gd 2014

Rapport de D. Hong au nom du LOC

Partie 1 : des données sur la conférence

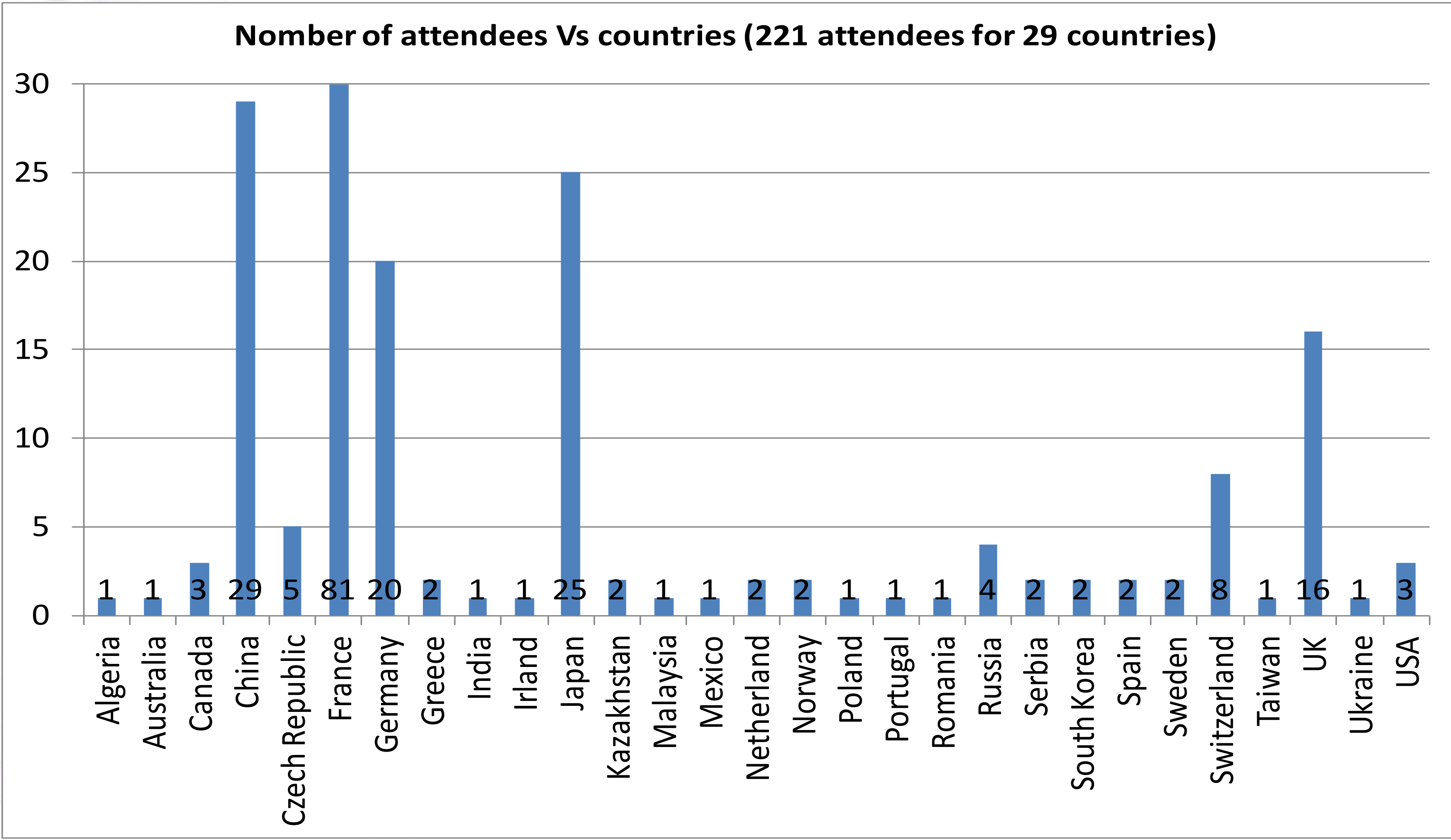
Partie 2 : articles sélectionnés dans les Topics B-M

20th International Conference on Gas Discharges and their Applications

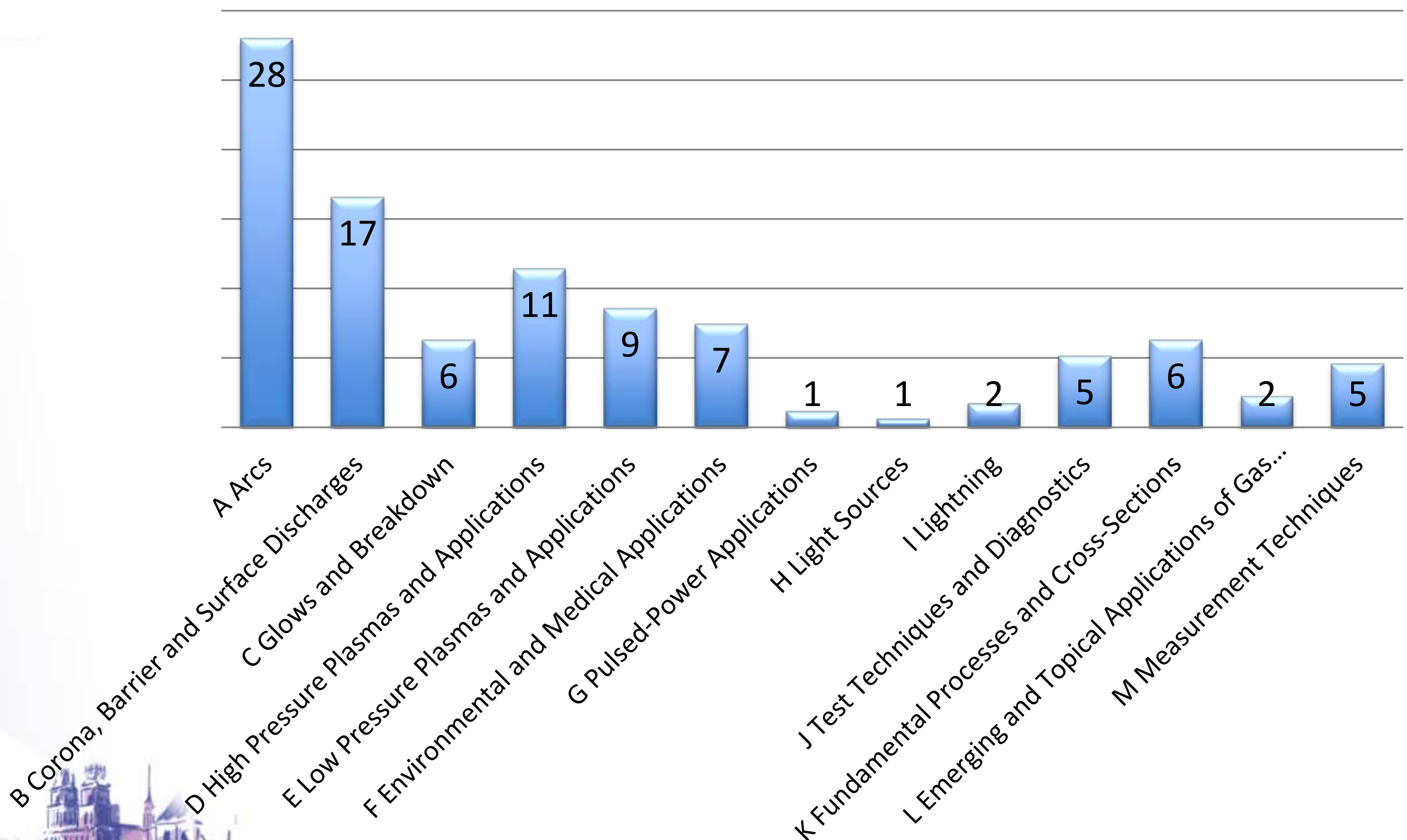
6 au 11 juillet 2014 à Orléans

Une forte implication de l'AAE :

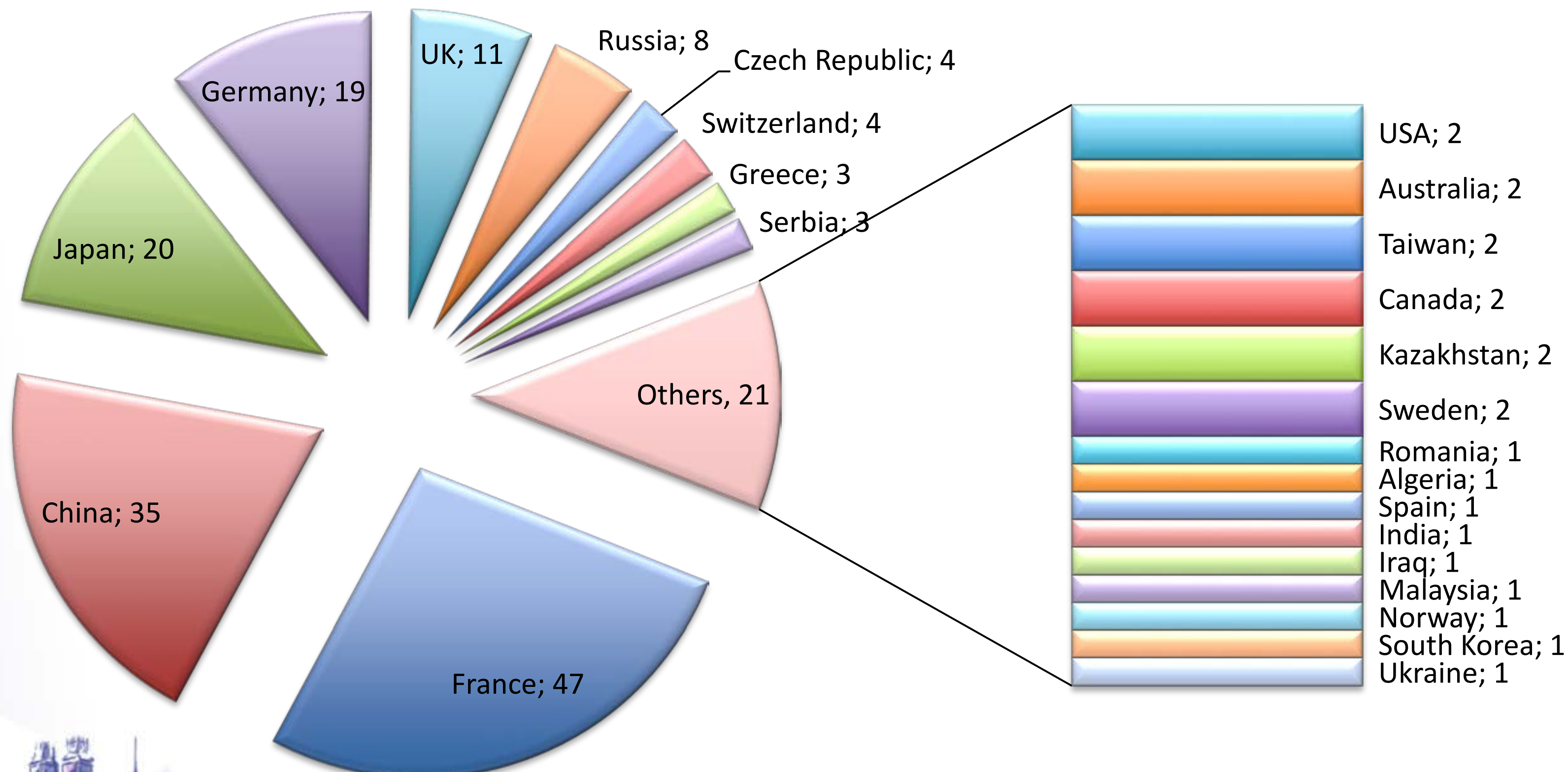
- ➢Organisateur GREMI, membre de l'AAE
- ➢Membre du comité « Executive Management Committee » : Alain
- ➢Membres du comité « International Scientific Committee » : Alain, Jean-Marc, Philippe et Dunpin
- ➢Participation des membres : Alstom, Schneider, Onera, Laplace, Laept, Spcts et GREMI
- ➢Animation d'un workshop (table-ronde): Yann (WS1), Philippe (WS3 avec Seeger)
- ➢Session chairs : Alain, Philippe, Pierre, Jean-François
- ➢Sponsoring : AAE (1250€TTC) et Alstom (1200€HT)


Nomber of attendees Vs countries (221 attendees for 29 countries)
30
25
20
15
10
5
0
1
1
3
29
5
81
20
2
1
1
25
2
1
1
2
2
1
1
1
4
2
2
2
2
8
1
16
1
3
Algeria
Australia
Canada
China
Czech Republic
France
Germany
Greece
India
Irland
Japan
Kazakhstan
Malaysia
Mexico
Netherland
Norway
Poland
Portugal
Romania
Russia
Serbia
South Korea
Spain
Sweden
Switzerland
Taiwan
UK
Ukraine
USA

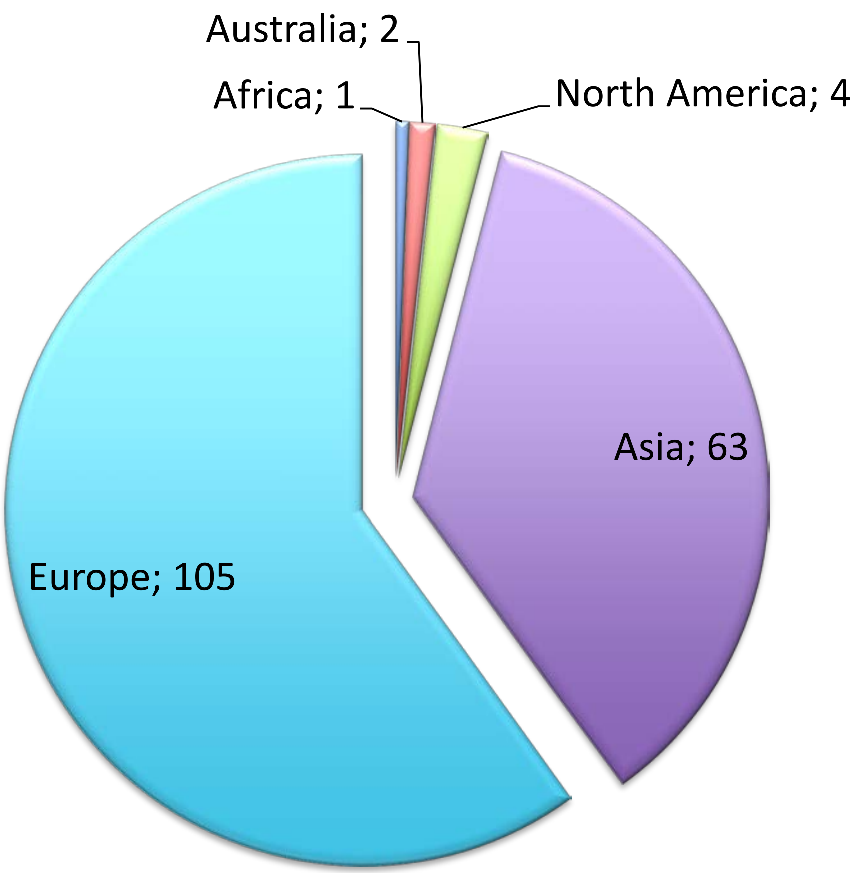
Number of papers Vs Topic (in percentage, 175 proceedings)



