Lau Gatignon, IEFC workshop, 08-03-2012

Secondary Beams and Areas: Status and Plans

This is based on many fruitful discussions and in particular on the work of many people. Many thanks to all who contributed to the studies made and to the East Area day!

Outline

- Outcome of the East Area Day
  - Updated user requests
  - New layout in view of DIRAC dismantling
  - Irradiation facility in view or R2E an AIDA projects
- North Area renovation
  - Status of the renovation activities: EN, CV, magnets
  - Schedule and foreseen activities during LS1
  - Priority list to assure operations and restart in 2014

East Area Day

- An East Area Day took place on Wednesday 1st of February

  https://indico.cern.ch/conferenceDisplay.py?confId=167761

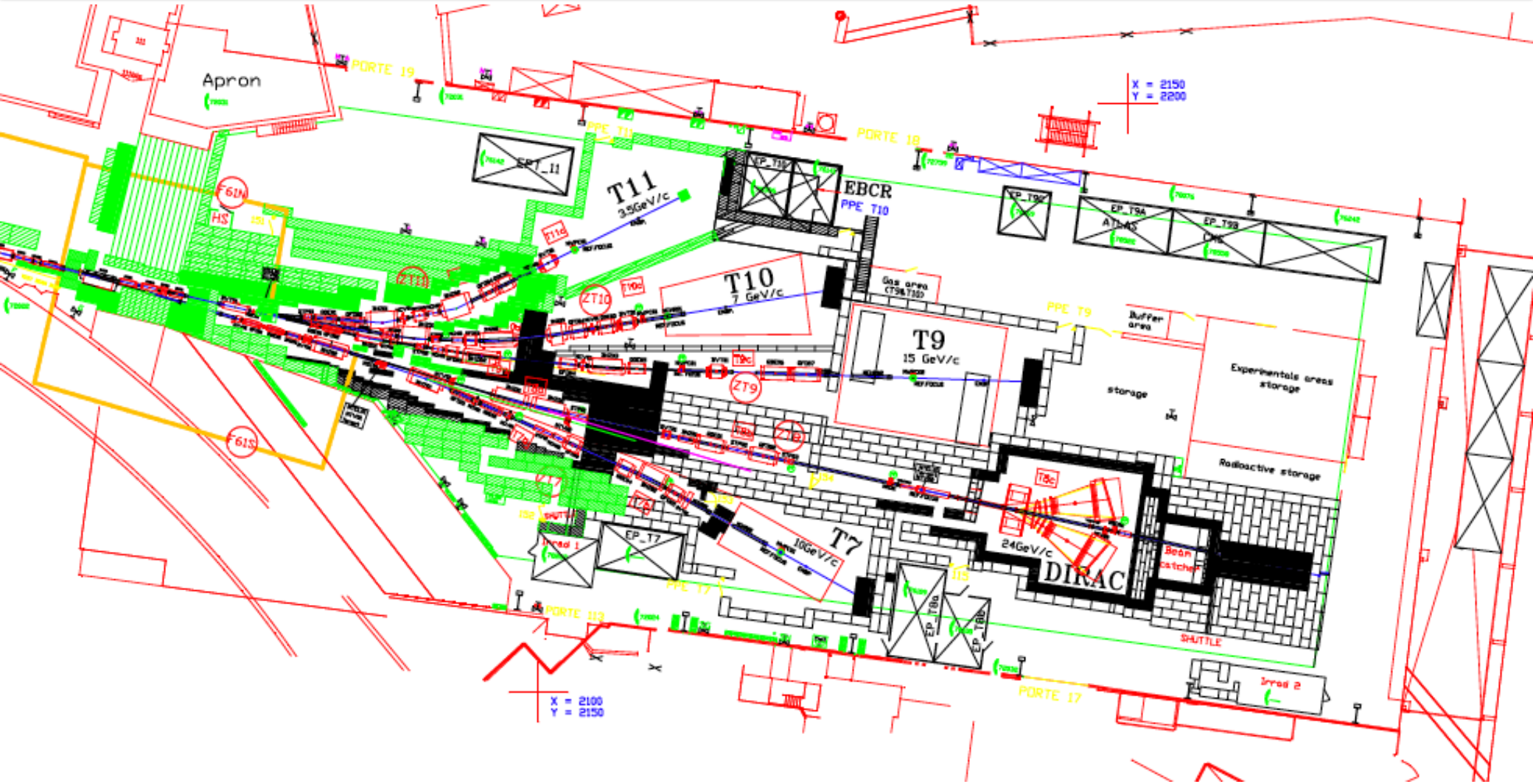
- The purpose of the day was two-fold:
  1. Does the proposed layout meet the physics and test beam needs
  2. Is the layout realistic and feasible and does it match the issues in terms of reliability, radio-protection, safety and resources

- The day was organised in 4 sessions:
  1. Explain the proposed project
  2. User needs, what and when

     ALICE, LC tests, Neutrino tests, CLOUD, **R2E, AIDA**
  3. The consolidation in technical terms
  4. How and when?

- The day was very well attended and there were many useful discussions.

