Workshop
Hydrological Optics : Measurements and Modelling

Convidado Externo – Emmanuel Boss – University of Maine

Projeto: FAPESP 2015/19653-0

Organizado pelo

Laboratório de Instrumentação de Sistemas Aquáticos (LabISA) – INPE/OBT

19 e 20 de abril de 2016

10 às 18:00 horas

Auditório do Instituto Interamericano para Pesquisas em Mudanças Globais - **IAI**

Auditório José Simeão de Medeiros – **LabGeo**

Sala 27 - **Prédio Asa**

Instituto Nacional de Pesquisas Espaciais - INPE

São José dos Campos - SP

Participantes

Apoio Financeiro

Particle size distribution of inland cyanobacteria: Preliminary analysis

INPE – National Institute for Space Research

Felipe de Lucia Lobo - *Post Doc. Jr (CNPq) – felipe.lobo@inpe.br*

Evlyn Novo

Cláudio Barbosa

Lino Sander de Carvalho

Daniel Schaffer

FURG – Federal University of Rio Grande

João Sarkis Yunes - jsyunes@furg.br

Pablo Santos Guimarães

Edi Morales Pinheiro Júnior

Introduction

- Particle Size Distribution of phytoplankton is important:
  - Behaviour, movement
  - Grazzing, Ecology, Strategy
  - Species identification (size and shape)

- Spikes and peaks can be associated with groups/species – need validation.

- Ahn e Grant (2007) show high correlation between PSD- LISST and PSD- optical micrography.

- Karp-Boss et al. (2007) evaluates the cell shape effect on the PSD measured by LISST and microscopy.

Introduction

- **PSD** provides information about the
- **Volume Scattering Function (VSF)** which is key for bio-optical modelling
- **Remote Sensing Application**

Introduction

Volume Scattering Function (VSF)

$$\beta\theta = dI/[EdV] \quad (1)$$

Input data for Bio-optical models Hydrolight

$$b = 2.\pi.\int_0^{\pi} \beta.sin(\theta)d\theta \quad (2)$$

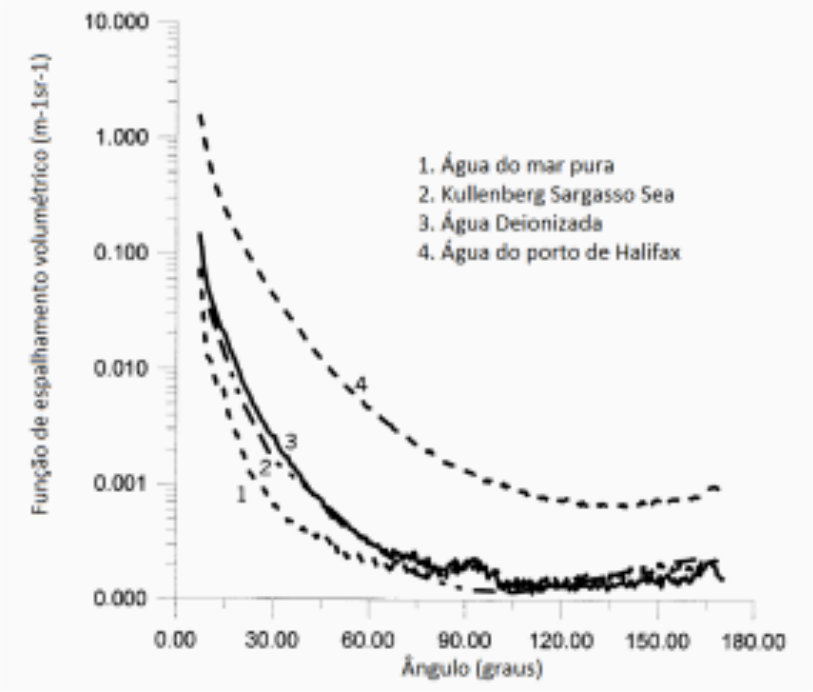
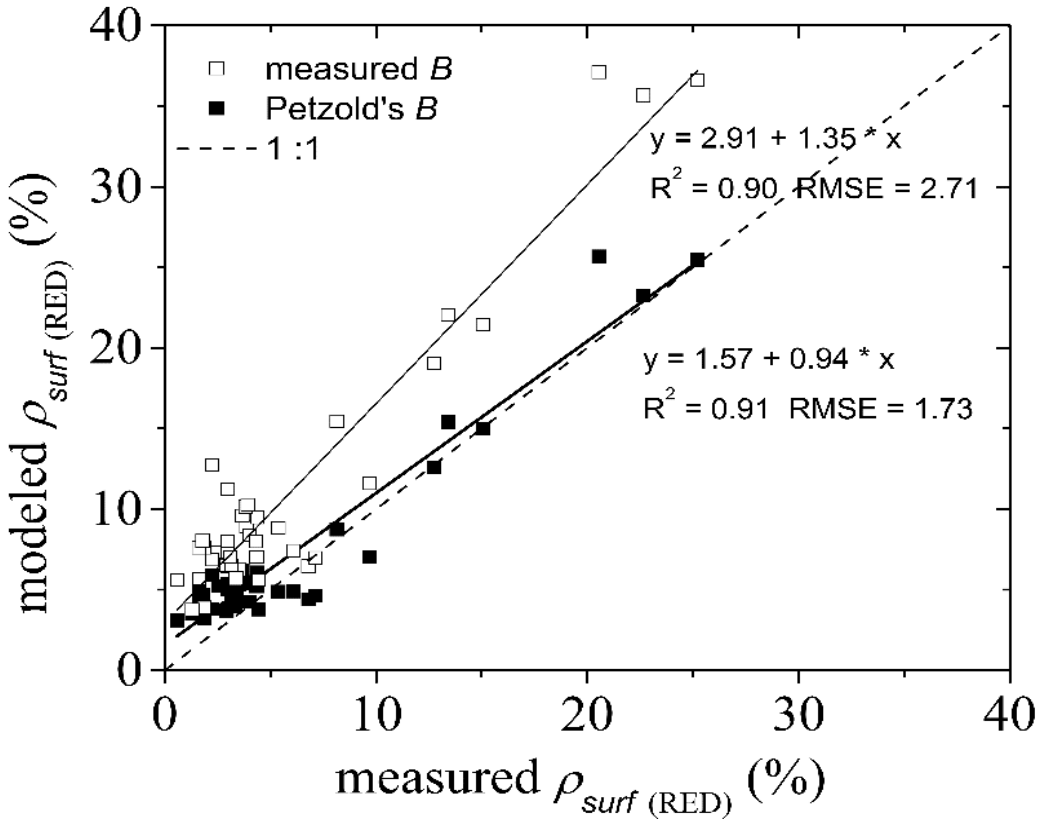


Figura 1: Medições em laboratório da VSF para 1) Água do mar pura, 2) Sargasso Sea, 3) Água Deionizada e 4) Água do porto de Halifax. Fonte: LEE & LEWIS, 2003.

Adapted from Daniel, 2014

Introduction

For example, …



Introduction

- To investigate the importance of phytoplankton PSD on VSF, LabISA (INPE) purchased one PSD meter: LISST-Portable that measures PSD of each sample.

- Improve Bio-optical models aiming algae bloom monitoring.

Objectives

- The goal is to characterize the PSD of three cyanobacteria species cultivated in laboratory (at FURG).

- The ultimate goal is to provide VSF derived from PSD and simulate its consequences to modeled AOPs (such as Rrs).

Specific Objectives

- Measure PSD of three cyanobacteria:
  - *Microcystis aeruginosa*, *Anabaena sp.*, e *Synechocystis sp*.

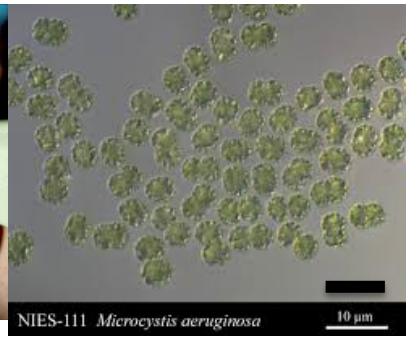
- Validate PSD derived from LISST with PSD derived from microscopy analysis.

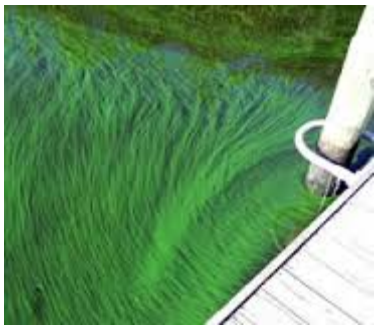
- Evaluate PSD as indicator (proxy) of cyanobacteria species..

