Lessons learnt from WANF(*) dismantling

Outline

- Introduction
  - WANF/HiRadMat location
  - WANF operation
- WANF dismantling
  - Preparation
  - Dismantling
  - Waste treatment
- Lessons learnt
- Conclusions

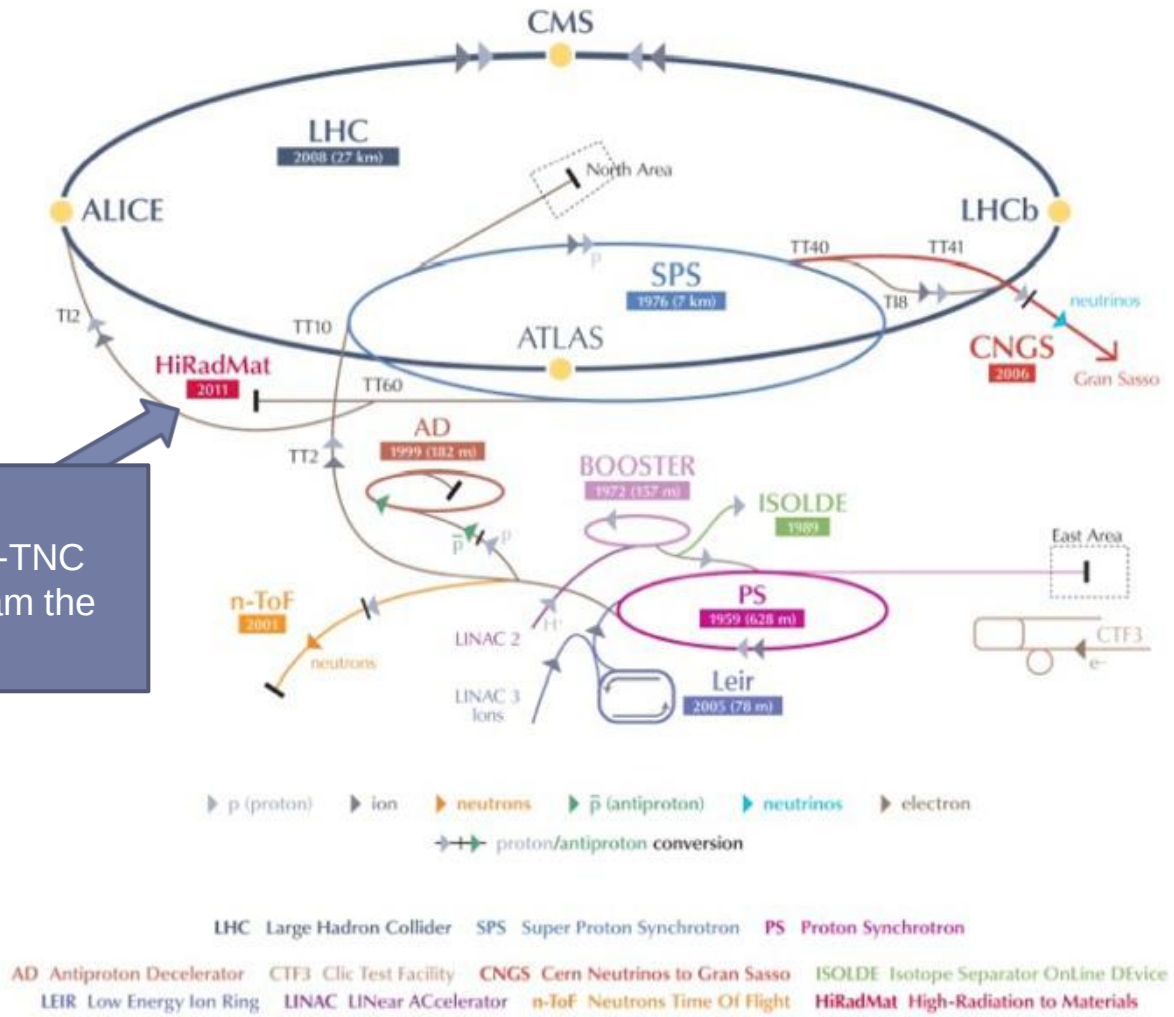
(*) West Area Neutrino Facility

See also paper:
TUPS059-IPAC2011

Ans PARDONS, Sebastien EVRARD and the
WANF dismantling team, CERN

HiRadMat/WANF location

The experimental area of HiRadMat is in the WANF-TNC target cavern, just upstream the old T9 WANF



