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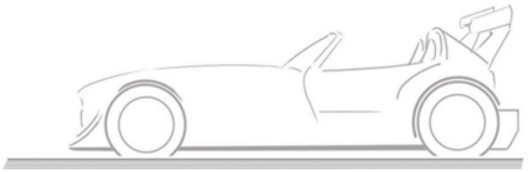
FORZE HYDROGEN RACING TEAM DELFT

Designing, Building and Testing a Race Car Fuel Cell System using LABVIEW



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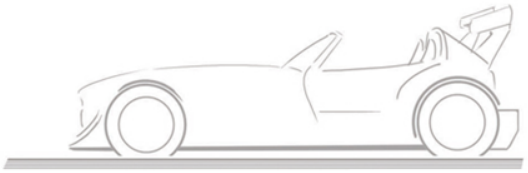
Content

- Introducing Forze Hydrogen Racing
- The Forze V
- Using Labview
- Future...



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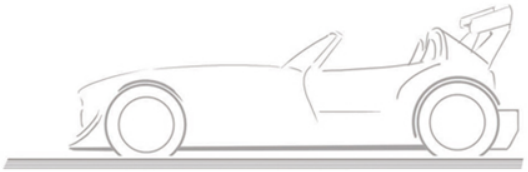

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Mobility Event
Bavaria City Racing
Formula Zero EU Championship
Tech Event
Formula Zero Race, Torino

2009

AutoRAI Amsterdam
Formula Student Silverstone 2011
World Record attempt The Hague
Green Aruba II
Bavaria City Racing Rotterdam

2011

To be determined:

Nürburgring H_2 record
CCRC competition (DNRT)
Dutch Supercar Challenge

2013

2008

JEC Composites Event Paris
HET Instrument
Formula Zero Rotterdam GP

2010

Challenge Bibendum Rio de Janeiro
Formula Zero GP, The Hague
Lowlands
Aruba goes Green
Electronica Germany

2012

Formula Student Silverstone 2012
Rotterdam City Racing
Electric Supercar Stadsrally
Zwickau Meets Friends
Energy Fair Den Haag
Electronica Munich

Forze V specs:

- 18 kW Fuel Cell
- 60 kW (85 hp) Peak Motor Power
- 315 kg
- 200 kJ Energy Buffer
- 28 L, 350 bar H_2 tank

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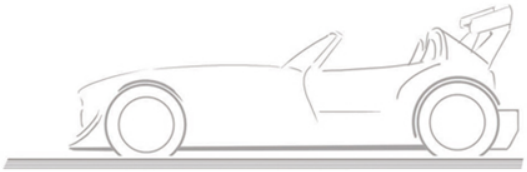
Performance:

- 0-100 km/h in less than 5 seconds
- Top speed: 120 km/h
- 1 hour of racing on a full tank (600g of H_2)