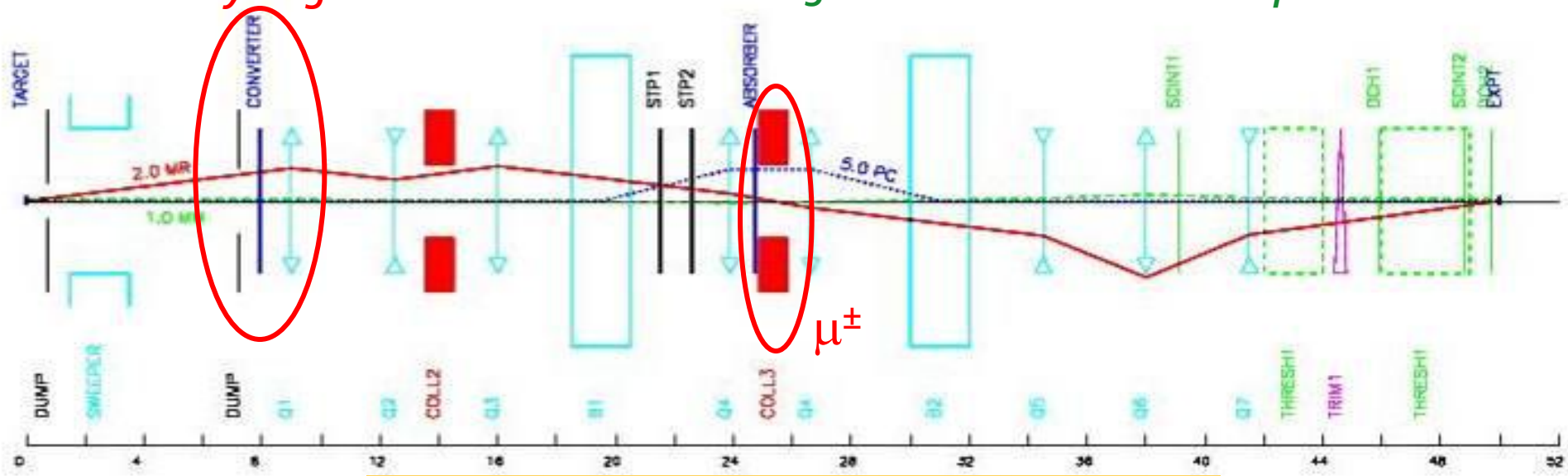
Layout existing East Area



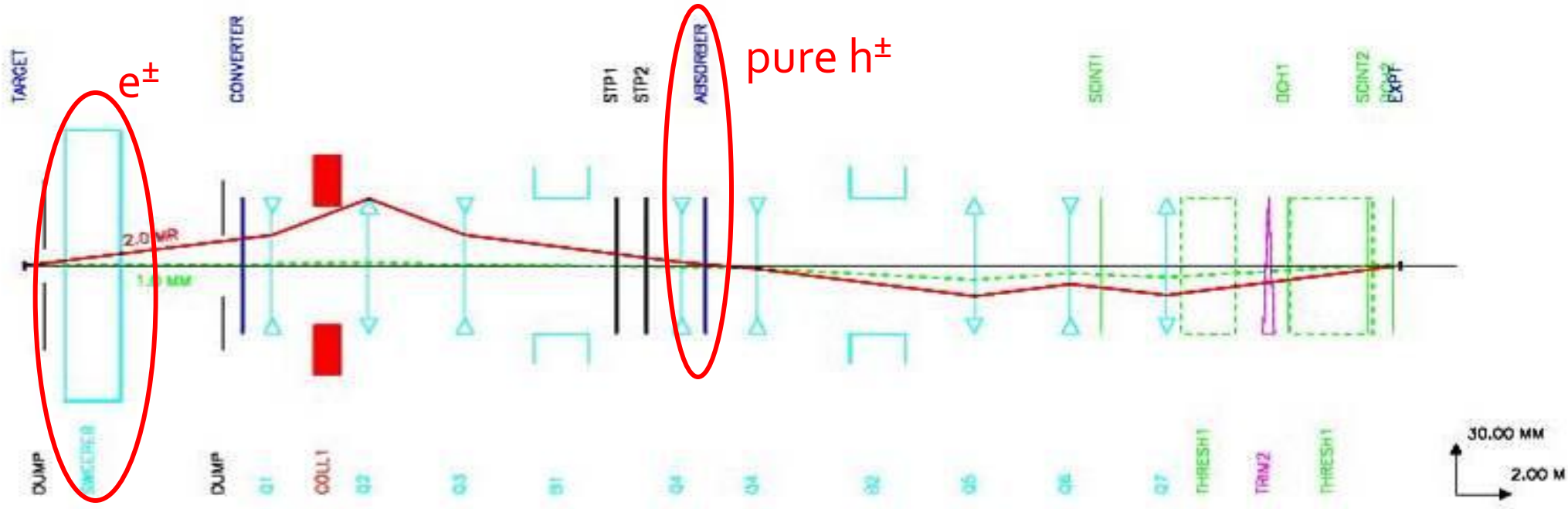
Session 1 – new layout

Uses "dummy magnets"

~5x better transmission than present lines!



GENERIC NEW EAST AREA TEST BEAM OPTICS



Parameters of secondary beams

Parameter	T9 (new)	T10 (new)	*old T9*
Length (up to last beam element) [m]	50.2	4.7	*54.3*
Max. beam momentum [GeV/c]	15	12	*10*
Momentum resolution [%]	0.7	0.7	*0.7*
Max. momentum band [%]	±15%	±15%	
Horizontal acceptance [mrad]	±4	±5	±4.8
Vertical acceptance [mrad]	±2.8	±3	±4
Magnification at final focus (H, V)	0.75, 0.86	0.92, 0.58	*0.81, 0.91*
Typical RMS spot size [mm] for acceptance colls at ±10 mm, $\Delta p = \pm 1\%$	1.5, 2.0	1.6, 1.5	*1.5, 2.0*
Maximum flux per spill	10^6	10^6	*10^6*

Proposal for new IRRAD facility

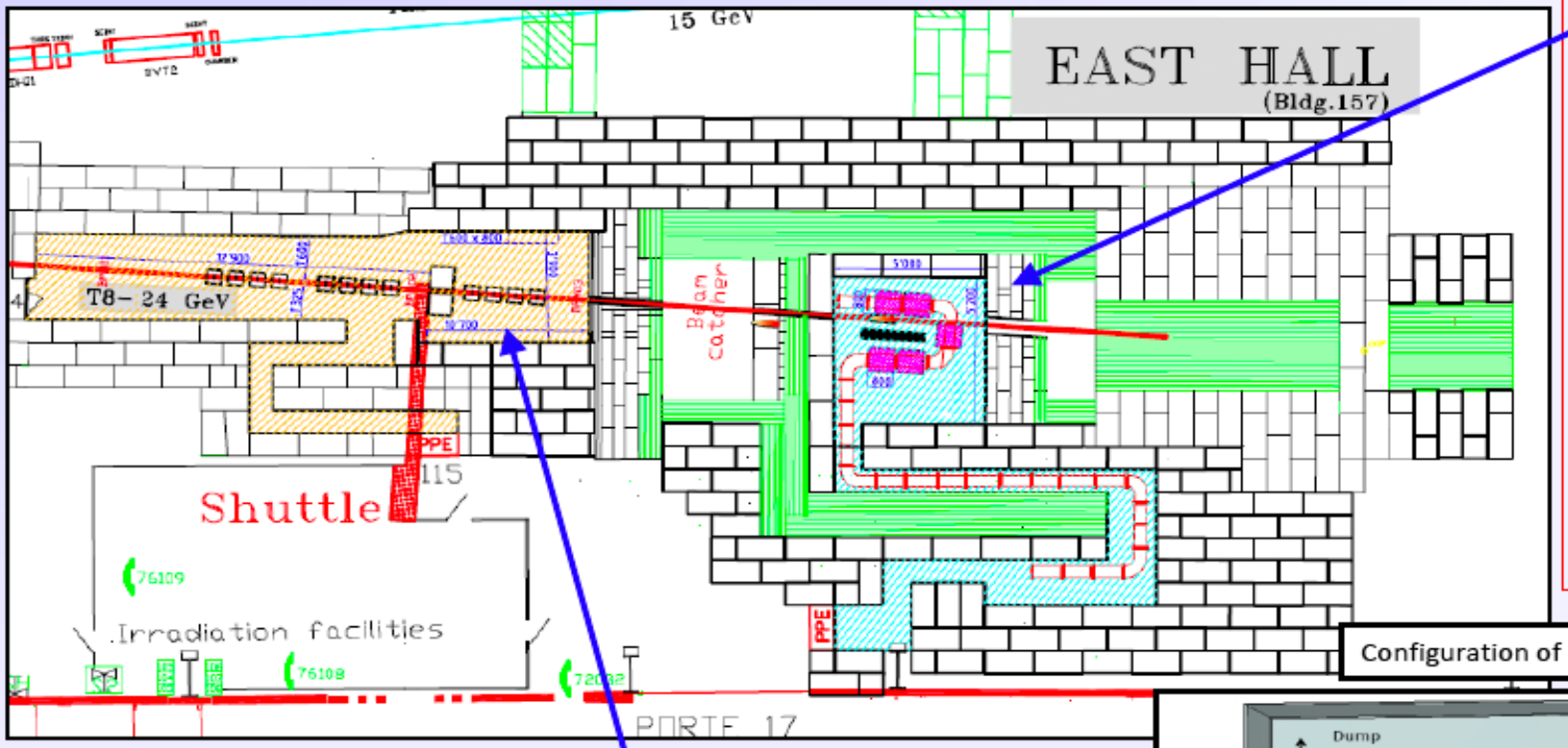
- Use the space that will be liberated by DIRAC
- Access independent of the rest of the East Area
- Optimised layout for shielding and dose reduction to personnel, with ventilation, local shielding, infrastructure and space for easy accessibility
- Provision for services
- Can use same proton cycles for both facilities
- Funding could be available from the projects
- Aggressive time scale imposed by LHC needs (R2E) and AIDA project duration

Requires dismounting of DIRAC a.s.a.p.!

Layout studies using the DIRAC experimental area

- **Collaborative work:** CERN EN & PH; AIDA & R2E

M. Brugger, M. Calviani, L. Gatignon, M. Glaser, E. Lebbos, M. Moll

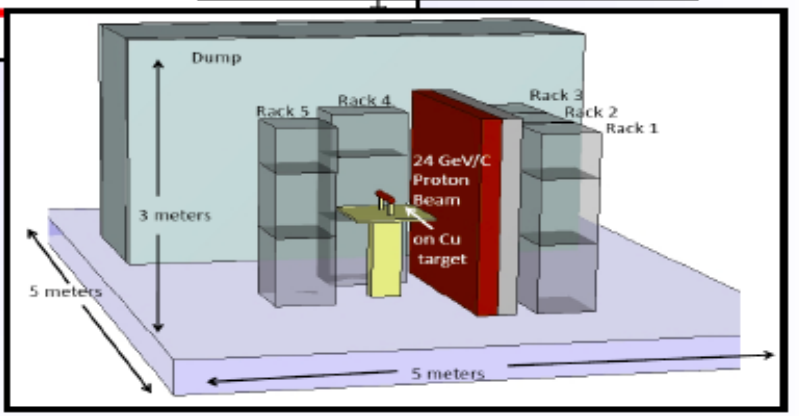


Mixed Field Facility

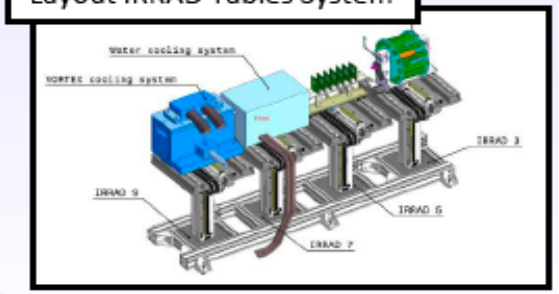
multiple user communities:
LHC machine
LHC Experiments,
Dosimetry (RP),
MC benchmarking

rail system on floor for heavy material, shuttle system or small rail system on ceiling (?)

