MOTREM

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Water JPI
Pilot Call Final Meeting
4th of June 2018, Helsinki

MOTREM

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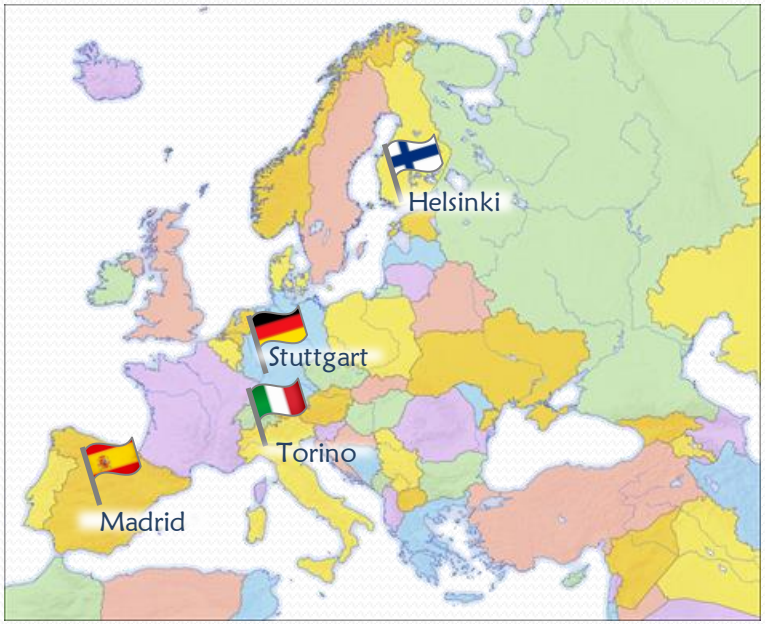
Integrated Processes for Monitoring and Treatment of Emerging Contaminants for Water Reuse

URJC – Universidad Rey Juan Carlos (Spain)
UST – Universität Stuttgart (Germany).
UH – University of Helsinki (Finland).
UNITO – Università di Torino (Italy).
FCC Aqualia S.A. (Spain).
Bruker Española, S.A. (Spain).



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MINISTERIO DE ECONOMÍA Y COMPETITIVIDAD

Universität Stuttgart

Bundesministerium für Bildung und Forschung

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MINISTERO DELL'ISTRUZIONE, DELL'UNIVERSITÀ E DELLA RICERCA

FCC Aqualia

CDTI Centro para el Desarrollo Tecnológico Industrial

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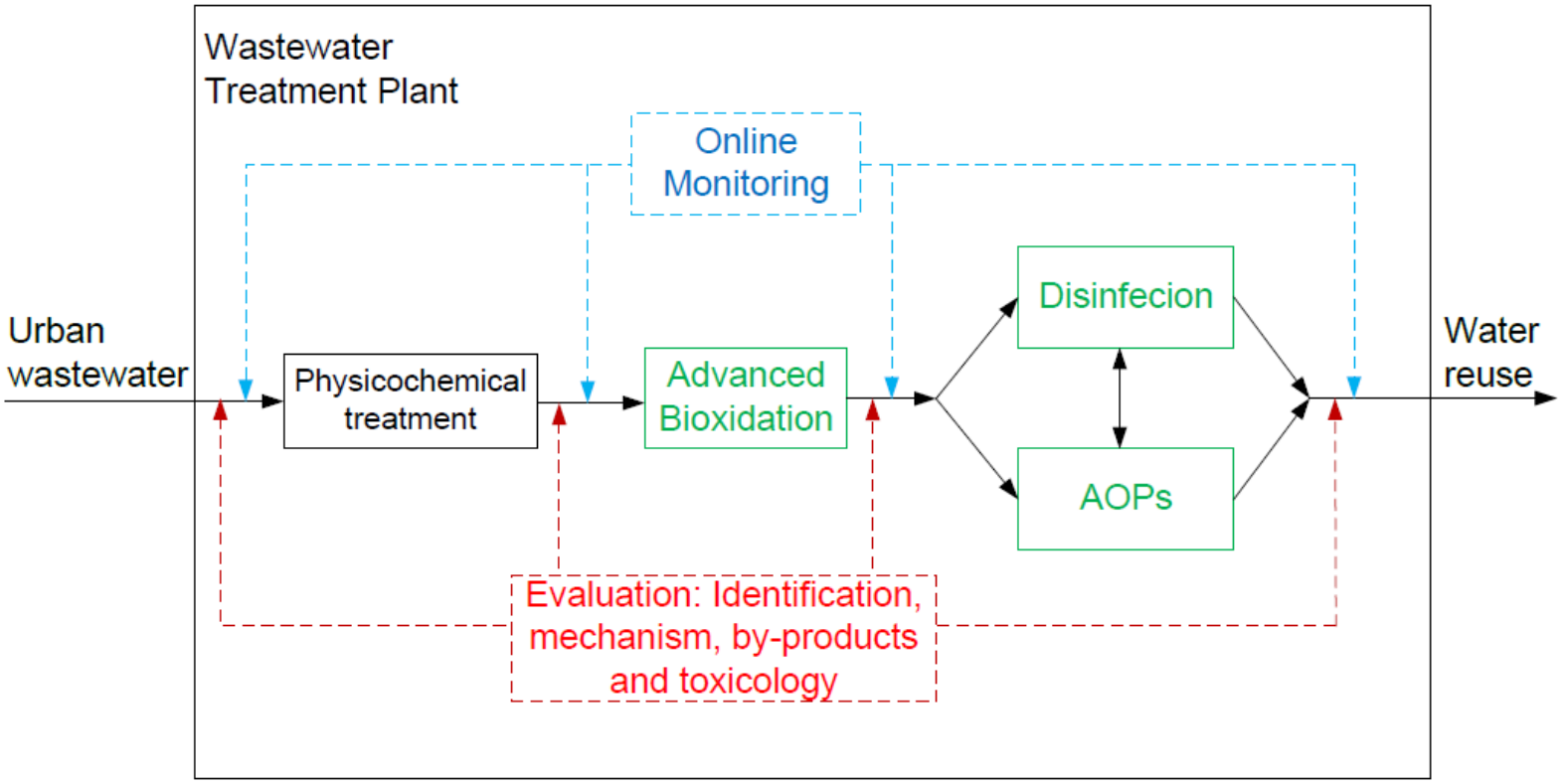
Integrated Processes for MOnitoring and TReatment of EMerging Contaminants for Water Reuse – Conceptual Diagram



MOTREM Work-Packages

WORK PACKAGES

Project execution is structured in 5 work packages:

WP1 Development of New Treatment Technologies (*URJC*)

WP2 Development of New Monitoring Technologies (*UST*)

WP3 Emerging Contaminants Evaluation (*UH*)

WP4 Dissemination and Exploitation of Project Outcome (*AQUALIA*)

WP5 Project Coordination and Management (*URJC*)

Scientific and technological results

Main topics:

a) **Optimised biotreatment processes** with enhanced efficiency in the removal of CECs based on the incorporation of specific microorganisms.

b) **Optimised disinfection technologies and AOPs** able to deal simultaneously with the inactivation of pathogenic microorganisms and CECs before water reuse or discharge to the environment.

c) **Optimised technologies for the monitoring** of the WWTP operation regarding the removal of CECs, including analytical procedures and measurements of integrative parameters.

d) **Identification of the most representative CECs** for the evaluation and monitoring of the efficiency of the water treatment processes, including its degradation mechanism and toxicology.

Scientific and technological progress

WP3 – Emerging Contaminants Evaluation

Selection of representative ECs

Representative micropollutants for monitoring in a municipal WWTP were selected. The final list included 10 target compounds (20 as an extended list) that were chosen based on:

- Current and forthcoming legislation,
- Frequency of occurrence in municipal WWTP,
- Expected concentration levels,
- Elimination potential in conventional and advanced treatment.
- Analytical feasibility

The short list comprises:

Chemical	CAS	Acronym	Reason
Atrazine	1912-24-9	**ATZ**	Target
Caffeine	58-08-2	**CFN**	Indicator
Carbamazepine	298-46-4	**CBZ**	Indicator/Target
Diclofenac	15307-79-6	**DCF**	Target
Estron	53-16-7	**EST**	Target
Ibuprofen	51146-56-6	**IBP**	Indicator
Simazine	122-34-9	**SMZ**	Target
Sucralose	56038-13-2	**SCL**	Indicator
Sulfamethoxazole	723-46-6	**SMX**	Target
Triclosan	3380-34-5	**TCS**	Indicator/Target

The extended list additionally comprises:

Chemical	CAS	Acronym
Metoprolol	51384-51-1	**MTP**
Iopamidol	60166-93-0	**IPM**
HHCB (Galaxolide)	1222-05-5	**HHCB**
HHCB-Lactone (Galaxolidone)	N/A	**HHCB-L**
DEET	134-62-3	**DEET**
Terbutryn	886-50-0	**TBT**
Bisphenol A	80-05-7	**BPA**
Tris-chloroethyl-phosphate (TCEP)	115-96-8	**TCEP**
Perfluorooctanic acid (PFOA)	335-67-1	**PFOA**
Acesulfame K	55589-62-3	**ACF**

LCT Standard Analytical Method

Complete analytical method for the rigorous determination of these substances based on:

- Standard extractions cartridges.
- Use of isotopically labelled internal standards.
- GC-MS/MS, LC-MS/MS, LC-TOF/MS analytical equipment.

LC

- Column: Waters Acquity UPLC HSS T3 1,8µm, 2,1x100mm
- Eluent A: 5% MeOH / H2O + 0,1% Formic acid
- Eluent B: 100% MeOH + 0,1% Formic acid
- Flow: 0,2 ml/min
- Gradient, 22 min:
  - 1 min 100% A
  - 10 min 100%A -> 100% B
  - 8 min 100 % B
  - 3 min 100% A
- Injection volume: 20 µl

TOF

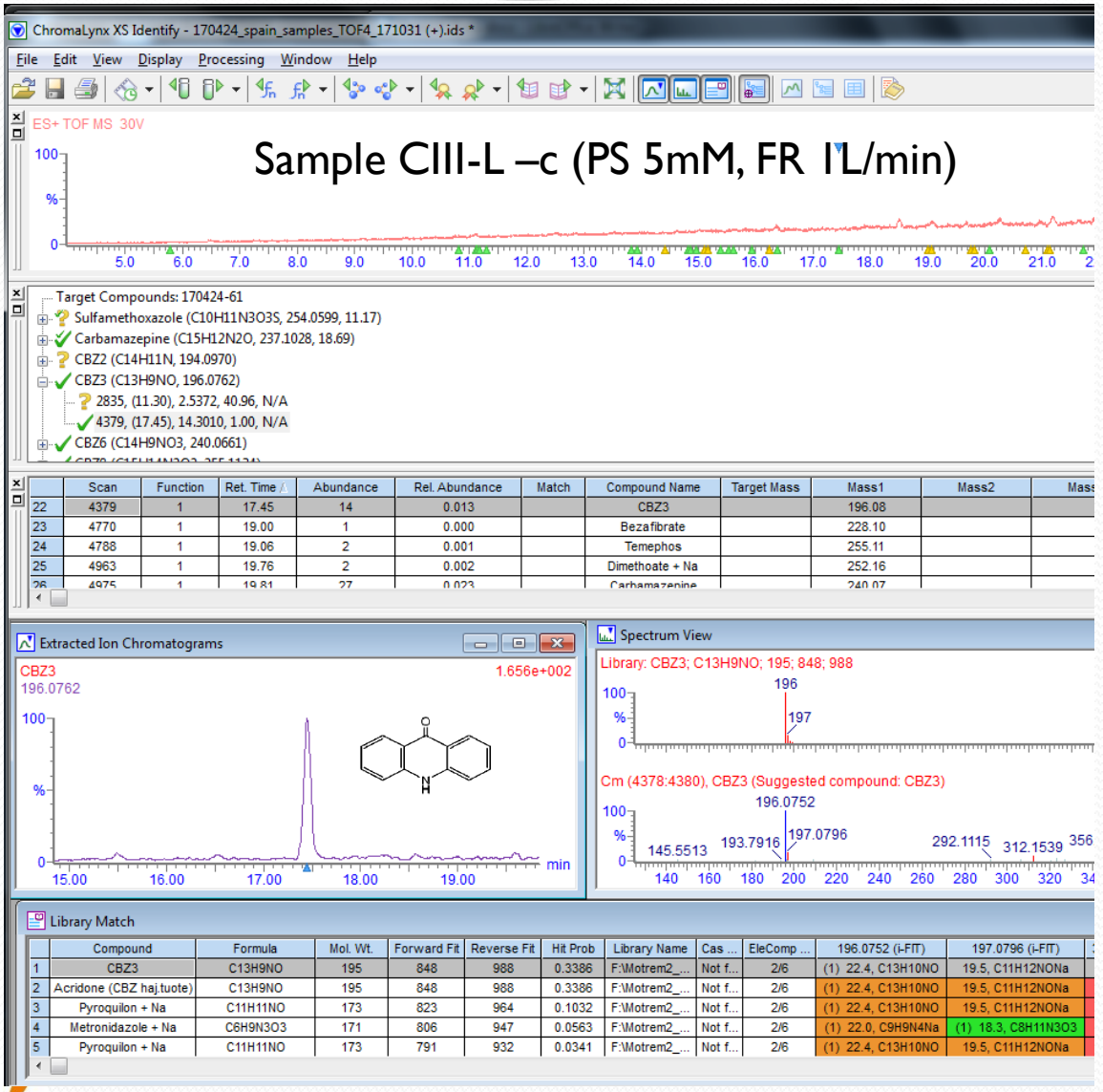
- Scan range: 60-1000 m/z
- 0,9 sec scan time, interscan delay 0,1 s
- Separate runs for ESI + and -
- ESI+: Caffeine, Simazine, Carbamazepine, Atrazine, Estrone
- ESI-: Sulfamethoxazole, Sucralose, Diclofenac, Triclosan, Ibuprofen

LCT Standard Analytical Method: Validation Data

	ESI(+)	ESI(-)	
	LOQ, ng/l	LOQ, ng/l	Linear range up to, ng/l
Caffeine	6.3		6000
Sulfamethoxazole	1.7	14	8000
Sucralose Na-adduct	17		4000
Simazine	0.3		100
Carbamazepine	1.3		4000
Atrazine	0.4		800
Estrone	4.4		800
Diclofenac	3.0		8000
Sucralose		48	8000
Diclofenac		2.6	8000
Ibuprofen		14	8000
Triclosan		8.5	200

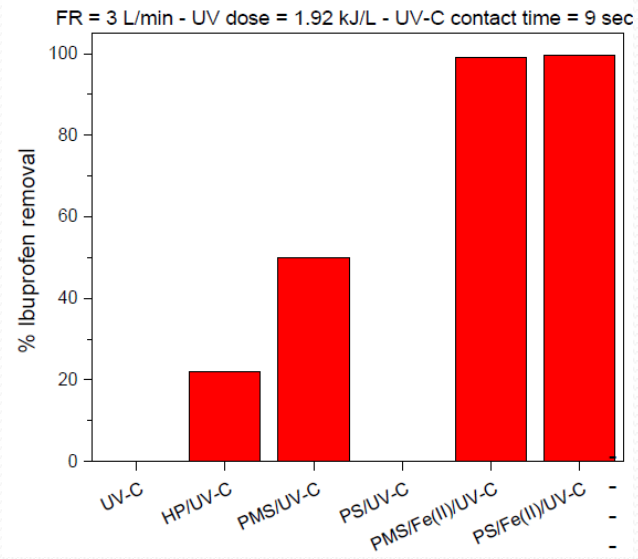
Post target LC-TOF

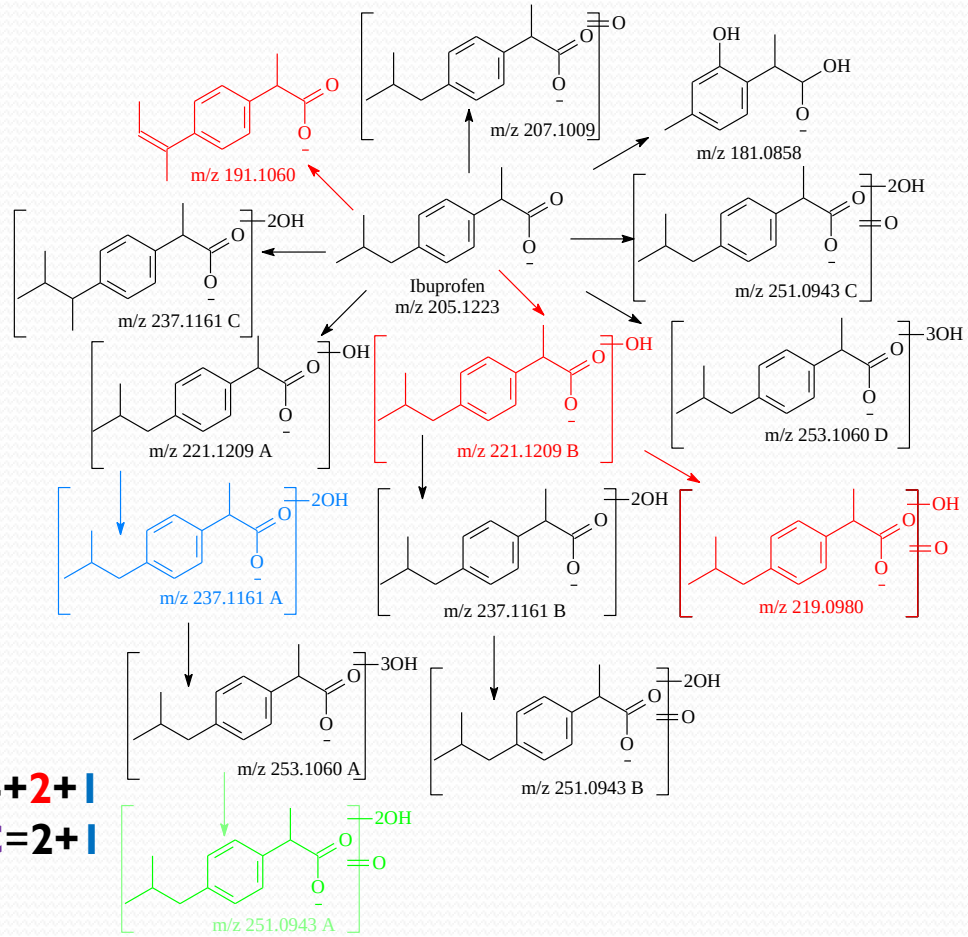
- A list of 30 possible transformation products of SMX, CBZ, and DCF was compiled using literature information
- These compounds were screened from the Spanish wastewater samples



