* What Future for the PS East Area and nTOF?

22 March 2011

Lau Gatignon / EN-MEF

*OUTLINE

* Introduction
* Present and foreseen activities in the East Area
  - *CLOUD*
  - *AIDA, IRRAD plans*
  - *Test beam activities*
* Reminder of proposed new layout
* Costs for operating the East Area for 20 more years
* nTOF Operation (2010-2011)
* Summary and conclusions

*INTRODUCTION

2004: Premature end of run due to F61S.BHZ01 failure (type MNP23)

2005: Construction of new MNP23 and Q120 magnets

2006: Three new MNP23 magnets burned out, DIRAC and IRRAD runs lost

2007: Replacement of F61S.BHZ01 by MCB. Works well but loss of cycle efficiency.
Presentation by W.Kalbreier at ABOC/ATC days, underlining bad shape of all East Area magnets and difficult conditions for their maintenance

2008: Installation of XDWC and scintillators in test beams. Great improvement!

2009: Presentation of conceptual layout for new East Area at IEFC workshop

2010: Start-up of East Area delayed by > 2 weeks due to MNP23 failure in T9
Presentation of detailed layout and cost for EA upgrade ay IEFC workshop.
Abandon the idea of PS2 with a new experimental area.
Request to investigate costs for 20 more years of operation.
Approval of AIDA

2011: Presentation of the global project and costs.

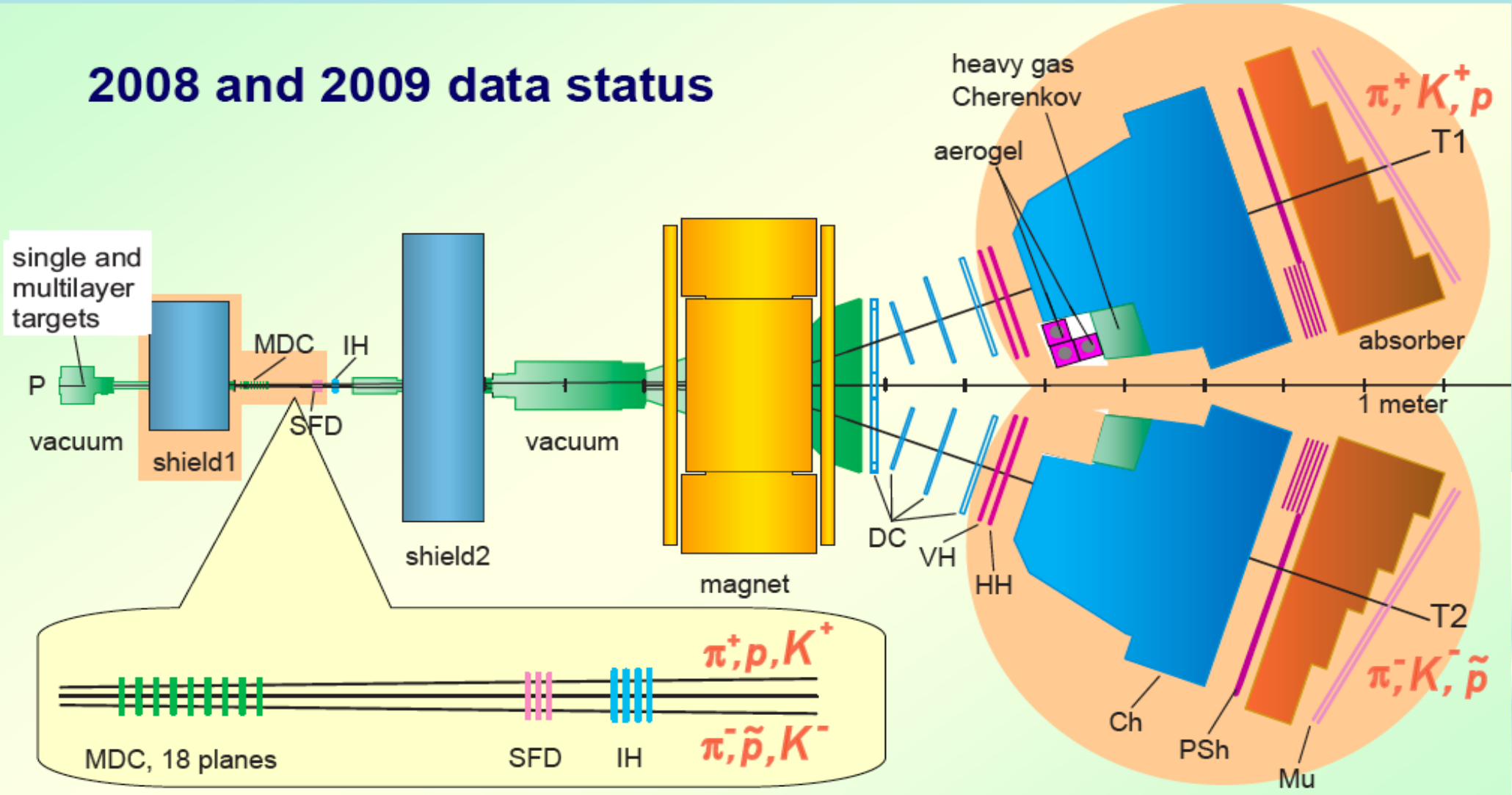
PRESENT ACTIVITIES IN EAST AREA

- 5 Beam lines: T7 (IRRAD), T8 (DIRAC), T11 (CLOUD), T9+T10 (test beams)
- T7 no longer used as test beam, only IRRAD.
  But difficult access (stop whole EA), marginal shielding and rates,
  far too limited in space
- DIRAC is expected to stop before the long shutdown.
  Then move to SPS or GSI? (No details known yet)
- CLOUD is considered to have a very interesting physics program
- There is a need for test beams at energies below the NA.
  Also the NA is heavily overbooked and the East Area can accommodate for a fraction of those requests, if the maximum energy is high enough.
- The East Area is used as much as ever!

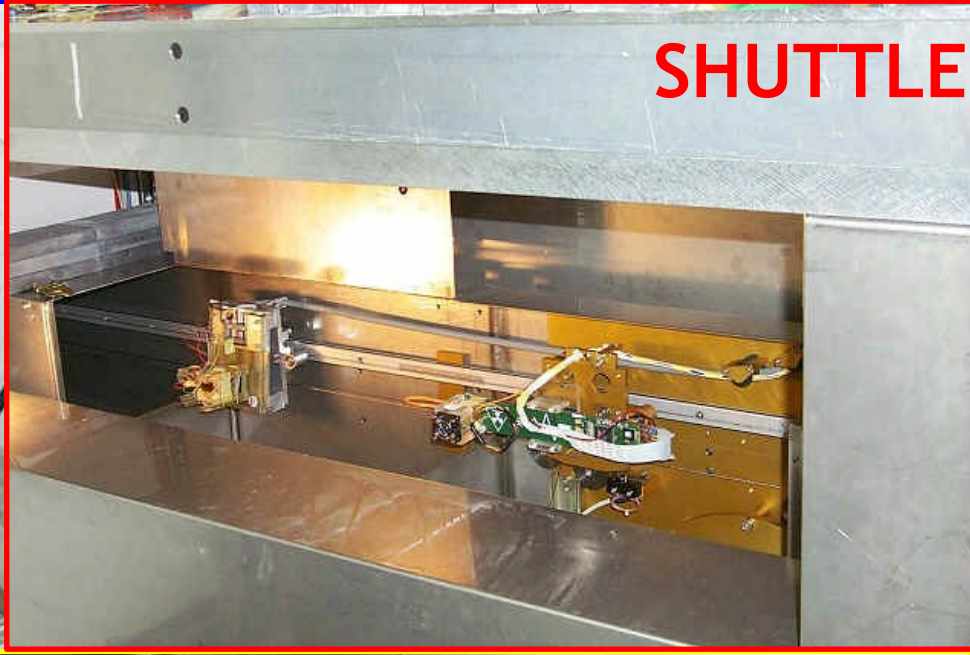
CLOUD (T11)

Upgraded DIRAC experimental setup

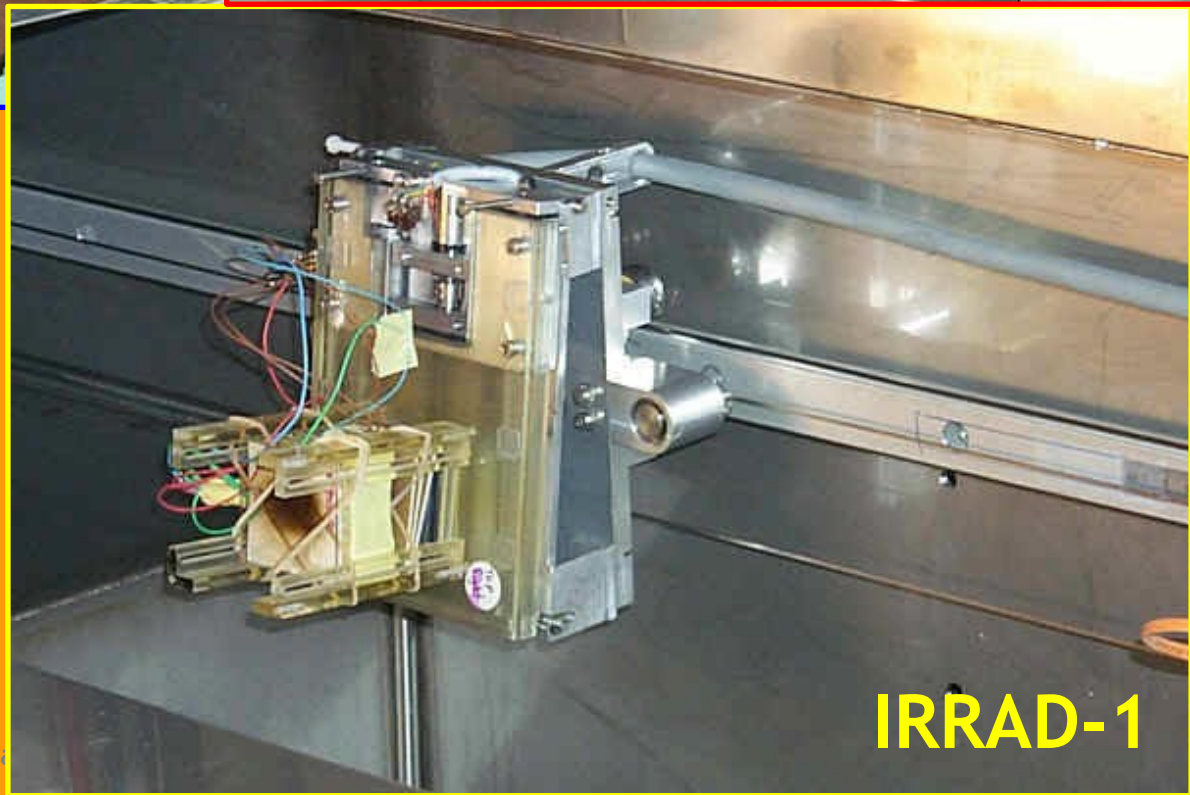
2008 and 2009 data status



Modifided parts



Neutron facility - shuttle



2-November-2010 2010 PS Fixed Target Programme

Version 2.0

Colour code: dark blue (dark shading) = not yet allocated ; yellow (light shading) = not allocatable or Machine Development