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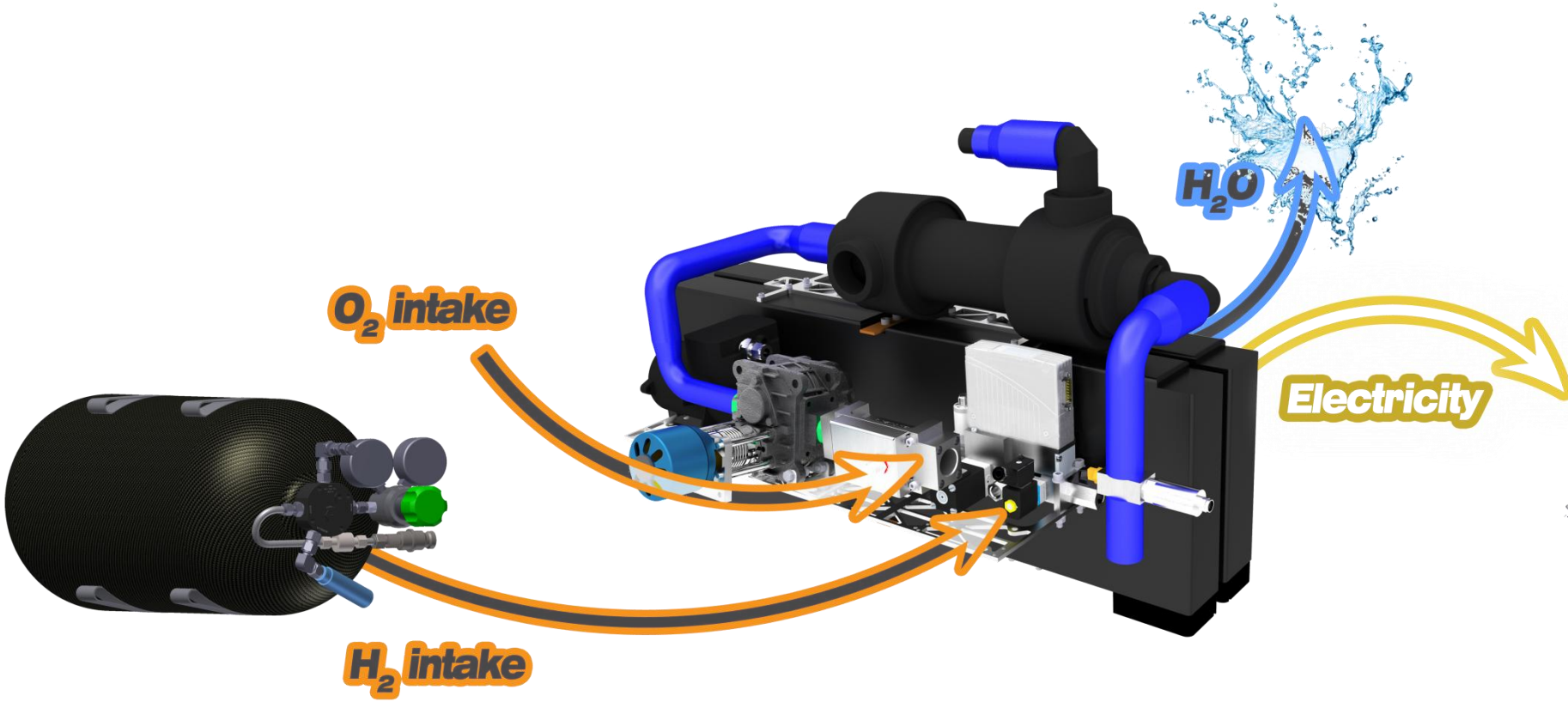

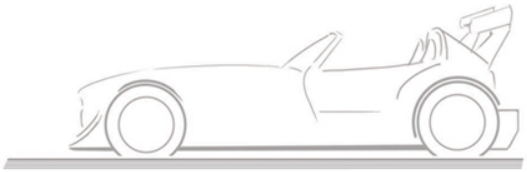

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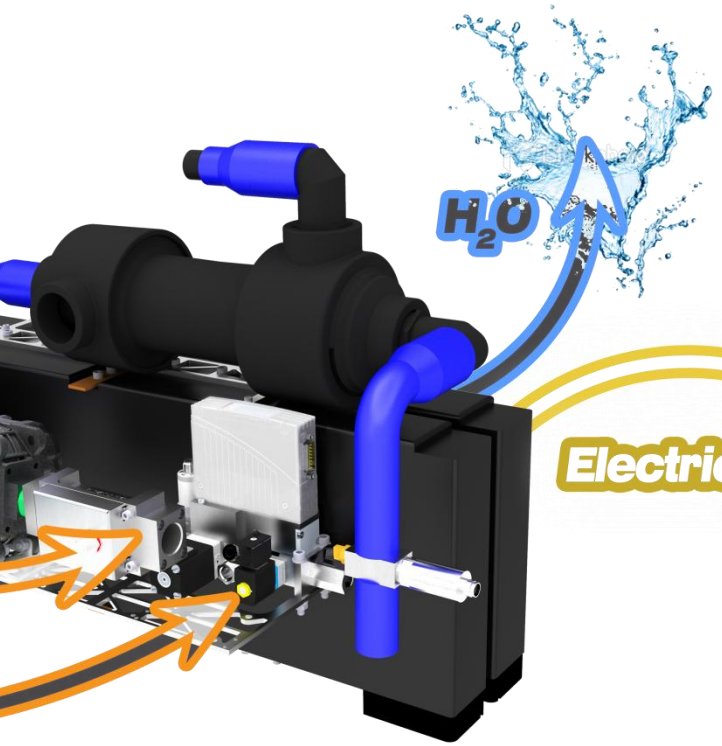
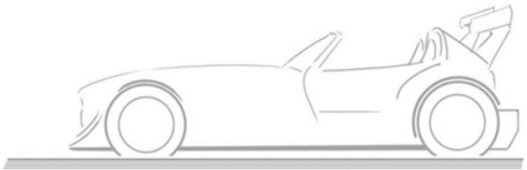


