

# Irradiation Facilities at CERN for RD-51

Mar CAPEANS  
CERN

Micro-Pattern Gas Detectors (RD-51) Workshop  
Nikhef, Amsterdam, April 16-18 2008

# Detector Development Phase

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From Prototype to Detector Systems, need several rounds of:

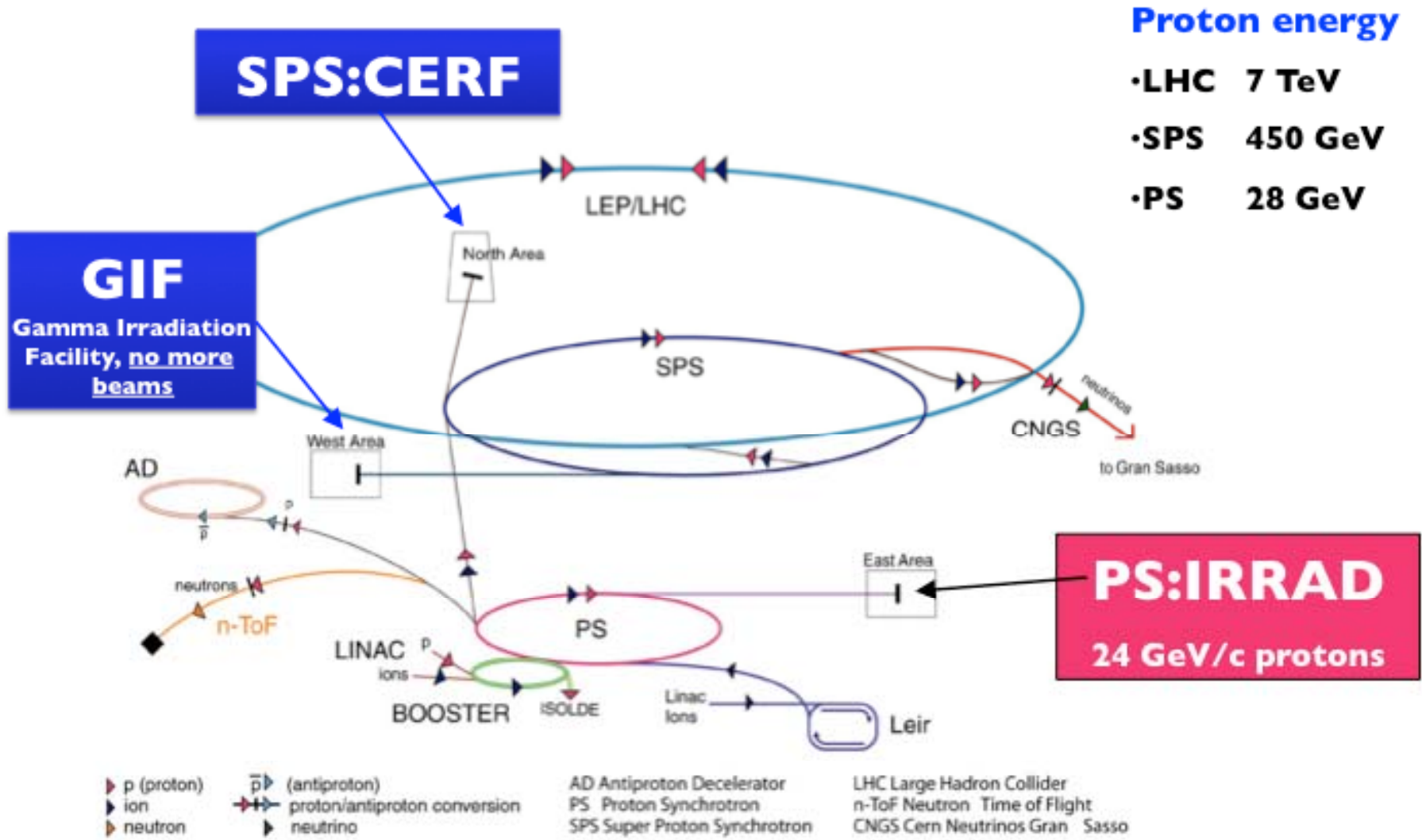
- ▶ Basic R&D
- ▶ Lab measurements
- ▶ Beam tests (performance)
- ▶ Long-term tests (aging)
- ▶ Detector material studies (radiation)
- ▶ Electronics (performance and radiation)
- ▶ Services validation (cooling, gas, etc)
- ▶ Final detector aging tests (large area irradiation)
- ▶ Final detector system tests
- ▶ Integrated system tests

