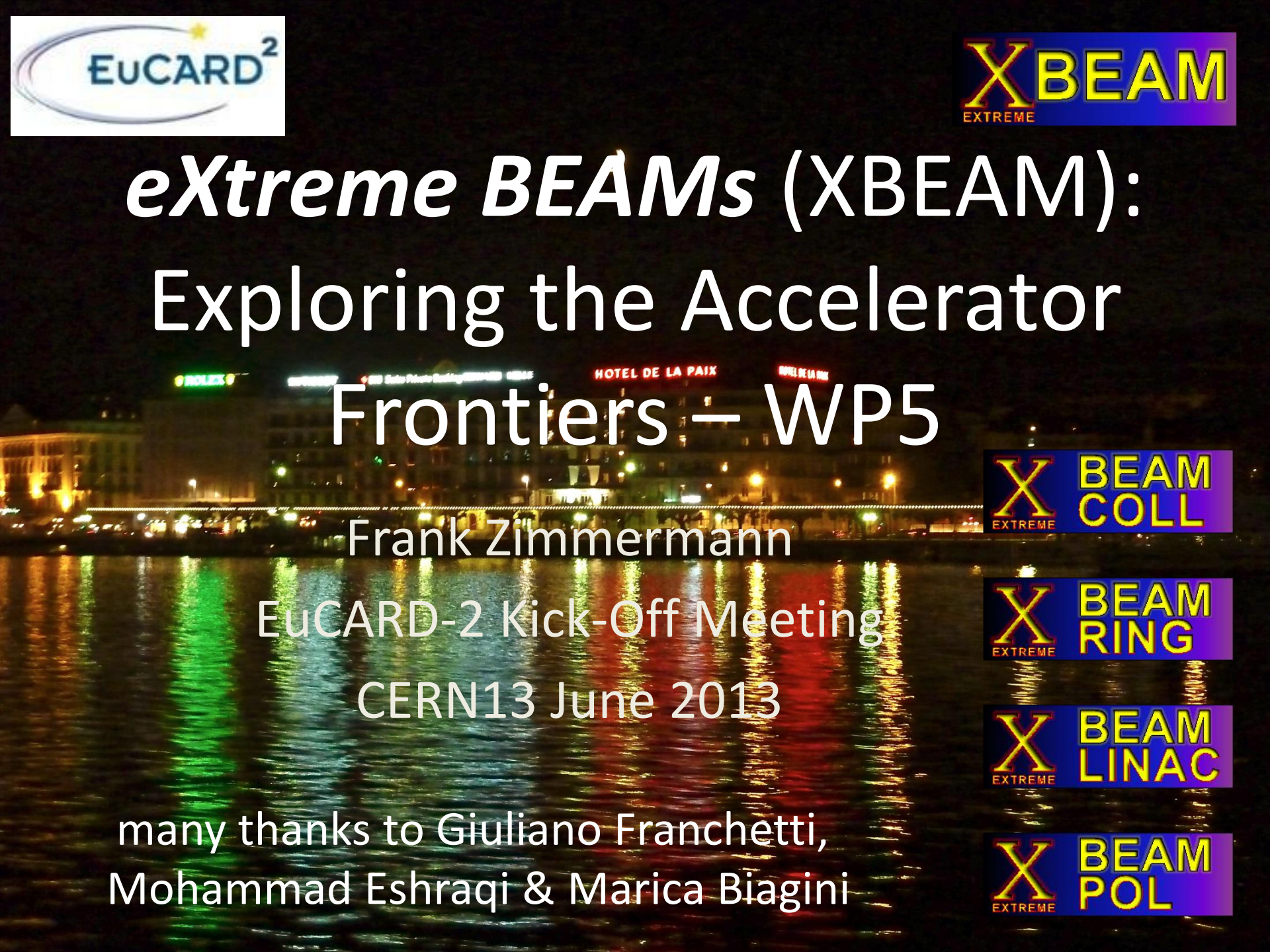

eXtreme BEAMs (XBEAM): Exploring the Accelerator Frontiers – WP5

Frank Zimmermann

EuCARD-2 Kick-Off Meeting

CERN13 June 2013

many thanks to Giuliano Franchetti, Mohammad Eshraqi & Marica Biagini

XBEAM network

platform for **information exchange and collaboration between communities**

e.g. proton, electron, nuclear physics, particle physics accelerator researchers; magnet designers; SRF experts; European industry, European universities and laboratories; pan European organizations (such as ESA)

