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WP5 – Radiation Protection

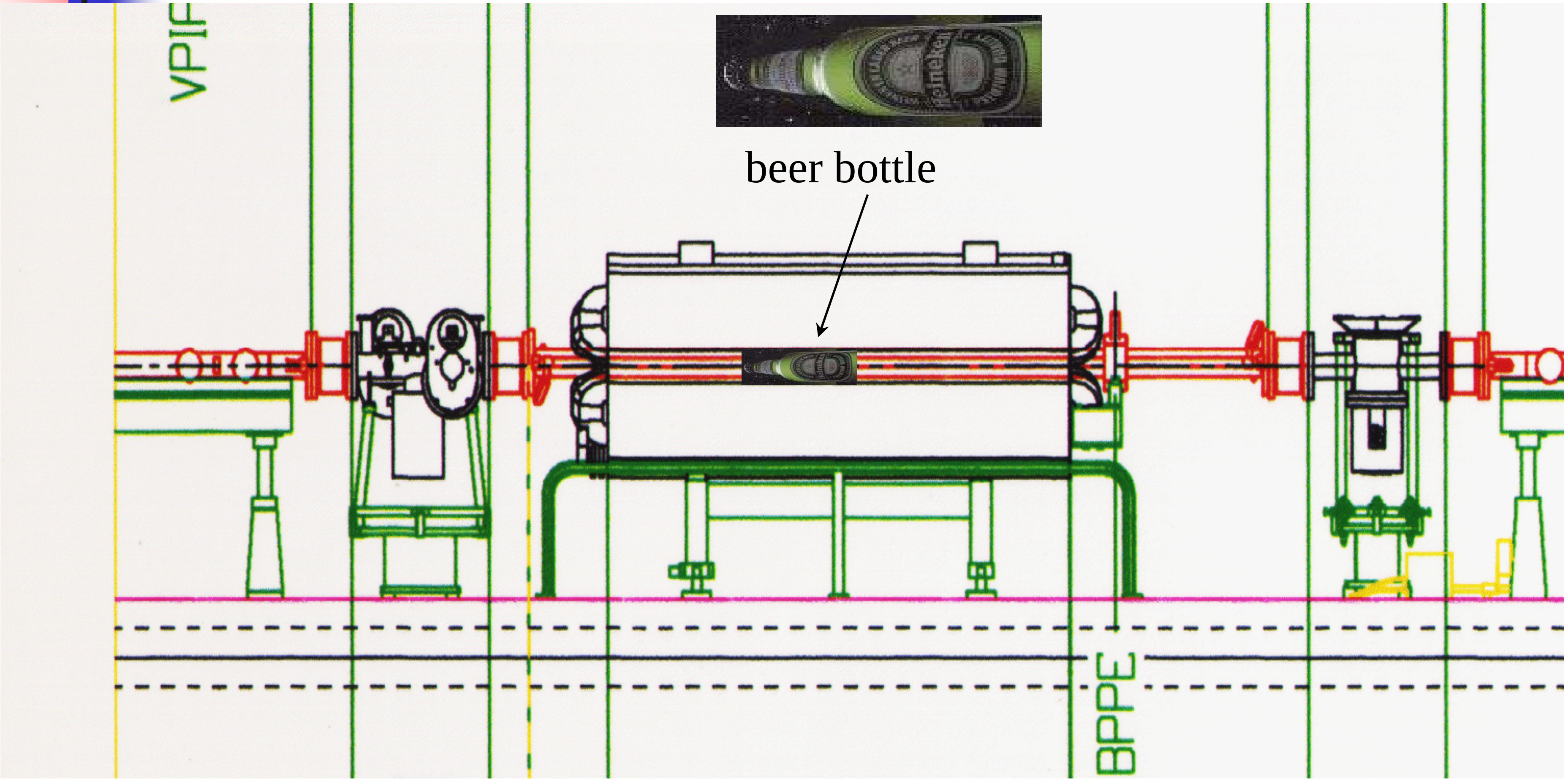
Progress Report 2009

Th. Otto on behalf of WP5 collaborators

The aim of WP5 in SLHC-PP

- The preparatory phase project cannot deal comprehensively with all radiation protection issues in SLHC, its experiments and its injectors
- We stride to identify "bottlenecks" in the sense of radiation protection
- This allows to
  - Think about original solutions already in the conceptual stage
  - Prioritise resources in the technical design phase

Flashback: a “bottleneck” at LEP



Steve Myers: “Unsociable sabotage, bottles were empty!!”