# Outline of this Talk

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- ▶ Existing and Future Irradiation Facilities at CERN
- ▶ Beam Tests
- ▶ Generic Aging and Material Studies Effort
  
- ▶ Towards an RD-5I Irradiation and Beam Test Programme

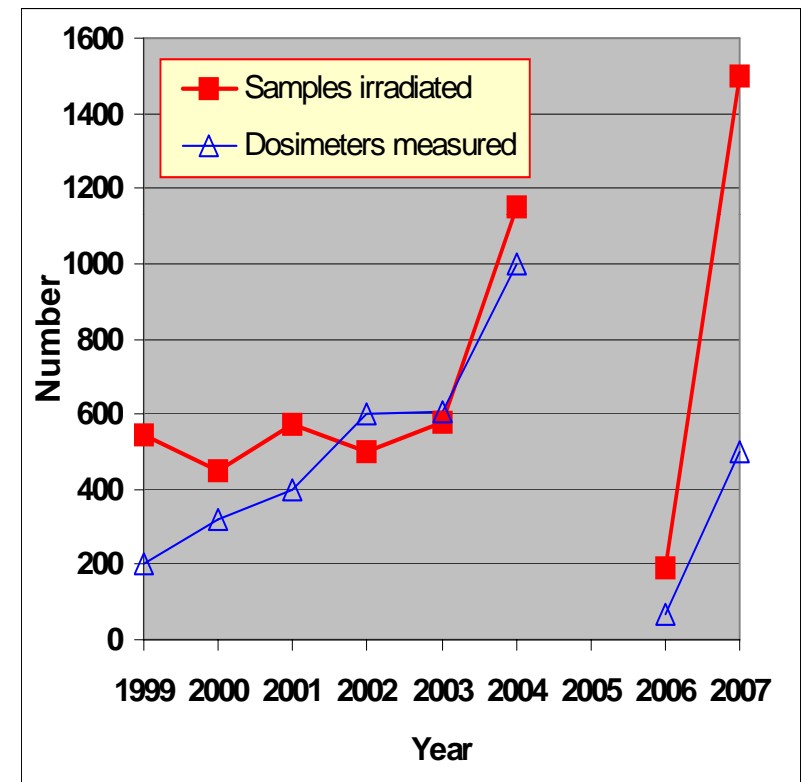
# Existing CERN Irradiation Facilities



# CERN PS East Hall: IRRAD

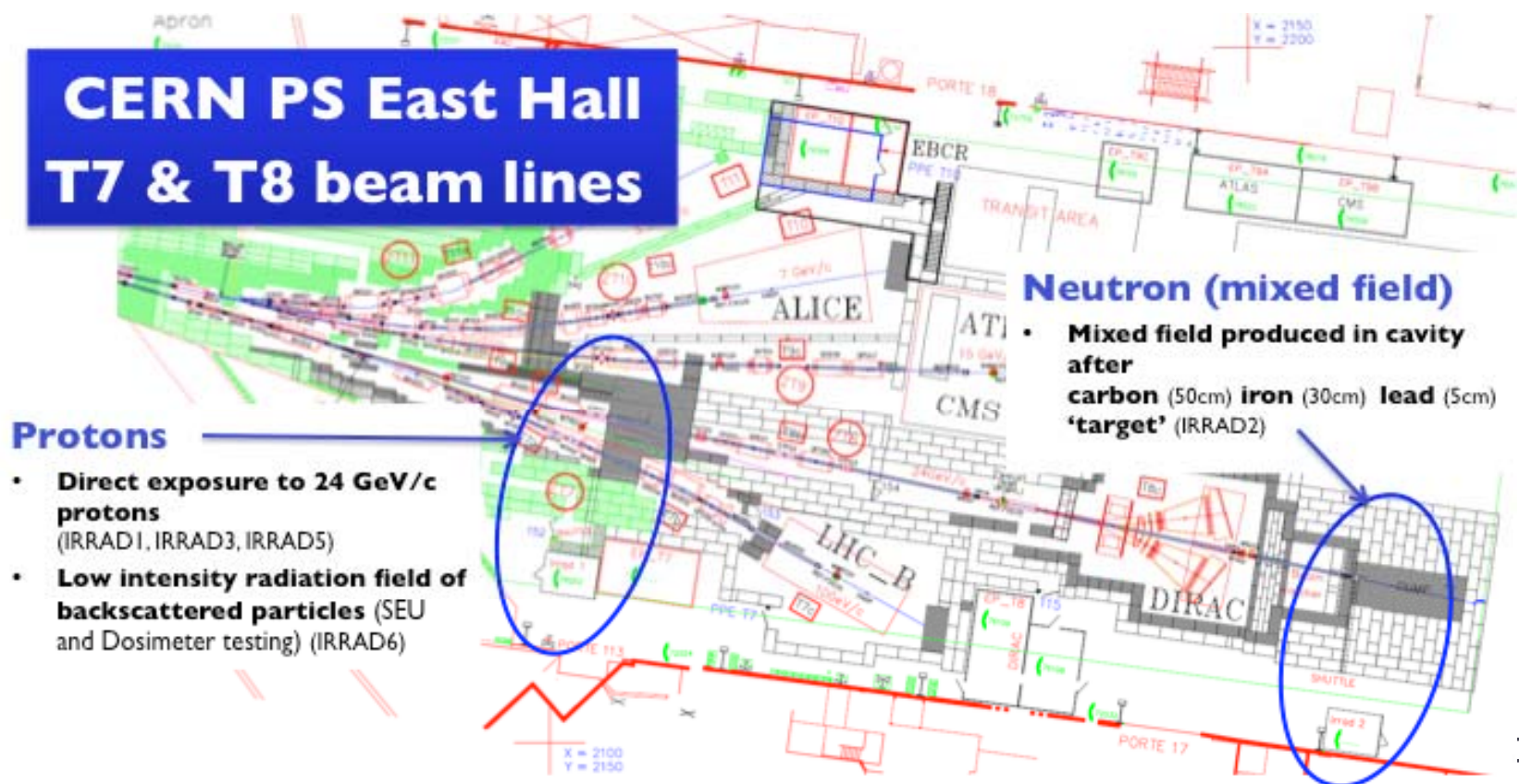
- ▶ The irradiation facilities in the PS East Hall belong to the common projects of the CERN PH department
