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towards green RPCs and MRPCs ...

detector **R&D projects**
thought on the basis of
key aspects
(not only structural)



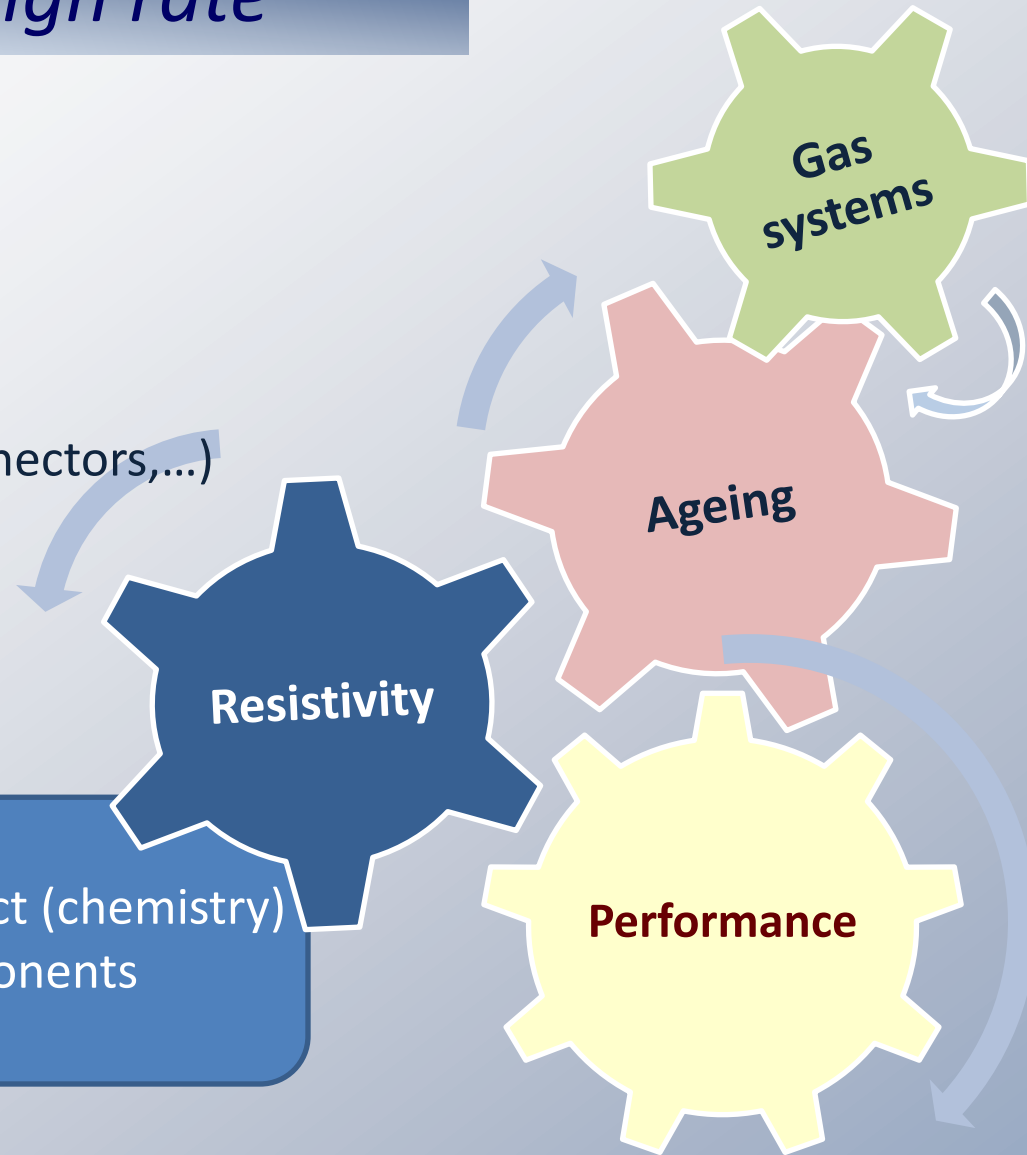
Detectors operating at high rate

Main constraints @LHC

- Layout already fixed (gas target)
- Electronics defined (q threshold)
- Power system (HV_{\max} limited, connectors,...)
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Focus on R&D