		P1		P2		P3		P4		P5		P6
		35 29 Apr 3 Jun		35 3 Jun 8 Jul		35 8 Jul 12 Aug		35 12 Aug 16 Sep		35 16 Sep 21 Oct		32 21 Oct 22 Nov
T7	Setup 7	20	Irradiation 15	Irradiation 33	2	28	7	Irradiation 35		Irradiation 35		Irradiation 32
T8	Setup 7	20	DIRAC 15	DIRAC 35		DIRAC 35		DIRAC 35		DIRAC 35		DIRAC 32
T9	Setup 7	20	CALICE GRPC 9	CMS PLT 6	CMS PLT 11	56	3	NA62_TB 20	15	NA62_TB 21	KLOE2 14	FACTOR 13	CALICE WHCAL 19
T10	Setup 7	20	ALICE TOF 8	7	5	ALICE PMD 8	ALICE TOF 15	ALICE VHMPID 7	ALICE VHMPID 11	ALICE FARICH 14	ALICE EMCAL 10	4	ALICE VHMPID 16	15	ALICE MUON 11	ALICE VHMPID 14	SUPERB 10	SUPERB 11	ALICE TOF 14	ALICE TRD 7
T11	Setup 7	32	3	CLOUD 30	5	35	4	CLAS12 16	15	25	CLOUD 10	CLOUD 32	

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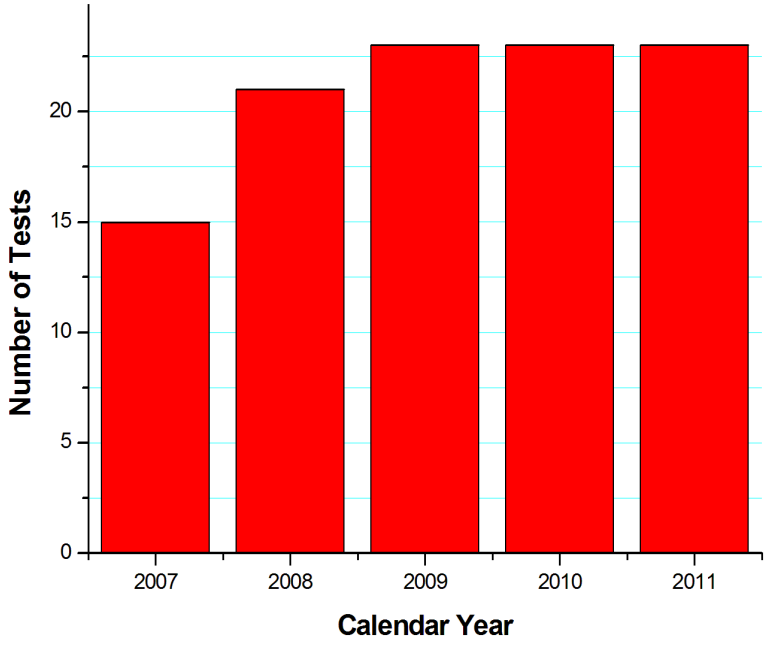
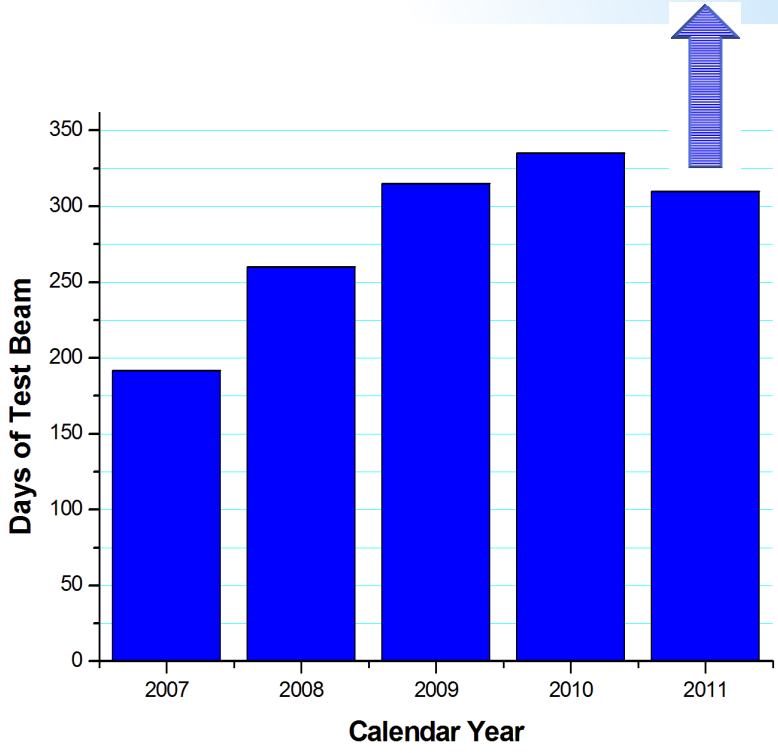
*AS POPULAR AS EVER:





WHCAL MUON TESTS IN T7 AREA

NA62 GIGATRACKER TEST

AIDA AND IRRADIATION FACILITY

- The AIDA project started on February 1st, 2011 and had a kick-off meeting at CERN from 16th till 18th of February.
- The AIDA proposal includes an upgrade of the IRRADiation facility in the East Area. Their budget of 430 kCHF covers 1 personnel plus some financial EU contribution to the installation. Normally one expects this to be accompanied by a CERN contribution.
- The detailed technical studies of a new layout require this new staff and preliminary investigations have started only very recently.
- On top of this a substantial sum (~1.5 MCHF) has been provisioned for the IRRAD facility (mixed fields) in the R2E project.
- R2E hopes to use the new facility as soon as possible, preferably immediately after the long shutdown (2014). Until then R2E will use H4IRRAD and CNRAD, but on the longer term these are insufficient.
- Initial studies are based on the assumption that DIRAC will stop before this long shutdown.

IRRAD REQUIREMENTS

- **Mixed Field Irradiations:**
  Important for the present LHC operation and for the LHC Upgrade.
  Need space for much larger volumes and more infrastructure than in the T7 facility.
  E.g. irradiations of power supplies.

- **Proton irradiations:**
  Beam flux can be accommodated for if no more DIRAC running.
  Beam characteristics compatible with present DIRAC beam parameters.

- Proton and mixed field can often use the **same protons**!

- Requires dismounting of DIRAC (PH funding?).
  Need formal decision on DIRAC future.

*PRELIMINARY LAYOUT PROPOSAL

*VERY PRELIMINARY COST ESTIMATE

Preliminary estimate for proton facility received from PH on 14th of March

		[KCHF]
1.	Remote controlled sample positioning systems	180 (less if shuttle can be reused)
2.	Cabling and instrumentation of irradiation zone	150
3.	Control rooms and control equipment	120
		450 KCHF
	Additional technical support during construction:	0.5 FTE
	Radiation Monitoring (RP)	?? in EAST HALL plan ??
	Access and Emergency Exit	?? in EAST HALL plan ??
	Shielding	?? in EAST HALL plan ??
	Ventilation	?? in Mixed Field Facility plan??

To be studied and validated in ATS

*Very preliminary cost estimate (2)

Preliminary estimate for mixed field facility received from PH on 14th of March

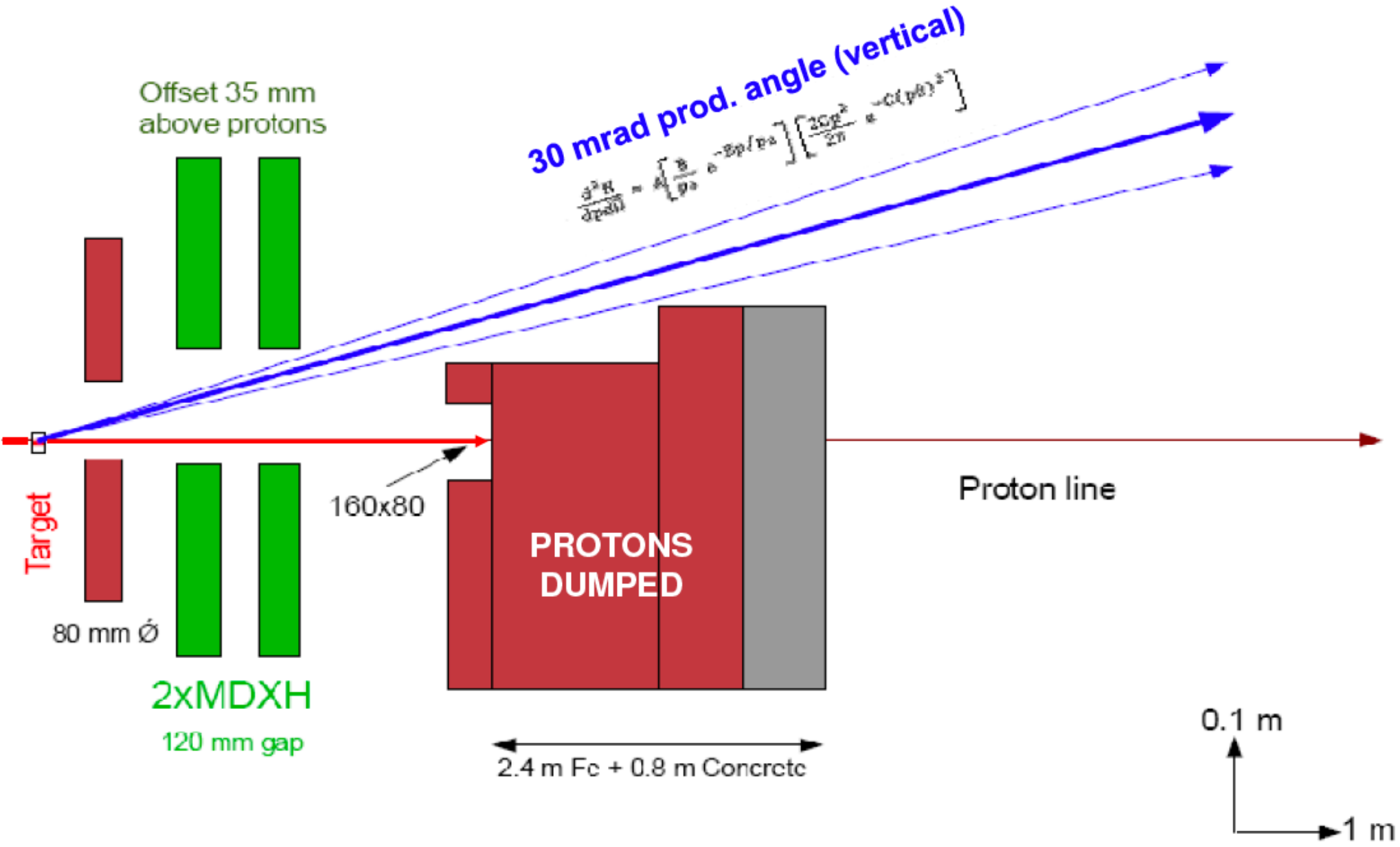
		[KCHF]
1.	Target Station (design & construction, vault,…)	300
2.	Shielding (only new and partly mobile part, fixed part and dump will be recuperated)	150
3.	Cooling & Ventilation	250
4.	Services (Cabling, Cooling, Control)	150
5.	Radiation Test Infrastructure (test stands, remote control, train, SAS, etc.)	250
5.	Access Control	100
6.	Monitoring (RP, RadMon, DAQ)	150
7.	Installation Support (FSUs)	150
	Total:	1500