- ▶ PH-DT (*M.Moll and M.Glaser*) provides the maintenance and constant upgrade of these facilities as well as dedicated irradiation experiments
- ▶ The facilities have been heavily used during the LHC R&D phase (in particular innermost detector components – silicon tracking detectors, electronics, materials)
- ▶ Annual availability ~130 days

M.Moll (CERN)



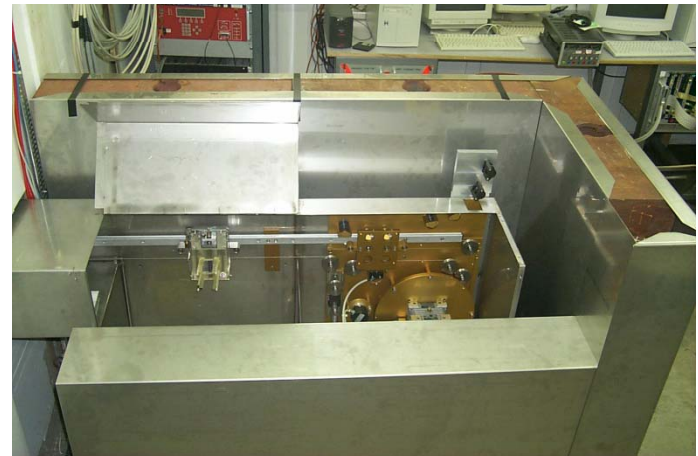
# CERN PS East Hall: IRRAD

- ▶ Three kind of irradiations are provided:
  - ▶ 24 GeV/c proton irradiations
  - ▶ Mixed field (mainly 1 MeV neutrons)
  - ▶ Organization/Coordination of irradiations outside of CERN



