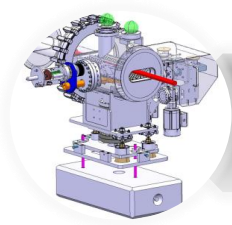


CERN expertise on Mechanics, Cryogenics, Vacuum and Material Science

EN-MME GROUP: MECHANICAL & MATERIALS ENGINEERING - DOMAINS OF ACTIVITIES



Engineering & Design
Measurement

- Internal **Design Office** facilities, ~42 designers (Staff and Industrial Support)
- CATIA / SmarTeam, ANSYS
- **Mechanical measurements lab**



Fabrication
Machining & Maintenance
Preparation & Subcontracting
Assembly & Forming

- 4000 m² of internal workshop facilities, 50 technicians (Staff and Industrial Support): CNC machining, sheet metal work & welding, electron beam & laser, vacuum brazing
- External **subcontracting service**
- Free access users workshop



Materials & Metrology

- **Material selection, analysis & metallurgy:** microscopy, mechanical testing
- NDT: US, radiography, tomography
- 350 m² of internal metrology facilities: CMM

We offer expertise in:

Many fields of technology and science (mechanics, electrics, electronics, physics etc...)

High vacuum and Cryogenic environment (technology, manufacturing and measurement)

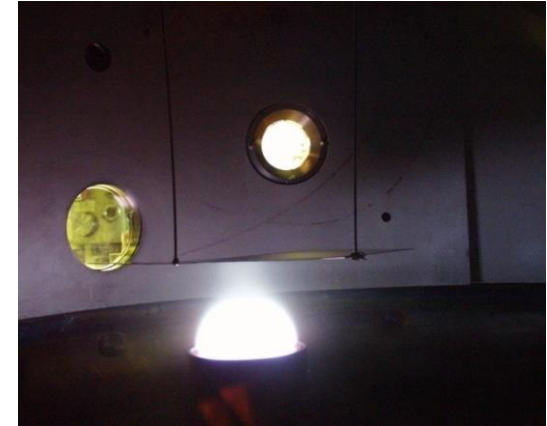
Material selection, analysis & metallurgy

Design and manufacturing of scientific devices and assemblies

TE-VSC GROUP: VACUUM, SURFACES AND COATINGS - DOMAINS OF ACTIVITIES

Expertise in the fields of:

- Design, construction, operation, maintenance and upgrade of high & ultra-high vacuum systems for Accelerators and Detectors.
- Vacuum sealing and leak-tightness technology
- Dynamic vacuum phenomena
- Vacuum control systems, interlocks and monitoring tools
- Management of the industrial support for vacuum work in accelerators
- Coatings, surfaces treatments, surface and chemical analysis for Accelerators and Detectors
- Thin film PVD coating (magnetron sputtering, evaporation)
- Thin-walled vacuum chambers, windows and bellows compensation systems
- Coatings, electroplating and surface cleaning techniques
- UHV characterization and of material and surfaces
- Degassing analysis and treatments
- Surface characterization and analysis (XPS, AES, Secondary Electron Yield)
- Chemical analysis (FTIR, UV-vis, Gas Chromatography, atomic absorption spectroscopy, DSC)
- Surface modification by surface finishing (UHV grade cleaning, etching, electroplating, electrochemical characterization...)



Lab size DC-magnetron sputtering facilities

Possibility to coat substrates up to 1.2 m length, substrate rotation for complex shapes

Up to 3 independent targets for alloy deposition with tunable composition



NEG (Non-Evaporable Getter)
TiZrV thin film coatings
Technology used to create and maintain ultra-high vacuum in the accelerator vacuum chambers

INTERESTS AND OPPORTUNITIES TO COLLABORATE

CERN has many (opportunities for) industrial collaborations

Only a limited manufacturing volume is done in our own workshop, mainly prototypes

We tender specific tasks in prototyping also to industry

Serial production in general is tendered to industry

3D printing with Laser, electron beam and new materials (polymer, metal and ceramics)

Powder sintering, PIM, MIM, CIM and other AM manufacturing methods and material development

The CERN Knowledge Transfer (KT) group handles the exchange with industry:

- NDAs
- Contract research
- Consultancy
- Services
- R&D Collaborations
- Licensing
- Spin-outs

Very successful case of KT in the field of coatings:

NEG license and partnership with a start-up company

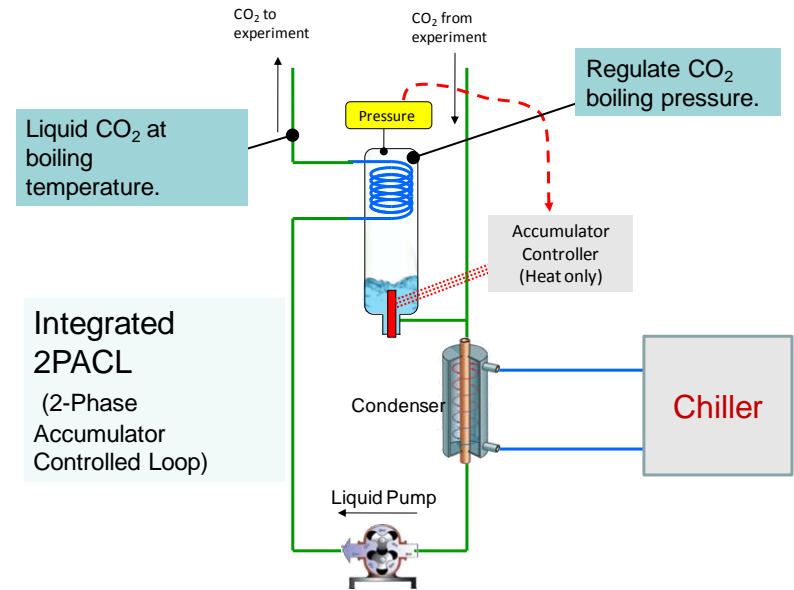
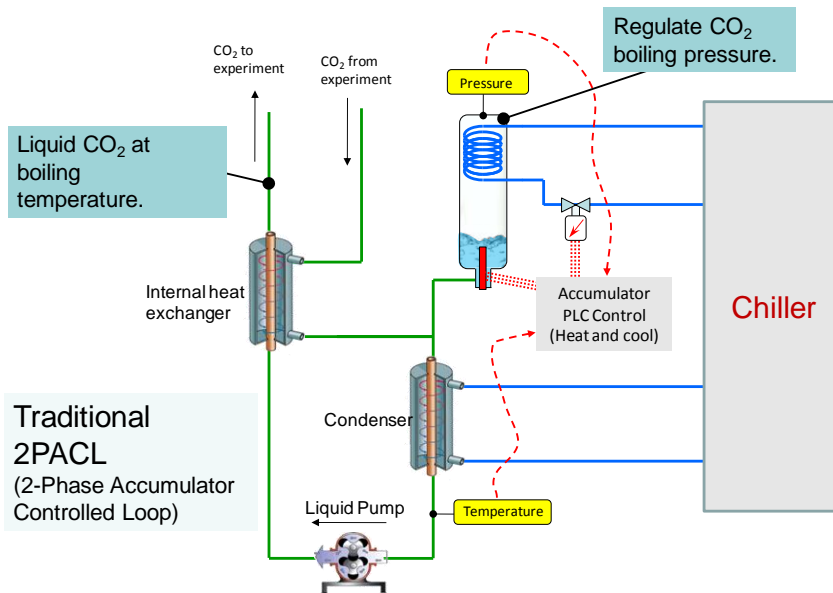
Development of a prototype production chain and a commercial product able to use diffused or indirect light and reach very high temperatures of up to 300 degrees. Now installed at GVA airport.

Also licensed to existing companies; in high demand.



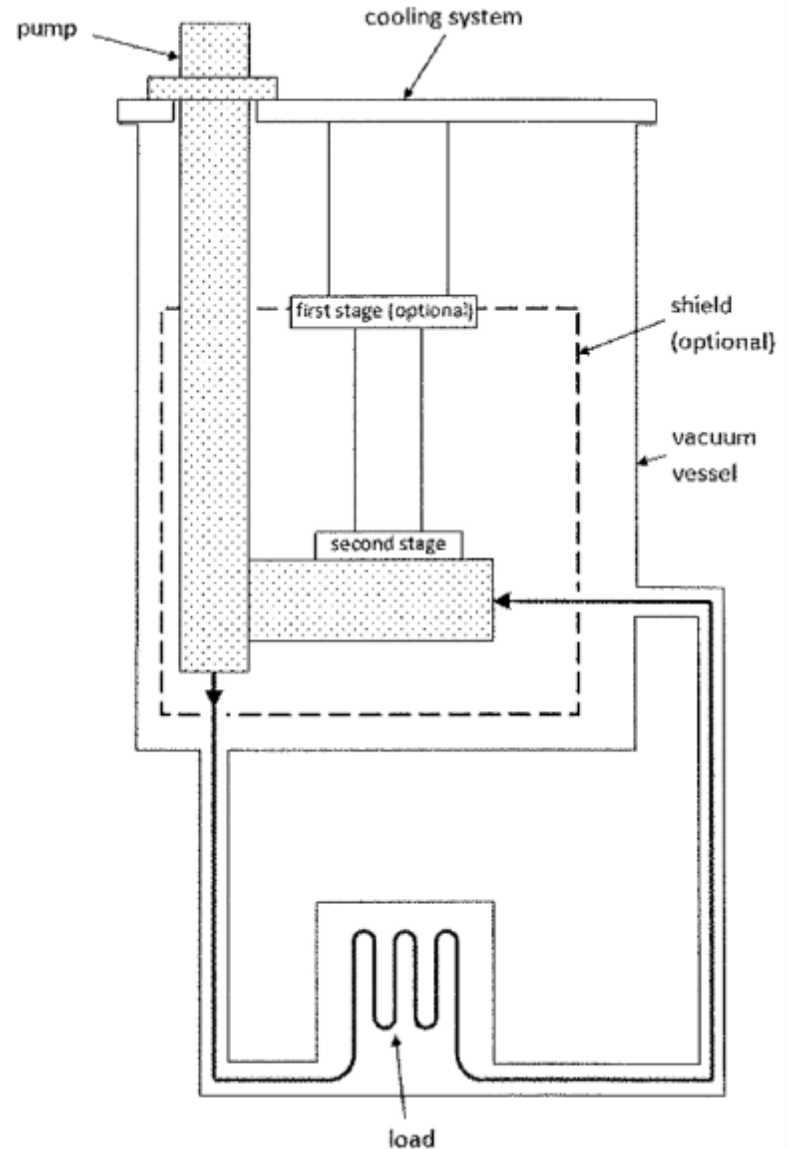
Integrated CO₂ cooling system

- Integrated 2-PACL modification of existing 2PACL system developed at Nikhef for the AMS-Tracker and LHCb-VELO CO₂ cooling systems.
- Different way of operating and control the original 2PACL concept. Makes system simpler, more reliable, better to control and cheaper.