Degradation intermediates

Example: the case of ibuprofen





TPs number vs treatments

HP/UV-C=9 **PMS/UV-C=3+3** **PS/UV-C= 4+2+1**
PMS/Fe(II)/UV-C=3+2+1 **PS/Fe(II)/UV-C=2+1**

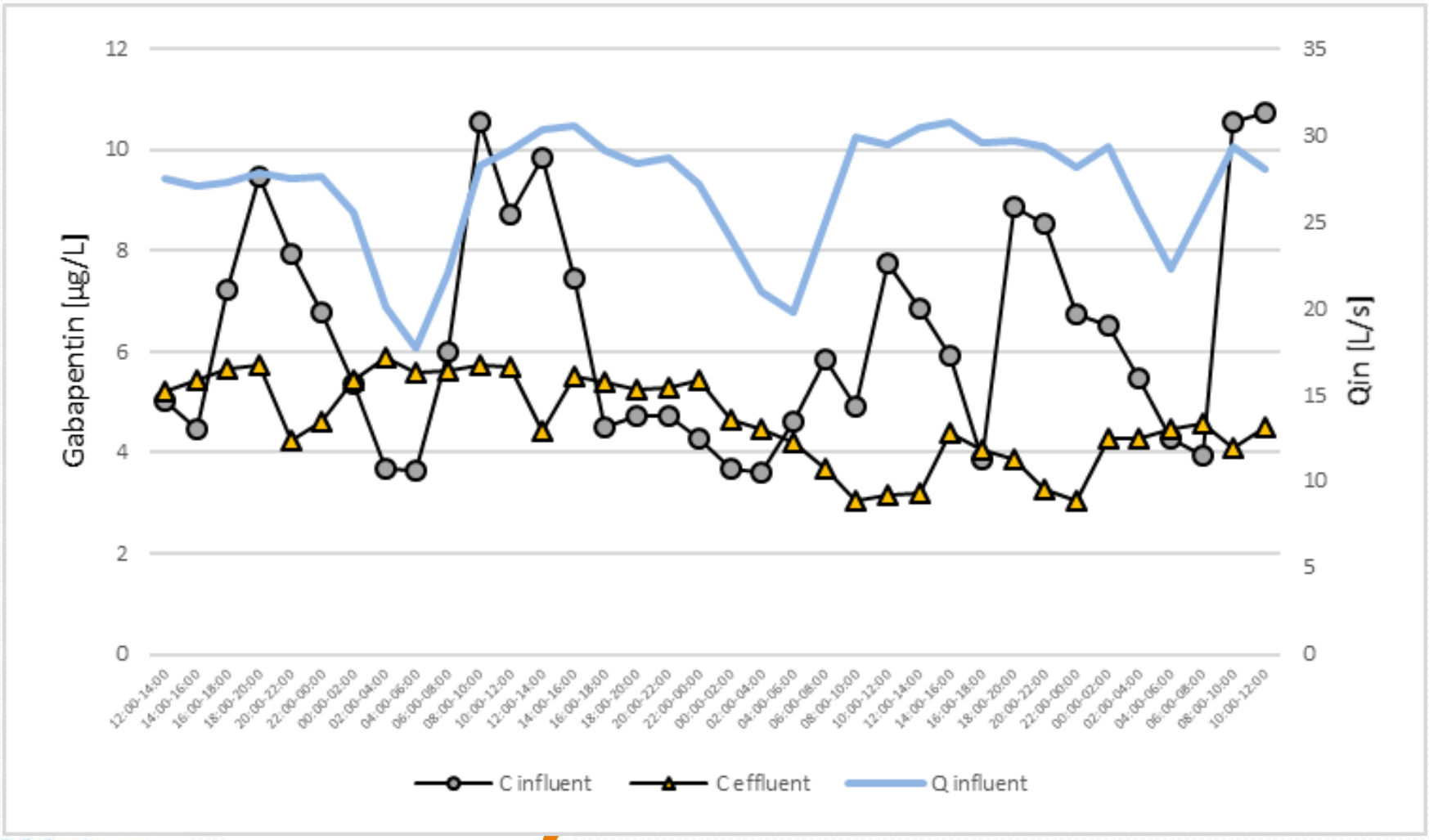
- ✓ 14 different TPs
- ✓ Some of them are common to several treatments.
- ✓ Other ones are specific to the treatment (green, blue)

Scientific and technological progress

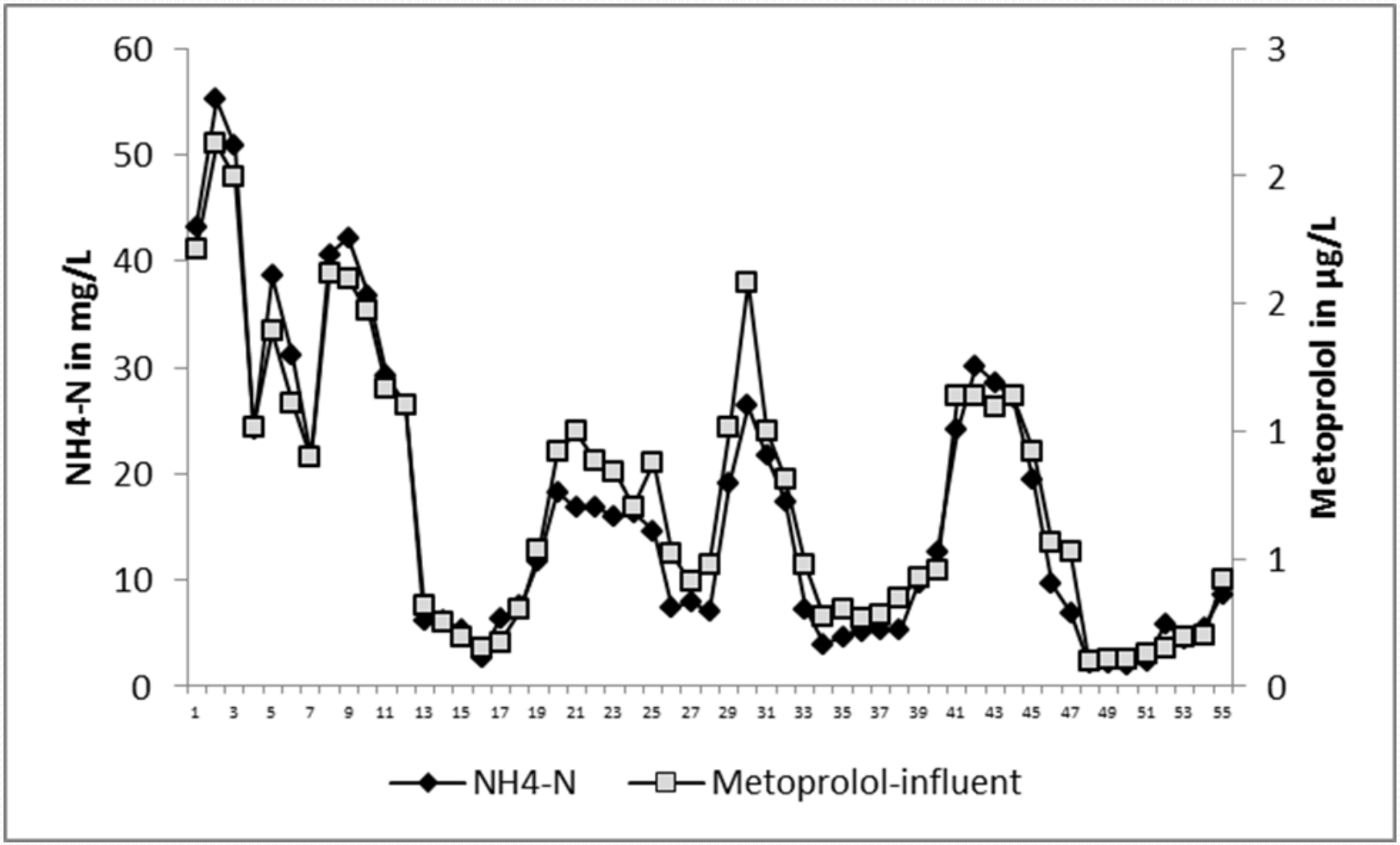
WP2 - Development of New Monitoring Technologies

Daily Fluctuations and HRT

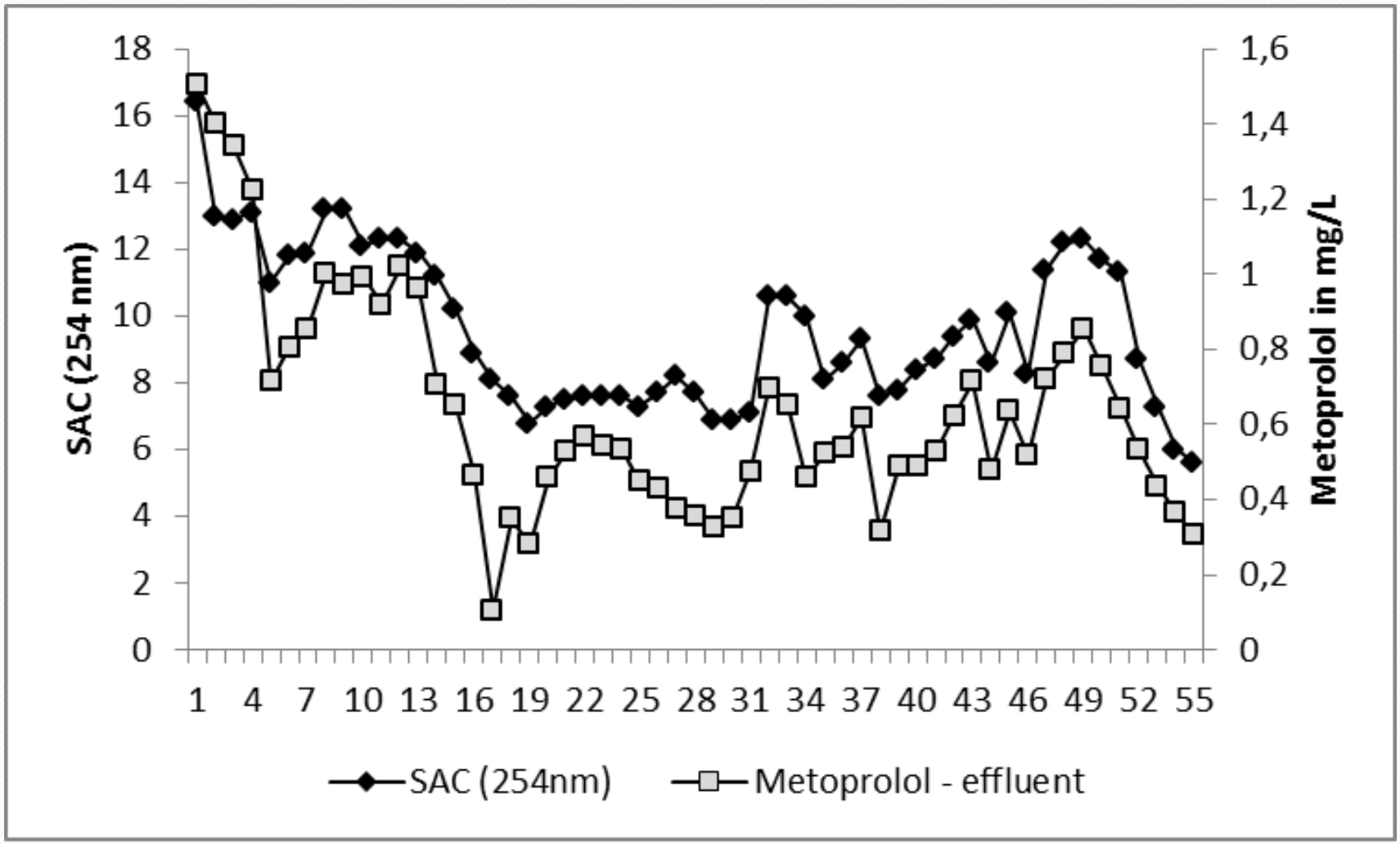
Example: System WWTP – Q variable,
2h-mixed samples for 72 h



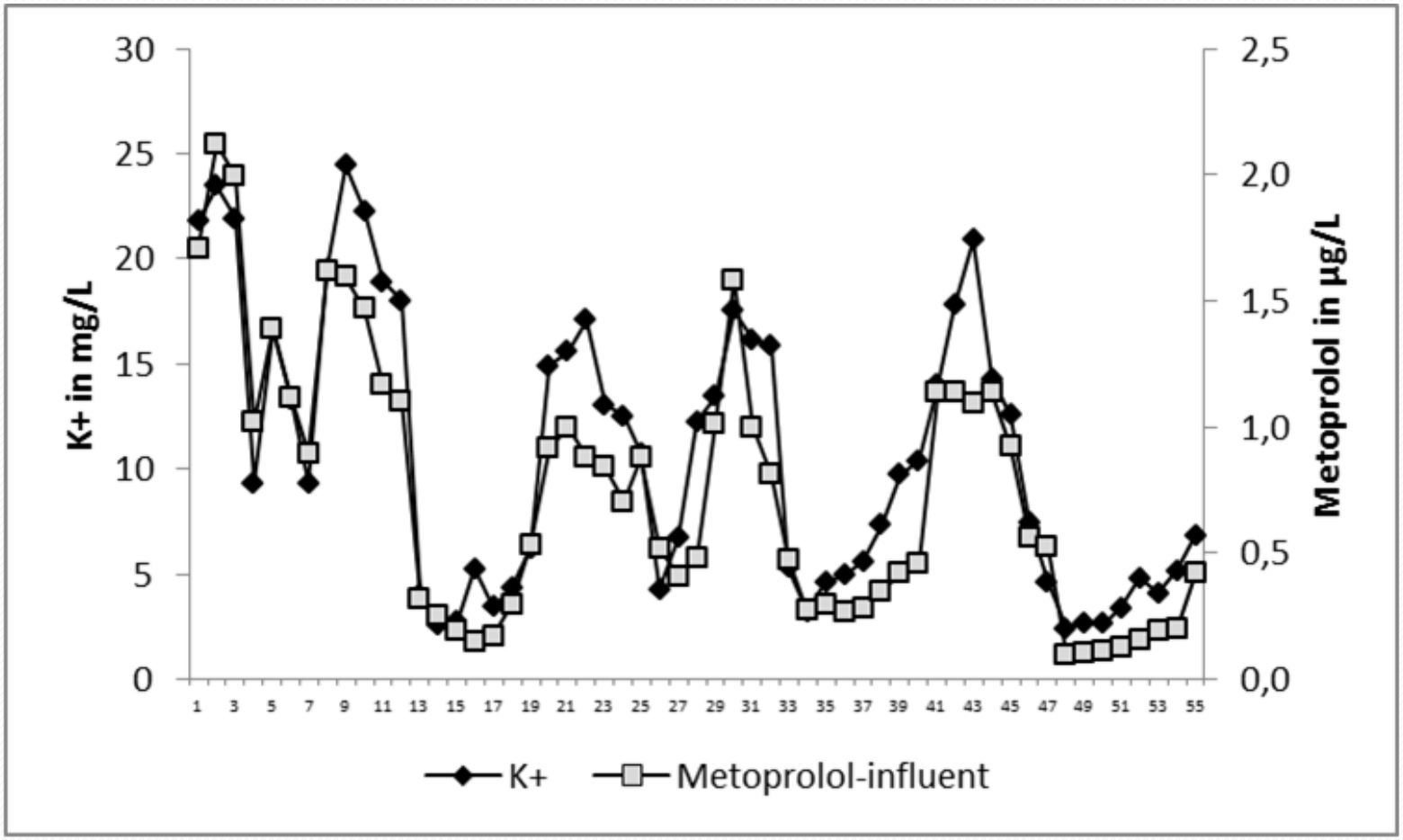
Correlation with conventional parameters



