TROJAN UV
WATER CONFIDENCE™

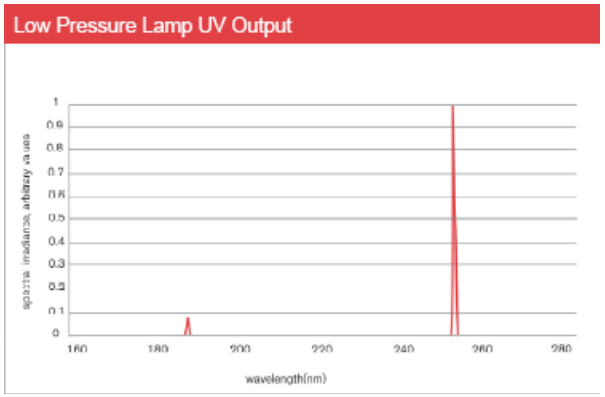
DOSI BIOASSAIG vs DOSI MITJA

Lloret de Mar,
09/03/2007

CONTINGUTS:

Introducció

Productes Trojan
Baixa Pressió



TROJANUV

Productes Trojan
Baixa Pressió NY

Capacitat

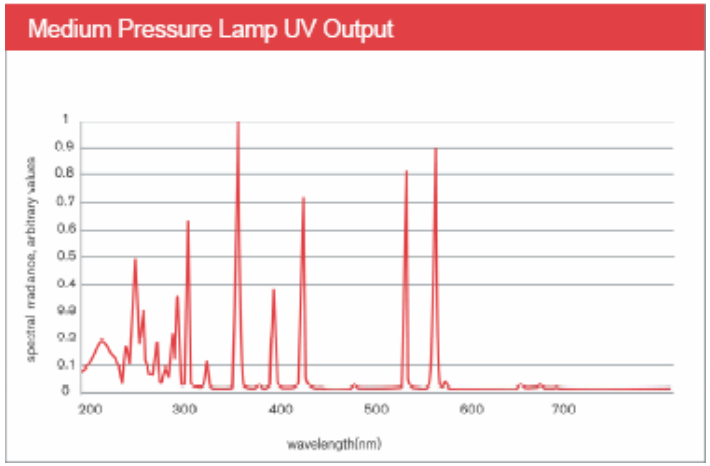
100 m3/sec

56 reactors – cadasqun de 150.000 m3/d

Població equivalent de 11 mil·lions d'habitants

TROJANUV

Productes Trojan
Mitja Pressió



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CARACTERISTIQUES

	Baixa Pressió	BP Amalgama	Mitja Pressió
Tipic Consum (W/cm)	0.6	1.7	125
Eficiència segons Heraeus	40%	30%	15%
Eficiència segons Philips	38 %	28 %	18%
Tipica Potència (W/cm)	0.23	0.5	18.8

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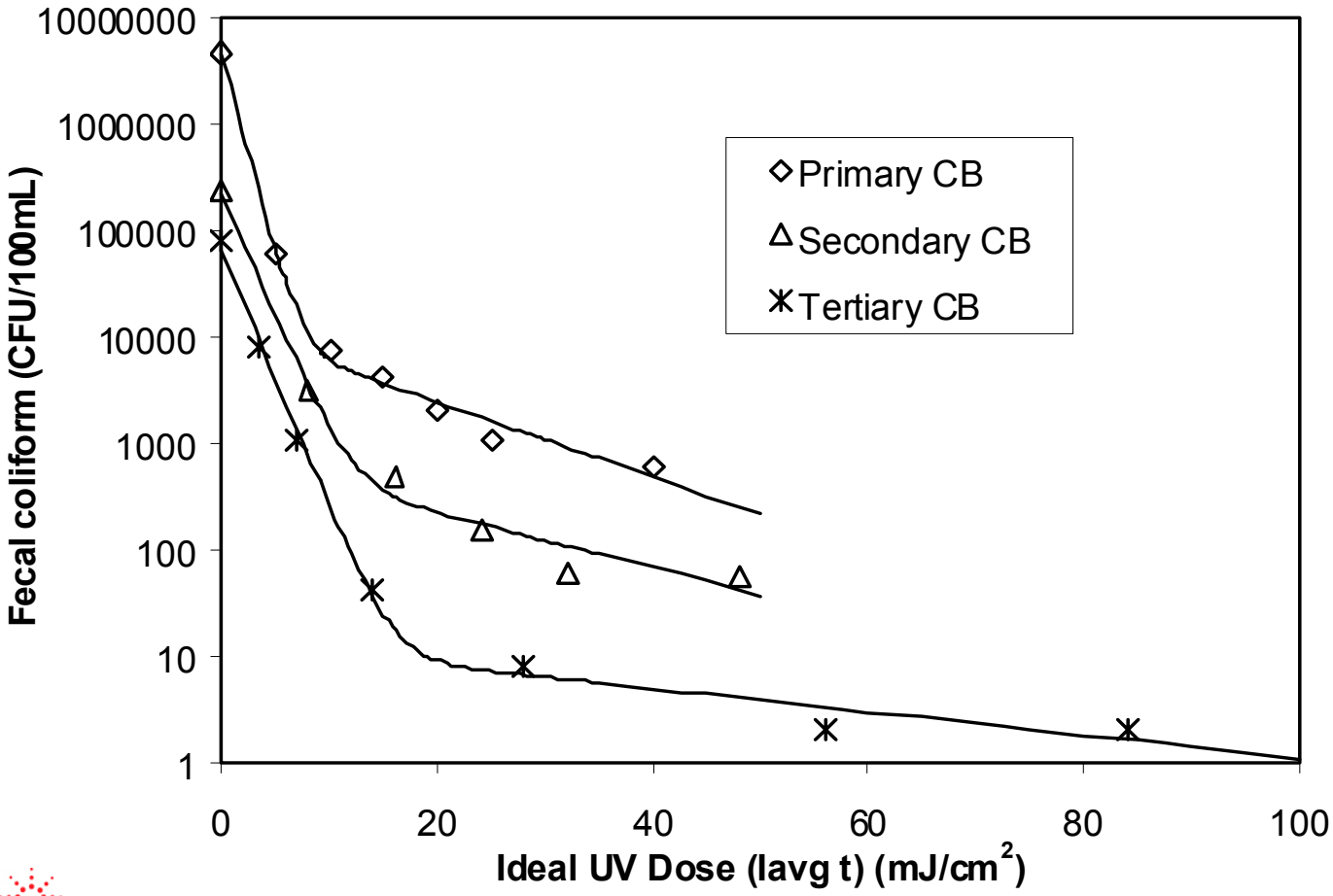
FACTORS D'INFLUÈNCIA

Paràmetre	Descripció	Impacte al Rendiment UV
Transmitància UV	Mesura d'absorció de llum UV	**Dosi Aportada:** La Transmitància UV afecta a la dosi aportada pel reactor UV
Sòlids Suspesos	Partícules poden fer ombres	**Dosi Requerida:** El tamany i nombre de partícules determinen la dosi necessària per arribar a un cert nivell de desinfecció.
Ferro	Pot provocar embrutiment a les baines de quars	**Operacional:** Redueix la quantitat de Dosi aportada per les làmpares

RESPOSTA TIPICA DE DEMANDA DE DOSI UV



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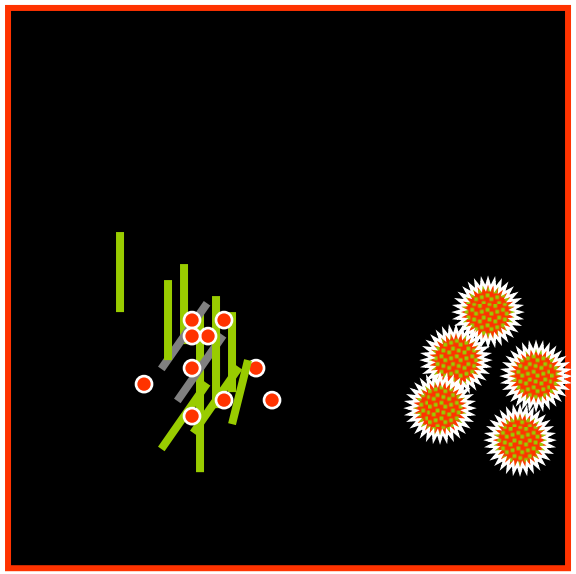
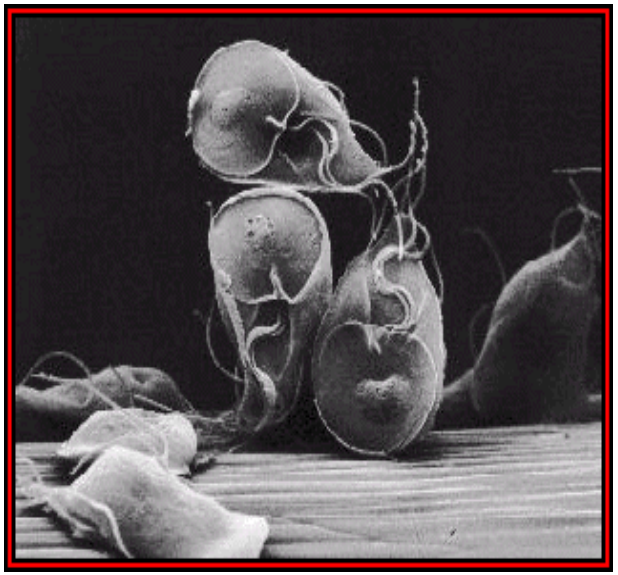
PATÒGENS

- Bacteries, virus i protozos a l'aigua residual i potable representen un risc potencial per a la salut pública

