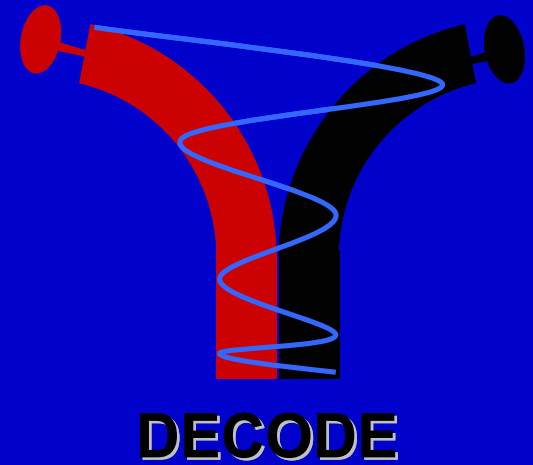


# Interaction between MEA design and ion contamination in PEFC stacks

Presented by: Rainer Glück



Carisma 2010

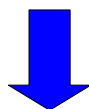
La Grande Motte

September 19<sup>th</sup> - 22<sup>nd</sup> 2010

DECODE – Understanding of **D**egradation Mechanisms to Improve **C**omponents and **D**esign of PEFC

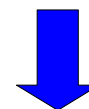


WP5 – Investigation of Degradation of Bipolar Plates and Seals

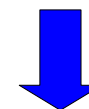


measurements of degradation on components by XPS, contact angle, roughness, optical methods...

Please see our poster at the poster session



measurements of degradation products in GDL, product water...



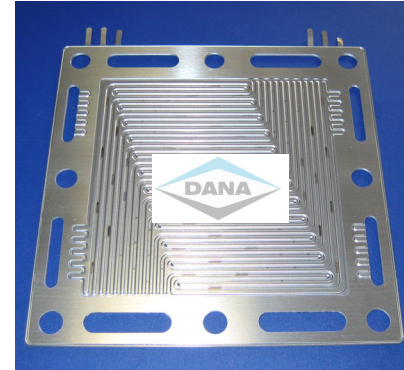
**degradation products in the ionomer?**

# DECODE – WP5

## ▶ BPP Design

metallic plates with 0.1 mm thickness  
graphite composite

channel numbers 12  
290 mm channel length  
channel area 0.62 mm<sup>2</sup>



## ▶ Material

AISI316L

AISI904L

AISI316L with gold coating  
composite



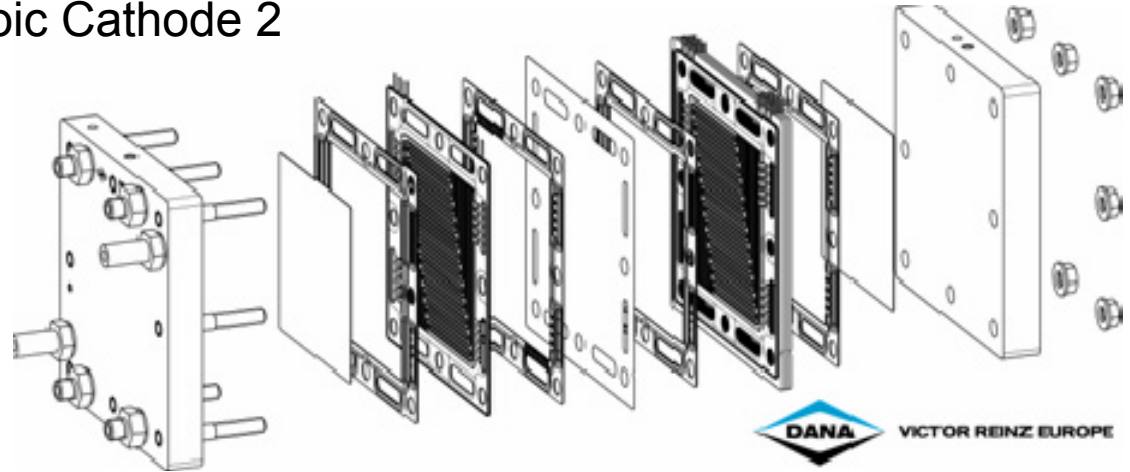
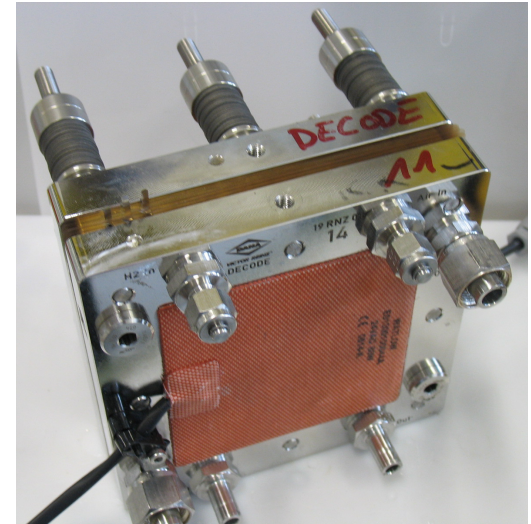
## ▶ Sealing