Correlation with conventional parameters



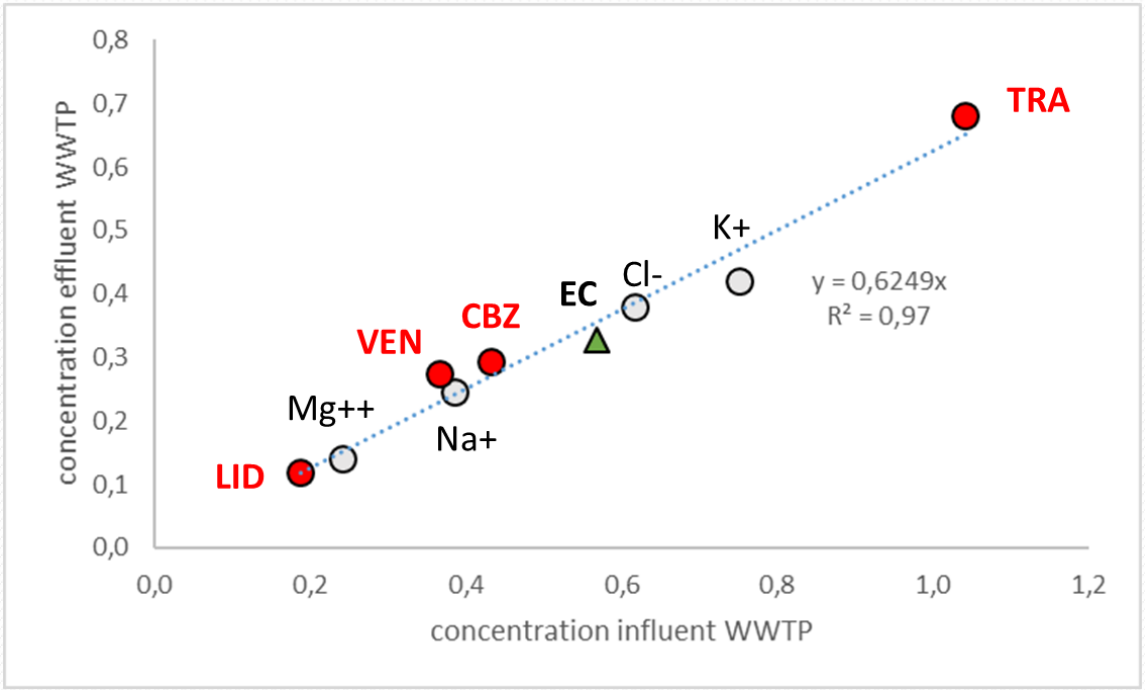
Correlation with conventional parameters



Correlation with conventional parameters

Verification of Sampling with conventional parameters

24h-mixed samples influent/effluent WWTP (E)



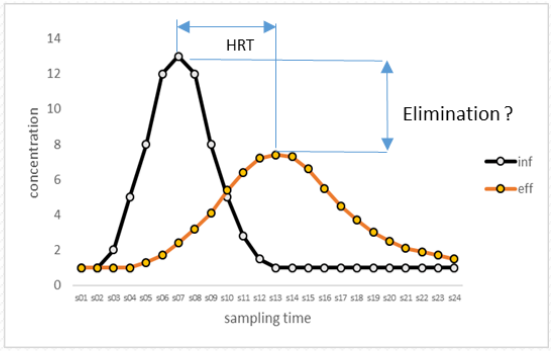
LID: Lidocaine; VEN: Venlafaxine, CBZ: Carbamazepine, TRA: Tramadol, EC: Electric Conductivity

Removal of micropollutants appr. 37 % ?

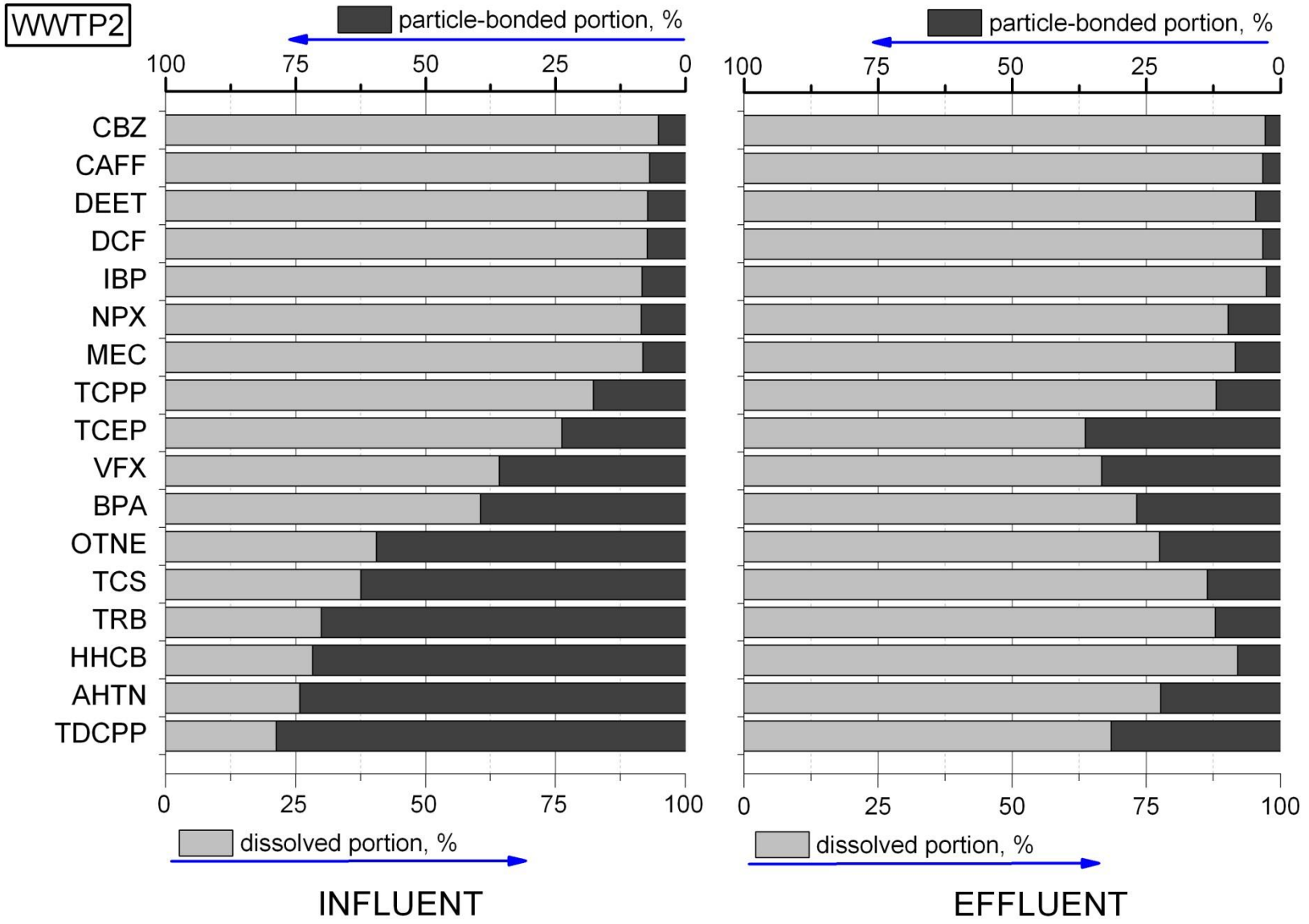
HRT not considered?

Dispersion?

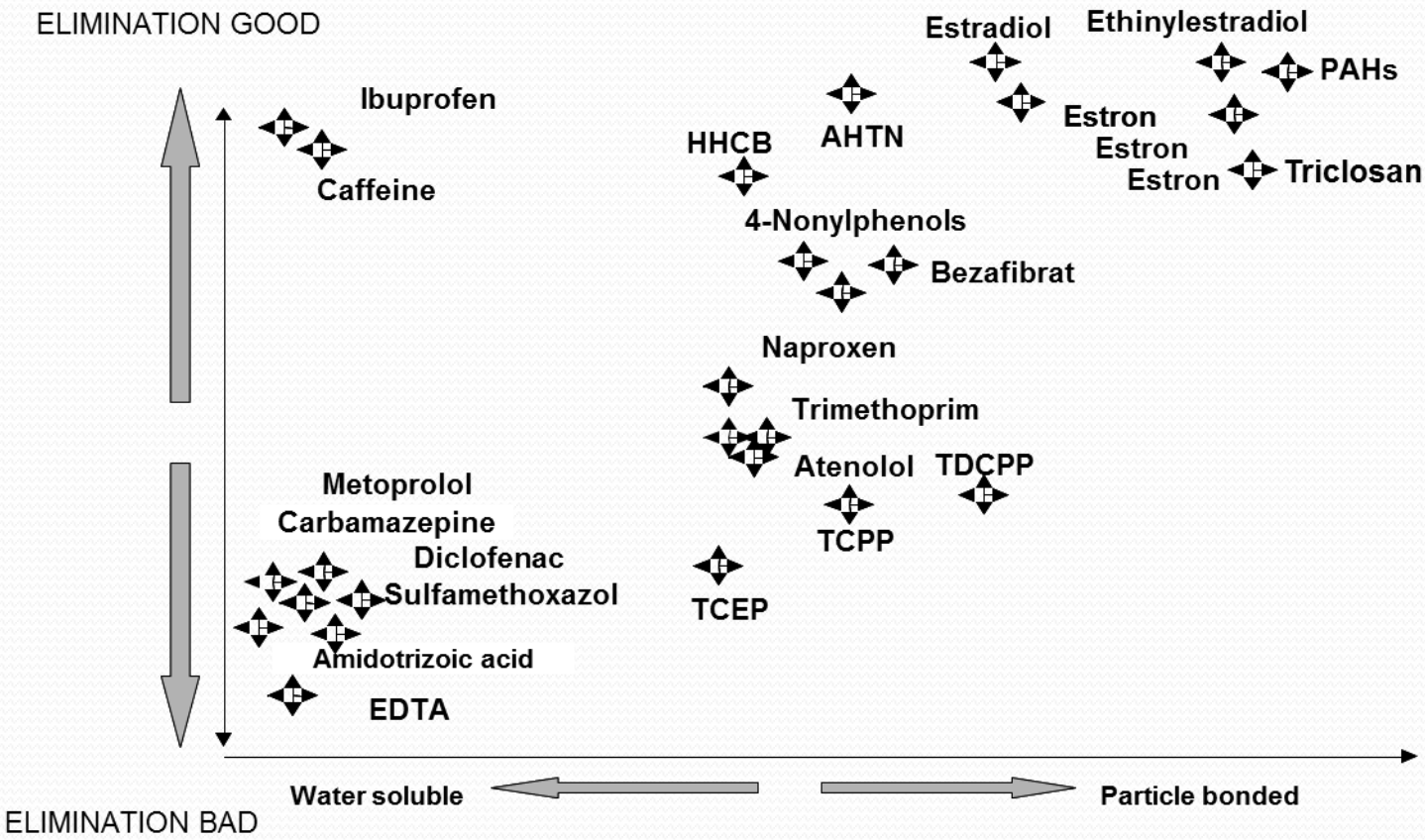
Foreign Water?



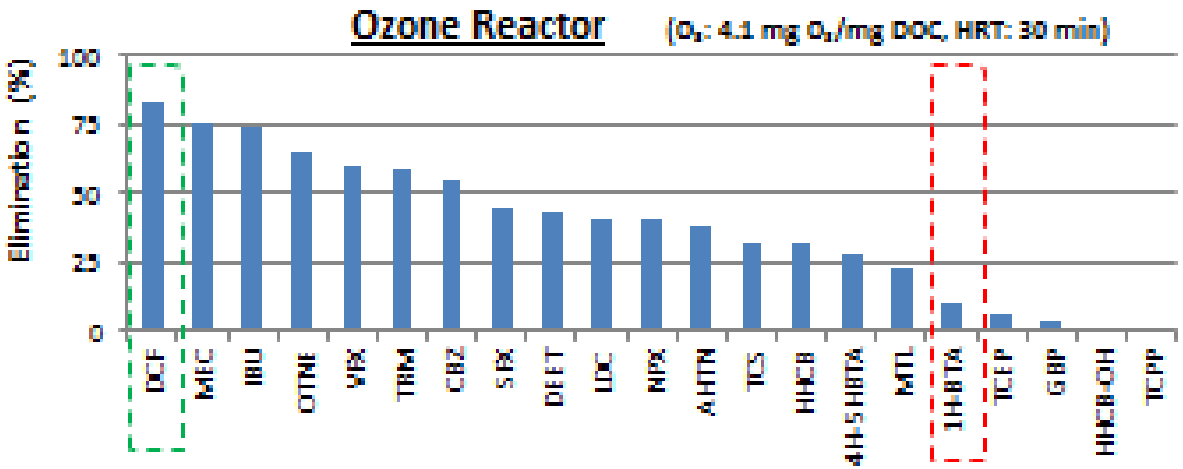
Dissolved vs Particle bonded



MICROPOLLUTANTS – ELIMINATION IN MUNICIPAL WASTEWATER TREATMENT

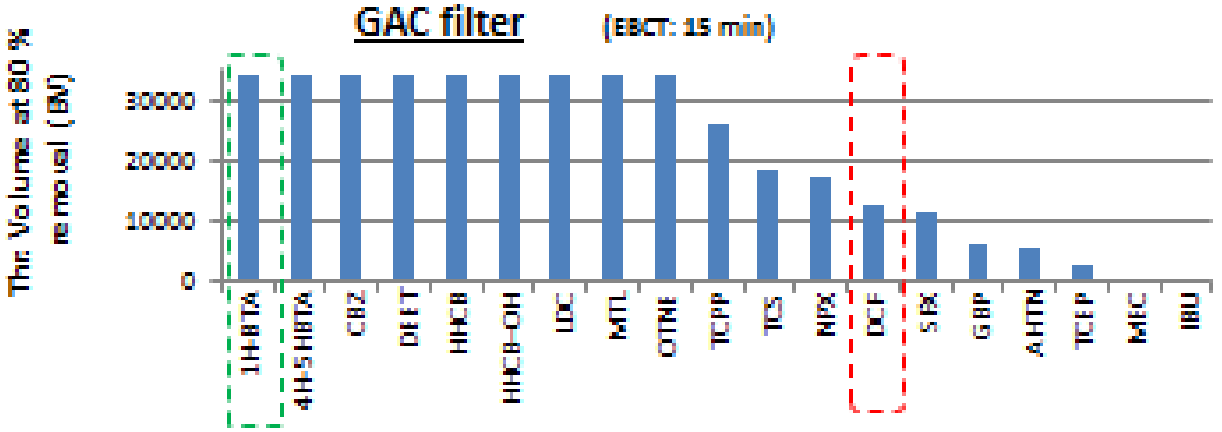


Selection of representative substances



Micropollutants are removed at different extent by each process based on their properties

➢ Process-related micropollutants to be used for control



Selection of representative substances

Selection should based on

- Process to be monitored
- Chemico-physical properties of the substance
- Occurence and detection frequency (periodic/episodic)
- Source and entry path
- Substances should be representatives of a group with a similar behaviour

