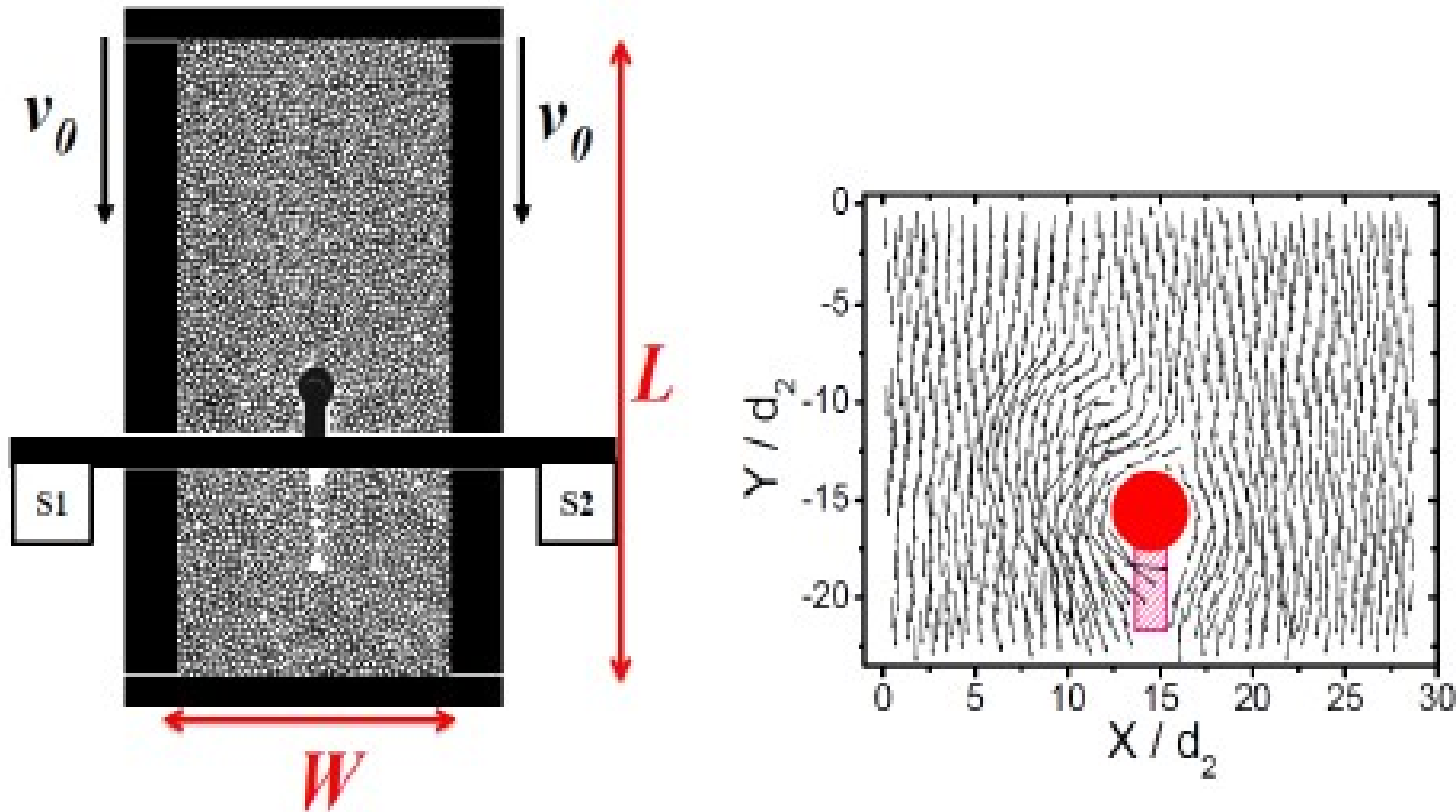
Jamming and Unjamming by Penetration of a Cylindrical Intruder inside a 2 Dimensional Dense and Disordered Granular Medium Cixous, Pierre; Kolb, Evelyne; Gaudouen, Niels; Charmet, Jean-Claude POWDERS AND GRAINS 2009: PROCEEDINGS OF THE 6TH INTERNATIONAL CONFERENCE ON MICROMECHANICS OF GRANULAR MEDIA. AIP Conference Proceedings, Volume 1145, pp. 539-542 (2009).

