WP5: HiRadMat@SPS – STATUS REPORT

Outline

- HiRadMat – overview/reminder
- Project status
- Next steps

I. Efthymiopoulos – CERN

The HiRadMat Facility

2 Goals

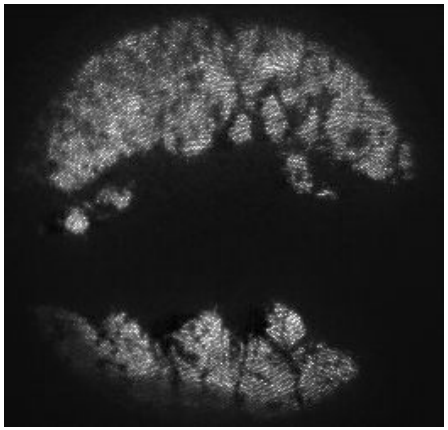
- Facility to study the impact of intense pulsed beams on materials
  - Thermal management (heating)
    - material damage even below melting point
    - material vaporization (extreme conditions), cavitation
  - Radiation damage to materials – change of properties
  - Thermal shock - beam induced pressure waves
- Important test bed for the design validation of LHC near-beam components before installation in the machine
- Uses an **LHC-type** beam **@450 GeV** from **1-288 bunches, 1.1-1.7×10^{11} ppb**
- Foreseen clients : LHC collimators, protection devices, machine components, material studies (bulk, superconductors), high-power targetry, irradiation tests of electronics
- Transnational Open Access within EUCARD to other teams

The HiRadMat Facility

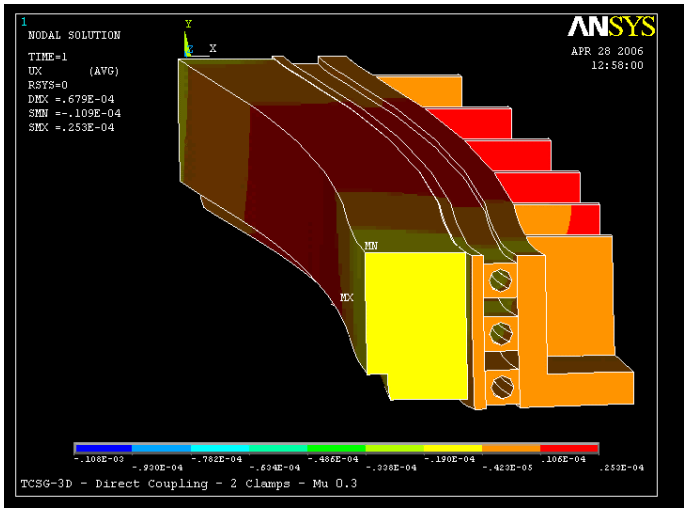
3 Examples – beam impact on materials

High-intensity beam on a solid target (Tu)

Courtesy: J. Lettry, CERN

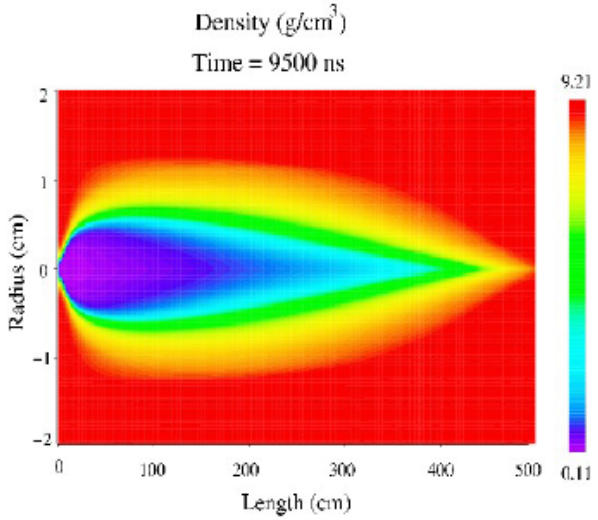


MERIT experiment: High-intensity beam on a liquid Hg-target



LHC collimator: Displacement analysis – 500kW load case for 10s
Loss rate 4×10^{11} p/s (Beam Lifetime 12min)

Courtesy: R.Assmann, CERN



High Energy Density Plasma formation, proton "Tunneling Effect"

Courtesy: N.Tahir, GSI

Making the HiRadMat Facility

The challenges!

- Construct a high-intensity facility designed to test materials at their damage limits

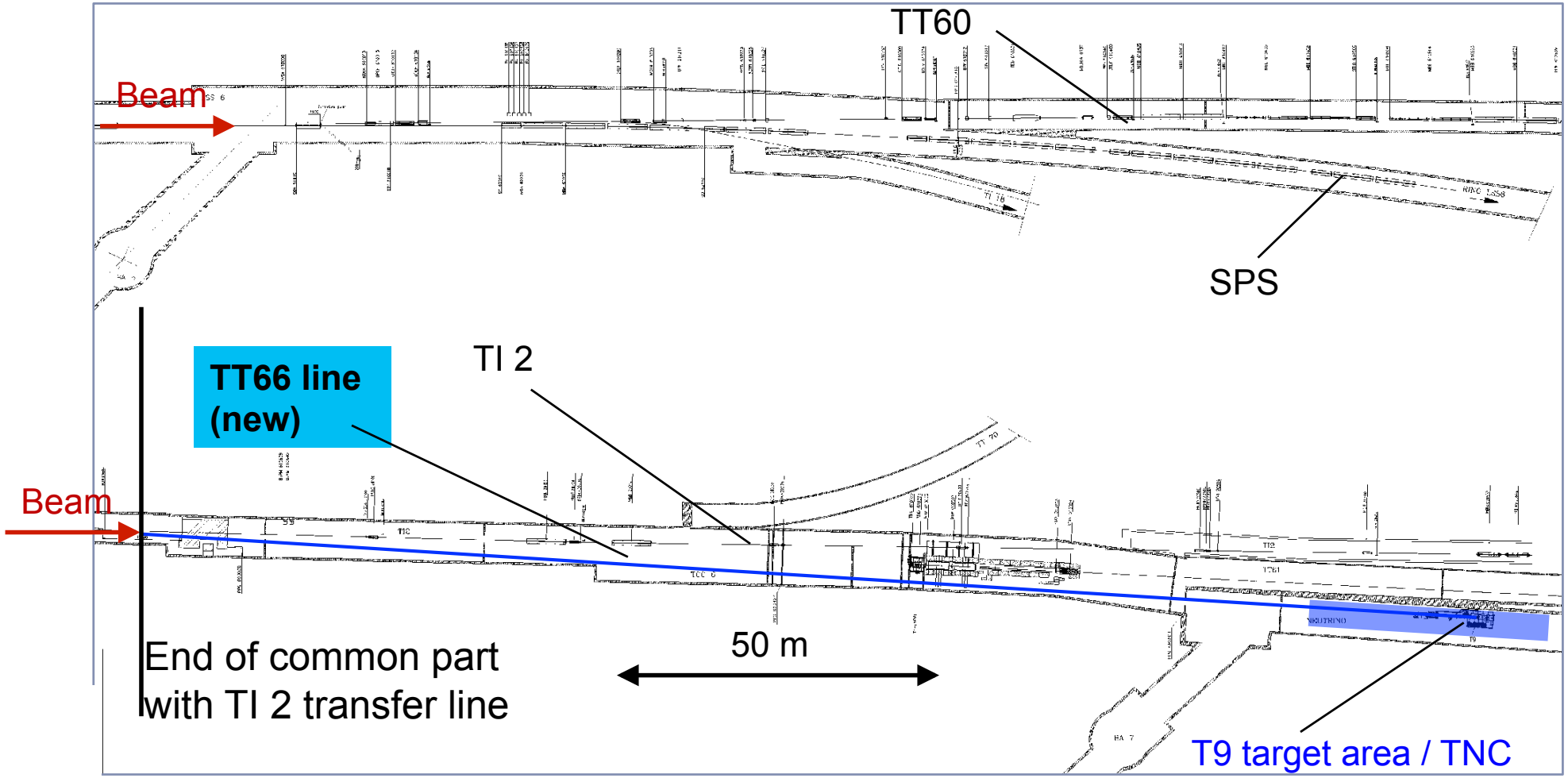
….without destroying the facility itself !!