Compact cryogenic pumping system

- Compact and robust pumping system capable of providing a constant flow of a cryogenic liquid or gas to a remote load.
- Can be integrated into a standard cooling system.
- For circulation of small amounts of re-condensed cryogenics in the ml/s range.
- Useful when object is integrated into a larger unit and:
 - Cannot be placed in a cryostat
 - Cannot be directly connected to the cold head
 - Is located remotely or in an environment that is not directly accessible.



Compact cryogenic pumping system

Applications

- With cryocoolers able to re-cool and or re-condense fluids (He) circulated to a “user”. It can also be applied to temperature ranges above the cryogenic. Well suited for cooling of remote objects, which may include:
 - Sensors
 - Superconducting magnets

Advantages

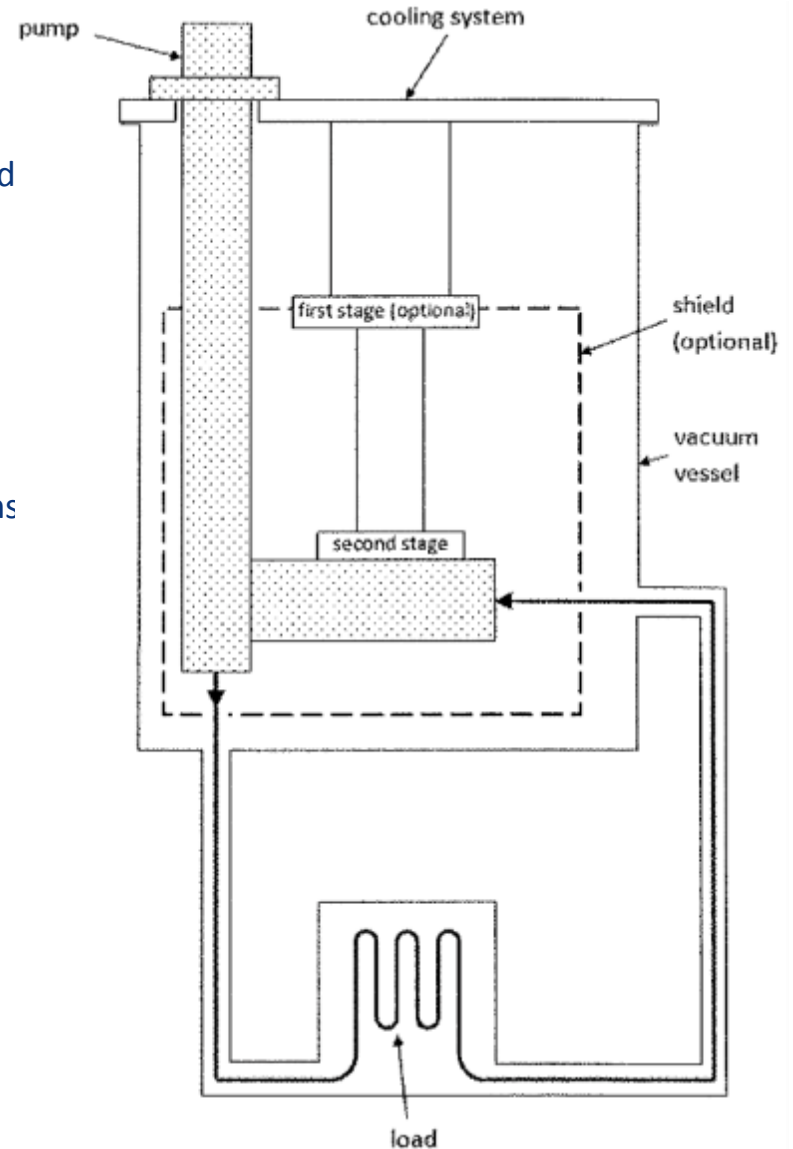
- Can circulate small amounts of re-condensed cryogens in the ml/s range and below.
- Allows the expansion of part of the fluid, providing a temporary cooling of the fluid beneficial for its functioning.
- Can also be applied to temperature ranges above the cryogenic, i.e. the low temperature and possibly also to even higher temperatures

Limitations

- Limited pumping capacity (ml/s range)

Intellectual property status

- Patent application filed (C31727PCT)



Rapid bellows compression tool

- For fast, easy and precise installation/removal of metallic bellows, typically in series installation and preventive maintenance operations.
- Allows fast axial compression/expansion of bellows using two concentric articulated collars permitting quick opening and closing around the bellow.
- Due to synchronized rotation of four threaded rods, the two articulated collars move parallel one to the other. The operator originates the rotation using serrated rollers, a crank or a motor.
- Can be adapted to different bellows that vary in shape and diameter, located in poor accessibility areas or requiring controlled compression and precise mounting.



Rapid bellows compression tool

Applications

- HVAC piping systems
- Vacuum and High-vacuum Technology
- General Engineering
- Bellows Used as Couplings
- Solar Technology
- Slip Ring Seal Fittings
- Shaft Seals
- Volume/Pressure Compensation

Innovative features

- Articulated collars surrounds the bellow
- Articulated collars move parallel one to the other
- Operated using serrated rollers, a crank or a motor

Advantages

- Fast installation, the new system is one piece
- Holds on the entire circumference of the bellow
- Uniform compression of the bellow
- Three different ways of manipulation to obtain compression/expansion