- to study and **overcome critical accelerator limitations,**
- to **boost performance** of present and future accelerators or colliders **beyond the state of the art**

help present projects (e.g. HL-LHC, FAIR, ESS, SuperKEKB,…) to reach their goals

lay the groundwork for next generation of extreme-performance accelerators in Europe (e.g. HE-LHC/VHE-LHC, LHeC, MESA, TLEP,…)

XBEAM network

XBEAM will push all accelerator frontiers: luminosity, energy, beam power, beam intensity, and polarization

luminosity: x10-100 (1000) higher than present state of the art

beam power: x10 higher

beam intensity: x10 higher

polarization: ≥60% (p), ≥30% (e^+), ≥80-90% (e^-)

XBEAM structure

Task 5.1. Coordination and Communication

coordinated by F. Zimmermann (CERN)

Task 5.2. Extreme colliders (XCOLL)

coord: F. Zimmermann (CERN), M. Biagini (INFN-LNF)

Task 5.3. Extreme performance rings (XRING)

coord: G. Franchetti (GSI), J. Struckmeier (GSI)

Task 5.4. Extreme SC linacs (XLINAC)

coordinated by M. Eshraqi (ESS)

Task 5.5. Extreme polarization (XPOL)

coordinated by K. Aulenbacher (JGU Mainz)

Coordination & Communication– 5.1

objectives & work:

- **coordinate and schedule WP tasks**, adjusting activities according to priorities and budget
- **monitor the work** and use of resources, informing project management and WP participants
- ensure compliance with contract obligations and **disseminate achievements**
- **organization of XBEAM internal steering meetings**
- organization of and/or support to **activity workshops or specialized working sessions**, implying the attendance of **invited participants from inside and outside the consortium**

Common Elements & Objectives

- **annual workshops** with publication of proceedings as well as **topical mini-workshops**
  - similar to past CARE-HHH and EuCARD-AccNet events
- support visitors and visits between partner institutes
- summer students; supporting travel of technical students, PhD students and postdocs/fellows
- **disseminating network results** by **journal publications** and by **seminars** at partner institutes, conferences, European universities, and via **web documentation**
- **integrate efforts of large laboratories, smaller institutes and universities; form and maintain community** capable of advancing technical realization & scientific exploitation of European accelerator infrastructure
- **create synergies across communities, countries & continents**

work plan for each task:

- identify issues for each project
- tentative workshop schedule, dates & location
- web site(s)
- ….


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COLL

Extreme colliders (XCOLL) – 5.2

objectives & work:

- **realize full potential of the LHC**, by means of LHC **luminosity and energy upgrades**, **and/or extension to LHeC, HE-LHC, VHE-LHC**
- maximize performance of **future Super B, Higgs and τ-c factories** (**SuperB, SuperKEKB, TLEP, SAPPHiRE**), and **hadron-lepton colliders** (**LHeC, eRHIC, MEIC**) and IRIDE
- explore key items for a **(Very) High-Energy LHC** (injector, synchrotron radiation, beam dynamics, magnets)
- provide guidance for the **LHC injector upgrade**
- become **THE European forum for** discussing key aspects of **extreme performance colliders**
- ultimate limitations, optimum solutions, beam experiments
- bring together experts in collider beam dynamics with specialists of magnets & collimation to find optimum solutions

Extreme colliders (XCOLL) – 5.2

projects:

High Luminosity LHC

Super KEKB

LHeC

RHIC relativistic heavy ion collider

RHIC

TLEP

$HZ^0W^-W^+t\bar{t}$

SAPPHiRE

INFN Istituto Nazionale di Fisica Nucleare

SuperB

High Energy LHC

VHE-LHC

Extreme colliders (XCOLL) – 5.2

example issues:

- top-up injection ($e^{\pm}$)
- off momentum aperture
- beam-beam effects incl. beamstrahlung
- cooling of hadron beams, e.g. CeC
- e^{+} sources & polarization

inter-WP issues:

- vertical emittance tuning (WP6)
- RF & energy efficiency (WP3, 5.3)

draft near-term schedule (preliminary):

- first workshop 16-18 October (TLEP & LEP3) with WP5.5
- WS on SuperKEKB commissioning, November 2013
- joint workshop TLEP & VHE-LHC, February 2014
- joint mini-workshop with ICAN on $\gamma\gamma$ colliders & Higgs factories

Extreme colliders (XCOLL) – 5.2

continuing/new collaborations:

- **CONACyT/CINVESTAV Mexico**
  - 2-3 new students
- **ESA**
- **ICAN *new!***


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BEAM
RING

Extreme rings (XRING) – 5.3

objectives & work:

- help **optimize performance of FAIR, ISIS and PSI-HIPA**, and guide the upgrade strategy for the **LHC injector complex**
- studies on critical **beam diagnostics** (e.g. continuous emittance & beam-loss measurements)
- ultimate limitations, optimum solutions, beam experiments
- studies on advanced **FFAGs designs**, including machine experiments at EMMA
- become **THE European forum for** discussing performance limitations of **high-intensity high-brightness hadron rings**
- bring together experts in beam dynamics with specialists of magnets and collimation to arrive at optimum upgrade solutions with risk mitigation

Extreme rings (XRING) – 5.3

projects:

FAIR

Science & Technology Facilities Council
ISIS

LHC Injectors Upgrade

PAUL SCHERRER INSTITUT
PSI

The high-intensity proton accelerator (HIPA)

G. Franchetti

Extreme rings (XRING) – 5.3

high intensity issues:

Long term effect of space charge

Lattice modeling

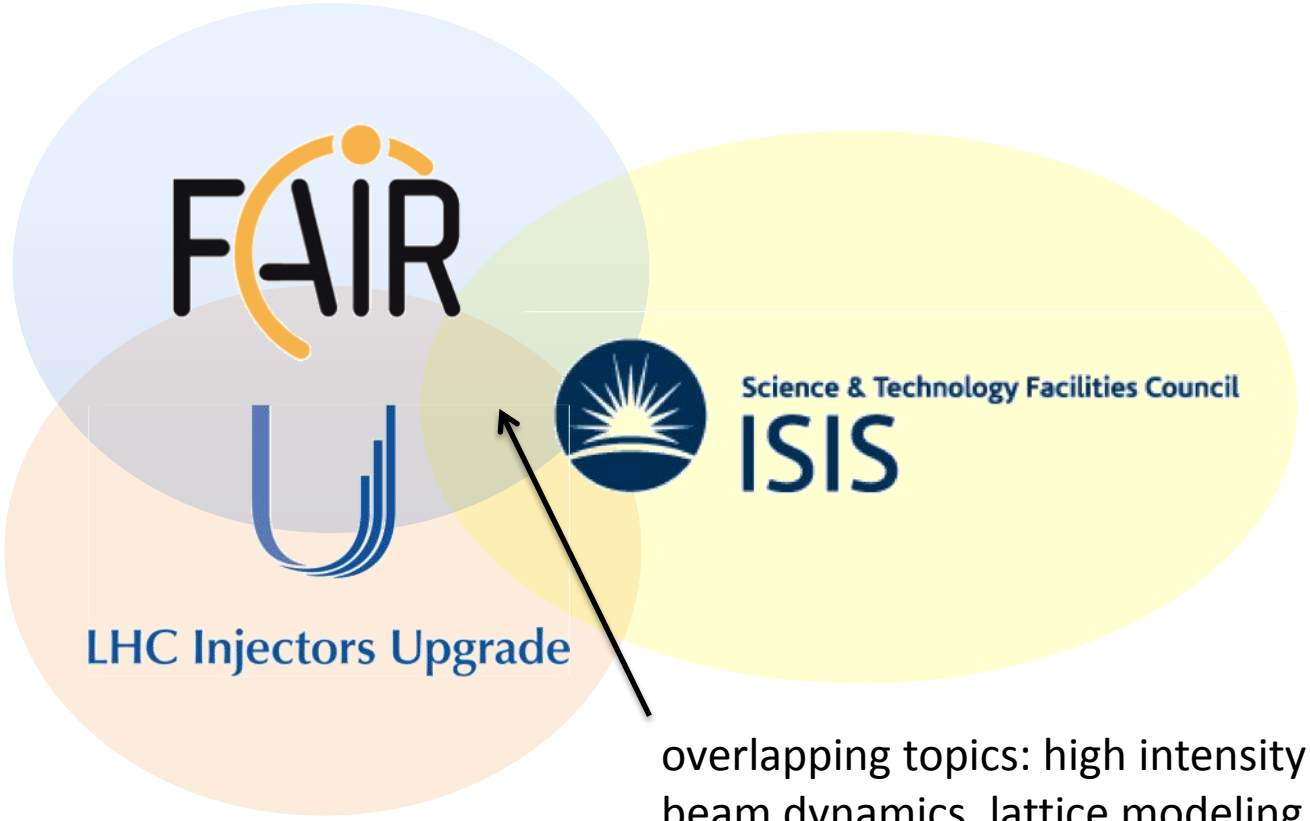
Diagnostics for high intensity

Benchmarking experiments

G. Franchetti

Extreme rings (XRING) – 5.3

synergies:



overlapping topics: high intensity beam dynamics, lattice modeling, benchmarking experiments

G. Franchetti

Extreme rings (XRING) – 5.3

example issues (preliminary):

FAIR

1) Consolidating beam loss prediction for high intensity bunched beams
2) Resonances compensation with space charge
3) Measurements of magnet multipoles in elliptic chambers
4) Consolidating benchmarking
5) Feedback systems for suppressing instabilities
6) Studies of bunch compression scenarios
7) Multi-turn injection studies
8) Slow extraction studies
9) High intensity beam diagnostics (tune measurements)

LIU

PSB Limitations due to Space Charge (beam loss and beam blow up)
Improving agreement between experimental data and simulations

PS Injection flat: Space charge, Headtail instability
Longitudinal CBI, beam loading, transition crossing
Flat top: longitudinal CBI, EC, TI
Completing benchmarking of codes with machine experiments.
Periodic resonance crossing and 4^{th} order
Studies on the integer

SPS Injection flat: Capture loss, longitudinal instability, Space charge
Whole cycle: longitudinal instability, EC

ISIS/EMMA

ISIS
1) Half integer studies
2) Improving accuracy in experiments
3) Develop a better understanding of beam loss
4) Third order driven resonance + effect of closed orbit
5) Experimental studies at high intensity Q-kicker, storage ring mode, etc…
6) developments of 3D codes

EMMA
1) Optimization of closed orbit distortions
2) Resonance crossing experiments
3) benchmarking of theory with experiments

G. Franchetti

Extreme rings (XRING) – 5.3

example schedule (preliminary):

1st workshop (M12)

magnets and nonlinear beam dynamics. Measurements of multipoles for non-circular chambers. …..
Space charge in diagnostics (IPM, tunes, etc.)…

2nd workshop (M24), SpaceCharge2014

simulations and experiments with high intensity beams

3rd workshop (M36)

topical

4th workshop (M48), SpaceCharge2016

simulations and experiments with high intensity beams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LINAC

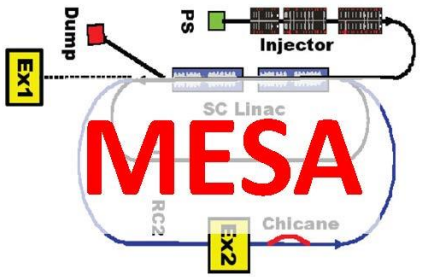
Extreme linacs (XLINAC) – 5.4

objectives & work:

- help **optimize performance of high-power SC linacs** such as **ESS, FRIB, HP-SPL, MYRRHA, MESA, eRHIC, or Project-X**
- study **beam dynamics issues**, e.g. **space charge, beam break up, ion effects, halo generation, beam losses, recirculation aspects,** and **energy recovery**
- ultimate limitations, optimum solutions, beam experiments
- advance crucial **beam diagnostics** like measurements of **beam profile and emittance**
- become **THE European forum for** discussing performance limitations of **high-intensity high-power SC linacs**, and optimizing designs of European SC linac facilities.
- bring together experts in beam dynamics with specialists of SRF and cryogenics to arrive at optimum upgrade solutions

