

HHH → ***Network***

Coordinated by F. Ruggiero and W. Scandale

High Energy
High Intensity
Hadron Beams



<http://care-hhh.web.cern.ch/care-hhh/>

CERN

Goals of the CARE-HHH Network

Coordinate and integrate the activities of the accelerator and particle physics communities, in a worldwide context, towards achieving superior **H**igh-Energy **H**igh-Intensity **H**adron Beam facilities for Europe

- **Roadmap for the upgrade of the European accelerator infrastructure (LHC and GSI accelerator complex)**
 - ✓ luminosity and energy upgrade for the LHC
 - ✓ pulsed SC high intensity synchrotrons for the GSI and LHC complex
 - ✓ R&D and experimental studies at existing hadron accelerators
 - ✓ select and develop technologies providing viable design options
- **Coordinate activities and foster future collaborations**
 - ✓ integrate the effort of major laboratories
 - ✓ integrate the effort of small labs and universities
 - ✓ assemble a community capable of sustaining the technical realisation and scientific exploitation of these facilities
- **Dissemination and outreach**
 - ✓ create an information network, publish and document results
 - ✓ set up a **web based beam dynamics code repository** and a **database for SC cable and magnets**
 - ✓ discuss improvements for existing hadron beam facilities in Europe

CARE-HHH Network – 3 Work-Packages

WP1: Advancements in Accelerator Magnet Technologies (AMT)

- coordinated by L. Rossi (CERN) and L. Bottura (CERN)
- keywords: stability and quench limit of LHC insertion magnets, **pulsed magnets for LHC and GSI accelerator complex upgrade**, magnets for booster ring, **high field magnet design**, optimisation of the overall cost

WP2: Novel Methods for Accelerator Beam Instrumentation (ABI)

- coordinated by H. Schmickler (CERN) and K. Wittenburg (DESY)
- keywords: tools and diagnostic systems for luminosity, **wire for beam-beam compensation**, advanced transverse beam diagnostics, feedback loops for orbit, chromaticity and coupling, advanced beam halo diagnostics, **remote diagnostics and maintenance of instrumentation**

WP3: Accelerator Physics and synchrotron Design (APD)

- coordinated by F. Ruggiero (CERN) and F. Zimmermann (CERN)
- keywords: **Interaction Region design for LHC luminosity upgrade**, optics design for booster synchrotrons, impedance calculations, **structured list of intensity limits**, electron cloud effects, beam measurements and advanced theoretical studies on halo formation and loss mechanisms

Main HHH Participating Institutes

	AMT	ABI	APD
CEA	×		
CERN	×	×	×
CSIC-CIEMAT	×		×
CCLRC	×		
DESY		×	×
GSI	×	×	×
INFN	×		×
PSI		×	
TEU	×		
WUT	×		

Associated Institutes: CRPP, ENEA, TUBE, ESRF, UPSA, FZK, TEMF,
US-LARP (BNL, FNAL, LBNL), JINR, IHEP, KEK

Additional collaborations: Un. Texas A&M (P. McIntyre), Un. Geneva (R. Flükiger)
⇒ **new** Un. Bologna (G. Turchetti)

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Ongoing HHH activities in 2005

- **Events:** A total of 7 workshops organized in 2005 (two are planned in December). Significant participation often extended to representatives of the European Industry. New working groups on Pulsed SC Magnets and LHC Luminosity Upgrade (machine-experiment interface with ATLAS and CMS)
- **Dissemination and outreach:** intense effort for dissemination of information. Several talks on HHH activities in European labs and Universities or in international workshops organized by other Institutions. Highlights from the HHH-2004 workshop were published in the CERN Courier in June 2005.
 - 14 new HHH publications in 2005, 4 of which are workshop proceedings
 - HHH web site finalized, with pages specific to each work-package
- **Exchanges and educational aspects:** Two US accelerator specialists hosted by CERN (AMT). Two junior scientists active in HHH hosted and supported, one by CERN (AMT), the other by the Univ. Benevento, Italy (APD). A master degree student was active at CERN on AMT issues. A master degree and a doctoral student just hired at CERN will investigate issues related to APD (D0 dipole) and AMT database, respectively. Two doctoral students have been working at CERN (APD) on LHC IR design aspects (dipole-first) and long-range beam-beam compensation, and a Summer Student has contributed to the setting-up of a dynamic accelerator-physics code web repository