Configuration of Mixed Field Area



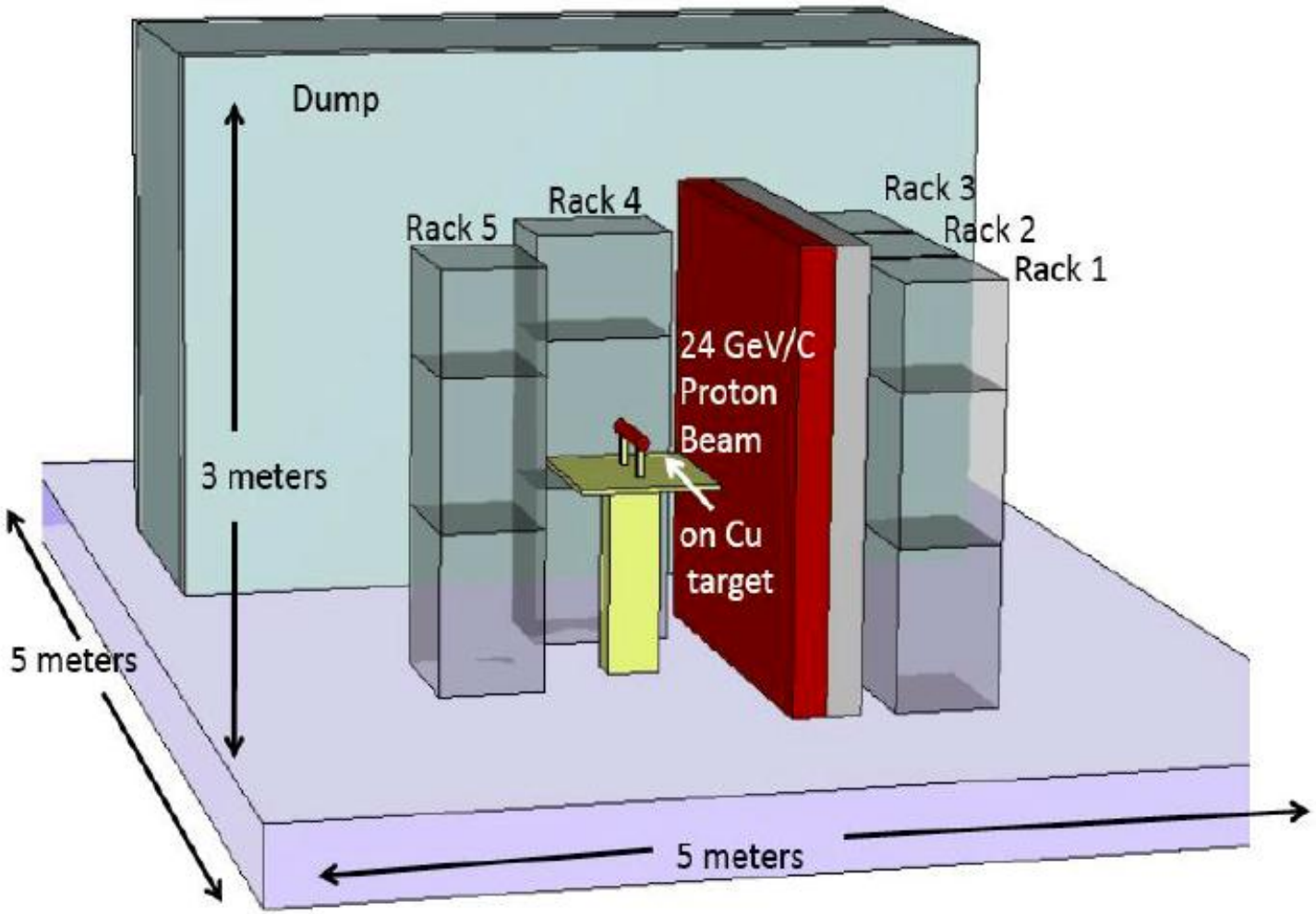
Layout IRRAD Tables System



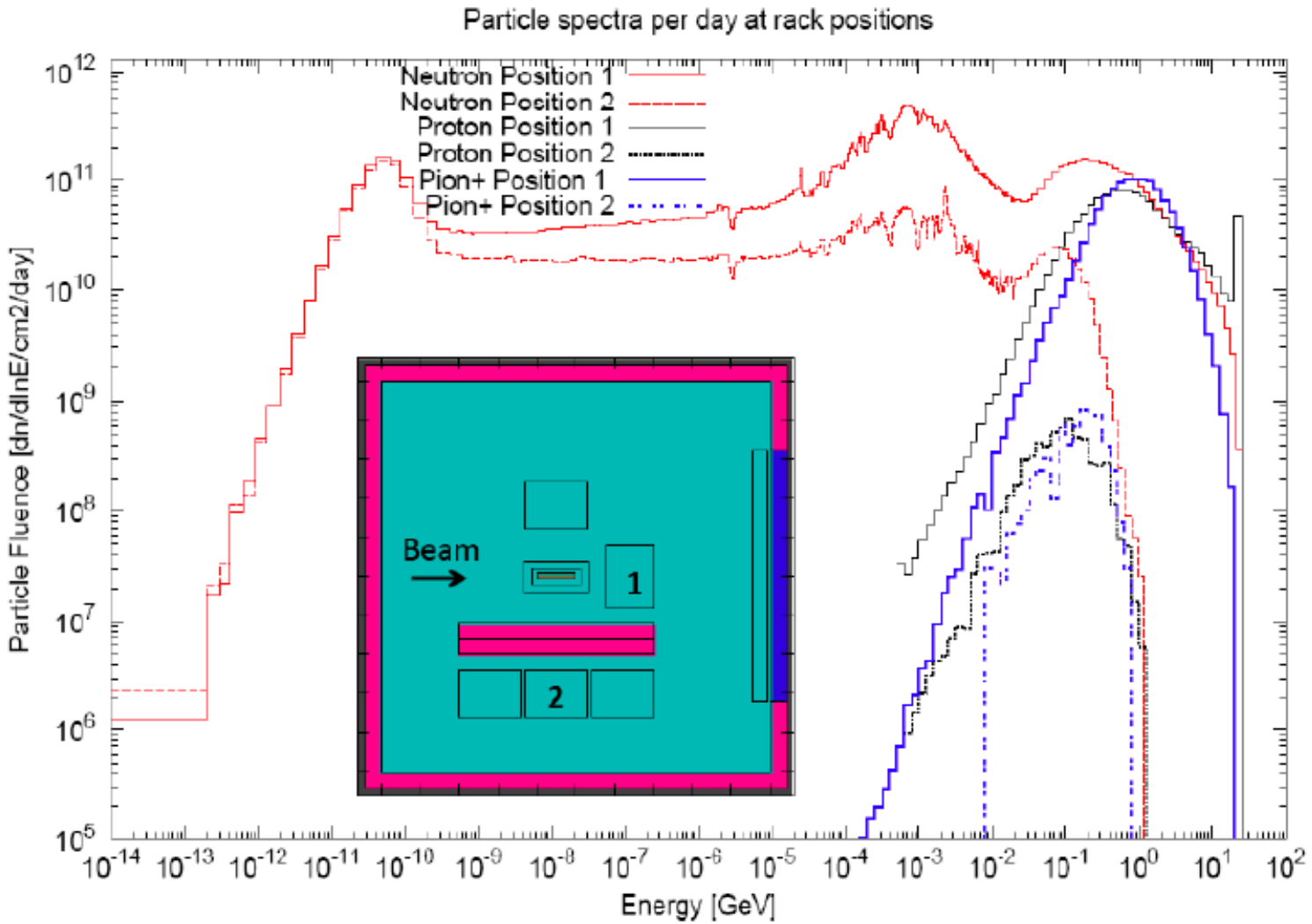
Proton Facility

- main user community:
  LHC Experiments
- Irradiation tables
- Cold boxes
- Shuttle system

The mixed field facility (R2E)