Limitations

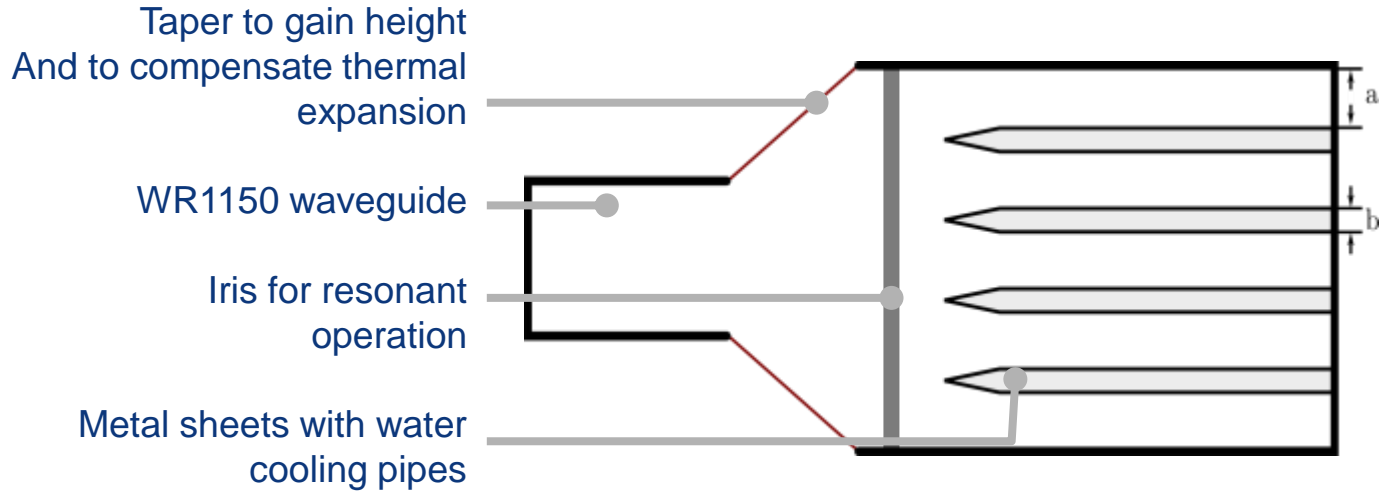
- The new system may require more space compared to existing solutions

Intellectual property status

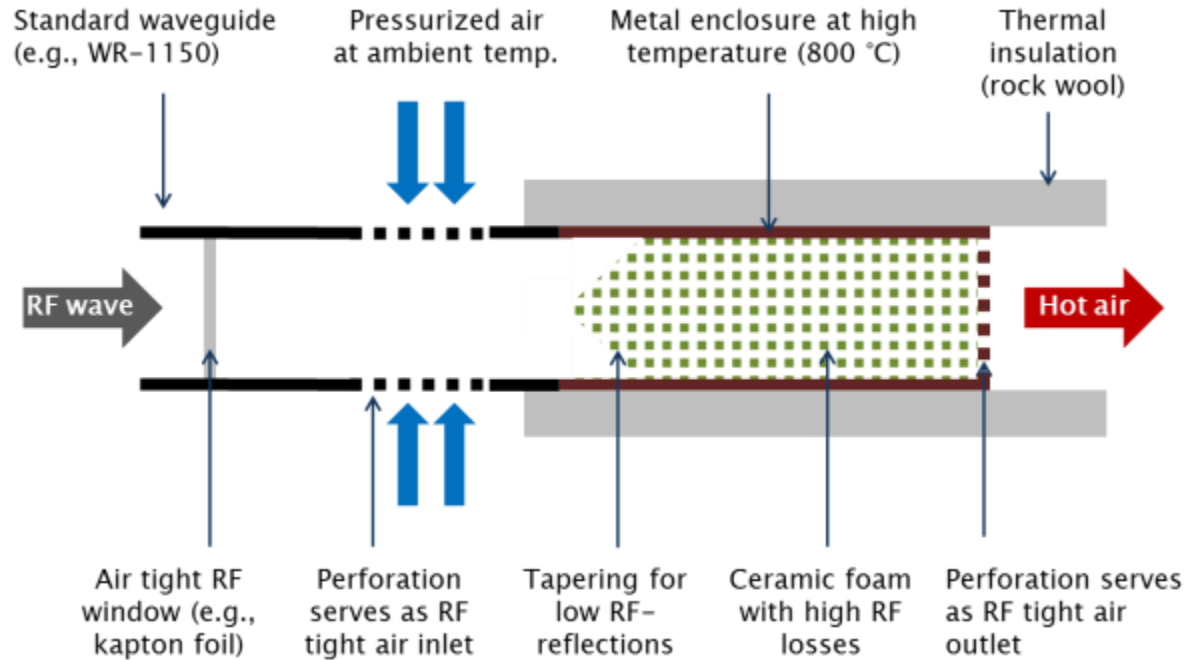
- Patent application filed (EP 12179567.8)



Cross section of a water cooled structure



Cross section of an air cooled structure



Technical results

- A low power prototype of the 2 loads has been constructed
- Narrowband material measurements of ferrite on a rubber carrier and SiC foam in a waveguide at 400 MHz have been carried out
- The concept and initial measurement results has been presented at “CW and High Average Power RF Workshop” in Lund, Sweden and at “IPAC 2012” in New Orleans, search for potential customers
- Broadband material measurements in a coaxial structure have been done recently (100 MHz – 2 GHz)
- Collaboration with RWTH Aachen to develop a ferrite powder plasma coating process. First samples have been done recently.
- Collaboration with Institute of modern physics, China, to adapt the technology of manufacturing commercial Crisp plates to waveguides
- Collaboration with CEA Saclay to use their high power RF test stand

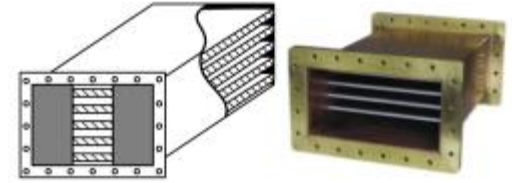


Figure 1: Prototype for the stacked structure built at CERN.