Jamming / unjamming transition

Simulations:

A.P.F. Atman

Gustavo H. B. Martins PIBIC – IC - Fapemig

Humberto S. Paiva – DFM - CEFET/MG
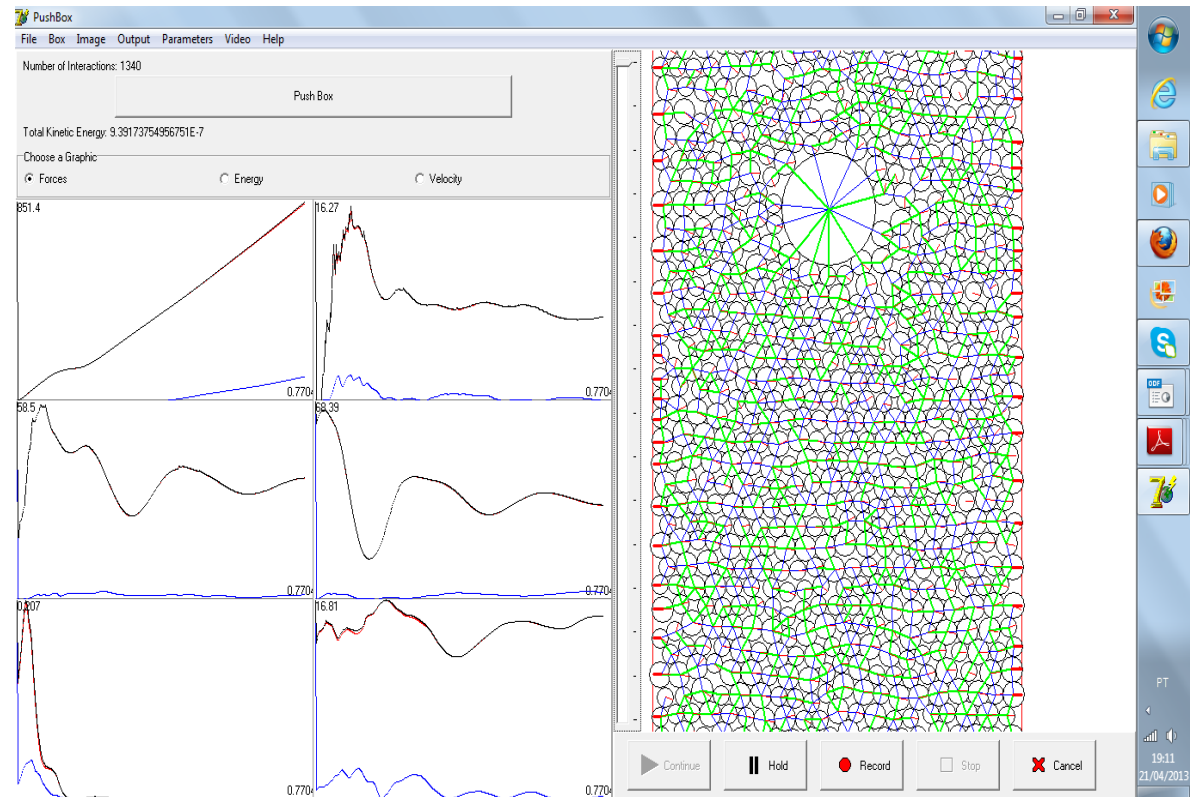
Comparison: experiments and simulations
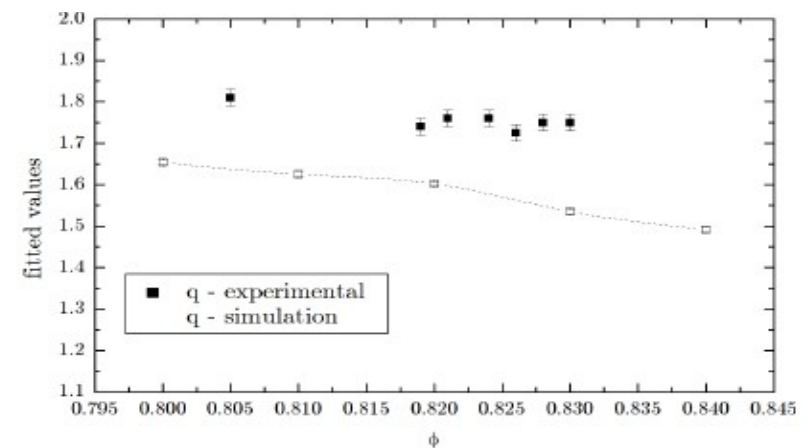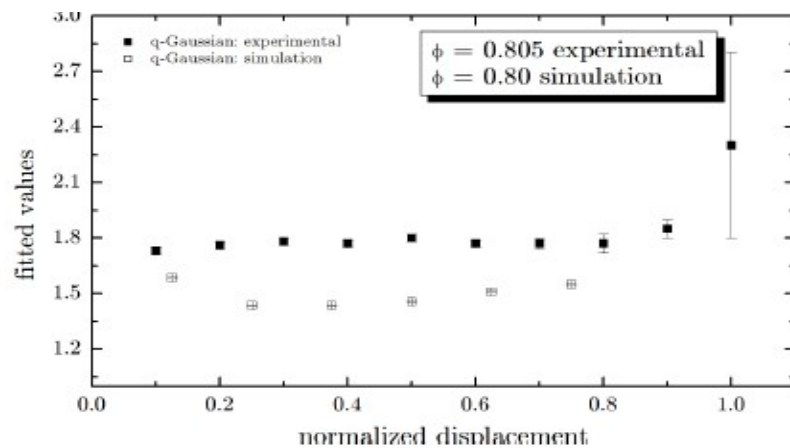