- Build ~300m of beam line and a HI irradiation facility without access to the areas!!
  - *Access to underground areas is possible only during the short (movable) stops of LHC and the short 2010/2011 shutdown*

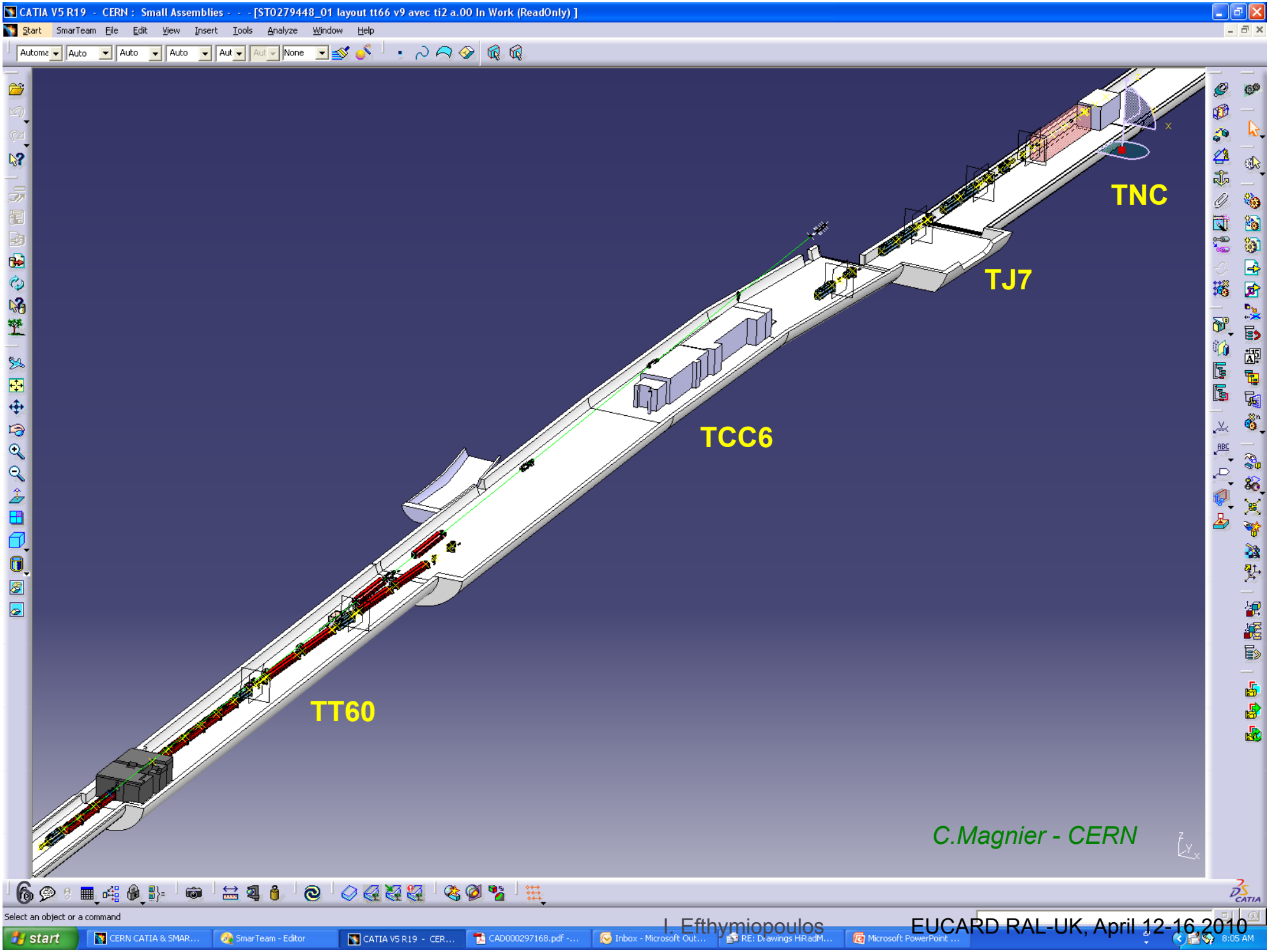
…flexible schedule, able to organize and do work in short notice