Extreme linacs (XLINAC) – 5.4

projects:



Extreme linacs (XLINAC) – 5.4

example issues:

- ions sources
- high power couplers
- modulators
- cavity failure due to beam loss (SNS)
- increased Field/Yield of SC cavities, XFEL,..

inter-WP issues:

- HOMs and SOMs (WP12.4)
- Reliability and availability (WP4)
- IOTs, other RF sources (WP3.3)

example schedule (preliminary):

- first workshop at ESS some time in November
- other workshops in different labs
- two workshops per year
- at least two workshops per subject (see above)

Extreme linacs (XLINAC) – 5.4

a special message from the XLINAC coordinator:

5 doctoral positions are being opened at ESS [Application deadline 04 September 2013]

The subjects are related to accelerator science, **XLINAC**, and especially to SRF.

Norway guarantees the financial support and ESS chooses the candidates.

Candidates shall apply through the Norwegian web site shown in: http://esss.se/vacancies.

In case of questions please contact Mohammad Eshraqi.


X
EXTREME
BEAM
POL

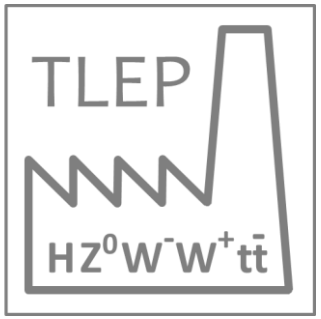
Extreme polarization (XPOL) – 5.5

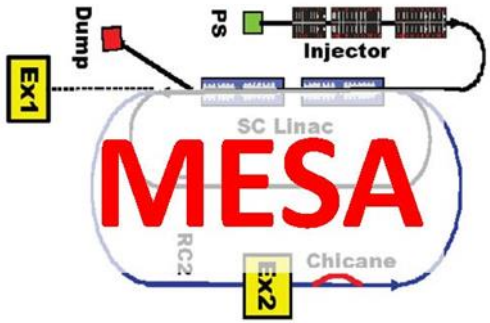
objectives & work:

- help **reach the lepton and hadron beams of highest possible polarization**, for future projects such as **SuperB, LHeC, MESA, TLEP, SAPPHiRE** and **RHIC-II/e-RHIC**
- study **polarized sources**, **preservation of polarization** during acceleration, **spin manipulation**, **depolarization mechanisms**, and **high-accuracy polarimetry**
- ultimate limitations, optimum solutions, beam experiments
- become **THE European forum for** discussing performance limitations of **polarized particle beams**
- bring together experts in beam dynamics with specialists on sources, magnets and beam instrumentation as well as particle physicists and laser experts to arrive at optimum solutions

Extreme polarization (XPOL) – 5.5

projects:





Extreme polarization (XPOL) – 5.5

example issues:

- polarimetry
- Siberian snake schemes
- polarization for hadron beams
- polarization for LHeC
- polarization in SuperKEKB & TLEP
- polarized sources (with WP 5.2)

inter-task issues:

- depolarization e.g. due to beam-beam (with WP 5.2)

draft near-term schedule (preliminary):

- first workshop 16-18 October (TLEP & LEP3) – with WP5.2
- topical workshop on polarimetry in 2014

deliverables :

1. Preliminary strategies, optimization, limitations, paths & parameters for
   - future hadron & lepton colliders;
   - future high-performance hadron rings;
   - future high-power high-current SC linacs; and
   - future polarized beams

