Cryogenic Safety
Beamline for Schools 2023

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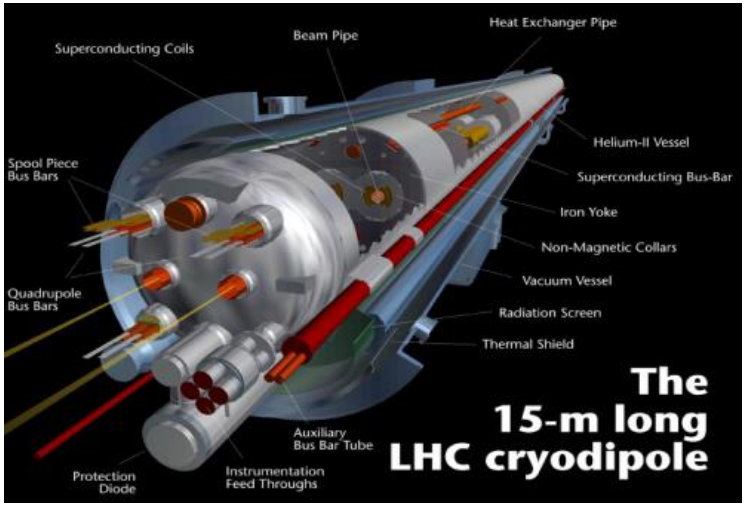
Welcome !

Cryogenics at CERN

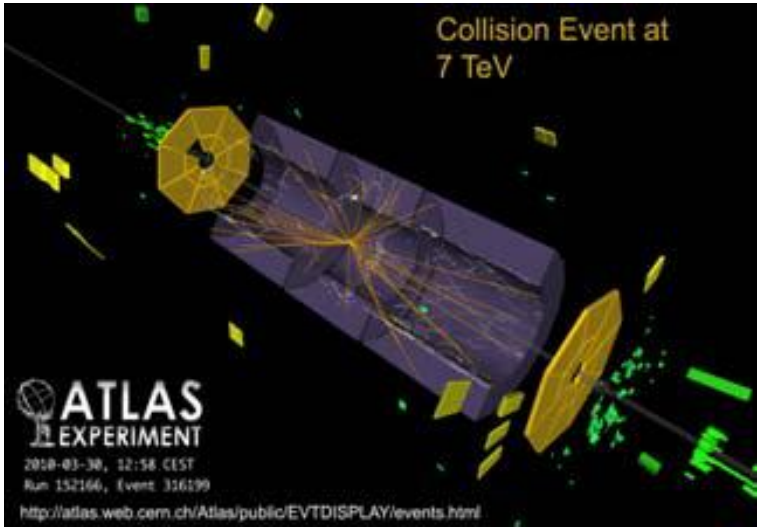
Main users – Accelerator magnets & cavities



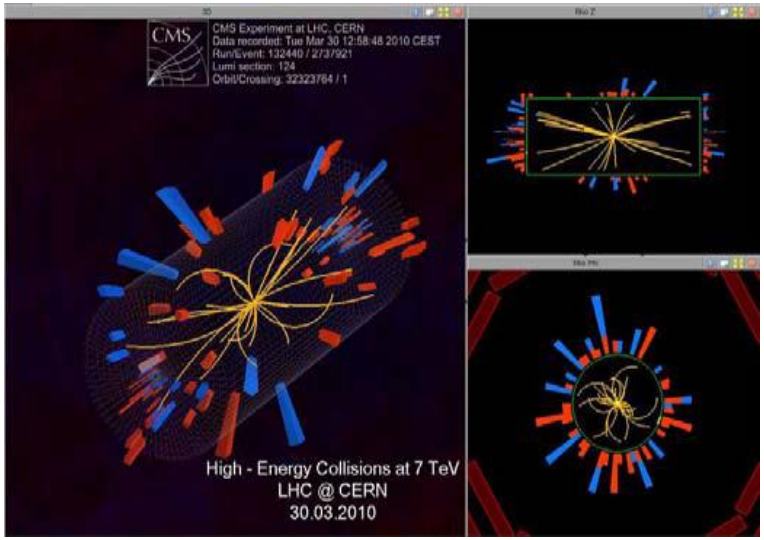
Superconducting magnets of LHC accelerator

Helium at different operating temperatures (thermal shields, beam screens, distribution and magnets,…)

Cryogenics at CERN
Main users – Physics detectors



Superconducting coils of LHC detectors (ATLAS, CMS)