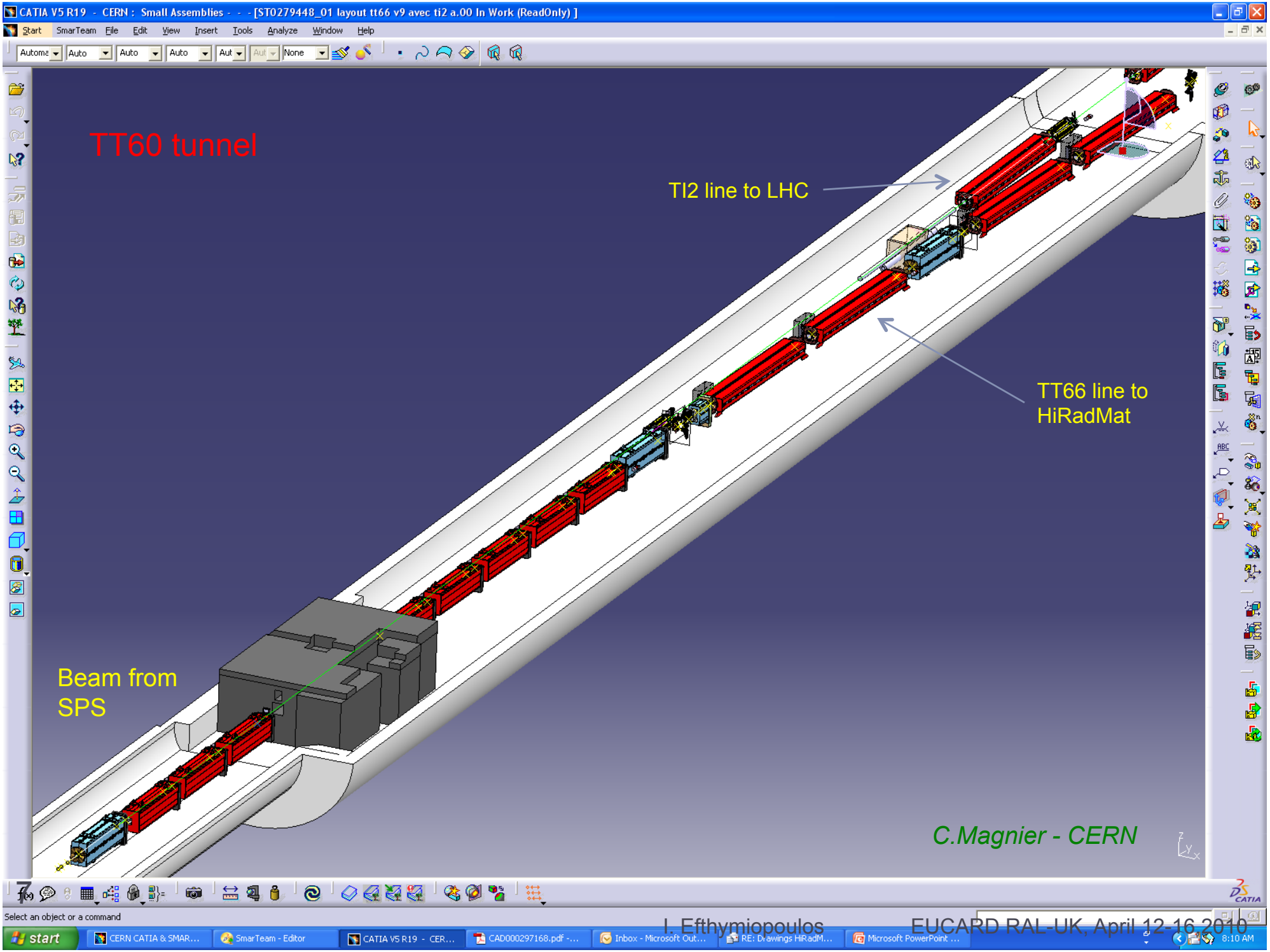
The HiRadMat Facility

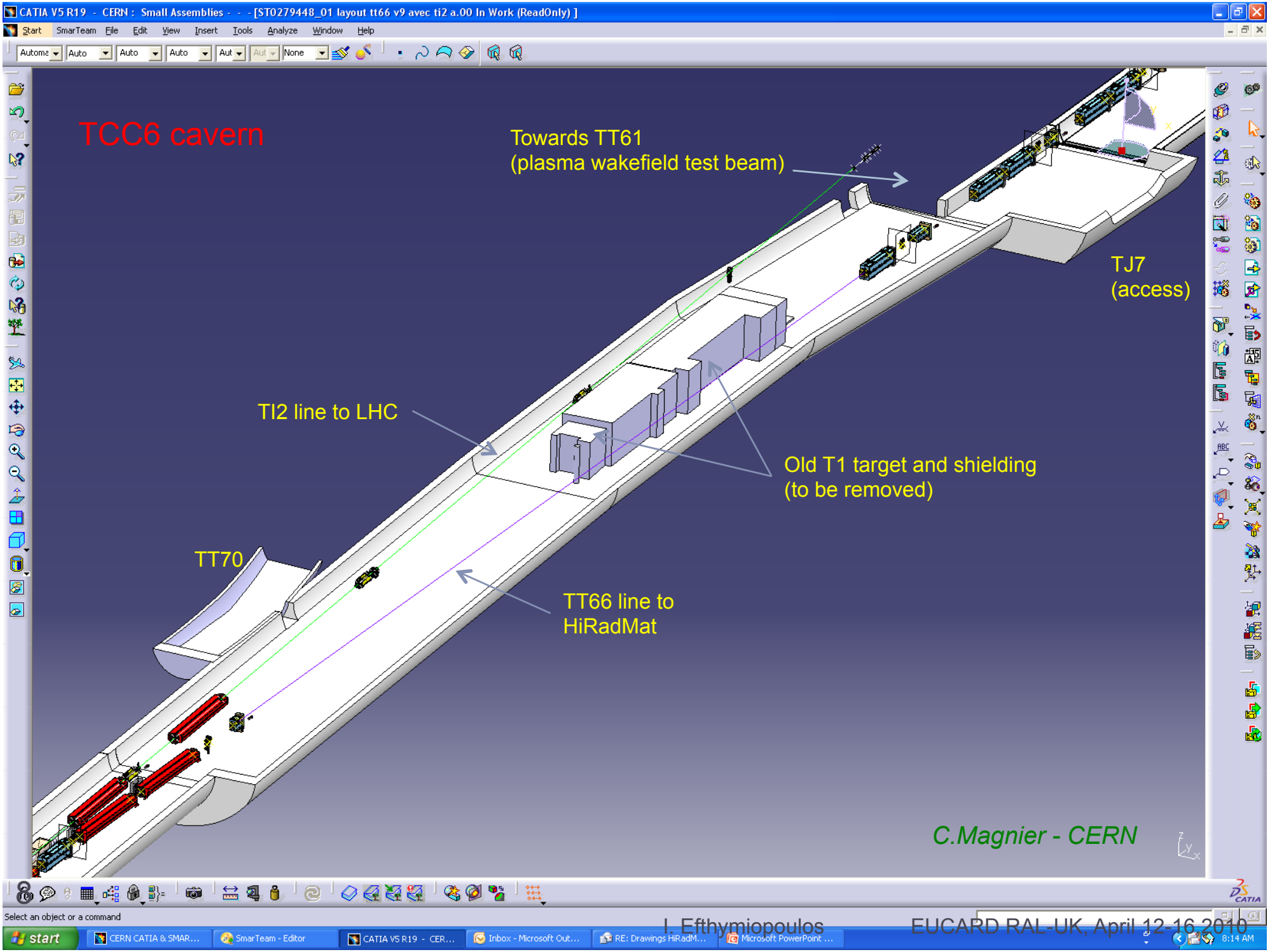
5 Primary beam layout

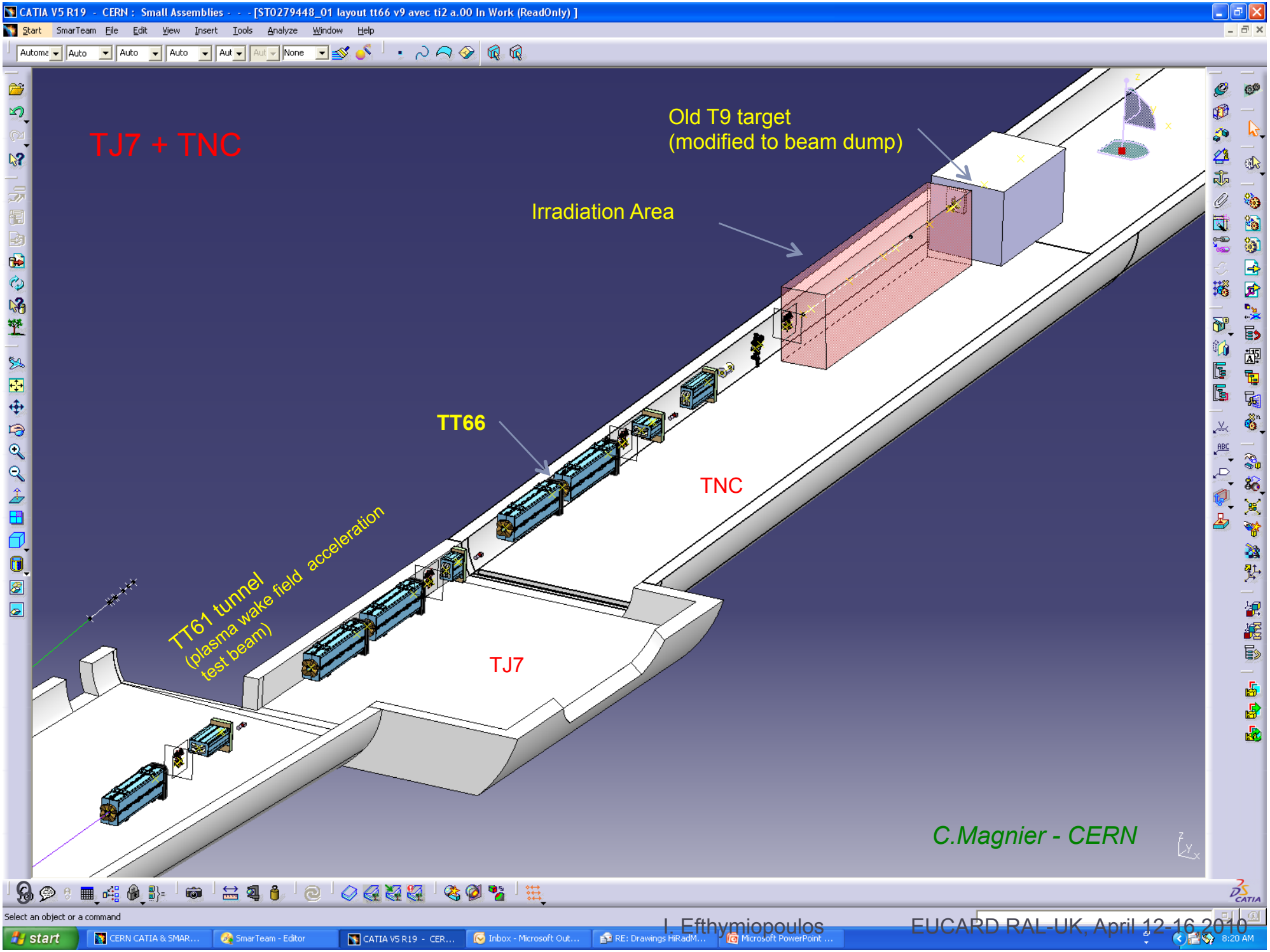


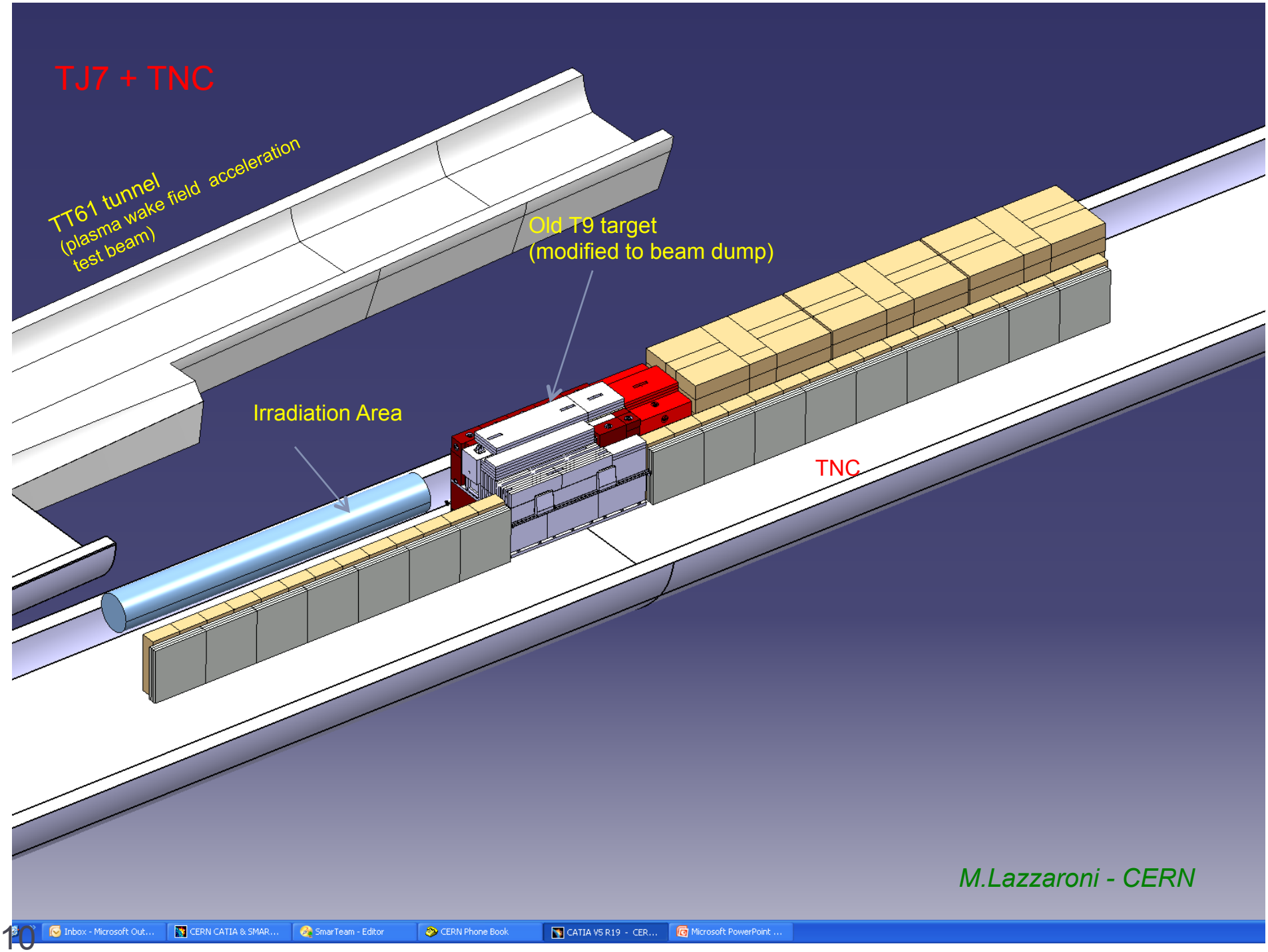
C. Hessler, 26/01/09


CATIA V5 R19 - CERN : Small Assemblies - - - [ST0279448_01 layout tt66 v9 avec ti2 a.00 In Work (ReadOnly)]
TNC
TJ7
TCC6
TT60
C.Magnier - CERN


CATIA V5 R19 - CERN : Small Assemblies - - - [ST0279448_01 layout tt66 v9 avec ti2 a.00 In Work (ReadOnly)]
TT60 tunnel
TI2 line to LHC
TT66 line to HiRadMat
Beam from SPS
C.Magnier - CERN
Select an object or a command


CATIA V5 R19 - CERN : Small Assemblies - - - [ST0279448_01 layout tt66 v9 avec ti2 a.00 In Work (ReadOnly)]
TCC6 cavern
Towards TT61
(plasma wakefield test beam)
TJ7
(access)
TI2 line to LHC
Old T1 target and shielding
(to be removed)
TT70
TT66 line to
HiRadMat
C.Magnier - CERN


CATIA V5 R19 - CERN : Small Assemblies - - - [ST0279448_01 layout tt66 v9 avec ti2 a.00 In Work (ReadOnly)]
TJ7 + TNC
Old T9 target
(modified to beam dump)
Irradiation Area
TT66
TNC
TT61 tunnel
(plasma wake field acceleration
test beam)
TJ7
C.Magnier - CERN


TJ7 + TNC
TT61 tunnel
(plasma wake field acceleration
test beam)
Old T9 target
(modified to beam dump)
Irradiation Area
TNC
M.Lazzaroni - CERN
Inbox - Microsoft Out...
CERN CATIA & SMAR...
SmarTeam - Editor
CERN Phone Book
CATIA V5 R19 - CER...
Microsoft PowerPoint ...