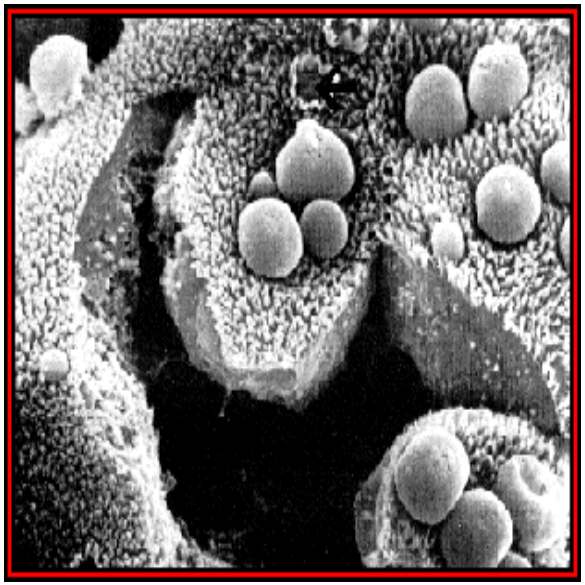
Bacteria (E.coli) **Virus (Hepatitis, Polio)**



Protozo (Giardia)



(Cryptosporidium)



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INACTIVACIÓ

Pathogen	Average UV Dose (mJ/cm^2) Required to Inactivate			
	1log	2log	3log	4log
Cryptosporidium parvum	**3.0**	**4.9**	**6.4**	**7.9**
Giardia lamblia cysts	**NA**	**<5**	**<10**	**<10**
Vibrio cholerae	0.8	1.4	2.2	2.9
Shigella dysenteriae	0.5	1.2	2.0	3.0
Escherichia coli O157:H7	**1.5**	**2.8**	**4.1**	**5.6**
Salmonella typhi	1.8-2.7	4.1-4.8	5.5-6.4	7.1-8.2
Shigella sonnei	3.2	4.9	6.5	8.2
Salmonella enteritidis	5	7	9	10
Legionella pneumophila	3.1	5	6.9	9.4
Hepatitis A virus	**4.1-5.5**	**8.2-14**	**12-22**	**16-30**
Pseudomonas aeruginosa	5.5	11	16.5	22
Saccharomyces cerevisiae (yeast)	7	14	21	28
Poliovirus Type 1	4-6	8.7-14	14-23	21-30
Coxsackie B5 virus	6.9	14	22	30
Rotavirus SA11	**7.1-9.1**	**15-19**	**23-26**	**31-36**

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Data summarized from the US EPA Workshop on UV Disinfection of Drinking Water, April 28-29, 1999, Arlington, VA

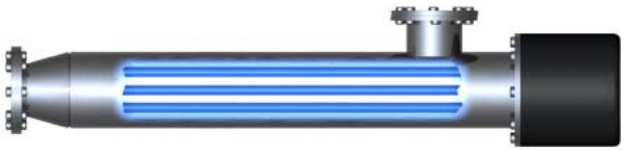
Dosi UV

CÀLCUL DE DOSI UV

La dosi UV és el producte de:

Intensitat (quantitat de llum UV per unitat de superficie que reb un àrea) **i**
Temps d'exposició (temps de contacte dins de la càmara del reactor)

Dosi UV = Intensitat X Temps d'Exposició



Dosi UV s'expressa en: $\mu Ws/cm^2$ (Microwats segons/cm^2)

mWs/cm^2 (Miliwats segons/cm^2)

mJ/cm^2 (Milijuls/cm^2)

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DOSI UV REBUDA A UN REACTOR

$$UV\ Dosi = UV\ Intensitat \times Temps\ Exposició$$

- Intensitat UV
  - Clase de làmpades UV i emisió
  - Nombre de làmpades
  - Geometria de la làmpada i reactor
  - Absorció UV del quars i aigua
- Temps d'exposició
  - Volum efectiu del reactor
  - Cabal
  - Hidràulica

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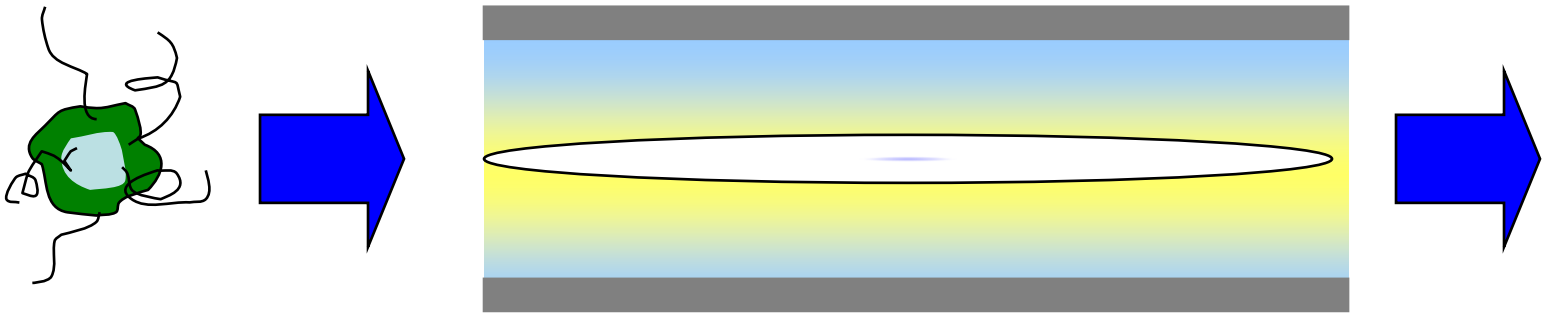
DOSI MITJA



Dosi demandada per la reducció
de 1 log = 10mJ/cm2

	E.g. 1	
Dose Received by 99% of Flow	100	
Dose Received by 1% of Flow	0	
“Average” Dose:		
Inactivation:		

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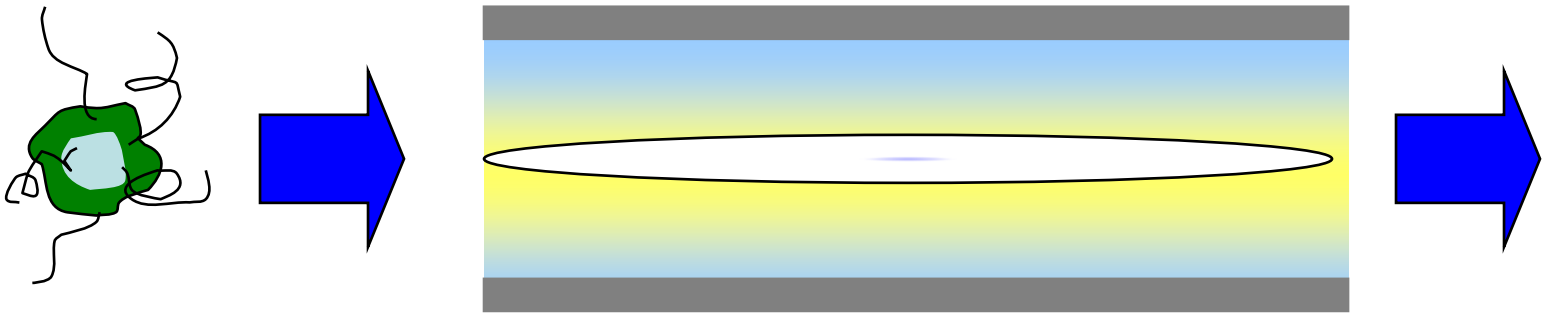
DOSI MITJA



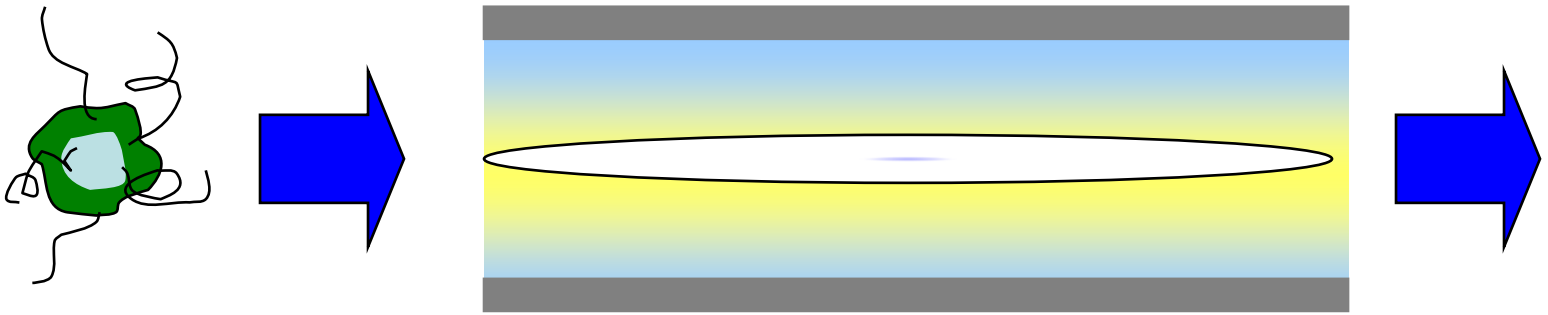
Dosi demandada per la reducció de 1 log = 10mJ/cm2

10 log?