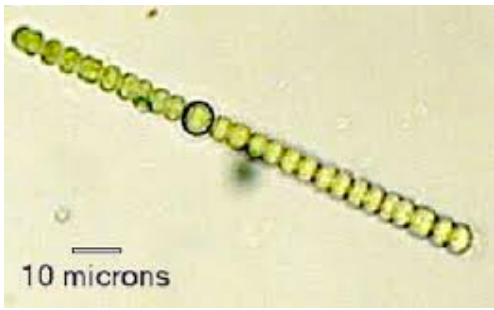
- If possible, derive VSF from PSD and use them as input data in Hydrolight simulations (R_{rs}).

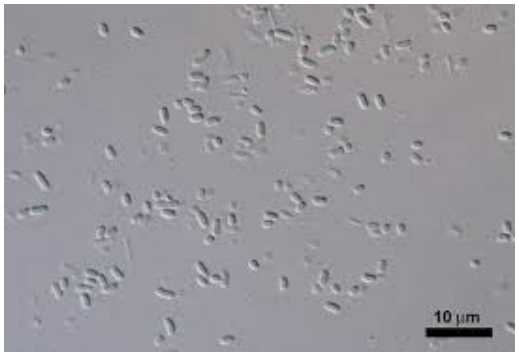
Material & Methods

- Cynobacteria *in vitro*
  - *Microcystis sp.*, individual colonial, mucilaginous;
  - *Anabaena sp*., filamentous, aerotopes (buoying);
  - *Synechocystis sp.*, small individual cells







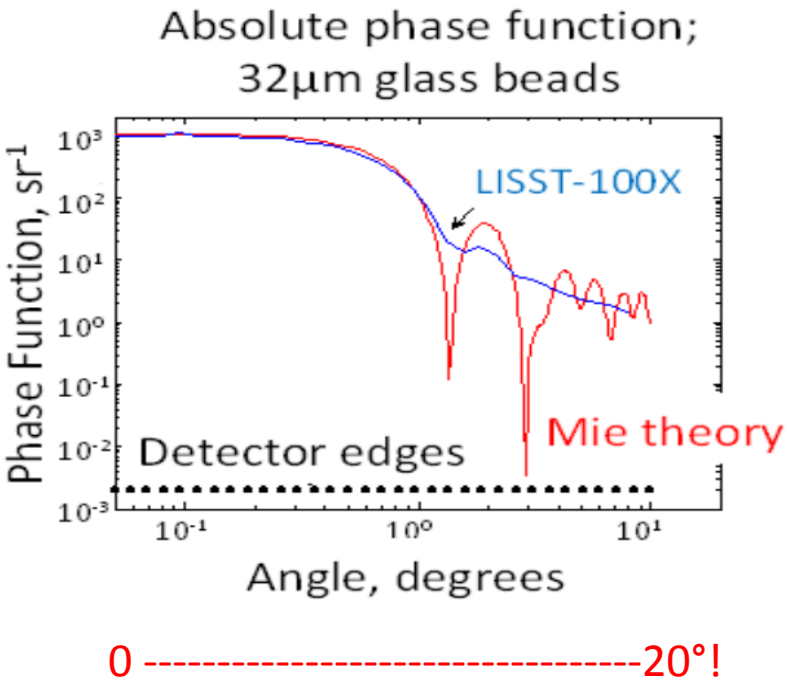


Material & Methods

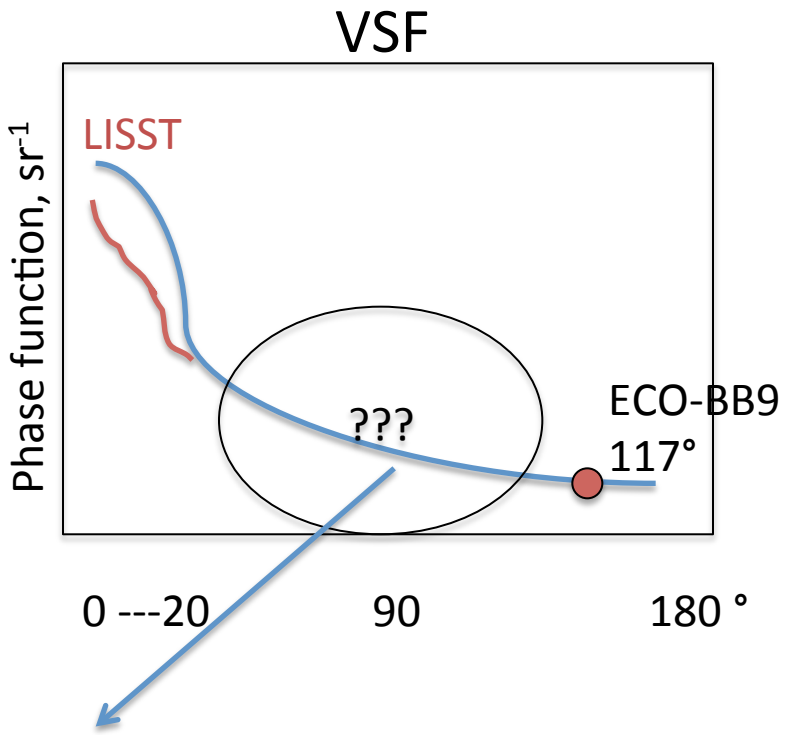
LISST portable

- Light beam at 670 nm through the water sample.
- Measures volume scattering in 32 bins (0 - 20°).
- Size interval (0.3 – 500 µm).
- Output: Particle Volume Distribution (µl/l)...??
  - PSD (freq.) or VSF??

Material & Methods



Agrawal *et al.* (2005)



1. **Algorithm models from Boss etal.?**
2. **??**

Material & Methods

total cells / ml

$$N = n*A/a*1/V$$

n = cells counts

A = glass microscope slide area= 4.33 cm^2

a = 10 photos area= 0.015 cm^2

V= glass slide volume = 2 ml

Wetzel & Likens, 2000

Biovolume (µl/l)

$$Biovolume = N * CV *1000$$

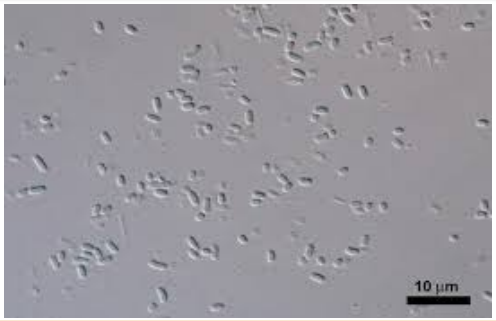
N = # of cells in 1 ml

CV = cell volume (µl)

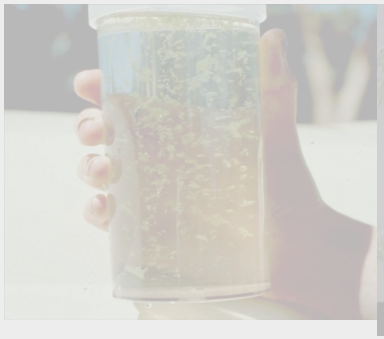
Hillebrand et al., 1999

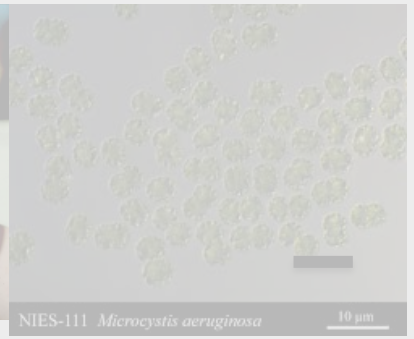
Results

- *Synechocystis sp.*, small individual cells

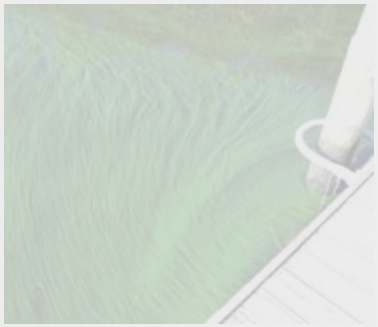


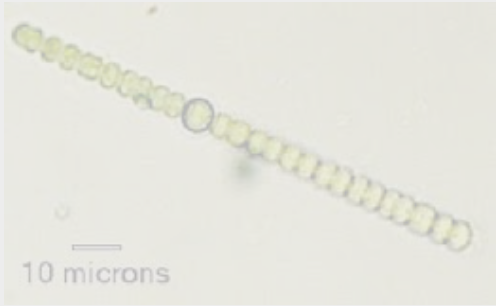
- *Microcystis sp.*, individual colonial, mucilaginous;