# CERN Proton Irrad Facility

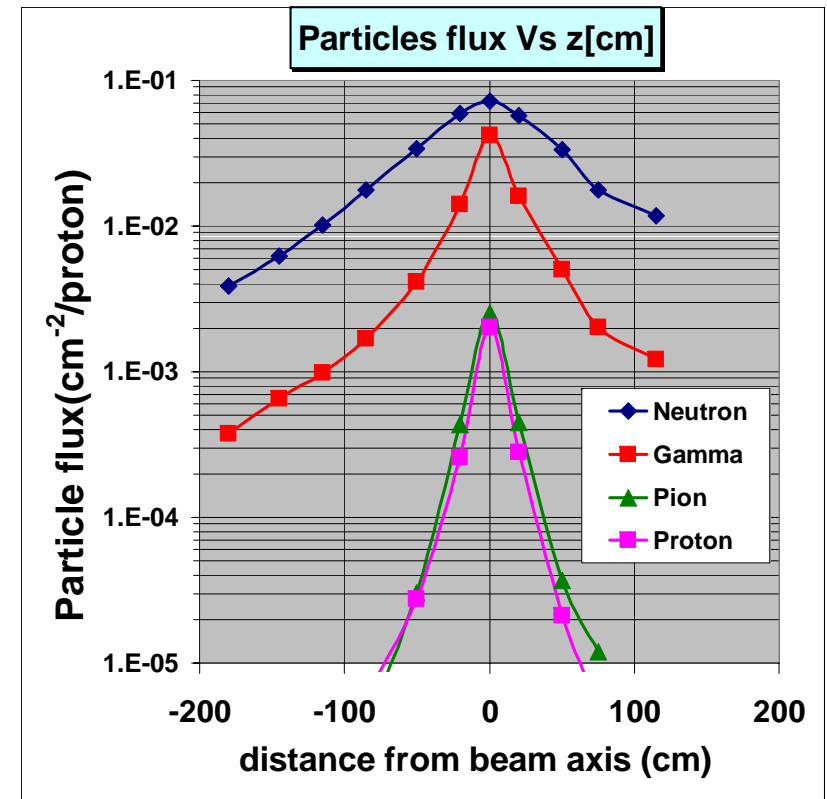
- ▶ Beam Energy: 24 GeV/c
- ▶ Proton flux:  $1-5 \times 10^{13}$  p/hour/cm<sup>2</sup>
- ▶ Beam spot: 2 x 2 cm<sup>2</sup>
- ▶ Located in the main beam area
  - ▶ Access on request (beam off everywhere!)
- ▶ Infrastructure
  - ▶ x-y-z movable tables (max 100 Kg)
  - ▶ Irradiation inside cooled (-20°C) and atmosphere controlled (e.g. N<sub>2</sub>) boxes (max volume 20x20x50 cm<sup>3</sup>)
  - ▶ Scanning over surfaces up to 20x20 cm<sup>2</sup> (according reduction in flux/cm<sup>2</sup>)



*M.Glaser, M.Moll*

# CERN Neutron Irrad Facility

- ▶ Particle field created by 24 GeV/c p on C/Fe/Pb targets
- ▶ Mixed field: n, p,  $\pi^+$ ,  $\pi^-$ ,  $\gamma$
- ▶ Neutron flux:  $1-3 \times 10^7$  n/s/cm<sup>2</sup> | MeV (at 50 cm from beam axis)
- ▶ Std. vol. 20 x 20 x 20 cm<sup>3</sup>