Two areas of interest:

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- The "super"-experiments after CMS and ATLAS:
  - 10-fold luminosity means 10-fold prompt radiation levels in the experiments
  - Can the inner detectors be operated ?
  - Can they be maintained ?
- The SLHC and its new injector chain:
  - Beam loss by design: injection, collimation
  - Change of the inner triplets:
    Phase 1 (L=2 10^{34}) and Phase 2 (L=10^{35})

Strategy for the "super"-experiments

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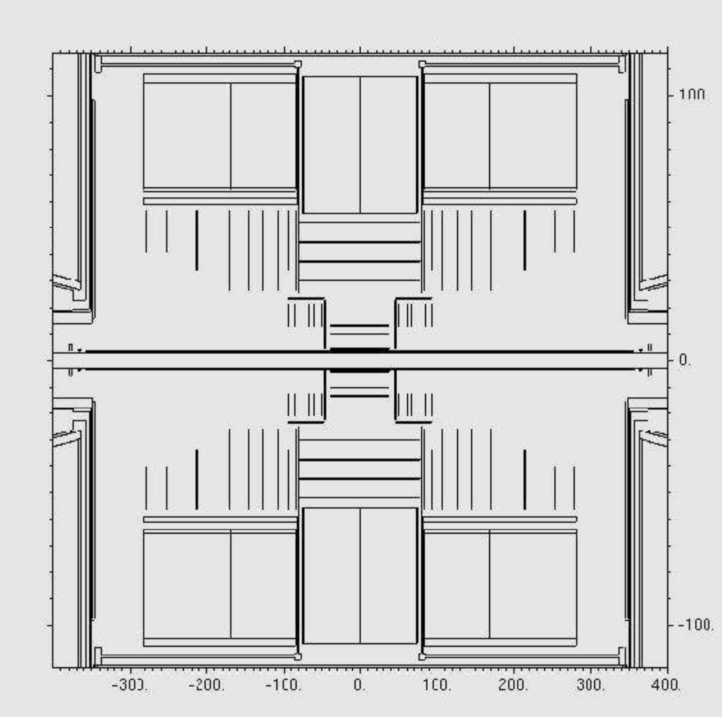
- Tool for predicting radiation effects in SLHC-experiments: Monte-Carlo simulations (mostly with Fluka-code)
  - *D:* Absorbed doses
  - φ:Secondary particle fluence rates
  - *A:* Material activation
  - *H**(10): Prompt and residual ambient dose rates
- "Trust is good, control is better"
  - Validate the simulations with measurements at LHC
  - Extrapolate to SLHC

Status of simulations

- CMS:
  - MC-model of CMS (Fluka) has been updated to "as-built" status by CERN-CMS and CERN-SC-RP
- ATLAS:
  - Previous MC model (G-Calor) no longer useable
  - ATLAS-model in Fluka under preparation by Sheffield and CERN
- Which simulations need to be simulated ?
  - The obvious: p-p-collisions at point-zero
  - The background: beam-halo, secondaries from collimators