HHH publications in 2005

1	CARE-Conf-04-24-HHH	Proceedings of the 1st CARE-N3-ABI networking meeting	Editors A. Peters, H. Schmickler, K. Wittenburg	April 2005
2	CARE-Conf-04-23-HHH	Proceedings of the 2nd CARE-N3-ABI networking meeting	Editors A. Peters, H. Schmickler, K. Wittenburg	April 2005
3	CARE-Conf-05-01-HHH	Proceedings of the ECLOUD'04 Workshop	Editor F. Zimmermann	Jan 2005
4	CARE-Conf-05-02-HHH	Proceedings of the HHH 2004 Workshop	Editors F. Ruggiero, W. Scandale, F. Zimmermann	June 2005
5	CARE-Conf-05-04-HHH	On the feasibility of a tripler upgrade for LHC	P. McIntyre, A. Sattarov	May 2005
6	CARE-Conf-05-05-HHH	Low- β quadrupole design for the LHC luminosity upgrade	R. Ostojic et al.	May 2005
7	CARE-Conf-05-06-HHH	Towards an optimization of the LHC intersection region using new magnet technology	P. McIntyre, A. Sattarov, J.-P. Koutchouk	May 2005
8	CARE-Conf-05-07-HHH	Killing the electron cloud effect in the LHC arcs	P. McIntyre, A. Sattarov	May 2005
9	CARE-Conf-05-21-HHH	Electron cloud measurements in the SPS in 2004	G. Arduini, et al.	May 2005
10	CARE-Report-05-08-HHH	Annual report on the HHH collaboration	F. Ruggiero, W. Scandale	Jan 2005
11	CARE-Report-05-15-HHH	First 2005 intermediate report on the HHH collaboration	F. Ruggiero, W. Scandale	April 2005
12	CARE-Report-05-22-HHH	Second 2005 intermediate report on the HHH collaboration	F. Ruggiero, W. Scandale	Sep 2005
13	CARE-Note-2005-017-HHH	Analysis of LHC low- β upgrades based on the Nb-Ti and preliminary conclusions on a Nb ₃ Sn	J.-P. Koutchouk	Oct 2005
14	CARE-Note-2005-???-HHH	MATPRO: a computer library of material properties at cryogenic temperatures	Lucio Rossi, M. Sorbi	Nov 2005

HHH-AMT

- Good progress on conductor development, codes and models for design, stability and protection studies, comparison of different IR options, and scaling laws
- Some **preliminary work on database for SC cable and magnets**
- Report on AMT organization and Conductor Development Roadmap (**Intermediate Delivery**) presented at HHH-AMT general meeting held at CERN on 11-12 November 2004 see http://amt.web.cern.ch/amt/events/meetings/CERN_Nov_2004/meeting_CERN_nov2004.htm
- **Excellent progress on the study of fast-pulsed SC magnets (GSI FAIR project and Super-SPS) and low-field magnets for a booster ring in the LHC tunnel**
- strong synergy with HHH-APD (LHC IR design and high energy injectors), HHH-ABI (machine protection), fusion magnet technology, and US-LARP
- AMT workshop on *Contact Tooling* delayed to 2006 (in a joint workshop on *Accelerator Magnet Design and Optimization*, **‘WAMDO’, Archamps, France, 3–7 April 2006**) and replaced by the **‘ECOMAG-05’** workshop on *SC Pulsed Magnets*

CARE-HHH-AMT workshop

Beam-Generated Heat Deposition and Quench Levels

CERN, 3-4 March 2005

80 specialists from CERN, INFN, CEA, IFJ-Krakow, GSI, DESY, Fermilab, Univ. Geneva and **SIEMENS**

Main topics:

- Study of the stability margin for the SC focusing triplet at the ultimate luminosity level
- Validation of the SC quadrupole design for the LHC luminosity upgrade
- Thermal transfer and superconducting stability
- Thermal models and their validation through experiments
- Comparison of codes for the simulation of thermal effects
- Experience on quench level from LHC magnet operation and test at CERN, and from beam and magnet operation at **DESY and Fermilab**