To be studied and validated in ATS
1500 kCHF provisioned in R2E project planning

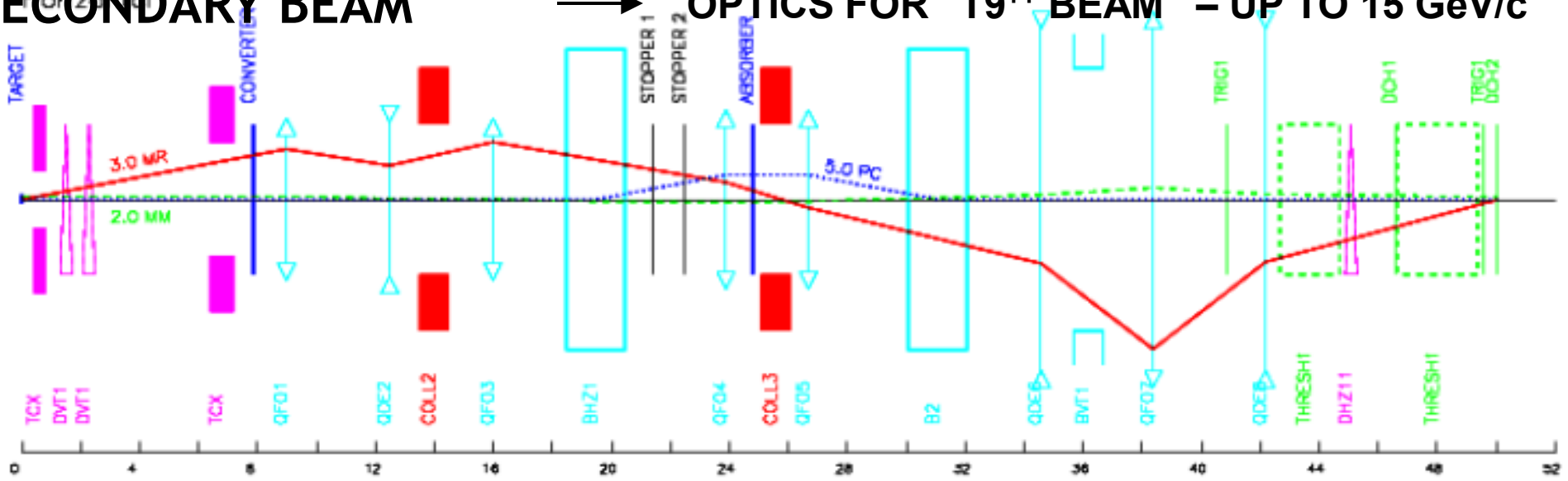
*BASIC PRINCIPLES FOR NEW EAST AREA

- Use fewer types of **reliable magnets** with spares
- Reduce roof shielded areas and **ease access to equipment**
- **Keep radiation restricted** to upstream areas as much as possible
- Keep T8 beam and DIRAC installed as it is until the end of DIRAC, or for IRRAD in case they take over the DIRAC location
- Replace SMH1 and F61S.BHZ1 by two MCB magnets in PPM mode, i.e. no more splitter *(F61S.BHZ01 replacement already done).*
- Could also serve IRRAD as now, through air, however not from ZT7.BHZ01 but from F61S.BHZ02
- **Design new beam(s)** to 1 (or 2) "North target" marguerite(s)
  - *two decoupled beams, but at the cost of cycle efficiency*
  - *two beams coupled by "wobbling station", coupled but higher cycle efficiency*
- Test beams can provide **pure** hadron and muon secondary beams up to 15 GeV/c and pure (> 95%) electron beams from γ conversion (up to about 10 GeV/c)

Inspired by and similar in spirit to West Area rebuild in the end of the 1990's!

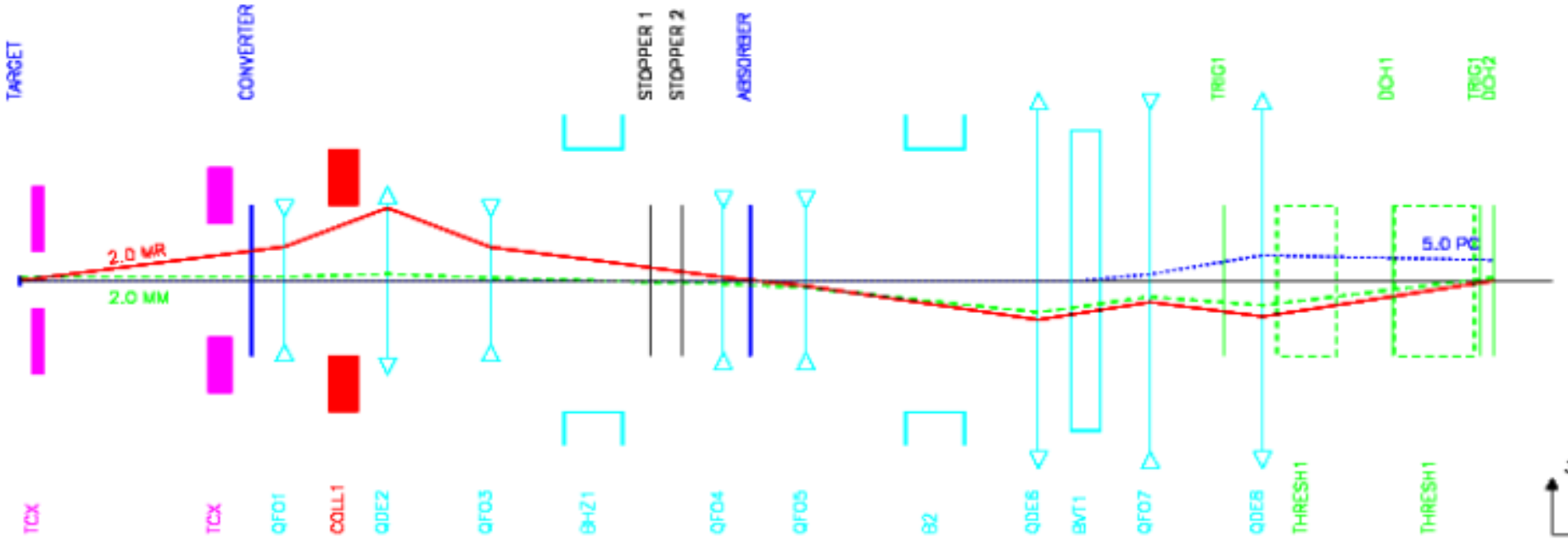

Offset 35 mm
above protons
30 mrad prod. angle (vertical)
Target
80 mm Ø
2xMDXH
120 mm gap
160x80
PROTONS
DUMPED
Proton line
2.4 m Fe + 0.8 m Concrete
0.1 m
1 m