# CERN Gamma Irradiation Facility (GIF)

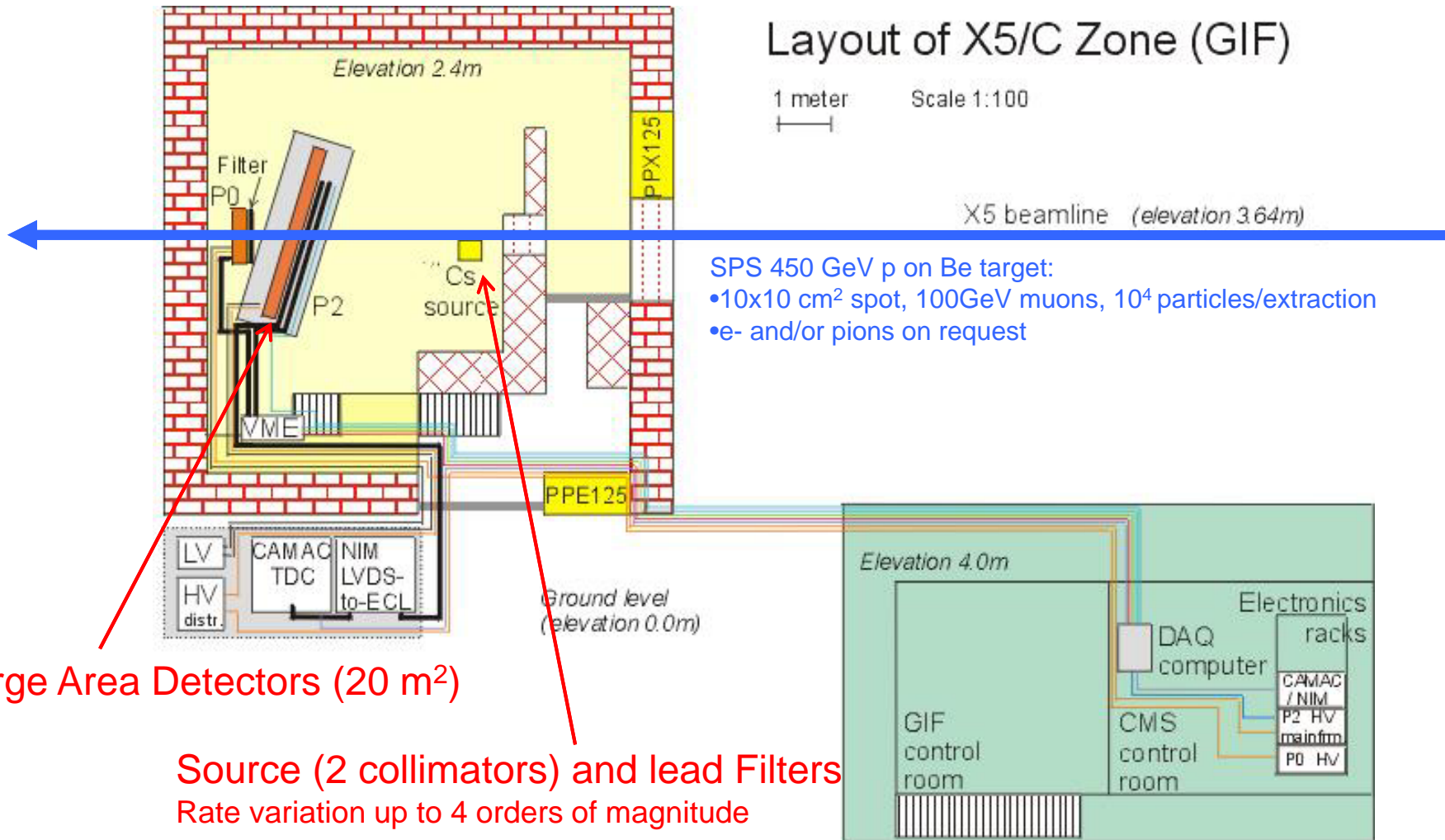
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- ▶ **1998: Combination of a gamma source and particle beams**
  - ▶ Gamma source  $\text{Cs}^{137}$  740GBq (1997) with 662 keV photons, at 50cm 15rad/h
  - ▶ Electron, pion and muon beams 5 to 250 GeV,  $10^6$ - $10^7$  particles/spill from SPS
- ▶ **2004 - 2009: gamma source (aged), NO particle beam**
  - ▶ Nominal Flux:  $0.86 \times 10^5$  photons/cm<sup>2</sup>/s at 4 m on axis of the source
  - ▶ 2<sup>nd</sup> collimated smaller beam providing  $4.4 \times 10^6$  photons/cm<sup>2</sup>/s at 1 m
- ▶ **CERN PH/DT facility, technical support by R.Fortin at present**

# CERN Gamma Irradiation Facility (GIF)

Layout of X5/C Zone (GIF)

1 meter Scale 1:100



SPS 450 GeV p on Be target:

- 10x10 cm<sup>2</sup> spot, 100GeV muons, 10<sup>4</sup> particles/extraction
- e- and/or pions on request

Large Area Detectors (20 m<sup>2</sup>)

Source (2 collimators) and lead Filters  
Rate variation up to 4 orders of magnitude