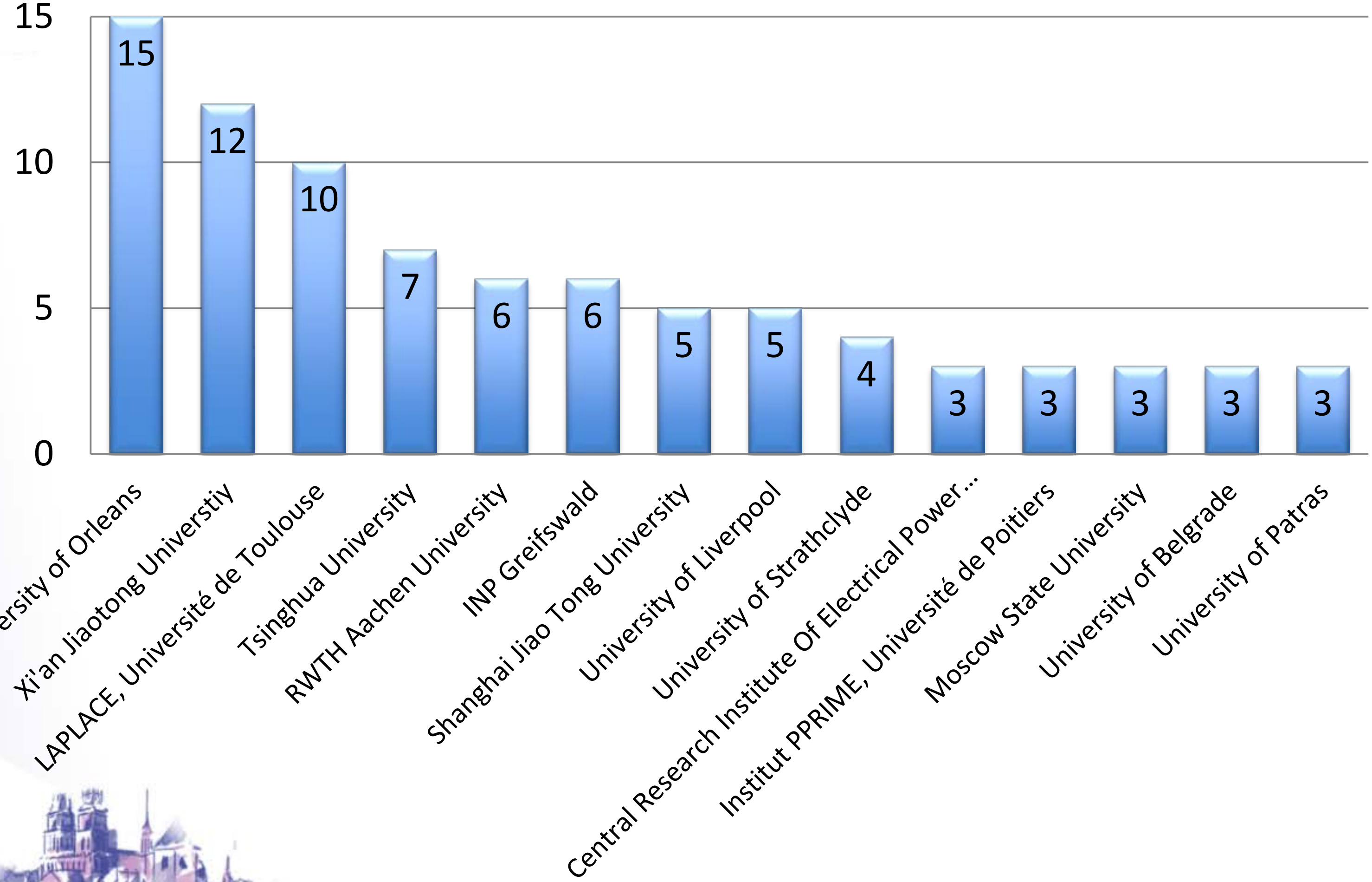
Number of papers Vs country (1st author's institution, , 175 proceedings)



Number of papers Vs continent (1st author's institution, 175 proceedings)



Number of papers (≥3) Vs Institution (for 1st author)



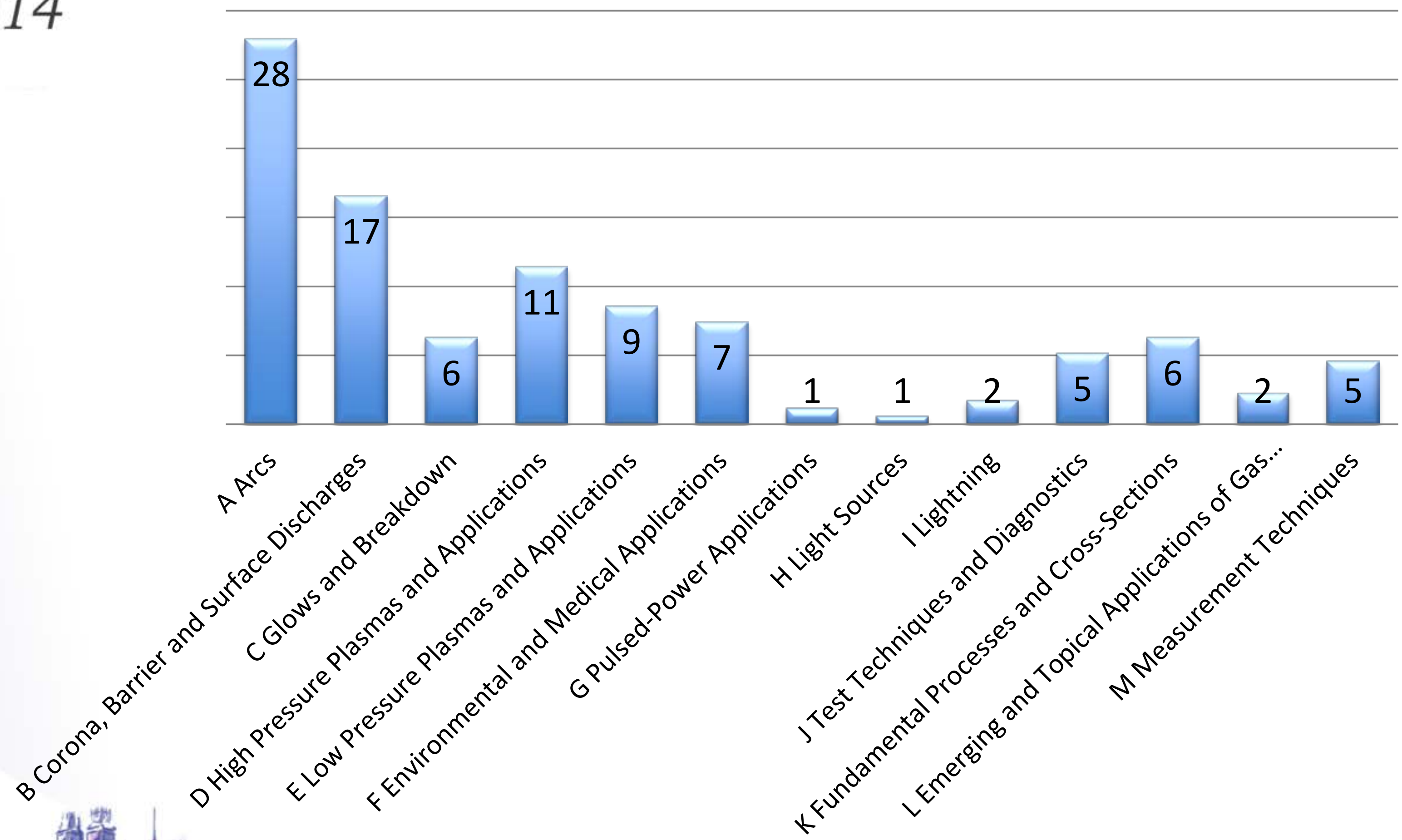
Partie 2

Articles sélectionnés

Topics B-M

2014

Number of papers Vs Topic (in percentage, 175 proceedings)



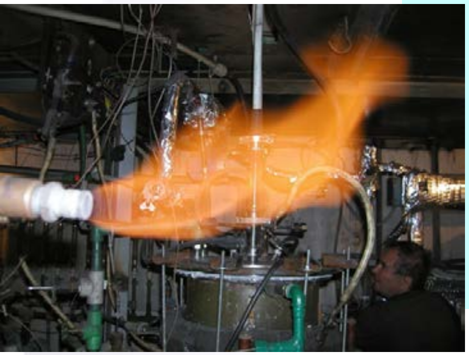
Topics B → M : 12 papers related to arc are selected.

Topic D: High Pressure Plasmas and Applications

D8: HIGH PRESSURE GAS DISCHARGE DEVICES APPLICATION FOR FUEL PROCESSING

V. Messerle, A. Ustimenko, O. Lavrichshev, E. Ossadchaya

Combustion problems Institute, Research Institute of Experimental and Theoretical Physics, Almaty, Kazakhstan



Traitement par plasma thermique de combustibles gazeux et solides.

Mots clés : Pyrolyse par plasma, gazéification, craquage d'hydrocarbures, etc.

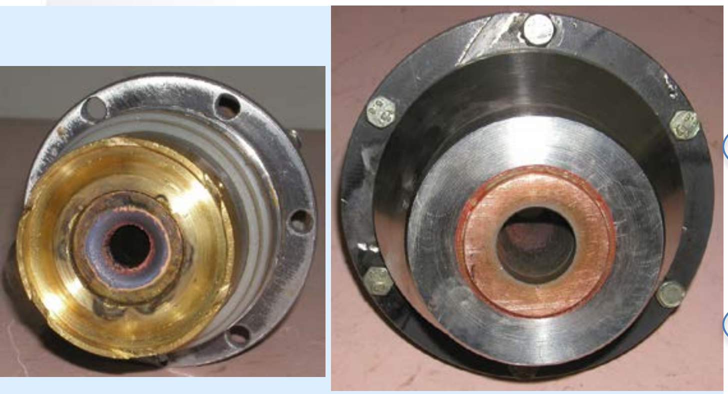
CONCLUSION

The optimal ranges of recommended process parameters for plasmochemical processing of fuel

Fuel / plasma forming gas	*T, K*	*Specific power consumption, kW·h/kg of fuel*	*Fuel conversion rate, %*	*Concentration mg/Nm³*	
				NO_x	*SO_x*
1. Plasmochemical preparation of coal for combustion (air)					
1.5–2.5	800–1200	0.05–0.40	15–30	1–10	1–2
2. Complex processing of coal (water steam)					
1.3–2.75	2200–3100	2–4	90–100	1–2	1
3. Plasma gasification of coal (water steam)					
2.0–2.5	1600–2000	0.5–1.5	90–100	10–20	1–10
4. Radiant-plasma processing of coal (air)					
1.5–2.5	800–1200	0.1–0.45	22–45	1–10	1–2
5. Plasma processing of uranium-bearing solid fuels (water steam)					
8-12	2500-3150	2–4	55-70	1-3	1-2
6. Plasmochemical hydrogenation of coal (hydrogen)					
10	2800–3200	6.5–8	70–100	0	0
7. Plasmochemical cracking of a propane-butane mixture					
18 м³/ч	1500–2500	2.2–3.8	98–100	0	0

D9 : HIGH PRESSURE PLASMA TORCH

V.E. Messerle, A.B. Ustimenko, V.Zh. Ushanov



Anode and cathode parts of the 100 kW plasma torch

✓ Long-life DC arc plasmatron up to 200 kW of adjustable power was developed and tested in laboratory and industrial conditions.

✓ Life length of the cathode totals more than 900 hours (*normalement, durée de vie <500h*). The experiments confirmed principal possibility for unlimited long-life of the cathode filmed with carbon nanostructural material (*grâce à la présence du gaz d'hydrocarbures*).

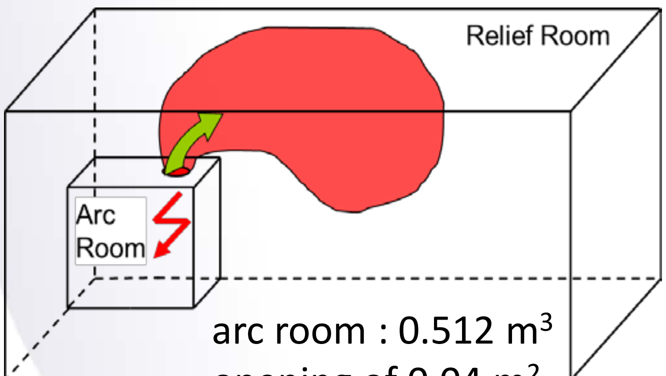
✓On the base of atomic microscopy, SEM, TEM and the Raman-spectroscopy investigation, it can be concluded that the cathode condensate is a composite carbonic stuff made of carbon nano-clusters which consists mainly of single and multi-walled carbon nanotubes and other carbonic forms including some quantity of the copper atoms intercalated to the carbonic matrix.

✓ In the regimes with overflow of propane/butane the soot contained 10 % of composite material in the form of nanotubes was received.

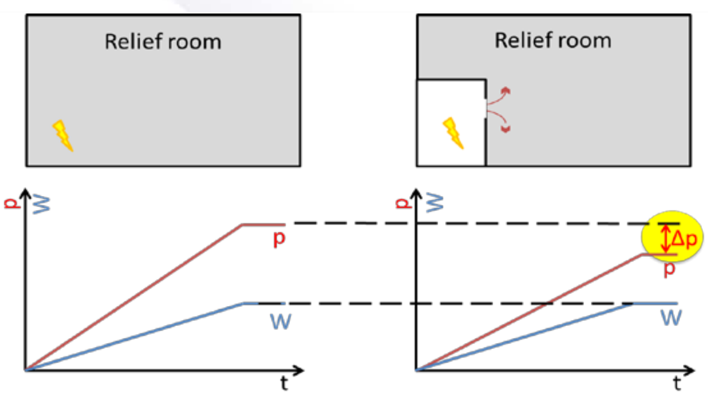
D10 : Influence of Arc Energy Absorbers on the Enclosure Effect in Case of Internal Arcing in Electrical Installations

S. WETZELER[1]*, K. ANANTAVANICH[2] AND G. J. PIETSCH[1]

[1] Institute for High Voltage Technology, RWTH Aachen University, 52056 Aachen, Germany
[2] Transmission System Engineering Division, Electricity Generating Authority of Thailand, Nonthaburi 11130, Thailand



arc room : 0.512 m^3
opening of 0.04 m^2,
relief room : 27 m^3.



- Arc energy absorbers are a means to reduce overpressure due to internal arcing in relief rooms by heat absorption.
- Absorbers reduce the effective size of the relief opening with the result of enhanced thermal energy input in the arc volume. By this the heat absorption effect in the relief room is less pronounced or even overcompensated due to the enclosure effect.

