



**SIEMENS**  
*Ingenuity for life*

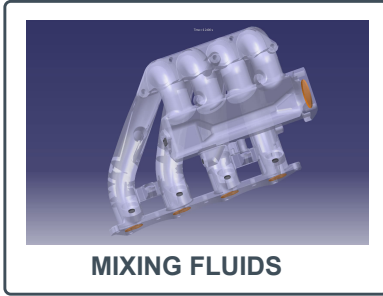
# FloEFD – Frontloading CFD for Automotive Lighting & ADAS

Alexey Kharitonovich

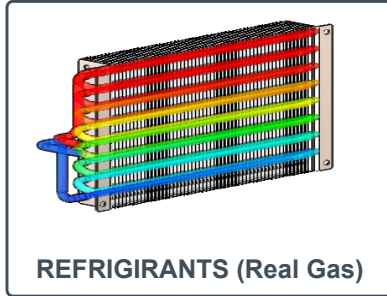
what is **FloEFD**?

# FloEFD – General Purpose CFD Simulation Software

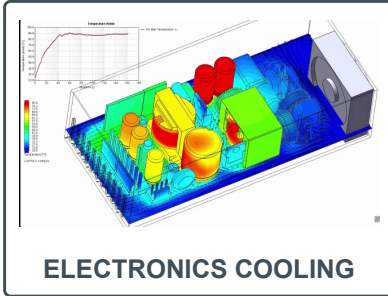
## CAD embedded CFD for Thermal-Radiation-Fogging-Flow management



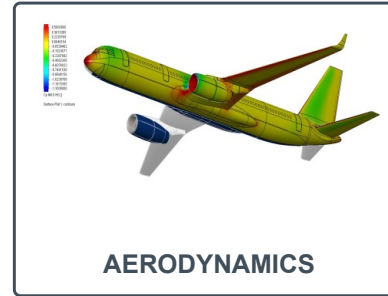
MIXING FLUIDS



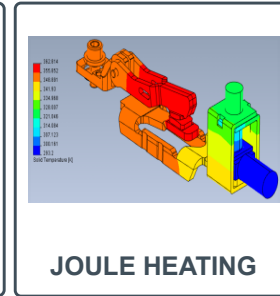
REFRIGERANTS (Real Gas)