Main outcomes: very useful also for LHC commissioning

- ◆ magnet stability and heat deposition code benchmarking
- ◆ generated concrete work on tables for quench limits for all LHC magnets

CARE-HHH-AMT Topical Meeting

Insulation and Impregnation Techniques

CERN, 22-23 March 2005

About 30 specialists from CERN, LBLN, INFN, Univ. Twente, GSI, **Univ. Texas A&M**, KEK, CEA, **CIEMAT**, **MIT**, NSCL, CCLRC, and industry: **ANSALDO**, Fraivillig Technologies, Composite Technology Development

Main topics: SC conductor insulation, Insulation of metallic parts, Insulation of inter-layers, Resin composition, Radiation resistance, Fibre filling and sizing, Heat transfer properties \Rightarrow **synergy with Insulation work-package in NED**

Main Outcome: it is difficult to identify a single material with all required mechanical properties \Rightarrow best candidate '**polyimide spray**'



CARE-HHH-AMT Workshop 'ECOMAG-05'

SC Pulsed Magnets for Accelerators

Frascati, 26–28 October 2005

(originally not foreseen as a CARE-HHH-AMT 2005 milestone)

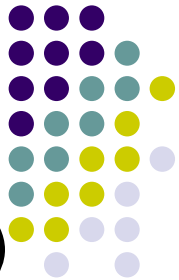
70 participants from CERN, INFN ENEA, GSI, CEA, EPFL, JINR, MIT, CIEMAT, KEK, IHEP, EFDA, Bochvan institute of Inorganic Materials, Univ. Twente, Ohio State Univ. and from 6 European Industries acting on SC magnets or SC materials \Rightarrow **strong synergy with HHH-APD**

Main Topics:

1. define a set of agreed parameters for the development of **low-loss SC magnets** ranging from low field, continuously pulsed (typically 2 T peak, 4 T/s, 100 mm aperture, 108 cycles) to medium field, high-duty cycle magnets for storage and booster rings (typically 6 T peak, 1 T/s, 80 mm aperture, 106 cycles),
2. translate the requirements into specifications for performance of strand, cable, magnet and auxiliaries
3. define the R&D required to achieve the above specifications and produce a tentative road-map for a procurement and prototyping activity \Rightarrow **common magnet parameters for CERN and GSI!**

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HHH Networking Results (highlight talk by L. Bottura)



- More than 70 participants (initial plan on 30 to 50)
- 17 laboratories and universities
 - Bochvar Institute, CEA, CERN, **CIEMAT**(*), **EFDA-CSU**(*), **ENEA**(*), **EPFL-CRPP**(*), **FzK**(*), GSI, IHEP, INFN-Frascati, INFN-Genova, INFN-Milano, JINR, KEK, **MIT**(*), Ohio State
 - (*) fusion/energy laboratories
- 7 major European industries:



HHH-ABI

- Active collaboration and coordination on Beam Instrumentation issues has continued with the **US-LARP** programme. H. Schmickler attended a US-LARP coordination meeting at Port Jefferson 6-8 April 2005
- DESY-CERN collaboration in **machine protection** issues has been established: i) A fast detection circuit for magnet power supply failures was developed for DESY and transferred to CERN. ii) Some LHC beam loss monitor are installed in HERA and tests are ongoing to check their system properties
- Spin-off from the first HHH-ABI workshop on “*Trajectory and Beam position measurements using digital techniques*” ⇒ common **EU-FP6 design study work between CERN, GSI, TU Darmstadt, FZ Jülich and the company I-Tech** on digital beam position measurements
- Spin-off from the 2nd HHH-ABI workshop on *“DC Current Transformers and Beam-Lifetime Evaluations”* ⇒ beam lifetime measurement and indicator for the long lifetimes at the DESY storage rings were substantial improved in 2005

3rd CARE-HHH-ABI workshop

Remote diagnostics and maintenance of beam instrumentation devices
Hirschberg (near Heidelberg), 6–7 December 2005
about 20 participants expected

The focus of HHH-ABI includes **improving LHC commissioning and operation, in addition to GSI and LHC Upgrade**, and the associated need for remote diagnostics and maintenance for beam instrumentation provided by CERN partners such as US-LARP