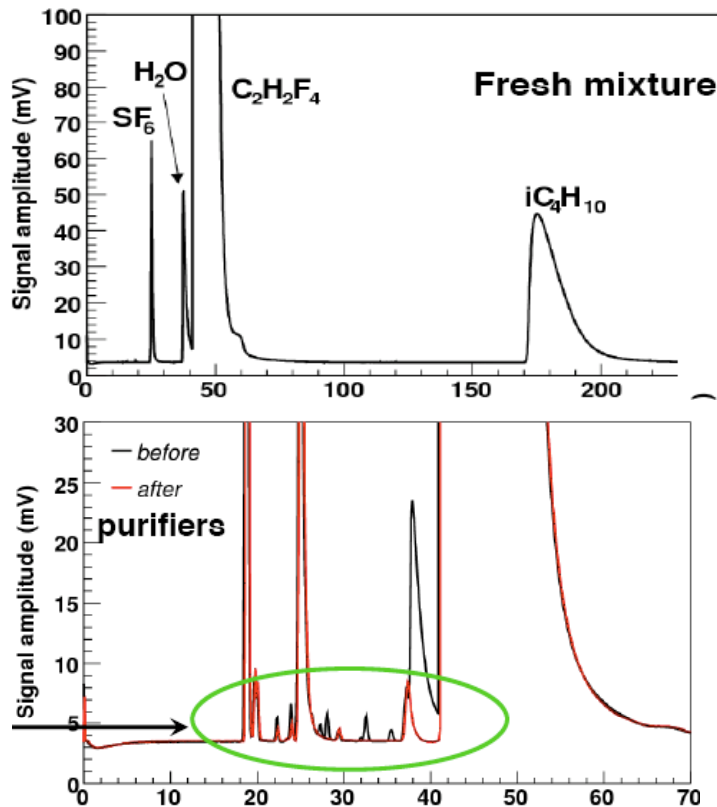
# CERN **G**amma **I**rradiation **F**acility (GIF)

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- ▶ **Users:**
  - ▶ LHC experiments (mainly gas detectors, calorimeters)
  - ▶ Also PS/SPS experiments, LHC machine
- ▶ **Annual availability ~ all year round**
- ▶ **> 190 NIM articles**

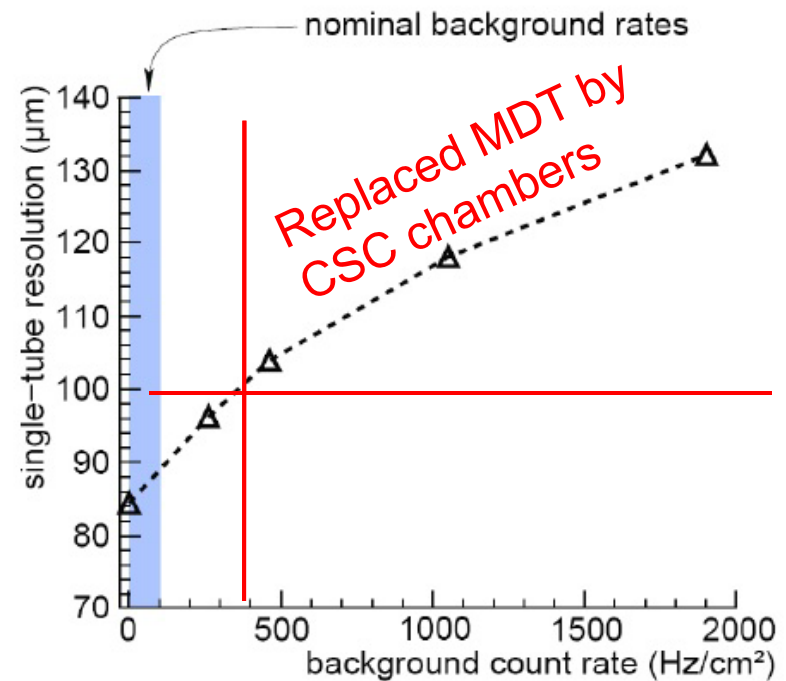
# Examples of Findings at GIF

- ▶ Validation of Closed-loop Gas Systems (and its filtering elements) for LHC RPC detectors



- ▶ Characterization of ATLAS Muon MDT: study of detector resolution as function of background rate

(gamma source = background, beam = signal)



# Future CERN Irradiation Facilities

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- ▶ LHC (accelerator and detectors and their electronics) will need more irradiation experimentation with time, as flux (luminosity) increases
  - ▶ SLHC  $\sim 10 \times$  LHC
- ▶ LHC detectors/electronics may need available set-ups to perform tests at short-notice
- ▶ Key for new detector developments

# Irradiation Facilities Upgrade Task Force

## ▶ Goals:

- ▶ Coordinate the effort CERN wide
- ▶ Upgrade the facilities according to user requirements
- ▶ Find common solutions