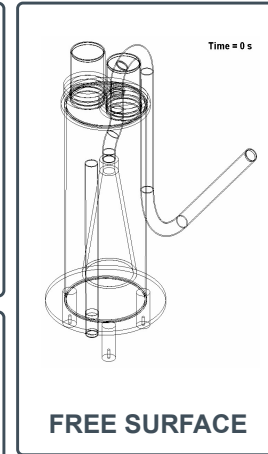
ELECTRONICS COOLING



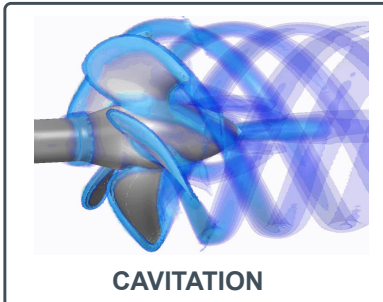
AERODYNAMICS



JOULE HEATING



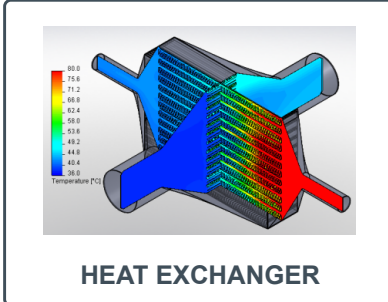
FREE SURFACE



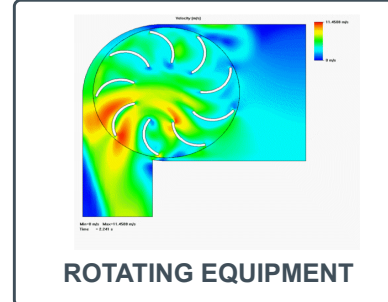
CAVITATION



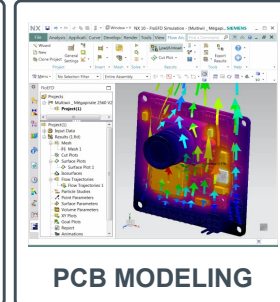
CONDENSATION



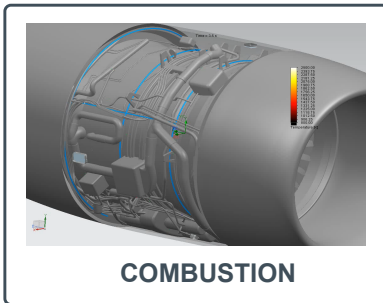
HEAT EXCHANGER



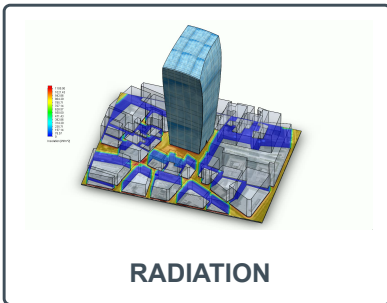
ROTATING EQUIPMENT



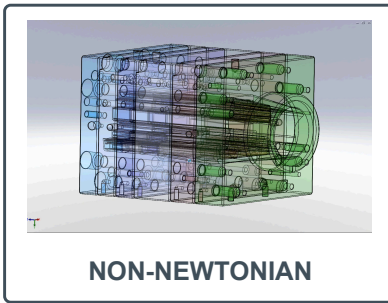
PCB MODELING



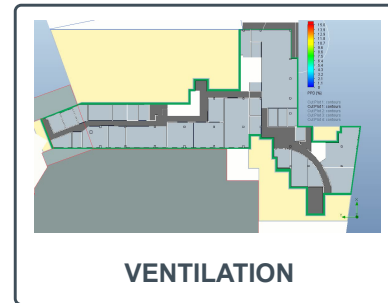
COMBUSTION



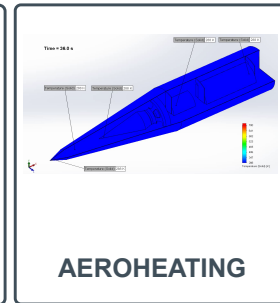
RADIATION



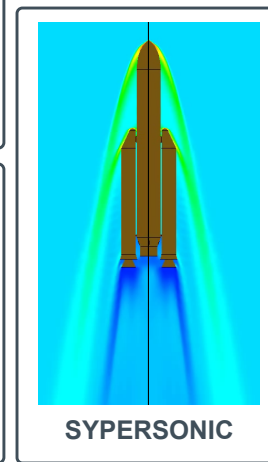
NON-NEWTONIAN



VENTILATION



AEROHEATING



SUPERSONIC

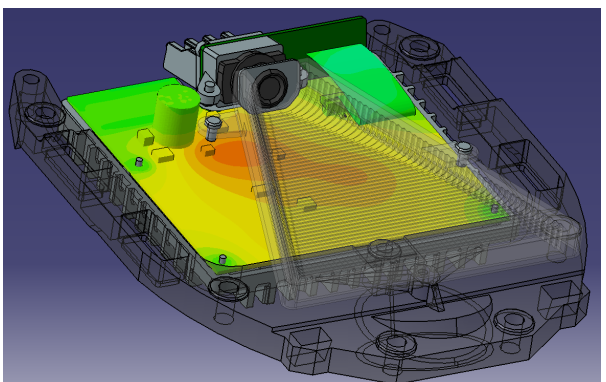


why **FloEFD**?