Scientific and technological progress

WP1 - Development of New Treatment Technologies

Efficient Biodegradation of ECs with ABOP

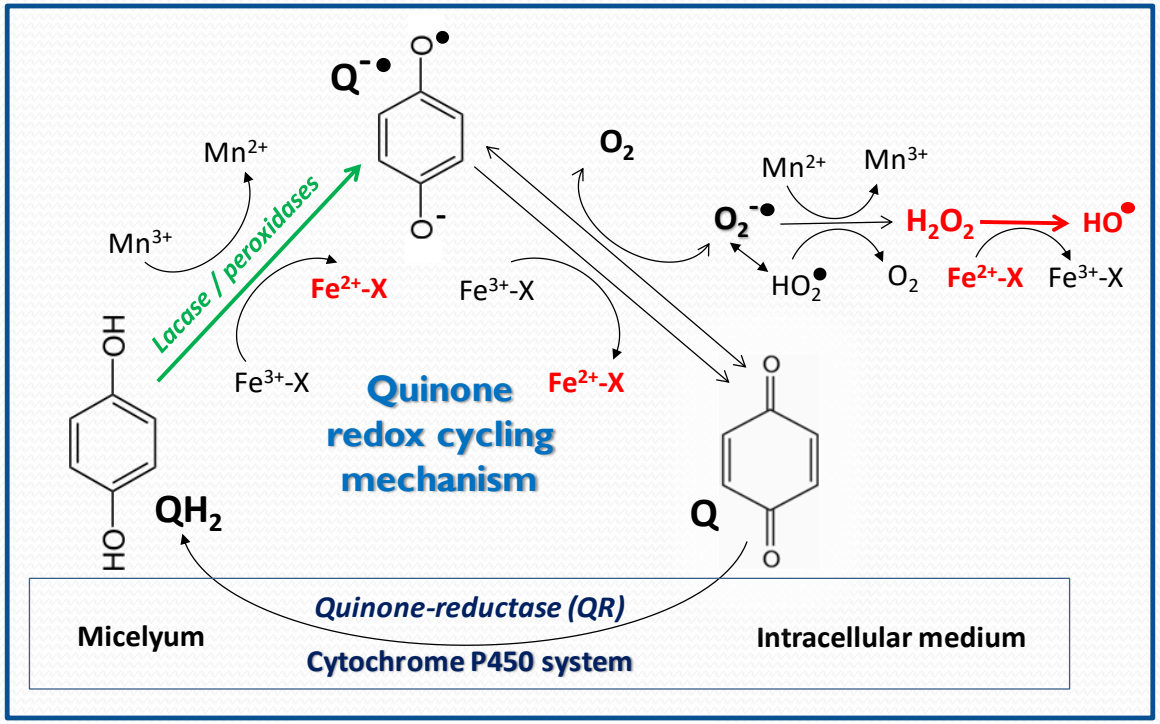
Trametes versicolor

Ganoderma lucidum

Advanced bio-oxidation process (ABOP) mediated by white-rot fungi

- Biological Fenton-like system
- Non-specific biodegradation system
- Preconditioning is not needed

Generation of oxidizing radicals by extracellular enzymes



Process catalysed by intracellular quinone reductase (cytochrome P450 system) and any of the ligninolytic enzymes of white-rot fungi (peroxidases and laccases)

Key points

- Quinone mediator
- Fe (II) and Mn (II) species

Supplementary substrates for AOBP

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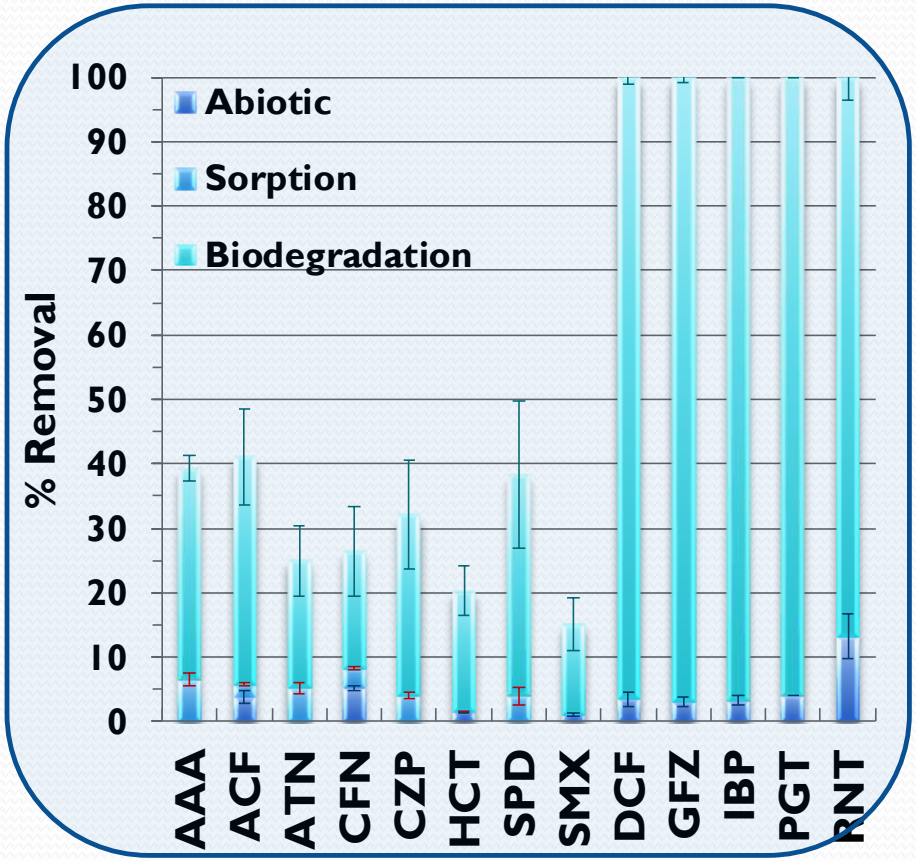
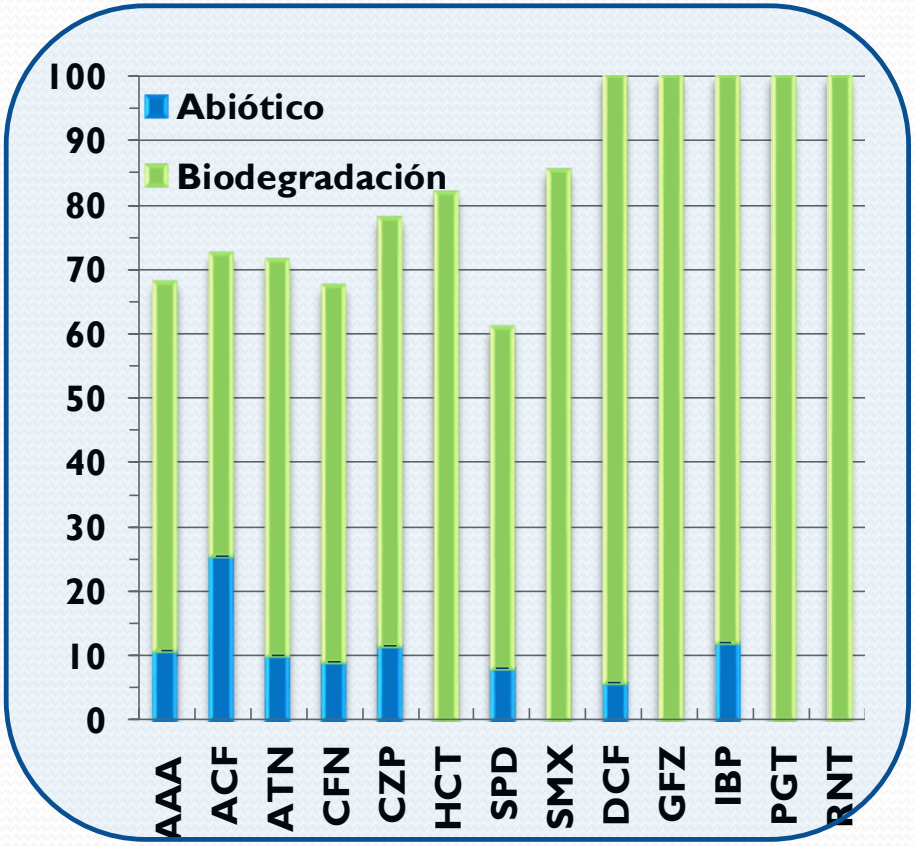
Efficient Biodegradation of ECs with ABOP

Bioassays in batch reactors



ONLY DEFINED MEDIUM



DEFINED MEDIUM +
SUPPLEMENTARY SUBSTRATES
FOR AOBP

Addition of Fe(III), Mn(II) and DMBQ activator

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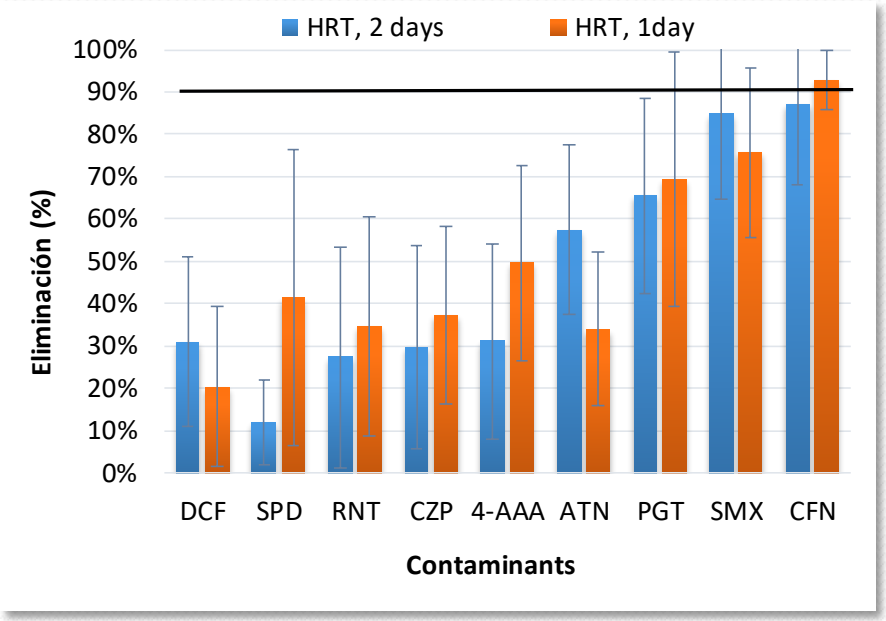
Efficient Biodegradation of ECs with ABOP

Fungal biodegradation in continuous Rotating Biological Contactors (RBCs)

Units	1 (5 discs each)
Total volume	24.5 L
Disc diameter	30 cm
Disc area	1.42 m^2
Disc submerged	40% (10 L)
Rotation speed	20 rpm
HRT	1-2 days
Temperature	26±2°C



C-TOC Reduction ≈ 80%

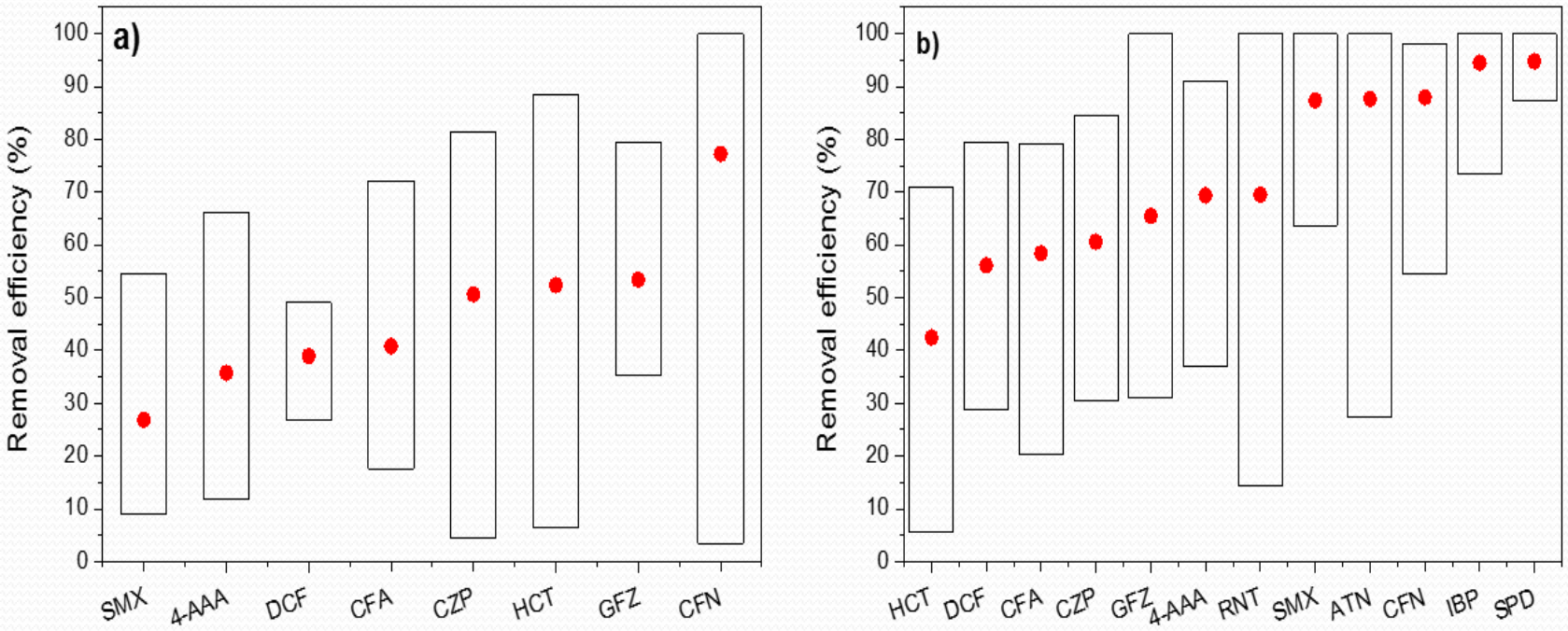
N-NH_4^+ Reduction ≈ 90-95%

Efficient Biodegradation of ECs with ABOP

CONTINUOUS TREATMENT USING ROTATING BIOLOGICAL CONTACTORS

A. Synthetic Urban WasteWater (SUWW), spiked 50 μg/L, 1d HRT

B. Real Urban WasteWater (RUWW) from DAF (URJC), spiked 50 μg/L, 1d HRT



Intervals of removal of pharmaceutical compounds for the treatment of a) SUWW and b) RUWW (red dot: average value)

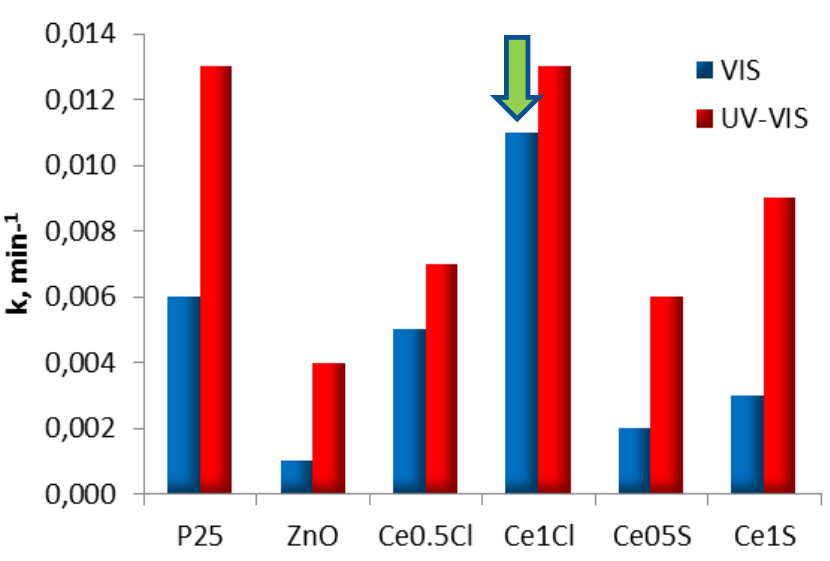
ZnO and Ce-ZnO photocatalytic materials

Synthesis

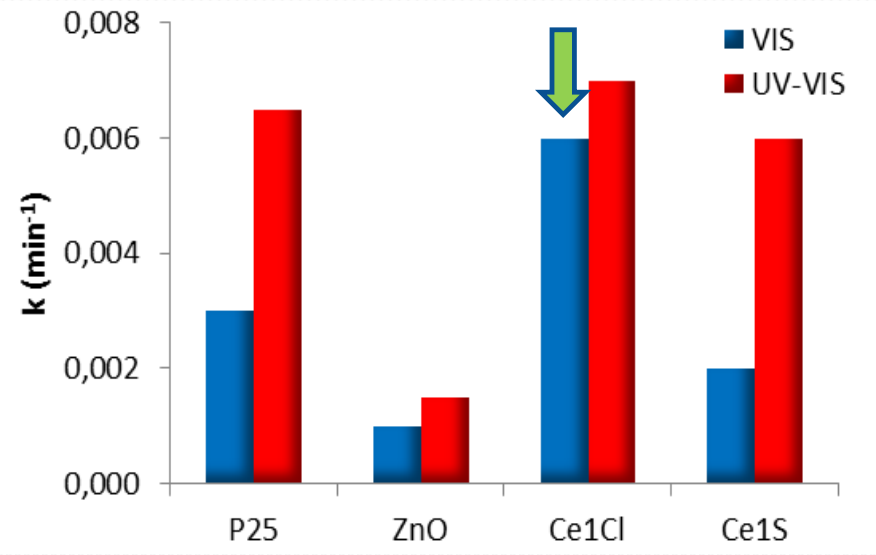
ZnO and Ce-ZnO synthesised via hydrothermal route from Zn acetate and $Ce(SO_4)_2$ or $CeCl_3$ at 0.5 % level (Ce05S) (Ce05Cl) and 1 % level (Ce1S) (Ce1Cl).