The HiRadMat Facility

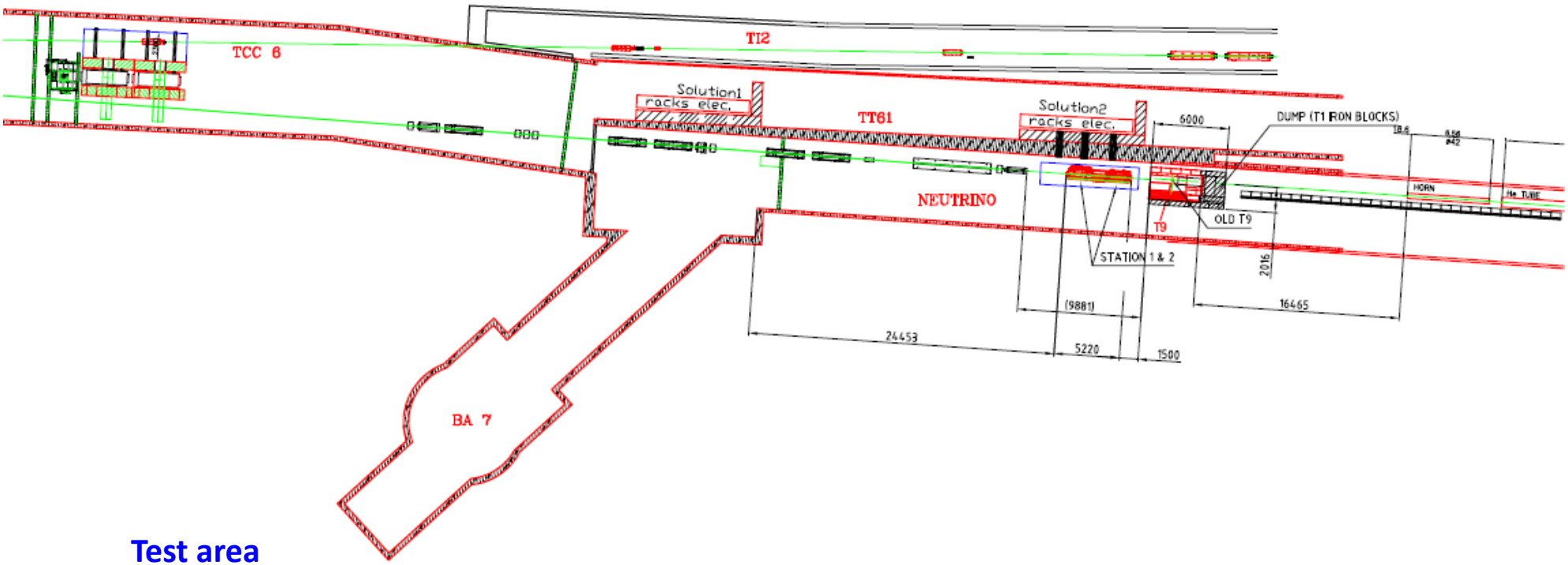
Primary proton/ion beam parameters

Parameter	Unit	Value (proton beam)	Value (lead ion beam)
Beam energy	GeV	**450**	36.9×10^3 (177.4 GeV/n)
Bunch intensity	particles	5×10^9 to **$1.15(1.75)\times10^{11}$**	7×10^7 to 3.64×10^9
Bunch length	cm	11.2	11.2
Number of bunches	-	1 – **288**	1 – 52
Bunch spacing	ns	25	≥ 100
Pulse energy	MJ	2.4	21.5×10^{-3}
Pulse length	μs	7.2	5.2
Peak power	GW	340	2.3×10^{-3}
Normalized emittance (1σ)	μm	3.5	1.4
$\sigma_x \times \sigma_y$ at exp. (baseline)	mm^2	1.0	1.0
$\sigma_x \times \sigma_y$ at exp. (request)	mm^2	**0.25 – 4.0**	0.25 – 4.0
Integrated beam intensity (protons)		**10^{16} protons/year** **10 experiments × 10^{15} protons(max)/exp** **~30÷100 extractions/exp**	

Beam design: C.Hessler, M.Meddahi

The HiRadMat Facility

Irradiation area layout: TT66 line & TNC tunnel

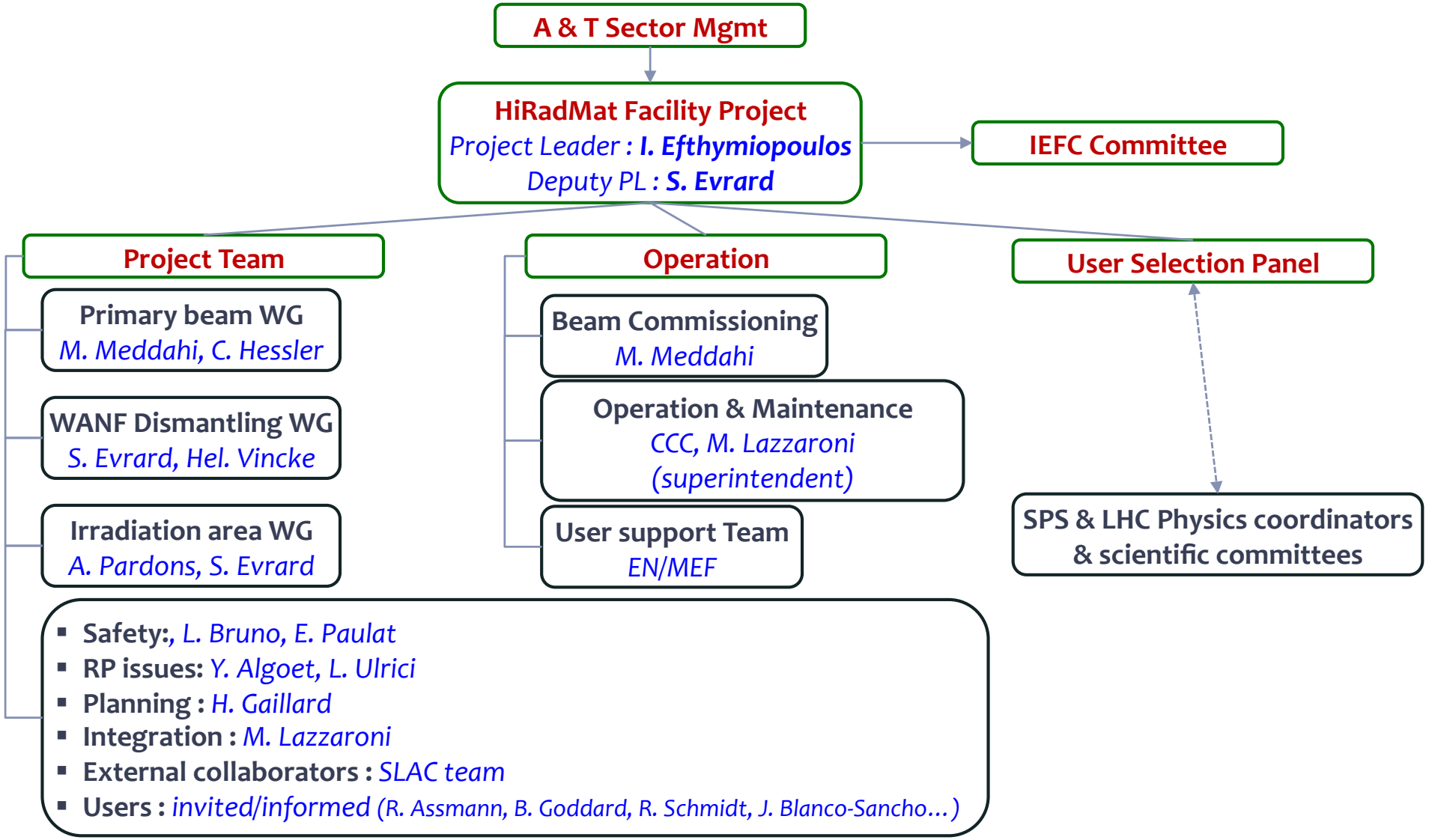


Test area

- **~10 m** long. space upstream the T9 target
- **[1.5,3.0] m** lateral space
- Possibility for fast installation of experiments
- Cool-down space downstream the TNC tunnel
- If requested, areas for test of electronics or component irradiation can be prepared