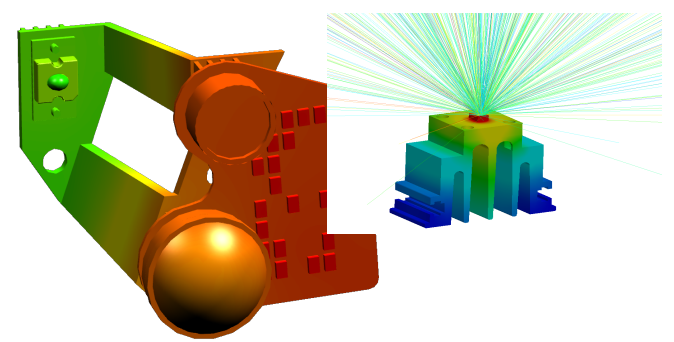


# FloEFD – CFD adjusted for AL and ADAS

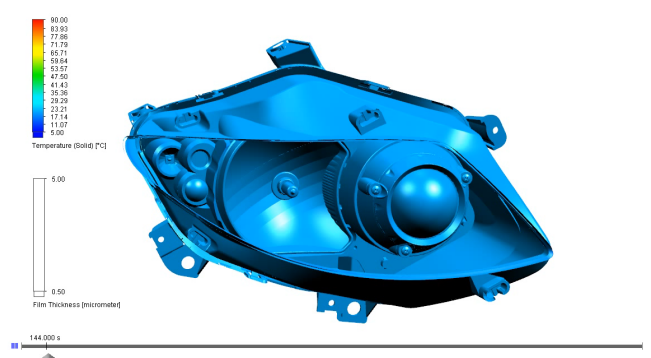
## Developed together with Automotive Lighting and ADAS Engineers