Electricity

Converting

Mec

Re



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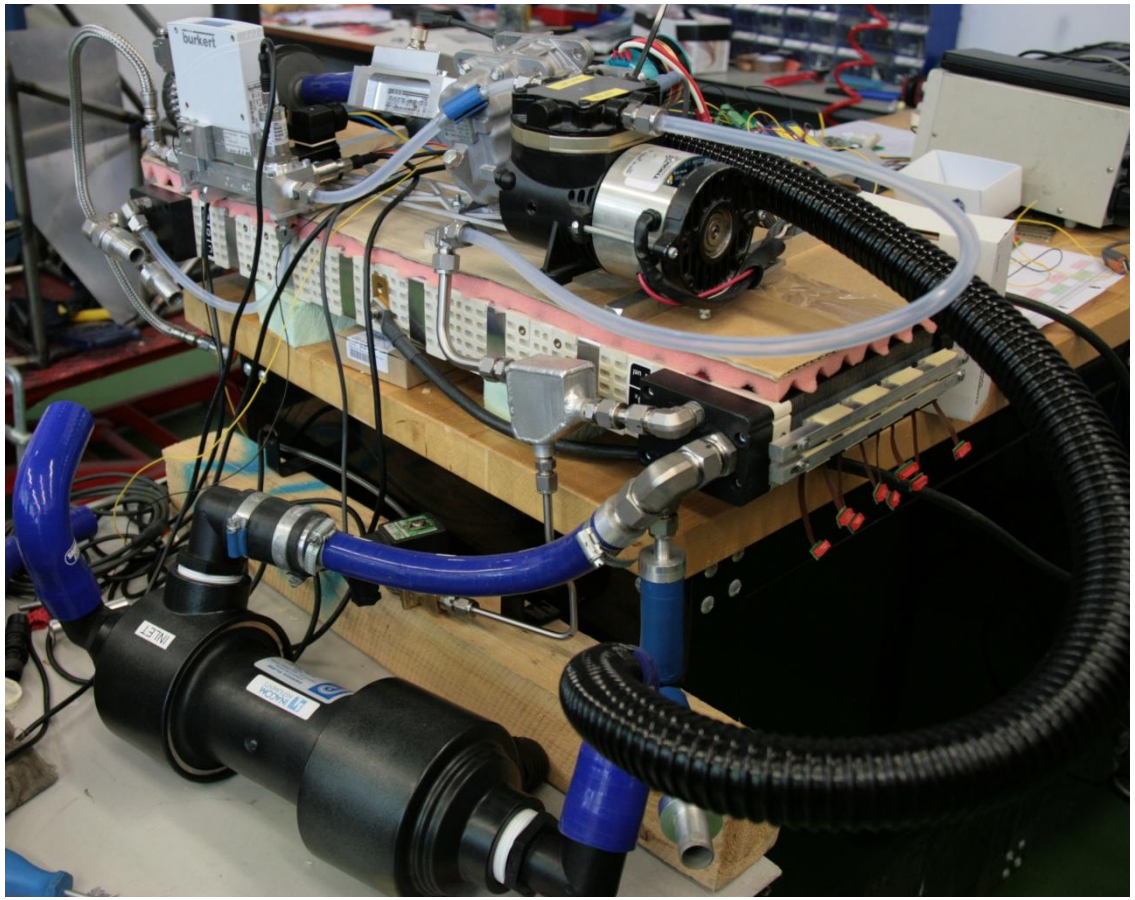
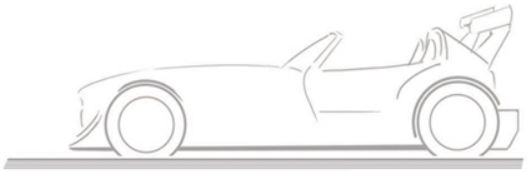
How to test a fuel cell