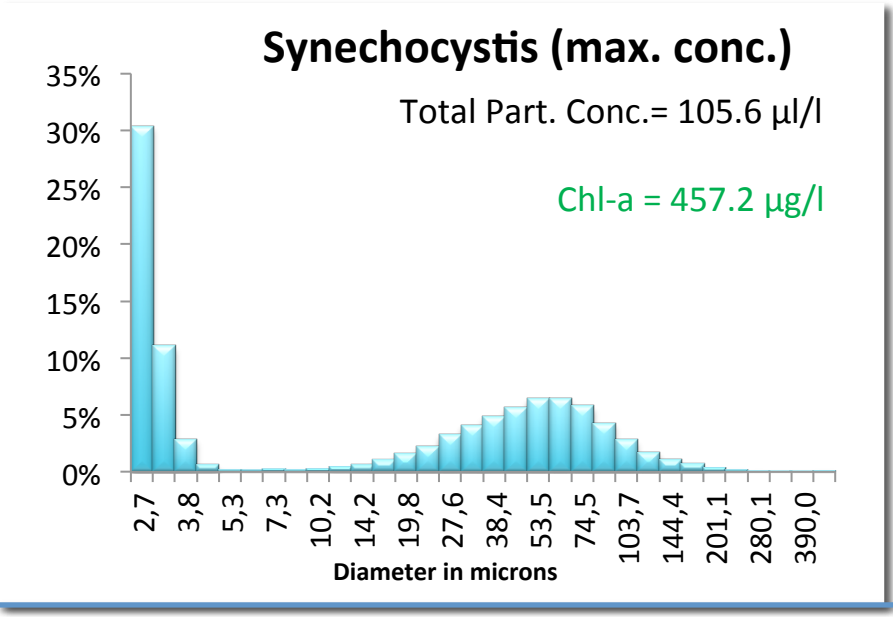


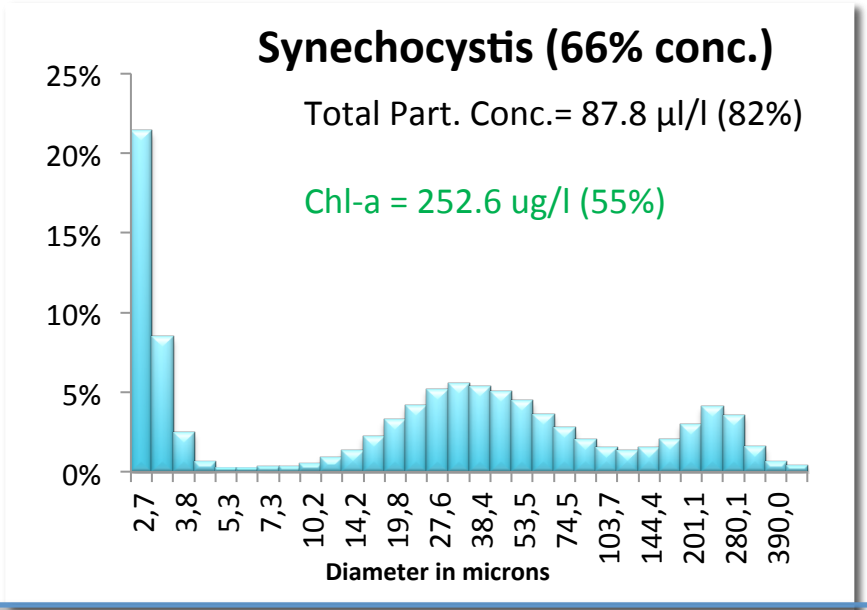
- *Anabaena sp.*, filamentous, aerotopes (buoying);