## ▶ Questionnaire sent out:

<http://irradiation-facilities.web.cern.ch/irradiation-facilities/>

### Irradiation facilities at CERN

<b>contents</b>	Future irradiation facilities at CERN - Questionnaire -
<ul style="list-style-type: none"><li>• <a href="#">Irradiation facilities working group</a></li><li>• <a href="#">Questionnaire regarding future CERN irradiation facilities</a></li><li>• <a href="#">Radiation facilities at CERN</a></li></ul>	CERN is presently evaluating the needs for future irradiation facilities at CERN. You are kindly requested to facilitate this operation by answering the below given questionnaire.
<b>Restricted</b> to Working Group Members:	This enquiry is covering the needs for gamma, proton and mixed field irradiation facilities as well as the need for a future GIF facility and fast extraction tests.
<ul style="list-style-type: none"><li>• <a href="#">Questionnaires and statistics</a></li><li>• <a href="#">Statistics pages as on 18.3.08</a></li><li>• <a href="#">Internal documents</a></li></ul>	Please fill in one questionnaire per type of radiation facility you require from the following list:
<a href="#">Irradiation Facilities Working Group © 2008</a> <a href="mailto:irradiation-facilities@cern.ch">irradiation-facilities@cern.ch</a>	<ul style="list-style-type: none"><li><a href="#">Pure gamma</a></li><li><a href="#">GIF++ (gamma irradiation combined with particle test beam)</a></li><li><a href="#">Proton</a></li><li><a href="#">Mixed field (neutron-dominated)</a></li><li><a href="#">High-energy high-Z ion</a></li></ul>
	Please feel free to forward this questionnaire to interested colleagues.
	Many thanks for your help, Irradiation Facilities Working Group
	<small>Irradiation Facilities Working Group © 2008 <a href="mailto:irradiation-facilities@cern.ch">irradiation-facilities@cern.ch</a> - CERN</small>

140 answers

# Irradiation Facilities Upgrade

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- ▶ Trends:
  - ▶ **Proton / Gamma / Neutron**
  - ▶ Higher rate/dose (SLHC flux)
  - ▶ Large space for large samples and detectors
  - ▶ Dedicated beams
  - ▶ Better and user-friendly infrastructure to minimize set-up time
  
  - ▶ GIF with or without particle beam?
  - ▶ Dedicated set-ups or temporary installations?
  
- ▶ **Need input from RD-5 I community. Please, click below:**  
<http://irradiation-facilities.web.cern.ch/irradiation-facilities/>

# RD-5 I Beam Test Roadmap

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Build a permanent RD-5 I set-up in SPS line, over few years?

- ▶ Define subset of RD-5I groups involved in setting up and maintaining the facility, and also in defining the test programme
- ▶ Build common general infrastructure
  - ▶ Services (gas systems, cooling, HV, LV, cables, etc)
  - ▶ DAQ/Controls/Trigger modules
  - ▶ Analysis SW tools
  - ▶ Access to Magnet
  - ▶ High precision, fast beam telescope
- ▶ Goals:
  - ▶ Share resources
  - ▶ Minimize effort (keep infrastructure and upgrade it slowly)
  - ▶ Group requests (beam time)
  - ▶ Community building





# Aging Test & Materials Studies Effort

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- ▶ Over the next 4 years, CERN will invest some resources on **Facilities and Component Analysis for Detector R&D**. In addition to the upgrade of irradiation facilities, there is the wish of:
  - ▶ Creating a generic aging facility for gas detectors, building up on the experience and set-ups used during the construction and tests of LHC detectors (e.g. ATLAS TRT)
  - ▶ Start a focused R&D on materials for detector development towards SLHC

*CERN jargon: **White Paper, Theme 3, Workpackage 7***

*<http://ph-dep.web.cern.ch/ph-dep/InfoCommunication/FM/FM15Nov07/Linssen.pdf>*

# Aging Test & Materials Studies Effort

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- ▶ Establish reference procedures and generic facilities suitable for higher rates
- ▶ Perform tests, on short notice if needed
- ▶ Identify radiation tolerant and/or outgassing free and/or chemically compatible and/or etc. material lists – in particular for SLHC – and not limited to gas detectors:
  - ▶ Assembly materials (epoxy glues, rigid materials, etc.)
  - ▶ Sensors (slow control, radiation monitors) and complete devices
  - ▶ Fluids (active gases, coolants) and filtering techniques
- ▶ Produce (limited set of) compilation reports and catalogs