Workshop Goals: **i)** define realistic objectives for the operation and diagnostics of future hadron accelerators (including **LHC@FNAL**), **ii)** discuss in detail related technology issues and controls infrastructure, **iii)** propose concrete HHH-ABI workpackages and milestones for the coming 18 months

- 1st half day: The **Global Accelerator Network-Multipurpose Virtual Laboratory** initiative and others
- 2nd half day: Virtual Instrumentation Integration – principles and examples
- 3rd half day: Definition of work packages from the diagnostics view point

HHH-ABI continued

- Coordination meeting between DESY, GSI and CERN at DIPAC 2005 to review and (slightly) **redefine future CARE-HHH-ABI activities and deliverables**: e.g. tools for diagnostic systems for high intensity pre-accelerators, preservation of emittance in the accelerator chain
- Advanced Beam Instrumentation includes fast luminosity monitors, fast non-destructive betatron tune, chromaticity, and coupling monitors based e.g. on multi-carrier PLLs, profile monitors for direct measurement of the beam halo, fast feedback loops for orbit, coupling and chromaticity control, and Schottky monitors.
- Beam current transformers with $\sim 10^{-4}$ resolution are needed for beam lifetime diagnosis and machine protection: **saturation of the magnetic core at peak beam currents near 20 A is a challenging problem both for LHC and for the GSI FAIR project**, where Uranium ion beams will have peak currents of about 100 A
- **HHH-ABI workshop in 2006 on “Luminosity Measurements”**

HHH-APD

- Good progress on **comparison of alternative LHC IR designs**, beam dynamics studies and tests to validate different options
 - **ecloud and crystal collimation tests at FNAL**
 - ecloud and long range beam-beam compensation tests planned at RHIC
⇒ delayed to Sept 2006? after severe BNL budget cuts
- Contacts established with KEK, Cornell and LBNL regarding a possible design for LHC crab cavities to be tested at RHIC
- Significant progress on **code benchmarking and web repository**
- **Excellent progress on structured list of beam intensity limits**
- Initial work on optics solutions, RF upgrade paths, collimation and machine protection for pulsed SC synchrotrons
- Strong synergy with **HHH-AMT** (LHC IR design and High Energy Injectors) and **US-LARP**. Some synergy with **MW Proton Driver**
- APD workshop ***Towards a Roadmap for the Upgrade of the LHC and GSI Accelerator Complex*** foreseen in the second half of 2006

CARE-HHH-APD mini-workshop 'CC-2005'

Crystal Collimation in Hadron Colliders

CERN, 7–8 March 2005

About 80 specialists from CERN, INFN, PNPI, IHEP, FNAL, LBNL, Univ. of Aarhus, Helsinki Institute of Physics and Univ. of Texas.