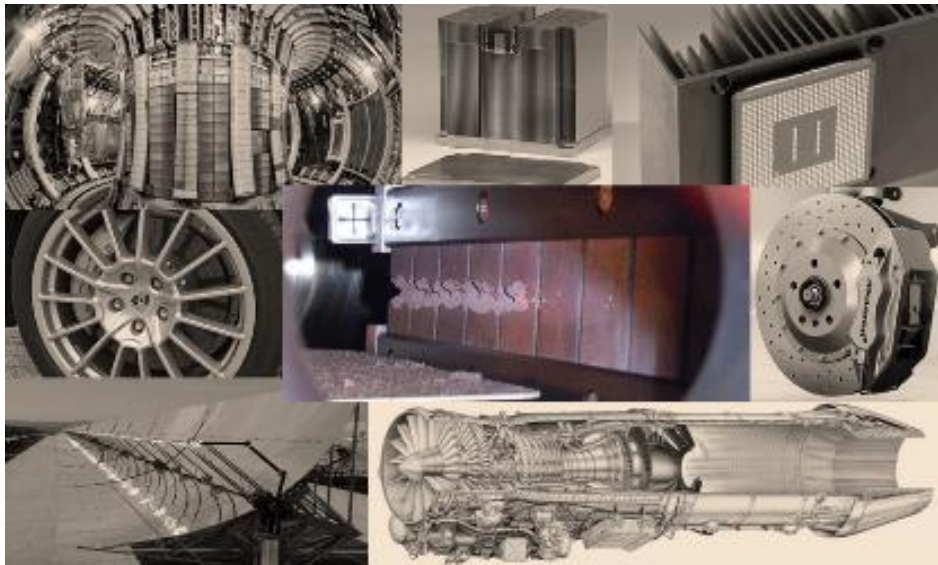
Figure 4: Setup to measure the prototypes of both proposed RF loads.



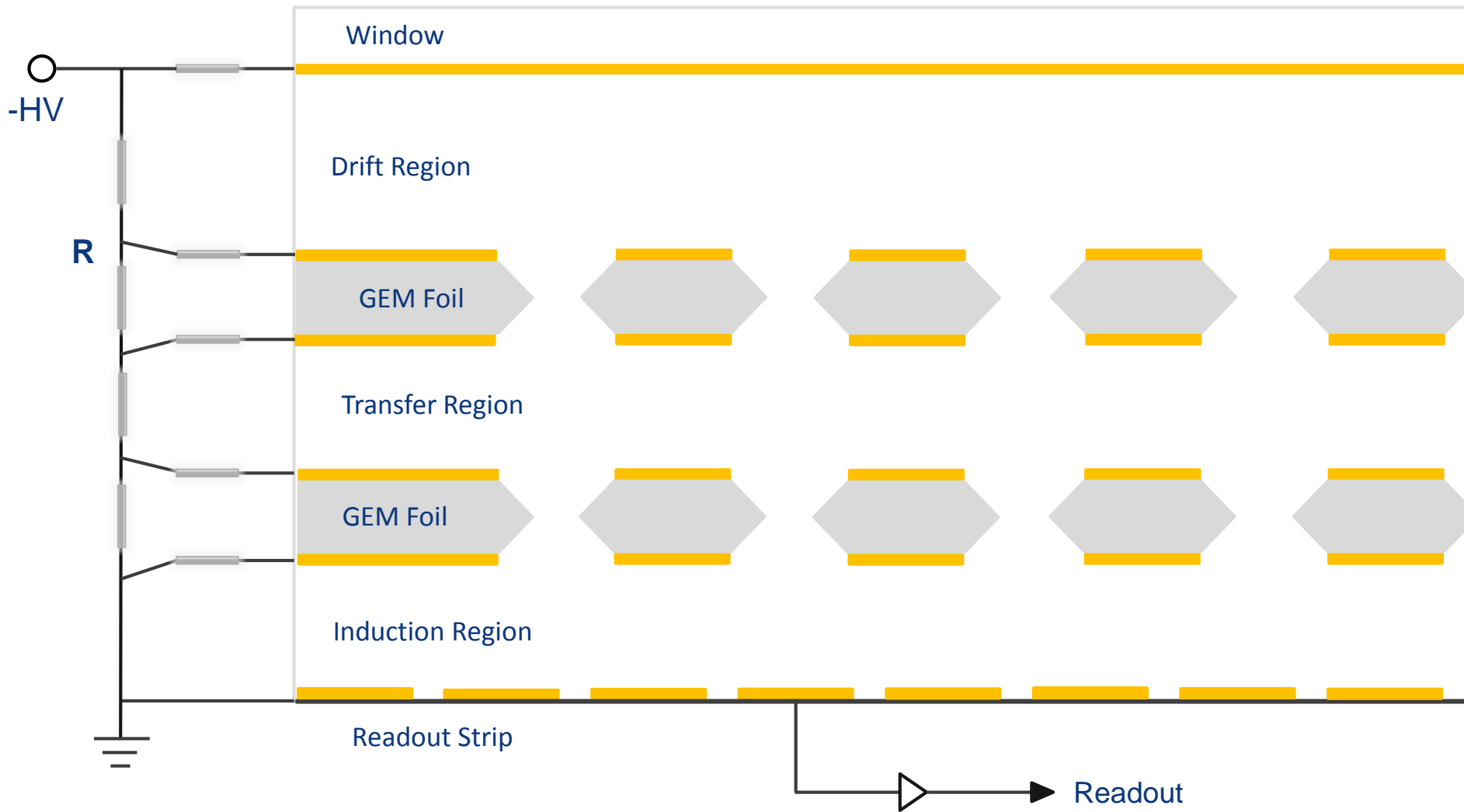
Broadband microwave measurement of SiC foam