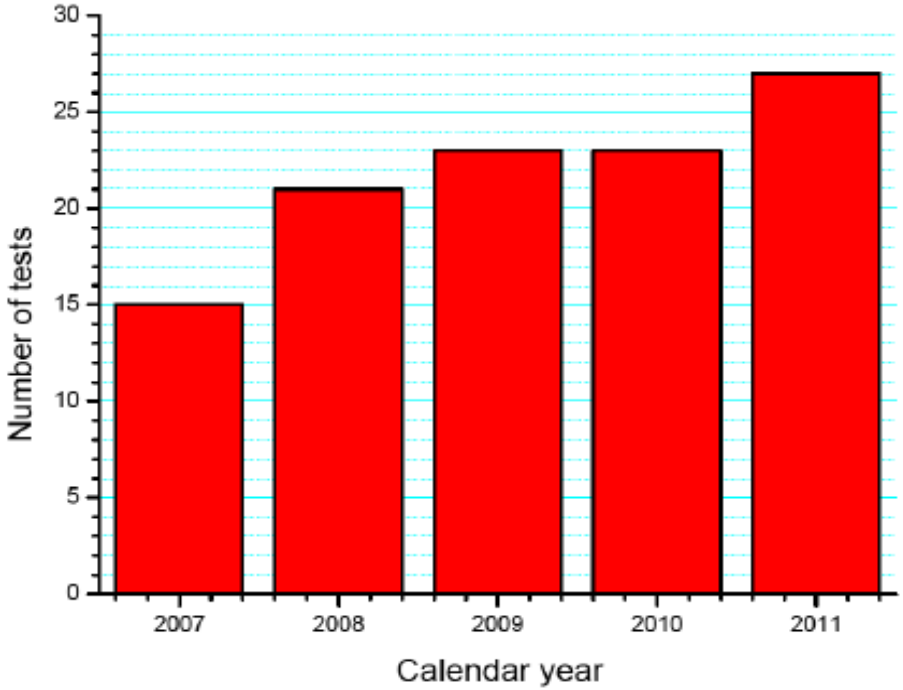
Energy spectrum in mixed field facility

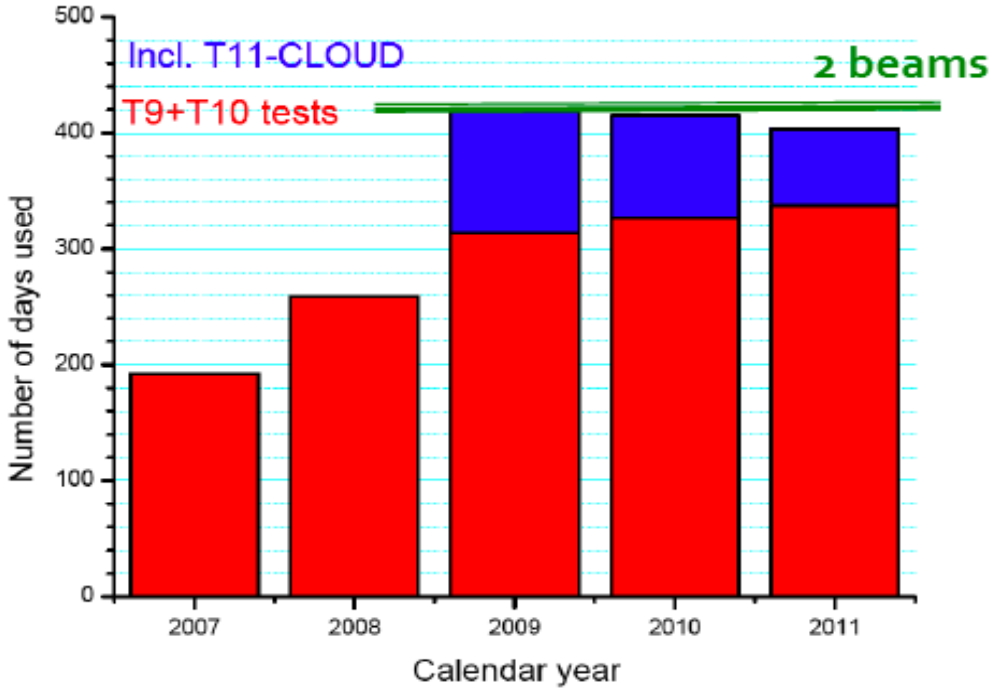


Session 1 – Beam characteristics

- In this proposal T11 is abandoned, but **T9 and T10 can be exploited all the time** in the new layout. The T7 line cannot be used anyway because of the IRRAD facility using the same primary branch. De facto T7 has been abandoned since 2004.
- Once DIRAC disappears (SPSC!), the shortage of cycles is no longer major issue.
- The new beam design of T9 and T10 has higher top momentum and allows **energy overlap with the EHN1 beams, as well as control over particle type**
- One of the main drivers of the new layout was the **improved access to the beam line equipment and the better handling of radiation to equipment**. This need was clearly expressed in previous workshops, in particular by TE-MSC and EN-STI.
  Also the difficulties to intervene (dose) are are strong argument!
- The new beams will be consolidated and will use reliable magnets with sufficient spares available.

Session 1 – User requests





Session 1 - outcome

- An energy overlap with the North Area beams is now possible
  - Well appreciated by the users
- H4IRRAD is judged insufficient for R2E after LS1
  - The rate is much lower and H4IRRAD is only part-time available.
  - Moving R2E to the East will relieve the pressure on H4 and EHN1
- CNRAD is not guaranteed to be available after LS1
- The T11 beam would be dismantled and CLOUD moved to T9
  - Keeping T11 would give one more beam (p.-t.) but strongly reduced maintainability and accessibility
- Consolidation of instrumentation, targets, stoppers, layout is essential
  - In particular also primary beam instrumentation

Session 2 – User input

- **ALICE** and the **LC teams** appreciate the higher top energy (overlap with EHN1 beams) and choice of particle type. For the LC a special time structure would allow to test their 'power pulsing' approach.
- **CLOUD** moves in the direction of wanting to keep T11 for maximum flexibility, but could live with the proposed T9 layout where they can get more space. Keeping T11 would need a study, **gains a dedicated beam for CLOUD**, but goes **against** the improved accessibility and maintainability of the beam lines.
- **Neutrino experiments** want low-energy beams (up to ~10 GeV/c) and a large magnet in their test area (ok in new layout, difficult in old).
- The **IRRAD** groups presented a design of a new layout in the T8 zone. This requires the fast dismounting of DIRAC if they want to install during LS1. This will depend on availability of resources (e.g. CV). This work is largely decoupled from the rest of the project.

Conclusions from Session 2

- **The East Area will remain an actively used facility** and must be kept operational in a reliable condition for many years to come. It fits well the foreseeable test beam activities, also e.g. thanks to the ease of access to the zones.
- Most if not all test beam users value particularly the free choice of particle type and the energy overlap with the EHN1 beams. All seem to support the concept proposed in the new layout.
- **The proposed layout was considered to be a good compromise between reliable operation and user requirements.**
- **The IRRAD move to T8 is urgent e.g. for R2E (LHC electronics) : LS1?**
  Note that IRRAD is a facility (i.e. with specialized service – in PH), not just a test area

Session 3 – main issues

- **The RP aspects** of the present area are not at all at modern standards, the new zone is far more promising.
- The **magnets** and **rectifiers** need urgent consolidation, otherwise long beam stops cannot be excluded (very old equipment).
- In general standardization of equipment is aimed for.
- The **CV systems** need a lot of work, but preparation work cannot start in the next months, due to conflict with LS1 preparations
- The scope of **CE works** is limited by the presence of asbestos. However, some repairs must be done, but remain to be planned.
- Cesar is asked for by several users

Present situation – *target area*

Courtesy Stefan Roesler

Not optimized according to modern radiation protection practices

- ageing components ⟹ ***frequent repair, water leaks,...***
- significant losses, long passages of beam through air, tight space, difficult access
  ⟹ ***comparably high individual and collective doses***
  ⟹ ***unjustified activation of air***
- corrosion ⟹ ***contamination risks***
- no ventilation system ⟹ ***risk assessments difficult***
  ⟹ ***faster corrosion***
- single water cooling circuit for target area and experiments
  ⟹ ***unjustified exposure of experimenters to activated water***
  ⟹ ***large volume of activated water***