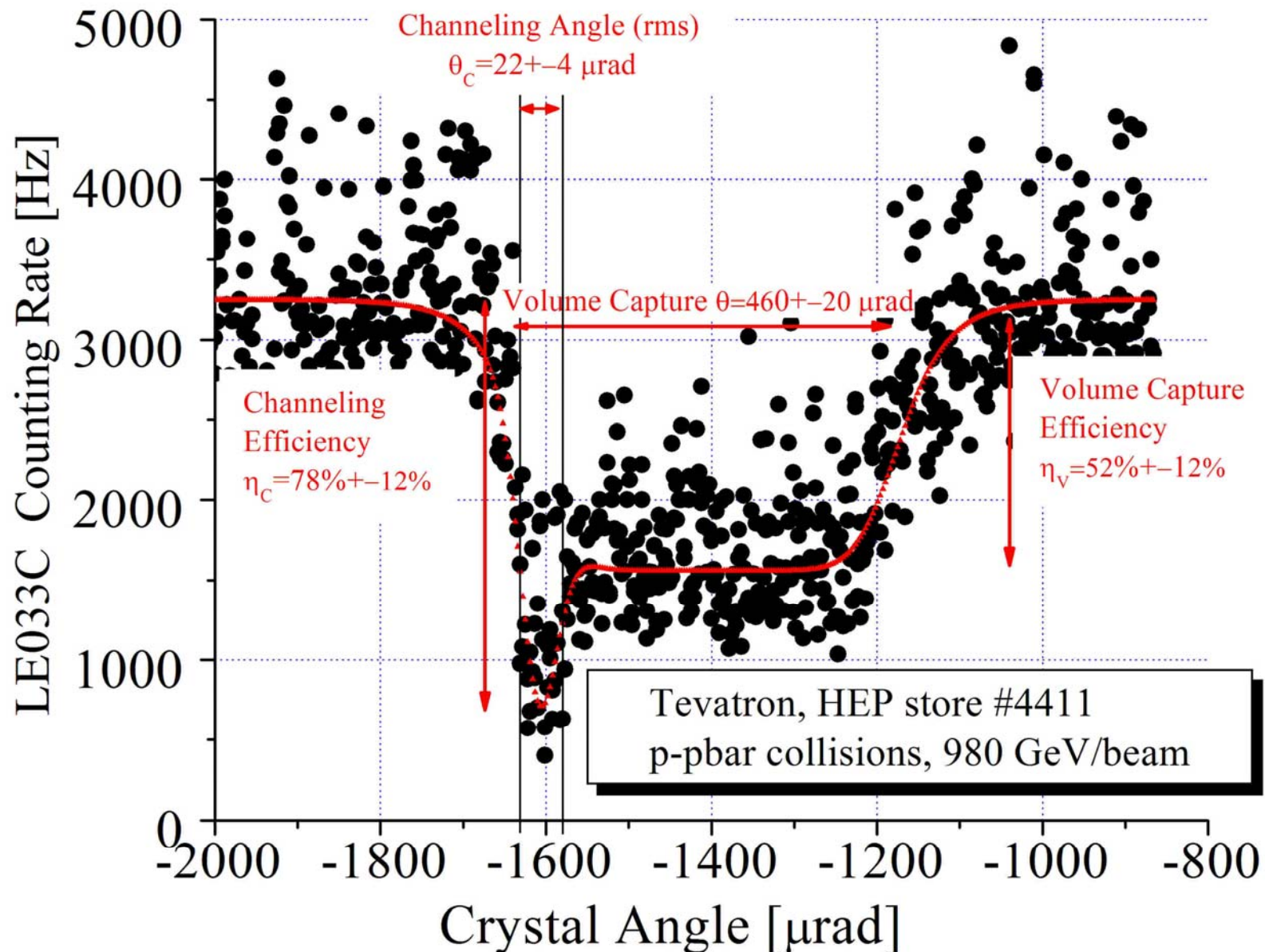
Main topics:

- Review of the beam cleaning requirements
- Review of crystal extraction experiments in circular accelerators
- Experience with crystals at the various colliders
- Crystal production, technologies and experimental procedures
- Crystal simulation
- Discussion on a proposal of a new experiment of crystal extraction and collimation at the CERN-SPS

Main Outcomes:

- Negative results at RHIC may depend on crystal quality
- New SPS experiment has been proposed (and financed by INFN)
- Meanwhile **excellent crystal collimation results at the Tevatron**
- **⇒ 2nd CARE-HHH-APD mini-workshop on *Crystal Channeling*, CERN, 8–9 December 2005**

Bent Crystal: 1TeV Channeling



CARE-HHH-APD Workshop 'LUMI 05' (40 participants)

Scenarios for the LHC luminosity upgrade

Arcidosso (Italy), 31 August–3 September 2005

⇒ strong synergy with US-LARP mini-workshop IR-2005 (Chicago, 3–4 Oct 2005) and HHH-AMT workshop 'ECOMAG05'

- optical designs and luminosity performance for alternative **LHC IR layouts with lower β^***
- beam-beam compensation schemes, crab cavities and machine-experiment interface (**reduced ℓ^***)
- machine and magnet parameters for new high energy injectors (**Super-SPS**) needed to increase integrated LHC luminosity

Main outcomes:

- Three IR layout options identified (HHH web repository with optics solutions will be set up):
 - 1) dipole-first based on **Nb₃Sn technology** with $\ell^* = 19$ m
 - 2) quad-first layout based on **Nb₃Sn technology** $\ell^* = 19$ m
 - 3) low gradient quad-first layout based on **NbTi technology**
- **New:** possible early beam separation by a “D0” dipole located a few metres away from the IP
- RF systems and bunch spacing, **New:** Super-PS