Example: ATLAS Model



Developed by several authors with version-control-software

Foresees alternative "branches", for example for SLHC-detector upgrades

From Ludovic Nicolas, Sheffield, and Zuzana Zajacova, CERN

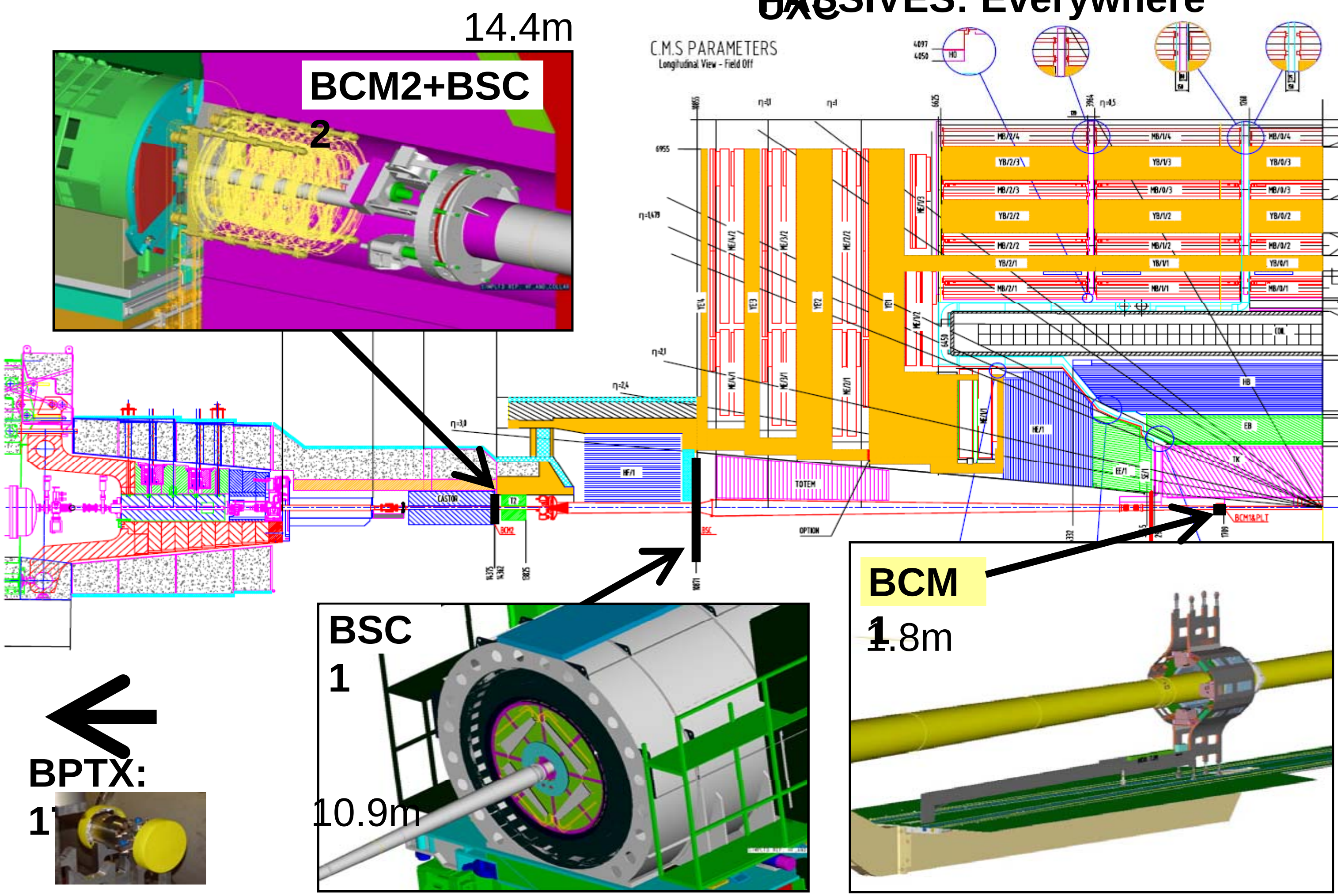
A dense network of detectors

Subsystem	Experiment	Characteristic	Observable	Institution
TLD + Alanine (future)	CMS	Passive	Absorbed dose	CERN-RP, PSI, DESY
Activation foils	CMS & ATLAS	Passive	Activation	CERN-RP
MPX	ATLAS (15) & CMS (5)	On-line	Particle fluence	Prague
CERN-RADMON	18 @ CMS	On-line	"Dose", n +had fluence,	CERN-EN
ATLAS-RADMON	ATLAS	On-line	"Dose", (ionizing, NIEL, neutron)	Ljubljana, CERN-ATLAS
BLM & BCM Diamond Detectors	CMS & ATLAS	On-line	Background and collision rate	
BSC Scintillator	CMS	On-line	Background rate	
Arizona Monitors	ATLAS (5)	On-line	n/γ fluence	Arizona
RAMSES	ATLAS & CMS	On-line	Ambient dose equivalent	CERN-RP