Ceramic Matrix Composites

- Materials investigated are **Copper-Diamond (Cu-CD)**, **Molybdenum-Diamond (Mo-CD)**, **Silver-Diamond (Ag-CD)**, **Molybdenum-Graphite (Mo-Gr)**
- Most **promising materials** are **Cu-CD** and **Mo-Gr**.
- Ag-CD and Mo-CD are, by now, sidelined as they are limited by (relatively) low melting temperature (Ag-CD) and insufficient toughness (Mo-CD).
- **Mo-Gr** is particularly appealing as it is **easy to machine**, is **versatile** and can be **coated with a Mo layer** dramatically **increasing electrical conductivity**

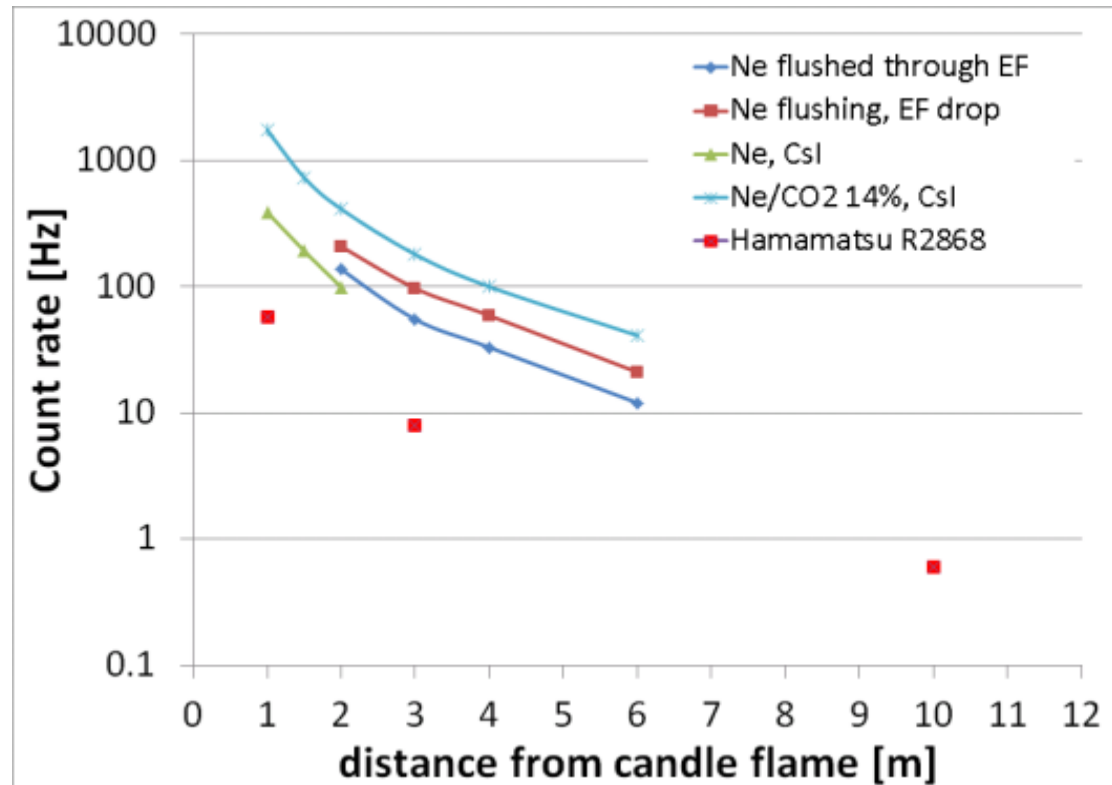
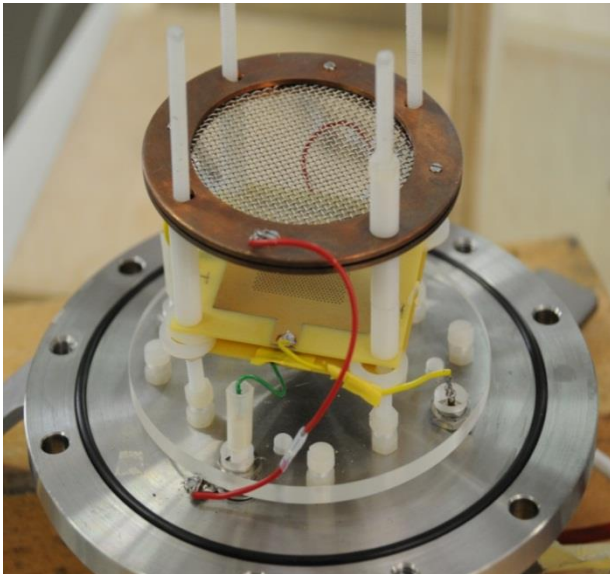
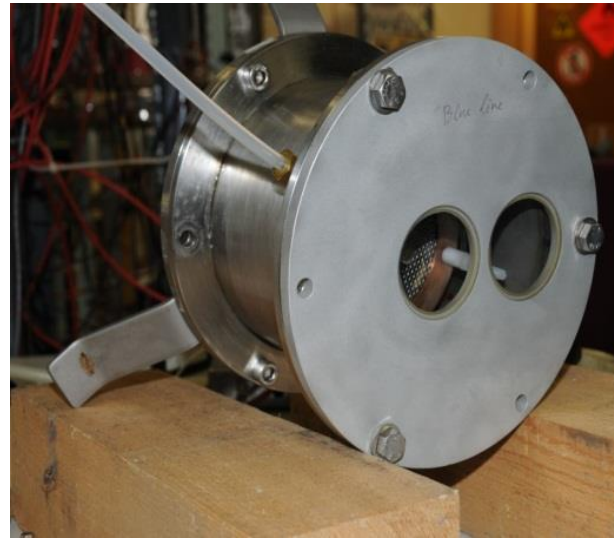