- integrated current, resistivity drift
- unknown gas-induced ageing effect (chemistry)
- characterization of new gas components
-



Detectors operating at high rate

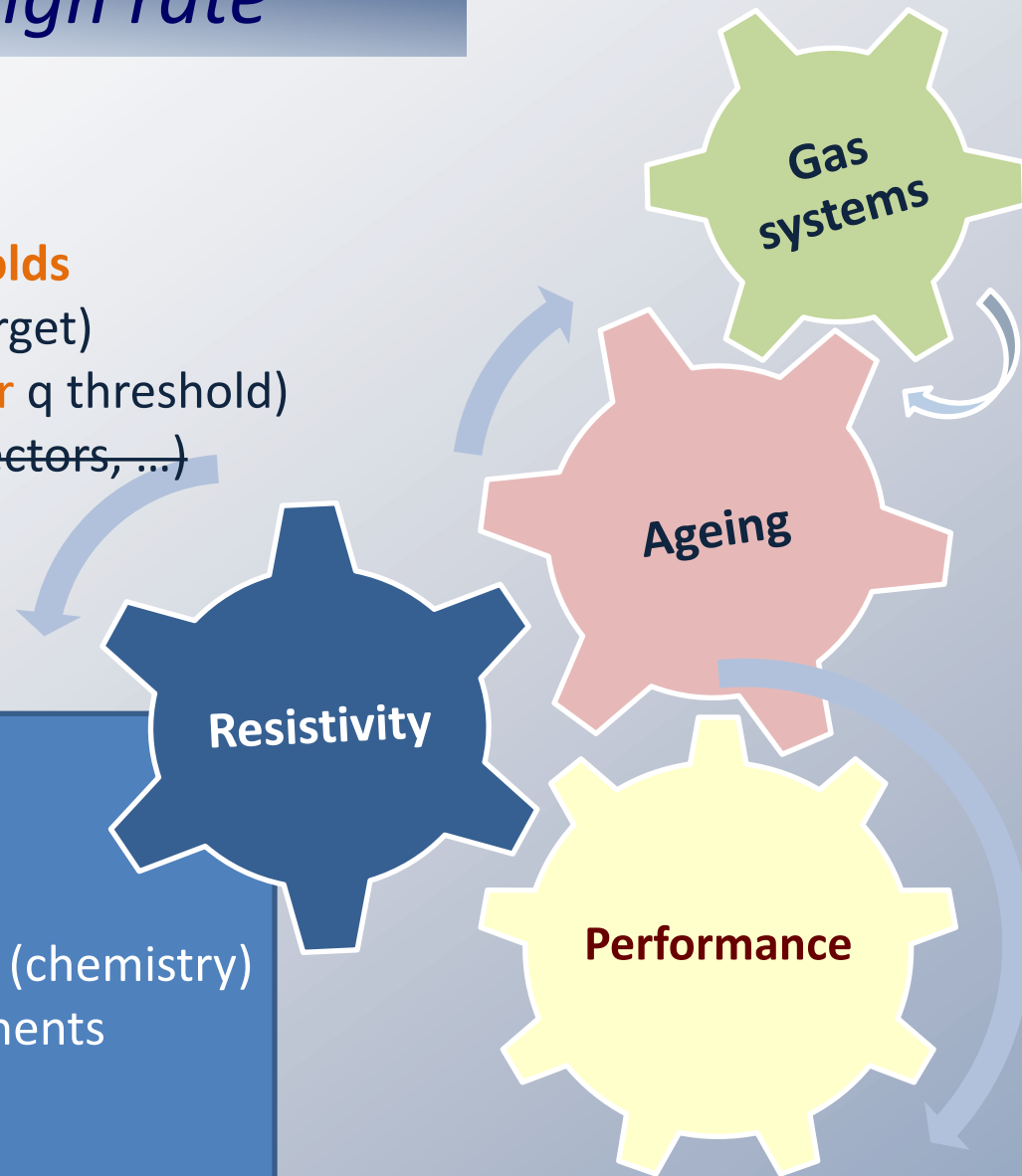
Main constraints @LHC Upgrades

towards reduced gas gaps and thresholds

- Layout already fixed (thinner gas target)
- Electronics defined improved (lower q threshold)
- Power system (Hv_{\max} limited, connectors, ...)
-

Focus on R&D

- heavier gaseous target
- working current, rate capability
- integrated current, resistivity drift
- unknown gas-induced ageing effect (chemistry)
- characterization of new gas components
- closed loop/gas disposal
-