	E.g. 1	
Dose Received by 99% of Flow	100	
Dose Received by 1% of Flow	0	
“Average” Dose:	99	
Inactivation:		

TROJAN UV

DOSI MITJA



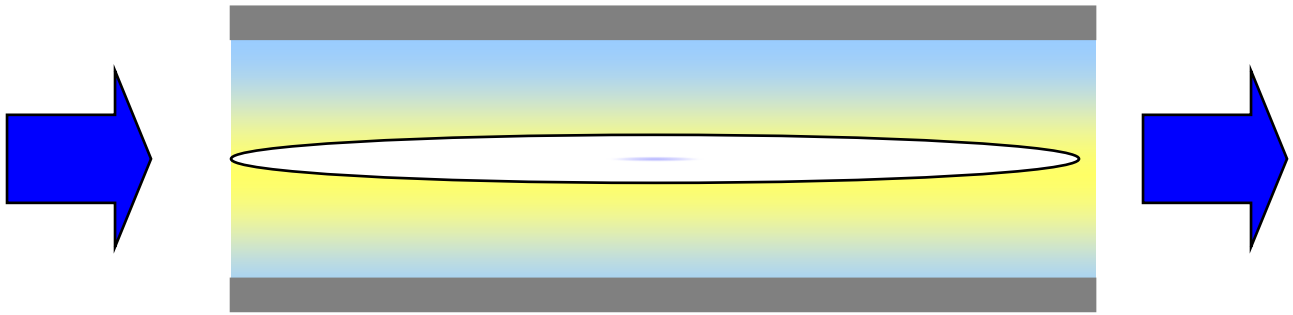
Dosi demandada per la reducció de 1 log = 10mJ/cm2

10 log?

	E.g. 1	
Dose Received by 99% of Flow	100	
Dose Received by 1% of Flow	0	
“Average” Dose:	99	
Inactivation:	no better than **2 log**	

TROJAN UV

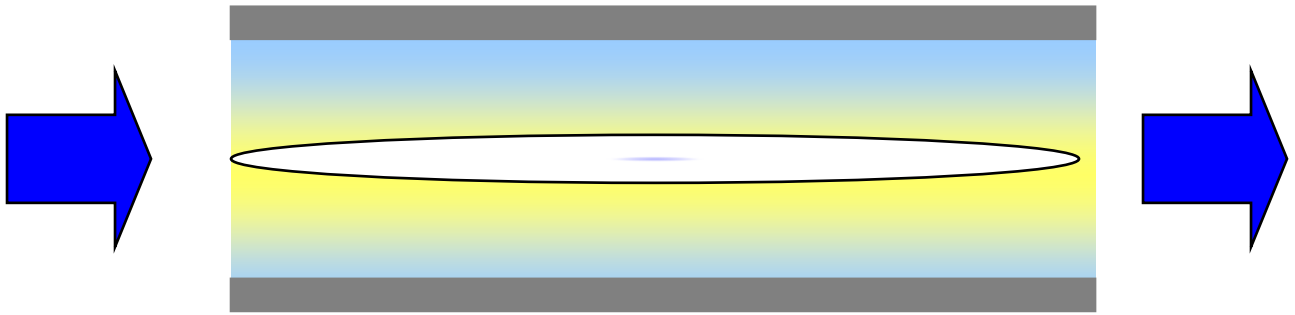
DOSI MITJA



	E.g. 1	E.g. 2
Dose Received by 99% of Flow	100	200
Dose Received by 1% of Flow	0	0
"Average" Dose:	99	
Inactivation:	no better than **2 log**	

TROJAN UV

DOSI MITJA



	E.g. 1	E.g. 2
Dose Received by 99% of Flow	100	200
Dose Received by 1% of Flow	0	0
"Average" Dose:	99	198
Inactivation:	no better than **2 log**	no better than **2 log**

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HISTOGRAMA DE DOSI

- Tots els reactors son no-ideals amb mescla imperfecta
- Existeix un nombre infinit de trajectories per cada reactor
- Cada trajectoria és única

$\Rightarrow$Cada microorganisme segueix una trajectoria diferent y reb una dosi UV diferent.

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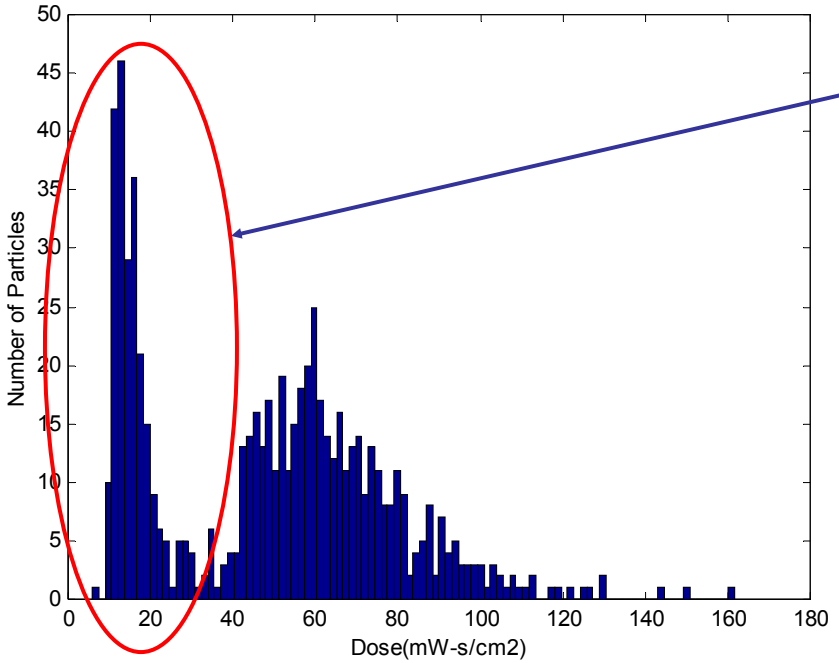
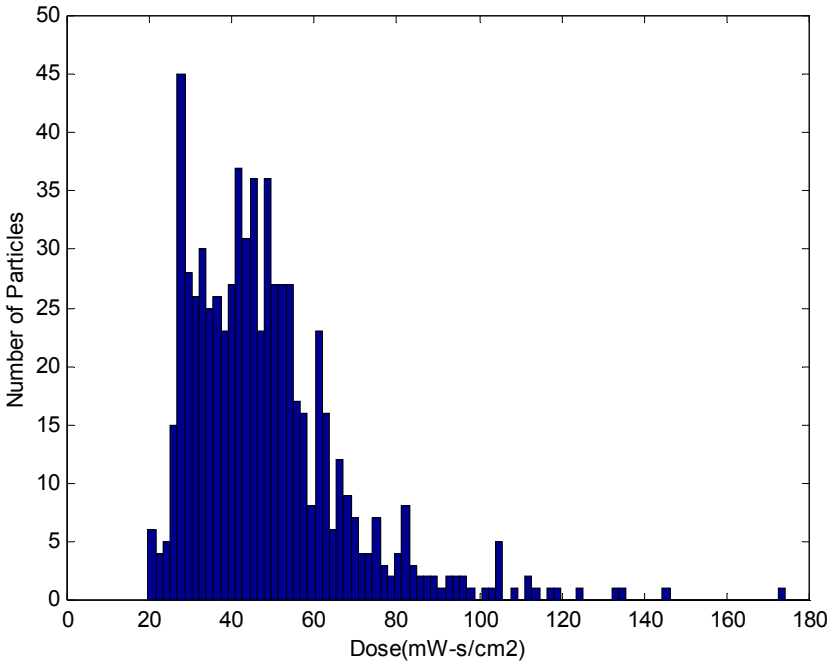
OPTIMIZACIÓ REACTOR



Reactor ineficàs causat per curt circuits

Reactor millorat per les mateixes condicions



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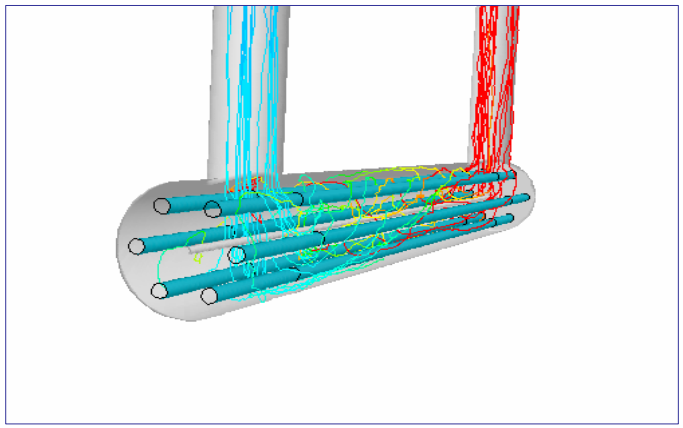
REACTORS UV I EFICIÈNCIES HIDRÀULIQUES

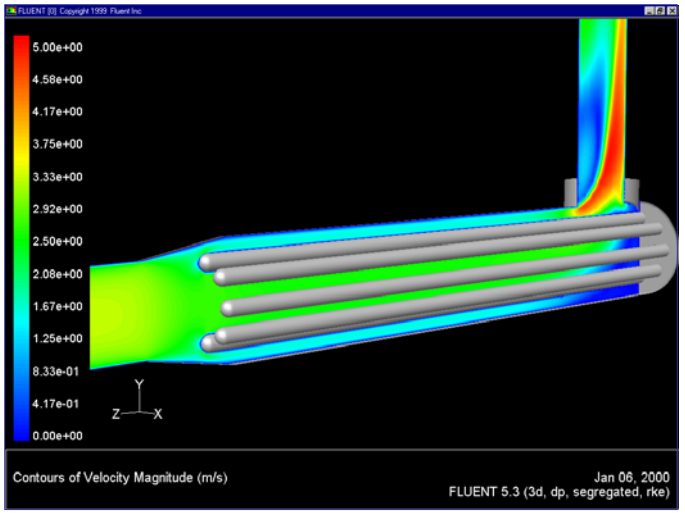


Reactor convencional

Eficàcia Hidràulica del 45%

UVLogic

Eficàcia Hidràulica del 80%



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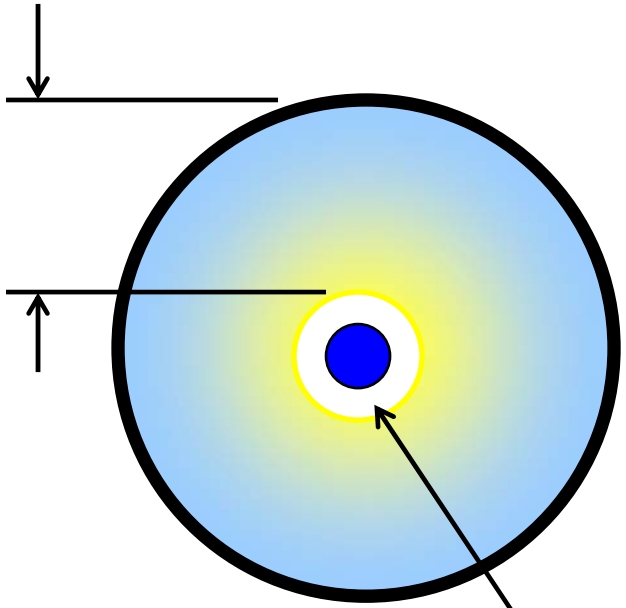
ESPAIAT ENTRE LÀMPARES

Secció d'un Reactor

Làmina d'aigua



làmpades & beina

Balanç

Energia perduda a la paret

vs.