Removal of Acesulfame K removal

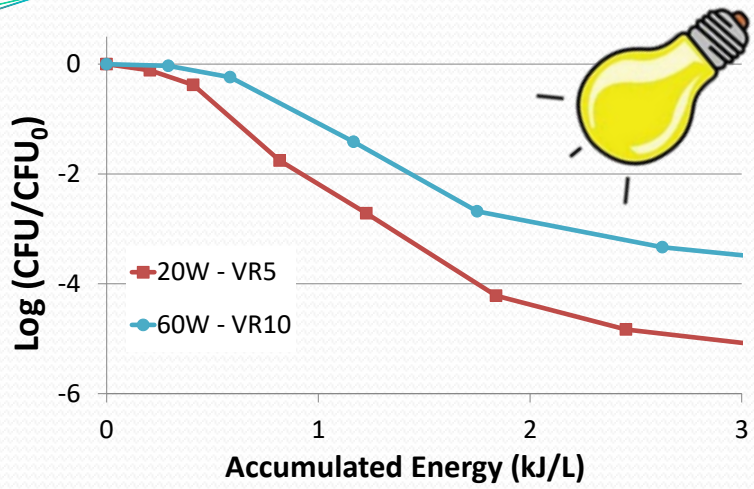
MilliQ Water

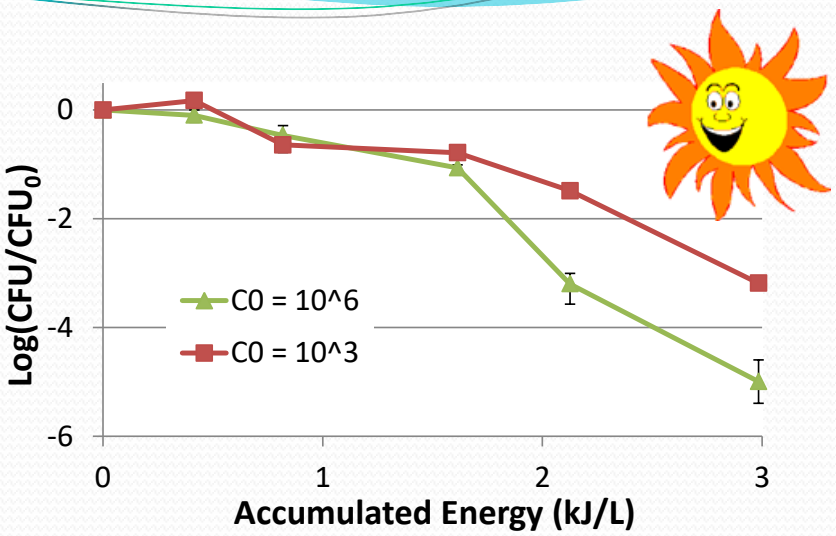


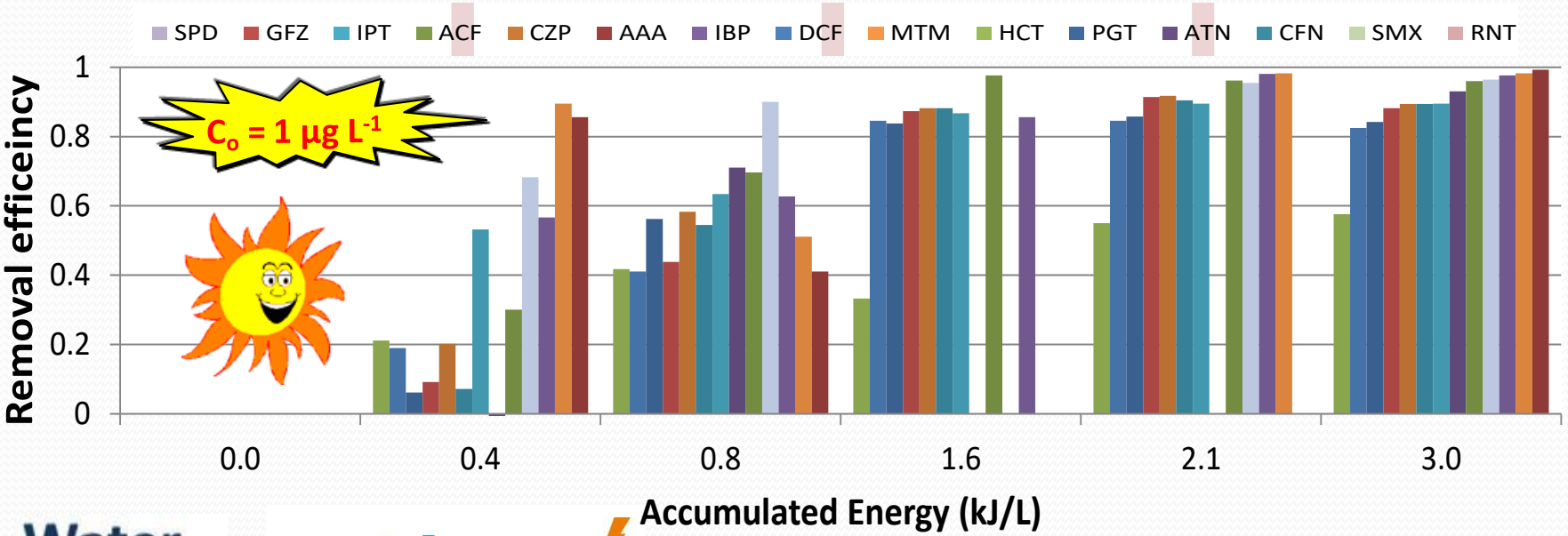
Real Water



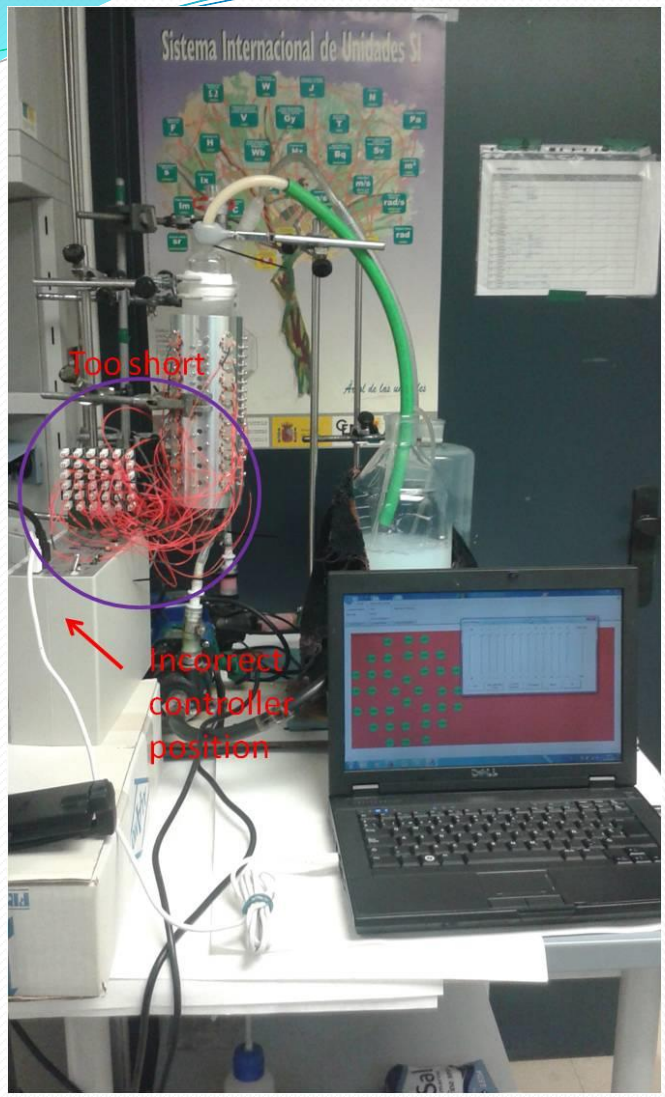
Efficient Removal of ECs during Photochemical Disinfection

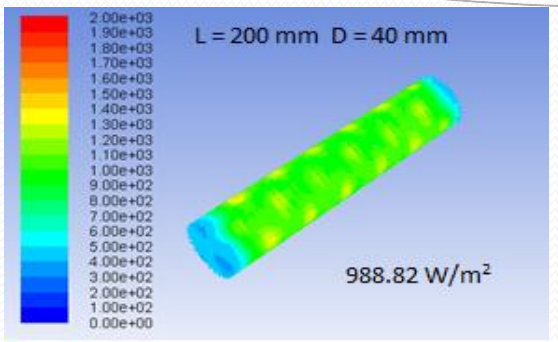


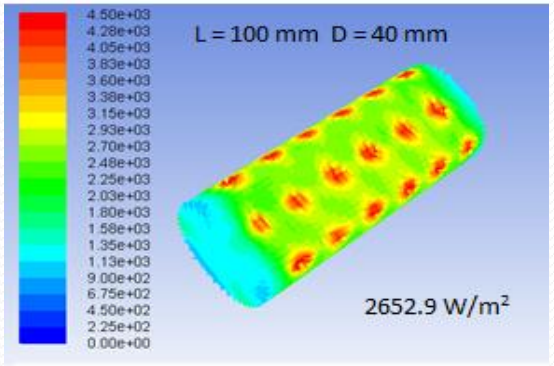


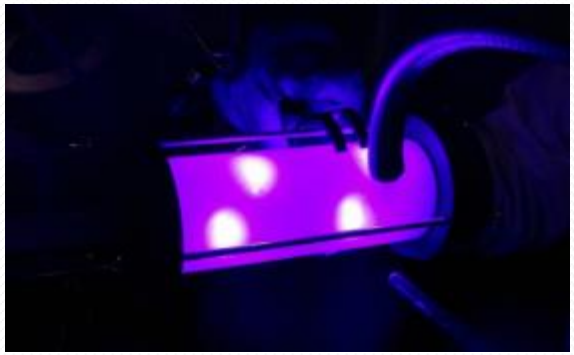


Advance Photoreactors for Disinfection & CEC Removal









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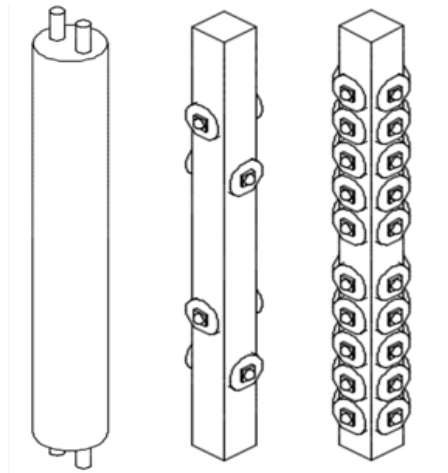
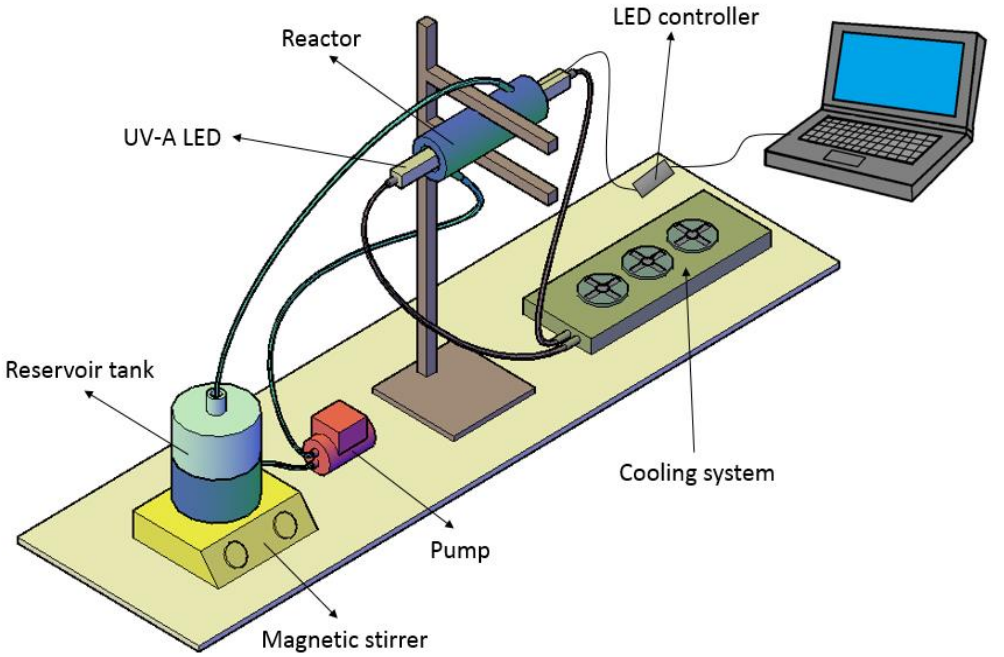
Advance Photoreactors for Disinfection & CEC Removal



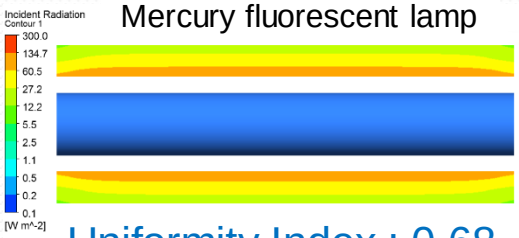
Mercury Fluorescent Lamp (Hg-FL)