From S. Müller, Z. Zajacova, G. Mornacchi, CERN

Monitor locations in CMS

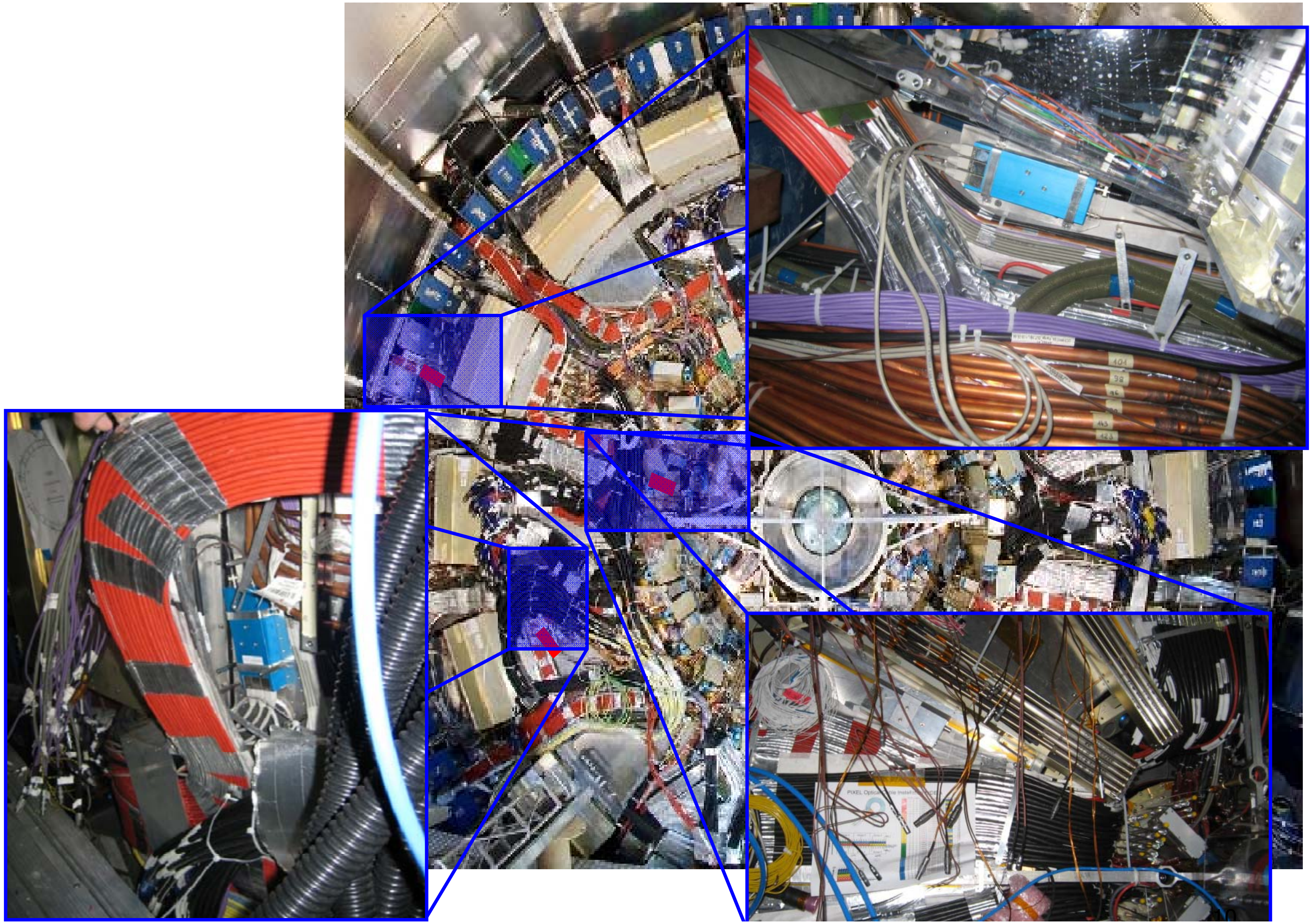
RADMON: 18 monitors around UXC
PASSIVES: Everywhere