Ineficiència del Reactor

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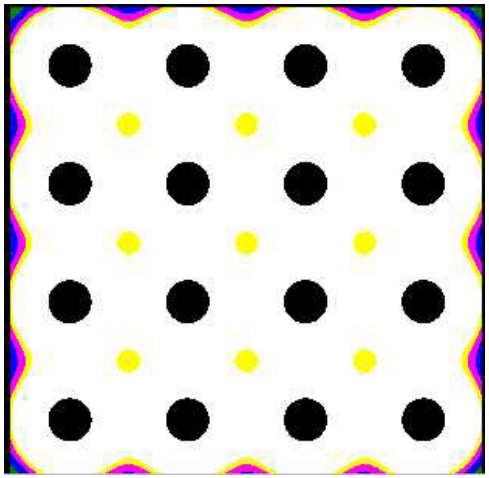
EFICÀCIA DEL REACTOR



Gris 0-1

Verd 1-2

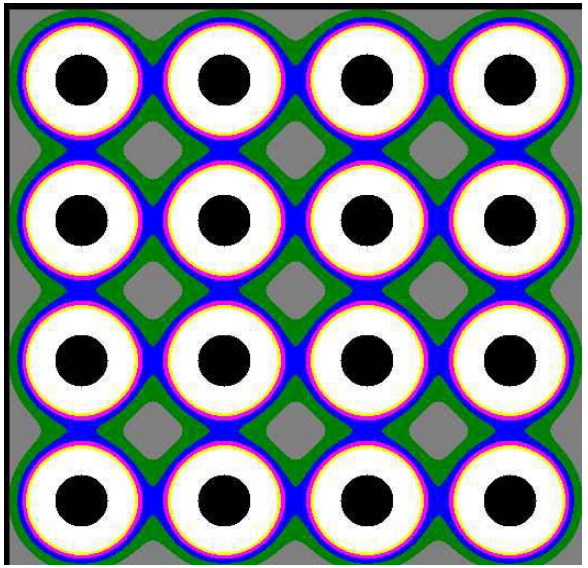
Blau 2-3

Rosa 3-4

Grog 4-5

Blanc >5

Mw/cm2



Camp llumínic creat amb 100 W I 7,6 cm d'espai amb 60% UVT

DOSI MITJA: 30 mJ/cm2

Camp llumínic creat amb 125 W i 12,8 cm d'espai amb 60% UVT

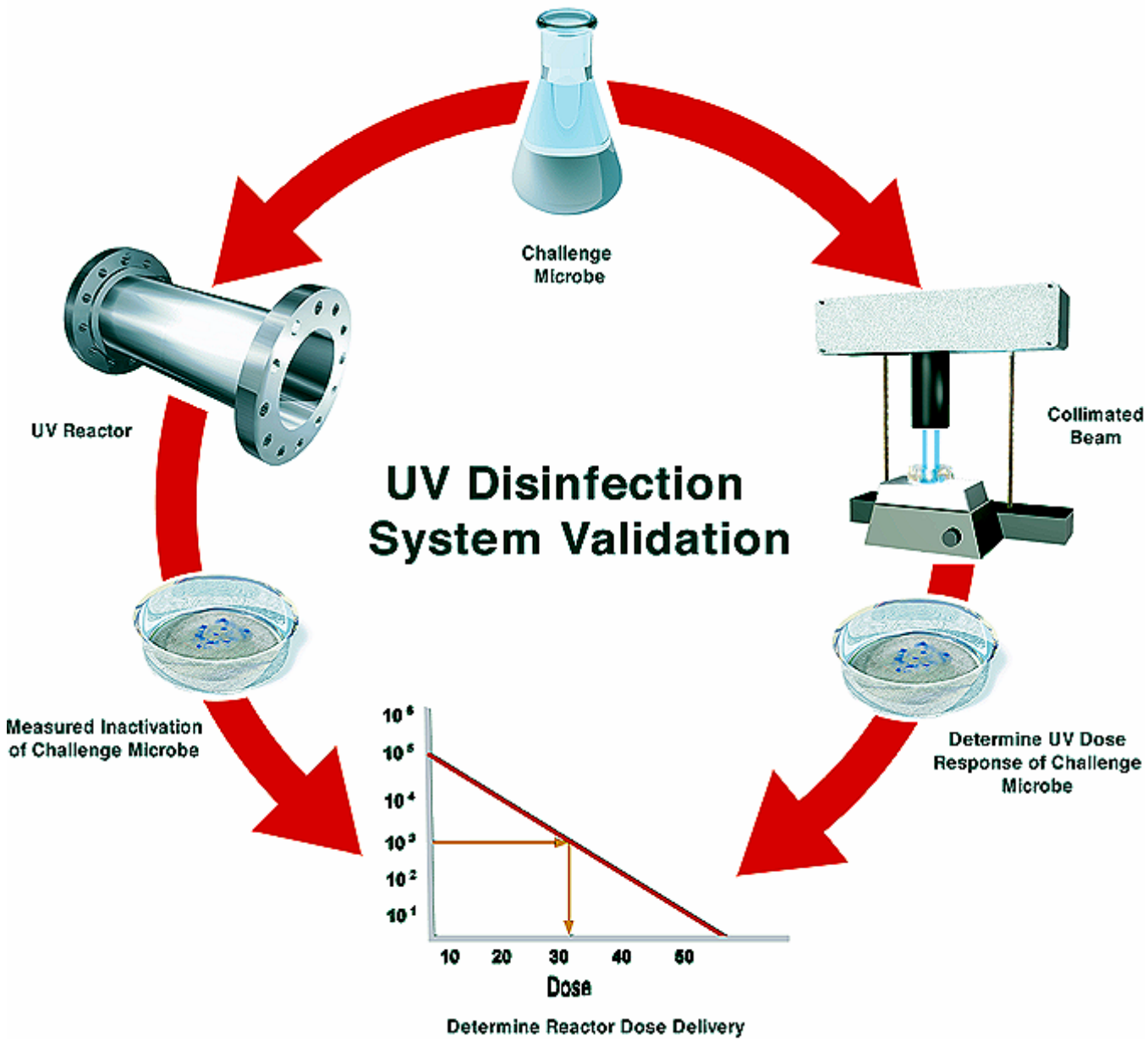
DOSI MITJA: 33 mJ/cm2

TROJAN UV

VALIDACIÓ :
EL MÈTODE DEL BIOASSAIG

- És l'única mesura correcta de comportament ja que inclou:
  - Potència de làmpades
  - Eficicàcia de reactàncies
  - Hidràulica
- Pràctica establerta al sector UV
  - NWRI, DVGW, ONORM, USEPA
- Compara el rendiment entre un "Reactor Ideal" (feix colimat) i un reactor real
- És reproduible si es segueixen els protocols establerts

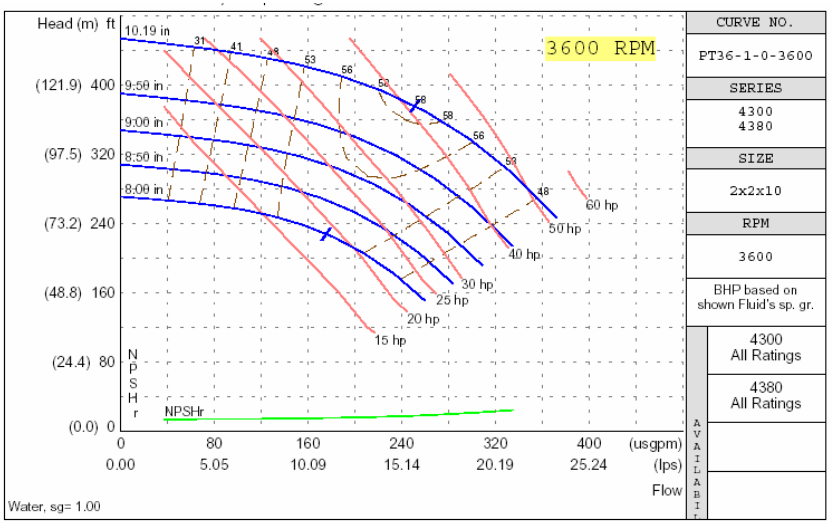
TROJAN UV


Challenge Microbe
Collimated Beam
Determine UV Dose Response of Challenge Microbe
Determine Reactor Dose Delivery
Dose
10
20
30
40
50
Measured Inactivation of Challenge Microbe
UV Reactor
UV Disinfection System Validation

TROJAN UV

Bioassaig és Simple!