separate sealing frames  
adjustable gasket height

Up to now 20 stack tests at various partners

## Test conditions for long term testing

- 5 cells
- current density 0.6 A/cm<sup>2</sup>
- constant current, interrupted by IE curves
- test duration 1000 h
- stack temperature 60 °C
- relative humidity anode 42 %, cathode 66 %
- stoic Anode 1.5, stoic Cathode 2
- Pressure 0 kPa
- GDL SGL 25 BC
- commercial MEA



**DANA** VICTOR REINZ EUROPE

## Degradation products in the ionomer?

### Possible cationic contaminants

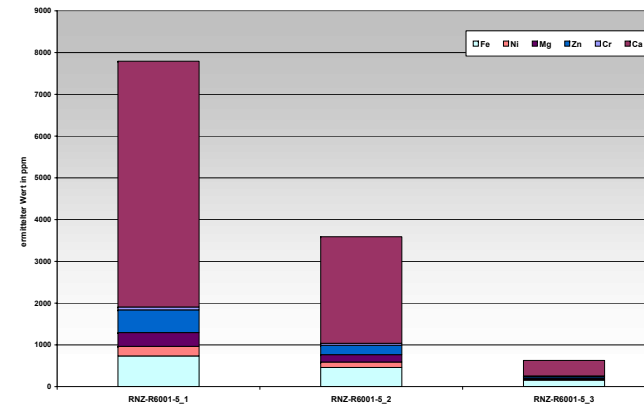
- iron, chromium, nickel,
- zinc, magnesium, copper, calcium,
- silicone

### Re-protonation of polymer and analysis of solution by ICP at ZSW

#### Procedure

- separating the GDL from active area directly after disassembling of the stack
- cut out the active area with a ceramic scissor
- breaking the active area in smaller pieces
- boil the active area three times in nitric acid
- analyze the solution by ICP (inductive coupled plasma)

Dilution series



LOQ and LOD

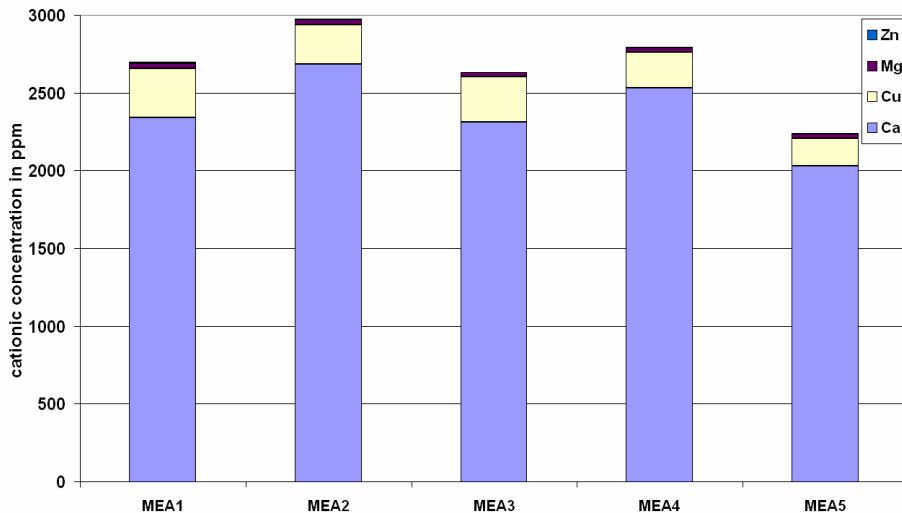
Element	LOQ	LOD
Ca	3 ppb	30 ppb
Cr	5 ppb	50 ppb
Cu	2 ppb	20 ppb
Fe	2 ppb	20 ppb
Ni	5 ppb	50 ppb
Mg	1 ppb	50 ppb
Mn	5 ppb	50 ppb
Zn	1 ppb	10 ppb