Gas Electron Multipliers GEMs



Flame/smoke detector

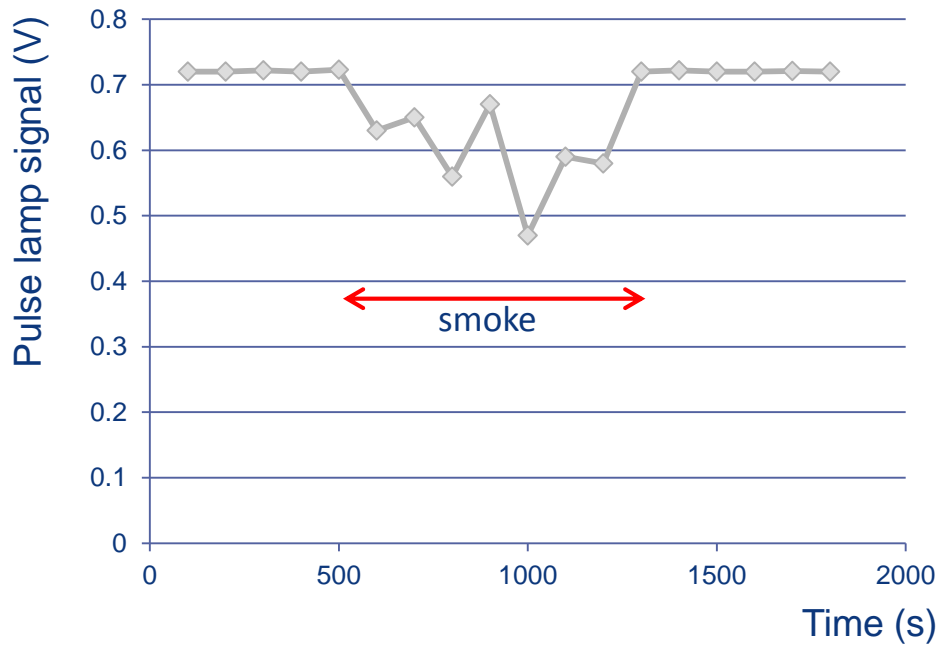
- Tests performed on two prototypes equipped with RETGEMs: one flushed with Ne saturated with Ethyl-ferrocene (EF) photosensitive vapours, the other one with CsI photocathode.
- Comparison to commercial devices: RETGEM-based detector sensitivity one order of magnitude larger than best commercial device (Hamamatsu)



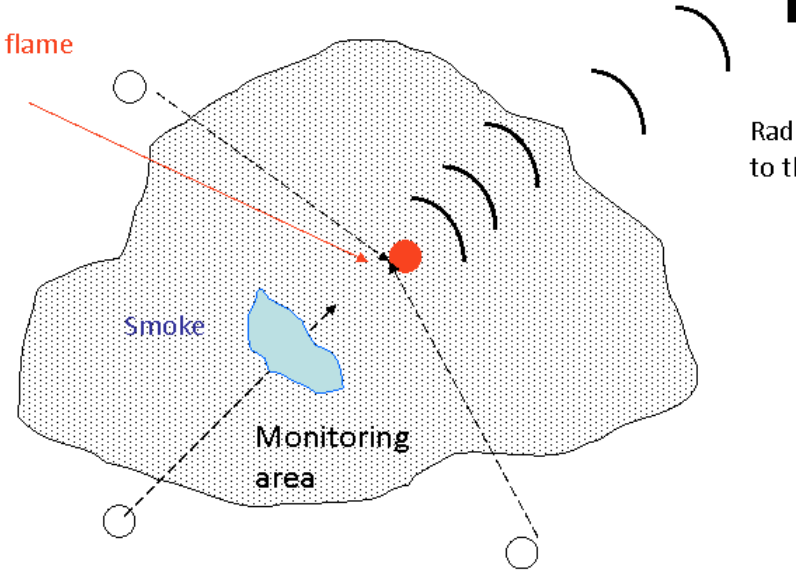
Flame/smoke detector

Smoke detection: in combination with compact pulsed UV sources the detector will also be able to detect smoke and dangerous gases.

- Prototype flushed with Ne+EF has been tested with pulsed D₂ lamp placed at 1.5 m