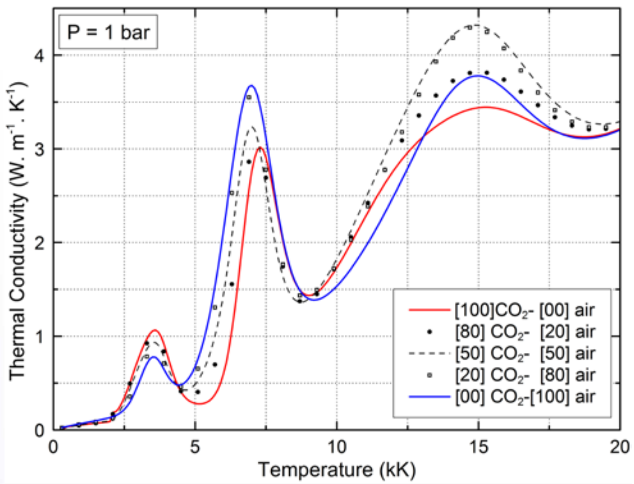
→ A proper choice of the effective absorber size is necessary. This can be realized by either enlarging the relief opening or enlarging the size of the absorber (in a distance of the opening).

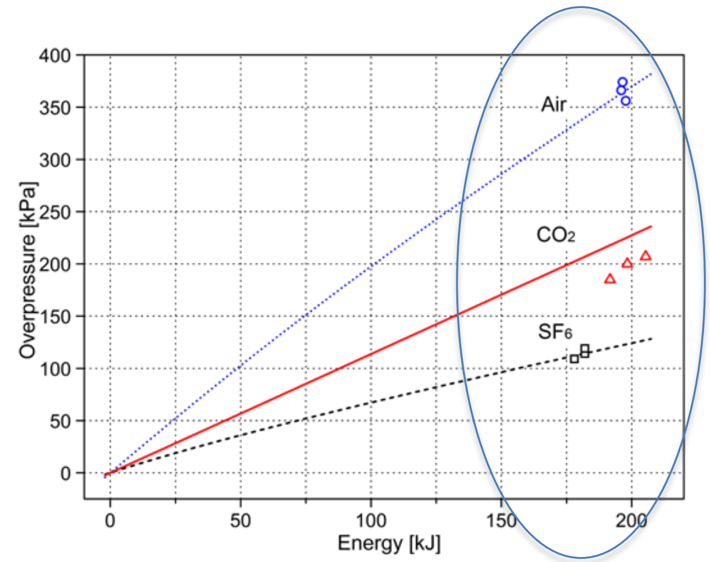
D11: Influence of Insulating Gas on Pressure Rise in Electrical Installations due to Internal Arcs

S. WETZELER[1], Y. CRESSAULT[2], G. J. PIETSCH[1*]

[1] Institute for High Voltage Technology, RWTH Aachen University, 52056, Aachen, Germany

[2] Laplace, Université de Toulouse 3, 31062 Toulouse, France



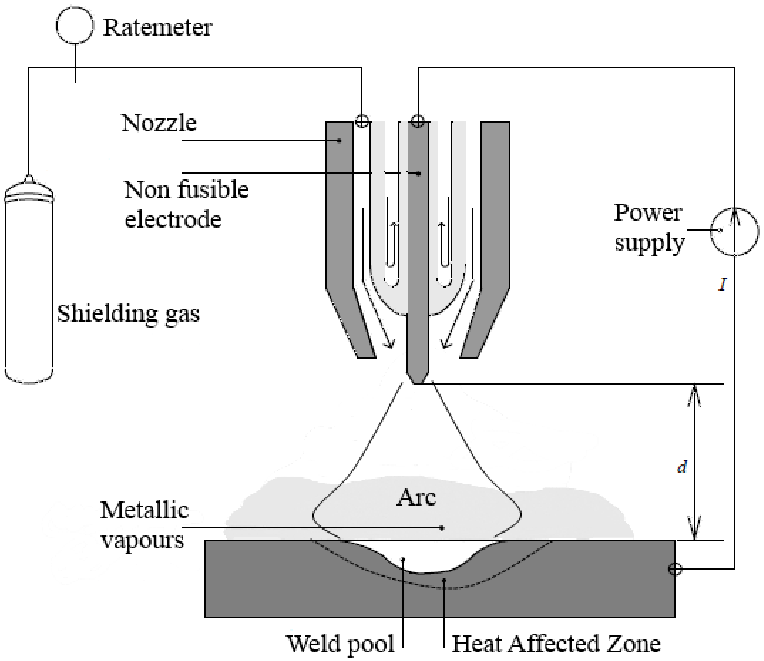


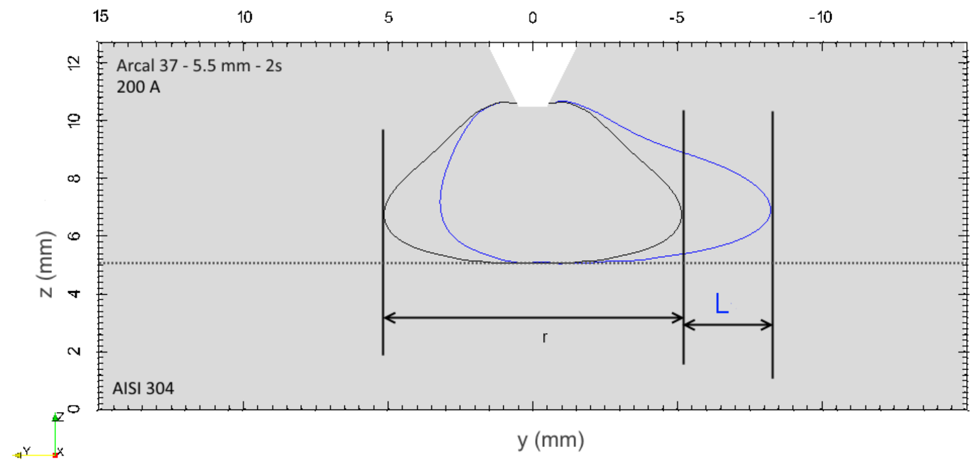
- Replacing SF_6 by CO_2 the switchgear design has to be re-considered with respect to internal arcing
  - Especially the pressure rise within the switchgear compartment: overpressure lowest in SF_6 and highest in air → CO_2 in between

- For reliable pressure calculations in CO_2 insulated switchgear the input data are provided
  - Pressure and temperature dependent gas data of CO_2/air mixtures
  - Thermal transfer coefficient
  - Arc voltage

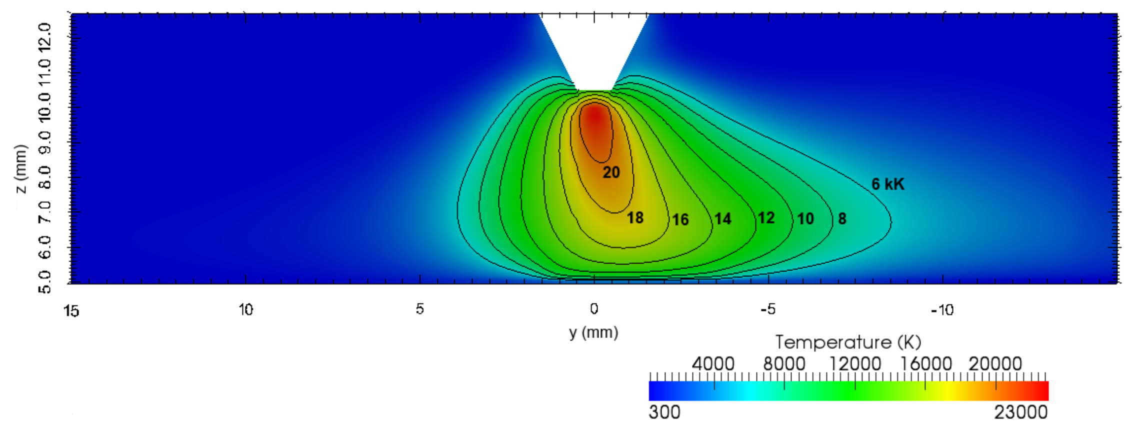
D12: Interaction model between an electrical arc and a material: welding TIG application

J Mougenot, J-J Gonzalez, P Freton and M Masquère





Effects on plasma



Development of a **3D** model of **coupling arc and material** in a TIG configuration taking into account the **movements** in the melted zone and the **presence of metallic vapours**

This code is applied for **arc blow deflection** due to mass clip position

Influence of **process parameters** on blow deflection

Investigate other kind of magnetic deflection

Include the torch movement and the cathode into the model

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D14:

Modeling Nozzle Geometry changes Due to the Ablation in High-Voltage Circuit Breakers

Sina Arabi[†], Jean-Yves Trépanier[†], Ricardo Camarero[†] and Assen Vassilev[‡]

[†]Ecole Polytechnique de Montreal and
[‡]ALSTOM Grid, ARC

To presents a new mathematical model to couple plasma flow simulation with erosion and movement of the PTFE walls in a HV circuit breaker chamber

1. *A transient model was used to study the erosion of a PTFE nozzle in a circuit breaker in a long-operation time,*
2. *The presented model includes all the relevant physics of the arcing flow*
3. *The two regions, gas and PTFE, are coupled at the surface by appropriate energy and mass balances*
4. *The radiated heat from the arc recessed the nozzle surface, widened the throat and consequently, raised the mass flux*
5. *Rising the nozzle mass flux, affects the performance of the whole system*
6. *This study has demonstrated its ability to simulate qualitatively and to some degree, quantitatively the ablation effect under operating conditions*

PLASMA-AIDED GASIFICATION OF BIOMASS STUDY OF A SELF-BLOWING GLIDARC

P. ESCOT BOCANEGRA*, J-M.CORMIER,

GREMI, PolyTech'Orléans, 14 rue d'Issoudun, BP 6744, 45067 Orléans Cedex 02, France

ABSTRACT

This paper talks about the plasma effect on different mixtures of oxygen and propane in a gas recirculation plasma reactor. In addition numerical results obtained from PFR simulation are used for discussion.. The plasma used in the reactor is made by three gliding atmospheric pressure arc discharges supplied independently by three direct current generators. The results show that the mixture composition influences the consumption of C_3H_8 and O_2 and the production of NO_x, CO and CO_2.

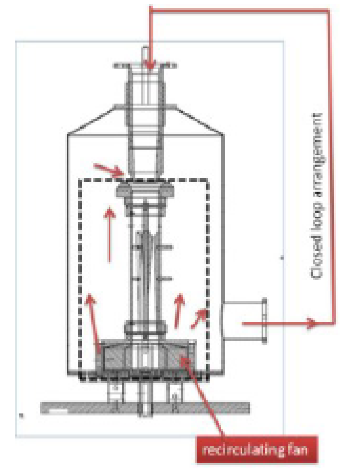


Fig. 1 Self blowing glidarc

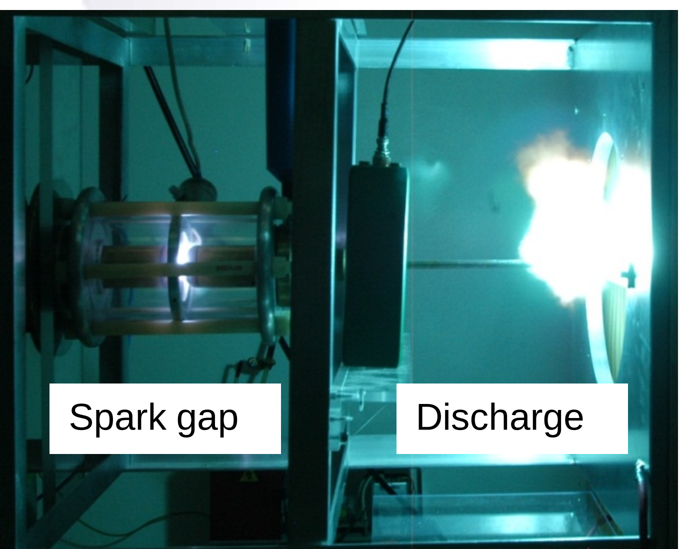
Fig. 2 Three gliding arc in plasma reactor

I3: Study of a high current arc used for direct lightning effect characterization

C. Zaepffel, R. Sousa Martins, L. Chemartin and Ph. Lalande

ONERA, Lightning and plasmas applications unit

- Designed of a test stand able to produced DBC* current waveform with 100 kA peak current
- Use of OES to evaluate T and P (LTE)
- Use of stereo correlation to measure mechanical deformation



Future works:

- Results on composite material (already successfully tested)
- Tomography to ascertain cylindrical assumption
- Database improvement (metallic species) and validation
- Coupling fast camera with the spectrometer
- Schlieren
- Another test stand delivering current A waveform (200 kA and more…)

J3: Electric spark discharge in air characterization using electrodes erosion

S.Bernard, P.Gillard (PRISME, univ of Orléans)
S.Pellerin, M.Wartel, M.Sankhe, D.G.Astanei (GREMI)

Outline

- Context : dust explosion hazards
- Experimental device: modified Hartmann tube (*generation of a dust cloud*)
- Ignition parameters determinations
  - Minimum Energy of Ignition
  - Ignition delay
- Optical Emission Spectroscopic diagnostic
  - Used methods
  - First integrated results
- Summary and Conclusion
  - N_e and T determinations
  - Spatially and temporally resolved diagnostics

- **Modified Hartmann tube to MIE (*Minimum Ignition Energy*) determination**

- **First diagnostic of the Spark, using eroded material**
  - Temperatures determination in three zones of the spark (*diagramme de Boltzmann, OH-Specair*)
  - Plasma that seems close to the equilibrium
  - Cooling effect of the metallic vapours close to the cathode
- **Next steps**
  - Determination on electron density, and plasma composition
  - Determination of the spatial temperature and electron density distributions, at least close to the cathode
  - Study of the temporal evolution of the plasma, and interaction with the dusts

J6: INVESTIGATIONS ON THE INTERACTION BETWEEN SWITCHING ARC AND QUENCHING GAS IN INSULATING NOZZLES BY OPTICAL MEASUREMENTS

Gregor Nikolic, Artur Mühlbeier, Dr. Patrick Stoller (ABB), Armin Schnettler

Institute for High Voltage Technology, RWTH Aachen University, 52056 Aachen, Germany

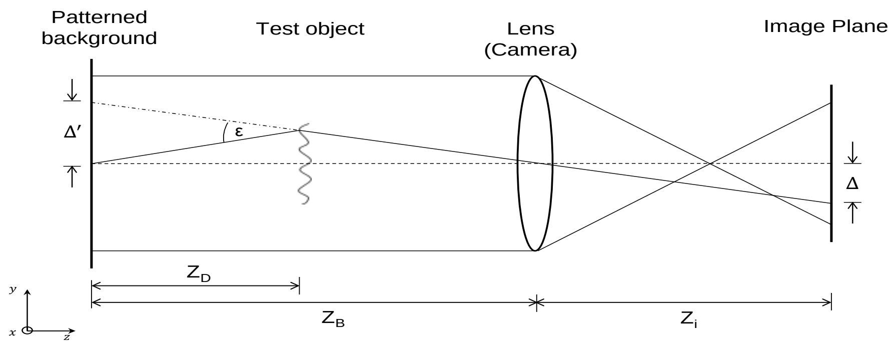
Optical Investigation Methods

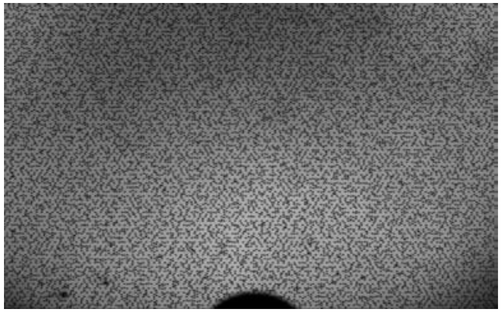
Background Oriented Schlieren (BOS)