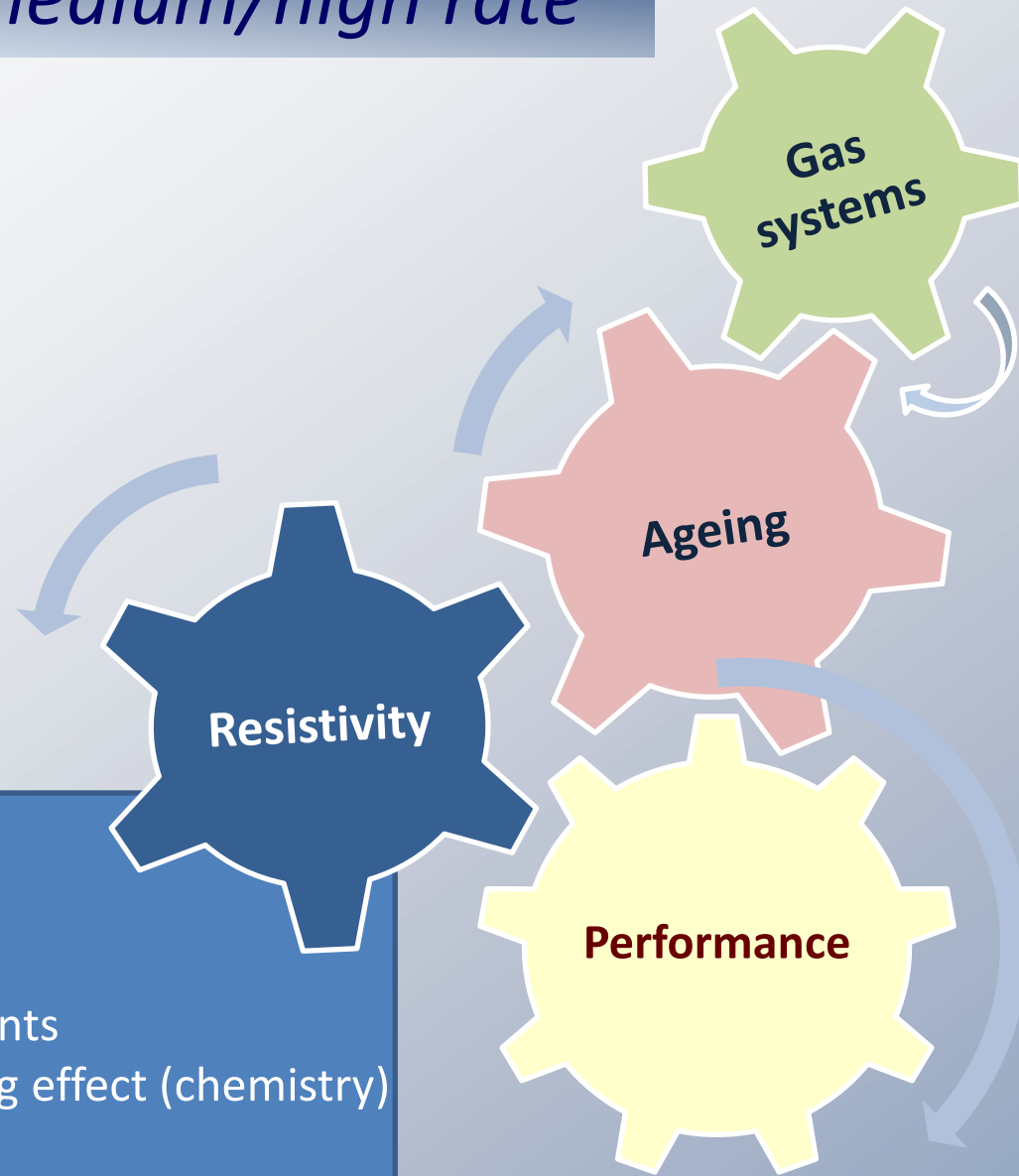
Detectors operating at medium/high rate

Main features @Future Colliders

- no constraints (blue sky)
- high rate (lower q /electrodes)
 - thinner gap/electrodes
 - improved electronics
 - new materials
- excellent time resolution
 - thinner gap

Focus on R&D

- heavier gaseous target
- working current, rate capability
- integrated current, resistivity drift
- characterization of new gas components
- unknown gas/material-induced ageing effect (chemistry)
- closed loop/gas disposal
-