SECONDARY BEAM → OPTICS FOR "T9++ BEAM" – UP TO 15 GeV/c



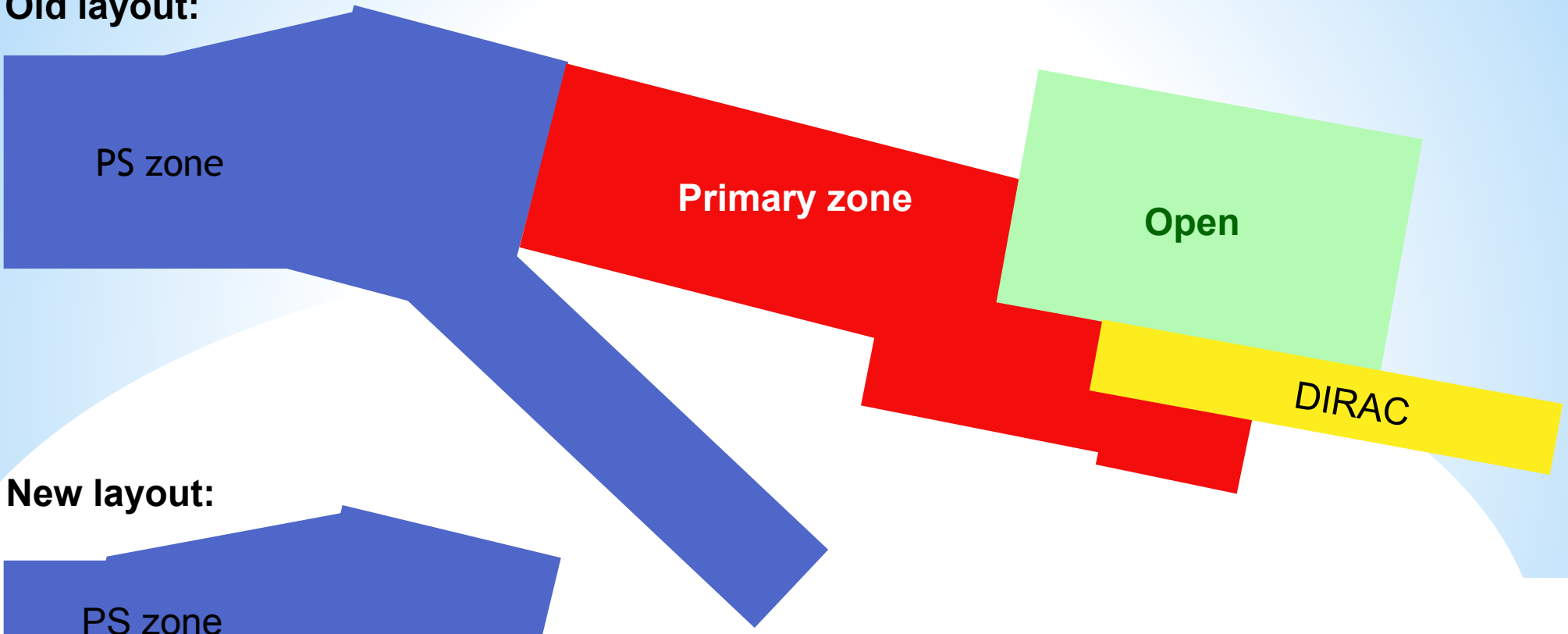
OPTICS FOR NEW EAST AREA TEST BEAM T9

Vertical

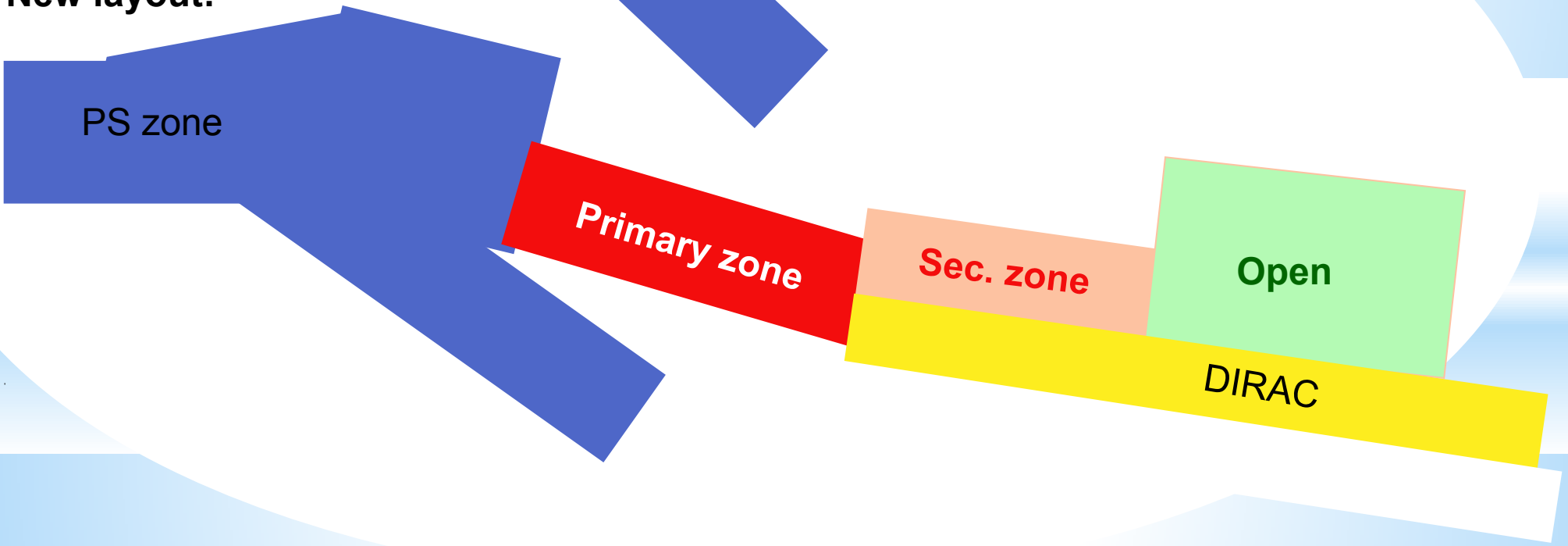


The shapes are made as overlays on the old, respectively new layout drawing, on the same scales

Old layout:



New layout:



What does this bring us?

* Compatibility with requirements from DIRAC/IRRAD and CLOUD
* More flexible and better test beams, but (effectively <<) 1 less

  Higher top momenta, small production angles, choice of particle type
* Only use agreed ‘healthy’ magnets with sufficient spares

  All magnets and rectifiers exist - reduced cost
* Primary beam is dumped almost immediately after target

  High (also induced) radiation levels restricted to minimal areas
* Very restricted number of magnets is under (less heavy) roof shielding

  The ones in a limited zone following the primary area have only a thin roof shield. Many have no roof shielding.

*2011 Version

*COST OF LAYOUT TRANSFORMATION

ITEM	GROUP	COST	FTE	COMMENTS
Transport & handling	EN/HE	170	0.25	6.5 months x 3p + 10 kCHF material
Rectifiers		45		
Magnets & services	TE/MSC	250		
Vacuum layout	TE/VSC	900	0.2	Revised upward, includes new control etc.
Access	GS	40		
Survey	BE/ABP		0.4	
Radioprotection		20	0.85	
Project coord & mgmt	EN/MEF		1	
Others (BI, gas, etc)		80	0.3	
Designer	EN/MEF	50		6 months for CATIA drawings
TOTAL		**1555**	**3**	

*CONSOLIDATION COSTS (1)

ITEM	GROUP	COST	FTE	COMMENTS
Magnets	TE/MSC	150	3.5	517 kCHF if old layout
Rectifiers	TE/EPC	2800	5	
Electrical infrastr AC	EN/EL	1650		Transformers date from 1961!
Electrical infrastr DC	EN/EL	130		
Air conditioning building	EN/CV	985		
Cranes	EN/HE	600		Keep/upgr 40 t crane + 'palan'
Ventilation prim. zones	EN/CV	260		*Assume DIRAC = primary area*
Access control building	GS	**70**		
Controls upgrade	BE/CO	90	0.5-2	Cesar like in North Area
Sub-total consolidation		6735	~10	

*CONSOLIDATION COSTS (2)

ITEM	GROUP	COST	FTE	COMMENTS
Magnet cooling	EN/CV	**600** +100	0.5 (i.e. 0.2 design, 0.2 superv, 0.1 eng)	Separate cooling primary areas, but up to 5° warmer water For cooling tower
Magnet cooling improvement	EN/CV	**500**		To avoid increase of cooling water inlet temperature by 3-5°C
Beam stoppers & marguerites	EN/STI	500	3	New marguerites to be studied 1 FTE can be a fellow
Control rooms consolidation	EN/MEF	120		ALGECO barracks
Asbestos?	DGS/SEE	~ 200		Only obligatory parts, tbc
Sub-total		**2020**	**3.5**	
Sub-total Consolidation		**8755**	**13.5**	

Baseline suggestion for CE works

- Consider as an option the remedial works on main roof and external walls, not touching false roof (avoid asbestos removal), including re-sealing of al junctions and joints with external envelope to meet relevant air tightness specifications and best practice
- Do not improve insulation otherwise as costs would exceed benefits and the implications would be complicated and lengthy in time.
- Consider double windows.

*CONSOLIDATION COSTS (3)

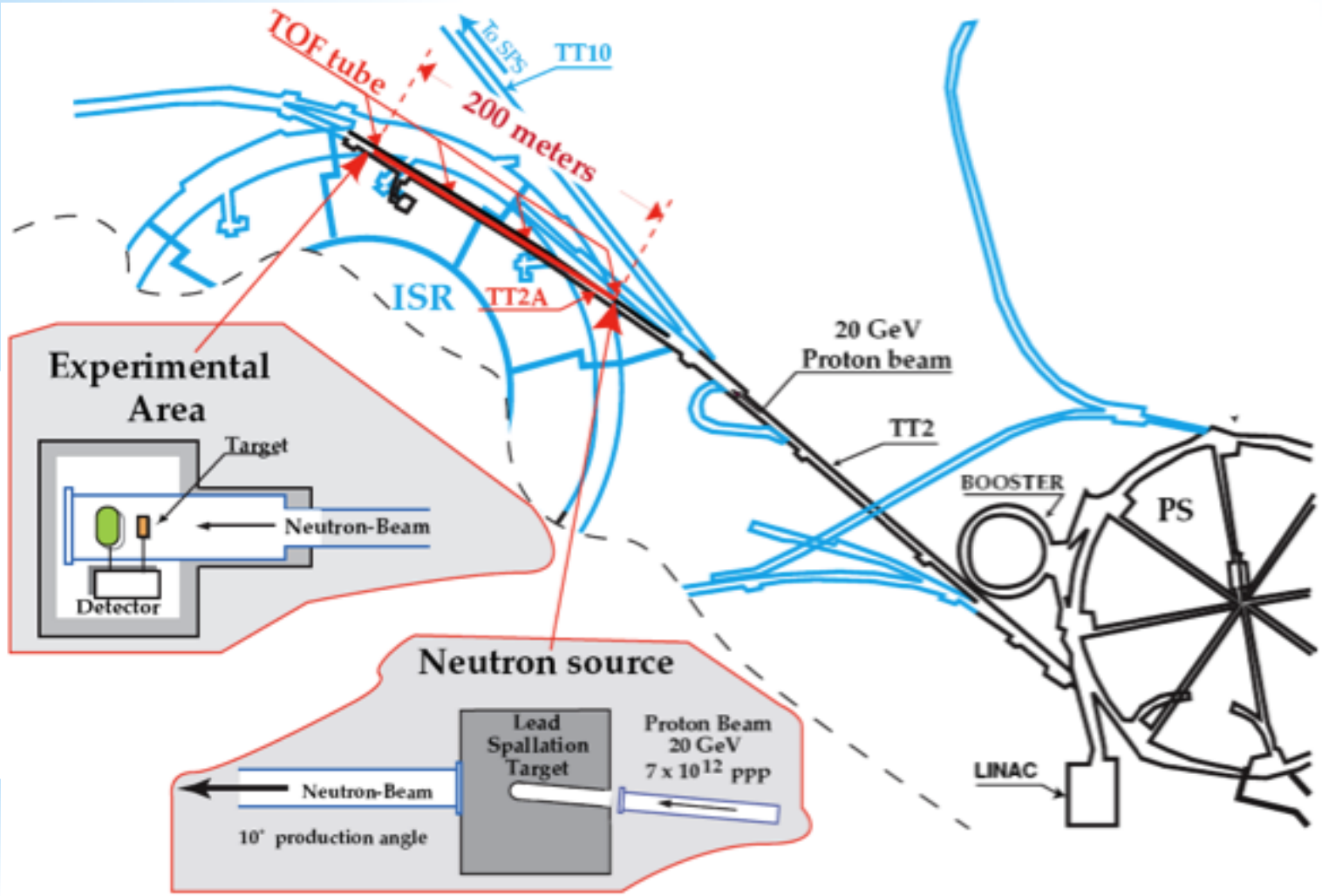
ITEM	GROUP	COST	FTE	COMMENTS
Civil engineering issues, i.e. re-cladding of the roof double windows incl rooflights)	GS/SE	*<< 2200 Guess ~* **1.5 MCHF**	1.5	To be balanced vs. energy saving. Need full survey. One project eng. plus 0.5 draughtsman
Replacement PVC cables	EN/EL	1500		From rectifier to TB. **~ 2100 if old layout**
Upgrade to RAMSES-II	DGS/RP	300		Already in consolidation
Various items		~200		
Sub-total		**3200**	**1.5**	
Consolidation total		**11955**	**15**	
Layout change		**1555**	**3**	
GRAND TOTAL		**13510**	**18**	*+ 300 kCHF for RAMSES-II*

Excluding IRRAD transformation and DIRAC dismounting

Timescale

- The duration of the work in the zone for the layout transformation is estimated to be a year.
  The transformation from DIRAC to IRRAD comes on top .
- Most of the consolidation work can be done in the shadow of this and/or in subsequent shutdowns.
- The long shutdown would fit ideally from the user perspective, but probably the timing would be driven by the MTP.