→ A consolidation is urgently required and encouraged by RP

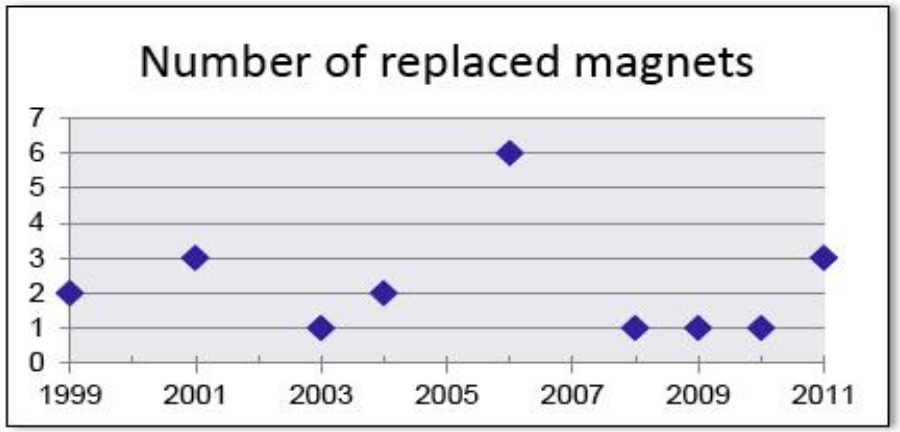
Summary and conclusions

Courtesy Stefan Roesler

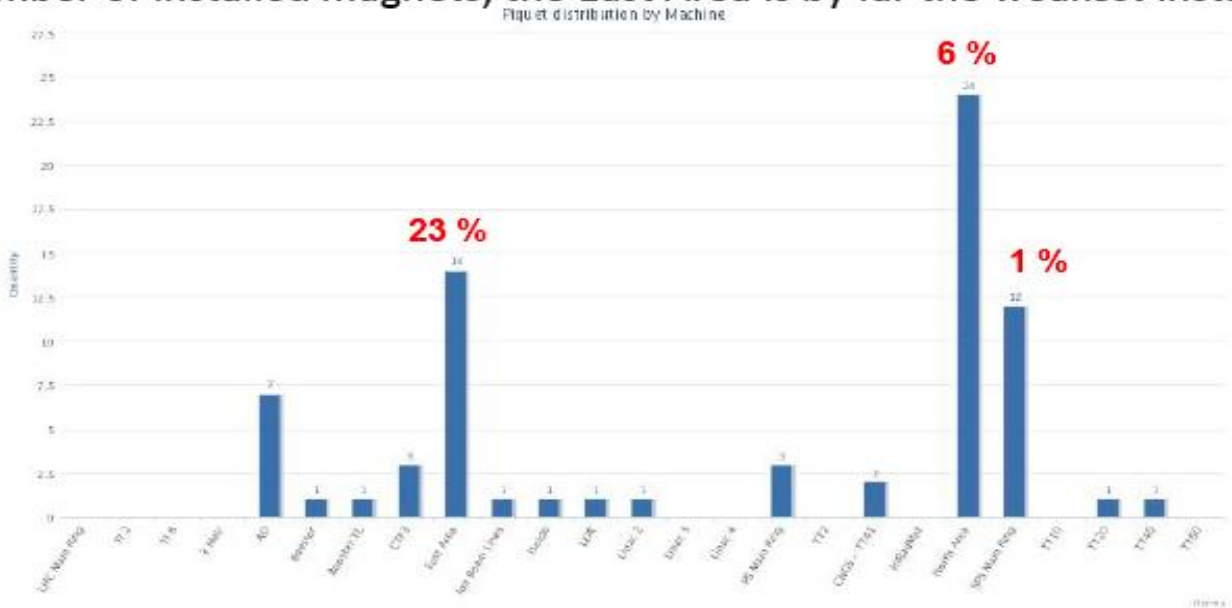
- The present East Area is not optimized according to modern radiation protection practices. (high losses, tight space, no ventilation, corrosion, single cooling circuit,...)
- Thus, a consolidation (especially of the target area) is urgently required and supported by RP, if possible during LS1.
- Preliminary shielding studies have been performed and are integrated into the present design, further and more detailed studies are needed, in particular for mazes, accidents as well as for activation of components, liquids and air.
- The monitoring (RAMSES) budget requirement of 300+150kCHF seems appropriate. The manpower needs have to be revised once a draft schedule is available.
- A dedicated mixed-field facility for testing electronics equipment (replacing H4IRRAD and CNRAD) would be of advantage from an RP point-of-view.
- All work has to be well planned and optimized (ALARA, DIMR level I or II). RP is available for advice.

Magnets reliability

- Failures since 1999 : Total of 20 magnets with a rate of 1.7 magnet/year



With respect to the number of installed magnets, the East Area is by far the weakest installation at CERN



Session 3 - conclusions

- It was clearly demonstrated that a thorough consolidation of the East Area becomes urgent. **The expected lifetime of some magnets does not go beyond 2015!**
  Many of the power converters are 30-40 years old (like in some other areas).
- The radiation aspects will be significantly improved in the new layout, as well as the magnet situation.
- The asbestos in roof and walls makes an insulation upgrade to modern standards unrealistic, but local improvements combined with CV renovation will improve significantly the present situation. We do not plan to touch the asbestos.
- CV cannot start serious work on this project in the coming months (September?)
  Similarly the power converter upgrade can only start after LS1 for the ones to be replaced and during LS2 for the ones to be consolidated.
  But this activity could be separated from the layout change.

Session 4 – staging

- R2E considers the IRRAD move urgent for LS1. The need is understood, but the resources are an issue. To be discussed.
- The spending can be staged relatively flexibly by cutting the project into more or less independent parts.
  However, the layout change of primary zone + secondary lines will take ~ 18 months without beam at some stage.
- The civil engineering works has to be entered in the GS planning.
- The need of serious consolidation has become obvious.
  LS1 seems impossible, LS2 is too late.

Do we have to give up a year of physics in the East Area?

Work packages

#	WP for layout change	Cost (kCHF)	FTE
1	Preparatory work (crane, etc)	980	0.1
2	Beam and areas layout change	4165	12
3	IRRAD upgrade (implies DIRAC dism.) estimate	2100	2.5
	Total for layout change WP	**7245**	**14.6**

#	WP for consolidation	Cost (kCHF)	FTE
4	Power converters	2800	11
5	Electrical infrastructure AC	1650	0.2
6	Air conditioning building plus civil engineering work	2805	1.5
7	**Replacement PVC cables**	**1500**	0.2
	Total for consolidation WP	**8755**	**12.9**

Example of a staging scenario

- WP 1-2-3 during LS1 or as soon as possible after. Resource issues
- WP 4-5-6-7 are 'normal' consolidation, to be put in balance with NA consolidation

Conclusions East Area

- The new layout is a good compromise between user requirements and maintainability
- Maintainability requires simplicity and therefore maintaining T11 dedicated to CLOUD is not favored from this point of view, but preferred by CLOUD
- The IRRAD upgrade is an urgent request for LS1 (R2E).
  Staging this part of the project forward seems possible from the technical point of view (but resource issue).
- In general the equipment is aging and it is not obvious in what condition the East Area will survive till LS2. A way of defining staging scenarios has been indicated.
- A change of layout requires a year without EA operation if not during LS1 or LS2.
- Thanks to all who contributed to the work and to the East Area Day!

Overall cost

Sub-project	MCHF	FTE
East Area layout change	1.5	3
East Area consolidation	12.4	21.5
To be done at same time as layout change	3.65	9.1
Can be done later	8.75	12.4
Irradiation facility upgrade estimate	2.1	2.5
Total	**16.0**	**27**

Can be spread over several years

Detailed breakdown exists in document attached to East Area Day page

NORTH AREA CONSOLIDATION

- The North Area was built in the mid 1970's
- Its beams and **infrastructure** need consolidation if the area has to continue operation for another few decades
- The North Area is heavily used and in recent years the requests exceed the available beam time by more than a factor of 2
- The North Area houses a number of major experiments: COMPASS (EHN2), NA62 (ECN3) plus several experiments (NA61, NA63) and many test beam users and R&D activities in EHN1.
- Recently an activity has started in EN-MEF to assess the specific needs for consolidation and the associated costs and resources. This activity is coordinated by Mats Wilhelmsson. It will be done along the same lines as what was done for the accelerator consolidation projects.

Status of NA renovation activities: Buildings

- The main CE activities are related to roof repairs and the consolidation of sewage and drain systems. Asbestos is present in five of the buildings, but a strategy for remains to be defined.
- A strategy for crane consolidation in the North Area has been defined. The most economic solution is to replace 6 of the 10 cranes and to refurbish the other four.
- The sanitary installations are in a pitiful state. Also a general face lift of the building would be welcome → visibility!

Status of NA renovation activities: EL

- A serious upgrade is required for the high-tension electric supply to the various area and the installations. More detailed studies are required.
- For the BT networks, four domains where intervention is needed have been identified:
  - The pulsed network needs a full maintenance
  - The general service power distribution (400 V) must be renovated (electrical cupboards, etc)
  - The assured power systems (UPS, Diesel) need an overhaul
  - The dedicated power distribution to the experiments must be consolidated
- In association with the power converter renovation, replacement of old DC and AC cabling may be required (PVC).

Status of NA renovation activities: Magnets & PC

- Magnet repairs are an annual activity. Some magnet types are without spares, in particular e.g. MSN magnets are critical and spares must be procured.
- The power converters are still the original units and date from 1977.
  Not only are they old and prone to failure, but also their setting precision is not satisfactory in all cases. Their renovation will become important. Cost ~20 MCHF.
- In this budget estimate the AC power supplies and the cabling are not yet included.