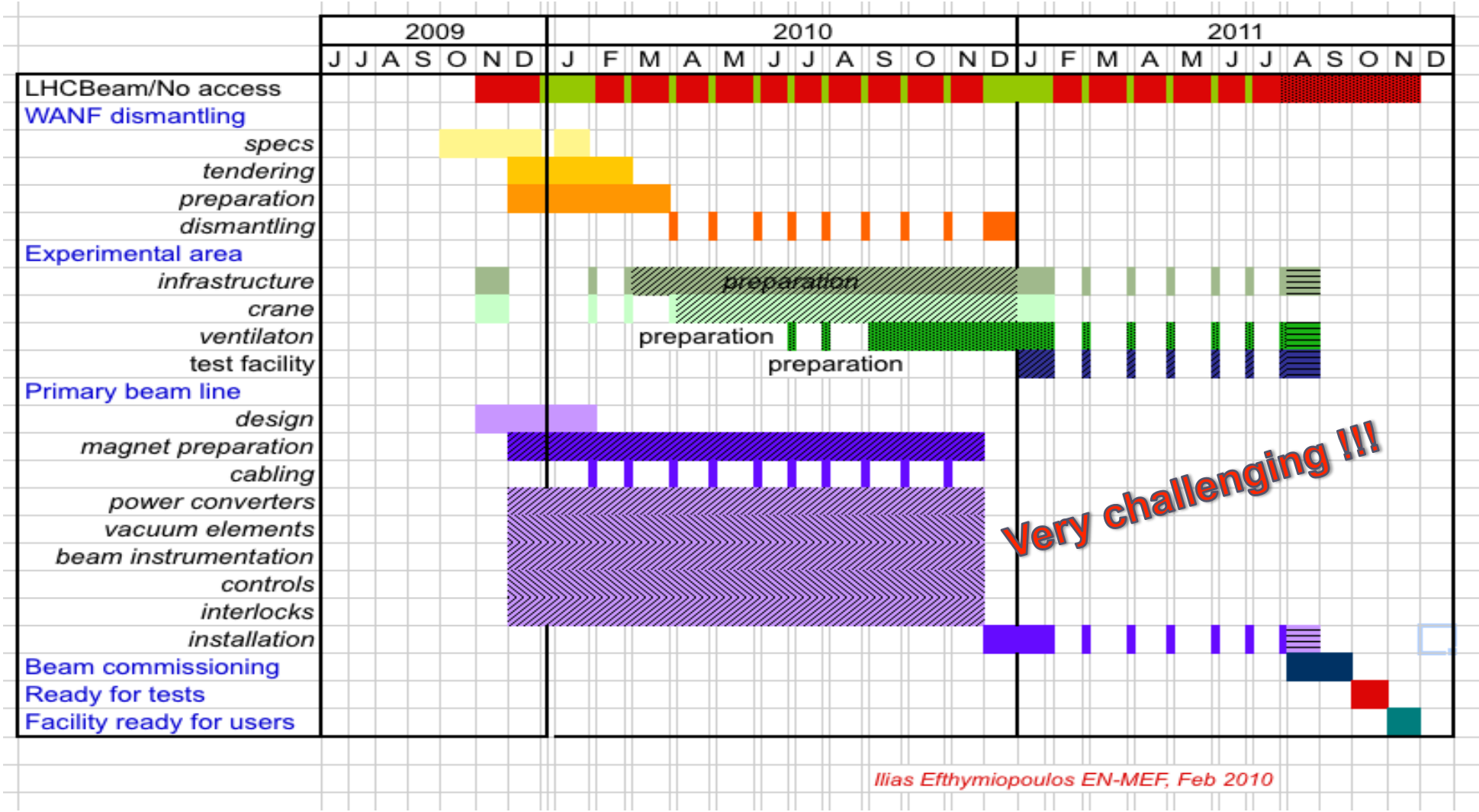
The HiRadMat Project

Project structure



Post-Chamonix 2010 schedule

14 Master schedule



The HiRadMat facility

- **Primary beam**
  - Design completed
  - Weekly meetings with equipment groups to monitor projects
  - Integration ongoing; installation schedule available

- **WANF dismantling**
  - Good progress → (photos)

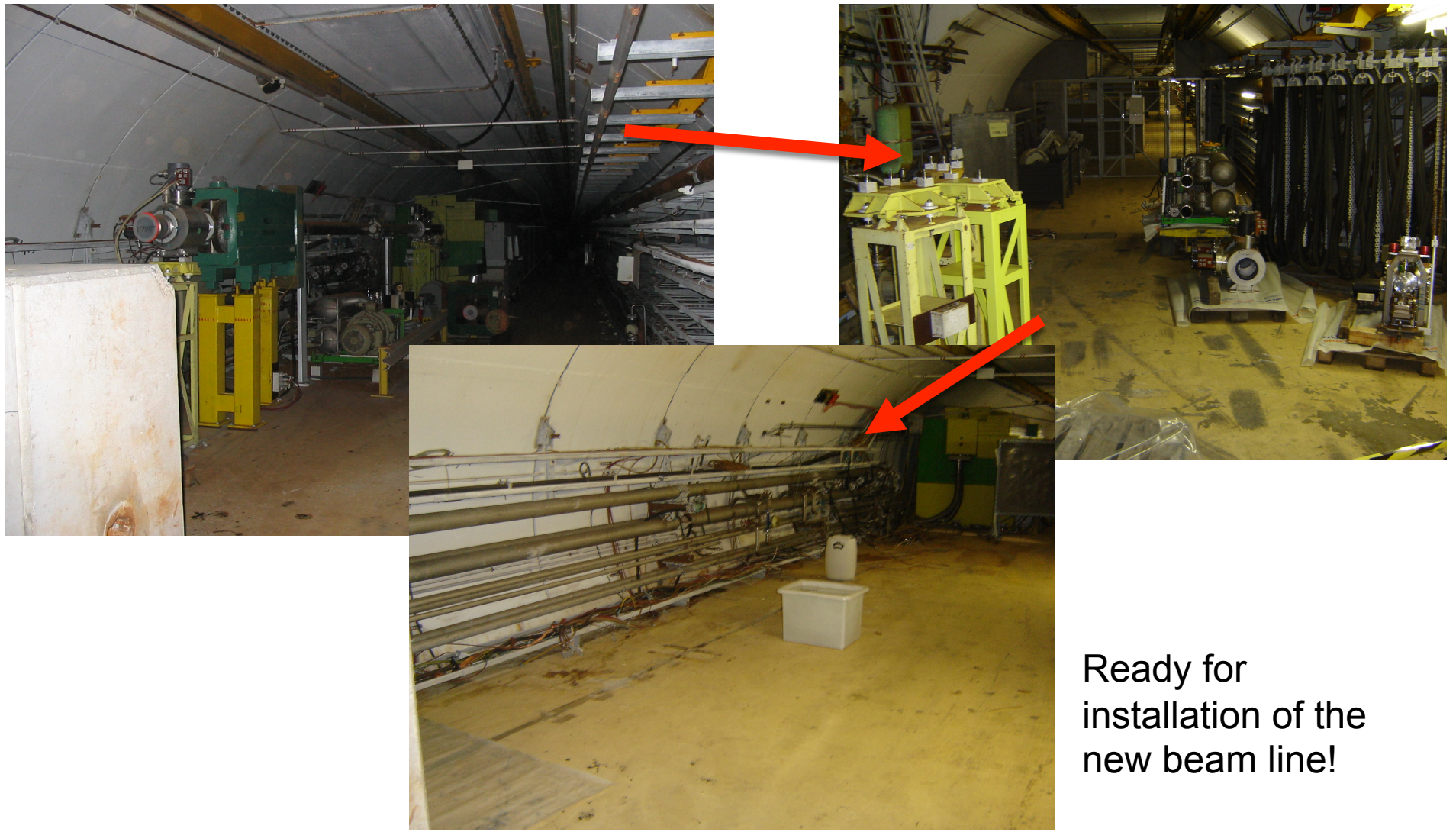
- **Irradiation area**
  - Design ongoing : beam dump, test setup
  - Focus on services & infrastructure needed for the tests
  - Safety issues