- Simplified arrangement, only camera and patterned background
- Determination of the deflection angle from the shift of the background pattern between reference recording without test object and recording with test object

$$\varepsilon = \frac{\Delta \cdot Z_B}{Z_D \cdot f} = \frac{\Delta'}{Z_D} \sim grad(n)$$ (f = focal length)

- Camera focuses on the background pattern
- Reconstruction of the refractive index field by filtered back projection



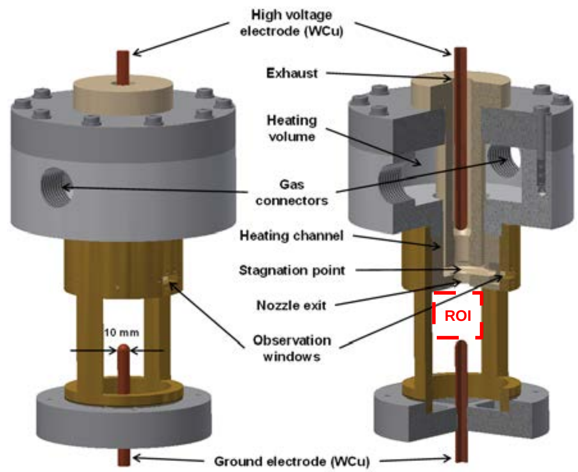


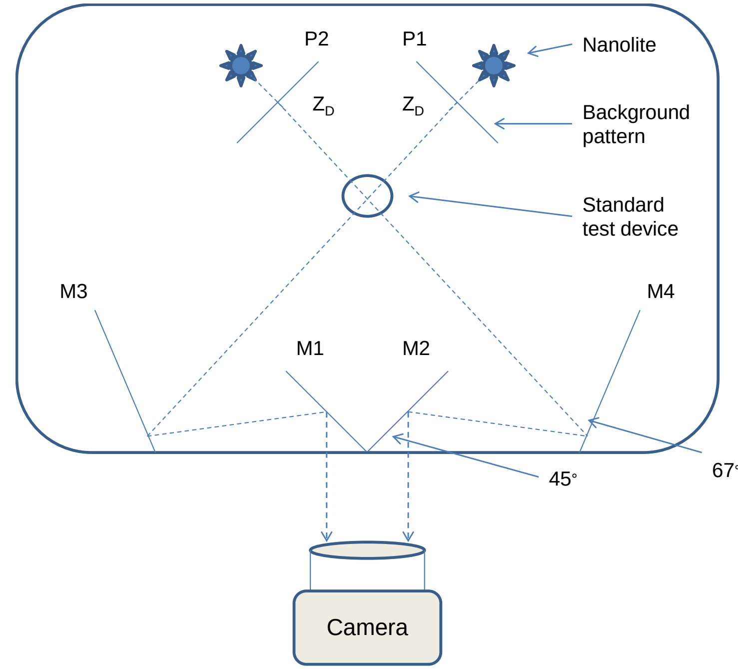
Experimental Setup

Circuit Breaker Model and Parameters

- Experiments in a synthetic test circuit with I_{peak} = 3.5 kA at f = 50 Hz
- Blow gas pressure of Δp = 0.7 MPa in the mixing volume

- Optical measurements using a PCO SensiCam 370 LF
- Exposure time t_{exp} = 200 ns
- Light source NANOLITE spark lamp with nanosecond flash duration
- Rotating blind shutter for reducing the light intensity from the arc during the high current phase





Summary and Outlook

- BOS method applicable for density measurements from one and two viewing directions
- Identification of a characteristic upstream shift of the Mach disc before current zero
- Identification of turbulent mixing at the boundary layer between arc plasma and blow gas flow
- Improved localization of the decaying plasma channel by measurements from two viewing directions

Next steps:

- Expanding of the experimental setup to more than two viewing directions
- Increase of the image resolution

L4: Synthesis of (B-C-N) Nanomaterials by arc discharge

D .Gourari, M. Razafinimanana, M. Monthioux, R.Arenal, F. Valensi, S. Joulié, V. Serin

Boron-Carbon-Nitrogen ($B_xC_yN_z$) nanotubes have potential applications such as photo-luminescent materials, electron emission, or high temperature transistors

1- Feasibility of the insertion of Boron in a graphenic structure (sp2) hybridization; a high content of B in the system is detrimental to the SWCNTs yield.

2- Identification and **correlation** of the **plasma properties**, **growth zone temperature** and synthesised nano-product.

3- Doping confirmation; synthesis of BN nanoparticles.

4- Further works are expected (temperature of the heavy particles determined by molecular spectroscopy, densities of species) to evaluate the role of the deviation from LTE (Local Thermodynamic Equilibrium) in the plasma on the synthesis and doping nanotubes.

M5: Electron temperature and density measurements in GTAW and GMAW processes by Thomson scattering

Marina Kühn-Kauffeldt, José-Luis Marquès and Jochen Schein

UniBw München, LPT, Neubiberg, Germany

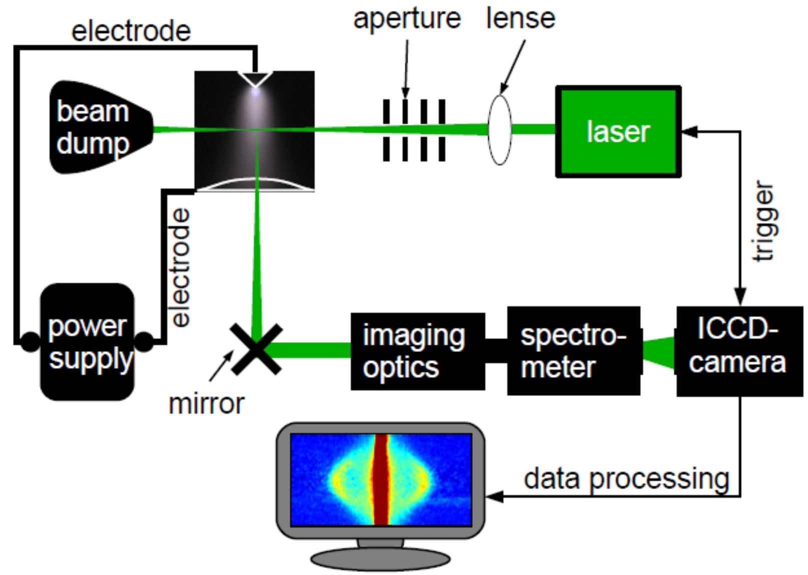
Open question:
How the presence of different gases and metal vapor influences the behavior of the arc?

Useful tool:
Thomson Scattering as a diagnostic for the temperature and density of the welding arc plasmas

Advantages:

- simultaneous electron temperature and density measurement
- localized measurement
- knowledge of plasma composition is not necessary
- plasma has to be optically thin only in a small spectral range

parameter	*GTAW*	*GMAW*
laser	Nd:YAG	
	532 nm	
laser energy	25 mJ	
pulse duration	3-5 ns	
beam ∅	500 μm	
ICCD QE	10 %	50 %
accumulations	250	5



- GTAW at I=150 A: maximum $T_e \approxeq 18000K$ and $n_e \approxeq 1.4e10^{23}m^{-3}$
- GMAW at I=400 A: maximum $T_e \approxeq 14000K$ and $n_e \approxeq 1.6e10^{23}m^{-3}$
- lower temperatures and higher densities in the GMAW process may result from presence of metal vapor in the arc

- Thomson scattering was successfully applied to stationary and transient welding processes
- data can be used to estimate plasma composition
- *planned*: validation of the GMAW measurement using Stark broadening for electron density measurement

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MODELING NOZZLE GEOMETRY CHANGES DUE TO THE ABLATION IN HIGH-VOLTAGE CIRCUIT BREAKERS

S. ARABI1*, J-Y. TRÉPANIER1, R. CAMARERO1 AND A. VASSILEV2 (p479)
1 Department of Mechanical Engineering, École Polytechnique de Montréal, Campus de l'Université de Montréal, H3T 1J4, Montréal, Canada
2 Alstom Grid, 130 rue Léon Blum, 69611 Villeurbanne Cedex, France

This paper presents a new CFD tool for transient analysis of surface ablation of a Poly-Tetra-Fluro-Ethylene (PTFE) nozzle of a high voltage circuit breaker.

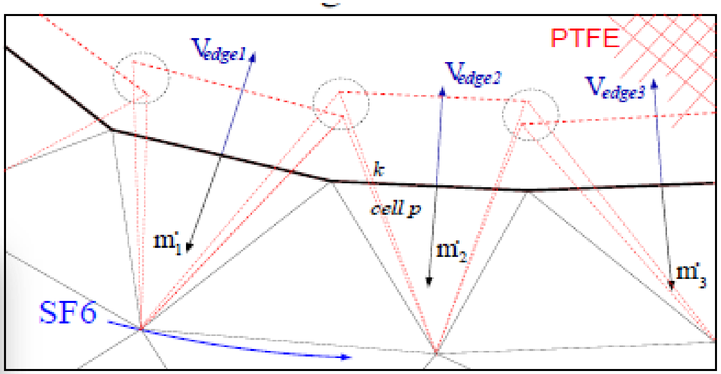
The developed solver fully couples the arcing flow field inside a circuit breaker chamber including radiation, ablation and nozzle wall recession.

The presented numerical simulation evaluates the changes in the nozzle mass flux due to the recession of the PTFE surface, in 10 consecutive applied current cycles.

$$S_m = \frac{1}{V_p}\sum_{k=1}^{N_{sides}} \dot{m}_{p,k}, \qquad S_e = S_{ohm} + S_{rad} + e_g S_m,$$

Debitm² = frac Flux /(Hv + Eint3500 – Eint1000)

The radiative energy is computed from the P1 approximation as follow



ALSTOM

Paper review

The applied current cycle is repeated in **10 consecutive** times to predict the changes in the nozzle mass flux in a long-operation time. In the present simulation, the peak current is **56kA** and the arcing time for each cycle **is 6.4ms**.

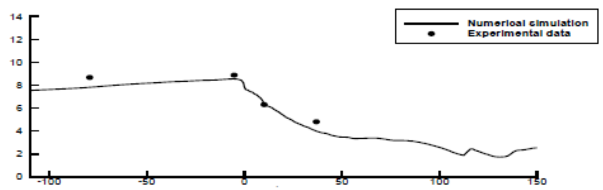


Fig. 6: Axial pressure distribution at, t=7ms, I=26.4 kA.

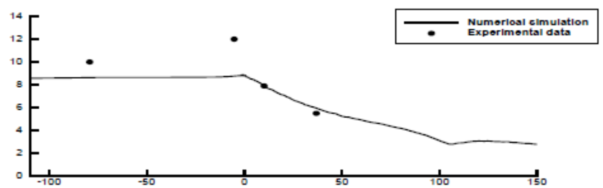


Fig. 7: Axial pressure distribution at, t=9ms, I=55.7 kA.

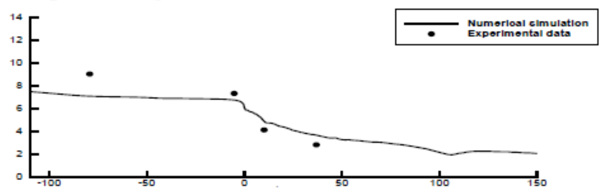
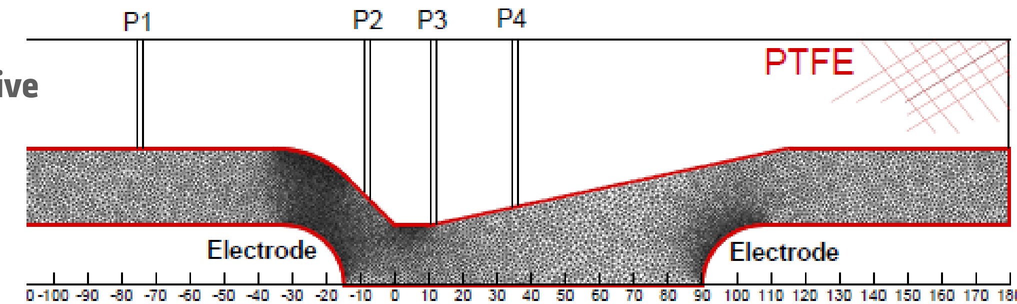
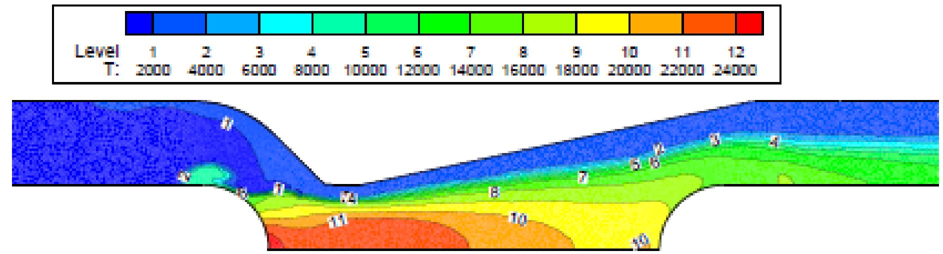


Fig. 8: Axial pressure distribution at, t=11ms, I=35.5 kA.





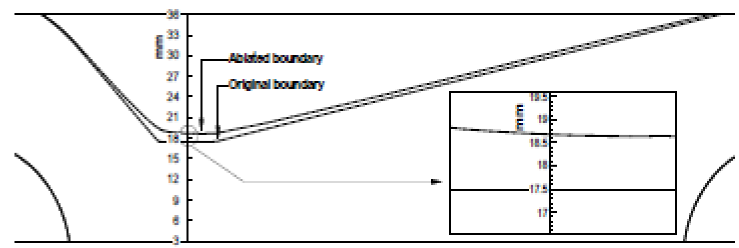


Fig. 12: Geometry change after applying 10 current cycle.

By comparing the amounts between the end of the 10*th* and 1*st* cycles, there is about a 9.5% rise in the mass flow rate
Real CB validation at ARC

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Paper review

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CFD BASED MULTI-PHYSICS SIMULATION OF COMPRESSIBLE FLOW THROUGH NOZZLE OF SF6 GAS CIRCUIT BREAKER

SUMEDH P. PAWAR[1]* AND ATUL SHARMA[2]
[1] Global R&D Center, Crompton Greaves Ltd. and Ph.D. student, IIT Bombay, Mumbai, 400042, India
[2] Mechanical Engg. dept. IIT Bombay, Mumbai, 400042, India

The study is done on a simplified geometry - a convergent-divergent nozzle geometry with two electrodes called as **Lewis nozzle (EPM case)**

Numerical simulations are done using general purpose commercial CFD software ANSYS FLUENT 13.0. However, in-house C programs are developed to model physics such as MHD and radiation.
The numerical development and its coupling with th software is validated on a transient and 2-D axisymmetric problem - for a low DC current of 300

A detailed CFD analysis is presented here to discuss the reasons for the variation of temperature, arc radius and arc voltage along the axis.