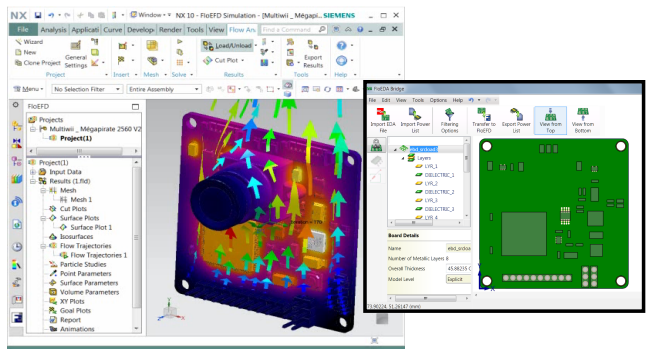
Thermal Management in CATIA V5



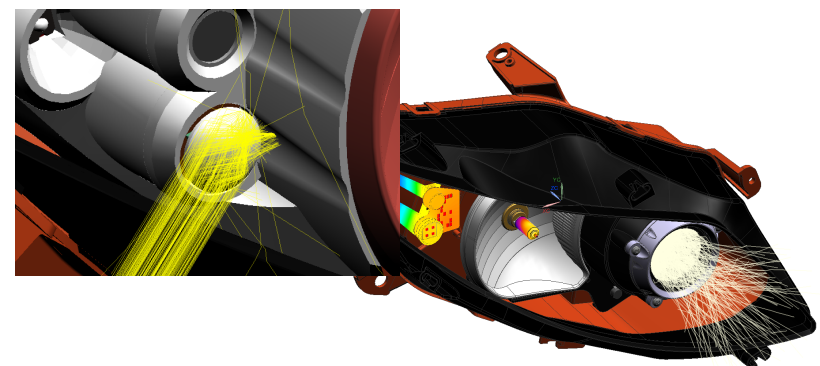
Thermal-Optical-Electrical LED model



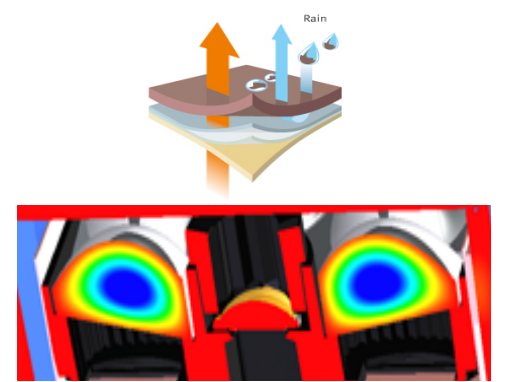
Fogging and Defogging



EDA Import and Joule Heating



Thermal and Solar Radiation and Ray Tracking



Water Sorption and Membrane

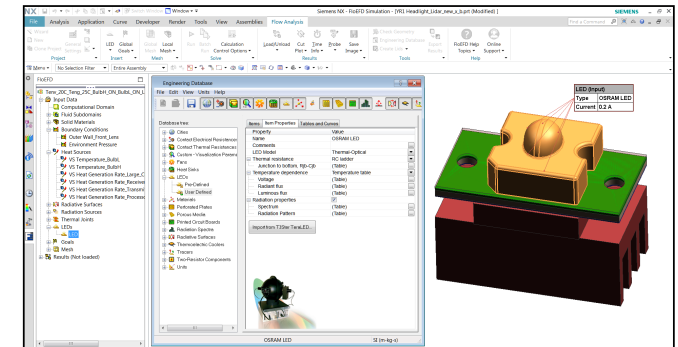
# FloEFD – CFD powered by Hardware Measurement

## LED Thermo-Optical-Electrical Compact Model Generated by Measurement



### LED Thermo-Optical-Electrical Compact model

User Input: Forward Current (Ampere)



Output:

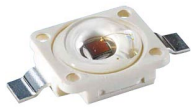
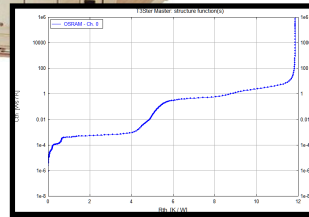
- Junction T
- Dissipated Power
- Luminous Flux

LED (Input)	OSRAM LED
Type	OSRAM LED
Current	0.2 A
LED (Output)	
T junction	67.52 °C
LED Heat Generation Rate	0.304 W
Luminous Flux	95.84 lm

T3Ster



Thermal Characteristics (Structure Function)

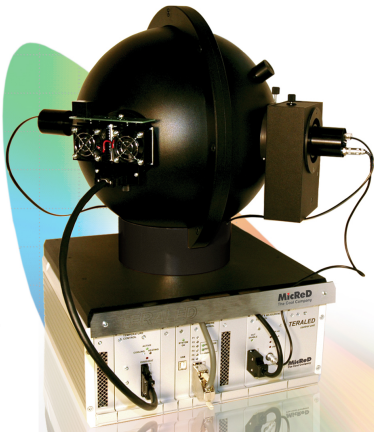


Thermo-Optical-Electrical Characteristics (.xCTM)

Optical and Electrical Characteristics (Diode characteristics, Radiant, Luminous Flux)

Optical Test Report											
Project: 1AV_Orsam_Order											
Date: Thu Jun 14 12:46:12 2012											
Meas. Mode: Combined(T3Ster + Booster)											
Temperature Control Mode: Tambient (True)											
Target Ref. Temp.	Temp	T <sub>ref</sub>	T <sub>junction</sub>	Power	T <sub>ref</sub>	T <sub>junction</sub>					
[°C]	[A]	[°C]	[°C]	[W]	[°C]	[°C]	[°C]	[°C]	[°C]	[°C]	[°C]
30.0	0.350	30.7	67.50	31.7	—	—	—	—	—	—	—
Forward [V]	15.969	15.969	17.030								
P <sub>tot</sub> [mW]	5899.3	5899.3	12772.8								
P <sub>rad</sub> [mW]	1179.2	1179.2	2046.3								
WPE [%]	20.9	20.9	16.0								
S <sub>ep</sub> [mW/°C]	-2.324	-2.324	-6.434								
η [lm]	347.1	347.1	383.5								
η [lm/W]	62.1	62.1	65.7								
φ [lm]	716.5	716.5	3179.3								
CCT [K]	7085.0	7085.0	7036.1								
x	0.3070	0.3070	0.3003								
y	0.3074	0.3074	0.2948								
Target Ref. Temp.	Temp	T <sub>ref</sub>	T <sub>junction</sub>	Power	T <sub>ref</sub>	T <sub>junction</sub>					
[°C]	[A]	[°C]	[°C]	[W]	[°C]	[°C]	[°C]	[°C]	[°C]	[°C]	[°C]
30.0	0.350	30.1	67.50	32.7	—	—	—	—	—	—	—
Forward [V]	15.692	15.692	16.771								
P <sub>tot</sub> [mW]	5492.3	5492.3	12378.1								
P <sub>rad</sub> [mW]	1116.0	1116.0	2007.7								
WPE [%]	20.3	20.3	15.2								
S <sub>ep</sub> [mW/°C]	-2.324	-2.324	-6.434								
η [lm]	329.9	329.9	357.1								
η [lm/W]	59.9	59.9	62.7								
φ [lm]	702.7	702.7	3106.6								
CCT [K]	7491.0	7491.0	8096.1								
x	0.3008	0.3008	0.2948								
y	0.3015	0.3015	0.2875								