The HiRadMat facility

Highlights – Dismantling old WANF beam line

The HiRadMat facility

Highlights – Dismantling old TT66 beam line



Ready for installation of the new beam line!

The HiRadMat facility

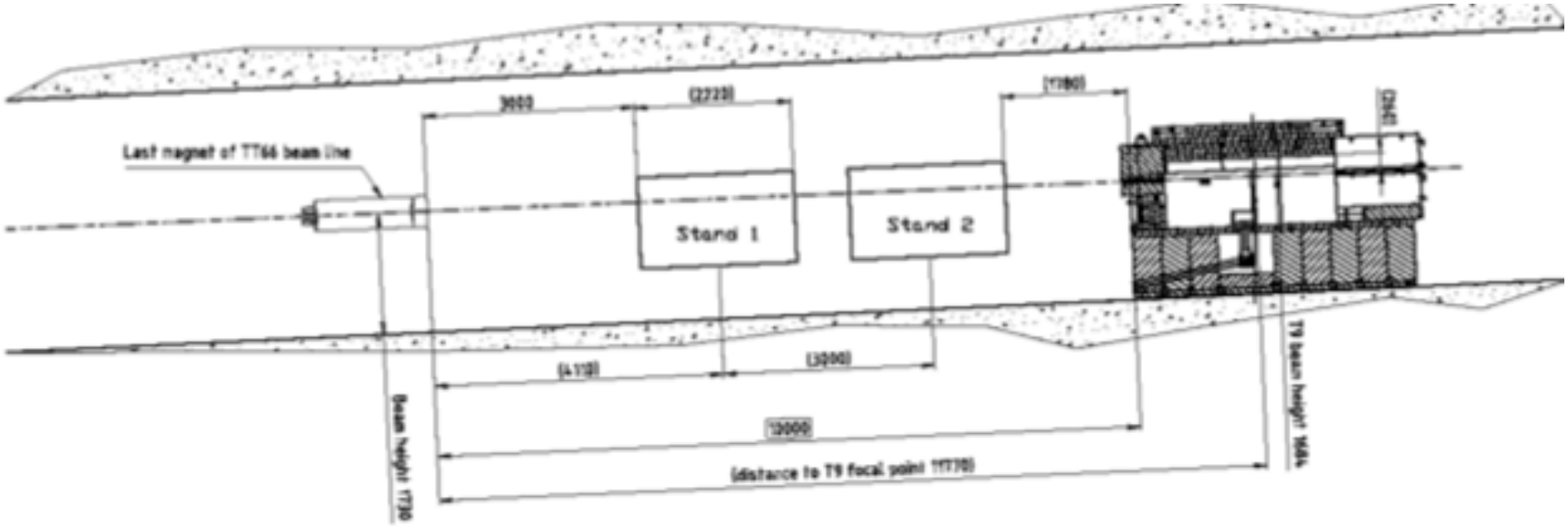
Highlights – Dismantling old T1 target

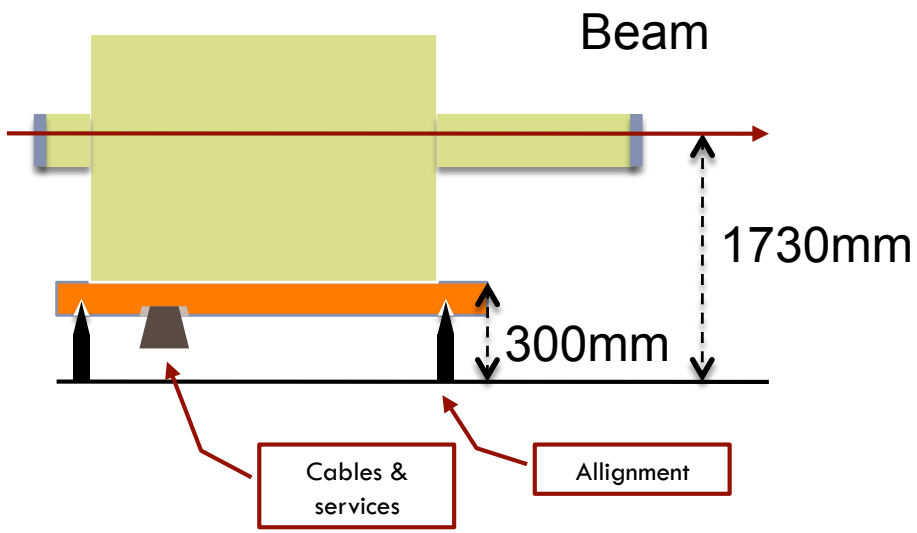
Existing passage for magnets!
Almost impossible → decided to completely remove T1 target

Special shielded forklift with automatic hook to manipulate radioactive blocks → **only one person and with x5 less dose !!**