Tentative conclusions for the LHC IR Upgrade

- We do need a back-up or intermediate IR upgrade option based on NbTi magnet technology. What is the maximum luminosity?
- A vigorous R&D programme on Nb₃Sn magnets should start at CERN asap, complementary to the US-LARP programme, to reach an LHC luminosity of $\sim 10^{35}$ after 2015
- Alternative IR layouts (quadrupole-first, dipole-first, D0, flat beams, Crab cavities) should be rated in terms of technological and operational risks/advantages

Towards a baseline design

Following the approach proposed by Barry Barish for the ILC, I suggest to:

- **Define a Baseline**, i.e. a *forward looking* configuration which we are reasonably confident can achieve the required LHC luminosity performance and can be used to give an accurate cost estimate by mid-end 2006 in a “Reference Design Report”
- **Identify Alternative Configurations and rate them** in terms of technological and operational risks/advantages
- **Identify R&D** (at CERN and elsewhere)
 - To support the baseline
 - To develop the alternatives

Reference LHC Luminosity Upgrade: workpackages and tentative milestones

accelerator	WorkPackage	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	after 2015
LHC Main Ring	Accelerator Physics											
	High Field Superconductors											
	High Field Magnets											
	Magnetic Measurements											
	Cryostats											
	Cryogenics: IR magnets & RF											
	RF and feedback											
	Collimation&Machine Protection											
	Beam Instrumentation											
	Power converters											
SPS	SPS kickers											
	Tentative Milestones	Beam-beam compensation test at RHIC	SPS crystal collimation test	LHC collimation tests	LHC collimation tests	Install phase 2 collimation	LHC tests: collimation & beam-beam			Install new SPS kickers	new IR magnets and RF system	
	Other Tentative Milestones	Crab cavity test at KEKB	Low-noise crab cavity test at RHIC	LHC Upgrade Conceptual Design Report		LHC Upgrade Technical Design Report	Nominal LHC luminosity 10^{34}			Ultimate LHC luminosity 2.3×10^{34}	beam-beam compensation	Double ultimate LHC luminosity 4.6×10^{34}

LHC Upgrade
Reference
Design Report

R&D - scenarios & models	
specifications & prototypes	
construction & testing	
installation & commissioning	

Reference LHC Upgrade scenario: peak luminosity $4.6 \times 10^{34}/(\text{cm}^2 \text{ sec})$

Integrated luminosity $3 \times \text{nominal} \sim 200/(\text{fb} \cdot \text{year})$ assuming 10 h turnaround time

new superconducting IR magnets for $\beta^* = 0.25 \text{ m}$

phase 2 collimation and new SPS kickers needed to attain ultimate LHC beam intensity of 0.86 A

beam-beam compensation may be necessary to attain or exceed ultimate performance

new superconducting RF system: for bunch shortening or Crab cavities

hardware for nominal LHC performance (cryogenics, dilution kickers, etc) not considered as LHC upgrade

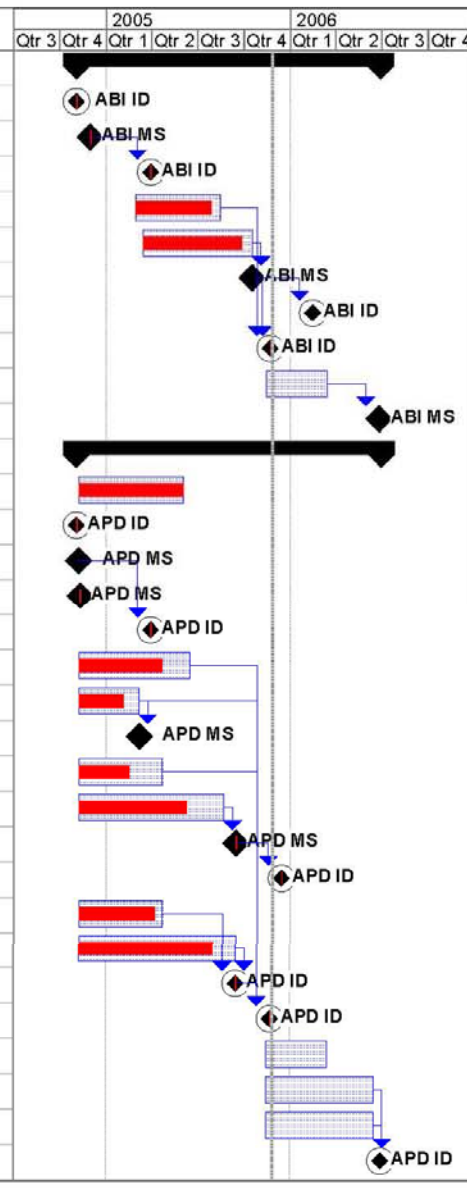
R&D for further luminosity upgrade (intensity beyond ultimate) is recommended: see Injectors Upgrade