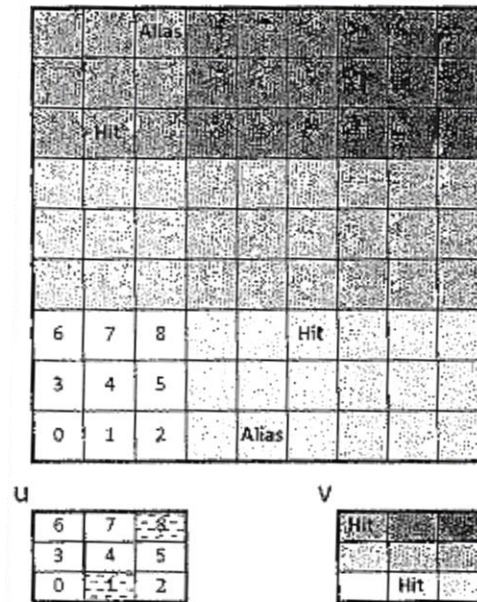
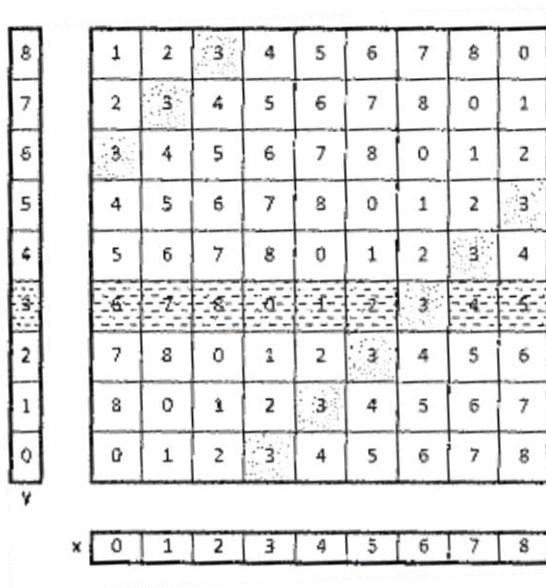
Array of our flame detectors



Network of pulsed UV sources

Data compression method for sparsely populated data and readout system for imaging detectors

- Method & system for compressing sparsely populated data.
- Data may be generated by array of sensitive elements of an imaging detector.
- Invention particularly suited for compression of data from imaging detectors.
- Further relates to frontend readout circuits for such imaging detectors.



MedEgun: Charge breeding for cancer therapy

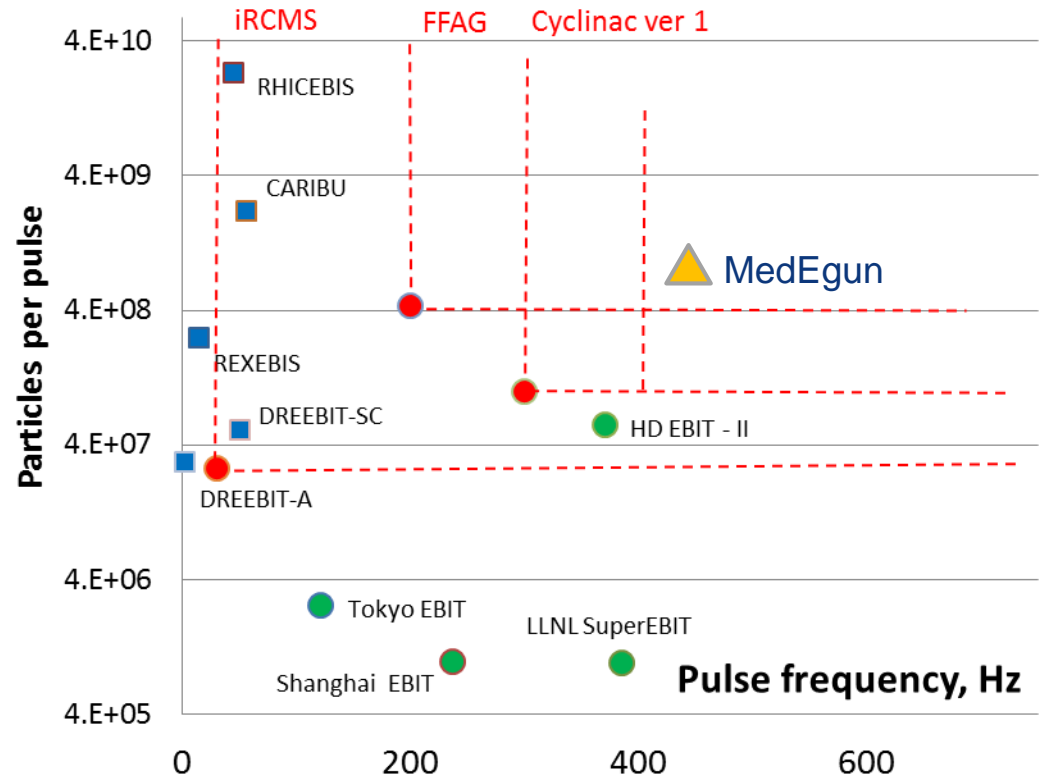
Plan:

High-compression electron gun ion source (EBIS)

- + Potentially very fast
- + Short ion pulses <5 us attainable for carbon ions (aim for single-turn inj.)
- + 6⁺ ions out of the source
- + Very low beam contamination

Requirements for charge breeders

EBIS/T as 2nd generation IBT C⁶⁺ injectors



Other technologies

- Aluminium ConFlat flange
- Compact cryogenic cooling pump
- Cryogenic Saving Unit
- Diaphragm System
- Fast front-end readout electronics for photon and electron counting applications
- Flame Detector
- Gas electron multiplier
- High power high frequency loads for energy recovery
- Integrated CO₂ cooling system
- Micro Chemical Vias
- Mounting mechanism for cantilever with high precision positioning
- Non-evaporable getter (NEG) thin film coatings
- OrthoPix Data compression
- Palladium thin-film coatings
- Pulse tube refrigerator/cryo-cooler
- Radon detector with high gas gain, operable in high humidity
- Rapid bellows compression tool
- Reduction of SEY by magnetic roughness
- Resistive MicroMegas
- RF Waveguide Vacuum Valve
- Thermal Management Materials
- Timing and High Rate Capable (THRAC) Gas Detector
- Titanium polishing