Different types of cryogens (Helium, Nitrogen and Argon)

Cryogenic Hazardous Events

Thermo-physical properties

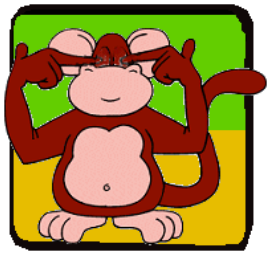
Fluid	^4He	N_2	Ar	H_2	O_2	Kr	Ne	Air	*Water*
Boiling temperature (T_b) in K at 1.013 bar	4.2	77.3	87.3	20.3	90.2	119.8	27.1	78.8	***373***
Latent heat of evaporation at T_b in kJ/kg	21	199.1	163.2	448	213.1	107.7	87.2	205.2	***2260***
Ratio volume gas (273 K) /liquid	709	652	795	798	808	653	1356	685	***…..***
Specific mass of liquid (at T_b) in kg/m^3	125	804	1400	71	1140	2413	1204	874	***960***

1 L of cryogenic fluid expands to about 700 L (0.7 m^3) of gas when warmed to ambient temperature (at constant pressure)

Demonstration: LN_2 properties: clear liquid, mist of moisture, balloons

Cryogenic Hazardous Events

Cryogens – Warning signs



Eyes

Ears

Nose

Liquid or gaseous cryogens are odourless and colourless.

Surface temperatures are not obvious

The human senses do not warn!

OFTEN ONLY secondary signs:

Ice, water, air condensation (!) → indicates cold surfaces

Fog → may indicate a leak of liquid or gazeous cryogens

Cryogenic Hazardous Events

Pressure rise

Explosion of a Dewar with 50 L - 2005

Example of a Dewar LN2 50L

Demonstration: Table tennis ball, film box

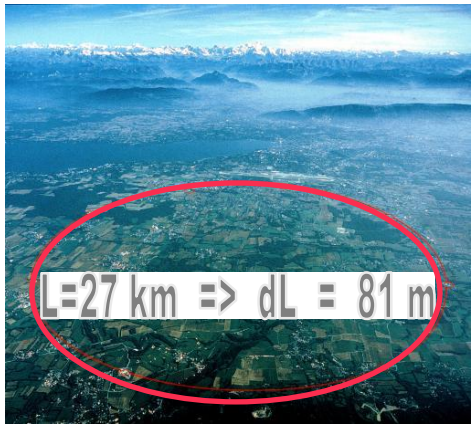
Cryogenic Hazardous Events
Technical risks

Embrittlement

- Some materials become brittle at low temperature and rupture when subjected to loads
- Protect surrounding equipment/structures from crogens discharge.

Thermal contraction (293 K to 80 K)

- Stainless steel: 3 mm/m
- Aluminium: 4 mm/m
- Polymers: 10 mm/m



Demonstration: Rubber tube, Al plate hole

Cryogenic Hazardous Events
Technical risks

Combustion / Fire

- Use of flammable cryogens (e.g. Hydrogen).
- Liquid oxygen can cause spontaneous combustion. Adheres to clothing and presents an acute fire hazard.