- Controll air and H2 input
- Controll temperature
  → Cooling
- Controll output power
  → Dissipate produced power





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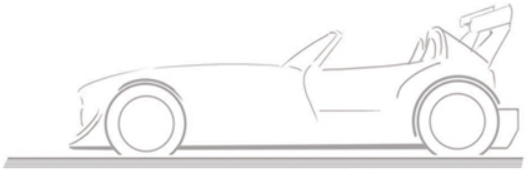
How we used Labview:

- Test setup
- Controlling air and H_2 inlet
- Monitoring the system:
  - Temperature
  - Pressure
  - Flows
- Ensure safe operation
- Taking care of start-up and shutdown sequence



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PID gains prop valve
proportional gain (Kc) 0,500
integral time (Ti, min) 0,010
derivative time (Td, min) 0,000
Activate Prop Valve PID
Prop Valve PID output
0,00
Reset Prop Valve PID
Prop Valve PWM
0 0,5 1 1,5 2 2,5 3 3,5 4 4,5 5
Recirculation pump
0 0,5 1 1,5 2 2,5 3 3,5 4 4,5 5
Air Pump Motor Speed PWM
0,051 0,055 0,06 0,065 0,071
CoolPumpRPM
800 1500 2000 2500 3000 3500 4000 4600
Purge Valve Duty Cycle
0 0,5 1 1,5 2 2,5 3 3,5 4 4,5 5
Load Power
0
0 2000 4000 6000 8000 10000 13000
PID gains pump motor
proportional gain (Kc) 0,006
integral time (Ti, min) 0,005
derivative time (Td, min) 0,000
Activate Pump Motor PID
Pump Motor PID Output
0,00
Reset Pump Motor PID
Purge Valve
0
Purge Valve
Stoich
0
Average cell voltage
0
high error
cell number
0
cell offset in mV
0
Recirculation Ctrl
Disable waterpump
CoolPumpCtrl ON
Shutdown
Start Fuelcell
Current + ON
Current + Offset
0
Required Voltage
0
Current Setpoint
0 50 100 150 200 250 300
Pressure Difference
0 0,05 0,1 0,15 0,2 0,25 0,3
CoolPumpInd ON
Startup complete
FC In Run Mode
Air pump PID
Prop Valve PID
Shutdown complete
Temperature > 75 C
LPB H2 Pressuree > 1.5 Barg
Differential Pressure < 0 Bar
Air Pressure > 1.5 Barg
Coolant Pressure > 1 Barg
Average Cell Voltage > 0.85 Volt
Differential Pressure > 0.5 Bar
Load Voltage
0,00
Volt
70 60 50 40 30 20 10 0
0
10427
Time
Load Current
0,00
Amps
300 250 200 150 100 50 0
0
11294
Time

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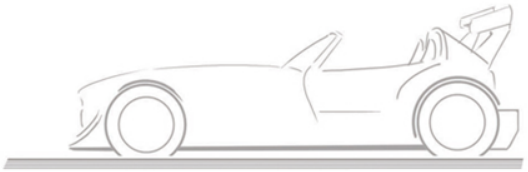
Benefits of Labview and CompactDAQ

- Easy to use, even for non-programmers
- Step by step expansion and testing of system
- Hardware (CompactDAQ) and software (Labview) one package
- System control from a single device (laptop)
- Control can be written before electronics are ready



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