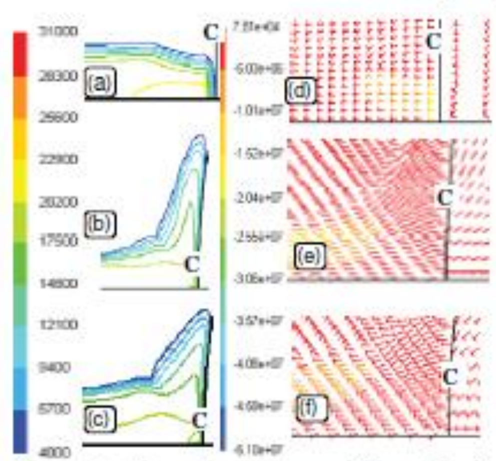

Fig. 4: (a-c) Temperature contour and Current density vectors (colored by radial Lorentz forces)-near the Cathode for (a,d) flat, (b,e) hemi-spherical and (c,f) elliptical tip of the electrodes

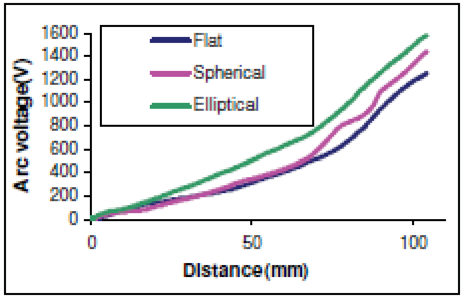

Fig. 7: Comparison of arc voltage for the various shapes of the tip of the electrodes

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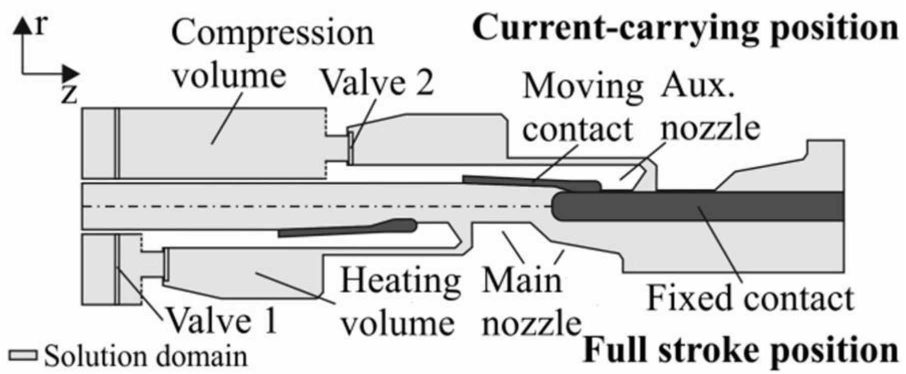
IMPROVED MODELING OF ABLATION PROCESS IN HIGHVOLTAGE CIRCUIT BREAKERS FOR SWITCHING ARC SIMULATION (A22 p155)

A. PETCHANKA[1]*, F. REICHERT[1], J.-J. GONZALEZ[2] AND P. FRETON[2]
[1] Siemens AG, E T HP CB R&D ENG 1, Nonnendammallee 104, 13629, Berlin, Germany
[2] Université de Toulouse, LAPLACE, 118 route de Narbonne, CNRS-UPS, 31062, Toulouse,France

utilization of an improved model for the ablation process in the simulation of on-load switching-off processes in high-voltage circuit breakers (HVCBs).

In order to describe the plasma arc behaviour, a transient axisymmetric model is used which is based on the Fluent software.



two species SF6-C2F4 gas mixture is considered
Classical CFD from FLUENT

$$\nabla^2 \vec{A} - \frac{1}{c^2}\frac{\partial^2 \vec{A}}{\partial t^2} = -\mu_0 \vec{J},$$

$$Q_{rad} = \dot{M}\left(h(T) - h(T_p) + H_{vap} + \frac{v^2}{2}\right)$$

where Q_{rad} is the radiation flux, $h(T)$ is the specific enthalpy of the ablated material and T_p is the pyrolysis temperature.

The PTFE walls are considered as non-deformable.

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Paper review

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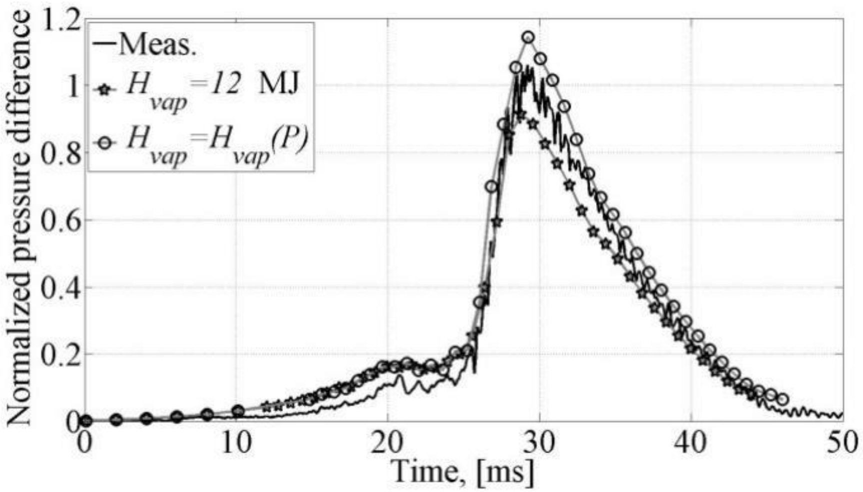
Two cases of evaluation of evaporation enthalpy are considered: constant value $H_{vap} = 12$ MJ/kg [4] and pressure dependent $H_{vap} = H_{vap}(P)$.

The calculation of $H_{vap} = H_{vap}(P)$ is based on the Maximum Entropy Principle (MEP)



It is shown that the consideration of PTFE evaporation enthalpy in dependence on pressure yields to best agreement between experiment and simulation.

Nevertheless, the approximation of the constant enthalpy stays in a satisfactory agreement with the measurements at the interruption current 25 kA.

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RADIATIVE PROPERTIES OF SF6-C2F4-Cu MIXTURES IN HIGH VOLTAGE CIRCUIT BREAKERS ARC PLASMAS: NET EMISSION COEFFICIENT AND MIXING RULES (p229)

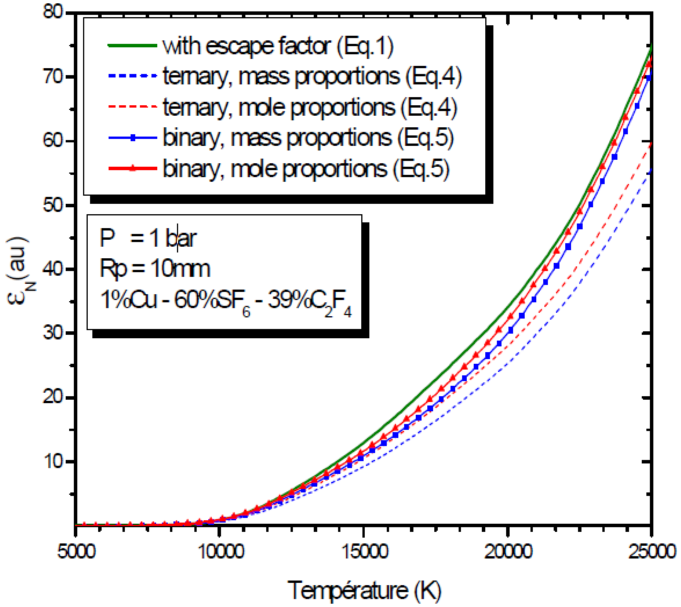
L. HERMETTE1,2, Y. CRESSAULT1*, A. GLEIZES1 , C. JAN1,2 and K. BOUSOLTANE2
1Université de Toulouse; UPS, INPT, CNRS; LAPLACE (Laboratoire Plasma et Conversion d'Energie), 2SIEMENS T&D E T HP GS R&D D G R1, 1 rue de la Neva, BP 178 38004 Grenoble, France

ABSTRACT

In this paper, we tried to estimate the radiative properties of SF6-C2F4-Cu thermal plasmas existing in High Voltage Circuit Breakers. The calculation was realized assuming LTE, binary and ternary mixtures with mass concentrations, temperatures from 300K to 30 000K and pressures of 1 bar and 8 bar.

Two methods were used to estimate these properties:

- the Net Emission Coefficient by neglecting the lines overlapping
- the mixing rules using either the NECs of the pure gases or the NECs of a given SF6-C2F4 mixture and of pure Cu plasma.



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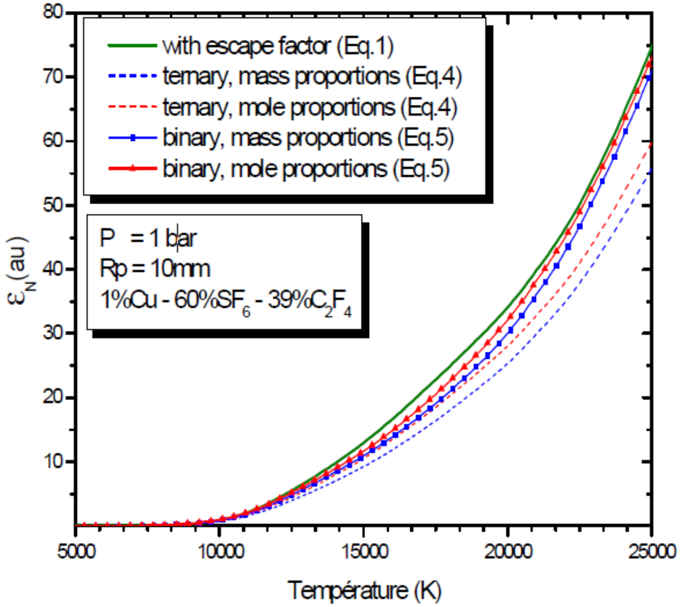
Proposition of two mixture laws.
The first one, called "ternary", tries to estimate the NEC of a ternary mixture from the NECs of the pure Gases

The second one, called "binary", is based on the NEC of the 50%SF6-50%C2F4 mixture and the NEC of the pure copper plasma



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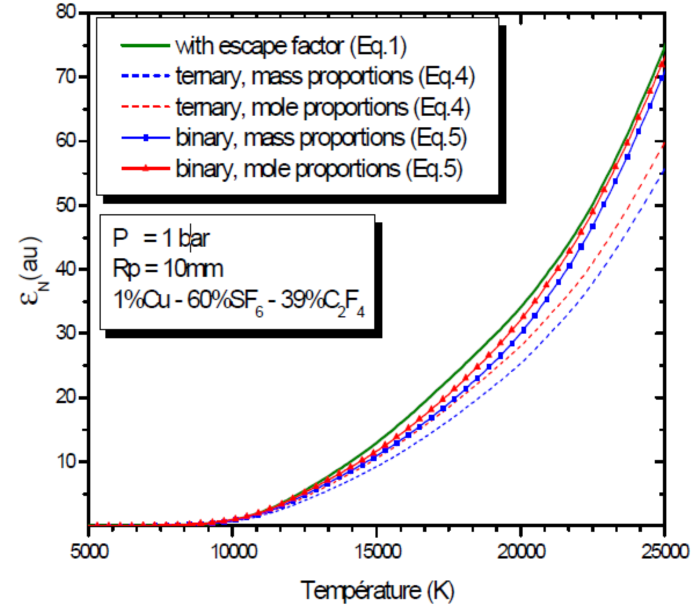
lines' overlapping could lead to significant differences for the high pressures.

"binary" interpolation with molar proportions is the best mixing rule to quickly estimate the NEC of a ternary mixture.

This law must be tested at higher pressures,
higher temperatures, and higher sizes of plasma.

New sophisticated laws have to be developed and tested in the future.



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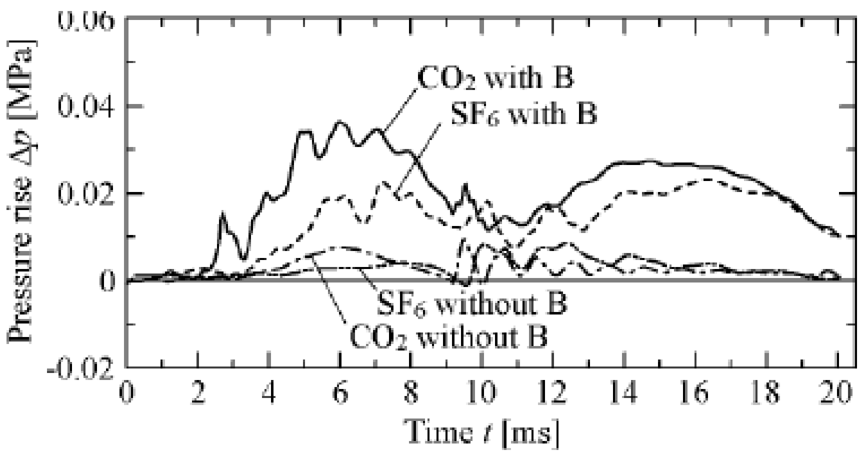
Paper review

CO2 ARC BEHAVIOR DURING CURRENT INTERRUPTION PROCESS IN A GAS CIRCUIT BREAKER WITH EXTERNALLY APPLIED MAGNETIC FIELD (p111)

T. TAKEMATSU[1]*, S. HIRAYAMA1, T. FUJINO1, M. ISHIKAWA1
S. OGAWA2, AND T. MORI2
1 University of Tsukuba, Tsukuba, 305-8573, Japan, takematsu@fmm.kz.tsukuba.ac.jp
2 Toshiba Corporation, Kawasaki, 210-0862, Japan

3D and time dependent MHD numerical simulations of a gas circuit breaker model with externally applied magnetic field for CO2 or SF6 gas (8kA max)

Numerical results show that applying **the magnetic field induces swirl flow**, which leads to the **pressure rise in the puffer chamber for both gases**. Just before second current zero, the arc forms cylindrical shape under the magnetic field for CO2 gas unlike SF6 gas where the arc column forms spiral shape.



Arc conductance is reduced by applying the magnetic field for both gases because heat convection around the arc is enhanced. Thermal interruption capability can be improved by applying the magnetic field for both gases.