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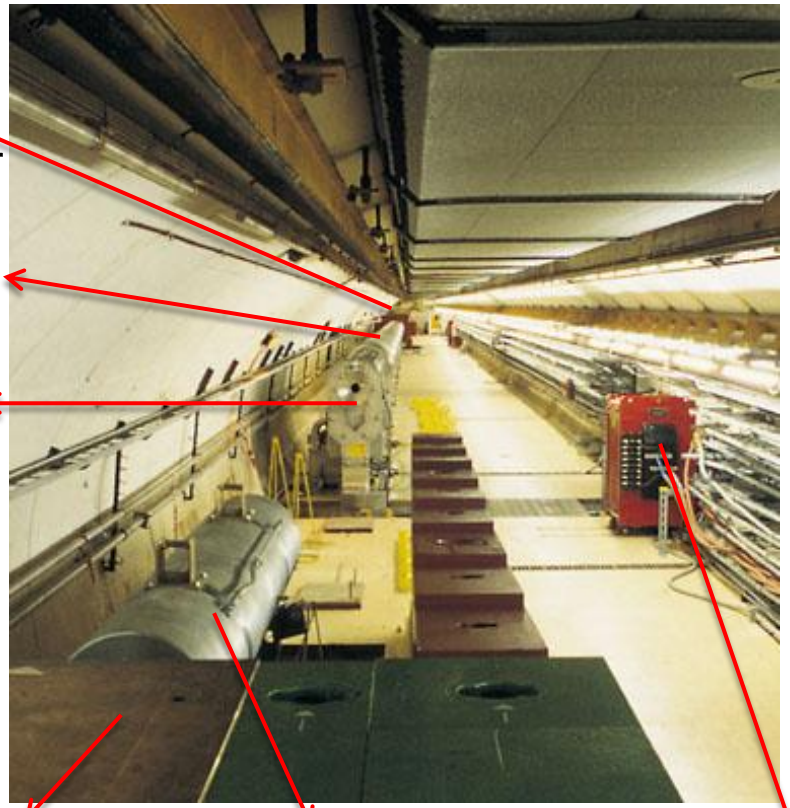
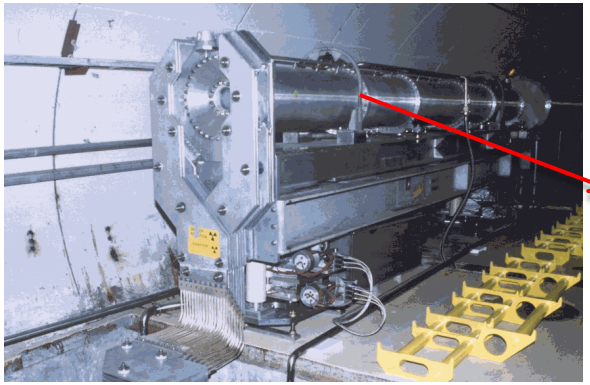
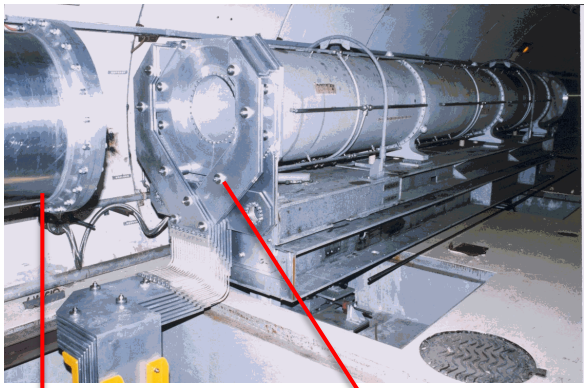
WANF installation 1992

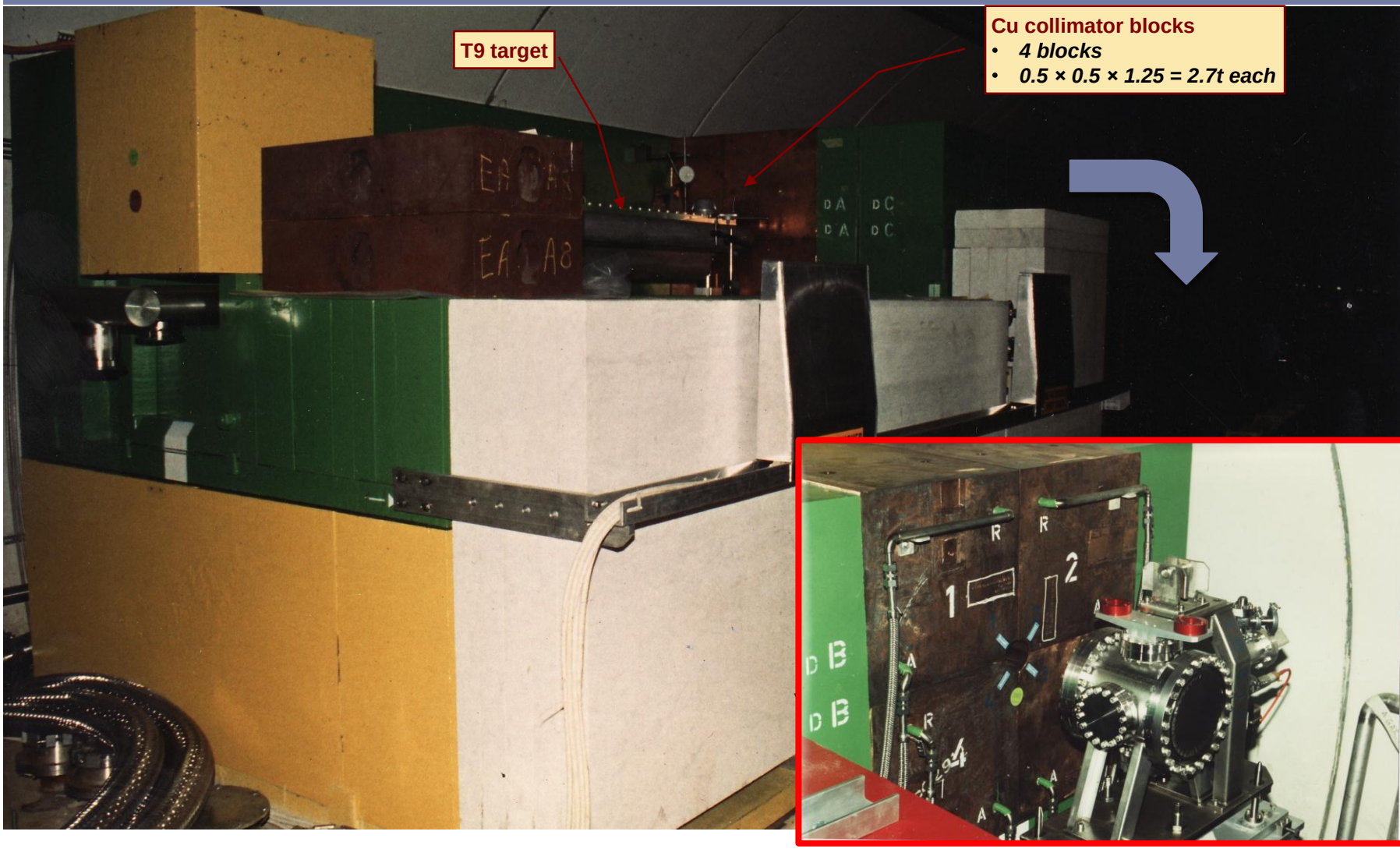






Note: This was in the pre-”electronic documenting” era!!!