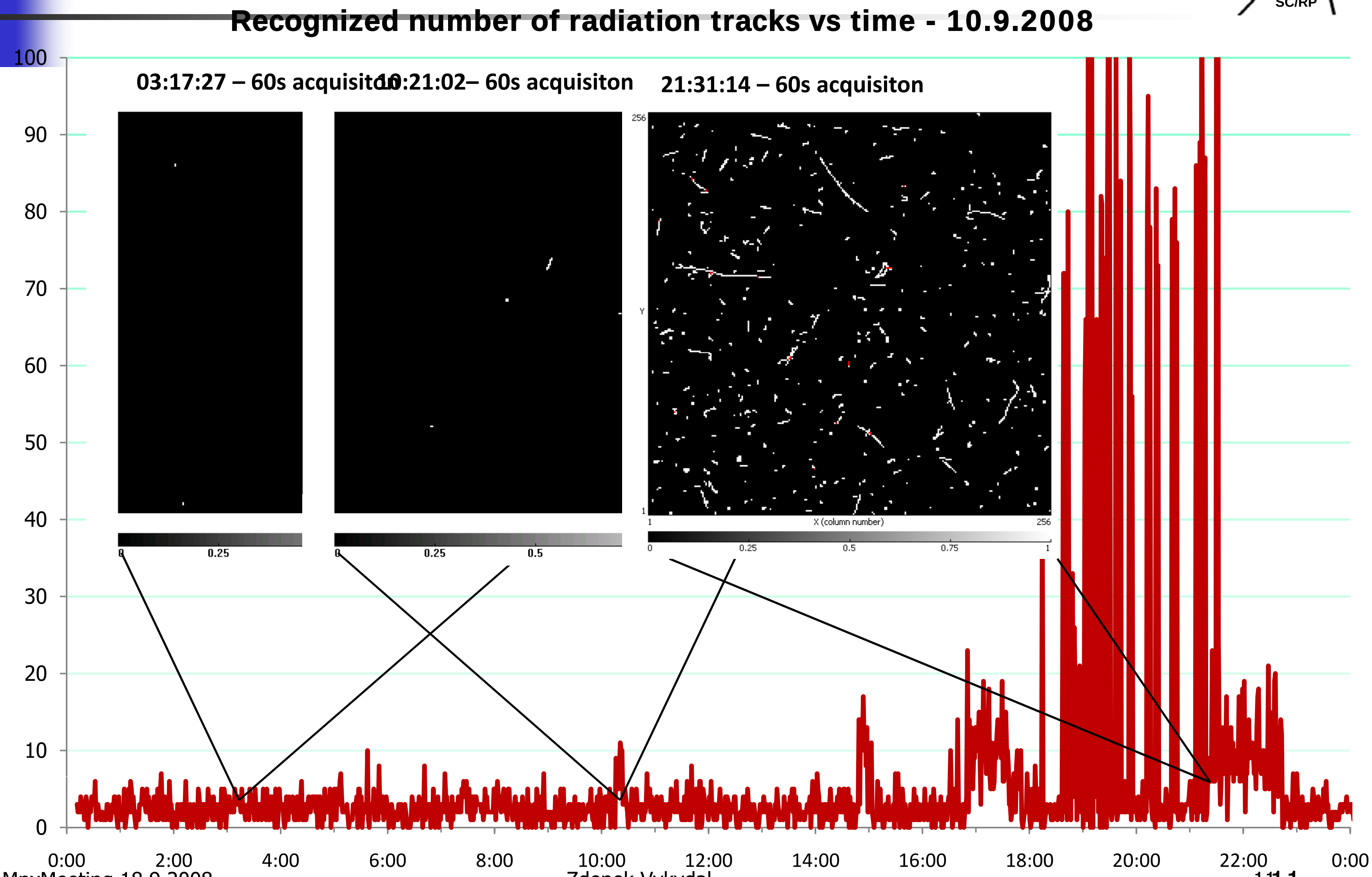
From Steffen Müller, CERN

MPX-locations in ATLAS

From Stanislav Pospisil,
Czech Technical University
Prague



ATLAS-MPX device no. 15
(close to Lucid detector)



First cross-collaboration synergies

- Activation detectors
  - copper and stainless steel foils
  - In ATLAS and in CMS
  - Complemented by Alanin absorbed dose detectors in CMS. ATLAS interested.
- Thermoluminescense detectors (TLD)
  - From Krakov via DESY and from PSI in CMS
  - Both collaborations interested in moderated TLD-n/γ-monitors in cave and in UX (ATLAS)
  - Use of track-etch neutron detectors to be explored

Interpretation of detector readings

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- Complex radiation fields in CMS and ATLAS: multi-particle and broad energy spectrum
- Calibration of some monitor systems in reference radiation fields still in progress
- Both experiments set up user interfaces for accessing data of radiation monitors and correlation with accelerator parameters
- The various observables must be correlated to quantities of interest to radiation protection: ϕ, A, $H^*(10)$

Overall status

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- Numerous different detector systems in and around detectors
- Waiting for beam in LHC
- Active detectors will deliver sufficient data once collisions take place
- Passive detectors can only be changed and evaluated at the end of 2010
- Interpretation still requires some effort.