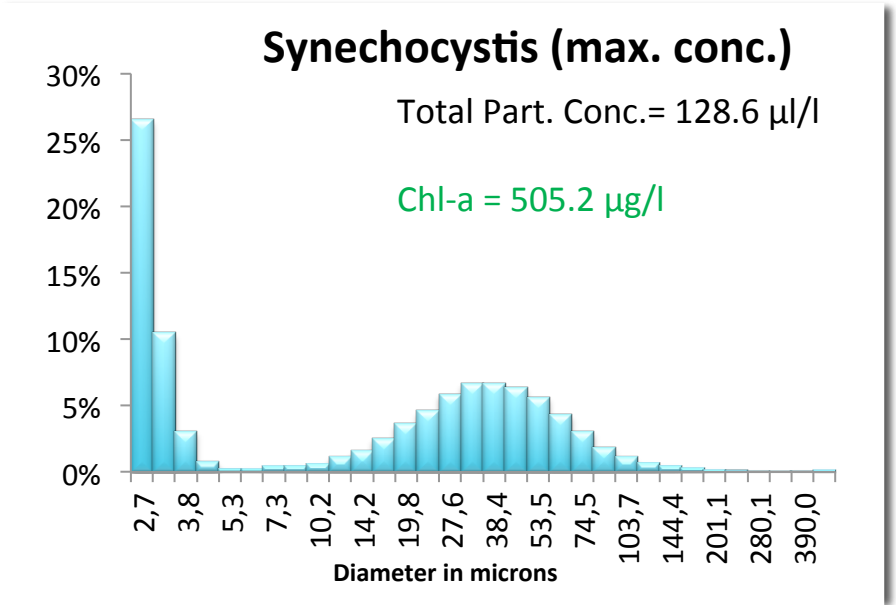




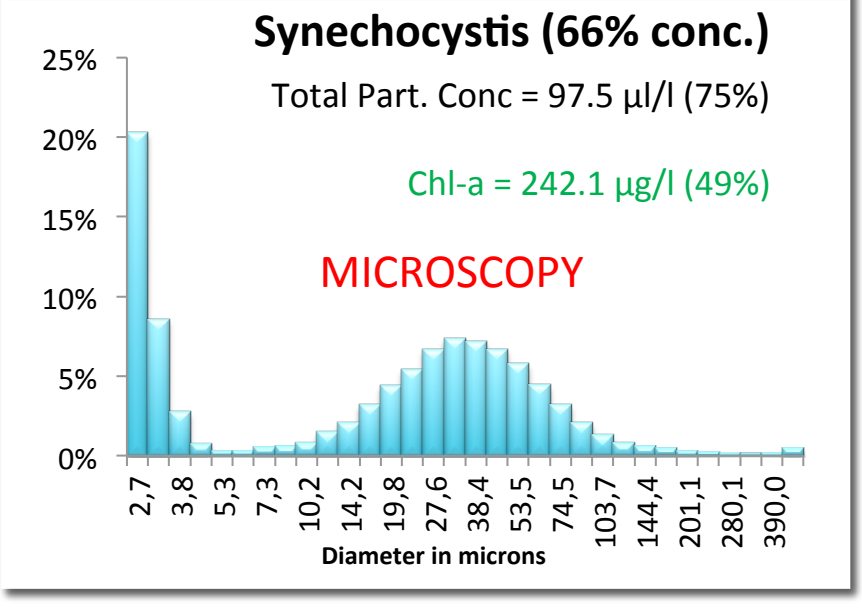
Results - Synechocystis LISST



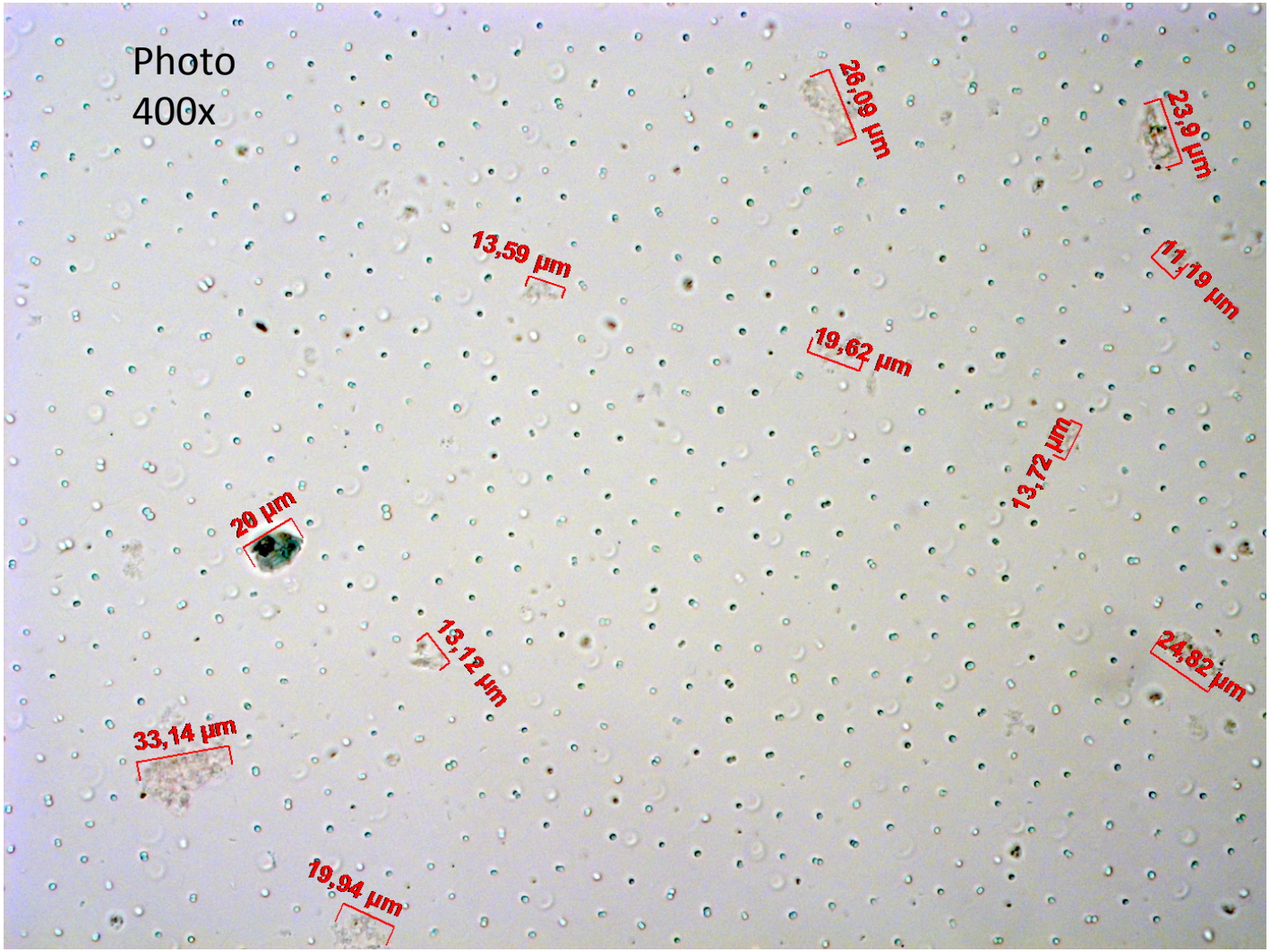




REPLICA

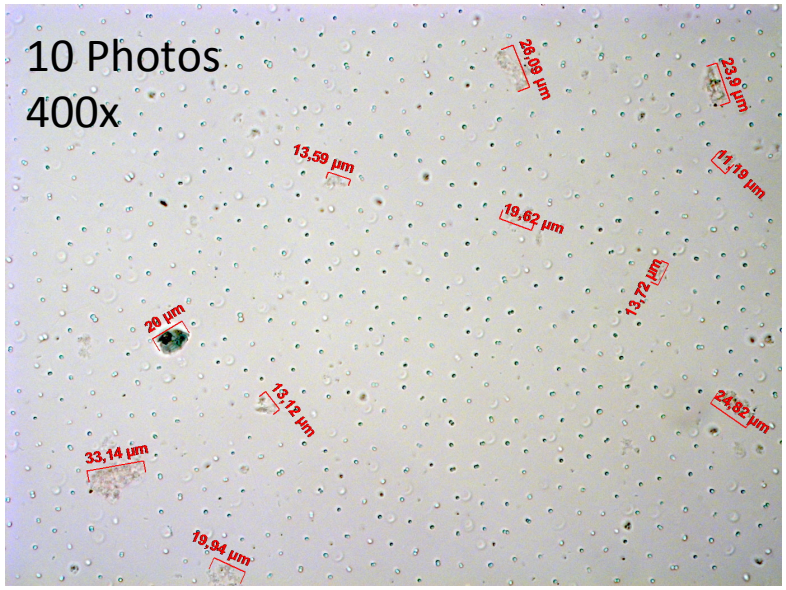


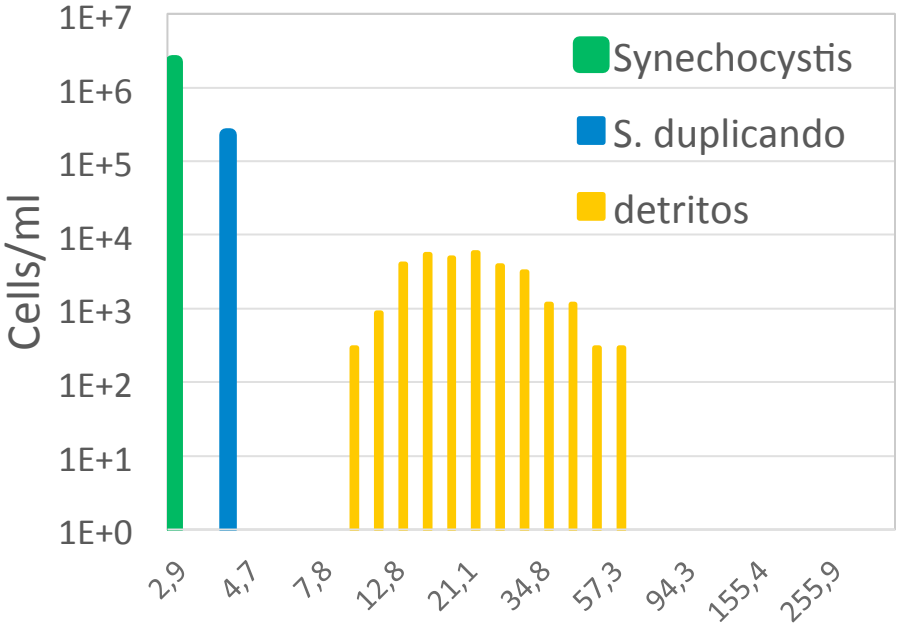
Results - Synechocystis



Dividing

Resultados - Synechocystis



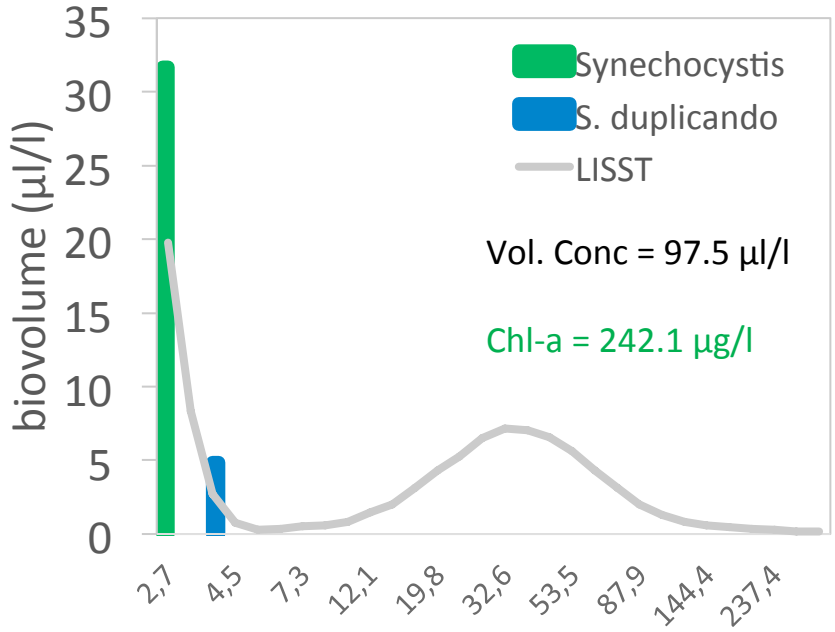


Biovolume

Synechocystis Diameter = 2.2 µm

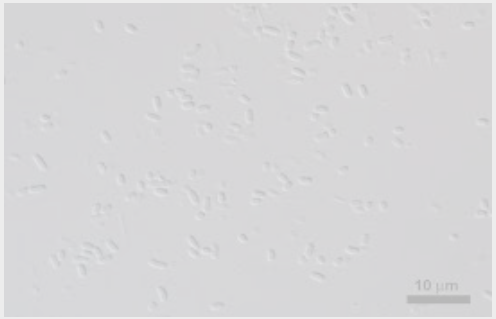
Vol. Synechocystis = $4/3*\pi * r^3$ = 14.4 μm^3

Vol. S. duplicando = x 1.5 = 21.2 μm^3

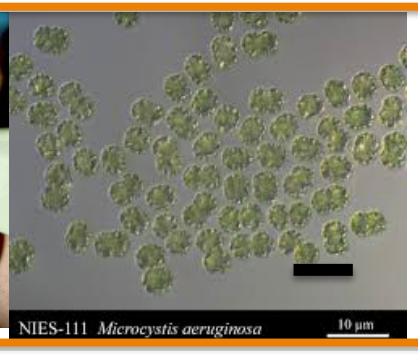


Results

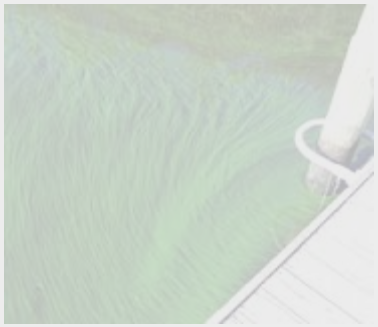
– *Synechocystis sp.*, small individual cells