*THE nTOF FACILITY



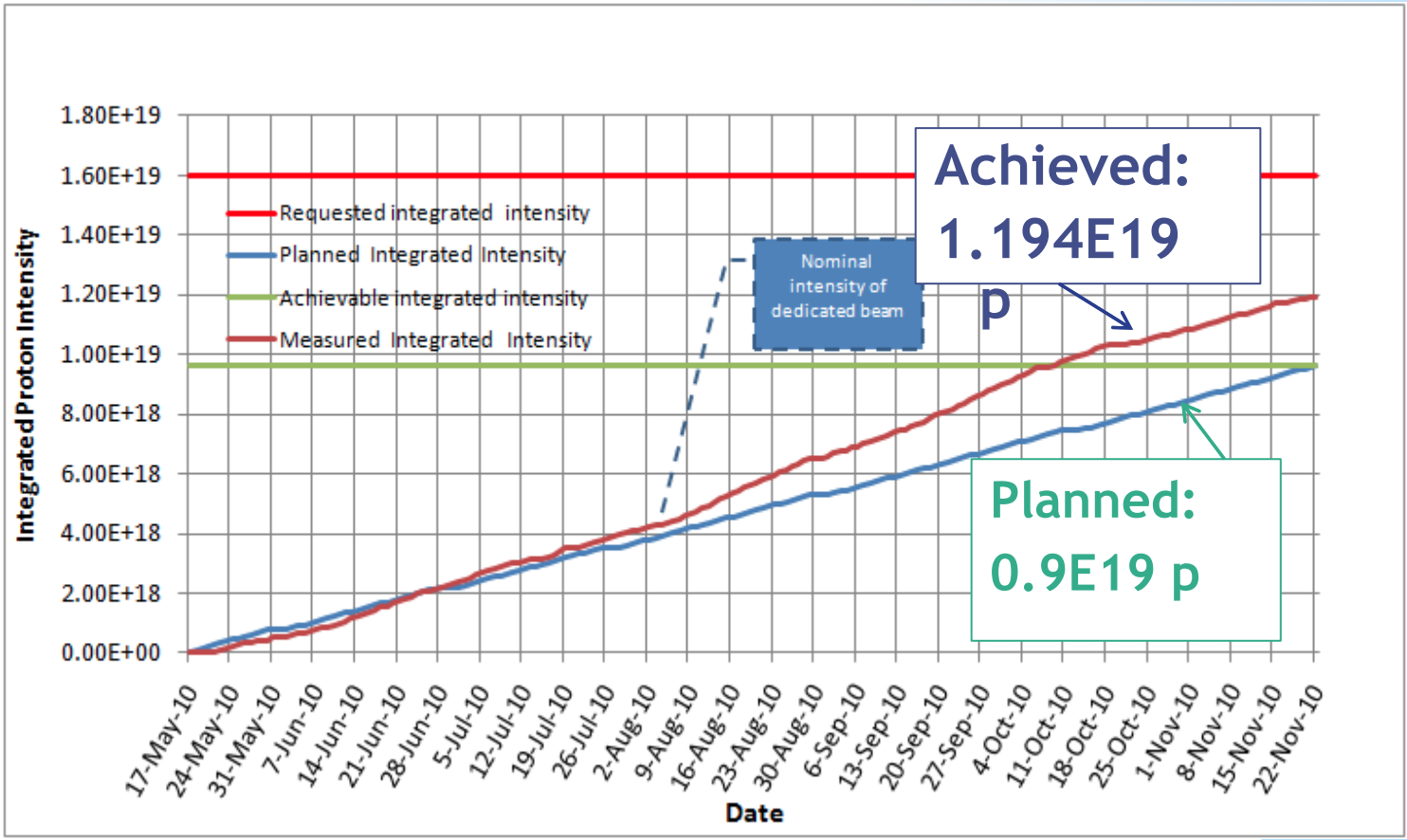
Nuclear waste transformation

Nuclear astrophysics

Fundamental nuclear physics

*nTOF OPERATION IN 2010

Integrated intensity planned and measured for 2010:



Thanks to Work Sector of Type A:

Neutron capture cross section measurements of ^{241}Am (nuclear waste transformation)

*nTOF OPERATION IN 2011

nTOF expects to accumulate 1.55 10^{19} protons on the nTOF target, which should allow them to advance on several approved proposals.

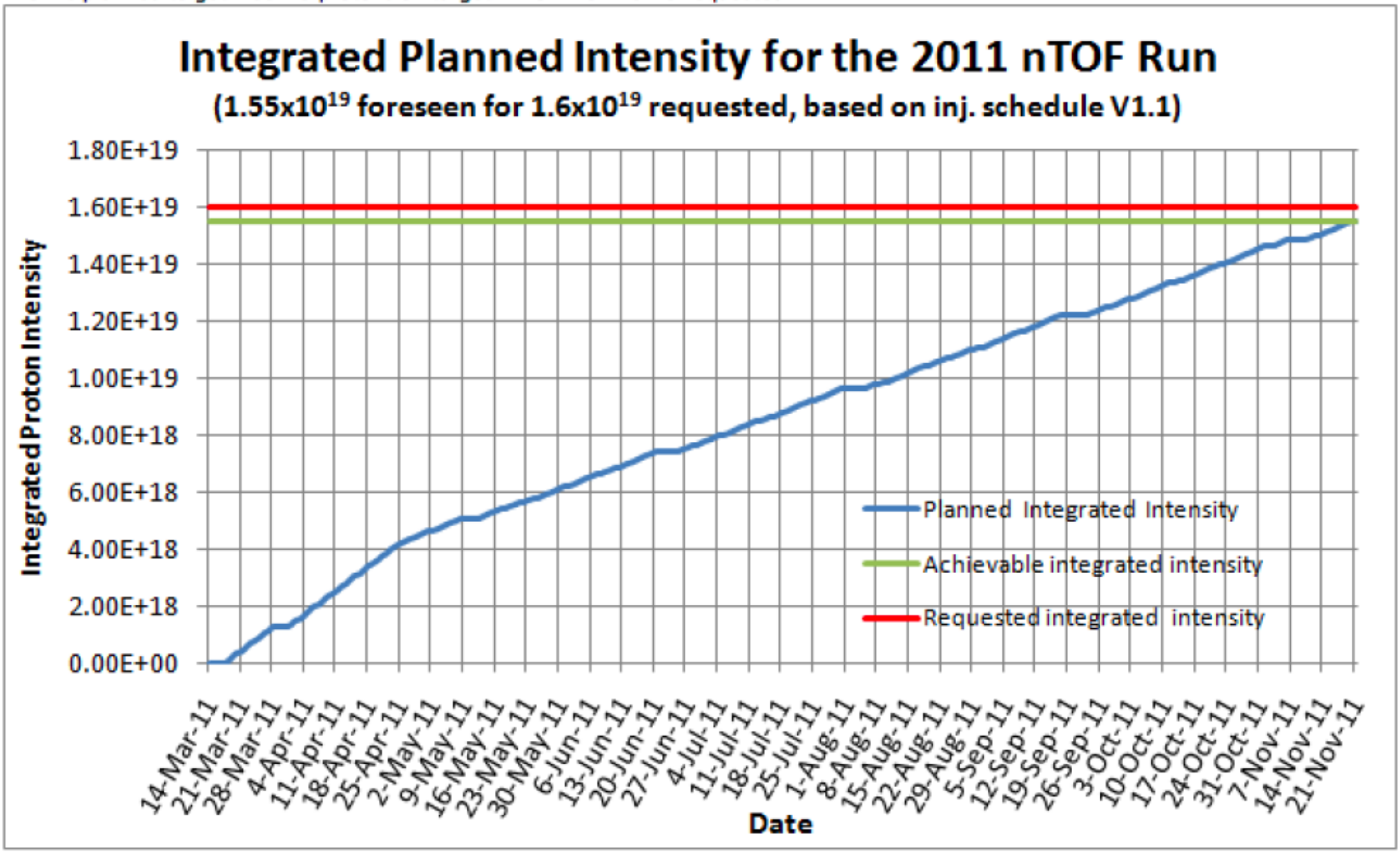
Some innovations:

- First use of μMGAS for measuring $^{33}S(n,\alpha)$: isotope for possible medical applications
- First use of large area pVCD diamond for $\sigma(n,\alpha)$ beyond the MeV frontier
- First use of μMGAS for measuring $\sigma(n,f)$ at high energy: $^{240,242}Pu$
- First ever measurement of the radioactive ^{63}Ni $\sigma(n,\gamma)$

Some challenges:

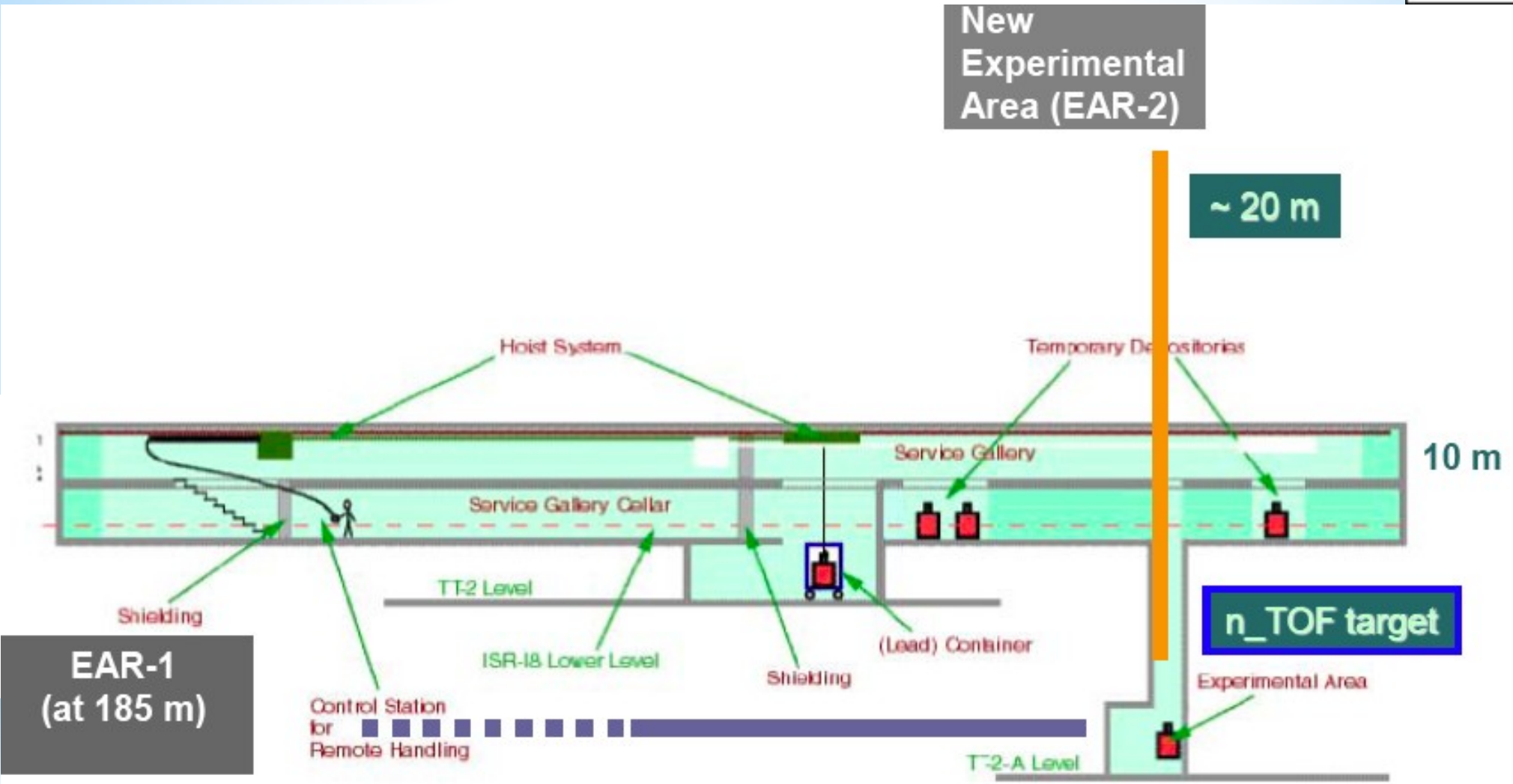
- The use of new (or combinations of) detection systems
- The unprecedented aimed accuracy for the $^{238}U(n,\gamma)$ measurement
- 2-3% overall accuracy between thermal and 1 MeV!

nTOF is planned to get 1.55E19 protons on target in 2011 for 1.6E19 requested.



Start of nTOF beam setting up in PS: Friday 11 March 2011
Start of nTOF beam delivery for physics: Friday 18 March 2011

*nTOF BEYOND 2011



Flight path length 20 m at 90° angle → higher flux, reduced t_o flash

*POTENTIAL APPLICATIONS OF EAR2

1. **Neutron fluence for neutron-induced fission and/or capture measurement on small masses**

   @ 20 m

   7-8*10^6 n/cm^2/pulse

   >20 MeV **8-9*10^5 n/cm^2/pulse**

2. **Testing of active electronic equipments for LHC and other applications**

   @20 m

   >20 MeV **8-9*10^5 n/cm^2/pulse**

   1 Pulse every 3 sec → 5-10*10^{10}n/cm^2/week

3. **Passive irradiation of (small) equipment in high fluence environment**

   @1.5 m

   1-2*10^{10}n/cm^2/pulse

   1 Pulse every 3 sec → ~ 3*10^{15}n/cm^2/week

SUMMARY AND CONCLUSIONS

- A new design of the East Area beams exists and the transformation costs just over 1.5 MCHF plus 3 FTE.
- However, to operate the area for two more decades in correct conditions an additional spending of about 12-13 MCHF seems required plus additional 15 FTE.
- This does not include the resources and time needed for DIRAC dismounting and IRRAD upgrade.
- The project would need one year of installation time and would allow much safer and correct exploitation of the area and would provide better quality beams.
- The East Area is already becoming increasingly popular and seems essential to satisfy the requests of test beam users, the irradiation facility and CLOUD.
- Also at the PS, nTOF has an active and successful program, in the past, at present and also for the future.

*THANKS TO (among others):

O.Aberle, V.Baggiolini, C.M.Bernard, Y.Bernard, J.L.Blanc, D.Bodart, Y.Body, Y.Bonnet, H.Breuker, M.Brugger, M.Calviani, J.Carr, D.Chapuis, G.Dore, G.Dumont, C.Griggs, J.Hansen, W.Kalbreier, M.Lazzaroni, G.Le Godec, P.Lelong, F.Loprete, A.Manarin, A.Masi, R.Molay, M.Moll, B.Morand, R.Morton, R.Necca, M.Obrecht, Th.Otto, J.Pedersen, S.Pelletier, E.Perez, B.Pichler, O.Prouteau, C.Rembser, S.Roesler, J.Spanggaard, R.Steerenberg, M.Tavlet, D.Tommasini, G.Vandoni, M.Widorski, Th.Wijnands, ….

With apologies to those that I may have forgotten

SPARE SLIDES

WHY A NEW LAYOUT FOR THE EAST AREA

Triggered by ABOC/ATC days in 2007

- Splitters lead to high beam losses in critical regions
  - high radiation levels
  - no beam loss monitors!
- Catastrophic situation of magnets
  - 63 magnets of **22 different types**, many critically weak and/or **no spares**
  - need **2 weeks to open & close concrete roof shield** + cooldown + repair
  - space very tight, access extremely difficult
  - high radiation levels
  - EA has only 8% of #magnets in NA, but needs same #FTE to maintain
- No remote control for most systems (motors in particular)

  No high level control system, no beam files

  Grossly insufficient beam instrumentation – *somewhat improved since then*

Recommendation: global review of East Area

Note: *Operational difficulties with F61N.BVT01 in 2008,*
T10 only 6 GeV due to two Q800 (smoke traces!), three Q120's replaced in 2009, …
+ F61N.DVT01 broken, suspected problems in T7 line, … (2009/2010)

*Magnets used for the new East Area

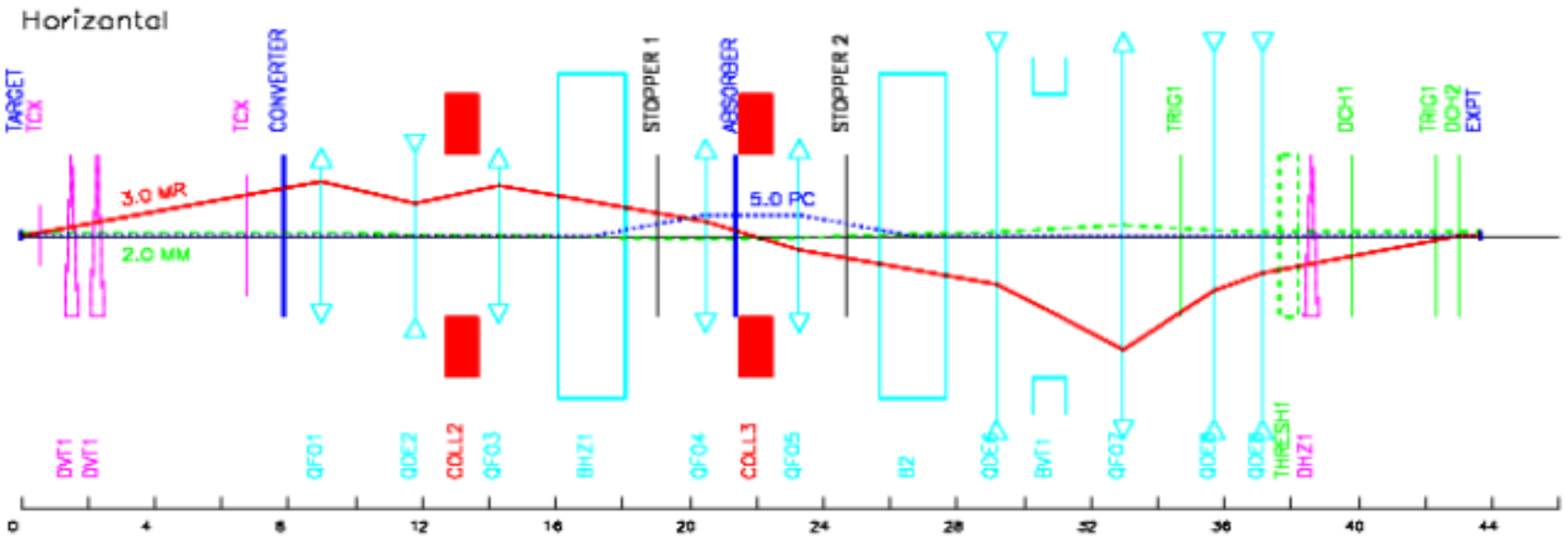
Type	# Avail	Locations where used									Used	#Spares
MCB	10	BP.BHZ1	BP.SMH1	BS.BHZ1	BS.BHZ2	BD.BHZ1	BD.BHZ2	BP.BHZ1	BN.BHZ2	+Spares at SPS	8	2
M100SP	4	B1.BVT1	B2.BVT1								2	2
M105	3	BS.DHZ1	BN.DHZ1								2	1
M200SP	10	B1.BHZ1	B1.BHZ2	B2.BHZ1	B2.BHZ2						4	6
MC200	7	BN.BVT1									1	6
MEA19	8	BP.DVT1	BP.DVT2								2	6
MNPA25	6	BP.DHZ1	BN.DVT1								2	4
MNPA30	7	BS.DVT1	BD.DVT1								2	5
Q100	17	B1.QDE6	B1.QDE8	B2.QDE6	B2.QDE8	B2.QDE8b					5	12
									Spares at SPS			
Q120	7	BP.QDE02	BN.QDE1	BN.QFO2	B1.QDE2	B2.QDE2					5	2
Q200	5	BD.QDE1	BD.QFO2	B1.QFO7	B2.QFO7	Spares at SPS					4	1
Q600	9	BP.QDE4									1	8
QFL	5	BP.QFO03	BS.QFO1	BS.QDE2							3	2
QFS	10	B1.QFO4	B1.QFO5	B2.QFO4	B2.QFO5						4	6
QDS	12	B1.QFO1	B1.QFO3	B2.QFO1	B2.QFO3						4	8
Q74	2 (?)	BP.QFO01									1	1
MDX	10	B1.DVT1a	B1.DVT1b	B2.DVT1a	B2.DVT1b	B1.DHZ1	B2.DHZ2				6	4
MEJ15	3										0	3