WANF installation 1992



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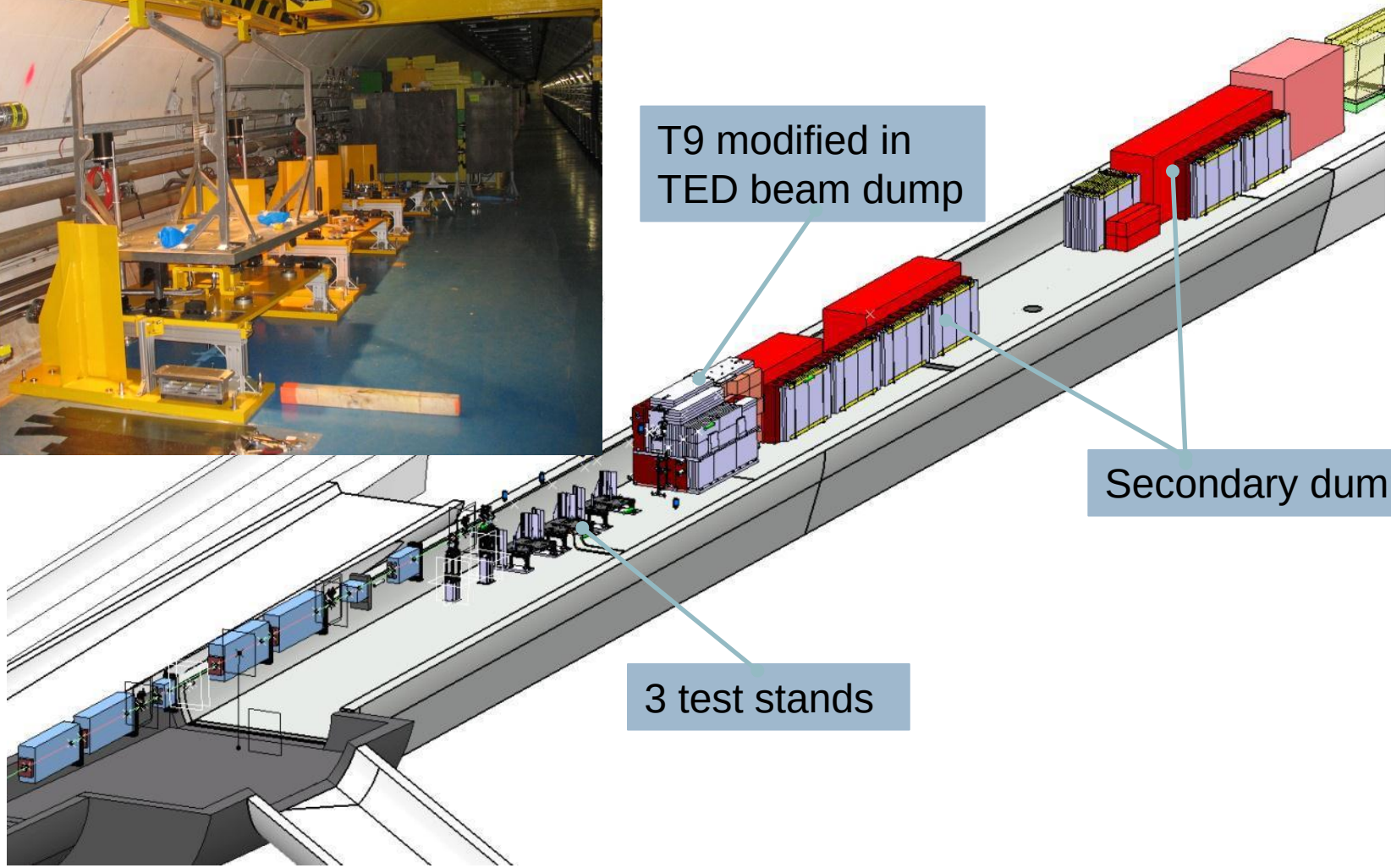
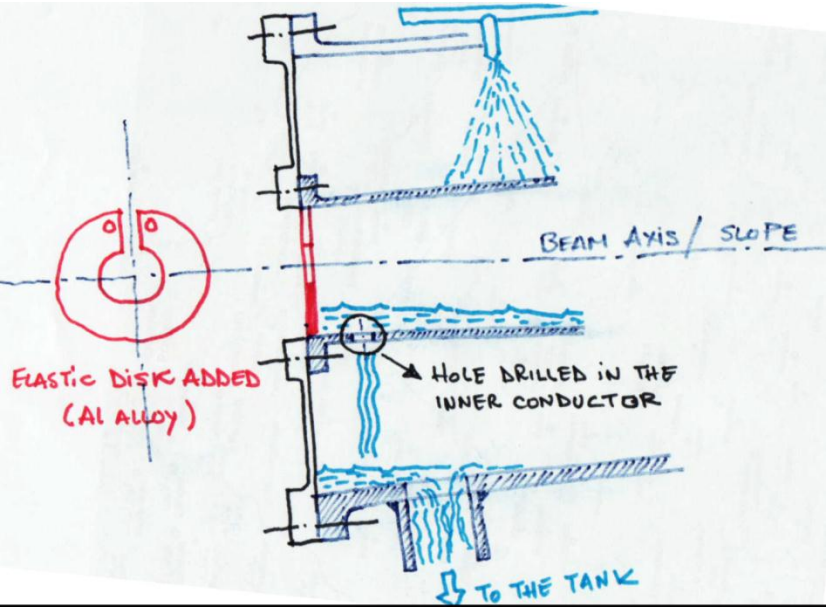
HiRadMat facility