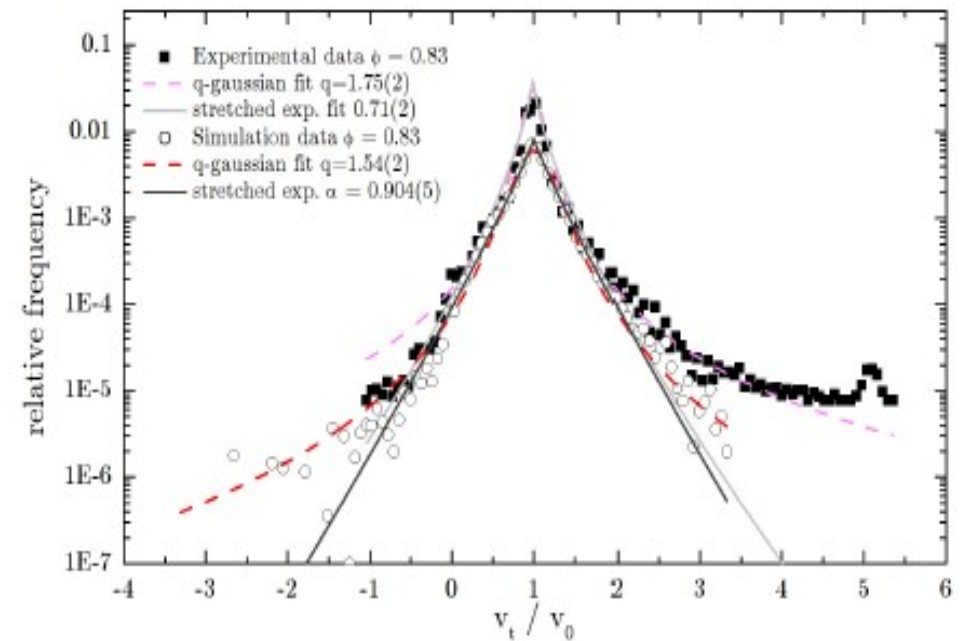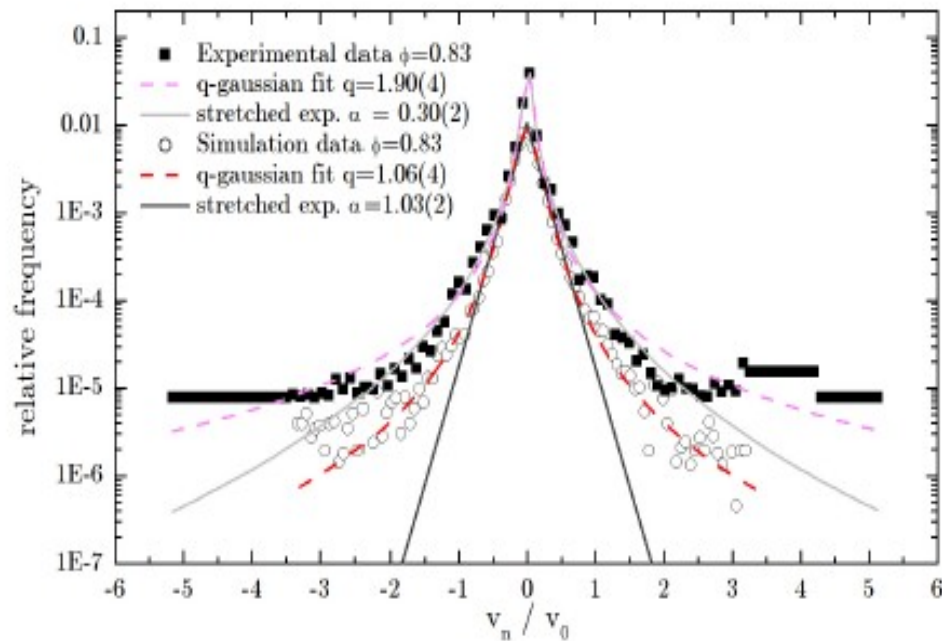
A.P.F. Atman, E. Kolb, G. Combe, H.A. Paiva, G.H.B Martins
Non-Gaussian behavior in jamming / unjamming transition in dense granular materials
Powders and Grains 2013, July 8-12, UNSW, Sydney, Australia, pp xxx-xxx, 2013.