- Corva d'una Bomba
  - Cabal vs. Alçada a una certa potència



- Corva de Bioassaig
  - Cabal per làmpada vs. Dosi a una certa UVT

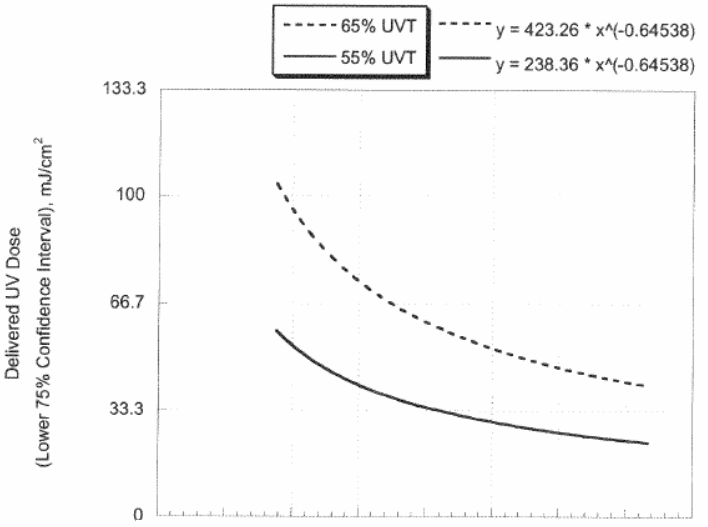


Figure ES-1
System Design Curves

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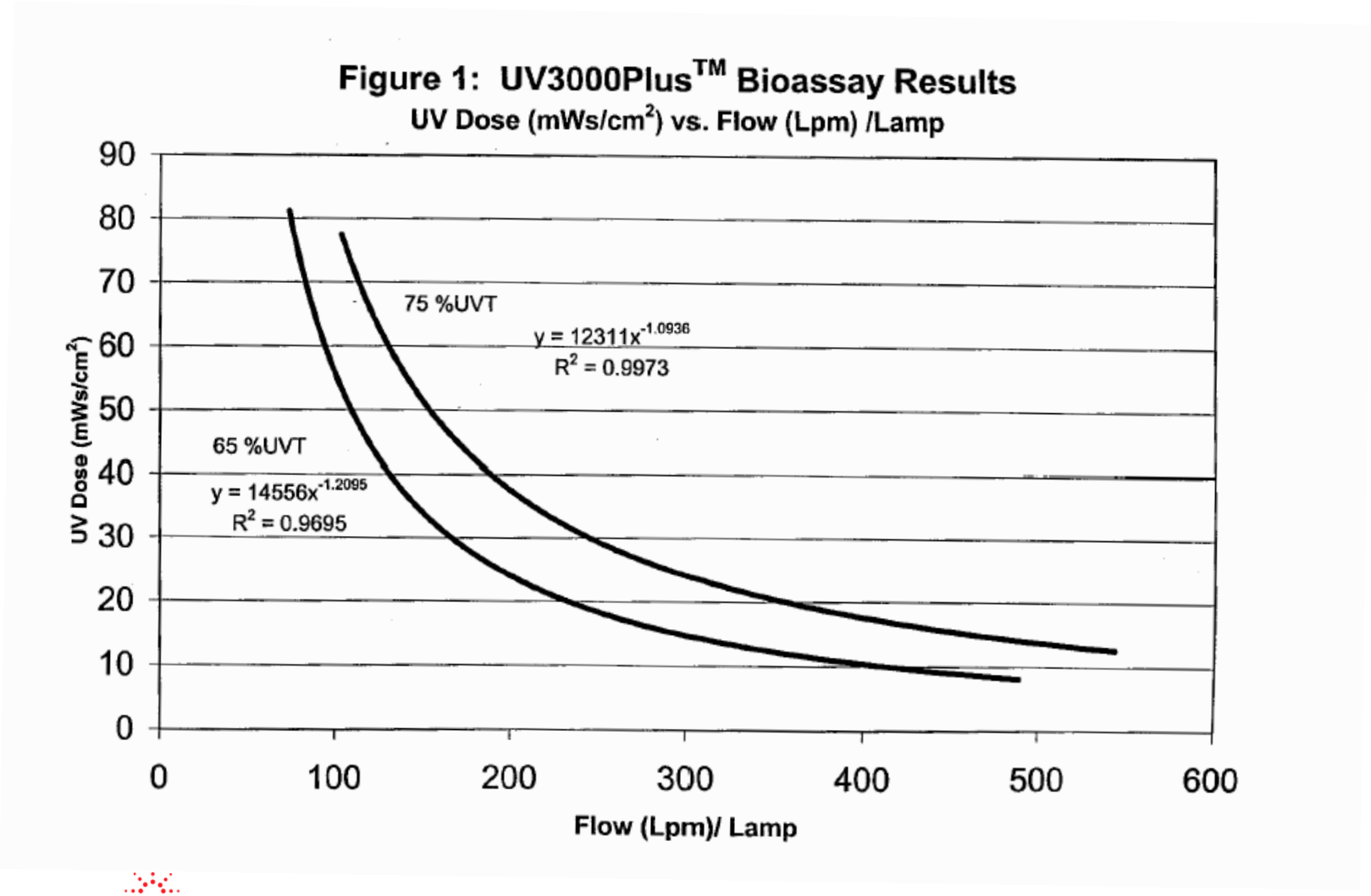
TIPICA CORVA VALIDADA DE BIOASSAIG



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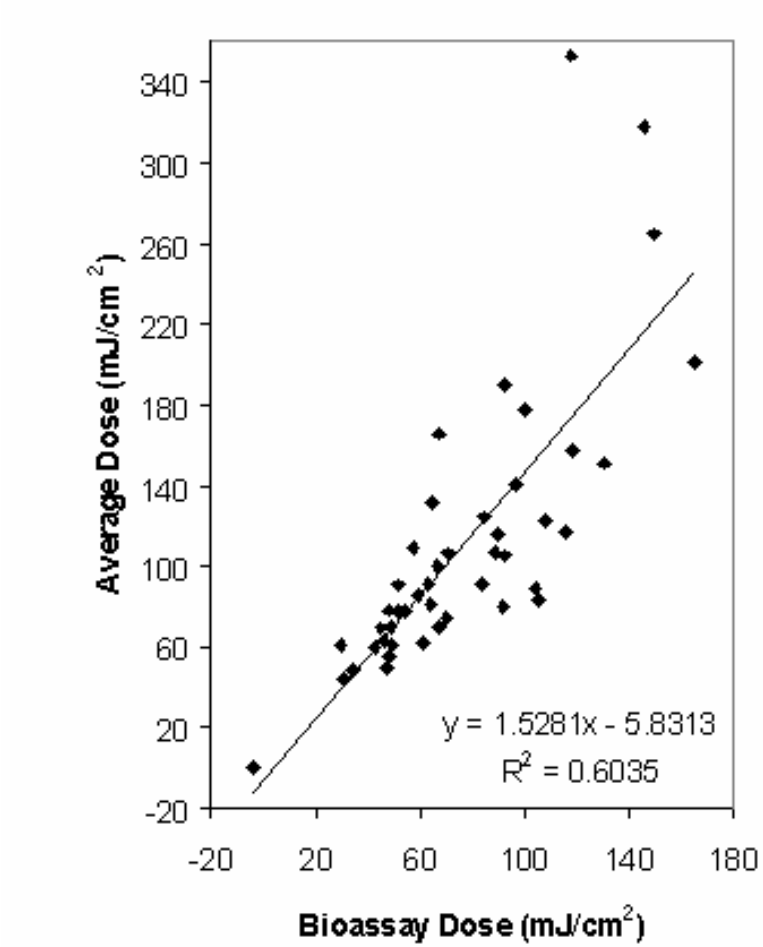
Bioassaig vs. Dosi Mitja: Poca Correlació, Més de un 100% d'Error



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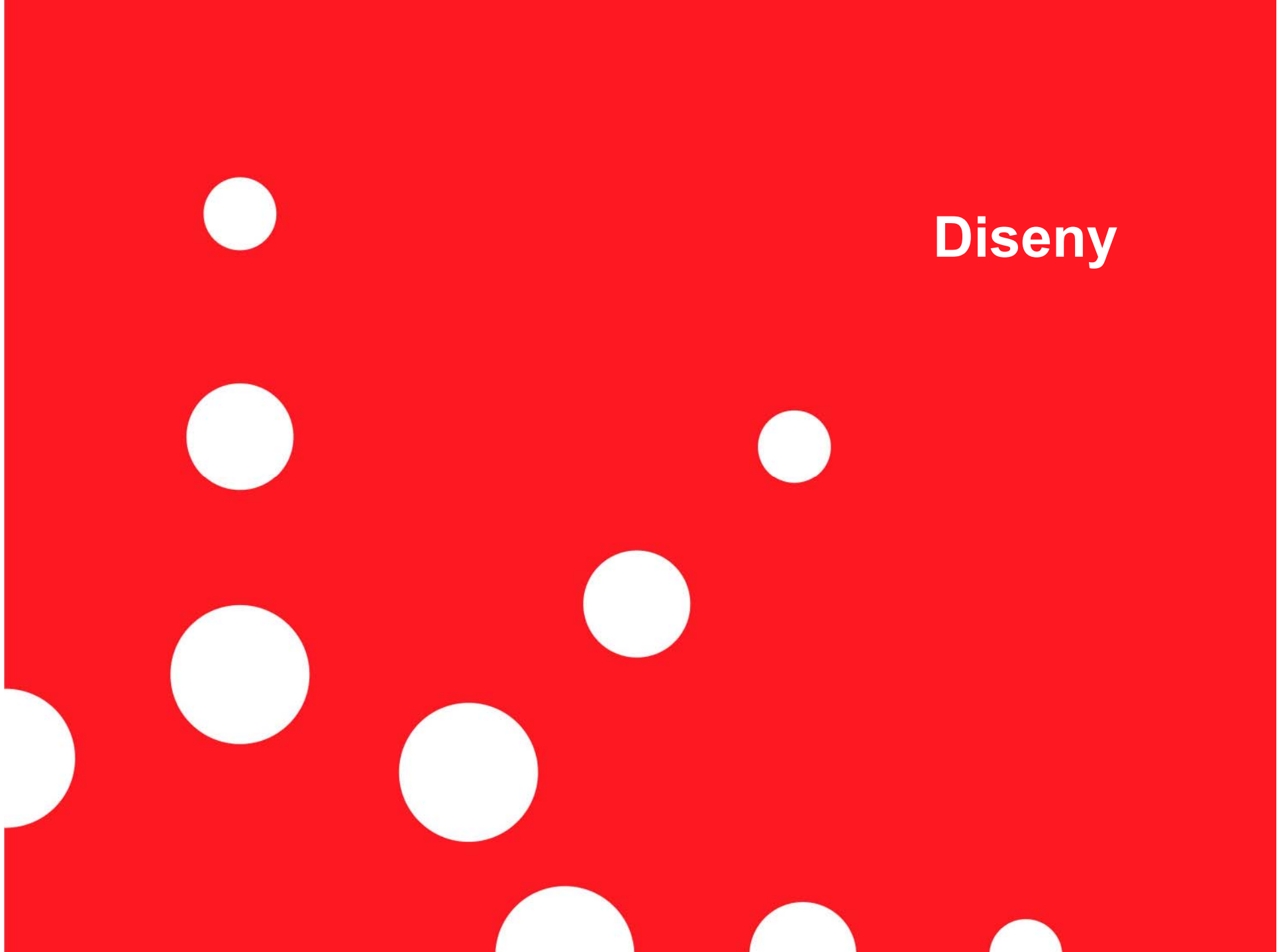
CONCLUSIÓ DE DOSI MITJA