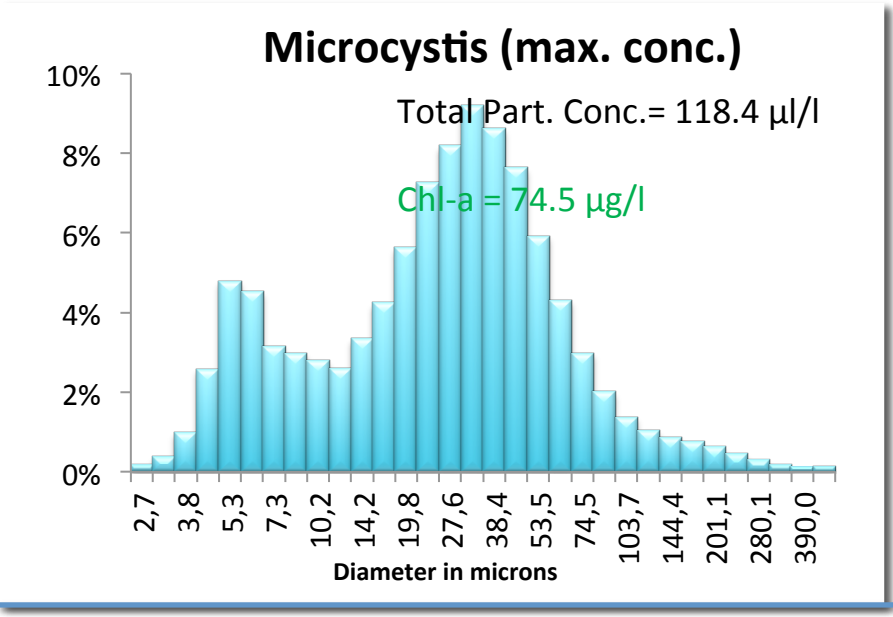
– *Microcystis sp.*, individual colonial, mucilaginous;

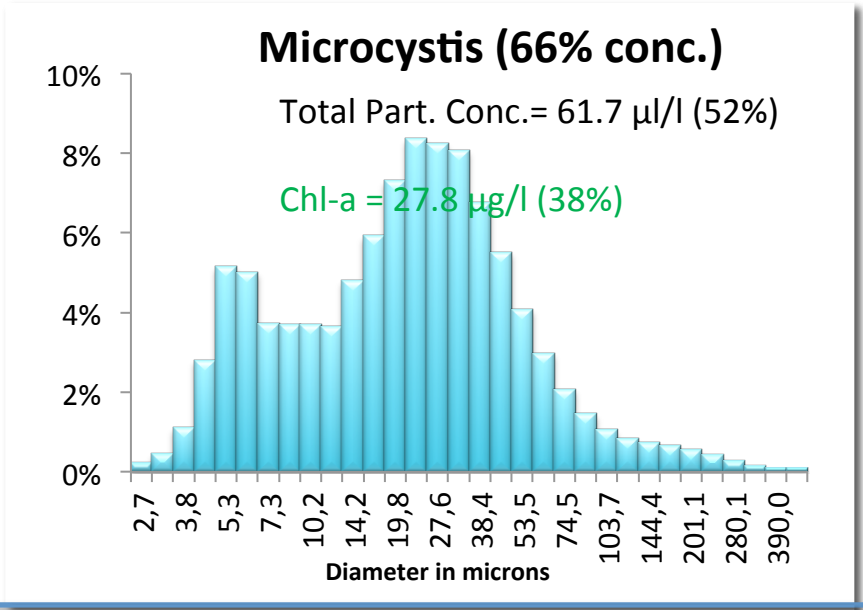


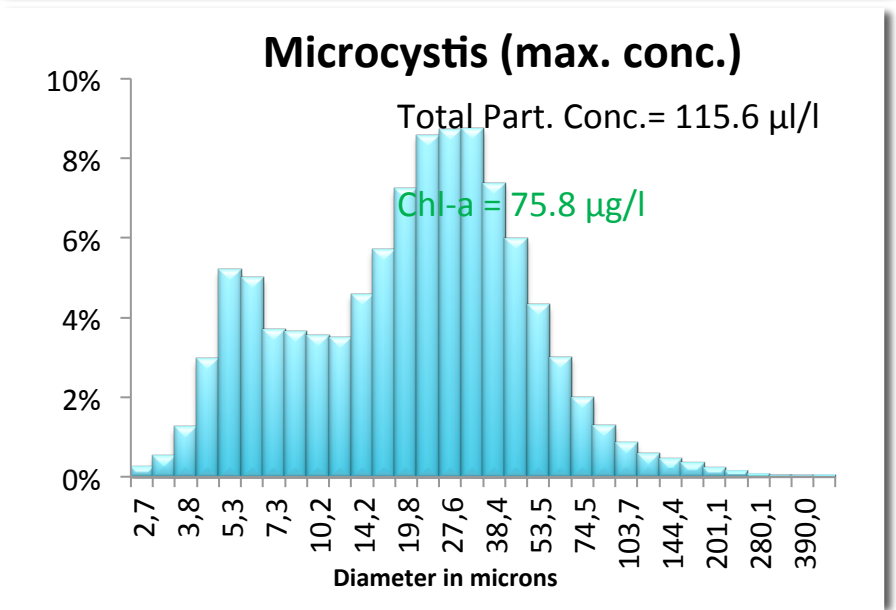
– *Anabaena sp.*, filamentous, aerotopes (buoying);