Summary:

Granulence* : "*...transition of velocity pdf from stretched exponential to Gaussian as the time lag is increased and the velocity spectrum increased, as well when the superdiffusive character of particle motion bear a remarkable analogy with the scaling features of the fluid turbulence.*"
O. Cazacu
Multiscale Modeling of Heterogenous Materials: From Microstructure to Macro-Scale Properties
John Wiley & Sons, 01/03/2013

* F. Radjai, and S. Roux, Phys. Rev. Lett. 89, 064302 (2002).

It should be corrected to "*...transition from q-Gaussian...*" ??

More sampling and temporal analysis for better comparison between experiments and simulations on jamming-unjamming case.

Experimental evidence of a *q*-Gaussian pdf for classical macroscopic system – granular material.

Special announcement:

www13.fisica.ufmg.br/rondickman60

SYMPOSIUM IN HONOR OF RON DICKMAN'S 60TH BIRTHDAY: EQUILIBRIUM, NON-EQUILIBRIUM AND COMPLEX SYSTEMS

HOME   PROGRAM   BIOGRAPHY   LOCATION   CONTACT

Search

WELCOME TO THE STATISTICAL MECHANICS SYMPOSIUM IN HONOR OF 60 TH BIRTHDAY OF PROF. RON DICKMAN

Dear Colleagues, Friends and Family of Prof. Ron Dickman,

It is my pleasure to welcome all of you to the Physics Department of UFMG to this Symposium to celebrate Professor Ron DickmanÂ´s 60th birthday, gathering scientists who made important contributions to his career.

The two-day event will be held on Thursday and Friday, June 20th and 21th, 2013 at the Physics Department of UFMG, in Belo Horizonte, capital of Minas Gerais state, Brazil.

I look forward to seeing you all on this very special occasion to celebrate Prof. Ron Dickman scientific career and achievements.

A. P. F. Atman
Centro Federal de EducaÃ§Ã£o TecnolÃ³gica - CEFET-MG and
National Institute of Science and Technology - Complex Systems

SPECIAL GUESTS & SPEAKERS

Robert Ziff
University of Michigan -USA

Miguel A. MuÃ±oz
Universidad de Granada - EspaÃ±a

Iwan Jensen
University of Melbourne - Australia

… and a bit of propaganda before ending :)

Posters:

FIG. 11. The scenario of all Anti-Imitators having the same initial condition - Random. The morphology has a strong influence over dynamic. Upper panels: left Regular Network; right-Conservative Network. Bottom panels: left-Random Network; right-Small World Network.

Figura 2 – Imagem de Satélite - Bairro Itapoã, Belo Horizonte - Google Earth® (esquerda). Mapa da ambiente conjugada à imagem de satélite (direita). A escala de cores indica o grau de afinidade do mosquito com o ambiente, com vermelho sendo o mais propício e em azul o menos propício.

## IS THERE ANY CONNECTION BETWEEN THE NETWORK MORPHOLOGY AND THE FLUCTUATIONS OF THE STOCK MARKET INDEX?

F.M. Stefan[1],[*] and A.P.F. Atman[2],[†]