- Dosi Mitja = Intensitat Mitja x Temps Mig d'Exposició
- La màxima Dosi possible pot ser aportada per un reactor
  - No existeix bona correlació amb el comportament del reactor
- El Bioassaig és l'únic mètode viable per provar el comportament del reactor
- Models numèrics validats proporcionen confiança en le comportament del reactor

TROJAN UV


Diseny

DISENY UV PER AIGUA REGENERADA

- Es determina el tamany del reactor en funció de les necessitats del client
  - Requeriments de Desinfecció (Geomean, percentile)
  - Factors de Risc
    - Eficiència de la làmpada
    - Envelliment de la làmpada
    - Neteja
  - Sempre es disenya amb Dosi > 12 mJ/cm2 per evitar possible fotorectivació

PAS 1: Determinar la Dosi

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QUALITAT DE L'EFLUENT I CRITERIS DE DESINFECCIÓ

Procés	Nivells desitjats de Desinfecció	Valors de Dosi
Primari	10,000 Coliforms Fecals / 100 mL Media Geomètrica	12 – 20 mJ/cm^2
Primari, Secundari	200 Coliforms Fecals / 100 mL Media Geomètrica	15 – 40 mJ/cm^2
Reutilització: Primari, Secundari, Terciari Filtracció	50 Coliforms Totals / 100 mL 95%ile	40 – 60 mJ/cm^2

- Dosis per sota de 12 mJ/cm^2 haurien de ser evitades per prevenir fotorectivació

TROJAN UV

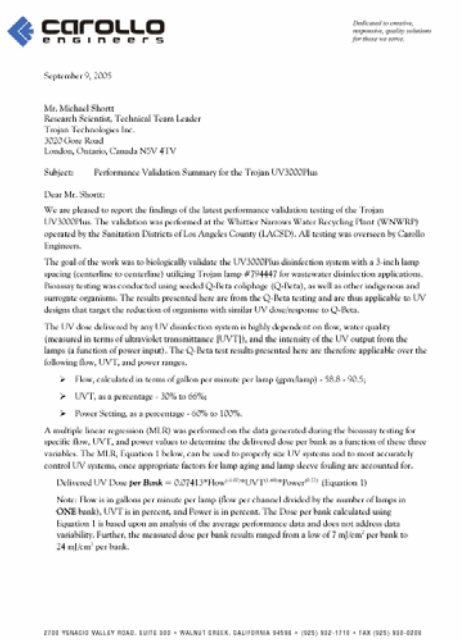
BASE DE DADES DE TROJAN PER AIGUA REGENERADA

- 500 plantes
- 18.000 corves de resposta de Dosi
- Dades recollides en 15 anys a tot el món
- Cada mostra:
  - Corva de feix col·limat
  - Planta, Data, Procés

PAS 2: Determinar el Cabal per làmpada

VALIDACIÓ

- Bioassaig
- Factor d'Envelliment
- Factor d'Embrutiment



carollo engineers

September 9, 2005

Mr. Michael Shortt
Research Scientist, Technical Team Leader
Trojan Technologies Inc.
3020 Gore Road
London, Ontario, Canada N5V 4T1V

Subject: Performance Validation Summary for the Trojan UV3000Plus

Dear Mr. Shortt:

We are pleased to report the findings of the latest performance validation testing of the Trojan UV3000Plus. The validation was performed at the Whittier Narrows Water Recycling Plant (WNWRP) operated by the Sanitation Districts of Los Angeles County (LACSD). All testing was overseen by Carollo Engineers.

The goal of the work was to biologically validate the UV3000Plus disinfection system with a 3-inch lamp spacing (centerline to centerline) utilizing Trojan lamp #794447 for wastewater disinfection applications. Bioassay testing was conducted using seeded Q-Beta coliphage (Q-Beta), as well as other indigenous and surrogate organisms. The results presented here are from the Q-Beta testing and are thus applicable to UV designs that target the reduction of organisms with similar UV dose/response to Q-Beta.

The UV dose delivered by any UV disinfection system is highly dependent on flow, water quality (measured in terms of ultraviolet transmittance [UVT]), and the intensity of the UV output from the lamps (a function of power input). The Q-Beta test results presented here are therefore applicable over the following flow, UVT, and power ranges.

- Flow, calculated in terms of gallons per minute per lamp (gpm/lamp) - 58.8 - 90.5;
- UVT, as a percentage - 30% to 66%;
- Power Setting, as a percentage - 60% to 100%.

A multiple linear regression (MLR) was performed on the data generated during the bioassay testing for specific flow, UVT, and power values to determine the delivered dose per bank as a function of these three variables. The MLR, Equation 1 below, can be used to properly size UV systems and to most accurately control UV systems, once appropriate factors for lamp aging and lamp sleeve fouling are accounted for.

Delivered UV Dose **per Bank** = 0.07413*Flow$^{(-1.470)}$*UVT$^{(1.486)}$*Power$^{(0.77)}$ (Equation 1)

Note: Flow is in gallons per minute per lamp (flow per channel divided by the number of lamps in **ONE** bank), UVT is in percent, and Power is in percent. The Dose per bank calculated using Equation 1 is based upon an analysis of the average performance data and does not address data variability. Further, the measured dose per bank results ranged from a low of 7 mJ/cm^2 per bank to 24 mJ/cm^2 per bank.

2700 YGNACIO VALLEY ROAD, SUITE 300 • WALNUT CREEK, CALIFORNIA 94598 • (925) 932-1710 • FAX (925) 930-0208

carollo engineers

March 25, 2004
6836A.00

Mr. Mike Shortt
Trojan Technologies, Inc.
3020 Gore Road
London, Ontario, Canada N5V 4T7

Dear Mr. Shortt:

This letter will certify that Carollo Engineers, P.C. has completed the analysis of lamp aging data for the Trojan UV3000Plus low pressure high output amalgam lamp and it has performed within acceptable tolerances identified in the "Lamp Age Factor Testing" section of the AwwaRF/NWRI 2003 Guidelines for Drinking Water and Water Reuse. Complete data is presented in our report titled **"Lamp Age Factor for the Trojan UV3000Plus System - Final April 2003."** The data satisfies requirements for an end of lamp life factor of 0.82 at 9,000 hours.

Sincerely,

CAROLLO ENGINEERS, P.C.

Andrew T. Salveson, P.E.

ATS:ml

carollo engineers

March 25, 2004
6836A.00

Mr. Mike Shortt
Trojan Technologies, Inc.
3020 Gore Road
London, Ontario, Canada N5V 4T7

Dear Mr. Shortt:

This letter will certify that Carollo Engineers, P.C. has completed the analysis of sleeve cleaning data for the Trojan UV3000Plus sleeve cleaning system and it has performed within acceptable tolerances identified in the "Cleaning Mechaniam Testing" section of the AwwaRF/NWRI 2003 Guidelines for Drinking Water and Water Reuse. Complete data is presented in our report titled **"UV3000Plus Interim Sleeve Cleaning Report - Final April 2003."** The data satisfies requirements for a sleeve fouling factor of 0.95.

Sincerely,

CAROLLO ENGINEERS, P.C.

Andrew T. Salveson, P.E.