No explanaition for the differences of behaviour

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Paper review

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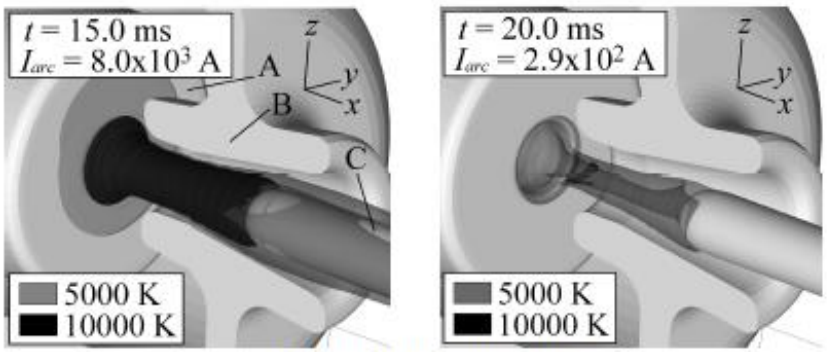
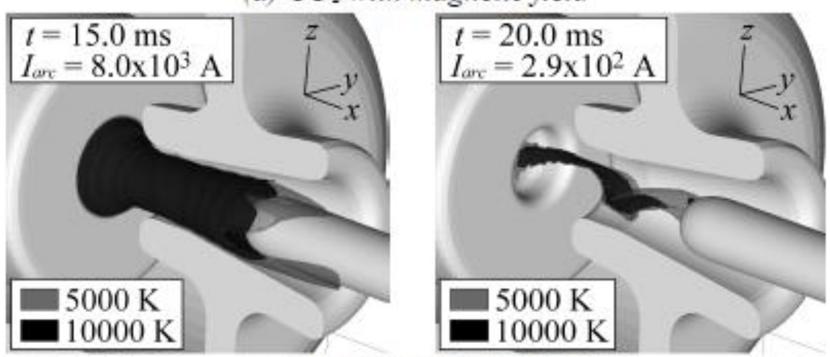


(a) CO_2 with magnetic field



(c) SF_6 with magnetic field

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Paper review

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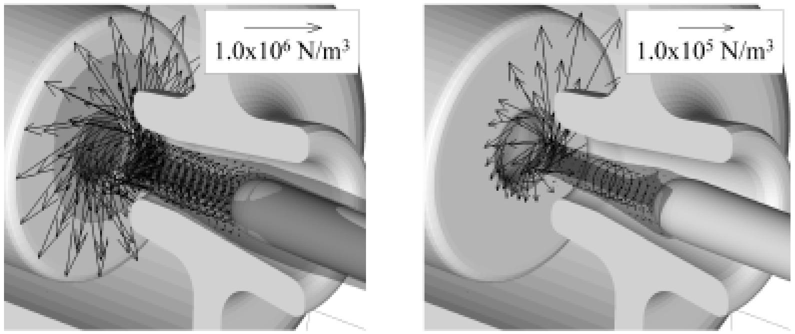

(a) t = 15.0 ms *(b) t = 20.0 ms*

Fig. 5 Three-dimensional distributions of vector of Lorentz force and isosurface of temperature T = 5000 K with applied magnetic field at (a) t = 15.0 ms and (b)t = 20.0 ms for CO_2.

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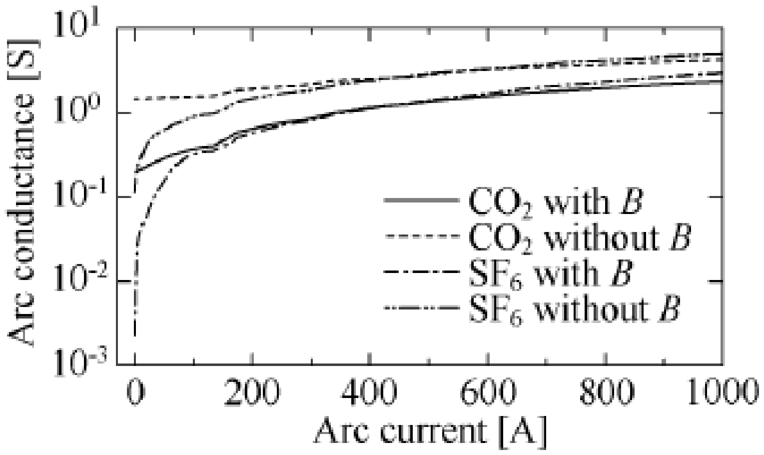

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No explanaition for the differences of behaviour

Paper review

NUMERICAL SIMULATION ON TWO-TEMPERATURE CHEMICALLY NON-EQUILIBRIUM STATES IN DECAYING SF_6 ARCS AFTER APPLICATION OF RECOVERY VOLTAGE

Y TANAKA[1], K SUZUKI[2]

[1]Faculty of Electrical and & Computer Eng., Kanazawa Univ., JAPAN.

ABSTRACT

This paper describes calculation results by the developed two-temperature (2T) chemically non-equilibrium (CNE) model for a decaying SF_6 arc plasma with transient recovery voltage (TRV) application. The developed model solves energy equations for electrons and heavy particles, mass conservation equations for each of 19 species in SF_6 arc plasmas, accounting for totally 122 reactions. Transient distributions of electron temperature and heavy particle temperature as well as CNE composition were obtained for a decaying SF_6 arc plasma considering non-equilibrium effects.

Energy for electrons:

$$\frac{3}{2}kn_e\frac{DT_e}{Dt} = \nabla\cdot(\lambda^e_{tr}\nabla T_e) - Q_{e-h} + Q^e_{heat} \quad (6)$$

$$Q^e_{heat} = \nabla\cdot(\frac{1}{m_e}\frac{5}{2}kT_e\Gamma_e) + \sum_{\ell=1(\beta^f_{e\ell},\beta^b_{e\ell}\neq 0)}^{L}\Delta Q_\ell + \sigma_e|E|^2 - P_{rad} - Q^e_{exc} \quad (7)$$

Mass of species j:

$$\rho\frac{DY_j}{Dt} = \nabla\cdot(\rho D_j\nabla Y_j) + S_j, \quad (8)$$

$$S_j = m_j\sum_{\ell}^{L}(\beta^b_{j\ell}-\beta^f_{j\ell})\left(k^f_\ell\prod_{i=1}^{N}n_i^{\beta^f_{i\ell}} - k^b_\ell\prod_{i=1}^{N}n_i^{\beta^b_{i\ell}}\right) \quad (9)$$

The equation of state:

$$p = p_e + p_h \quad (10)$$

$$p_e = n_e kT_e \quad (11)$$

$$p_h = \sum_{j(j\neq e)}^{N} n_j kT_h \quad (12)$$

Mass density:

$$\rho = \frac{p}{k\frac{Y_e}{m_e} + k\sum_{j=1(j\neq e)}^{N}\frac{Y_j}{m_j}T_h} \quad (13)$$

Energy conversion by excitation:

$$Q^e_{exc} = \sum_{j=1(j\neq e)}^{N}\left[k(T^j_{ex})^2\frac{\partial \ln Z_j(T^j_{ex})}{\partial T^j_{ex}} - kT_h^2\frac{\partial \ln Z_j(T_h)}{\partial T_h}\right]\nu_{eh}n_e \quad (14)$$

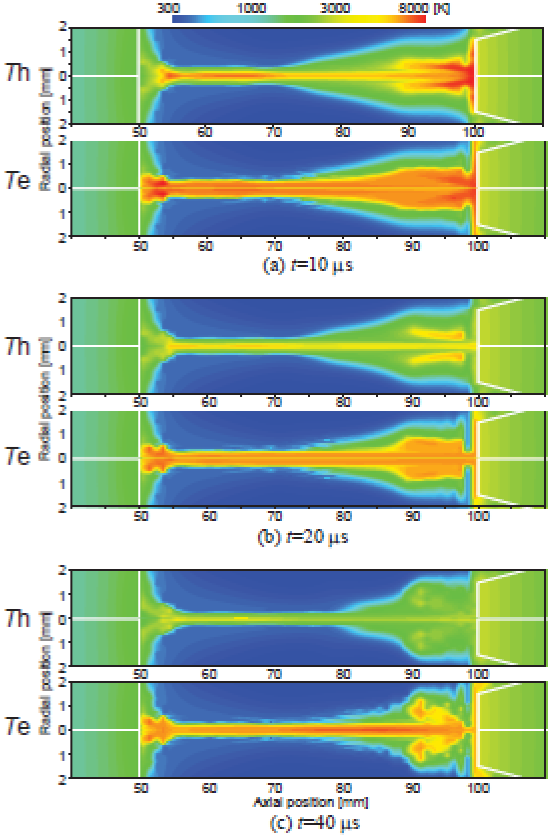
Energy conversion by elastic collision:

$$Q_{e-h} = \sum_{j=1(j\neq e)}^{N}\frac{3}{2}k(T_e - T_h)\frac{2m_jm_e}{(m_j+m_e)^2}\nu_{eh}n_e \quad (15)$$

Effective reaction heat:

$$\Delta Q_\ell = E_{react}\left(k^f_\ell\prod_{i=1}^{N}n_i^{\beta^f_{i\ell}} - k^b_\ell\prod_{i=1}^{N}n_i^{\beta^b_{i\ell}}\right) \quad (16)$$

Paper review

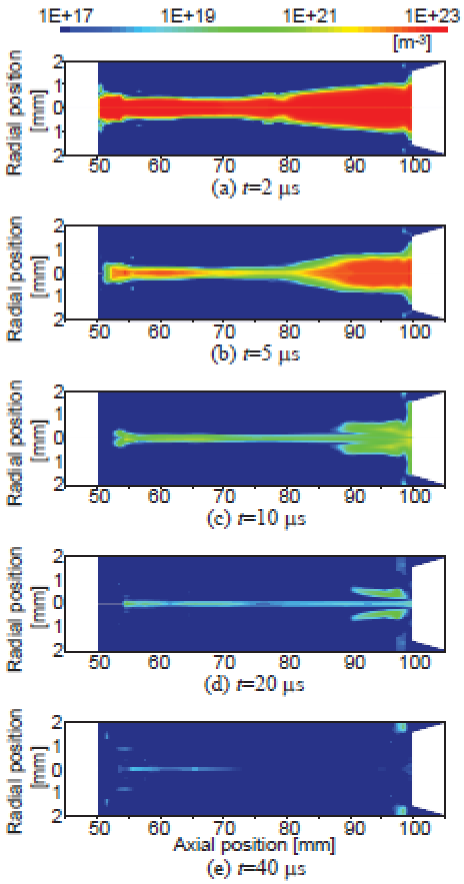


(a) t=10 μs

(b) t=20 μs

(c) t=40 μs

Fig. 3. Transient spatial distribution in the electron temperature and the heavy particle temperature between the electrodes in an SF_6 arc at RRRV=0.1 kV/μs.



(a) t=2 μs

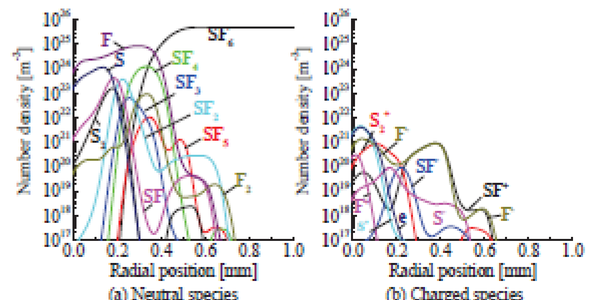
(b) t=5 μs

(c) t=10 μs

(d) t=20 μs

(e) t=40 μs

Fig. 4. Electron density distribution in an SF_6 arc at RRRV=0.1 kV/μs.



(a) t=5 μs

A two-dimensional numerical thermo-fluid model of SF_6 arc plasmas was developed with consideration of not only CNE effects but also 2T effects self-consistently. Two energy equations for electrons and heavy particles were separately solved to obtain the behaviors of electron temperature T_e and heavy particle temperature T_h. Results showed that 2T state and CNE effects were clearly seen in a residual SF_6 arc plasma in case of TRV application with RRRV=0.1 kV/μs.

No compaison with LTE
No final withstand calculation

Paper review

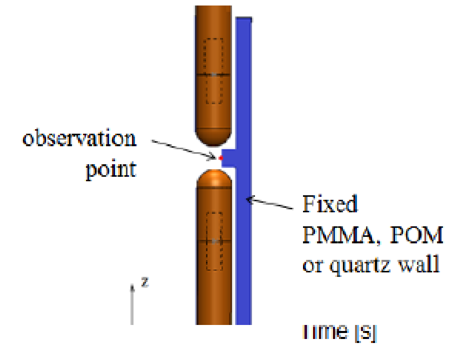
ARC JETS BLOWN BY OUTGASSING POLYMERS IN AIR (p99)

M. BECERRA[1,2], A. FRIBERG2
[1] Royal Institute of Technology –KTH–, School of Electrical Engineering, 100 44, Stockholm,Sweden
[2] ABB Corporate Research, 722 66, Västerås, Sweden

This paper describes experimental results about the behaviour of arc jets transversely blown in the presence of outgassing polymers (POM –CH_2O– or PMMA –$C_5H_8O_2$–).
The arc jets are ignited in air between copper electrodes under a 2 kA, 50 Hz AC current.
High speed photography and optical emission spectroscopy are used to study the mechanism leading to the increase of the arc voltage when polymers are used instead of non-ablating materials (e.g.quartz).

It is found that the transversal blowing flow caused by the injection of ablation vapours have a weak effect on the arc voltage build-up.

Instead, the chemical changes in the plasma environment appear to better explain the observed increase in the arc voltag when polymers are used.



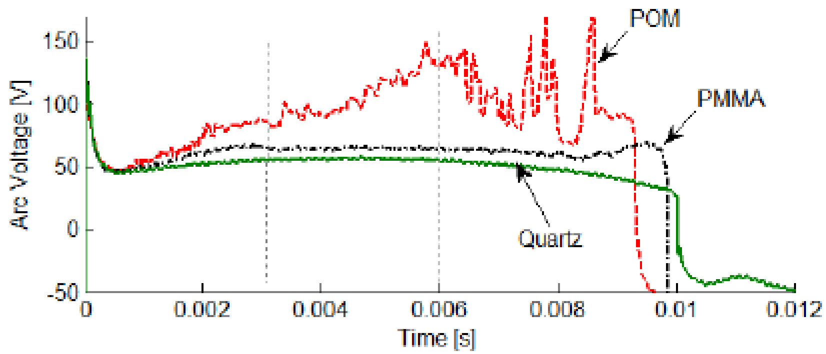


Fig. 2. Measured current and arc voltage for the different wall materials.

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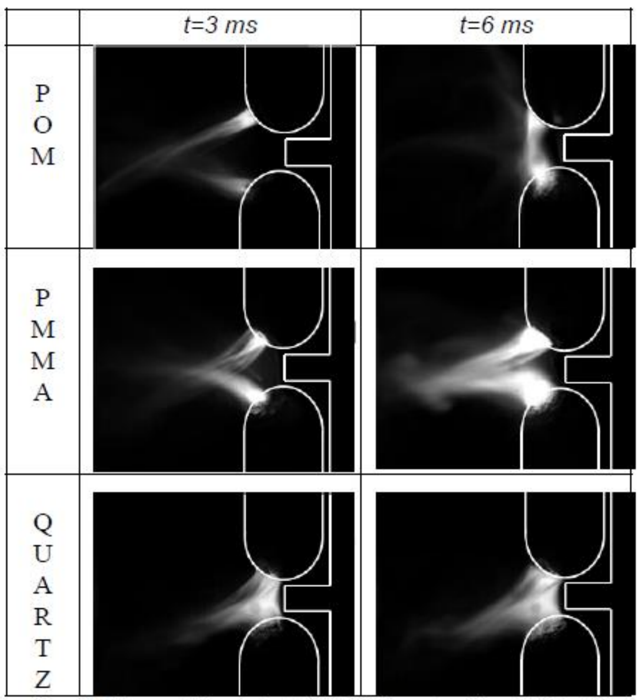
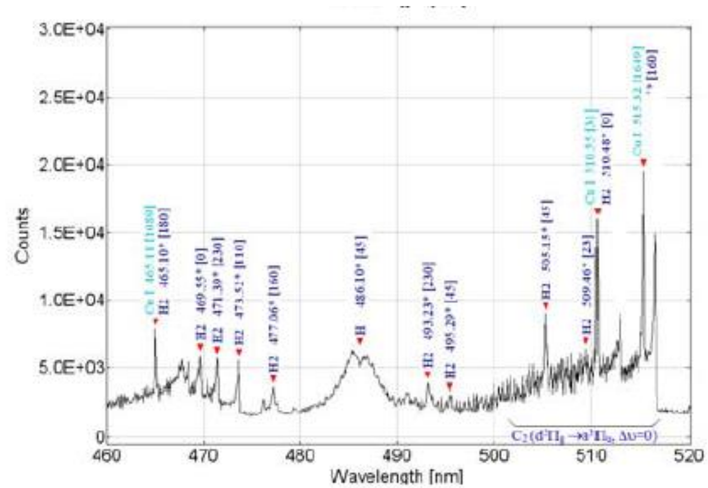


Fig. 3. Pictures of the arc jets for the different wall materials at 3 and 6 ms.