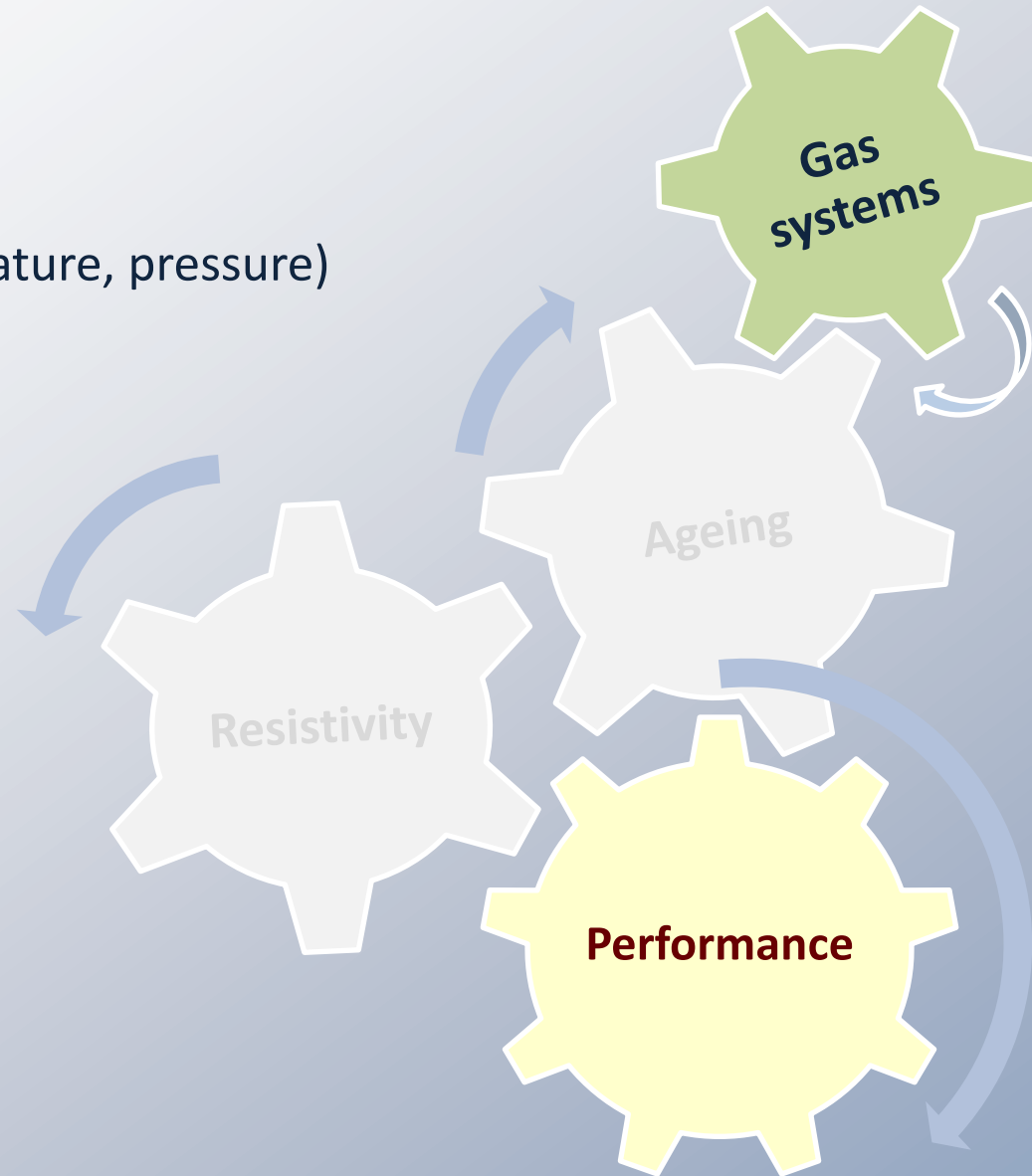
Detectors operating at low rate

Main constraints

- environmental constraints (temperature, pressure)
- safety (EEE)
- costs
-

Focus on R&D

- binary gas mixture (EEE)
- heavy gaseous target (altitude)
- sealed detectors
- closed loop/gas disposal
-



Where we are

Gas systems

R&D for low/medium/high rate

Gas Recirculation

[CERN, Rome ToV, ...]

- complex apparatus (also “lab size”)
 - high reliability in terms of stability and quality of the delivered gas mixture required
- today: 90% in average for long term operations*

R&D for low/medium/high rate

Gas Recuperation

[CERN (CF_4 , C_4F_{10} , R134a), ...]

- different complex techniques (mix-dependent)
 - high reliability in terms of quality of the recuperated gas required
- today: up to 80%(from exhaust, fill/empty oper.)*

R&D for low/medium/high rate

Gas Disposal

[external companies]

- complex apparatus
 - extremely expensive
- today: not foreseen*

Possible replacement of R134a/CF4 → HFO1234ze

HFO1234ze:

To be used with other gases to reduce working point

Warning on F- production

Warning on life time in atmosphere

Helium:

Not always possible in
Complex apparatus (PMT)

See results on RPCs from
CERN, ATLAS, CMS, EEE

CO₂:

Adding CO₂ increase the
current (x2, x3)

See results on RPCs from
CERN, CMS, ATLAS, LHCb/Ship, ALICE, EEE

**Aging due to
chemistry and current
under study**



Under study by
ECOGAS@GIF++ Collaboration
and AidaInnova program

Are there any other alternatives?

Possible replacement of SF6

3M™ Novec™ 5110 (CF ₃ C(O)CF(CF ₃) ₂) GWP <1	3M™ Novec™ 4710 ((CF ₃) ₂ CFCN) GWP 2100
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See results on RPCs from CERN