BP = Primary line
BD = DIRAC beam line

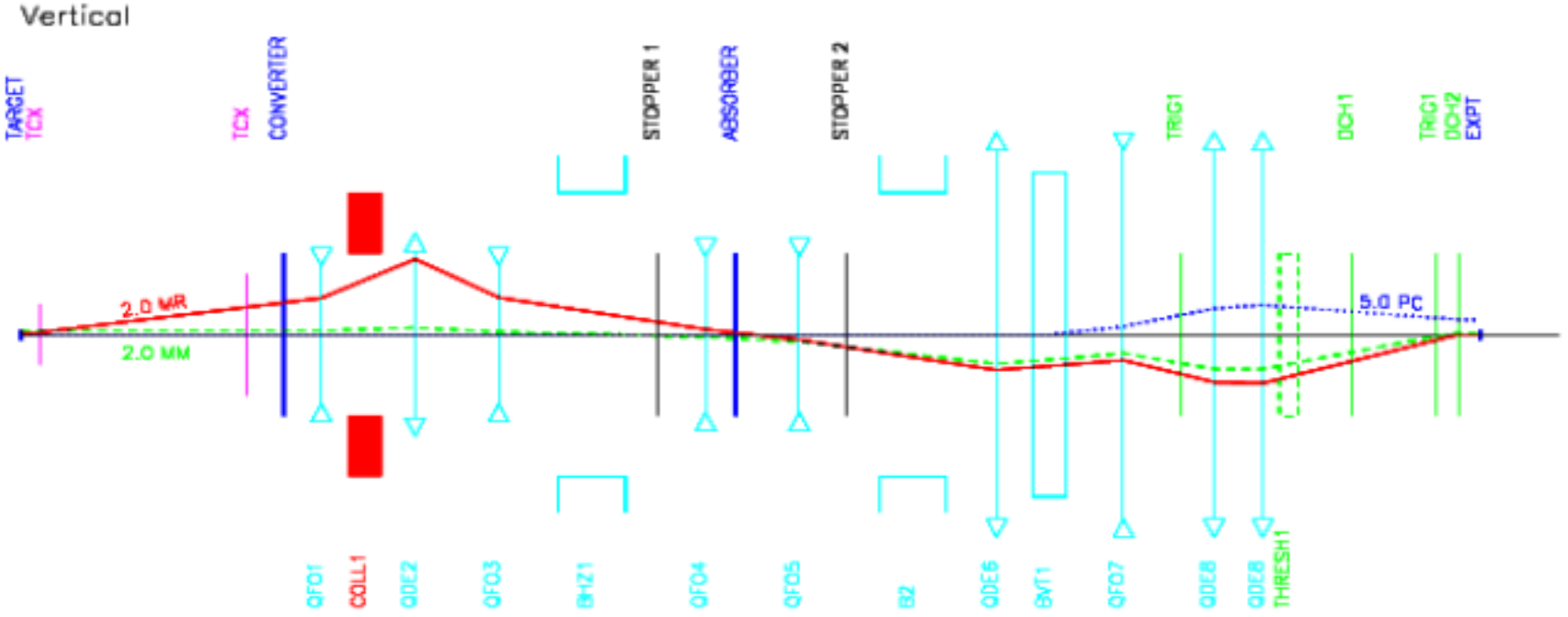
BN=North branch
BS=South branch

B1 = Secondary beam #1
B2 = Secondary beam #2

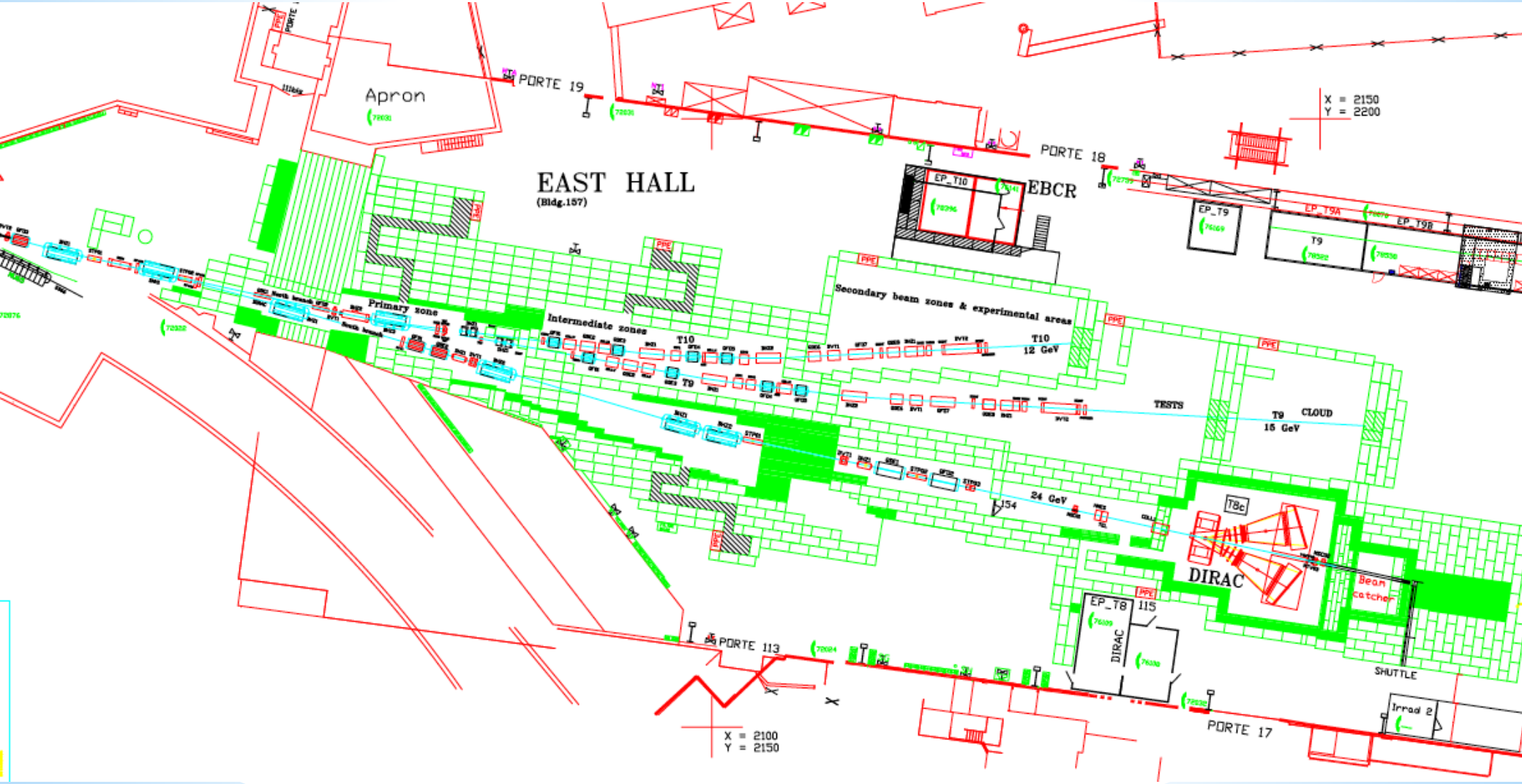
Green shading = spares
Red shading = unavailable



OPTICS FOR NEW EAST AREA TEST BEAM T10



Proposed layout (from 2010 slides)



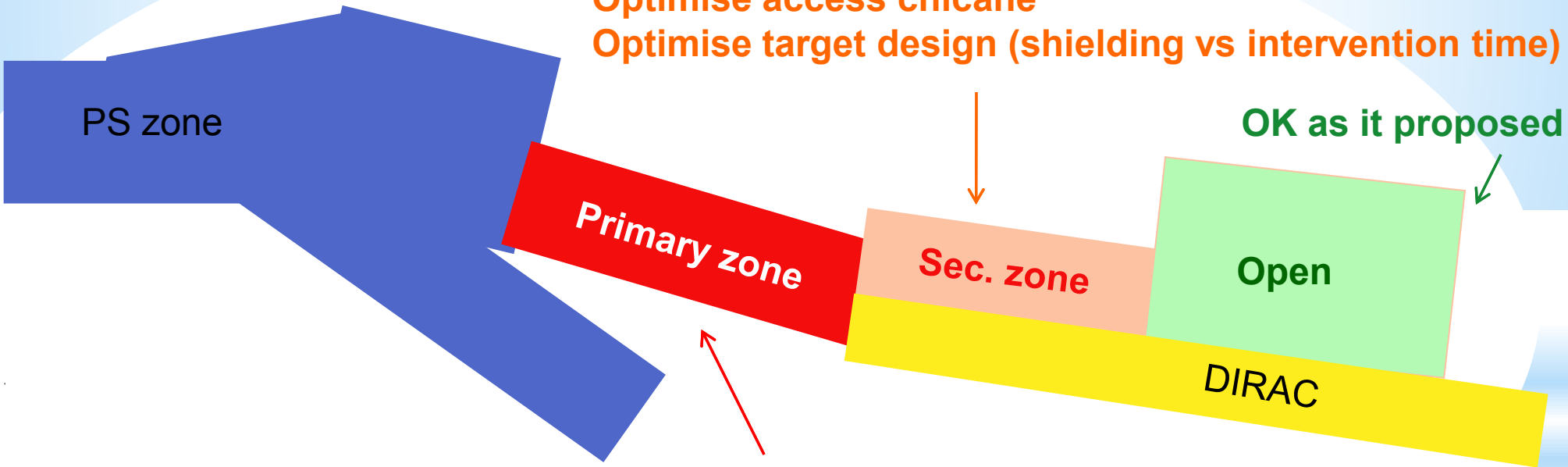
*Shielding and RP issues

Carefully studied by Thomas Otto / RP (then)

Thickness of shielding 2.4 m (as shown before)
Height of walls > 4 m to reduce sky-shine

No roof shielding required

Optimise access chicane
Optimise target design (shielding vs intervention time)



OK as it proposed

Side shielding thickness 6 to 6.4 m (as now)
2.4 m roof shielding, i.e. 0.8 m Fe + 1.6 m Concrete
Need ventilation (cf nTOF target area)
Optimise entrance chicane