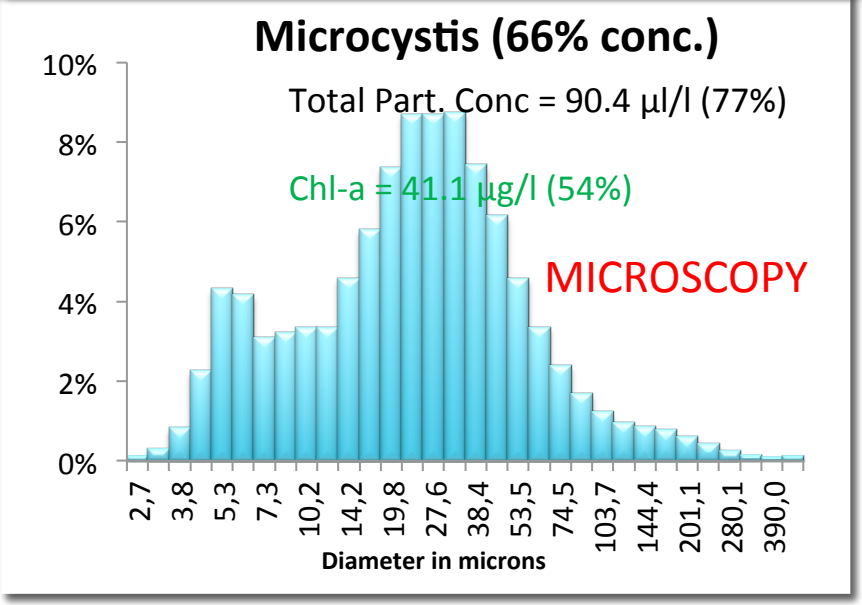
Resultados - Microcystis LISST



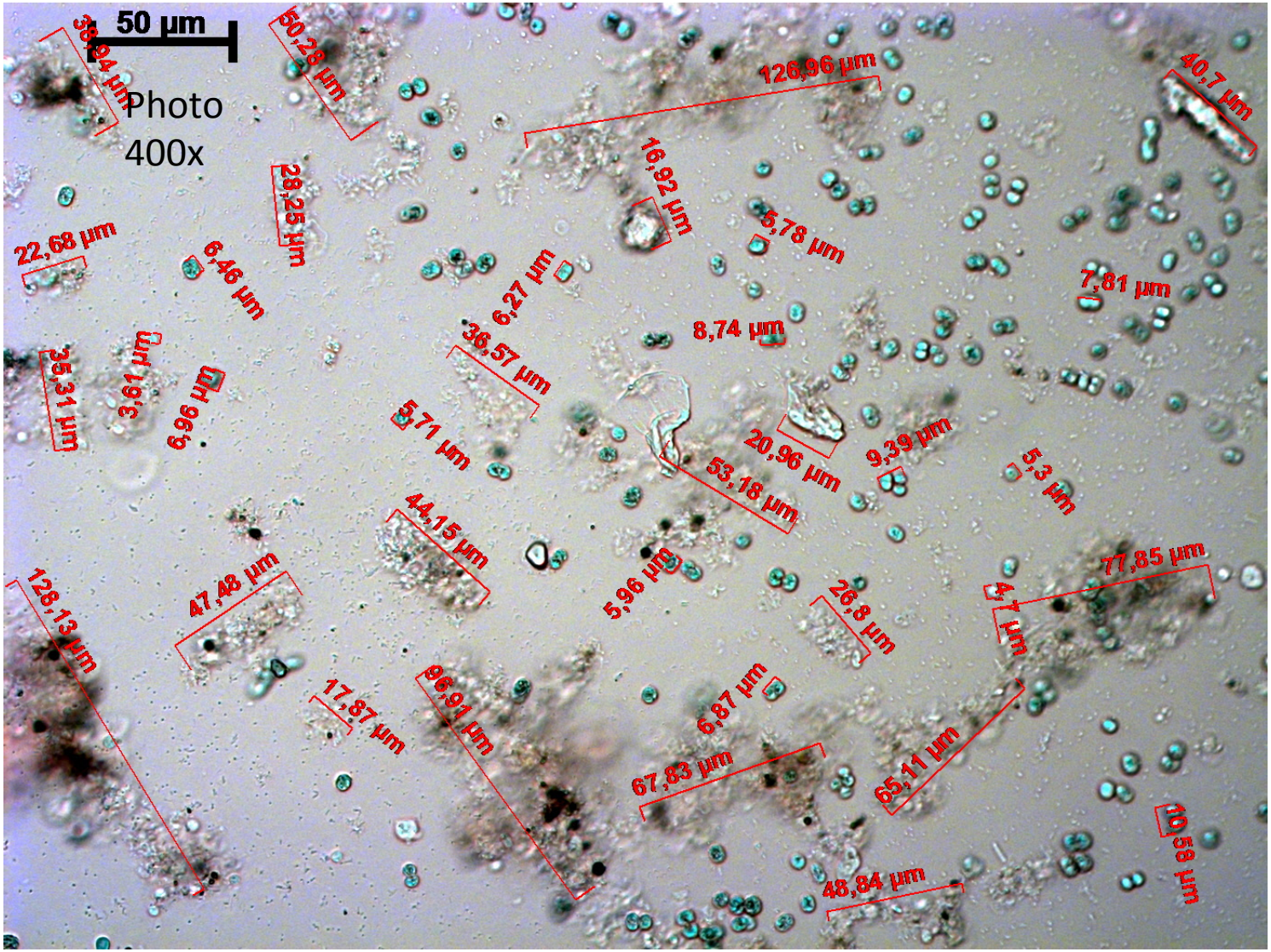




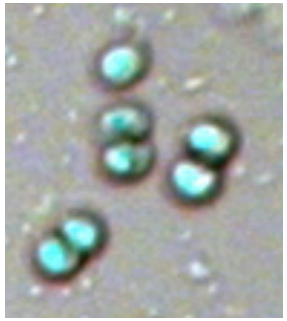
REPLICA



Results - Microcystis



Dividing



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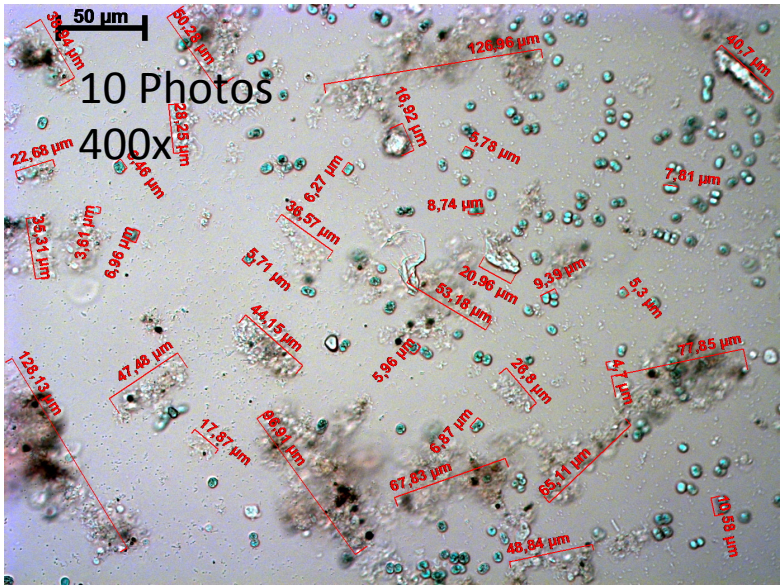
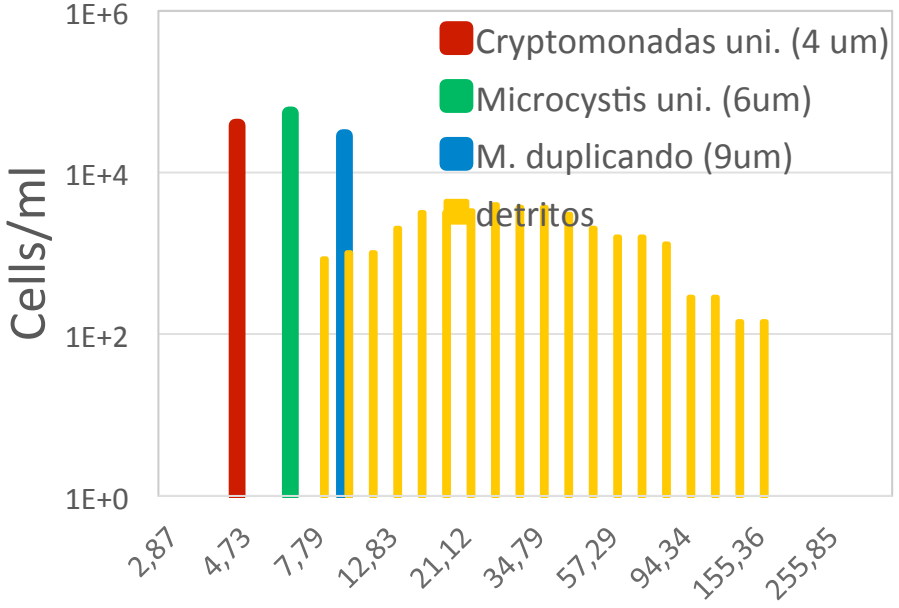




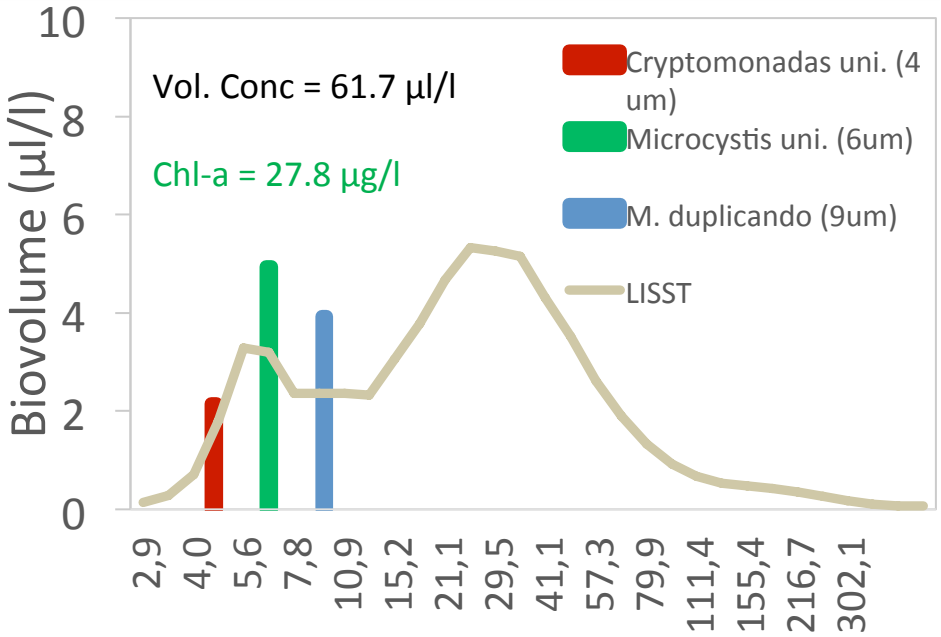
Biovolume

Cryptomonadas diameter = 4.3 µm
Microcystis Diameter = 6.2 µm

Vol. Cryptomonadas = $4/3*\pi * r^3 = 55.7\ \mu m^3$

Vol. Microcystis = $4/3*\pi * r^3 = 91.4\ \mu m^3$

Vol. M. duplicando = x 1.5 = $137.2\ \mu m^3$



Results

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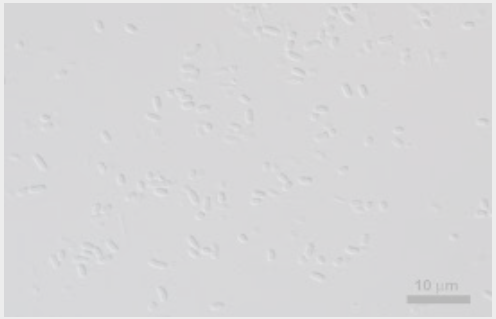