CF₃I:
Good performance
but toxic

See results on RPCs
from CMS and CERN

C₃H₂ClF₃:
Good performance

See results on RPCs from
ATLAS

**Aging due to
chemistry and current
to be studied**

Possible reduction of R134a

Lower percentage of R134a and addition of CO₂

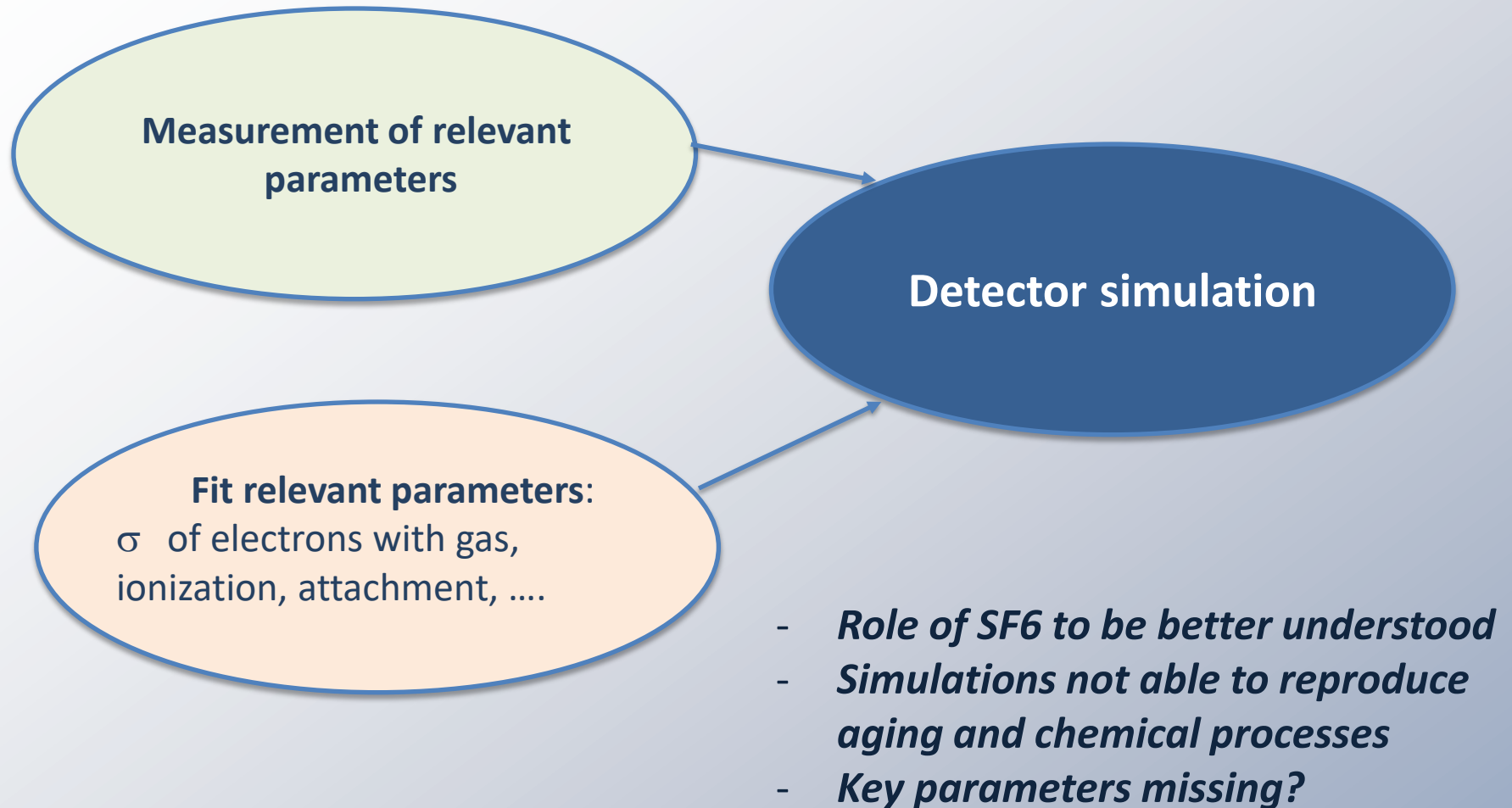
See results on RPCs from CERN

Less exotic gases

Aging due to current
to be studied

Not fully ecological
R134a still present
SF₆ doubled

Simulations



Let's start our open discussion