## Tab water contents: calcium, magnesium, copper, zinc

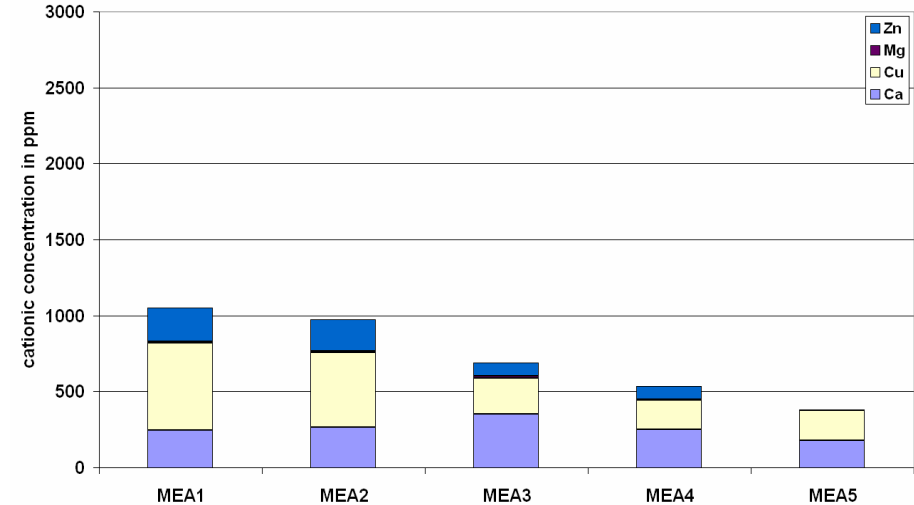
DECODE 19 stack (composite bipolar plates)

DECODE 15 (AISI316L bipolar plates)

tab water contents in MEA  
Stack DECODE 19 with bipolar plates of composite



tab water contents in MEA  
Stack DECODE 15 with bipolar plates of AISI316L



March 2010 →

**cleaning of humidifier system**

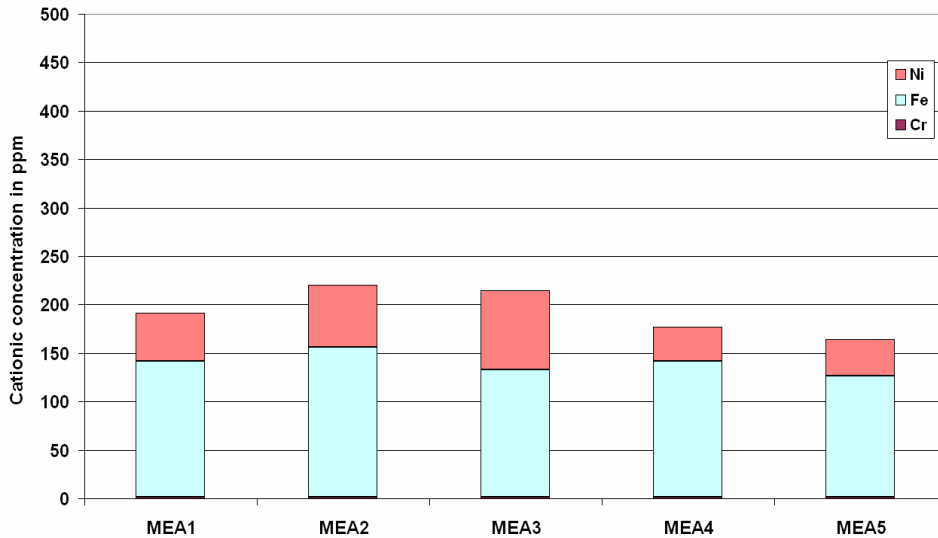
→ June 2010

## Corrosion products: nickel, iron, chromium

degradation products (composite)

degradation products (AISI316L)