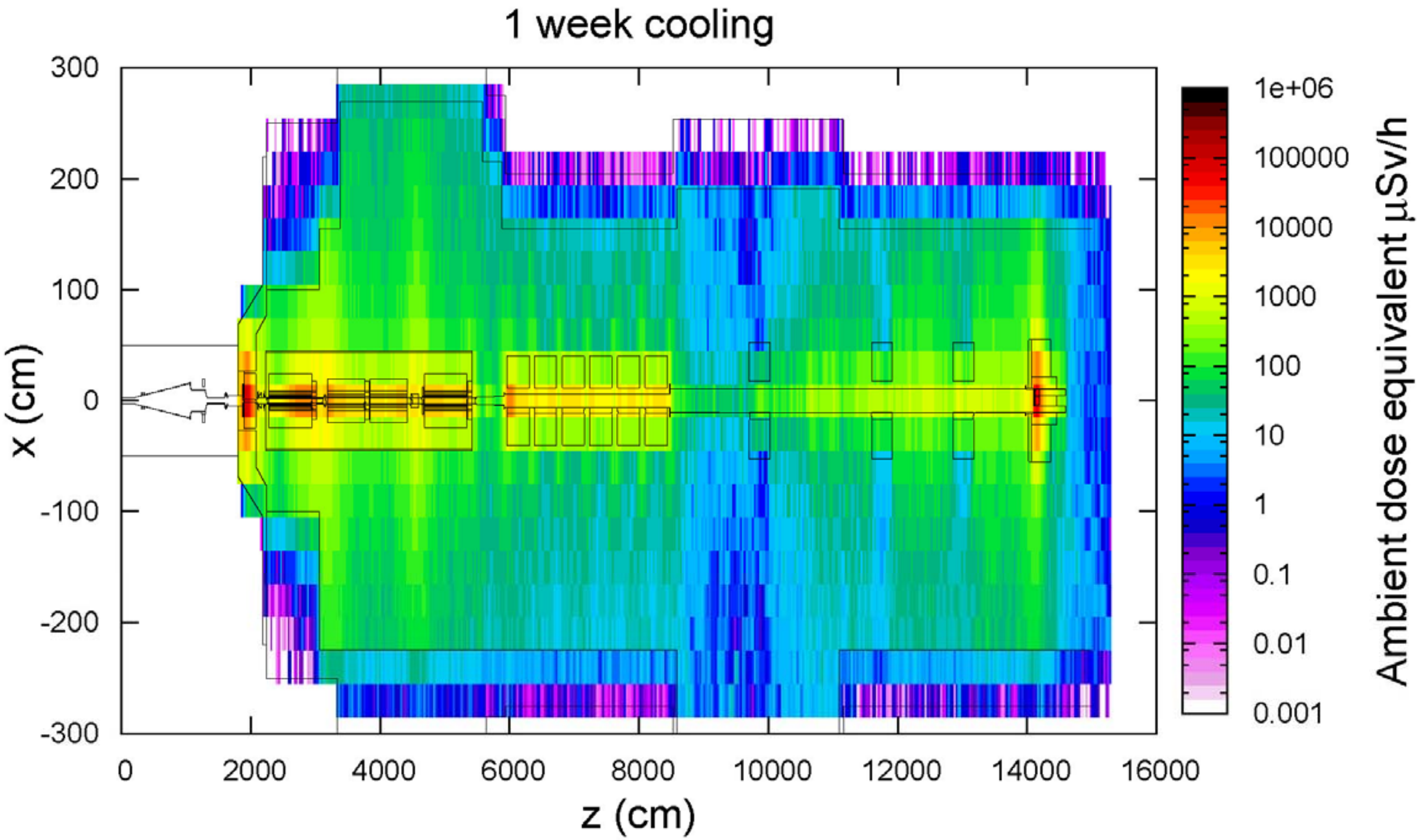
Strategy for SLHC and Injectors

- Identify likely beam loss points in close collaboration with accelerator designers
- Evaluate consequences for radiation protection:
  - *A:* activation of accelerator components, building structures, ground (water) and air
  - *H**(10): Prompt and residual ambient dose rates
- Use approximative models
- This approach delivers sufficient information to guide major design decisions before the technical design phase

Critical areas so far:

- LINAC-4 – PSB: H^--injection
- LPSPL – PS2: H^--injection, internal dumps, collimators
- SLHC: inner triplets (for Phase 1, L=2 10^{34})
- Beam cleaning in SLHC: collimator regions sector 3 & 7