TeraLED



# FloEFD – CAD embedded CFD (CATIA, NX, Creo, SE, SW)

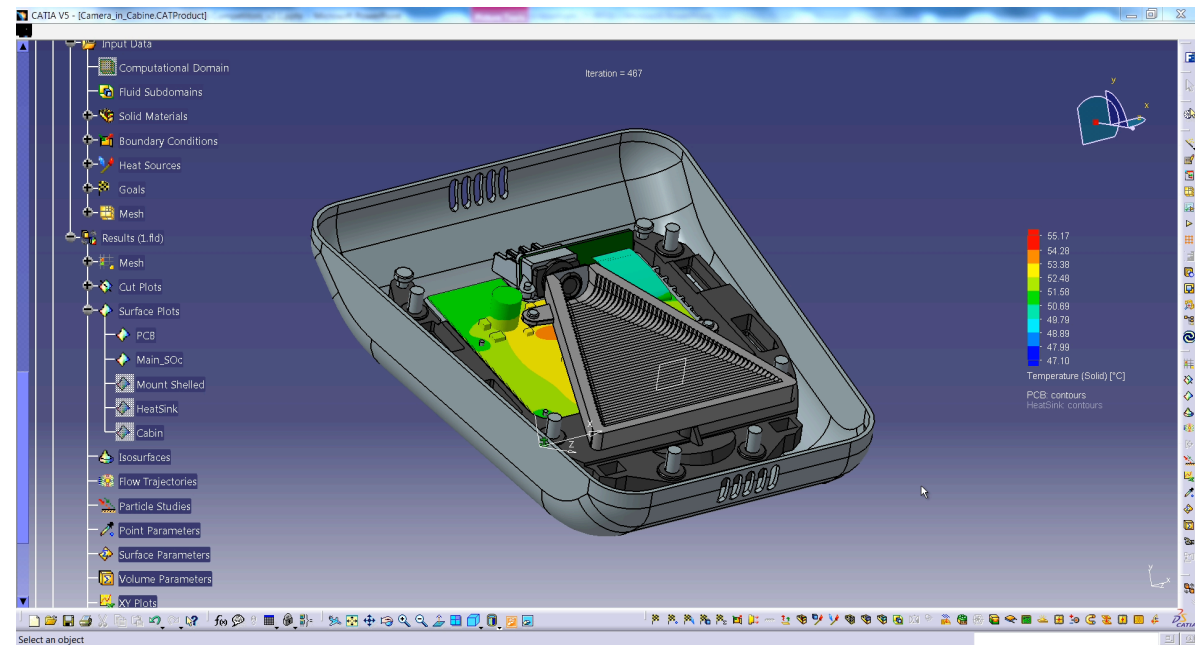
## Easy to use at early design stages by design engineers

**SIEMENS**  
*Ingenuity for life*

**Mentor Graphics & NX CAD**  
Circuit Board Development, Solid Model, Thermal Analysis

**SIEMENS**  
*Ingenuity for life*

- PCB can be imported with different level of details, including explicit resolution of copper tracers and vias meaning that EDA data is imported into NX as solid geometry.