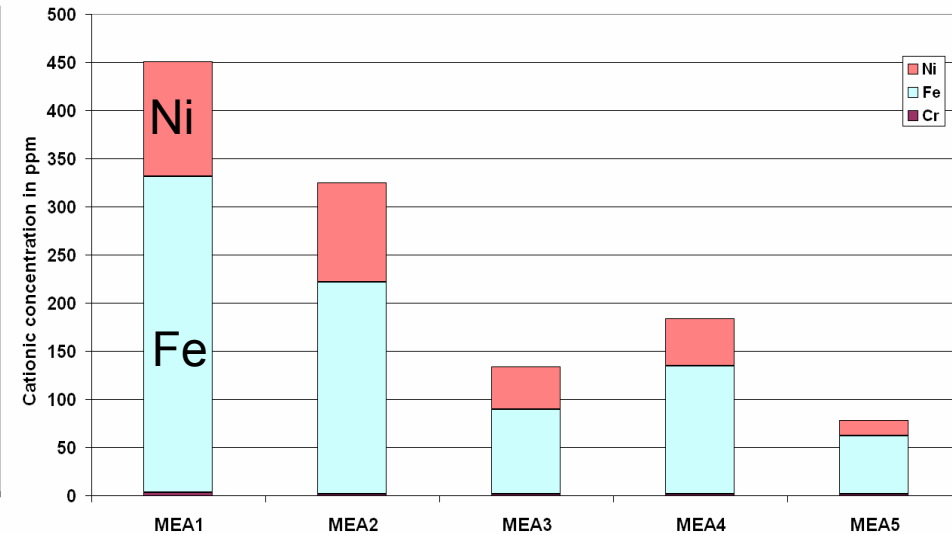
metallic cations in MEA  
Stack DECODE 19 with bipolar plates of Composite



Total sum of metallic cations in the stack

**968 ppm**

metallic cations in MEA  
Stack DECODE 15 with bipolar plates of AISI316L



Total sum of metallic cations in the stack

**1172 ppm**

comparable metallic contamination of both materials – **can this be possible?**

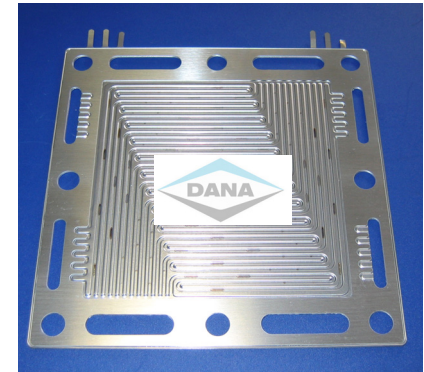
# DECODE – WP5

## Identification of the contamination paths

bipolar plate

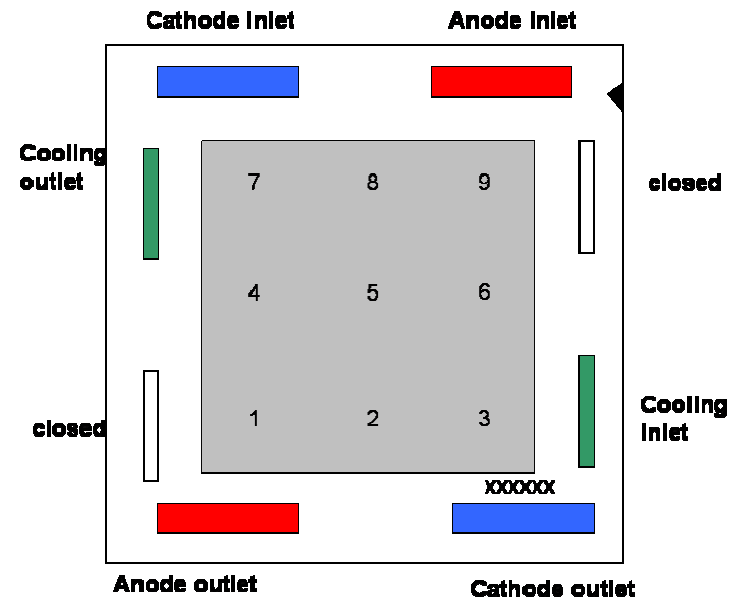
gas path (Humidification, Piping)

cooling path (e.g., MEA port cut-outs)



to get a more detailed view, the active area was cut in 9 segments.