5 Experimental area upstream of WANF target shielding



WANF operation 1993-1998

- A total of 7.10 ^{19} protons was delivered on target
- A few words on humidity in the WANF facility:
  - New ventilation system from 1993 ("it was even worse before")
  - Several water leaks from primary beam magnets
  - Water infiltrations in access tunnel



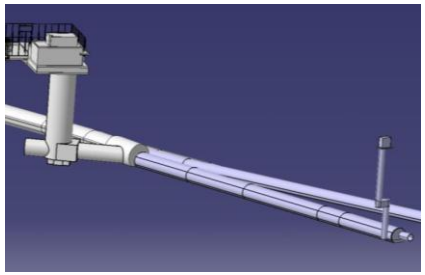
- Horn leak observed in 1998:
  - 25l/day, inner conductor
  - Hole drilled in conductor
  - Retainer ring inserted
- Since 1998: closed, no ventilation

WANF in 2012

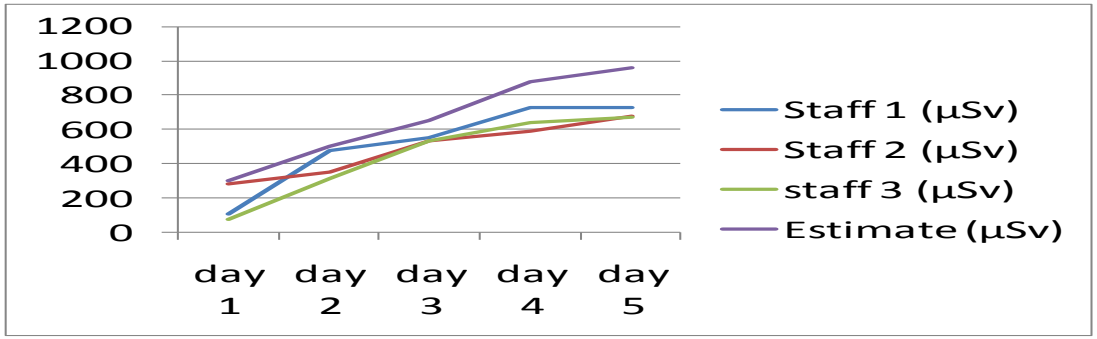
Rust!

WANF dismantling

Preparation



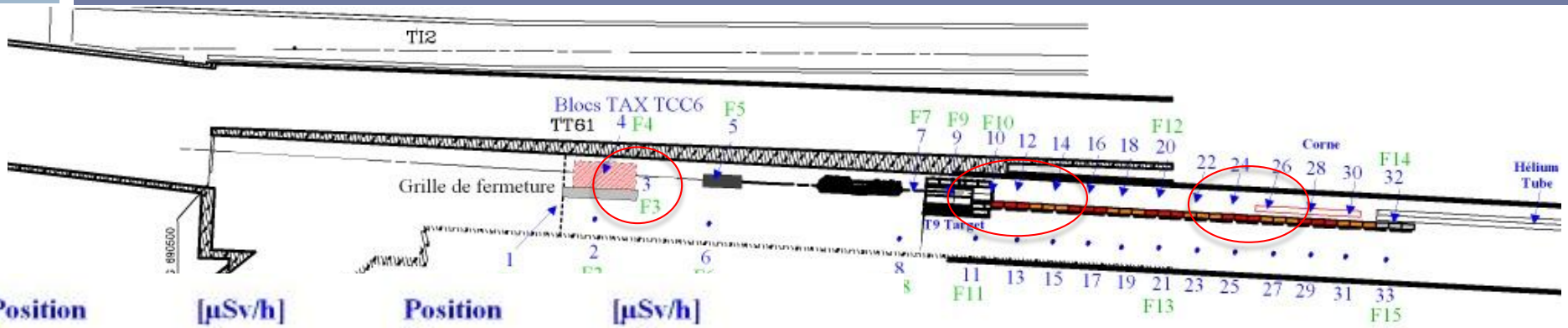
- Laser scanning of whole area performed
- Remnant radiation dose rate measurements - survey
- Fluka calculations for inaccessible hot-spots
- Classification as controlled area – high radiation (>2mSv/h)
- Overhead crane refurbishment
- Build/equip escape path (b. 846)
- Update/install general safety systems (emergency interrupters, phones, fire fighting water)
- Cleaning of TNC:



- Smear tests taken (at max. contamination): reduction by a factor 10 f
- Collective dose 2.2 mSv (2.8 mSv was estimated)

Dose rates before dismantling

Just to give an idea



Position	[µSv/h]	Position	[µSv/h]
1	10	21	135
2	7	22	270
3	18500	23	90
4	280	24	1000
5	140	25	75
6	75 à 100	26	2300
7	630	27	90
8	280	28	600
9	450	29	85
10	7000	30	330
11	500	31	65
12	9000	32	300
13	700	33	75
14	10000		
15	730		
16	2100		
17	400		
18	600		
19	250		
20	300		

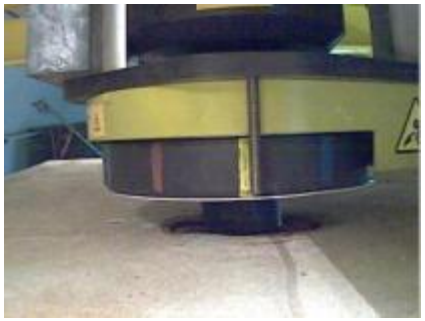
WANF dismantling

Hot objects & high remnant radiation dose

→ Remote handling tools

- Cameras on renovated crane and in TNC
- Automatic hook for standard blocks
- Shielded fork lift
- Several custom-made hooks & lifting beams

→ Shielding during intervention & transport



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WANF dismantling

Example 1: WANF Horn & collimator removal

- Horn and support manually dismounted from TNC and sent to waste storage in ISR(*)
- Collimator and support 80% remotely dismounted and sent to waste storage in ISR