Contrary to measurements of optical emission from the arc column [5], the recorded spectra show clear differences in the chemical composition of the gas in front of the polymer surface for POM and PMMA

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NUMERICAL STUDY ON SELF-EXCITED OSCILLATION SWITCHING CURRENT IN HVDC MRTB (p207)

YANG LI, MINGZHE RONG, CHUNPING NIU*, YI WU, MEI LI AND FEI YANG
State Key Laboratory of Electrical Insulation and Power Equipment,
School of Electrical Engineering, Xi'an Jiaotong University, Xi'an 710049, China

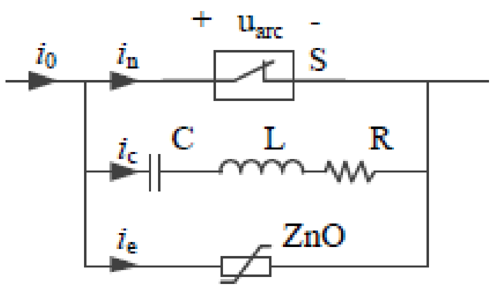

Fig. 1 Structure of Self-Excited Oscillation DC Breaker

Numerical study of current self-excited oscillations during the opening of HVDC metallic return transfer breaker (MRTB).
The switching arc is simulated using **MHD theory coupled with the electric circuit variation** (previously, Cassie Mayr applications)

The calculated result gives **good agreement with the experiment**, and shows that the arc model can accurately simulate the current oscillation and the commutation process in MRTB.

$$\frac{\partial(\rho\phi)}{\partial t}+\nabla\cdot(\rho\phi\vec{v})-\nabla\cdot(\Gamma_\phi\nabla\phi)=S_\phi$$

+MHD (Navier Stokes 2D - FLUENT)

$$\frac{1}{C}i_c+L\frac{d^2 i_c}{dt^2}+R\frac{di_c}{dt}=\frac{du_{arc}}{dt}$$

$$i_0=i_n+i_c$$

The MRTB prototype is designed to break about 5.2 kA of DC current. The results from both simulation and experiment show that the current oscillation starts at about 16.5 ms and the total arc time is about 24 ms when the commutation capacitor bank and inductor are 72 μF and 173 μH, respectively.

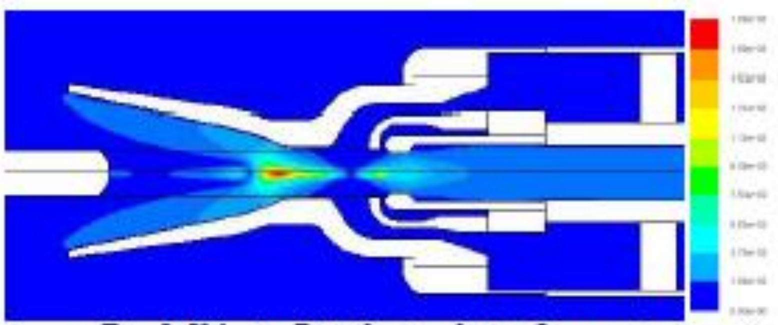

Fig. 5 Velocity Distribution during Interruption

This study can help improve the current interruption capability of MRTB.

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Paper review

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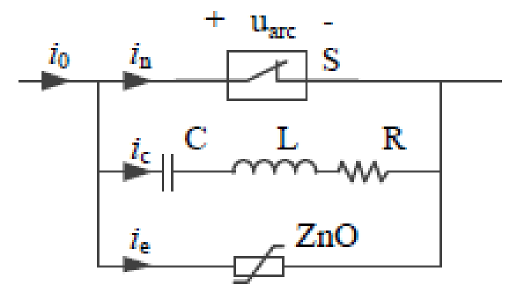

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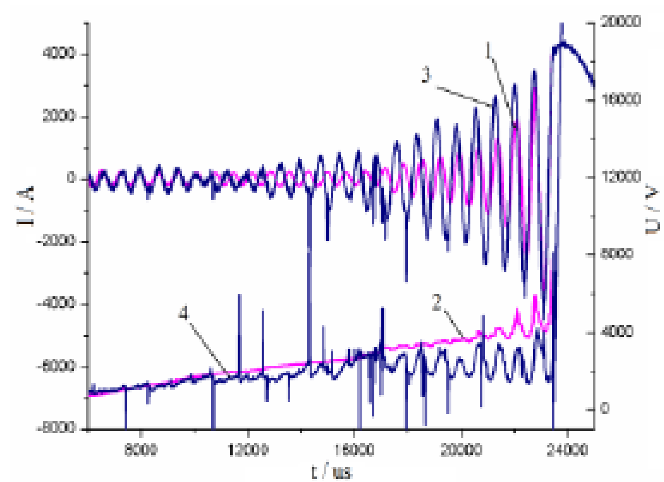

1, 2- Calculated arc voltage and current oscillation of commutation branch
3, 4- Tested arc voltage and current oscillation of commutation branch
Fig. 6 Current Oscillation and Interruption

$$\frac{d^2 i_c}{dt^2} + R\frac{di_c}{dt} = \frac{du_{arc}}{dt}$$

$+ i_c$

Particular phenomenon at 16ms: cold gas creating oscillations of the arc (visible on tests but not calculations)

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Workshop 1: Properties of thermal and quasi-thermal plasmas
Chair: Dr Yann Cressault

Workshop 2: Electrohydrodynamic effects produced by corona, barrier and surface discharges
Chair: Pr Eric Moreau

Workshop 3: Modeling of HV circuit breakers: where do we stand and what are the challenges
Chair: Dr Martin Seeger, Ph Robin-Jouan

Workshop 4: Major challenges in the diagnostics of non thermal plasma sources relevant for biomedical applications
Chair: Dr Eric Robert

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Workshop 1: Properties of thermal and quasi-thermal plasmas

Chair: Dr Yann Cressault

Transport properties :

- **Anthony Murphy** (CSIRO Materials Science and Engineering), Australia

Radiation :

- **Kloc Petr** (Centre for Research and utilization of Renewable Energy), Czech Republic

Workshops

Workshop 1: Properties of thermal and quasi-thermal plasmas
Chair: Dr Yann Cressault

Radiation

2 different regions: arc core (dominating emission) and ext

- For SF6: maximum 10-15 frequency bands
- Non LTE: not necessary for current extinction (for high T; to be revised for small T applications)
- NEC:
  - if no interaction with Teflon nozzle, quite applicable
  - If Teflon nozzle, great deviation since flux is badly calculated
  - P1 or DOM is preferred (NEC deviation with pressure since absorption is increasing with pressure)

Workshops

Workshop 1: Properties of thermal and quasi-thermal plasmas
Chair: Dr Yann Cressault

Transport coeffcients:

pour la composition, la communauté est d'accord pour dire que Potapov n'est pas correct
Mais pour les autres propositions, il n'y a pas d'unanimité. VD Sanden ne semble pas non plus adapté.

Pour les hautes pressions, Viriel et Debye-Euckel corrections doivent être considérées.

Difficulté à mesurer la conductivité électrique, thermique et viscosité pour des mélanges thermiques, plus simple pour des gaz purs.

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Présentations en annexe

Workshop

Workshop 3: Modeling of HV circuit breakers: where do we stand and what are the challenges?
Chair: Martin Seeger/ Ph Robin-Jouan

Tuesday, 17:45-18:45
In the recent meeting of the Current Zero Club (http://www.currentzeroclub.org/) in Suzhou/China, a discussion was started about the quality of modeling of the physical process in High Voltage SF6 circuit breakers.

Discussed issues were for example:

- What is the importance of Non-LTE effects?
- How turbulence should be modeled?
- When should 3D effects be modeled?
- Material issues?

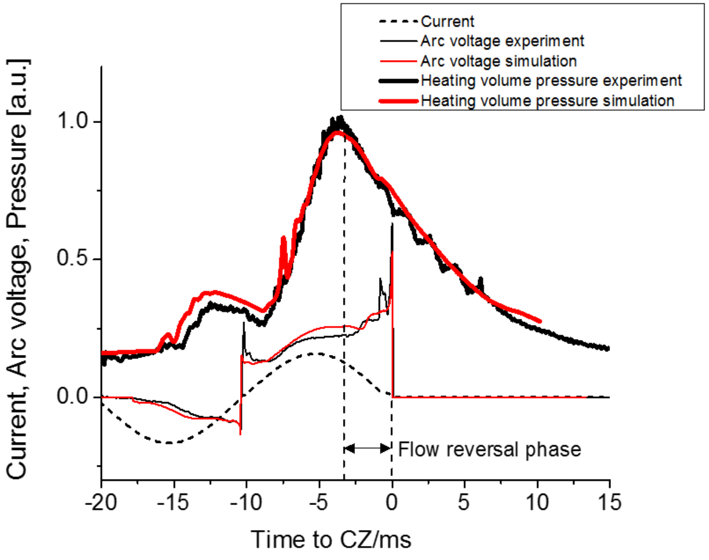
This discussion will be continued within a "gas inner circle" meeting at the GD2014, which is open to everybody who is interested in the topic.

High current phase

July 6-11, 2014 - Orléans - France
20th international conference on gas discharges and their applications

- **We can predict**: arc voltage, pressure build up
- **Turbulence**: small impact, however important for mixing (e.g. exhaust, heating volume…); Turbulence model helps our simulation tools to converge and perhaps don't help us to understand turbulence
- No Phd about measurements or Direct simulation
- The only way is to make comparisons between experiments and modelling: creation of a working group ?
- **Non-equilibrium:** small impact (arc fringes only)
- **3D**: small impact in standard geometries (arc root attachment, 3D flow geometries, rotating arcs)
- **Erosion** from contact and nozzles → important for pressure build up
  - Do we need to go forward in more detailed models ?
  - Data are missing for the charge filled PTFE
  - Vapours or particles are injected?
  - PTFE does not react to the spectra uniformly: this should be taken into account
- **Radiation**: P1 model delicate because of the boundary condition application. DOM very costly. Possible usage of hybrid model P1/DOM (depending on the bands). NEC simple rapid but needs to define arc radius; cylindrical approximation and absorption factor definition
  - Radiation spectra: everyone has his database: creation of a working group ?
  - Data base to define for non-equilibrium conditions

Measurements: Radiation spectra: different sources but no unique solution
Possibility to make dedicated benchmarks on simple mock up (precise conditions to define)
Common research project for data bases with financial contribution could be addressed



Example for ABB result

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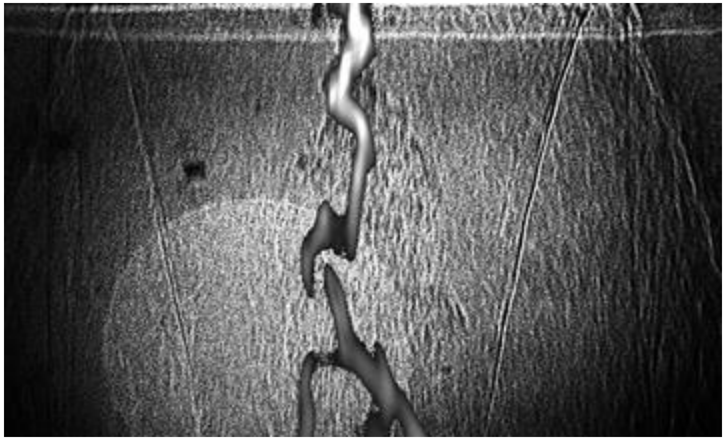
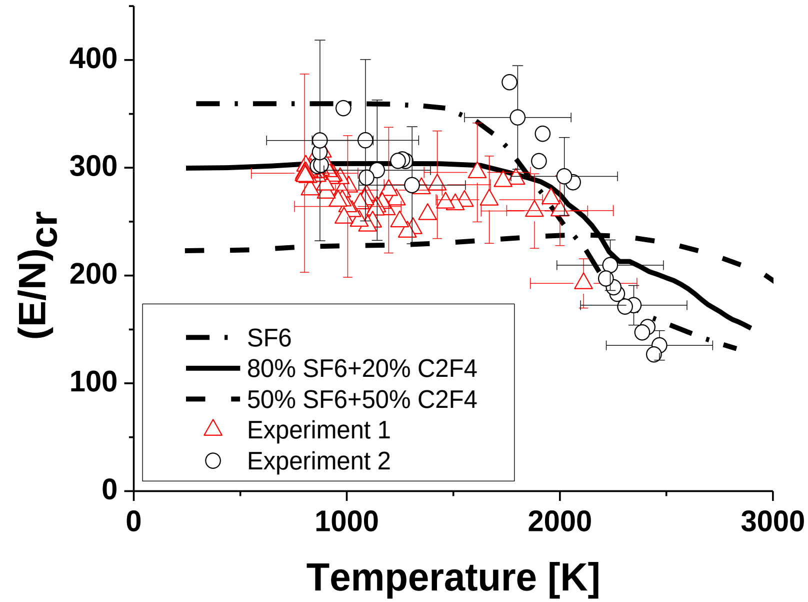
Thermal interruption

- **Not well predicted**
- **Turbulence**: decisive
- **Non-equilibrium**: probably large influence
  - Adding some streamer leader theory to get some full discharge prediction in a disequilibrium model (chemical and thermal)
  - Chemical equilibrium is more important from Tanaka's point of view
  - Very complicated model: is it possible to get it simpler ?
- **3D**: arc structure of 3D type
- **Erosion** from contact and nozzles → copper vapor has influence on interruption
- **Radiation**: possibly some impact?
- **Measurements**: Reference experiments? Spectroscopy is the most adaptive mean to diagnostic current zero phase : proposal for shared campaign ?



Dielectric recovery

- **Prediction**: E/N, streamer, leader
  - Hard to measure the dielectric withstand for SF6 ; still validations are required
- **Turbulence**: great impact (early phase)
- **Non-equilibrium**: impact ?
- **3D**: great impact (exhausts,…)
- **Erosion** from contact and nozzles → vapor has influence on interruption and needs to be taken into account (specially GCB)
- **Radiation**: less relevant
- **Measurements**: Reference experiments?