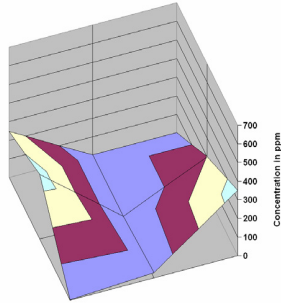
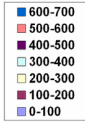
each segment was re-protonated and analyzed separately by ICP.



## DECODE19 stack, Cell3, Composite

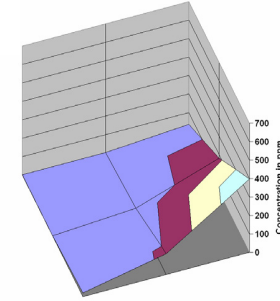
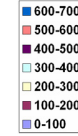
## DECODE15 stack, Cell3, AISI316L

Fe-allocation in MEA3  
DECODE 19

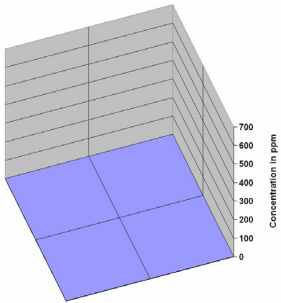


**iron**

Fe-allocation in MEA3  
DECODE 15

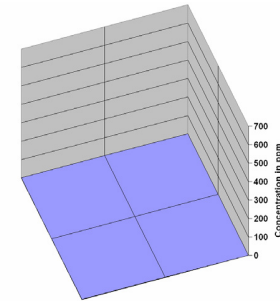
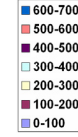


Cr-allocation in MEA3  
DECODE 19

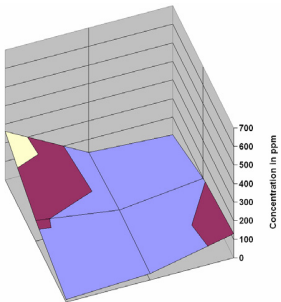


**chromium**

Cr-allocation in MEA3  
DECODE 15

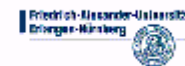
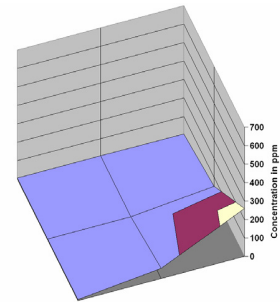


Ni-allocation in MEA3  
DECODE 19



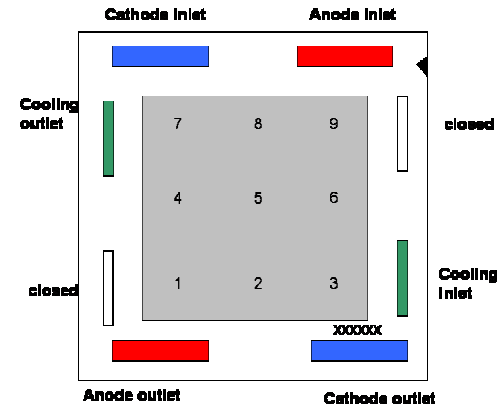
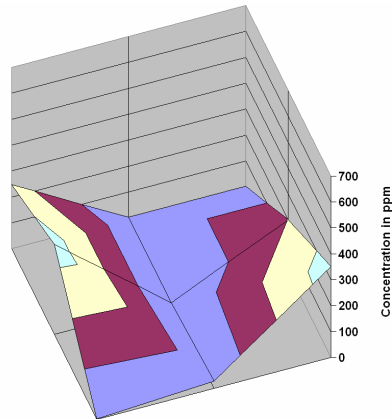
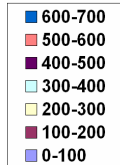
**nickel**