[1] Federal Center for Technology of Minas Gerais - CEFET–MG,
Av. Amazonas 7675, 30510-000, Belo Horizonte-MG, Brazil.
[2] Departamento de Física e Matematica and National Institute of Science and Technology for Complex Systems,
Centro Federal de Educação Tecnológica de Minas Gerais, CEFET–MG,
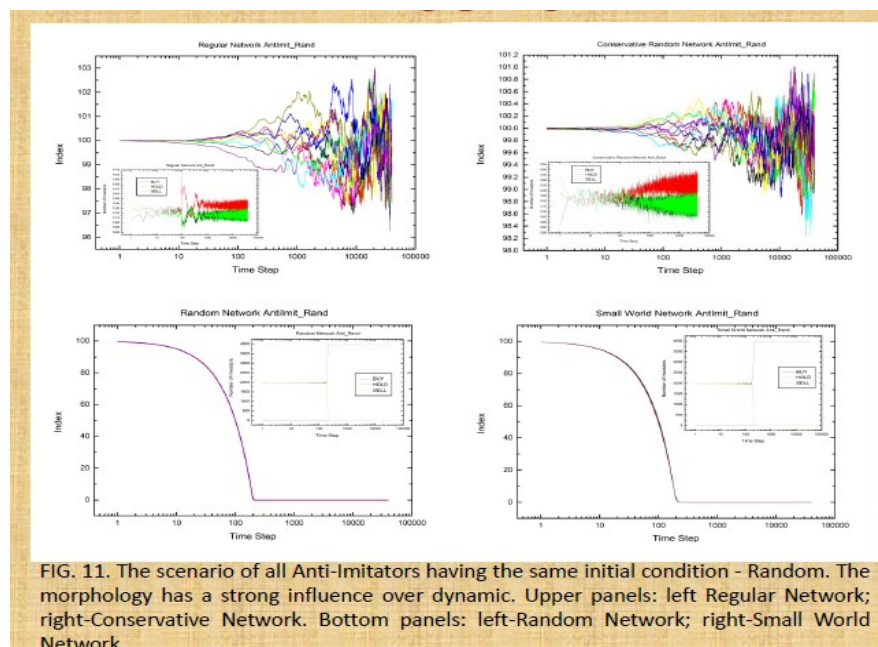
MODELAGEM COMPUTACIONAL DA PROPAGAÇÃO DA LEISHMANIOSE: EFEITO DO RUÍDO AMBIENTAL NO COMPORTAMENTO DOS VETORES

**Fabíola Fernandes de Oliveira** – fabiolaf_o@yahoo.com.br
Departamento de Engenharia Ambiental, Centro Federal de Educação Tecnológica de Minas Gerais, CEFET-MG, 30550-000, Belo Horizonte, MG, Brasil.

A.P.F. Atman – atman@dppg.cefetmg.br
Departamento de Física e Matemática e Instituto Nacional de Ciência e Tecnologia – Sistemas Complexos – INCT-SC, Centro Federal de Educação Tecnológica de Minas Gerais, CEFET-MG, 30550-000, Belo Horizonte, MG, Brasil.

Cíntia Loureiro dos Santos – cintialoureirosantos@yahoo.com.br
Mestrado em Modelagem Matemática e Computacional, Centro Federal de Educação Tecnológica de Minas Gerais, CEFET-MG, 30550-000, Belo Horizonte, MG, Brasil.
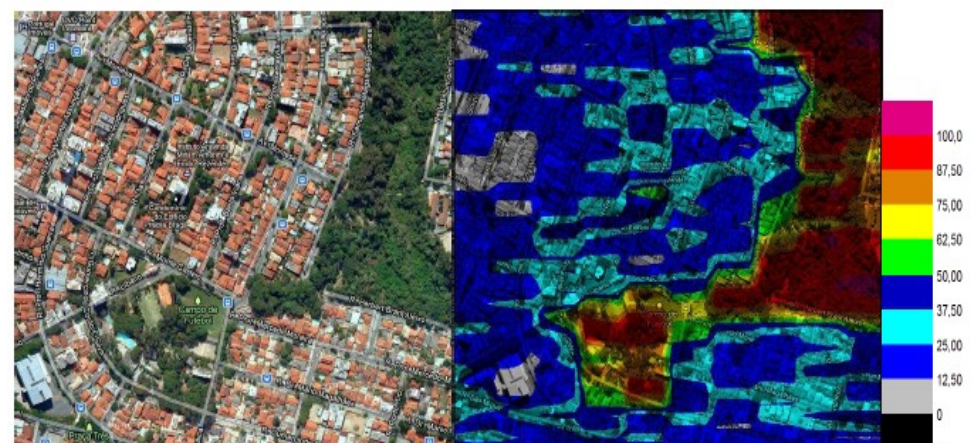
Thank you for attention!!!

atman@dppg.cefetmg.br

A.P.F. ATMAN

GESC - Grupo de Estudos em Sistemas Complexos
PPGMMC - Programa de Pós-Graduação em
Modelagem Matemática e Computacional
Departamento de Física e Matemática - CEFET-MG
INCT - Sistemas Complexos