HHH deliverables and milestones compared to the original plan

- 2004: HHH and HHH-APD web sites \Rightarrow OK
 - 2005: Creation of a first web-based Beam Dynamics Code Repository \Rightarrow OK
 - 2006: Web-based database for SC cable and magnets \Rightarrow delayed to 2007
-
- All milestones in 2005 have been met, proceedings of all past workshops and Intermediate Deliverables have been or are being published
 - Work for web-based database on SC cable and magnets will start only in 2006 (new Doctoral Student finally recruited at CERN)
 - Excellent progress on pulsed SC magnets, connections with Fusion (ITER) and US-LARP, quench limits and LHC IR design, magnets for booster ring, beam instrumentation, and structured list of beam intensity limits

ID	Task Name	2005				2006			
		Qtr 3	Qtr 4	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Qtr 1	Qtr 2
1	N3: HHH Networking Activities								
2	All Work Packages								
3	Network coordination, dissemination, and outreach								
4	<u>MS: Joint HHH/NED meeting at CARE04</u>								
5	General HHH meeting at CERN including non-EU partners								
6	ID: HHH Annual Report 2004								
7	Reinforce connections between Labs and Universities in all WP's								
8	Revisit priorities for all WP, improve HHH web site								
9	<u>MS: Annual HHH meeting</u>								
10	ID: HHH Annual Report 2005								
11	WP1 Accelerator Magnet Technology (AMT)								
12	ID: Interim report on AMT activities and reporting at the general CARE meeting								
13	<u>MS: General AMT meeting</u>								
14	Coordinate conductor development and tests								
15	<u>MS: AMT topical meeting on Insulation and Impregnation Techniques</u>								
16	ID: Proceedings of the 1st AMT topical workshop on Accelerator Magnet Superconductors								
17	ID: Report on AMT organization and conductor development roadmap								
18	Development of Web based database for SC Cables and Magnets								
19	<u>MS: Specific meeting on database</u>								
20	ID: First report on Web based database								
21	Codes and models for design, stability and protection studies for AMT1 and AMT4								
22	<u>MS: AMT mini-workshop on Beam Generated Heat and Magnet Quench Level</u>								
23	ID: Proceedings of AMT mini-workshop on Beam Generated Heat and Magnet Quench Level								
24	<u>MS: establish a catalog of existing codes for design, stability and protection studies</u>								
25	ID: Interim report on AMT activities and reporting at the general CARE meeting								
26	Catalog and comparison of different IR options (AMT4)								
27	<u>MS: AMT workshop on Contact Tooling</u>								
28	Studies of fast pulsed SC magnets for Super-SPS								
29	Review of developments in the US and for ITER on conductors and magnet technology relevant for AMT1-2								
30	Comparative studies of alternatives using low field magnets for AMT2 and AMT3								
31	Determination of scaling law for magnet and cryogenic cost for AMT5								
32	<u>MS: Preliminary report on scaling law for magnet and cryogenic cost (roadmap)</u>								