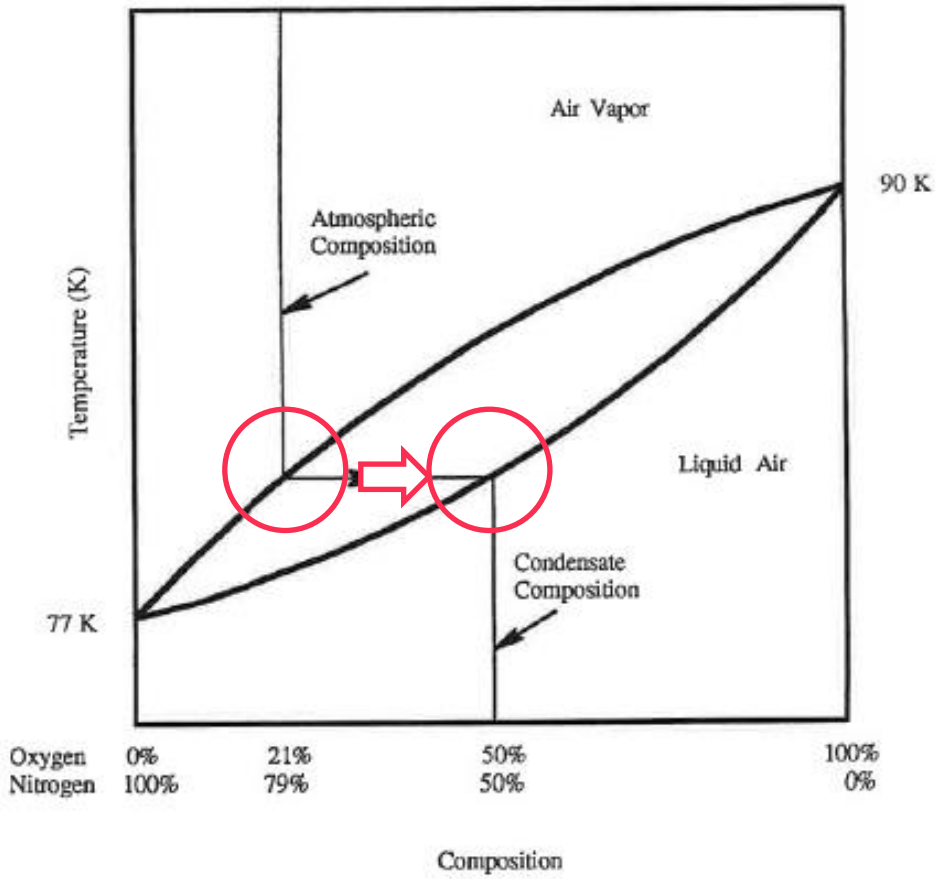
Condensation of atmospheric gases

- Innappropriate insulation or discharge of cryogens can lead to oxygen enrichment
- Mainly observed at tranfer lines and during filling operations

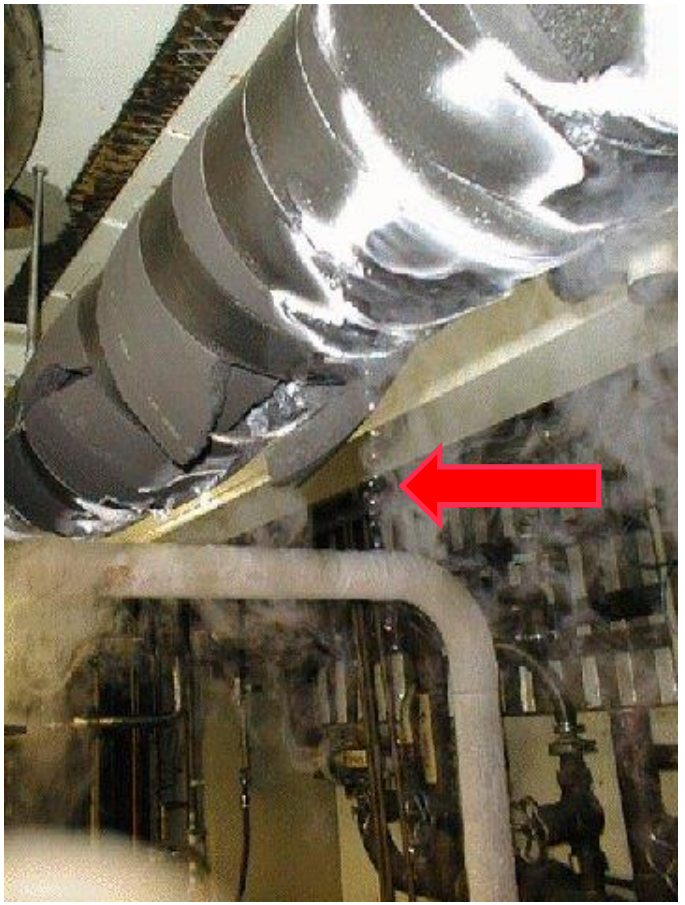
  (liquid air → **50% O_2** instead of 21% in atmospheric air)

Cryogenic Hazardous Events

Condensation of atmospheric gases – Oxygen enrichment



From: F. Edeskuty, Safety in the Handling of Cryogenic Fluids



Demonstration: Oxygen enrichment at cone

General Safety Practices
General practice



Wear Personal Protective Equipment (PPE)

- Safety glasses (or face shield)
- Cryogenic gloves → loosely fitting
- Full length pants that extend over shoe tops
- Closed-toed shoes that are impermeable to liquids

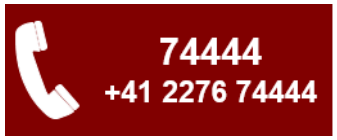
Warning signs to know and respect:

Demonstration: LN_2 through fabric

Thank you for your attention.

Be safe and have a great time!

In case of an emergency, call

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