8 LED System (8-LED)

40 LED System (40-LED)

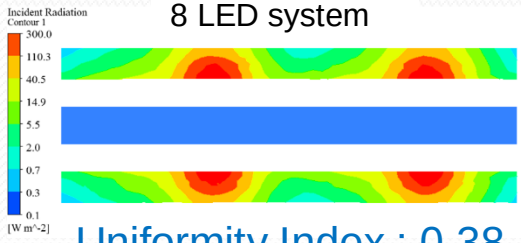


ANSYS Fluent



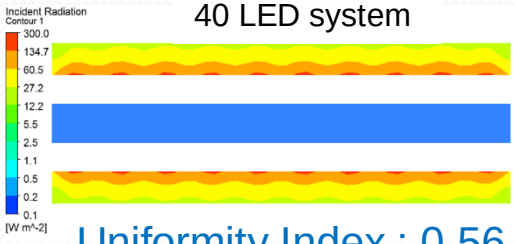
Mercury fluorescent lamp

Uniformity Index : 0.68



8 LED system

Uniformity Index : 0.38

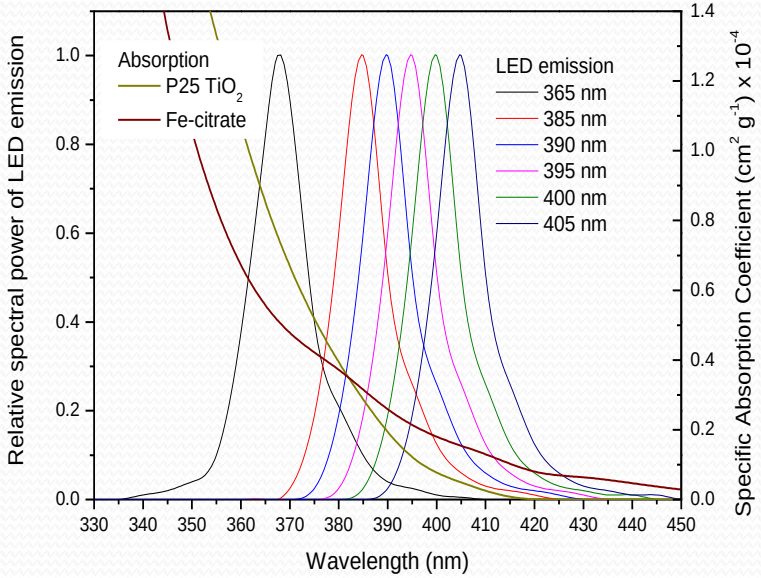


40 LED system

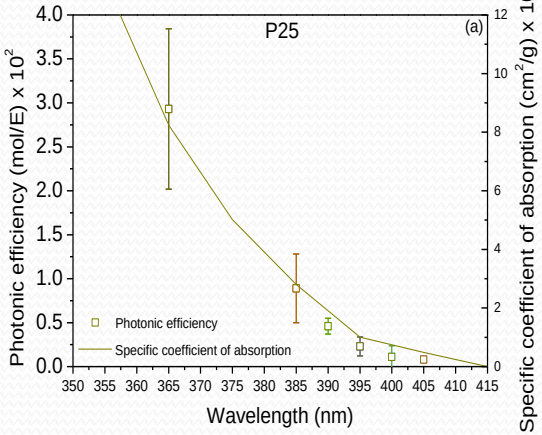
Uniformity Index : 0.56

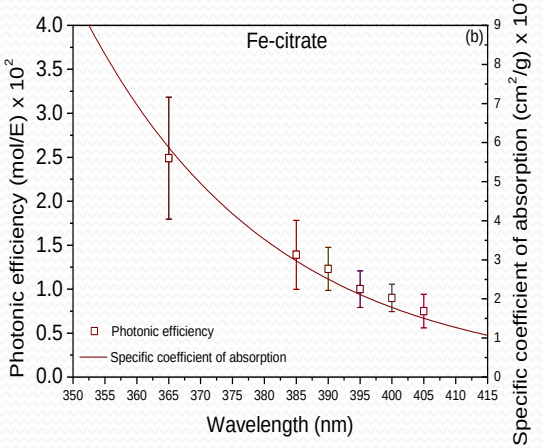
LED optimization

Advance Photoreactors for Disinfection & CEC Removal

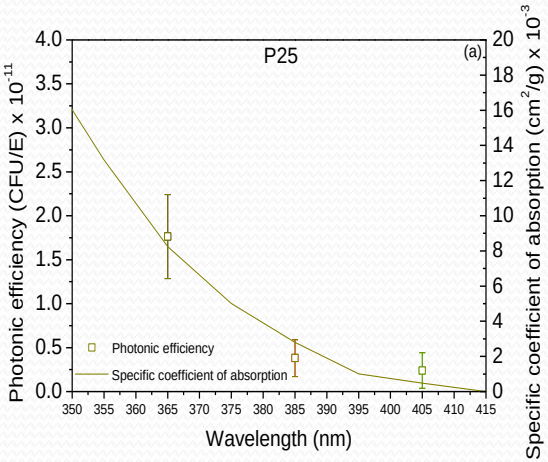


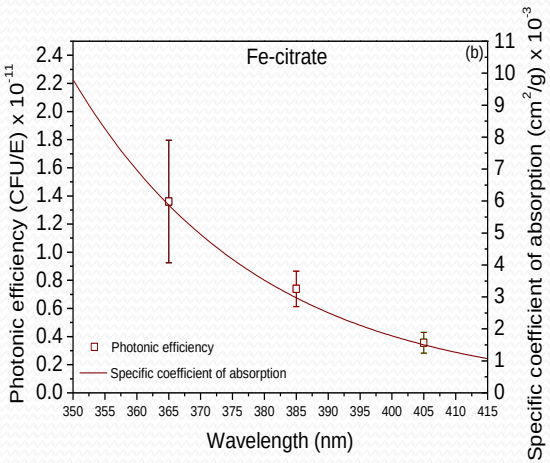
CHEMICAL OXIDATION





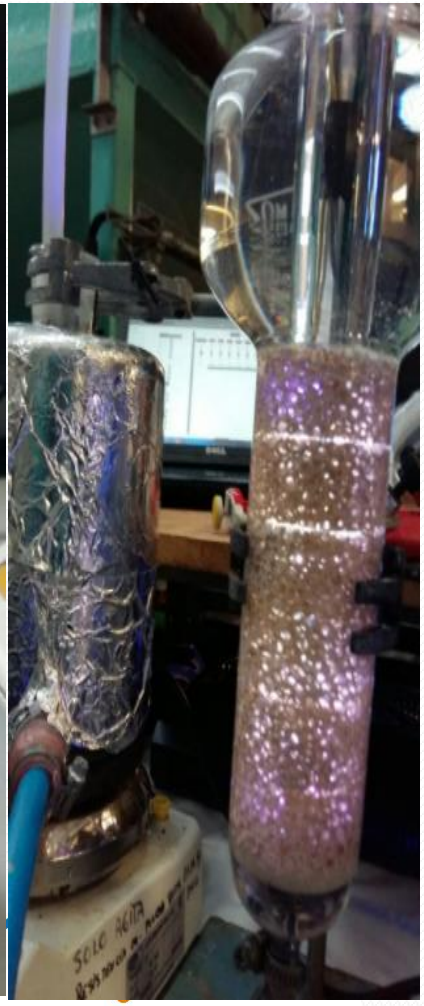
BACTERIAL INACTIVATION



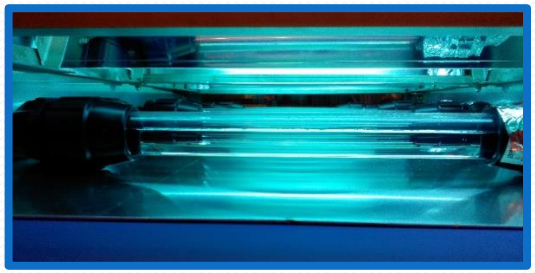


WP1: Task 1.3. Disinfection & Removal of emerging contaminants

Fixed-Bed Reactor: Catalytic Foams


Disinfection & CEC Removal: UV-C Pilot Plant



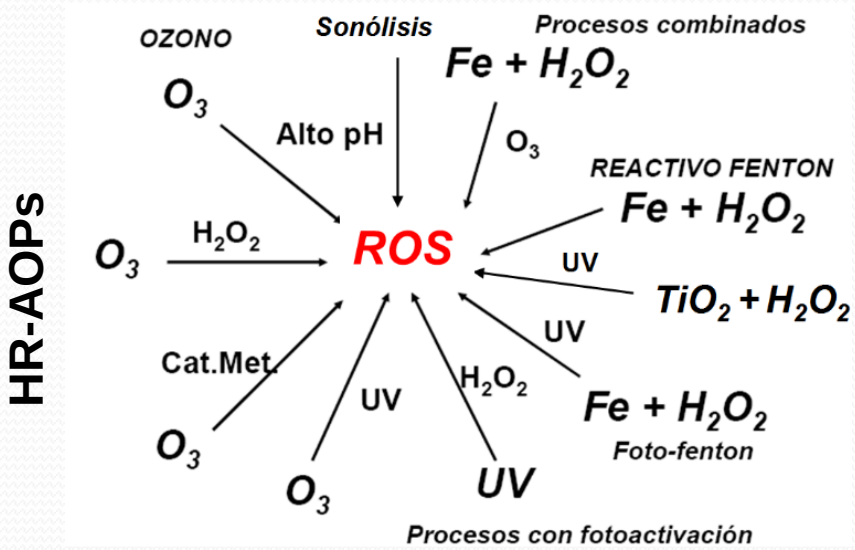
Treatments:

- UV-C
- PMS/UV-C
- PS/UV-C
- PMS/Fe(II)/UV-C
- PS/Fe(II)/UV-C
- H_2O_2/UV-C

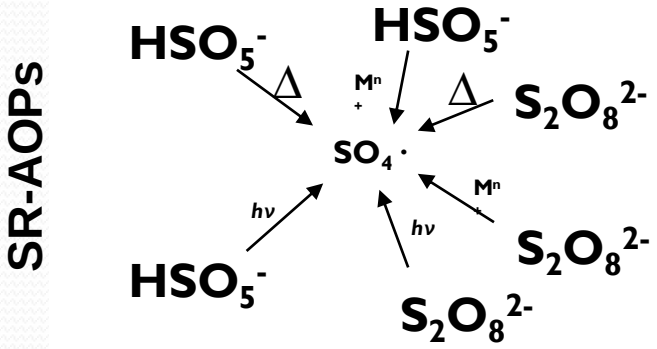
Maximum operational conditions

- 4 UV-C lamps (380 W; λ = 254 nm)
- 4 serial quartz pipes
- Illuminated volumen = 2.84 L
- Flowrate = 1 – 54 L/min
- Maximum contact time = 2.84 minutes

Advanced Oxidation Processes

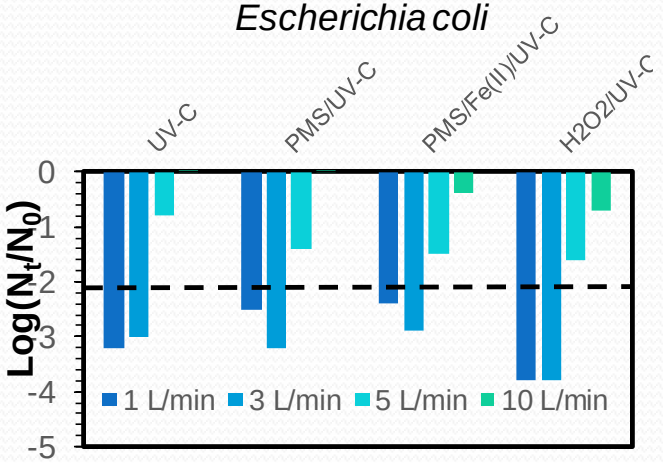


Oxidation Potential (V)								
F_2	·OH	SO_4 ·	O at.	O_3	H_2O_2	MnO_4^{2-}	Cl_2	ClO_2
3.03	2.80	2.60	2.42	2.07	1.76	1.67	1.36	1.15

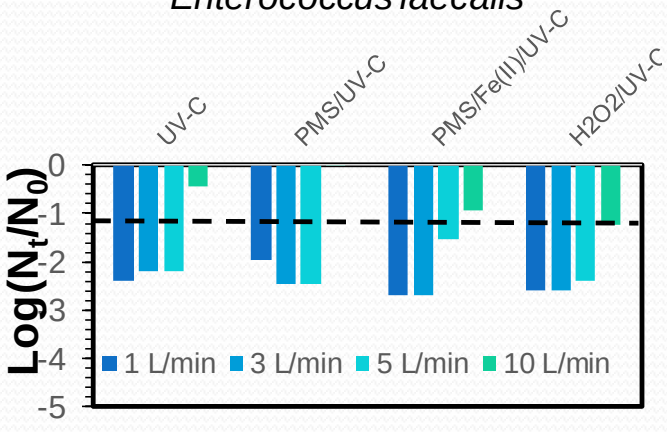


Disinfection & CEC Removal: UV-C Pilot Plant + Real WW

Escherichia coli

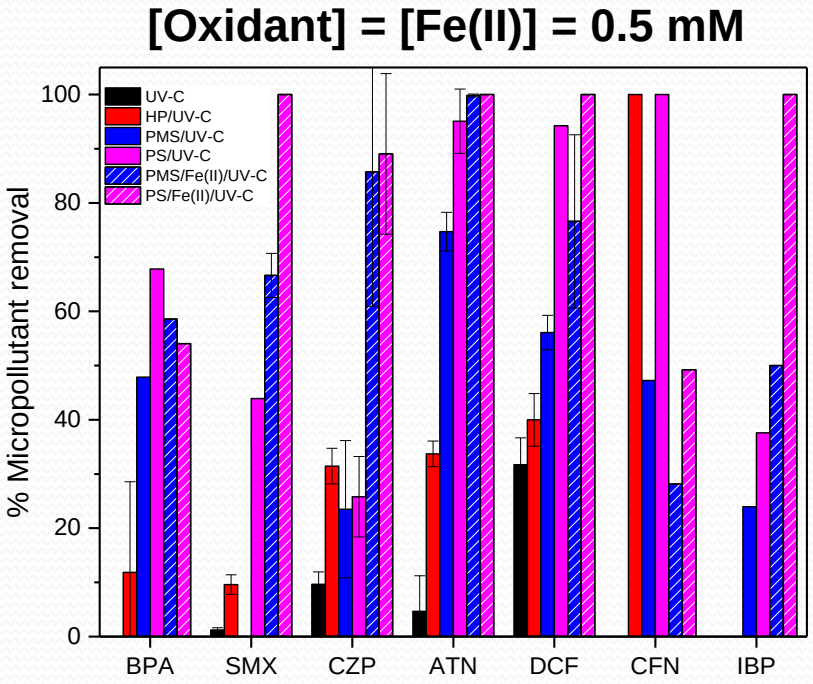


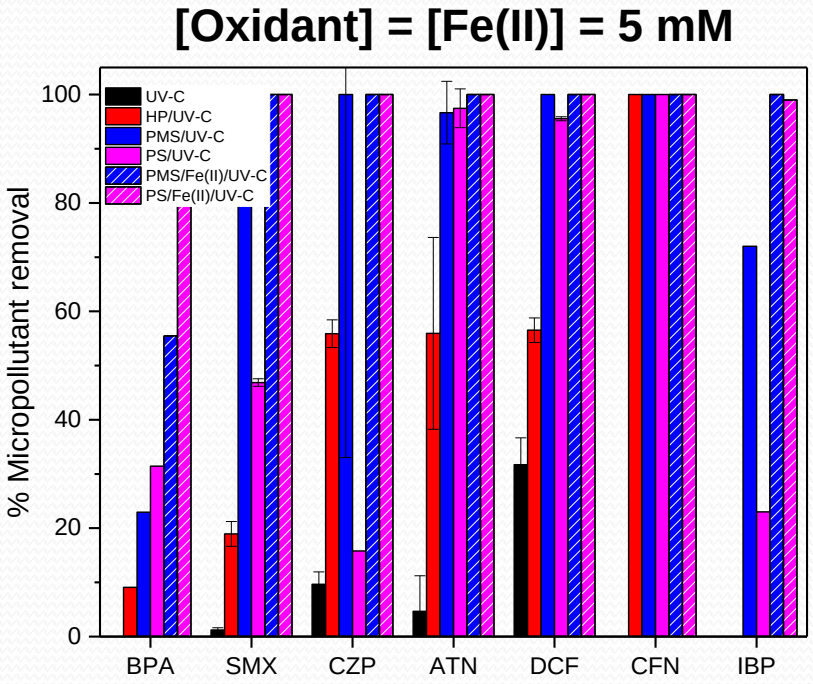
Enterococcus faecalis



Disinfection

Disinfection & CEC Removal: UV-C Pilot Plant + Real WW





CEC Removal

Intermediates

Carbamazepine (t_R=21.82 min; 42.8 ± 36.9 µg/L)

Number of TPs vs treatments:

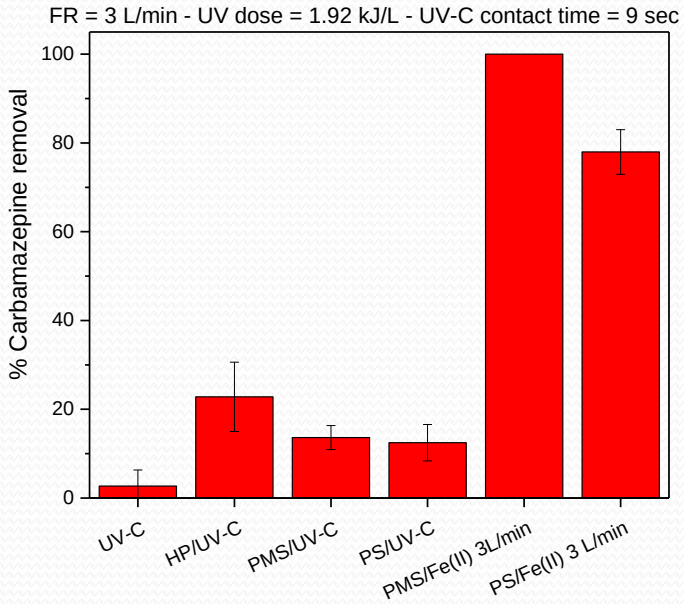
HP/UV-C=5

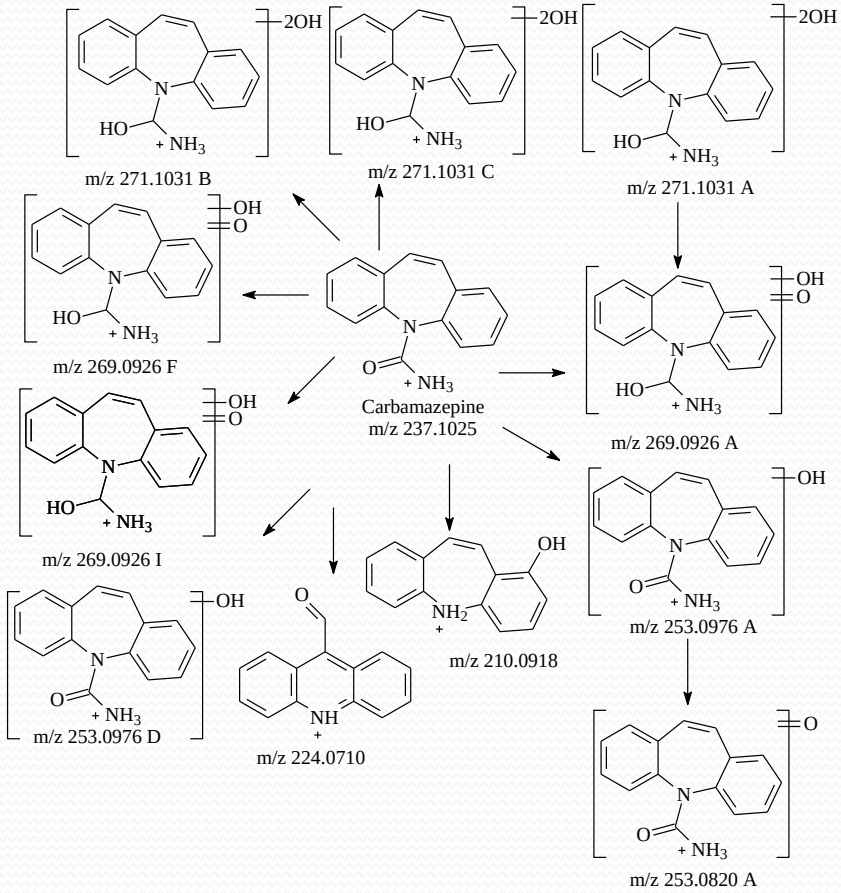
PMS/UV-C=2

PS/UV-C=5+2

PMS/Fe(II)/UV-C=3

PS/Fe(II)/UV-C=2+1+2





Disinfection & CEC Removal: UV-C Full Scale Plant WWTP

Full Scale UV-C Reactor: 2 campaigns

- 36,000 m^3/day
- 270,000 PE
- Biotreatment: Activated sludge
- UV tertiary treatment

Disinfection & CEC Removal: UV-C Full Scale Plant WWTP

Estiviel WWTP

Location: Toledo

Population equivalent: 270,000 PE

Design flow: 36,000 m^3/day

Influent: Urban WW

Biological process: Activated sludge

Effluent discharge: Tajo River

Tertiary treatment: 270 m^3/day (irrigation and internal industrial use)

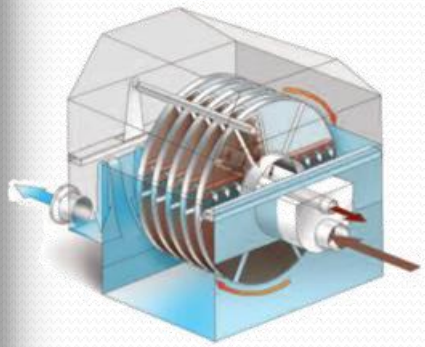
Coagulation/Flocculation – Sedimentation – Microfiltration (discs) – UV

Influent:

COD = 820 mg/l

BOD_5 = 450 mg/l

SS = 490 mg/l

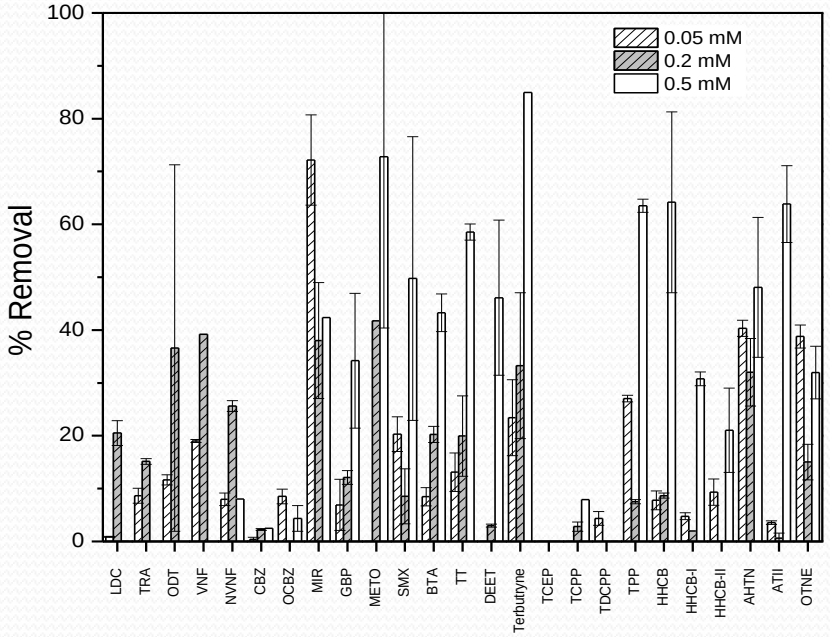


Microfiltration (8 discs) (10 µm)

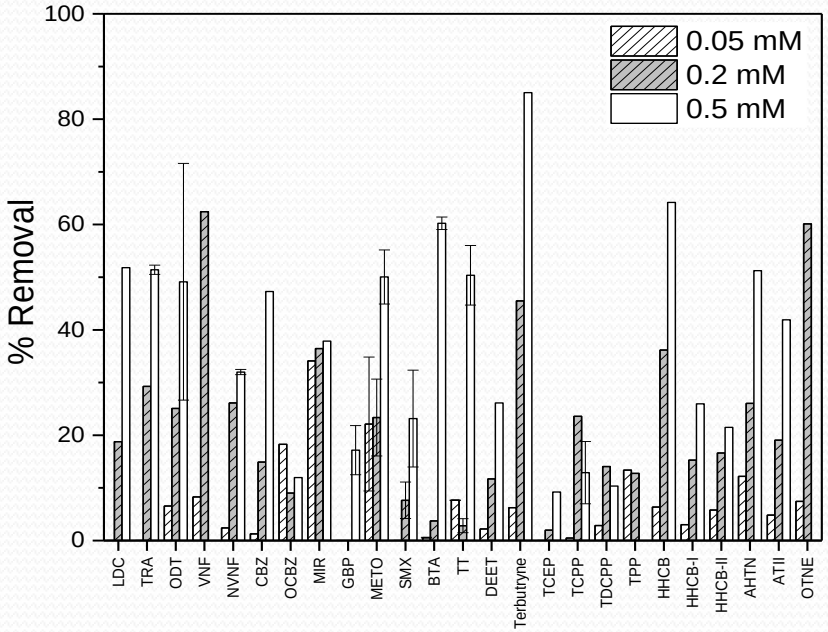
UV reactor (16 lamps)

Disinfection & CEC Removal: UV-C Full Scale Plant WWTP

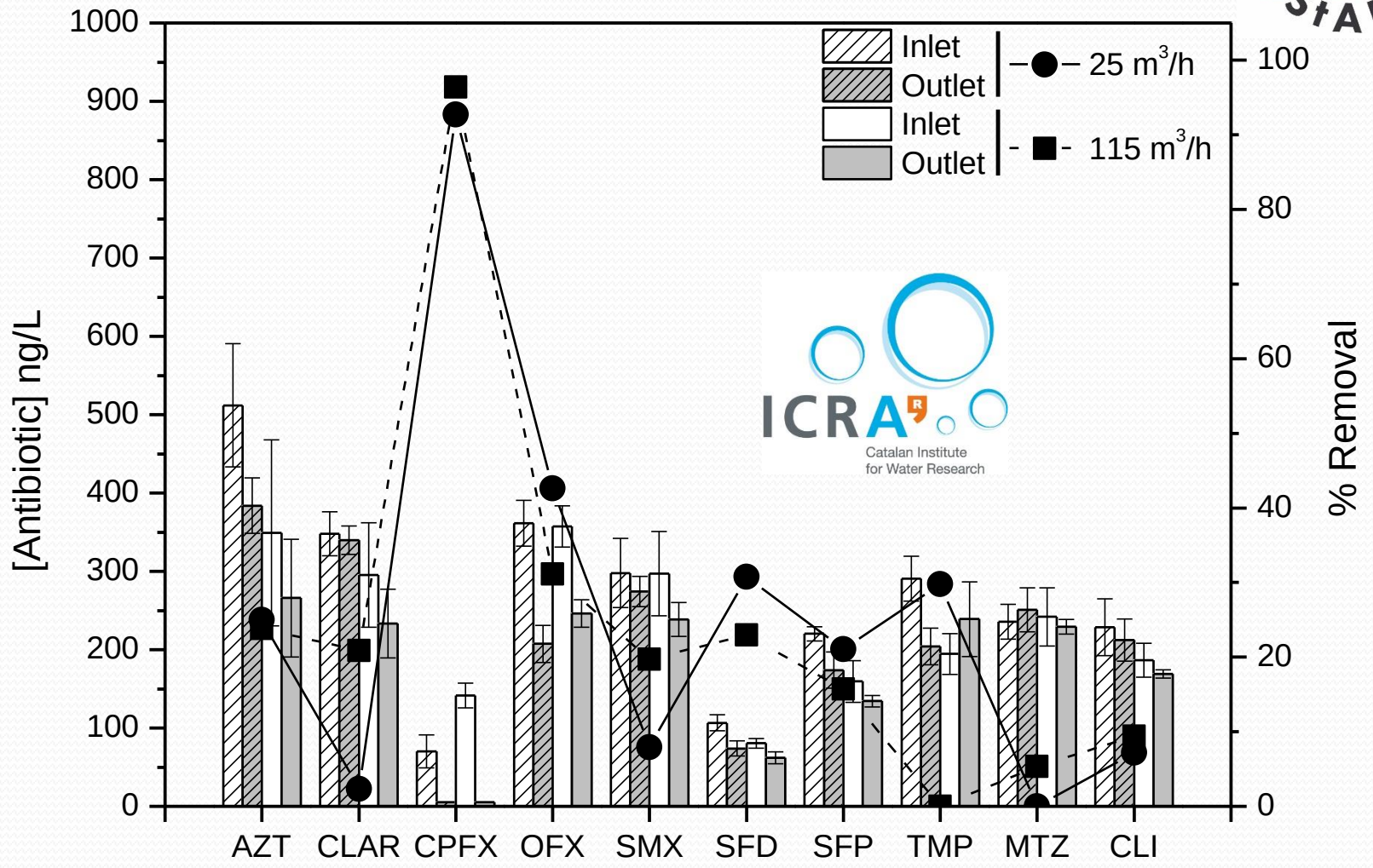
PMS/Fe(II)/UV-C treatment



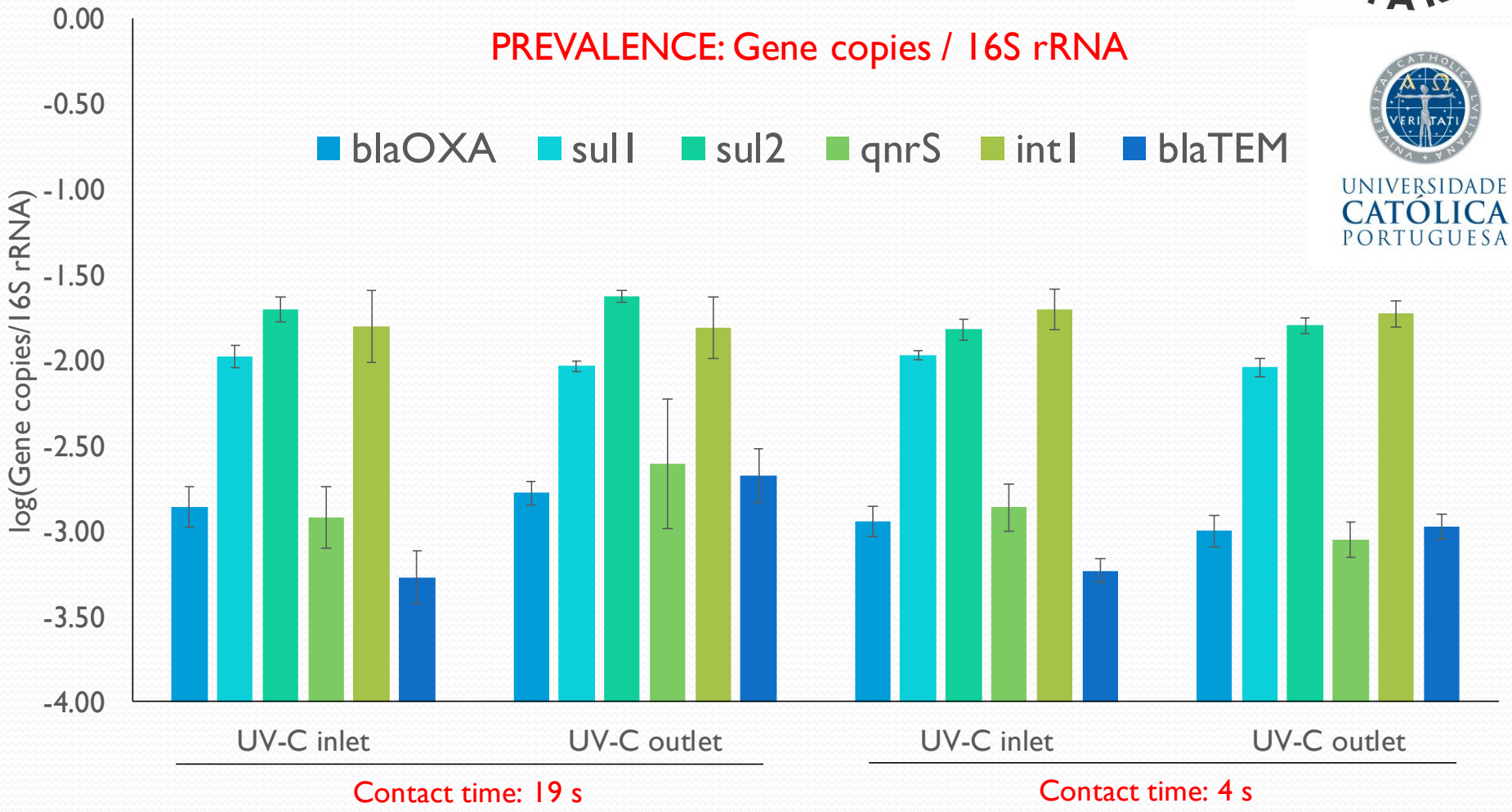
PS/Fe(II)/UV-C treatment



Removal of antibiotics



Removal of antibiotic resistance genes



Preliminary Economic Evaluation

Table 2
Economical estimation of operating cost of proposed oxidation treatments in the tertiary step.

UV-C contact time (s)	[Reagents]	UV-C**			H_2O_2/UV-C			PMS/UV-C			PS/UV-C		
		€/m³	% Removal	€/m³·order	€/m³	% Removal	€/m³·order	€/m³	% Removal	€/m³·order	€/m³	% Removal	€/m³·order
18	0.05				0.017	18	0.189	0.072	20	0.727	0.022	4	1.24
18	0.2				0.023	26	0.179	0.243	29	1.65	0.045	11	0.919
18	0.5	0.012	13	0.200	0.035	55	0.102	0.585	48	2.03	0.090	10	2.00
7	0.5	0.004	8	0.120	0.026	31	0.164	0.576	25	4.71	0.081	5	3.32
4	0.5	0.003	4	0.153	0.025	14	0.365	0.574	12	10.6	0.079	3	6.05

*H_2O_2, PMS and PS.

**No reagents required.

Most demanding operating conditions: highest UV-C contact time and reagents dosages.

Collaboration, coordination and synergies

Collaboration, with complementary key roles in:

- Treatment technologies (URJC).
- Monitoring and control of WWTP (UST).
- Analytical methodologies (UH).
- Mechanistic and toxicological studies (UNITO).
- Full-scale applications (AQUALIA).
- Analytical equipment (BRUKER).

Synergistic collaborations among them, beyond their individual work in the project.

Coordination and organization of the project: all the milestone and deliverables have been successfully and effectively completed without unexpected issues. The number of project meetings was sufficient, as a fluid communication was always kept.