(*) Intersecting Storage Rings

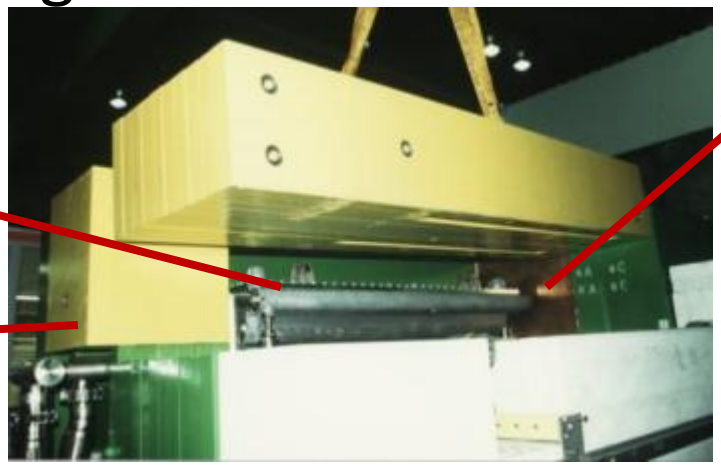
WANF dismantling

Example 2: T9 dismantling (transformation)

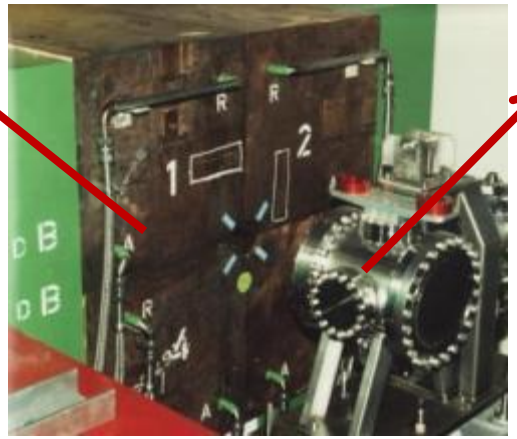
- T9 target station

Steel upstream collimator

ν-production target



Copper downstream collimator blocks

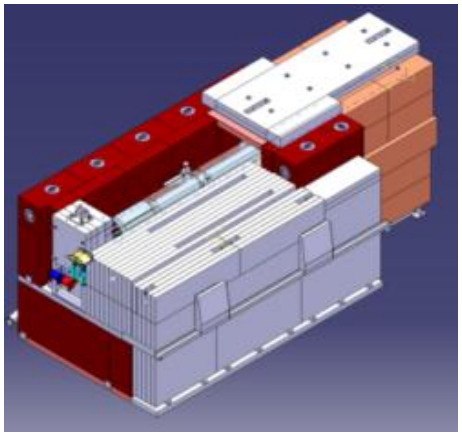


Downstream monitor

- T9: transformation to HiRadMat beam dump:

1. Remove target, all collimators & monitor
2. Replace upstream collimator with new collimator
3. Replace other items with TED(*)-type beam dump
4. Close shielding and complete HRM beam dump

(*) Target External Dump

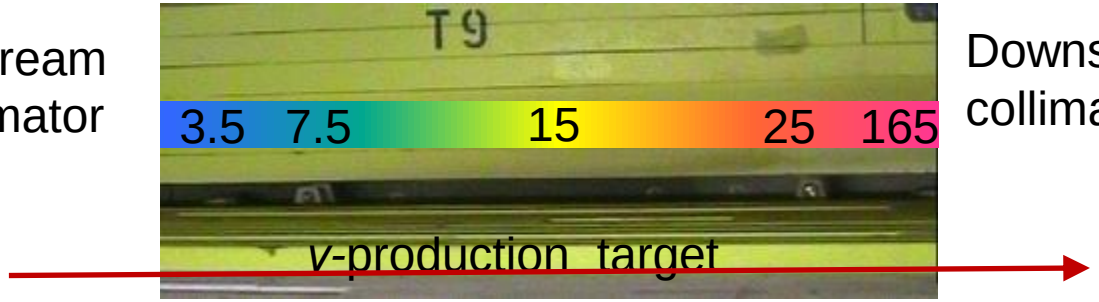


WANF dismantling

Target & upstream collimator

- Dose rate near target and upstream collimator

Upstream collimator



Downstream collimator

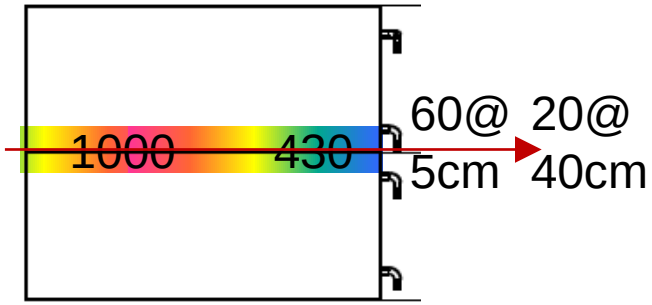
Dose rate (**mSv/h**) measured at contact with target container and cradles (12.01.11)

- Items designed in 1993 for remote removal!
- Remote removal, transport to ISR in shielded containers or on shielded trailers

WANF dismantling

14 Downstream collimator blocks dismantling: Challenges

- Dose rate in & near copper collimator blocks



Dose rate (**mSv/h**) measured inside and near the collimator (12.01.11)

Results & consequences:

- The case of T9 dismantling was presented to the ALARA Level 3 committee
- Review took place of detailed dismantling procedure by CERN safety specialists from outside the project
- Detailed risk analysis established
- Decision taken to NOT remove the copper blocks out of TNC yet
  - Blocks with handling plates will be placed in custom-build containers in a 40cm thick iron sarcophagus downstream TNC
  - The evacuation of the blocks from TNC will be carefully planned by EN/MEF & DGS/RP and executed in the “near” future (e.g. shut-down 2013)
- Green light from reviewers and hierarchy obtained to start T9 dismantling on 2/2/2012 (fast!)