Status of NA renovation activities: Others

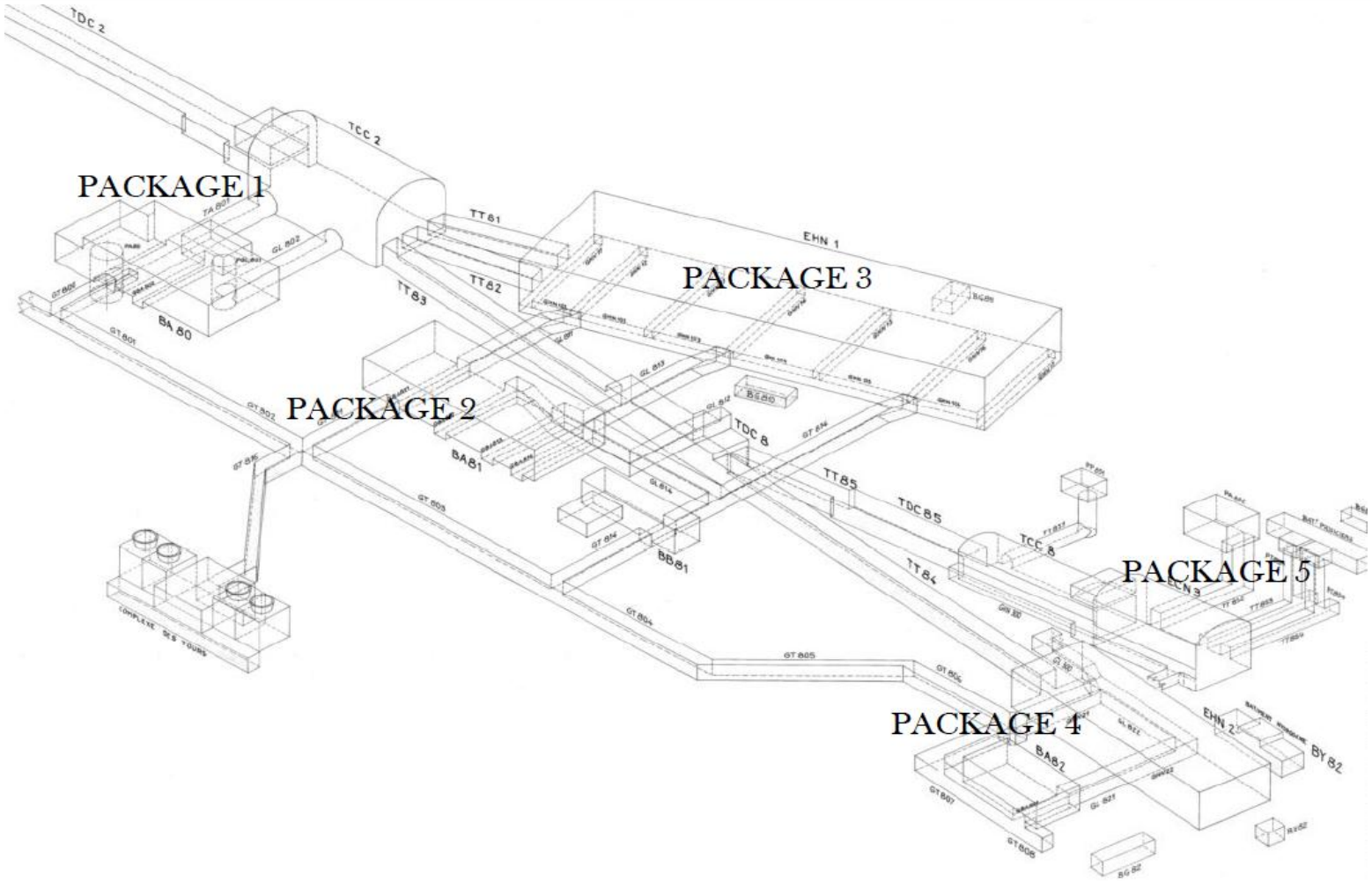
- The general ventilation systems in the buildings, galleries and counting rooms need renovation, including its controls systems and electrical infrastructure
- All main fluid networks need an overhaul (primary, raw, **chilled**, demineralised and drinking water). Also the compressed air distribution.
- Gas distribution, Vacuum infrastructure, Beam instrumentation, …

Preliminary cost estimate

Item	Cost (kCHF)
Civil Engineering	8500
Cooling and Ventilation	7725
Electrical infrastructure	8000
Cranes	4900
Power converters	20000
Gas infrastructure	1600
Other items	2000
Total	>52725

PRELIMINARY!!!

Staging possibilities



Critical issues for 2012 run:

Important consolidation work is already taking place in the NA to ensure smooth operation in 2012:

- The last phase of the consolidation of motorization will definitively remove one serious bottleneck in the control system
- **Particularly critical is the ongoing work in TDC2 and TCC2**:

  The repair of 8 (out of 12) TAX tables in TCC2 will allow:

  - the operation of the P42+K12 beams for NA62 during their technical run in October
  - primary beam operation for H4IRRAD in H4 and for UA9 in H8

  However, the repair of the T6 TAX (COMPASS beam line) will have to wait for LS1.

  Also work is starting on the consolidation of the vacuum in the splitter region and of the primary targets.

  All these activities are described in detail by Sebastien Evrard in the next talk.

NA: Schedule and foreseen activities during LS1

- NA62 project completion
- Installation of H8-VLE for neutrino experiments?
- GIF++ installation?
- Plus priorities for reliable operation in 2014:
  - Repair of TAX motors behind T6 (COMPASS) – See S.Evrard presentation
  - Consolidation for COMPASS-II
- …..

Summary for North Area

- A study has started to evaluate the consolidation needs of the North Area.
- The plan is to refine this study and resource estimates and to prepare the necessary risk factor analysis for the overall consolidation project.
- The very preliminary cost estimate is in the ballpark of ~50 MCHF.
- A breakdown will be made with risk assessment for all individual items.