Vast amount of samples from URJC and AQUALIA to UST, UH and UNITO

Water JPI Mid-Term Report

Identified problems or specific risks
The multidisciplinary work is somewhat missing, and should be considerable strengthen. This will be especially important in the future success of this project as several deliveries in the last part of the project will depend on strong collaborations at a multidisciplinary approach. I did not identified specific risks.

RECOMMENDATIONS
How to improve project scientifically?
As mention above, collaboration through a multidisciplinary approach will be crucial to improve scientifically. This said, the quality of the published papers holds a very high quality and reports important findings. No specific recommendations. Indicate if there is more cooperation with other JPI projects. If not present perhaps it can be more intensified.
How to advance the impact of the project?
There already seems to be a good impact from this project as several high quality papers has been published. However, to advance further the impact even a broader and larger number of possible stakeholders should actively be involved in the project (e.g. through spin-off projects). More mobility. I see nothing on costs of new technologies.

Collaboration between projects

Collaboration between MOTREM and STARE to explote the synergistic expertise developed in both projects.

Estiviel WWTP (**AQUALIA**, Toledo, Spain) + **URJC**

Antibiotics (**ICRA**) + Antibiotic Resistences (**UCP**)

Mobility

Consortium meetings, conferences, workshops, training courses and other events attended: 14 mobility actions + 80 conferences.

- Macarena San Martín (**UST**) and María José Martín de Vidales (**URJC**) at the facilities of **AQUALIA** in Estiviel WWTP (Toledo, Spain) for extensive on-week monitoring campaign of the plant in order to have a background of the plant behaviour before implementation of new technologies.
- Riikka-Juulia Lepistö (**UH**) did a short stay in **URJC** labs in order to implement the required sample treatment and analytical methodologies
- Irene Fiore (**UNITO**) did a 3-month research stay in **URJC** focused on the development and testing of new photocatalytic materials.
- 3 **URJC** researchers (Jorge Rodríguez, Carmen García, Victoria Romeral) and one researcher from **ICRA** (Saulo Varela) to **AQUALIA** Estiviel WWTP for 2 weeks.
- Jorge Rodríguez (**URJC**) did a short stay in **ICRA** to assist on the analysis of the huge amount of samples collected from the WWTP.

Infrastructures

URJC: Rotating **biological contactors**, Materials synthesis and characterization equipment (XRD, XRF, SEM, TEM, DR-UV-Vis, ICP-OES), **UV photochemical reactors**, **Pilot WWTP** Technological Support Centre at URJC, **Water analytical laboratory** (LAGUA) of URJC: Physicochemical & Microbiological analysis.

UST: **WWTP** for Education and Research (LFKW, ISWA), municipal **WWTP** of Herbolzheim (Germany). Analytical equipment DOC, TOC, metals, etc and **GC-MS, LC-MS-MS and ICP-MS**.

UH: Waters LCT Premier XE **LC-TOF-MS**, Waters GCT Premier **GC-TOF-MS**, Shimadzu QP2010 **Ultra GC-MS**.

UNITO: **ICP-AES, GC-QTOF-MS, HPLC-MS** (LTQ- Orbitrap, QqQ and QTrap analysers), TOC, HPLC UV-vis and fluorescence detectors, an ion chromatograph and a **Microtox** device.

AQUALIA: Real scale **WWTP** facilities were provided by AQUALIA (Mérida, Tortosa, Benquerencia and Estiviel WWTPs). The full-scale experiments on a UV-C reactor (16 UV-C lamps, WEDECO ELR-30-1; 330 W) and flow rates of 114, 75 and 28 m3/h, (4 – 18 s of UV contact time).

BRUKER: Applications Development Laboratory located in Madrid, **UHPLC–ESI–Q- TOF**, Bruker Maxis; **UHPLC–ESI–IT**, Bruker AmaZon Ion Trap; **UHPLC(OLE)–ESI–TQ**, Bruker EVOQ; and **GC-MS-MS** Triple Quad, Bruker SCION.

Water JPI

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Stakeholder/industry engagement

WP4 Dissemination and Exploitation of Project Outcome

Task 4.1 Public and industrial engagement

Objective: To disseminate project results and techniques as widely as possible to scientists, general stakeholders, end-users and public.

- Stakeholders identification (target market, regulatory authorities, environmental agencies, etc.) to transfer the knowledge developed by MOTREM consortium. **Questionnaires** from stakeholders
- Spread and distribution of knowledge: Publications and Dissemination activities
- Social networks and Website.
- Open international workshop: **23-24 November 2017** (speakers from universities, companies, research centers). Invitation to funding agencies and regulatory agents.
- Training Workshop. On **Friday 24th Nov** at **BRUKER**

Task 4.3 Prospecting plan

- Preliminary study of existing technologies in market

Water JPI

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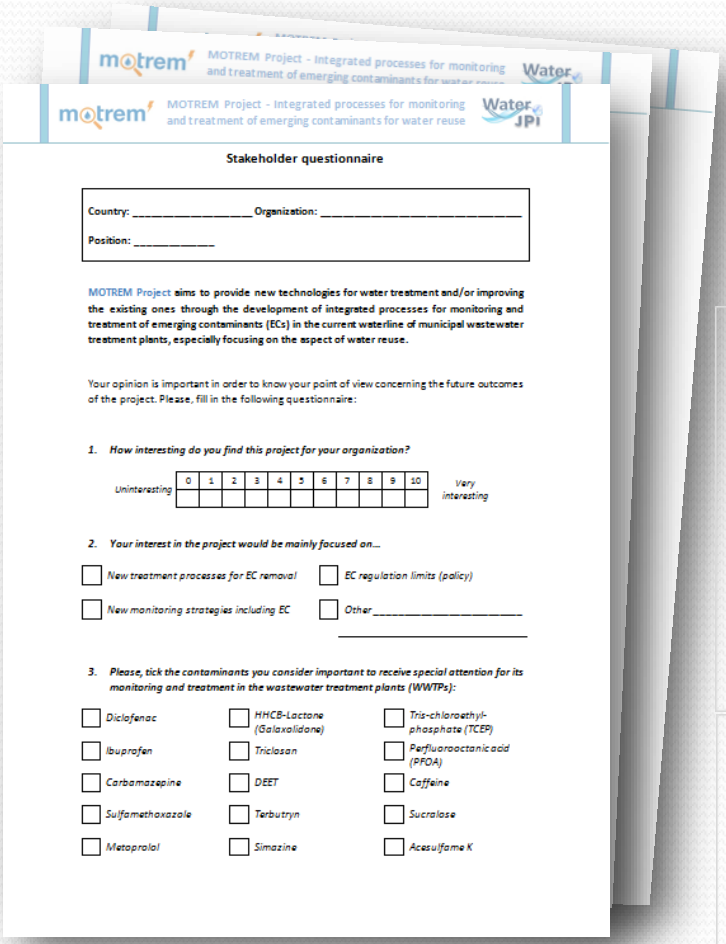
Stakeholder/industry engagement

Questionnaire for stakeholders



MOTREM Project - Integrated processes for monitoring and treatment of emerging contaminants for water reuse

Stakeholder questionnaire

Country: _____ Organization: _____

Position: _____

MOTREM Project aims to provide new technologies for water treatment and/or improving the existing ones through the development of integrated processes for monitoring and treatment of emerging contaminants (ECs) in the current waterline of municipal wastewater treatment plants, especially focusing on the aspect of water reuse.

Your opinion is important in order to know your point of view concerning the future outcomes of the project. Please, fill in the following questionnaire:

1. *How interesting do you find this project for your organization?*

Uninteresting	0	1	2	3	4	5	6	7	8	9	10	Very interesting

2. *Your interest in the project would be mainly focused on...*

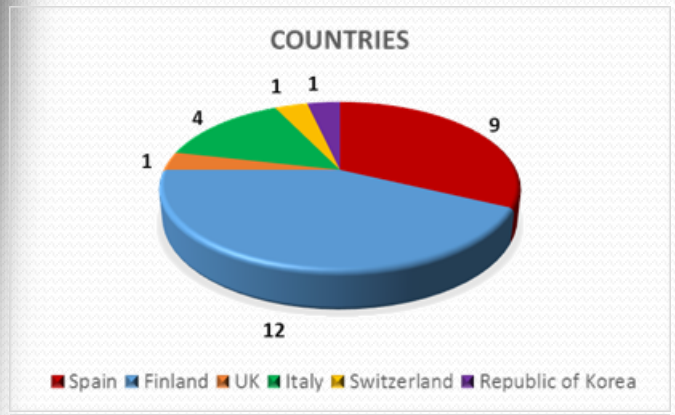
- ☐ New treatment processes for EC removal
- ☐ EC regulation limits (policy)
- ☐ New monitoring strategies including EC
- ☐ Other _____

3. *Please, tick the contaminants you consider important to receive special attention for its monitoring and treatment in the wastewater treatment plants (WWTPs):*

☐ Diclofenac	☐ HHCB-Lactone (Galaxolidone)	☐ Tris-chloroethyl-phosphate (TCEP)
☐ Ibuprofen	☐ Triclosan	☐ Perfluorooctanic acid (PFOA)
☐ Carbamazepine	☐ DEET	☐ Caffeine
☐ Sulfamethoxazole	☐ Terbutryn	☐ Sucralose
☐ Metoprolol	☐ Simazine	☐ Acesulfame K

- Interest in MOTREM project
  - Treatment, Monitoring, Regulation limits (policy)
- Most important ECs
- National/local legislation
  - Groundwater, Drinking water, Surface water

Etc.…



✓ 6 countries

✓ 9 universities

✓ 5 research centres

✓ 6 private enterprises

✓ 4 public entities

Stakeholder/industry engagement

FCC Aqualia, S.A. is the water management parent company of FCC, one of the largest European services groups. **Aqualia** is the first water management company in Spain, third largest private water company in Europe and sixth in the world, according to the latest ranking by the specialist publication, Global Water Intelligence, and serves 22.5 million users.

4 municipal WWTPs operated by AQUALIA:

- Mérida 
- Tortosa 
- Benquerencia
- **Estiviel** 

Stakeholder/industry engagement

ESTIVIEL WWTP (TOLEDO)

Location: Toledo **Population equivalent:** 270,000 PE **Design flow:** 36,000 m^3/day

Influent: Urban WW **Biological process:** Activated sludge **Effluent discharge:** Tajo River

Tertiary treatment: 270 m^3/day (irrigation / internal industrial use) → Coagulation/Flocculation – Sedimentation – Microfiltration (discs) – UV

Stakeholder/industry engagement

BRUKER MADRID Lab

Applications Development Laboratory
Chemical & Applied Markets

Provided with most of the last MS technologies from Bruker.

GC/MS/MS Scion™ Triple Quad (2 units)
LC/MS/MS Amazon™ SL Ion Trap (1 unit)
LC/MS/MS Q TOF Impact™ II (1 unit)
LC/MS/MS EVOQ™ Triple Quad (2 units)

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Stakeholder/industry engagement

Other companies:

- **DeNora Industries**, a company with several research centres throughout the world and devoted to the development of adsorbent materials to be exploited in water treatment.

- **IRIS**, a micro-enterprise which has a patent application on an innovative AOP device. It develops plasma technology applications to liquid/solid waste treatment, aimed to improve technical and economic efficiency of small scale - on site treatments enabling no waste / zero carbon footprint processes.

- **SMAT**, a large company dedicated to the management of the water cycle. SMAT manages the Integrated Water Service production and distribution of drinking water and waste water in the province of Turin.

Impact and Knowledge Output

Technical impacts:

- New **analytical methods** and protocols for MP.
- Reliable **indicator and surrogate parameters** for MP removal.
- Full scale WWTP tests of **technologies for MP removal** with cost analysis.

Societal impacts:

- Improvement in the wastewater treatment processes
- Assessment of the impact in recipient water bodies.
- Relevant information to set the basis of regulation of the discharges of CECs.
- Wastewater processes may also offer business opportunities to companies.

Impact and Knowledge Output

Local impacts:

- **Estiviel WWTP in Toledo**: influence the **WWTP staff** and the **local authorities** who were not aware of this environmental problem before the project.
- Public and private clients belonging to the third-party funding agencies of the **ISWA**, accept the necessity of adapted monitoring strategies and consider the requirements on appropriate sampling and monitoring strategies. Spillovers of the project tasks are passed on to **stakeholders at the executive level of German Federal states**, where UST is involved in WWTP monitoring programs.

Impact and Knowledge Output

Academic impacts:

- **Lectures** in master courses of the academic partners of MOTREM: UST German lectures for "**Environmental protection technology**", English lectures of the international programs "**Air Quality Control, Solid Waste and Waste Water Process Engineering (WASTE, UST)**" and "**Water Resources Engineering and Management (WAREM, UST)**".
- **More than 40 graduate and post-graduate** students have developed their bachelor, master and PhD thesis in the framework of MOTREM project activities. Here, the results of the project have already reached a large group of international and multidisciplinary working **future engineers**.

Impact and Knowledge Output

- **Publications**
  - International
    - Peer-reviewed journals JCR: **41**
      (**25** published + **10** submitted + **6** in preparation)
    - Communications in conferences: **67**
  - National
    - Communications in conferences: **12**
      (Spain, Germany, Finland, Italy)
- **Dissemination & Popularization**: **10**
  (1 Article + 5 conferences + 4 media appearances)

  Events were **administration representatives** or **general public** were present

FuturEnviro, Nov 2015

PROYECTO MOTREM: NUEVAS TECNOLOGÍAS PARA LA MONITORIZACIÓN Y TRATAMIENTO DE CONTAMINANTES EMERGENTES

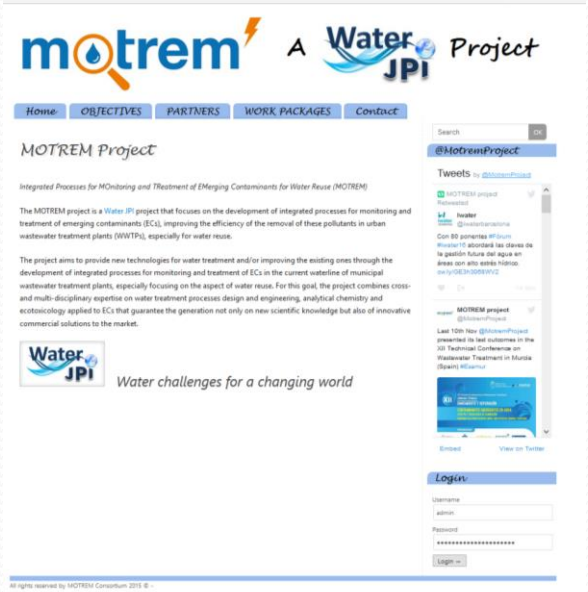
MOTREM PROJECT: NEW TECHNOLOGIESFOR MONITORING AND TREATMENT OF EMERGING CONTAMINANTS

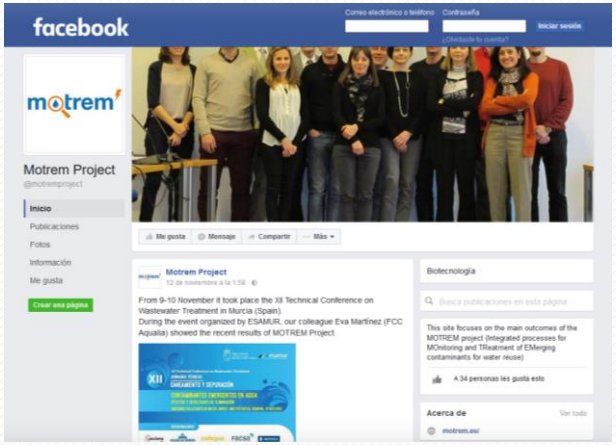
Impact and Knowledge Output

Website: http://motrem.eu

Facebook : https://www.facebook.com/motremproject

Twitter: @MotremProject





Continuation of work in the future

The **complementary expertise** of the partners of MOTREM project has been successfully demonstrated and exploited during the project, as the joint publications and collaborative activities have proven.

The synergistic profiles on different areas such as:

- Treatment technologies (URJC),
- Monitoring and control of WWTP (UST),
- Analytical methodologies (UH),
- Mechanistic and toxicological studies (UNITO) and
- Full-scale applications (AQUALIA)
- Partners from other Water JPI funded projects.

Will be definitively exploited in the future in the form of **new project proposals and collaborations**.

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Will be definitively exploited in the future in the form of **new project proposals and collaborations**.

Looking for funding….

Thanks!

MOTREM

Javier Marugán (URJC, coord.),
Bertram Kuch (UST),
Jukka Pellinen (UH),
Paola Calza (UNITO),
Frank Rogalla (AQUALIA),
Pedro Cano (BRUKER)

Water JPI
Pilot Call Final Meeting
4th of June 2018, Helsinki