The HiRadMat facility

19 The Irradiation area



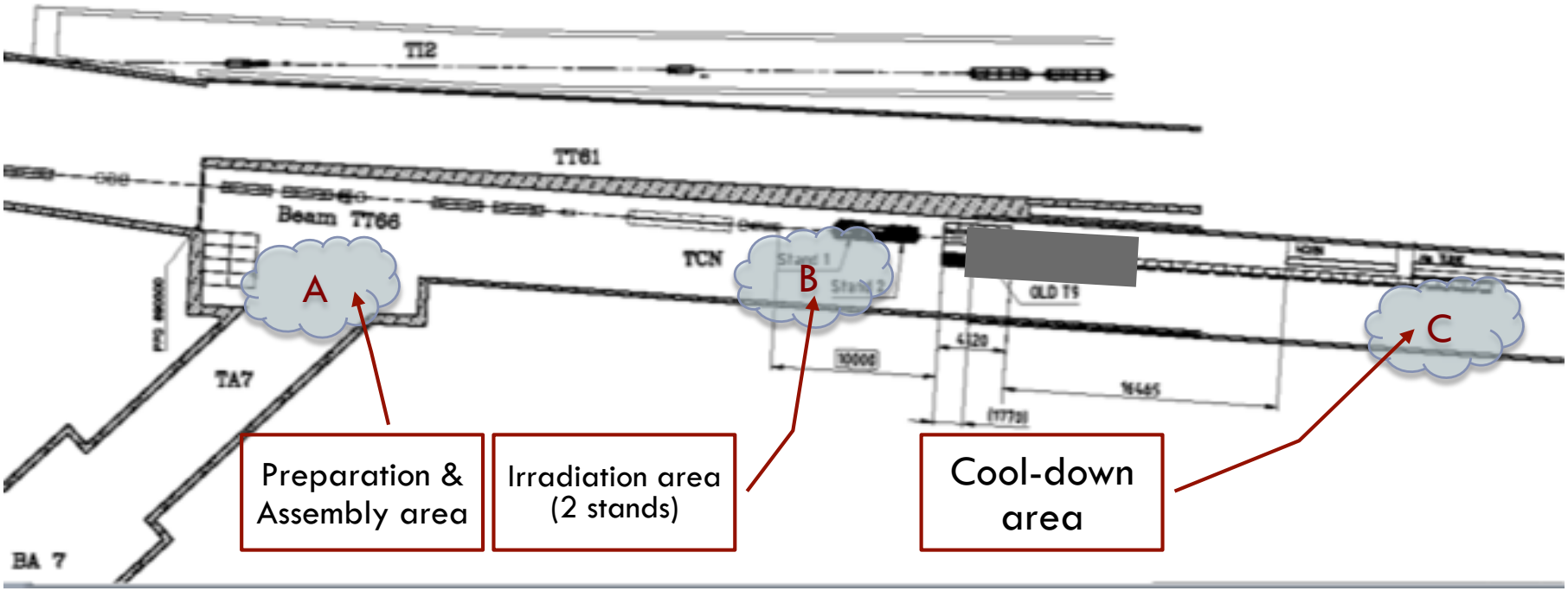


- Use base plate equipped with plug-in connectors for cables, cooling, etc. as interface
  - alignment to 0.1mm
  - remote operation with overhead crane – minimal human intervention for setup
  - Test equipment in vacuum or air depending on the test
- Beam windows is a critical issue → use same as CNGS

The HiRadMat facility

The irradiation area

- Life cycle of a test setup:
  1. Prepare 1(2) test setups each on is platform in the lab or assembly area
  2. Move them to the irradiation area – do the irradiations ; swap between the two remotely (either base platform movement or …)
  3. Move them to the cool-down area
  4. Recuperate them later for inspection/analysis in the lab



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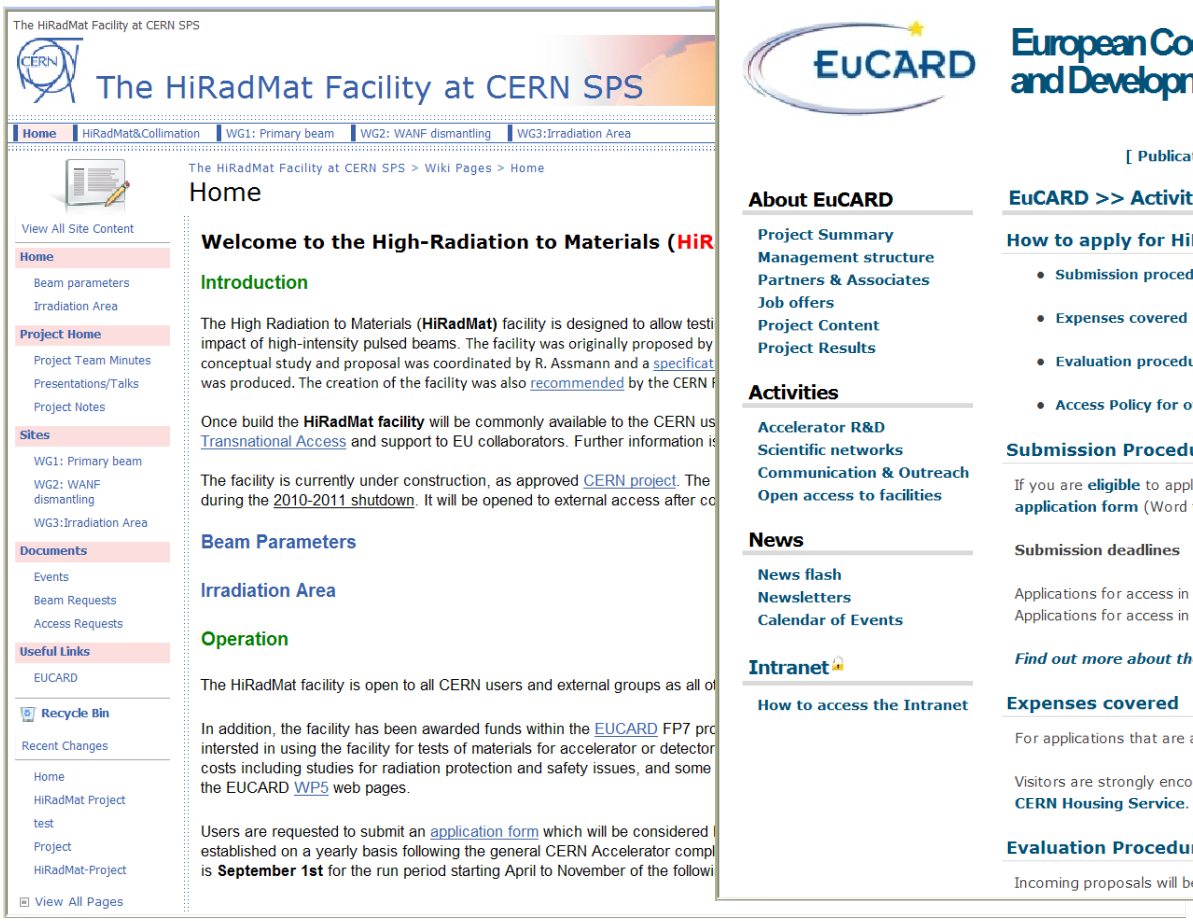
21 Open access

- Web pages for project and open access available
  - http://cern.ch/hiradmat - http://eucard.web.cern.ch/EuCARD/activities/access/



HiRadMat@SPS TA

Open Access

- EUCARD/WP5 provides funds to support user teams to exploit the facility
  - Application review at the **User Selection Panel**
  - Deadline : September each year for the next SPS run starting Spring the year after
  - Need still to clarify the operation of the facility as it will eventually take beam time from the SPS physics program

- So far: 8 beam requests, four more in the pipeline
  - Contractual requirement: 20 users/10 projects

- To optimally exploit the facility, would be excellent to couple the existing support with :
  - online monitoring, instrumentation (cameras, laser vibrometers, temperature measurements etc.)
  - beam-material impact simulation (also relevant for safety issues)
  - post-exposure analysis (lab, metrology, etc.)

  …and finally agreement for waste

Possible collaborations or a new EU project with material science colleagues?

WP5: HiRadMat@SPS

Summary

- The design of the facility is being completed, presently focusing on the irradiation area
- The construction of the facility is advancing as access allow. The excellent collaboration and support from all teams is our way out to the very tight and uncertain schedule
- Our target to have the installation of the facility completed for Summer'11 remains; and we look forward to welcome the first users later in the year after commissioning is completed

Thank you!