Ni-allocation in MEA3  
DECODE 15

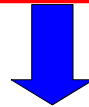


peaks are allocated to the coolant inlet and coolant outlet region

Fe-allocation in MEA3  
DECODE 19



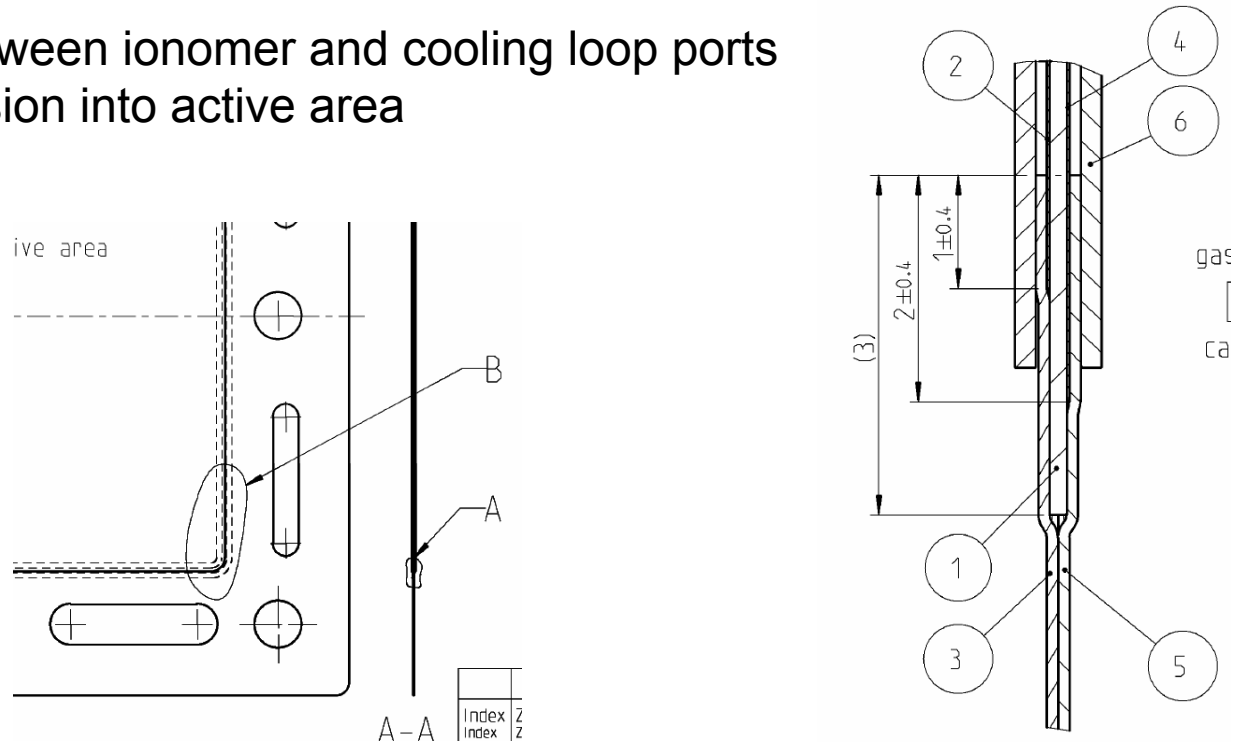
direct contact of the ionomer to the medias trough the port cut-outs



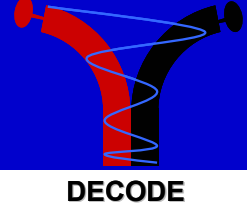
design proposal elaborated to avoid  
this contamination

## ► Design proposal to exclude external contamination of the MEAs

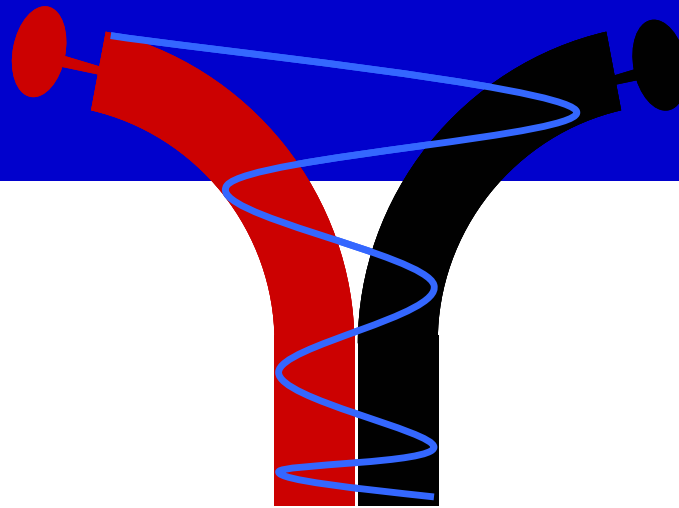
- no contact between ionomer and cooling loop ports
- no cross diffusion into active area



**Stacks with this new MEA design (SolveCore) are available,  
first results end of 2010**



# THANK YOU FOR YOUR ATTENTION



# DECODE

Thanks to the financial support of the DECODE project through the European Commission