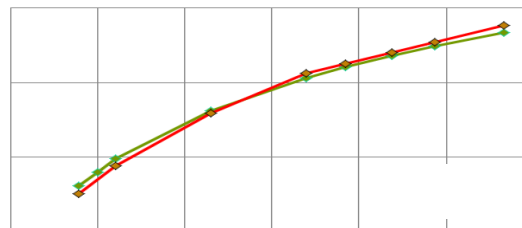


# FloEFD – Unique SmartCell™ Technology

Traditional CFD solver is powered by analytical and empirical models for high productivity without sacrificing the accuracy



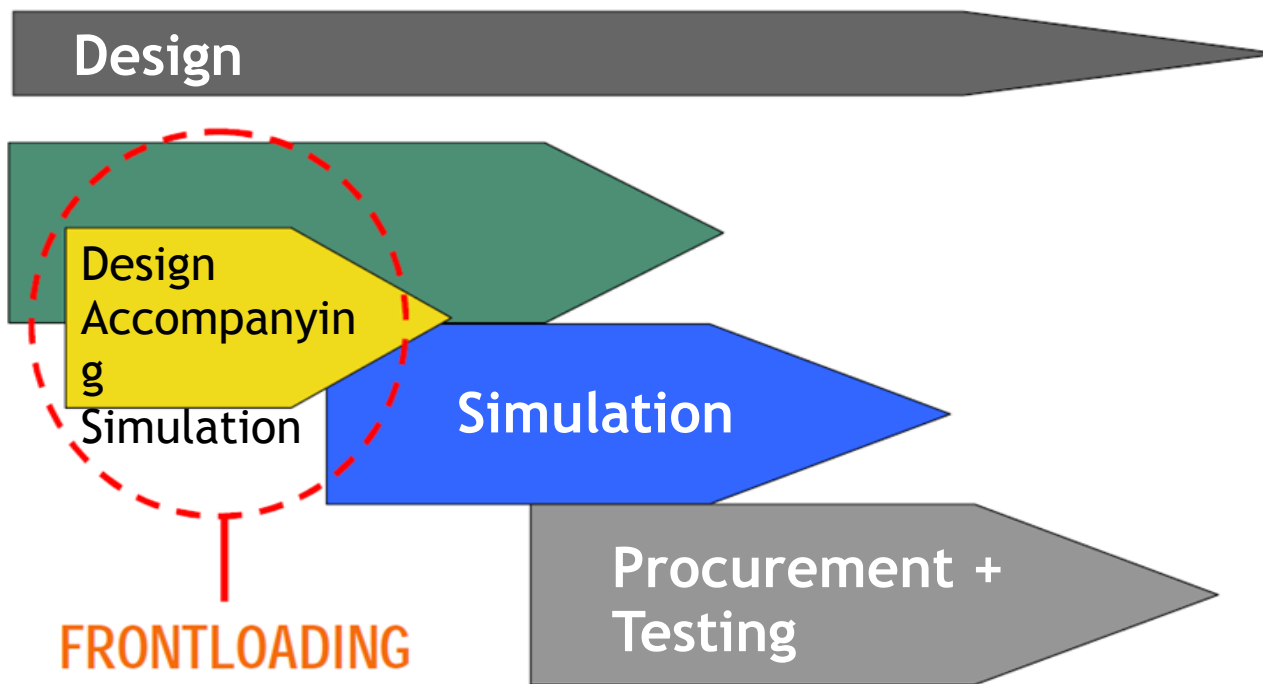
	User Time			Solver	Results Processing	Total
	Model Preparation	Mesh Settings and Generation	Project definition			
FloEFD	2.5	1	1	2	1	7.5
CFD	8	31	1	4	1	45



CFD vs FloEFD <1%

# FloEFD – Frontloading CFD

Enables simulation at earlier design stages by various user persona



**Recognizing** tendencies, evaluating comparison concepts and first concept designs early  
>> **increase of design quality**

In the following process, hardware and variant **iterations can be reduced**

>> **decrease development time and cost**