Example for ABB result

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GD 2014 - Scientific Programme — **Orléans - France**

Original paper no.	New paper no.	Scientific Session	Speaker
25693	H-1	H	Y. Zhao
26142	B-13	B2	H. Rabat
26317	B-27	B4	X. Wang
26494	E-3	E1	Y. Deng
26883	J-2	J	V. D. Karaventzas
27061	A-34	A5	Y. Tanaka
27062	A-43	A6	T. Nakano
27154	B-28	B4	X. Wang
27162	C-11	C	C. Mcgarvey
27214	A-24	A4	P. Kloc
27233	A-20	A3	M. M. Walter
27241	B-21	B4	L. Liu
27244	B-19	B3	D. Xiao
27248	E-14	E2	Y. Yasaka
27296	B-2	B1	A. Chollet
27307	A-4	A1	J. Liu
27338	A-9	A1	S. Pawar
27342	C-2	C	A. Chaikha
27347	A-14	A2	Q. Zhang
27348	E-4	E1	S. Aleiferis
27359	A-32	A5	M. Iwata
27360	J-7	J	X. Wang
27361	A-17	A3	M. Kotari
27362	A-11	A2	T. Takematsu
27364	F-9	F2	H. Zerrouki
27374	D-9	D2	A. Ustimenko
27376	D-8	D2	A. Ustimenko
27427	C-5	C	S. Chen
27428	J-1	J	G. Jones
27429	D-17	D3	A. Yang
27430	F-6	F2	T. Sakoda
27431	A-38	A5	L. Zhong
27434	K-7	K	L. Wei
27437	B-22	B4	D. Xiao
27447	K-4	K	S. Qin
27450	A-16	A2	J. Spencer
27451	I-1	I	O. Kravchenko
27453	K-2	K	Y. Deng
27461	C-9	C	Y. Fu
27466	F-13	F3	K. L. Pan
27467	A-13	A2	J. Zhang
27471	A-7	A1	J. Krowka
27474	F-2	F1	K. L. Pan
27477	F-5	F2	G. Wattieaux
27480	A-1	A1	F. Yang
27481	A-30	A4	Y. Wu
27484	C-1	C	Y. Wu
27485	L-1	L	I. Kosarev
27487	K-3	K	A. Chicheportiche
27489	L-2	L	I. Kosarev

Original paper no.	New paper no.	Scient ific Sessi	Speaker
27492	A-22	A4	P. Freton
27498	B-6	B1	H. Höft
27502	K-11	K	W. Wang
27503	B-3	B1	J. Jones
27504	C-3	C	W. Wang
27506	A-49	A6	Y. Inada
27507	A-3	A1	E. Panousis
27508	E-11	E1	C. Chang
27510	D-12	D2	J. Mougenot
27511	A-5	A1	F. Yang
27512	A-26	A4	Y. Pei
27514	B-9	B1	P. Arnold
27516	E-9	E1	S. Stepanov
27517	D-15	D2	F. Clément
27519	J-5	J	S. Stepanov
27522	A-21	A4	J. Schmiedberger
27524	M-7	M1	X. Zhou
27528	A-35	A5	Y. Li
27529	M-3	M1	C. Leu
27552	I-2	I	O. Kravchenko
27561	A-40	A6	Y. Cressault
27600	M-4	M1	M. Zhu
27606	A-47	A6	X. Li
27607	A-19	A3	K. Zhu
27624	B-5	B1	H. Ueno
27626	A-6	A1	X. Li
27627	J-8	J	G. Wattieaux
27635	M-1	M1	S. Aleiferis
27639	A-12	A2	M. Sato
27643	K-9	K	M. Hilbert
27721	F-4	F2	K. Masur
27729	E-5	E1	P. Chapon
27753	A-10	A2	E. Fjeld
27816	D-11	D2	G. Pietsch
27817	D-10	D2	S. Wetzeler
27864	K-10	K	C. M. Franck
27947	D-14	D2	J. Y. Trepanier
27948	A-29	A4	P. G. Nikolic
27950	J-6	J	P. G. Nikolic
27981	B-16	B2	E. Fourré
28008	A-46	A6	A. Coulbois
28105	A-42	A6	M. Baeva
28139	D-13	D2	C. Rond
28148	A-48	A6	R. Putzu
28232	A-28	A4	M. Weuffel
28234	E-8	E1	J. F. Lagrange
28274	A-33	A5	G. Asanuma
28316	I-3	I	C. Zaepffel
28346	B-7	B1	A. Bouarouri
28380	B-8	B1	R. Tirumala

Original paper no.	New paper no.	Scientific Session	Speaker
28391	B-4	B1	R. Mathon
28492	B-26	B4	Y. Geng
28498	C-8	C	H. Iwabuchi
28501	K-6	K	H. Akashi
28502	A-27	A4	D. Eichhoff
28505	B-1	B1	O. Ducasse
28506	B-17	B3	R. Waters
28509	F-1	F1	O. Eichwald
28510	B-12	B2	G. Huang
28511	C-7	C	Z. L. Petrovic
28513	A-15	A2	S. Gorchakov
28515	C-10	C	A. Taran
28532	M-2	M1	C. Duluard
28543	B-20	B3	I. Adamovich
28549	B-15	B2	C. Zhang
28552	A-31	A4	T. Yoshino
28555	B-25	B4	K. Bayoda
28558	J-4	J	S. Arumugam
28562	A-44	A6	A. Maslani
28565	M-8	M2	A. Petin
28566	D-19	D3	Z. L. Petrovic
28567	F-7	F2	Y. Zhao
28568	F-8	F2	S. Iseni
28570	E-2	E1	N. Skoro
28572	A-8	A1	M. Becerra
28573	K-5	K	E. Filimonova
28574	B-24	B4	S. Okada
28575	A-41	A6	Y. Xia
28576	A-39	A6	Y. Okano
28578	K-8	K	N. Popov
28579	A-2	A1	A. B. Murphy
28580	L-3	L	A. B. Murphy
28584	B-18	B3	K. Takahashi
28585	G-2	G	M. Hogg
28586	B-11	B2	H. Mu
28587	B-29	B4	E. Moreau
28590	C-6	C	D. Tanaka
28591	D-18	D3	L. Yu
28594	F-3	F2	S. Hasse
28598	A-45	A6	F. Valensi
28599	D-20	D3	S. Stepanyan
28600	L-4	L	F. Valensi
28601	D-6	D2	S. Leonov
28604	D-3	D1	K. Chatelain
28605	E-6	E1	R. Joussot
28606	D-1	D1	L. Chauvet
28607	J-9	J	C. Laurent
28609	E-7	E1	A. Klochko
28610	B-23	B4	F. Pontiga
28611	A-37	A5	C. Yeo

Original paper no.	New paper no.	Scient ific Sessi	Speaker
28616	A-36	A5	K. Tomita
28637	E-10	E1	F. Gherendi
28656	E-13	E2	W. P. Sun
28657	K-1	K	S. R. Sun
28669	D-7	D2	V. Felix
28670	F-11	F3	A. Khacef
28671	F-12	F3	A. Khacef
28678	D-5	D2	J. Gruber
28682	F-10	F3	T. Darny
28707	A-18	A3	B. Schottel
28708	E-1	E1	M. Mikikian
28726	A-25	A4	T. Sakuyama
28731	B-10	B2	K. Mehalaine
28736	G-1	G	D. Astanei
28737	D-2	D1	A. Farah Sougueh
28739	A-23	A4	Q. Castillon
28740	J-3	J	S. Pellerin
28743	M-6	M1	N. Cerqueira
28744	D-16	D3	P. Escot Bocanegra
28750	E-12	E2	S. Cuynet
28763	E-15	E2	F. Diop
28798	C-4	C	M. Kamarudin
28800	B-14	B2	J. S. Boisvert
35817	M-5	M1	M. Kühn-Kauffeldt
40040	D-4	D1	D. Zhou

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A1	27480	A-1	F. Yang
	28579	A-2	A. B. Murphy
	27507	A-3	E. Panousis
	27307	A-4	J. Liu
	27511	A-5	F. Yang
	27626	A-6	X. Li
	27471	A-7	J. Krowka
	28572	A-8	M. Becerra
	27338	A-9	S. Pawar
A2	27753	A-10	E. Field
	27362	A-11	T. Takematsu
	27639	A-12	M. Sato
	27467	A-13	J. Zhang
	27347	A-14	Q. Zhang
	28513	A-15	S. Gorchakov
	27450	A-16	J. Spencer
A3	27361	A-17	M. Kotari
	28707	A-18	B. Schottel
	27607	A-19	K. Zhu
	27233	A-20	M. M. Walter
A4	27522	A-21	J. Schmiedberger
	27492	A-22	P. Freton
	28739	A-23	Q. Castillon
	27214	A-24	P. Kloc
	28726	A-25	T. Sakuyama
	27512	A-26	Y. Pei
	28502	A-27	D. Eichhoff
	28232	A-28	M. Weuffel
	27948	A-29	P. G. Nikolic
	27481	A-30	Y. Wu
	28552	A-31	T. Yoshino
A5	27359	A-32	M. Iwata
	28274	A-33	G. Asanuma
	27061	A-34	Y. Tanaka
	27528	A-35	Y. Li
	28616	A-36	K. Tomita
	28611	A-37	C. Yeo
	27431	A-38	L. Zhong
A6	28576	A-39	Y. Okano
	27561	A-40	Y. Cressault
	28575	A-41	Y. Xia
	28105	A-42	M. Baeva
	27062	A-43	T. Nakano
	28562	A-44	A. Maslani
	28598	A-45	F. Valensi
	28008	A-46	A. Coulbois
	27606	A-47	X. Li
	28148	A-48	R. Putzu
	27506	A-49	Y. Inada

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B1	28505	B-1	O. Ducasse
	27296	B-2	A. Chollet
	27503	B-3	J. Jones
	28391	B-4	R. Mathon
	27624	B-5	H. Ueno
	27498	B-6	H. Höft
	28346	B-7	A. Bouarouri
	28380	B-8	R. Tirumala
	27514	B-9	P. Arnold
B2	28731	B-10	K. Mehalaine
	28586	B-11	H. Mu
	28510	B-12	G. Huang
	26142	B-13	H. Rabat
	28800	B-14	J. S. Boisvert
	28549	B-15	C. Zhang
	27981	B-16	E. Fourré
B3	28506	B-17	R. Waters
	28584	B-18	K. Takahashi
	27244	B-19	D. Xiao
	28543	B-20	I. Adamovich
B4	27241	B-21	L. Liu
	27437	B-22	D. Xiao
	28610	B-23	F. Pontiga
	28574	B-24	S. Okada
	28555	B-25	K. Bayoda
	28492	B-26	Y. Geng
	26317	B-27	X. Wang
	27154	B-28	X. Wang
	28587	B-29	E. Moreau
C	27484	C-1	Y. Wu
	27342	C-2	A. Chaikha
	27504	C-3	W. Wang
	28798	C-4	M. Kamarudin
	27427	C-5	S. Chen
	28590	C-6	D. Tanaka
	28511	C-7	Z. L. Petrovic
	28498	C-8	H. Iwabuchi
	27461	C-9	Y. Fu
	28515	C-10	A. Taran
	27162	C-11	C. Mcgarvey
D1	28606	D-1	L. Chauvet
	28737	D-2	A. Farah Souqueh
	28604	D-3	K. Chatelain
	40040	D-4	D. Zhou

Scientific Session	Original paper no.	New paper no.	Speaker
D2	28678	D-5	J. Gruber
	28601	D-6	S. Leonov
	28669	D-7	V. Felix
	27376	D-8	A. Ustimenko
	27374	D-9	A. Ustimenko
	27817	D-10	S. Wetzeler
	27816	D-11	G. Pietsch
	27510	D-12	J. Mougenot
	28139	D-13	C. Rond
	27947	D-14	J. Y. Trepanier
	27517	D-15	F. Clément
D3	28744	D-16	P. Escot Bocanegra
	27429	D-17	A. Yang
	28591	D-18	L. Yu
	28566	D-19	Z. L. Petrovic
	28599	D-20	S. Stepanyan
E1	28708	E-1	M. Mikikian
	28570	E-2	N. Skoro
	26494	E-3	Y. Deng
	27348	E-4	S. Aleiferis
	27729	E-5	P. Chapon
	28605	E-6	R. Joussot
	28609	E-7	A. Klochko
	28234	E-8	J. F. Lagrange
	27516	E-9	S. Stepanov
	28637	E-10	F. Gherendi
	27508	E-11	C. Chang
E2	28750	E-12	S. Cuynet
	28656	E-13	W. P. Sun
	27248	E-14	Y. Yasaka
	28763	E-15	F. Diop
F1	28509	F-1	O. Eichwald
	27474	F-2	K. L. Pan
F2	28594	F-3	S. Hasse
	27721	F-4	K. Masur
	27477	F-5	G. Wattieaux
	27430	F-6	T. Sakoda
	28567	F-7	Y. Zhao
	28568	F-8	S. Iseni
	27364	F-9	H. Zerrouki
F3	28682	F-10	T. Darny
	28670	F-11	A. Khacef
	28671	F-12	A. Khacef
	27466	F-13	K. L. Pan

Scientific Session	Original paper no.	New paper no.	Speaker
G	28736	G-1	D. Astanei
	28585	G-2	M. Hogg
H	25693	H-1	Y. Zhao
I	27451	I-1	O. Kravchenko
	27552	I-2	O. Kravchenko
	28316	I-3	C. Zaepffel
J	27428	J-1	G. Jones
	26883	J-2	V. D. Karaventzas
	28740	J-3	S. Pellerin
	28558	J-4	S. Arumugam
	27519	J-5	S. Stepanov
	27950	J-6	P. G. Nikolic
	27360	J-7	X. Wang
	27627	J-8	G. Wattieaux
	28607	J-9	C. Laurent
K	28657	K-1	S. R. Sun
	27453	K-2	Y. Deng
	27487	K-3	A. Chicheportiche
	27447	K-4	S. Qin
	28573	K-5	E. Filimonova
	28501	K-6	H. Akashi
	27434	K-7	L. Wei
	28578	K-8	N. Popov
	27643	K-9	M. Hilbert
	27864	K-10	C. M. Franck
	27502	K-11	W. Wang
L	27485	L-1	I. Kosarev
	27489	L-2	I. Kosarev
	28580	L-3	A. B. Murphy
	28600	L-4	F. Valensi
M1	27635	M-1	S. Aleiferis
	28532	M-2	C. Duluard
	27529	M-3	C. Leu
	27600	M-4	M. Zhu
	35817	M-5	M. Kühn-Kauffeldt
	28743	M-6	N. Cerqueira
	27524	M-7	X. Zhou
M2	28565	M-8	A. Petin

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Other interest papers

July 6-11, 2014 - Orléans - France

20[th] international conference on gas discharges and their applications

A. Arcs

Other interest papers

July 6-11, 2014 - Orléans - France

20th international conference on gas discharges and their applications

B. Corona, Barrier and Surface Discharges

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Other interest papers

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20th international conference on gas discharges and their applications

C. Glows and Breakdown

F. Environmental and Medical Applications

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Merci à l'AAE

Merci à vous tous!