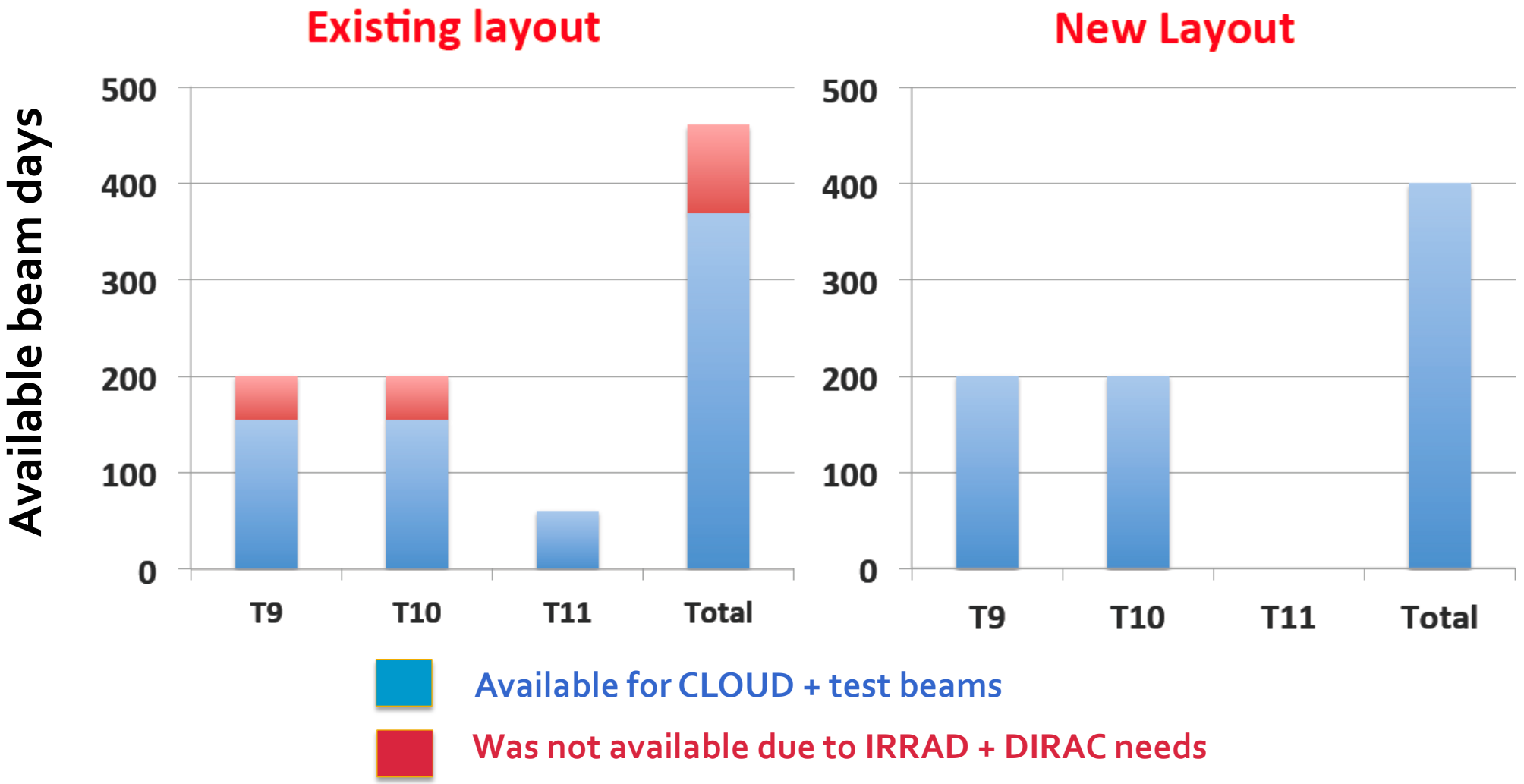
Extra slides

Example: shutdown 2011-2012

- During the 2011 run a water leak was detected on ZT9.QDE01, a Q74-type quadrupole in the T9 beam line. The spare Q74 magnet was brought to the workshop but it was considered radioactive (650 µSv/hr on contact) and slightly contaminated. It was agreed to replace it instead by a rather similar quadrupole of type Q75, but its coil was found to have a short-circuit. A study was launched to replace it by a 46 cm longer Q12-type quadrupole, but this intervention would be extremely heavy in terms of vacuum work (and dose) and would require the temporary dismounting of a very delicate and activated septum magnet in the T9 line. Finally it was agreed to prepare a working spare from parts of the installed Q74 and the spare Q74.
- In T10 a dipole magnet developed a short in the interlock system and the 2011 beam operation had to be stopped 10 days before the scheduled end of the proton run. Due to difficult access and high local dose levels, the magnet needs to be dismounted for the intervention. This, as well as the previous intervention requires opening of the 6 m thick roof shielding over a large surface.

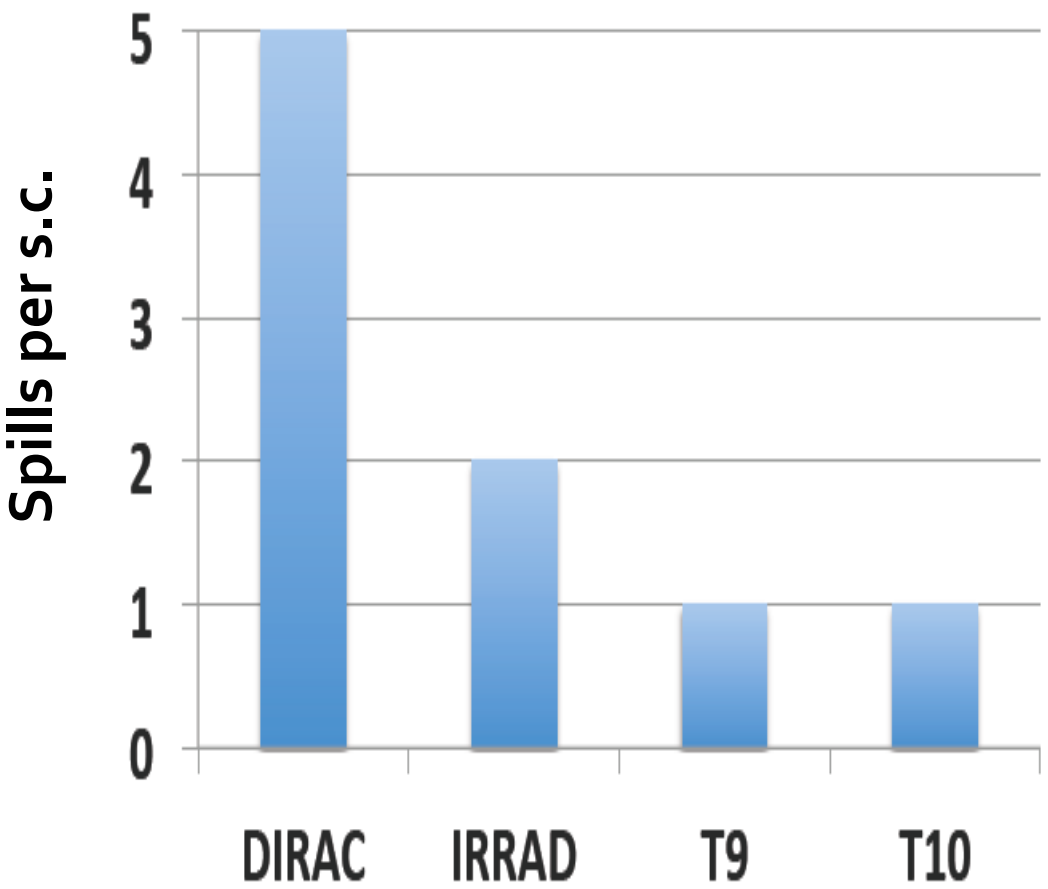
Example of a magnet replacement (2009)

Number of beam days for tests + CLOUD

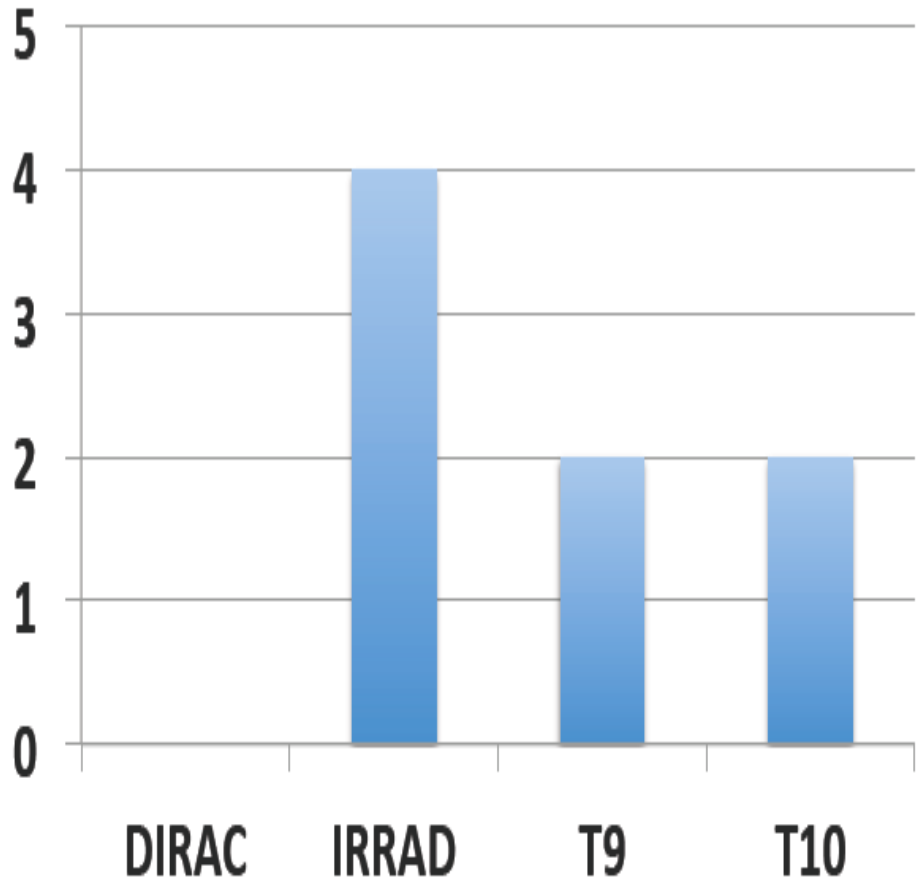


Spills per beam

So far (e.g. 2010):



Could become:



Layout change cost

Item	Groups involved	Cost [kCHF]	CERN FTE	See section
Transport and handling	EN/HE	170	0.25	3.16
Rectifiers	TE/EPC	45		3.6
Magnets and their services	TE/MSC	250		3.5
Vacuum layout	TE/VSC	900	0.2	3.7
Access	GS/ASE	40		3.10
Survey	BE/ABP			3.16
Radioprotection	DGS/RP	20	0.85	3.12, 3.14
Others (BI, Gas, etc)	various	80	3	all
CATIA Designer	EN/MEF	50		3.16
Project management	EN/MEF		1	3.16
Total layout change		**1555**	**3**	