ID	Task Name	2005				2006			
		Qtr 3	Qtr 4	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Qtr 1	Qtr 2
33	WP2 Accelerator Beam Instrumentation (ABI)								
34	ID: Interim report on ABI activities and reporting at the general CARE meeting								
35	<u>MS: 2nd ABI topical workshop on Beam Intensity and Lifetime measurements</u>								
36	ID: Proceedings of the 2004 ABI topical workshops								
37	Contribution to US-LARP activities/events and possible synergy with HHH WP1-WP3								
38	Study of tune control and remote diagnosis after identification of its limiting issues								
39	<u>MS: 3rd ABI topical workshop on Remote Diagnostics</u>								
40	ID: Proceedings of the 3rd ABI topical workshop								
41	ID: Interim report on ABI activities and reporting at the general CARE meeting								
42	Definition of possible new milestones								
43	<u>MS: 4th ABI topical workshop</u>								
44	WP3 Accelerator Physics and Synchrotron Design (APD)								
45	Further development of the APD Web Site with structured information flow								
46	ID: Interim report on APD activities and reporting at the general CARE meeting								
47	<u>MS: 1st APD topical workshop on Fast Synchrotrons and IR design HHH-2004</u>								
48	<u>MS: General APD meeting</u>								
49	ID: Proceedings of the 1st APD topical workshop								
50	Systematic comparison of alternative synchrotron and IR designs								
51	Determination of beam dynamics studies and experiments to validate different options (APD1-2, APD6-7)								
52	<u>MS: APD mini-workshop on Crystal Collimation</u>								
53	Studies relevant for APD3, APD4 and APD5, contribution to US-LARP events								
54	Identification of beam intensity limitations and determination of roadmap for Synchrotron and ID designs								
55	<u>MS: 2nd APD topical workshop on Fast Synchrotrons and IR design</u>								
56	ID: Proceedings of the 2nd APD topical workshop								
57	Establish a structured catalog of existing simulation codes for APD1-APD7								
58	Collect and document benchmarked codes								
59	ID: Creation of a first web based code repository								
60	ID: Interim report on APD activities and reporting at the general CARE meeting								
61	Definition of possible new milestones								
62	Definition of optics design options for IR layout and booster synchrotrons								
63	Assessment of impedance budget for booster synchrotrons								
64	ID: First structured list of intensity limits for booster synchrotrons and LHC								



Conclusions

- All the HHH 2005 milestones have been met
- All work-packages are progressing well in line with the original planning and in considerable synergy
- Some **activities have even been accelerated** or expanded: European labs, Universities, Industry, and International Partners are fully integrated
- We are collecting tangible results for each of the three work-packages as well as for the overall HHH Network organization
- **The CARE-HHH Network is definitely a *high-return* investment for Europe...**

Preliminary HHH workplan for the next 18 months

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		Qtr 4	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Qtr 1	Qtr 2
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21	ID: Proceedings of AMT WAMDO workshop															
22	Comparison of different IR options (AMT4) and steering of LARP magnet developments															
23	MS: AMT workshop on Coil Manufacturing Optimization															
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31	WP2 Accelerator Beam Instrumentation (ABI)															

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36	Contribution to US-LARP activities/events and possible synergy with HHH WP1-WP3															
37	Study of further beam instrumentation challenges for LHC commissioning and upgrade															
38	<u>MS: 4th ABI topical workshop on specific beam instrumentation technology</u>															
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43	WP3 Accelerator Physics and Synchrotron Design (APD)															
44	ID: Interim report on APD activities and reporting at the general CARE meeting															
45	<u>MS: 2nd APD mini-workshop on Crystal Collimation</u>															
46	ID: Proceedings of the 2nd APD topical workshop (LUMI-05)															
47	Further development of the APD Web Site: maintain beam dynamics codes repository															
48	Compare and further document benchmarked codes and alternative IR optics															
49	<u>MS: Creation of a web reference for alternative IR and synchrotron optics</u>															
50	Assessment of alternative optics designs for IR layout and booster synchrotrons															
51	Assessment of impedance budget for booster synchrotrons															
52	ID: First structured list of intensity limits for booster synchrotrons and LHC															
53	Beam dynamics studies and experiments to validate different options (APD1-2, APD6-7)															
54	Studies relevant for APD3, APD4 and APD5, contribution to US-LARP events															
55	Determination of a roadmap for Synchrotron and IR designs															
56	<u>MS: 3rd APD topical workshop on Fast Synchrotrons and IR design</u>															
57	ID: Proceedings of the 3rd APD topical workshop															
58	ID: Interim report on APD activities and reporting at the general CARE meeting															
59	Definition of possible new milestones															
60	Preparation of beam measurements for SPS+LARP high intensity tests and LHC commissioning															
61	Possible SPS tests on Crystal Collimation															