ATS:ml

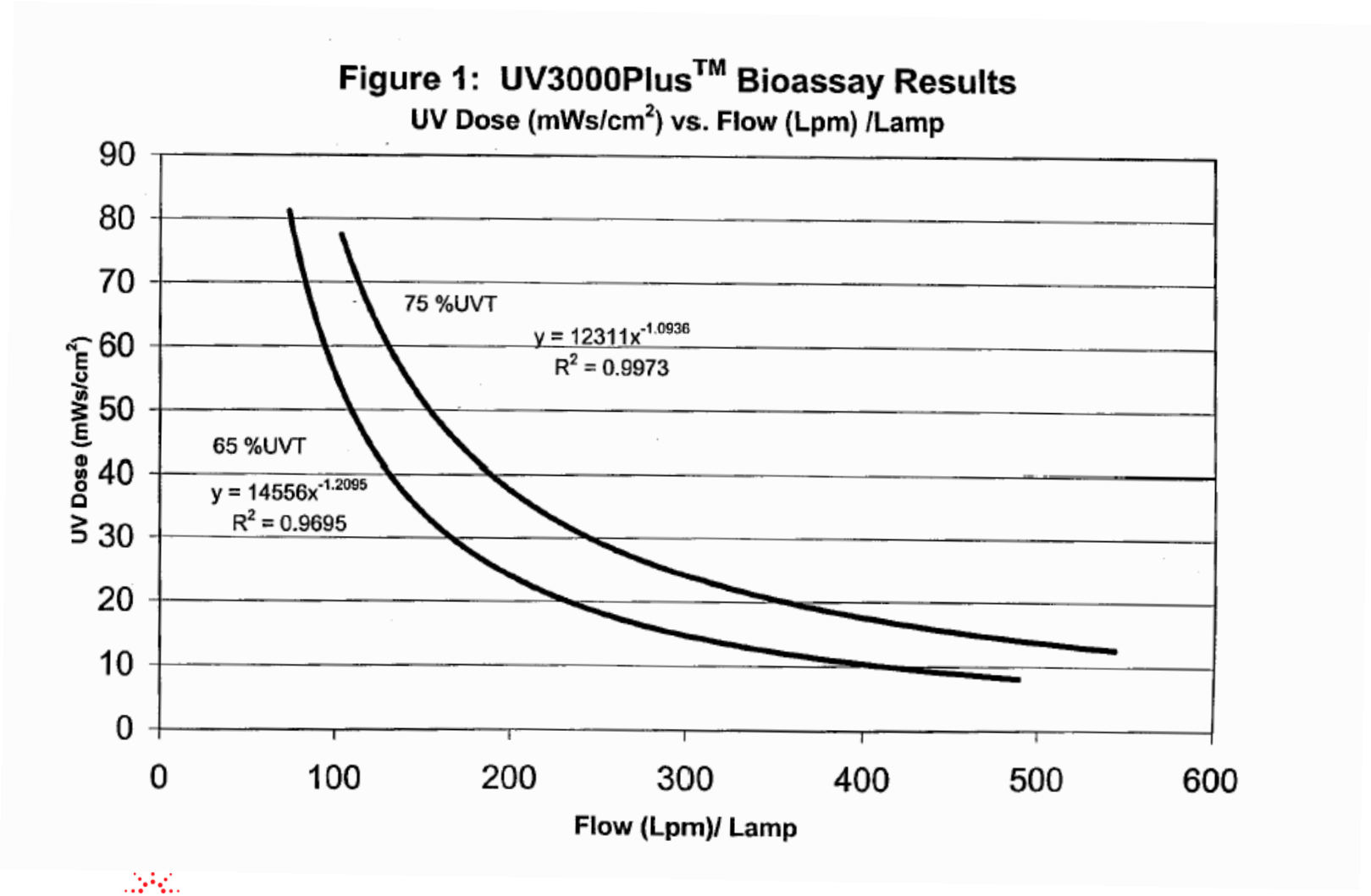
TROJAN UV

Validacions de Bioassaig per UV3000PLUS

	Dillon 3”	**Dillon 4”**	**Carollo 3”**	**Carollo 4”**	**NWRI 4”**
UVT	65%, 75%	65%, 75%	30% to 66%	55% to 77%	55% to 77%
Cabal / Lamp / Banc	0 to 30 m^3/h	0 to 30 m^3/h	10 to 15.4 m^3/h	1.4 to 28.7 m^3/h	1.4 to 28.7 m^3/h

TROJAN UV

TIPICA CORVA VALIDADA DE BIOASSAIG



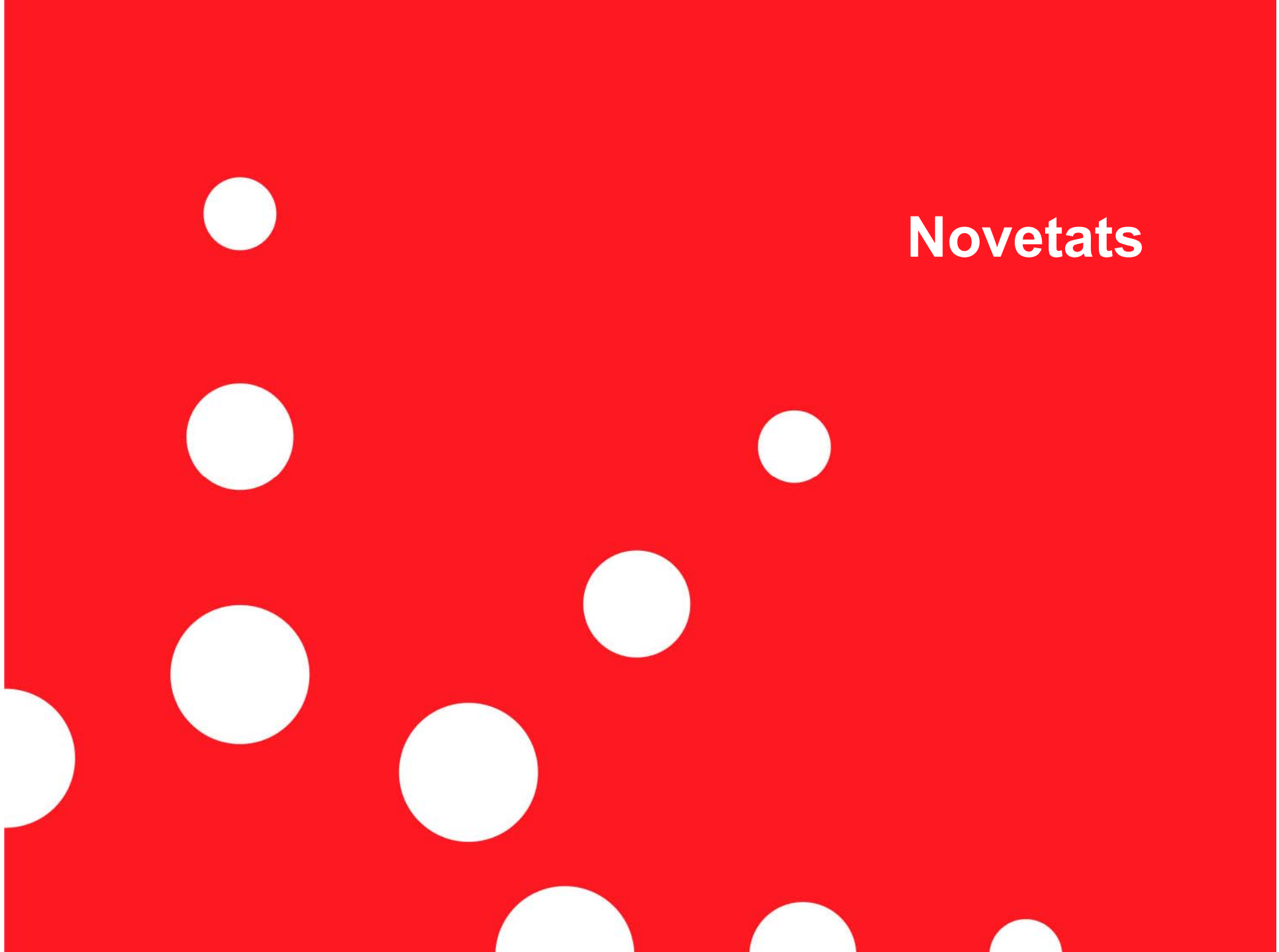
TROJAN UV

FACTORS DE SEGURETAT

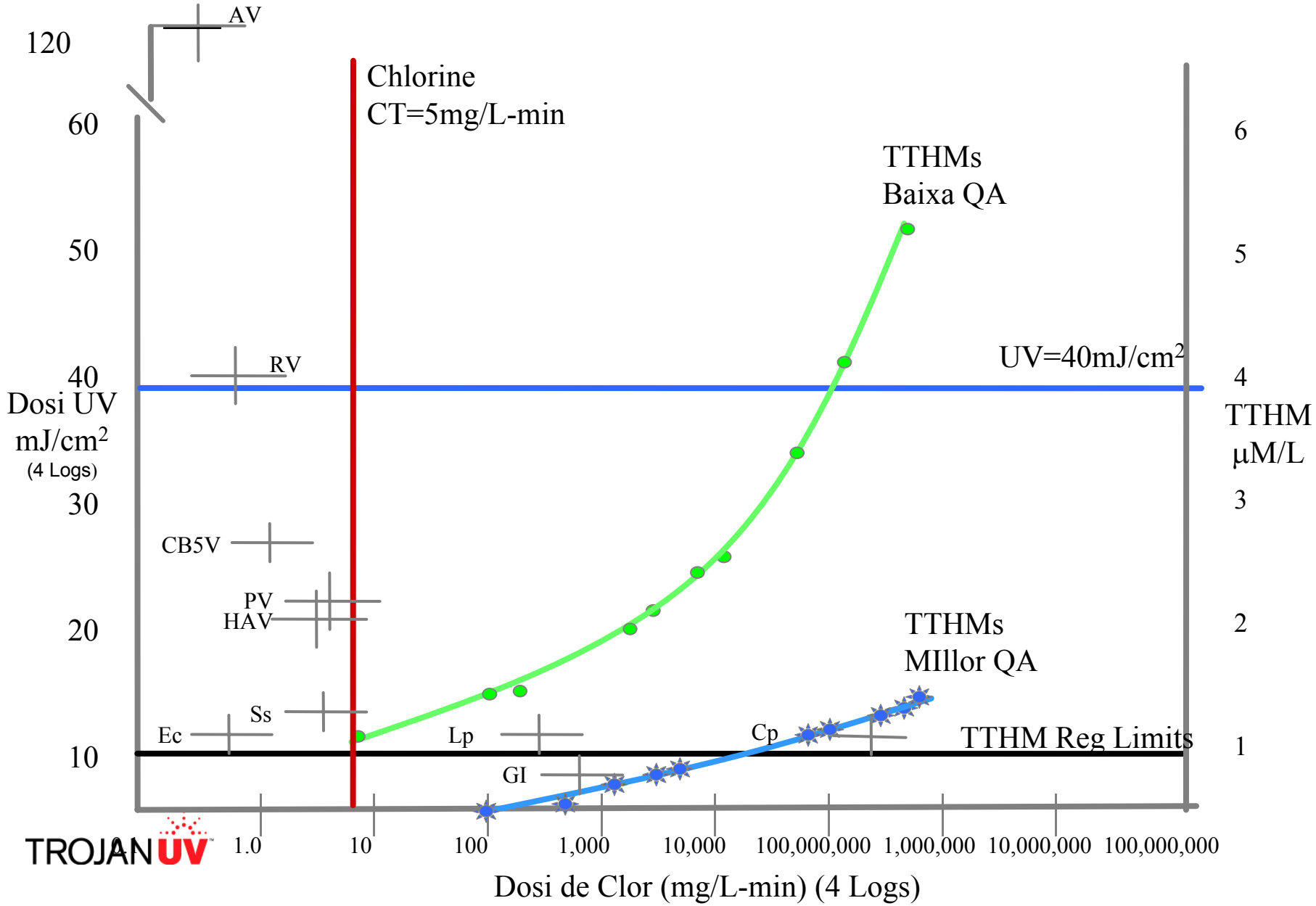
- Dosi = Bioassaig * neteja * envelliment