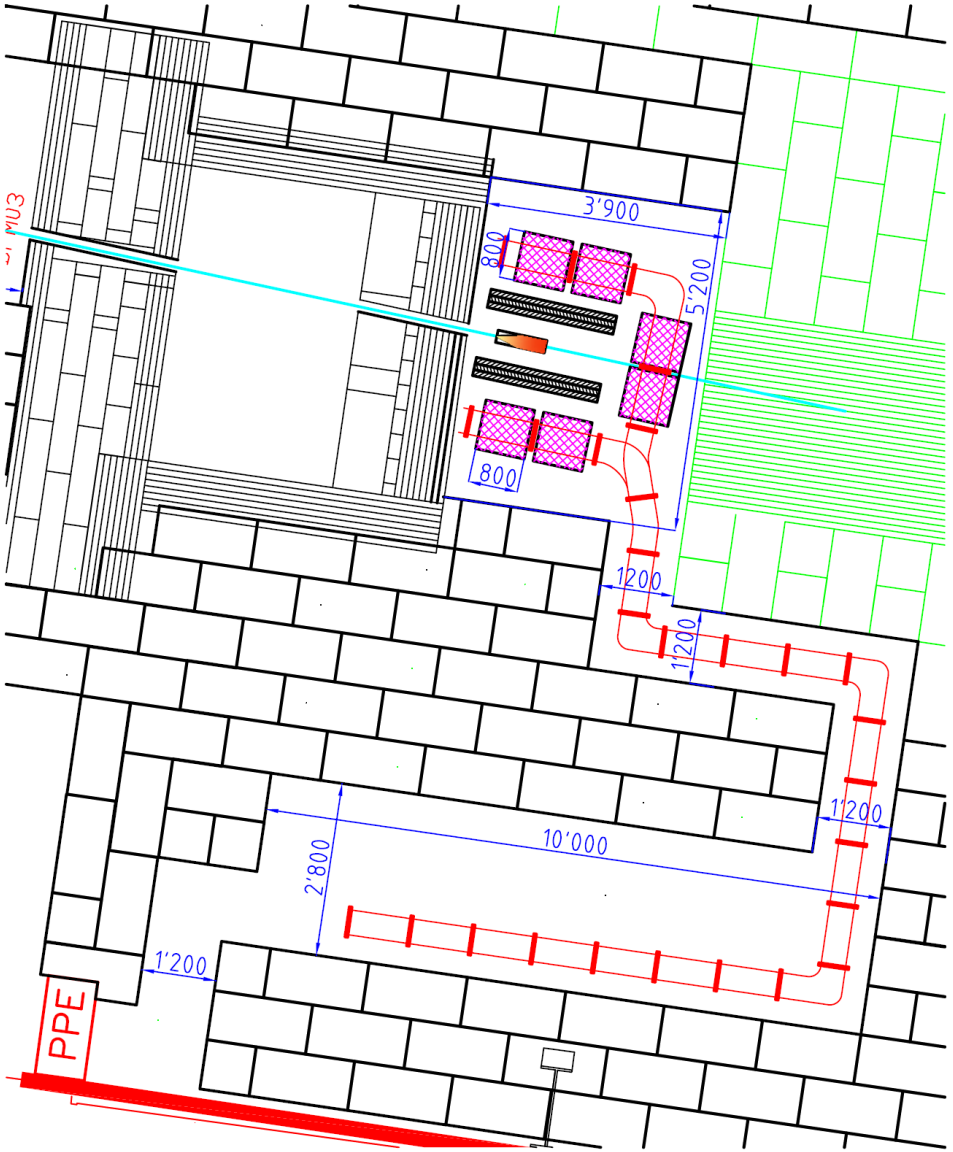
*Some remarks on CV/CE issues

- Improved building insulation could save ~265 kHCF/yr
- However, the civil engineering implications to achieve this are huge in time and costs, therefore not obviously economical.
- This will be aggravated by complications due to asbestos issues if work is done on the false roof and/or the walls. Complicated, long and expensive.

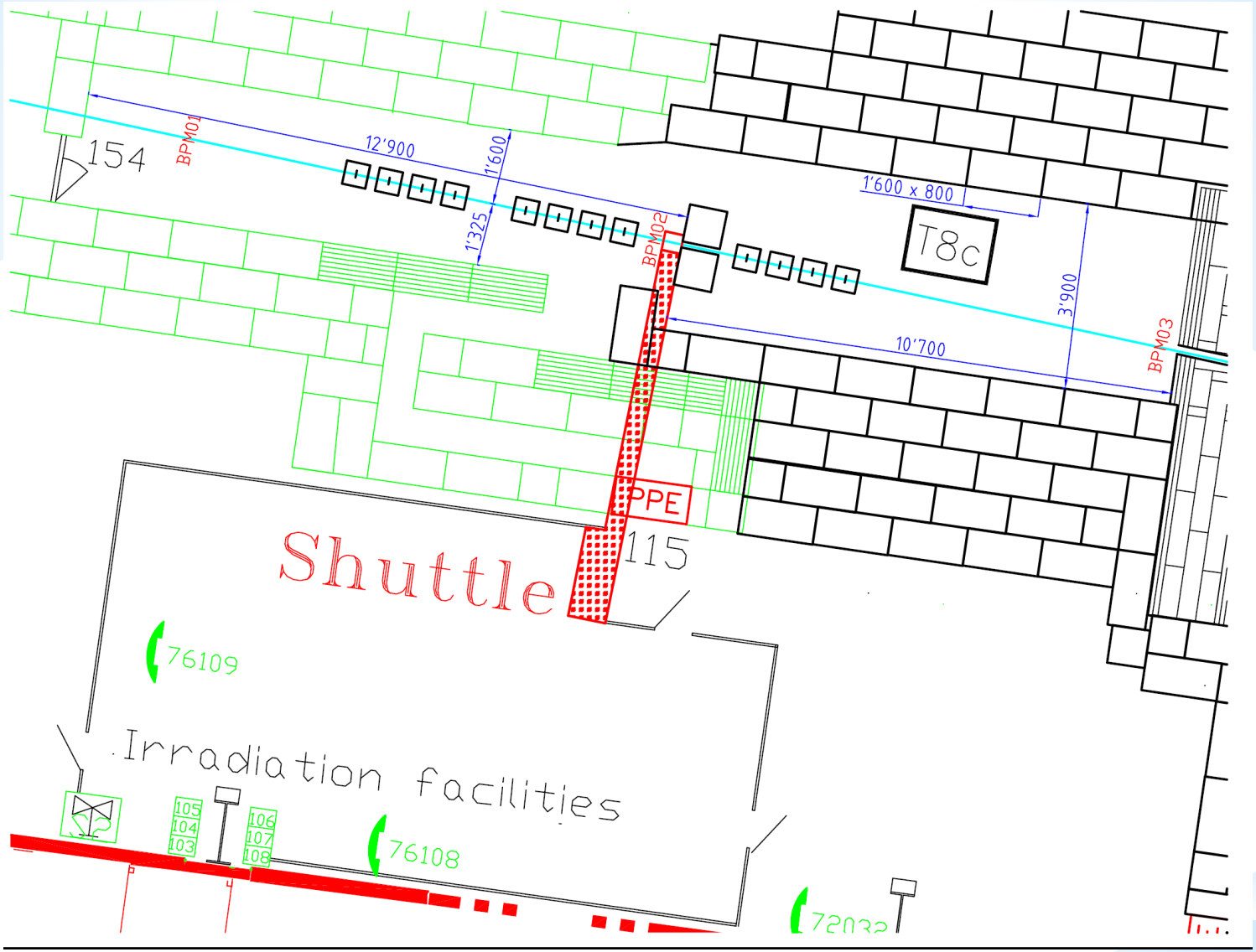
  Need to work at 20 Pascal under-pressure, etc. Co-activity implications.
- The asbestos situation in general is not critical and there is no obligation to intervene (apart from items touched by the works – new MTP), except for
  - the floors of the two galleries below the roof
  - some tubes which contain asbestos.

  Total cost for those interventions ~ 200 kCHF (to be confirmed).
- We therefore propose to limit ourselves to consolidate the status quo of the building and some simple improvements where appropriate.
- For heating one could consider local systems (e.g. in control rooms)
- A full building upgrade (+asbestos removal) requires a full study.

Mixed field facilities



*Proton facilities



Mixed-Field Facility (A&T Sector)

"Radiation To Electronics (R2E)" Activities in the Accelerator Sector

- **Presently:** radiation tests of existing equipment (TE/EPC, EN/EL, TE/ABT, TE/CRG, BE/BI, EN/STI, TE/MPE,…)
  - "covered" through CNRAD, H4IRRAD and external facilities
  - **problematic: available beam-time, intensity, access, turn-around,…**
  - **physics: external facilities (*e.g.*, PSI) can not fully cover the test requirements** (certain failure modes depend on particle type &energy)
- **'Near Future' (2011-2016):** component and system testing of **new development and upgrades**; test of **patch-solutions** for LHC (2014-2016 Operation Period!)
  - **problematic:** given the time-constraints (upgrade requirements, shutdown planning) -> **bottle-neck in available beam-time and turn-around;** test/ development of patch-solutions will require quick setups, tests, changes, re-testing (not possible in current facilities)
- **Long-Term: new developments of LHC** tunnel equipment, **LHC upgrade** requirements,
  - **besides above constraints:** CNRAD will not be available forever, H4IRRAD can't cover the full requirements, no flexibility (nor backup)

Proposed Solution: Mixed Field Facility in the PS-East-Area

General Aspects (Mixed Facility)

- Radiation testing is **part of qualification procedure** (no installation in radiation area without testing!)
- **Accelerator operation (not only LHC) relies on it** (present & future); Flexibility required in case of problems (patch-solutions require quick reaction)
- Higher intensities/luminosities will lead to **increased demand**
- **Upgrades** will require it at several levels (triplets, tunnel equipment, etc.)
- **Only a well conceived FACILITY can answer this in the long-term**

	CNRAD	H4IRRAD	External Facities	PS-IRRAD
Availability:	Limited	Limited	Limited	**Ok**
Access & Space	Very Limited	Ok	Limited	**Ok**
Services:	Limited	Ok	Limited	**Ok**
Flexibility:	Limited	Limited	Limited	**Ok**
Intensity:	Ok	Limit	Ok	**Ok**
Physics:	Limited	Ok (? LHC Tunnel)	Very Limited	**Ok**
Long-Term:	No	Limited	Limited	**Yes**
Costs:	Ok	Ok	High	**Reasonable**