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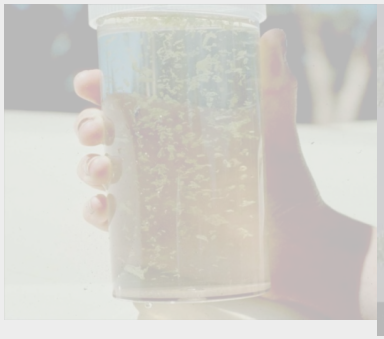
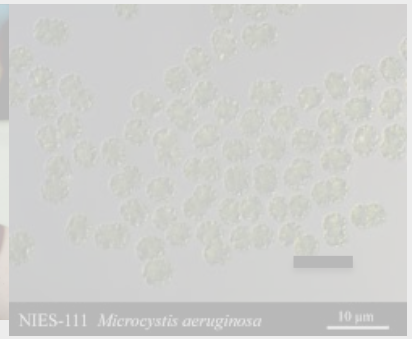
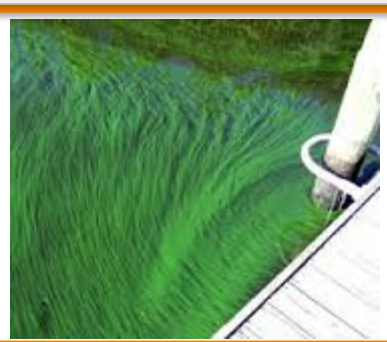
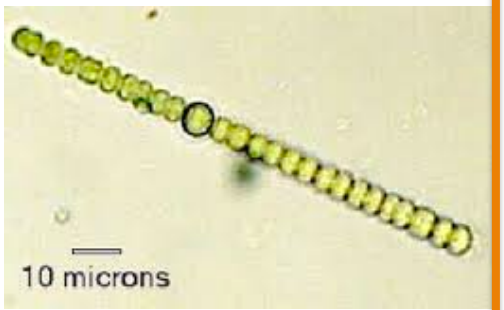


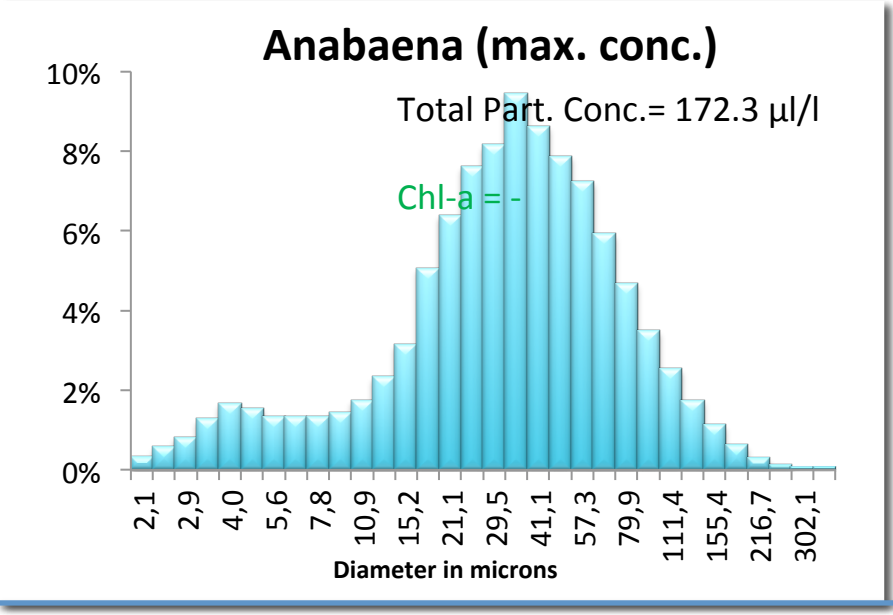


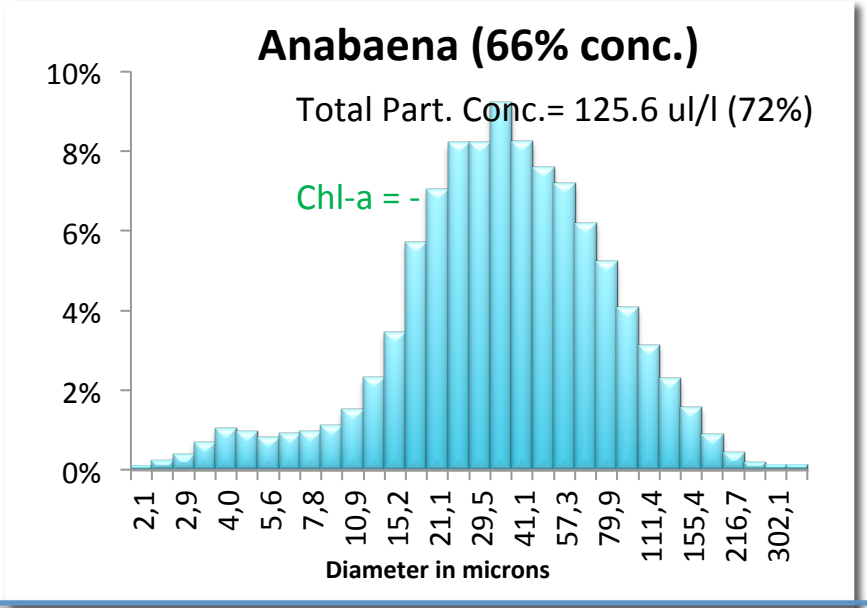
– *Anabaena sp.*, filamentous, aerotopes (buoying);