WANF dismantling

15 Downstream collimator blocks dismantling: Solutions

- Challenges:
  - Each block (2.7t) has hot outer surface
  - Axis of 2 blocks is outside range of overhead crane
  - Items not designed for remote handling (installed with forklift on 1993, 4 threaded holes per block)
- Solutions:
  - Lifting & shielding plates fixed manually on copper blocks
  - Custom-made lifting beam takes 2 blocks at the time
  - Shielding in place for all manual interventions
  - Extensive tests on mock-up (tools, training, camera)

Dismantling work took ~10 days, collective dose of ~1.2mSv




WANF dismantling

T9 downstream collimator dismantling in pictures

Moving upper blocks with fixed lifting plates

Blocks in temporary storage location

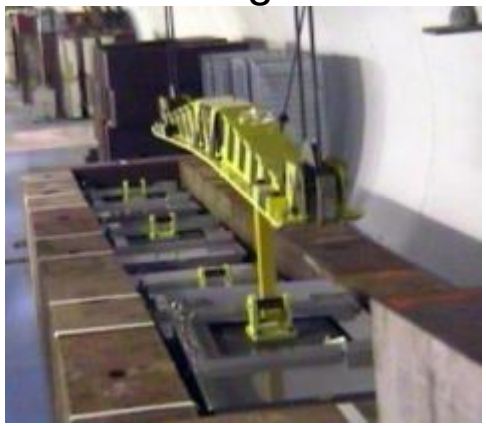
Sarcophagus with containers ready

Fixing plates on lower blocks

Separating blocks 2→1

Placing block in container

Lifting test before closing roof



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WANF dismantling

WANF dismantling = First dismantling operation at such a scale since LEP dismantling

- 95t / 323 m^3 of waste
- 800t of blocks moved

- Study & Planning
- Optimisation
  - waste conditioning,
  - measurement procedures,
  - storage & disposal possibilities
- Risk mgmt & documentation
  - DIMR documents
  - ALARA committee

Interim storage set-up (for conditioning and treatment)

Dismantling in TNC

Packaging
3 options: cleaning, plastic bags, box sarcophagus

Shipment
internal transport is preferred than public roads

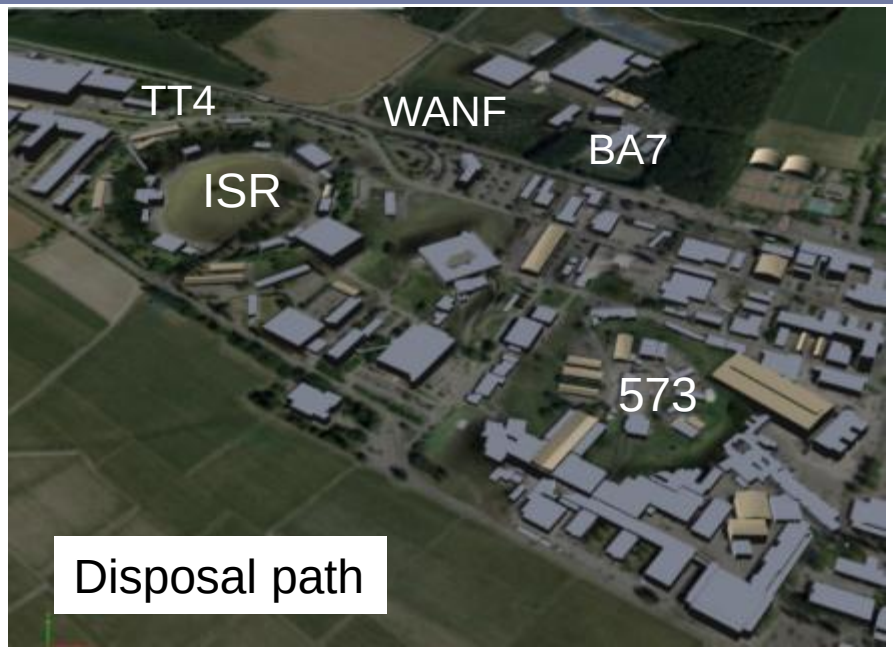
Conditioning and treatment Volume reduction in interim storage

interim storage at CERN prior to final disposal

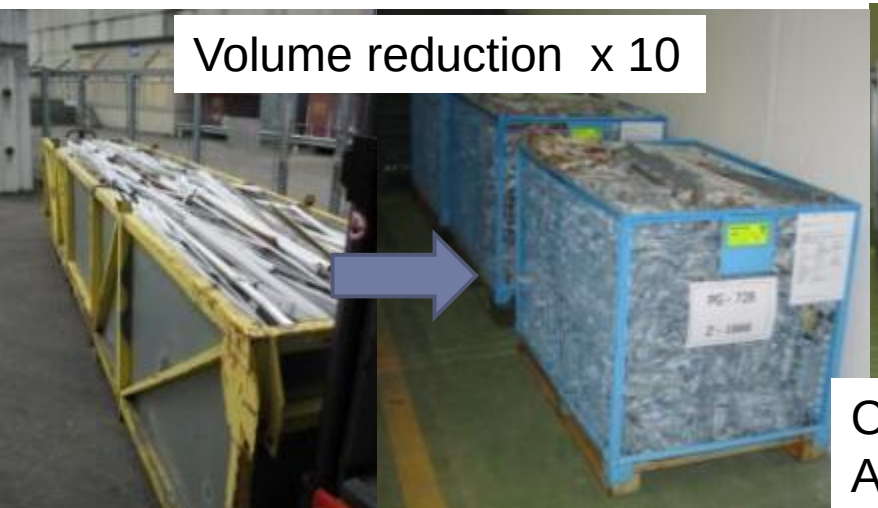
Waste treatment

Activated material management

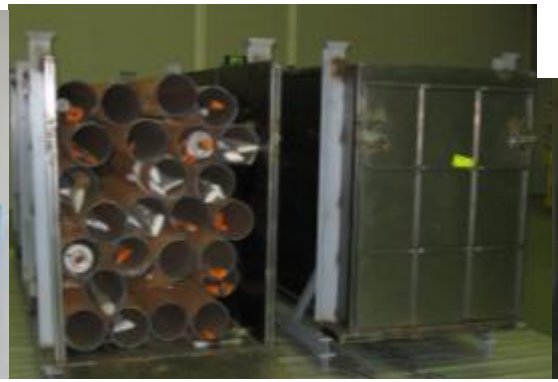
- Activated material is treated in several steps:
  1. Rough cleaning in WANF (specialized company ENDEL Nucléaire)
  2. Removal from WANF → TT61 → TT4
  3. In TT4: thorough decontamination and disassembling
  4. Volume reduction in RP waste workshop in building 573
  5. Convenient conditioning for long term storage
  6. Long term storage in ISR