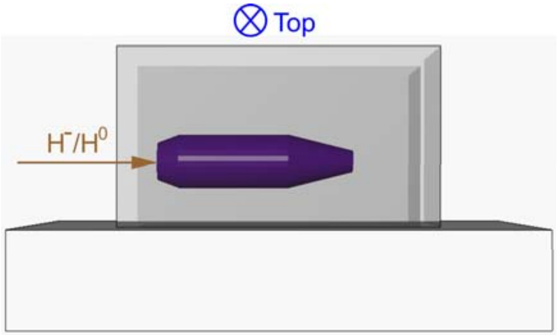
Example 1: Inner Triplet

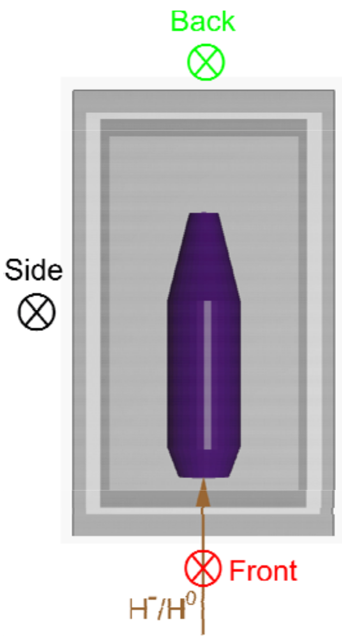


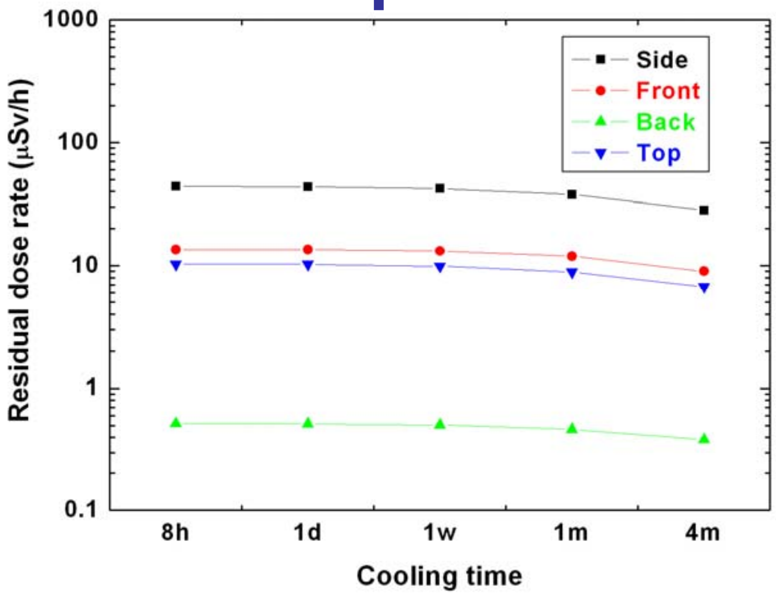
From Stefan Roesler and Markus Fuerstner, CERN

Triplets not optimised for exchange
Significant ambient dose rates

Example 2: H^--dump in PS2







Dump design very preliminary (taken from Fermilab Project X @ 8 GeV)

6.4E19 protons/year for 10 years, *H**(10) after different waiting times

First conclusion: PS2 injection dump can be shorter but should be wider

From Ekaterina Kozlova, GSI

Where do we go from here ?

- First Milestone of WP5:
  - A compilation of the “critical areas” for radiation protection in the injectors, SLHC, and experiments
  - Due March 2009
  - The WP5-roadmap for further progress
- Detector-Compendium:
  - Compile an overview of all radiation detector types in ATLAS and CMS
  - Foster cooperation between the two experiments in the area of radiation detectors (First step: ATLAS MPX in CMS)

What do we hope to report in one year from today ?

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- MC-models of CMS and ATLAS up & running
- Data from active detectors abundant and on the way to be understood
- Input to conceptual design of new injectors delivered and considered for design optimisation
- An optimised plan on how to change the inner triplets during the Phase 1 upgrade
- Passive detector results not before end 2010
- (Probably) no news on SLHC-collimators or on Phase 2 inner triplets

Talent required !

- In spite of the challenging program, SLHC-WP5 @ CERN-RP is experiencing difficulties in recruiting young researchers !
- Post-graduates interested in a CERN-Fellowship for work on accelerator-related ”bottlenecks” should contact Stefan Roesler or myself