Consolidation costs

Item	Groups involved	Cost [kCHF]	CERN FTE	See section
Magnets	TE/MSC	150	3.5	3.5
Converters	TE/EPC	2800	11	3.6
Electrical infrastructure AC	EN/EL	1650		3.3
Electrical infrastructure DC	EN/EL	130		3.4
Air conditioning building	EN/CV	985		3.1
Ventilation primary zones	EN/CV	260		3.1
Beam loss monitors	BEBI	30		3.9
Cranes	*EN/HE*	*600*		*3.11*
Access control to building	GS/ASE	70		3.13
Controls upgrade	BE/CO	90	0.5 - 2	3.9
Magnet cooling	EN/CV	1200	0.5	3.1
Collimator remote control	EN/STI	80		3.9
Beam stoppers and targets	EN/STI	500	3	3.8
Control rooms consolidation	EN/MEF	120		3.15
Asbestos removal (local)	DGS/SEE	200		3.2
RP upgraded to Ramses-2	*DGS/RP*	*300*		*3.12, 3.14*
Civil engineering works		1500	1.5	3.2
Replacement PVC cables		1500		3.4
Various items		200		all
Total consolidation		**12365**	**21**	

Excluding vacuum consolidation
(see previous slide)

IRRAD upgrade costs

Item	Groups involved	Cost [kCHF]	CERN FTE	See section
Transport and handling	EN/HE	170	0.25	4.6
Cabling and instrumentation	BE/BI	150	0.2	
Control room and equipment	EN/MEF	120		
Proton irradiation equipment	PH/DT	180		
Cooling and ventilation	EN/CV	250	0.2	
Mixed field irradiation eqpmt	various	700	0.9	
Mobile shielding	EN/MEF,STI	150	0.4	
Radiation monitoring	RP	150		
Access system	GS/ASE	25		
Installation support (FSU)	EN/MEF	150		
CATIA designer	EN/MEF	50		
Project management	EN/MEF		0.5	
Total IRRAD upgrade		**2095**	**2.45**	

List of work packages

From the technical point of view the work can be split over 7 relatively independent 'work packages':

- Preparatory work (crane, access control, RAMSES upgrade)
- Layout change beam lines (extended w.r.t. layout change per se)
  incl. DC electrical infrastructure and parts of consolidation program
- IRRAD upgrade and DIRAC dismounting
  DIRAC dismounting funded by experiment (or PH?)
  IRRAD mostly funded by R2E (up to 1,5 MCHF) and AIDA (150 kCHF) if done early enough
- Rectifier renovation (can be done at any moment, depending on resources)
  but easier if combined with layout change
- AC electrical infrastructure (transformers and electrical cupboards)
- Air conditioning and civil engineering work
- Replacement of PVC cables

Resources per work package

#	Package	Cost	FTE
1	Preparatory work	980	
2	Beam and areas layout change	4165	12
3	IRRAD upgrade and DIRAC dismantling	2100	2.5
4	Rectifiers	2800	11
5	Electrical infrastructure AC	1650	
6	Air conditioning building plus civil engineering work	2805	1.5
7	Replacement PVC cables	1500	
	Total	**16000**	**27**

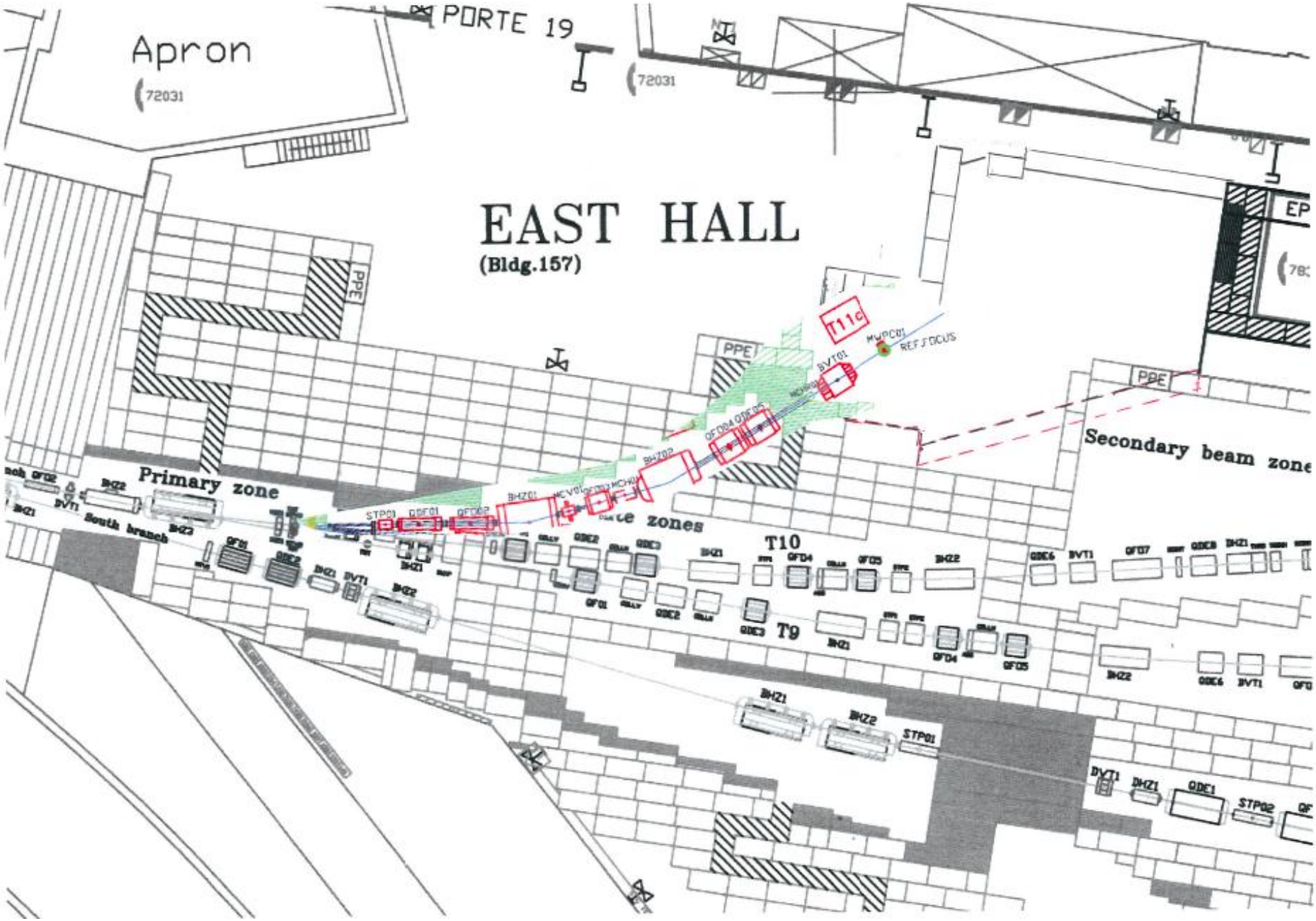
Example of a staging scenario

This one would allow to profit from the LS1 stop and to satisfy the IRRAD requests:

Year(s)	Packages	Cost	FTE	Time needed
2012	1	980		one shutdown
2013-2014	2+3+4+5	10710	25.5	1 year +1 shutdown
2015-2016	6+7	4305	1.5	2 shutdowns

However, possibly in conflict with available resources

However, if one decouples from LS1, the scale could be made sliding


Apron
72031
PORTE 19
72031
EAST HALL
(Bldg.157)
PPE
T11c
MWPC01
REFFOCUS
BVT01
PPE
PPE
Secondary beam zone
Primary zone
South branch
T10
T9
BHZ1
BHZ2
STP01
BVT1
QDE1
STP02

IRRAD split mixed field (R2E) - protons

Item	Groups involved	Cost [kCHF]	CERN FTE
Transport and handling	EN/HE	50	0.1
Remote control sample positioning	TE/EPC	180	
Cabling and instrumentation of zone	BE/BI	150	0.2
Control room with equipment	EN/MEF	120	
Access	GS/ASE	25	
CATIA Designer	EN/MEF	25	
Project management	EN/MEF		0.25
Total proton facility		**550**	**0.55**

Proton facility

Item	Groups involved	Cost [kCHF]	CERN FTE
Transport and handling	EN/HE	120	0.15
Target station design+construction	EN-STI	300	0.5
Services	EN/CV, EN/EL,	150	0.4
Cooling and ventilation	EN/CV	250	0.2
Test stands, train, remote control and other radiation test infrastructure	PH/DT	250	
Mobile shielding	EN/MEF,STI	150	0.4
Radiation monitoring	RP	150	
Installation support (FSU)	EN/MEF	150	
CATIA Designer	EN/MEF	25	
Project management	EN/MEF		0.25
Total proton facility		**1545**	**1.9**

Mixed field facility