Disposal path



Volume reduction x 10



Contaminated objects:
Adapted closed containers

Long term storage ISR

After dismantling: HiRadMat

Beam line in TNC

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HiRadMat

Experimental area in TNC

Designed as a “modern area”

✓Documented (drawings, procedures, safety file, …)

Also:

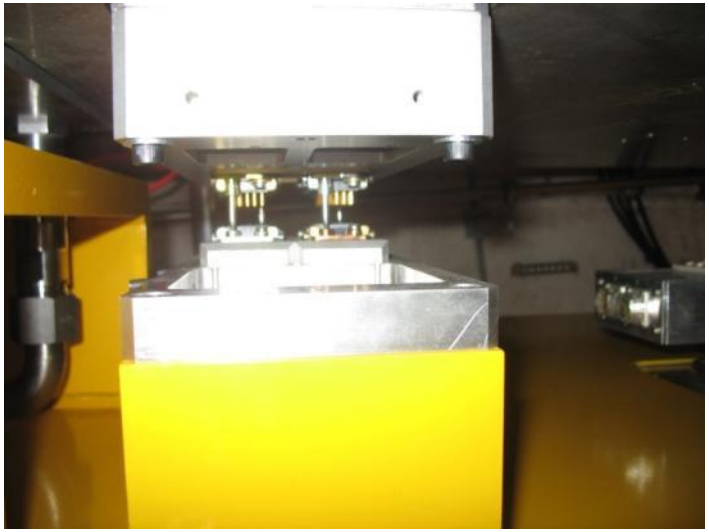
✓Tested equipment will be remotely handled

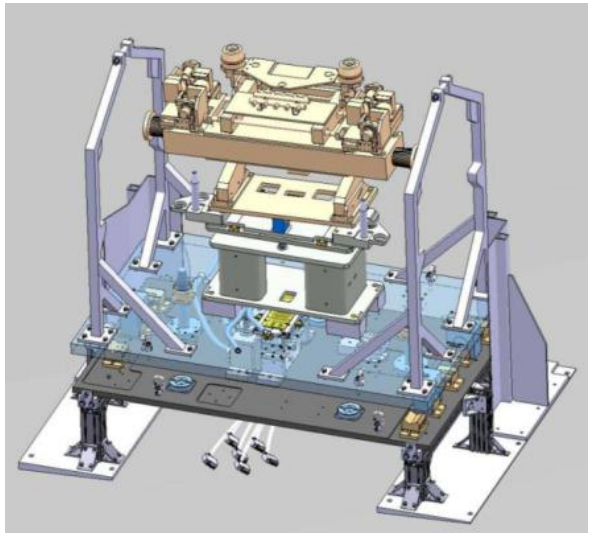
✓Cameras on crane

✓Remote signal & water connectors

✓Cool-down area downstream end of TNC

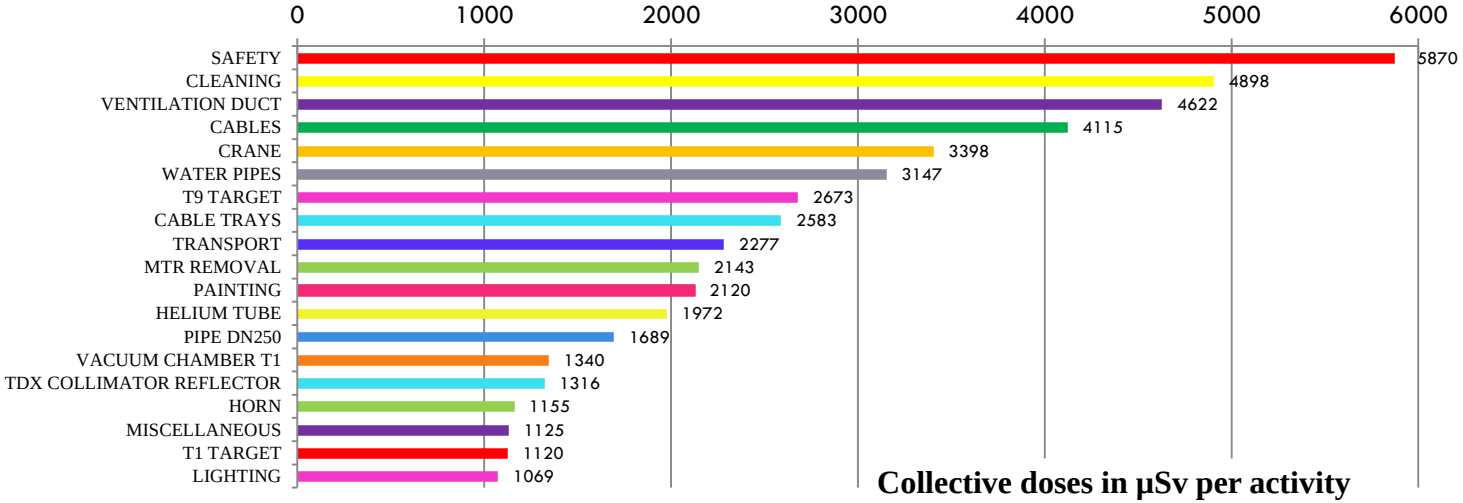
✓…….