# Summary

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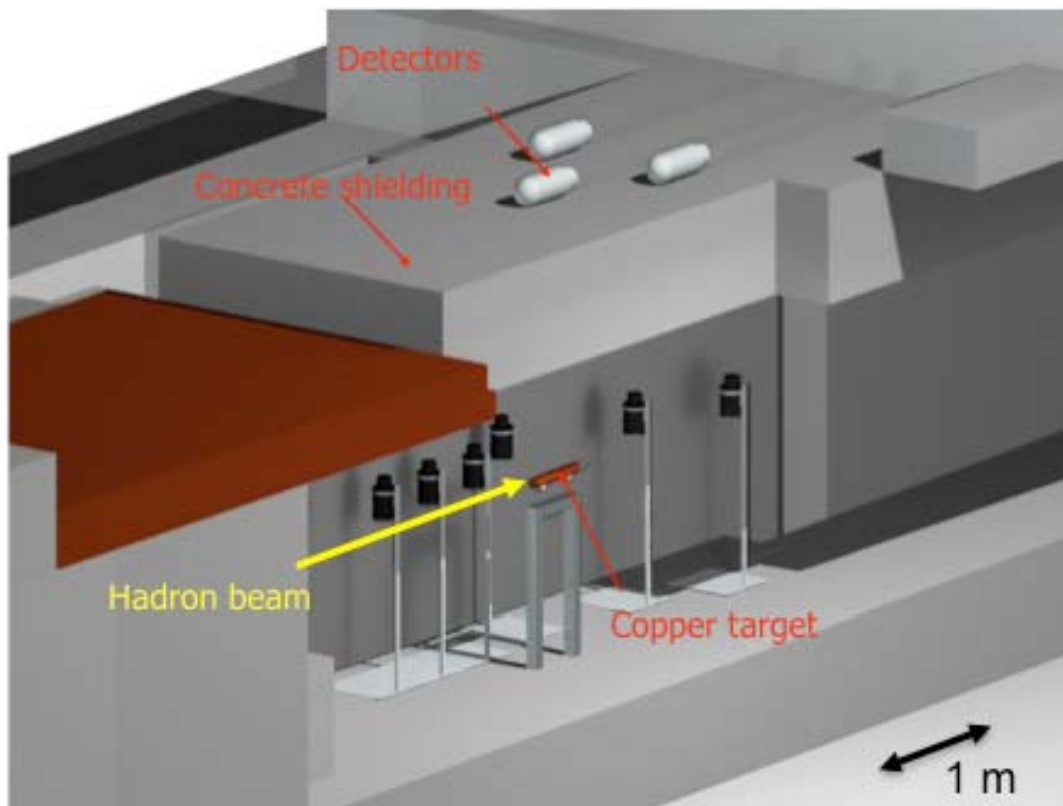
- ▶ CERN PH Department is starting an important effort towards upgrading and improving the CERN irradiation and beam test facilities
- ▶ RD-5 I, as a collaboration, should get involved, give input, participate and use these facilities in an optimal way
- ▶ Will require internal organization and a group taking responsibilities for operating these facilities for RD-5 I users
- ▶ Will help significantly in:
  - ▶ developing a real collaboration
  - ▶ creating a certain standard for measurements and qualitative results, going across the entire micro-pattern community

# Extra Slides

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# CERN-EU high-energy Reference Field (CERF) facility

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- ▶ 1992
- ▶ SPS Secondary beam line (H6) in North Area (Preveessin)
- ▶ 120 GeV/c hadron beam on Cu-target producing a high-energy mixed radiation field produced by EM and hadronic cascades

# CERF Facility

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- ▶ Neutron **field** (0.1-1 MeV and 10-100 MeV regions)
- ▶ **Dose:** 0.02 Gy/h to 10 Gy/h
- ▶ **Users:** test of dosimetric instrumentation, benchmark experiments for MC codes (Fluka), material activation studies, LHC beam loss monitors studies , space applications...
- ▶ **Annual availability** ~1-2 weeks
- ▶ Facility used by more than 70 scientists from 50 external institutes (~20 different countries) and various CERN groups (RP, AB, TS,...)
  - ▶ ~ 85 international publications
  - ▶ ~ 60 internal CERN notes