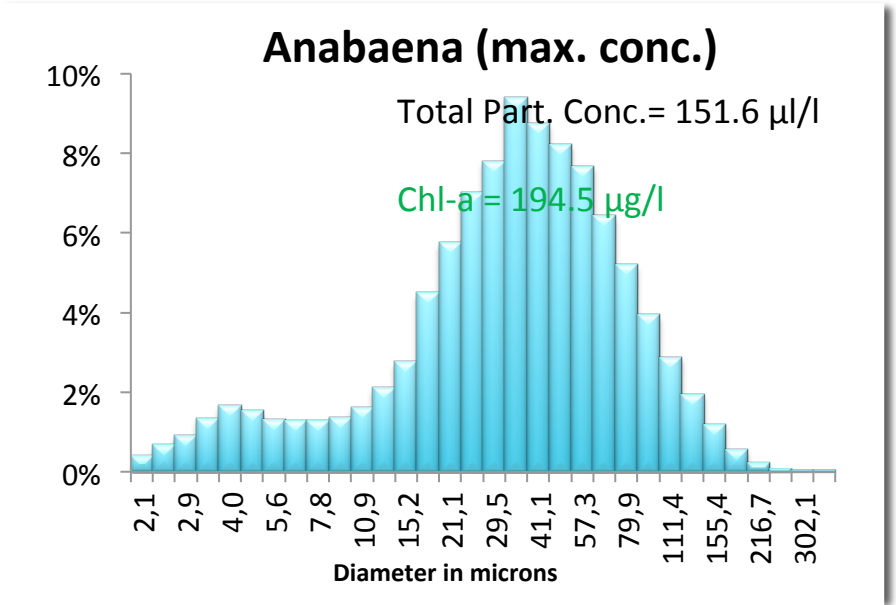




Results - Anabaena LISST







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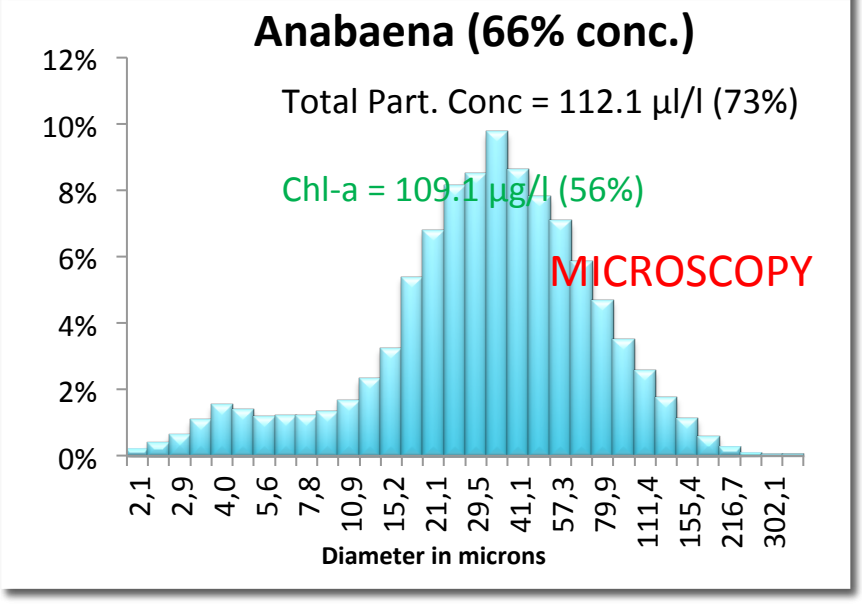
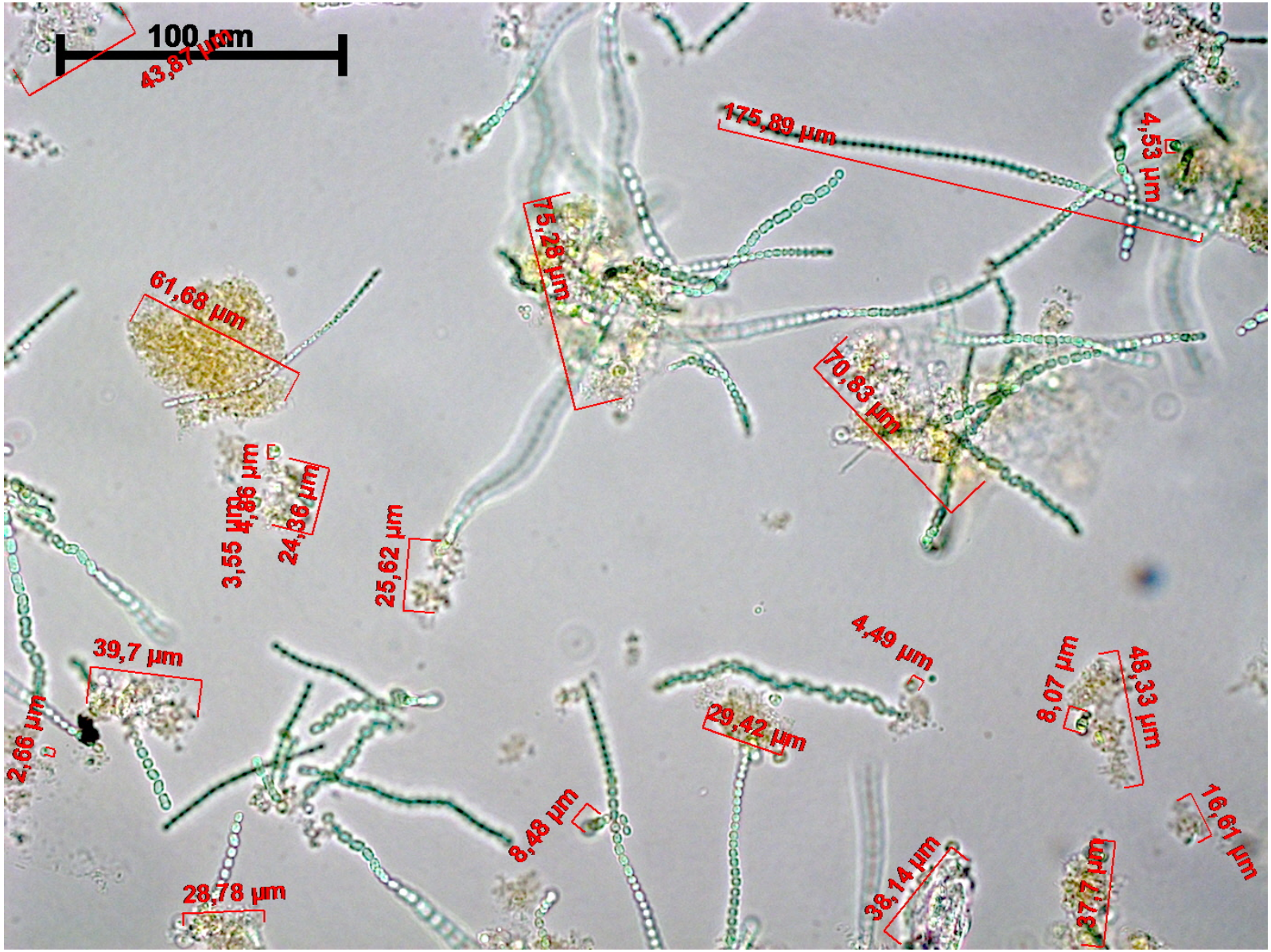
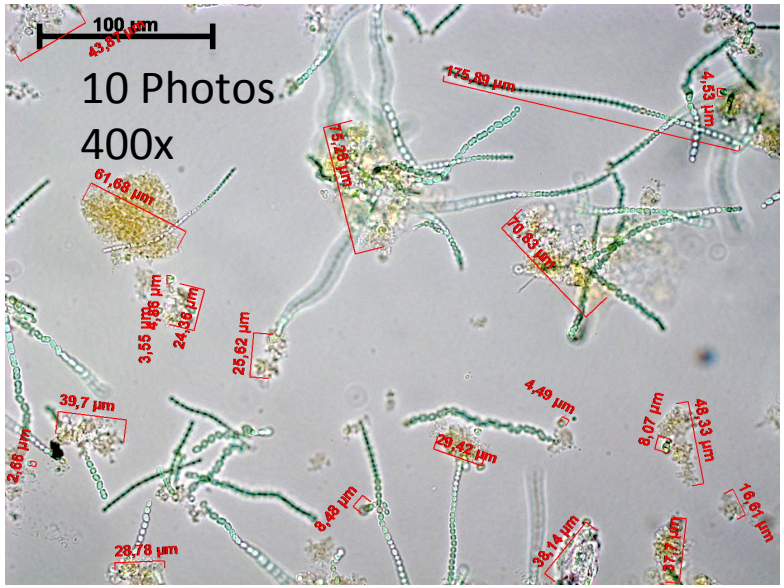


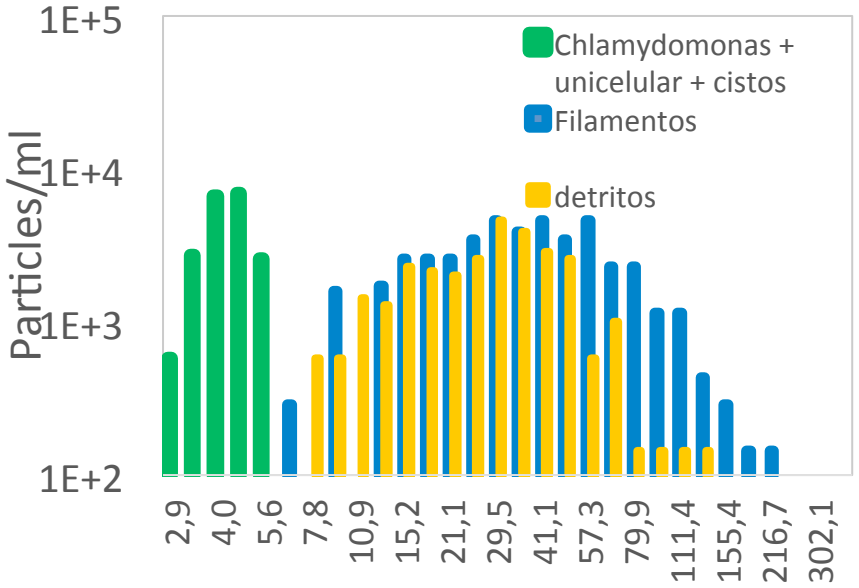
Results - Anabaena

Photo
400x



Results - Anabaena





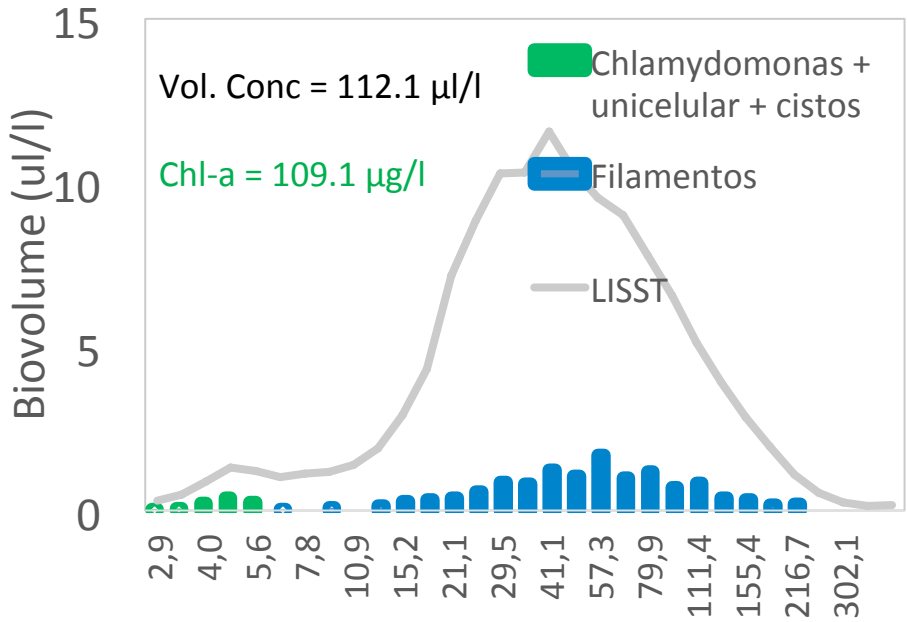
Biovolume

Chlamydomonas diameter = 4.0 µm
Anabaena (one cell) Diameter = 3.1 µm

Vol. Chlamydomonas = $4/3*\pi * r^3 = 33.8\ \mu m^3$

Vol. Anabaena = $4/3*\pi * r^3 = 20.4\ \mu m^3$

Vol. Filaments = *Vol Anabaena* * # cells



Discussion

- Evaluate into what extend non-linear PSD (opposed to Junge) can affect VSF.

- Estimate the contribuition of different species PSD to VSF
  - Limitation to 20 degree!

- Use VSF for different cyanobacteria as input Hydrolight to model AOPs (such as Rrs). Is that possible??