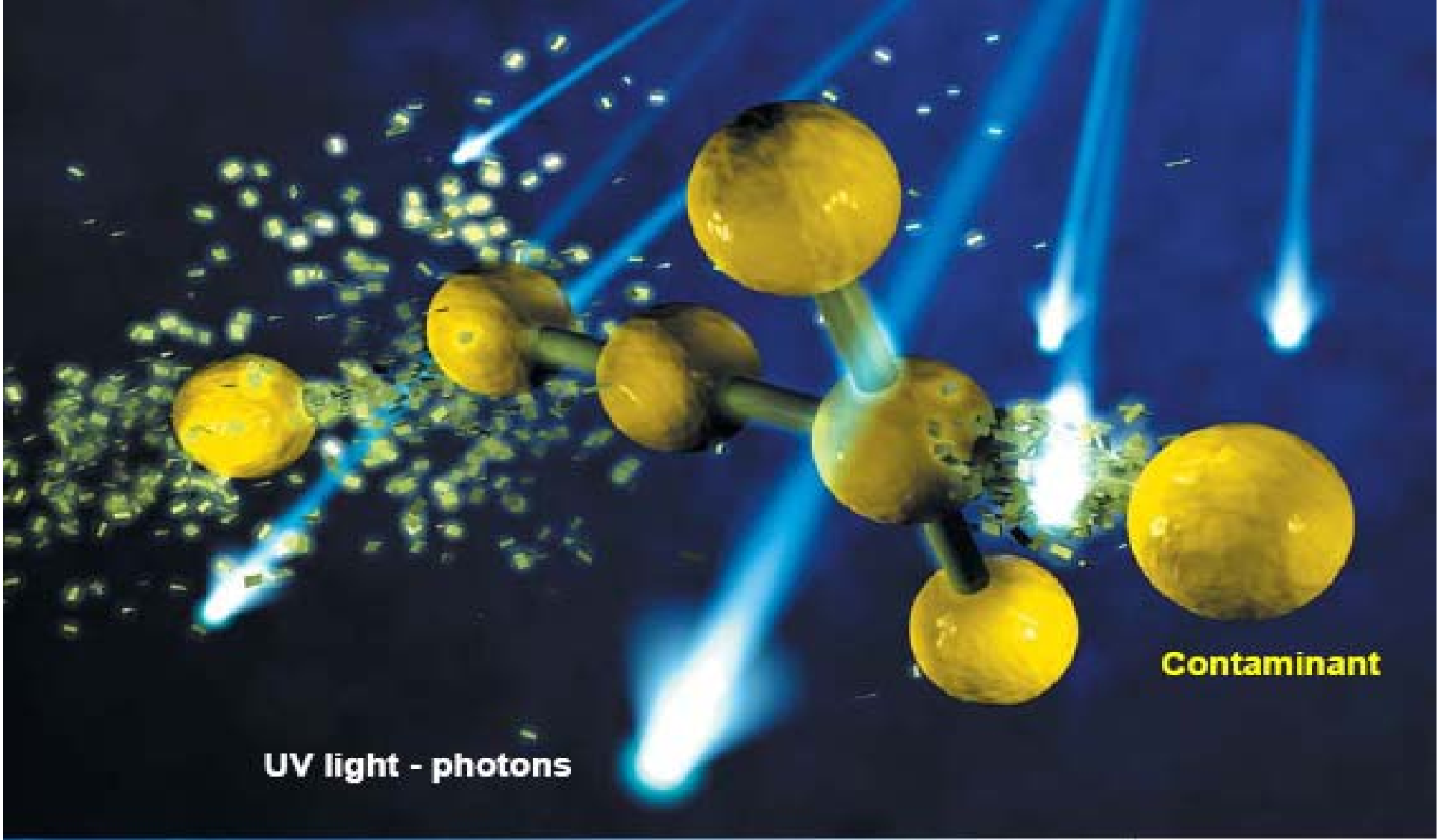
	Normativa 2003 NWRI	Validació Trojan
Factor neteja	0.8	0.95
Envelliment	0.5	0.98
Neteja * Envelliment	0.4	0.93

TROJAN UV


Novetats

COMBINACIÓ DE DESINFECTANTS

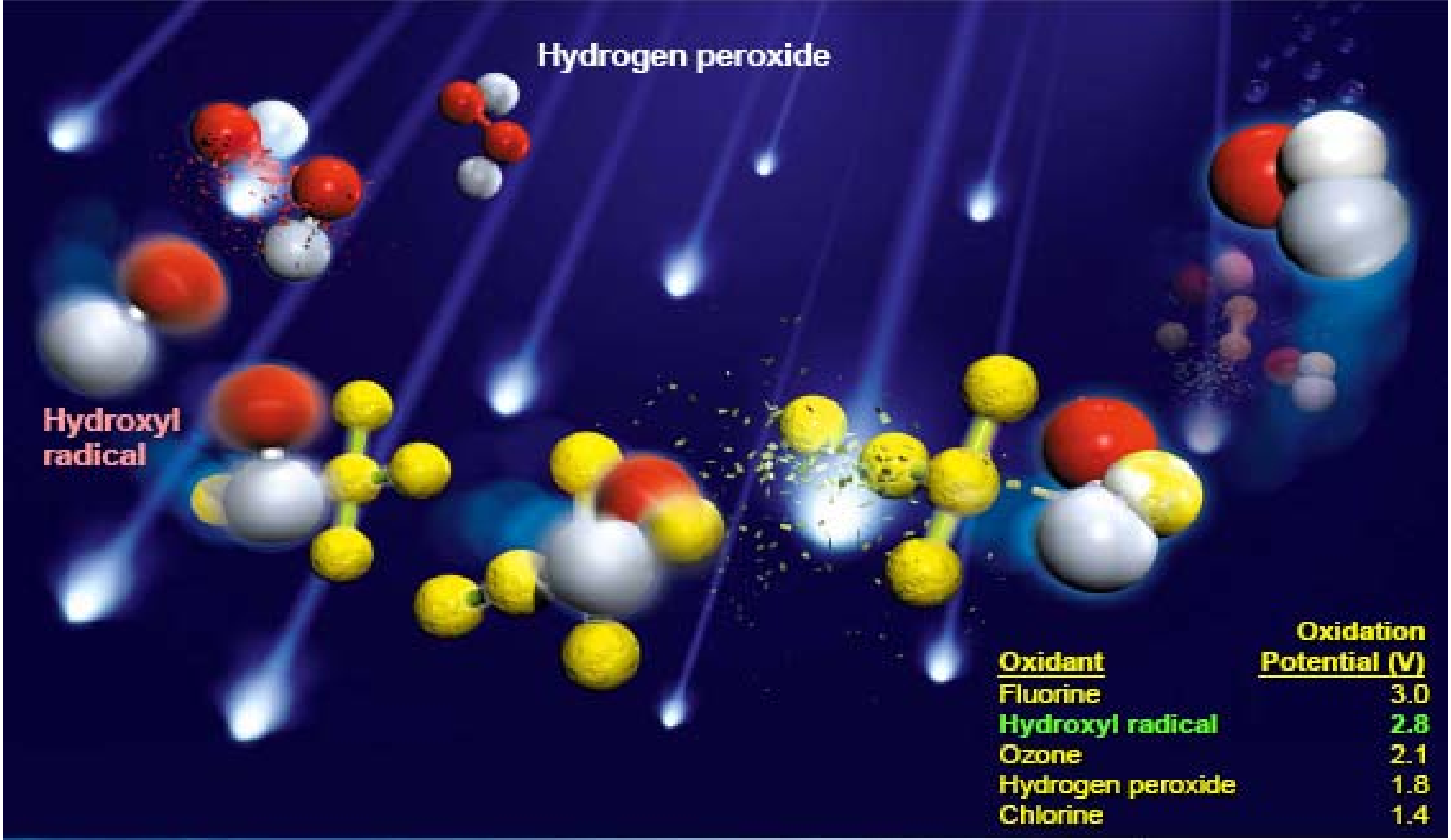




UV Photolysis

Trojan Technologies

TROJAN UV



Oxidant	Oxidation Potential (V)
Fluorine	3.0
Hydroxyl radical	2.8
Ozone	2.1
Hydrogen peroxide	1.8
Chlorine	1.4

UV Oxidation

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GRÀCIES