Dose summary

And what we learn from it



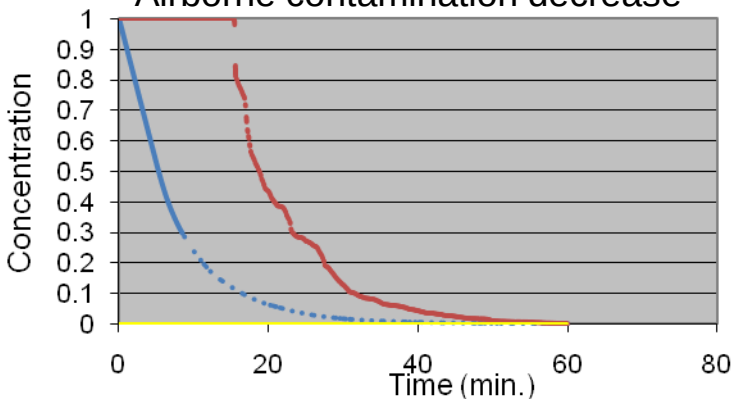
- **Optimisation, tools, training** brings from est. 210 man.mSv to 60 man.mSv (yes, it is worth it)
- The main contributions are from low dose rate but long-lasting activities, impossible to do remotely (by design) or carried out by less experienced personnel.

HiRadMat Safety file: Methodology

Demonstrative part: risk management example-stray radiation (external exposure)

- Design stage:
  - *Fluka simulations → CV and Ramses design*
  - *Dedicated handling means (lifting jig and eyes)*
  - *Prefabricated structure (easily removable)*
  - *Activated material management plan*
  - *Maintenance plan (reduced time in TNC)*
- Technical measures
  - *Access , ventilation and RP sectorization*
  - *Ventilation system*
  - *Ramses monitoring system*
  - *Remote controlled PR532 crane*
- Organizational measures
  - *Frequent radiation survey of TNC tunnel*
  - *Dedicated RP training*
  - *ALARA, JOLI & DIMR preparation*
  - *On-site close RP monitoring*
- Personal measures
  - *Training, IPE, dosimeters, …*

Airborne contamination decrease



Absolute Filter exchange

Equipment remote handling

Lessons learnt - I

- The dismantling of a non-operational facility must take place **as soon as possible** after a reasonable decay time. Any unjustified delay will increase the information and experience loss, as well as the degradation of the equipment. During decay time, the area should remain **ventilated and monitored** (will be done for CNGS)
- **Remote control** operations are the most effective way to **reduce** personnel **exposure**. However, it can take longer and must count on a highly reliable camera network.
- Contamination management implies the use of **dedicated lifting devices** and forklifts which have to be decontaminated at the end of the dismantling phase.

Lessons learnt - II

- **Dose recording** is essential to give accurate feedback. (Individual and job-based dose recording could be facilitated by using a tele-dosimetry system – see next slide)
- Motivation, performance and safety awareness of personnel are mandatory for success.
- The **design of a new facility** must take into account dismantling needs such as:
  - special design of future highly-activated equipment (remote control handling, dedicated lifting beam, plug-in connectors)
  - pre-fabricated infrastructure for easy and remote removal
  - tunnels equipped with reliable data networks for remote control operations and dose recording
  - walls and floors protected by rad-hard paint to minimize contamination

Conclusions

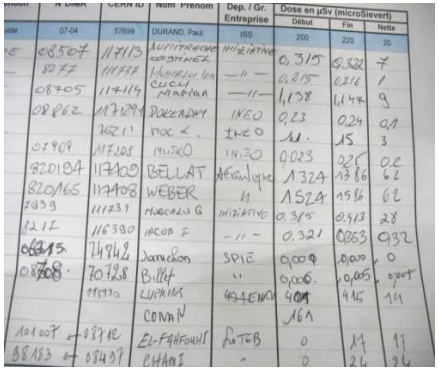
- The WANF tunnel was completely revamped to make way for the HiRadMat facility.
- The extraction of certain items from WANF took a great deal of organizing, using automatic hook devices, dedicated shieldings and video cameras to allow operators to keep their **distance** from the radioactive components.
- ALARA cannot be achieved without worker involvement. Motivation and performance of the exposed worker can be improved by actively **engaging the workforce in decision-making processes** in each stage of the work, from planning to post-job review and by **taking into consideration the feedback** of workers.
- The activity generating the highest collective dose is not the one where the highest activated items were handled, but the one where no remote removal was possible. Therefore, it is of prime importance to carefully **study and prepare the decommissioning phase** of a new facility as **from the design stage**.

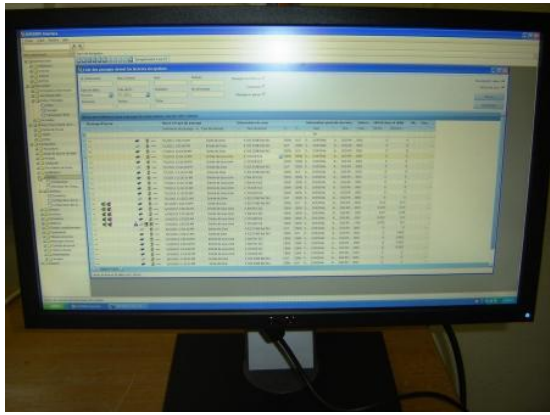
- Thank You!

Ideas

Operation in high radiation areas: ways of improvements

- Dose recording
  - From paper to nowadays technologies
  - DMC automatic readers being developed by DGS/RP (P. Carbonnez)
  - Access point reader and stand alone reader (RP technician)
  - Better DIMR follow-up (task based records)
  - RP database updated on-line
  - Acceptance tests in progress, pilot tests on Isolde, HiRadMat as first client in 2012 !





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Ideas

- Teledosimetry
  - RP technician could monitor 8 persons at the same time
  - On-site test last Monday
  - Improve telecom in underground areas

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