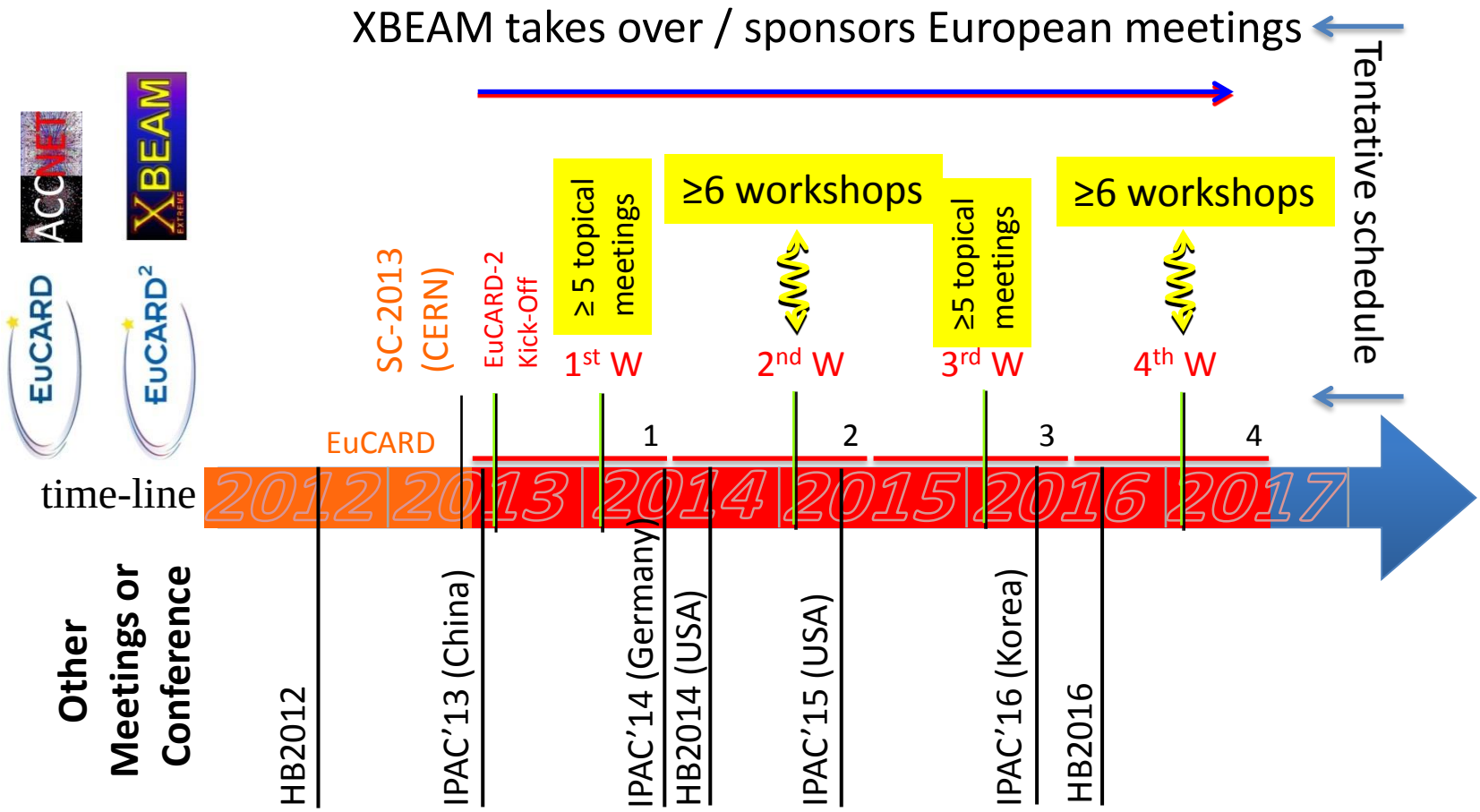
   [month 36]
2. Strategy for
   - future extreme beam facilities;

   [month 48]

milestones :

Milestone name	Work package(s) involved	Expected date	Means of verification
XCOLL topical workshop	5 (Task 5.2)	M12	XCOLL web pages
XRING topical workshop	5 (Task 5.3)	M12	XRING web pages
XLINAC topical workshop	5 (Task 5.4)	M12	XLINAC web pages
XPOL topical workshop	5 (Task 5.5)	M12	XPOL web pages
XCOLL topical workshop	5 (Task 5.2)	M24	XCOLL web pages
XRING topical workshop	5 (Task 5.3)	M24	XRING web pages
XLINAC topical workshop	5 (Task 5.4)	M24	XLINAC web pages
XPOL topical workshop	5 (Task 5.5)	M24	XPOL web pages
XCOLL topical workshop	5 (Task 5.2)	M36	XCOLL web pages
XRING topical workshop	5 (Task 5.3)	M36	XRING web pages
XLINAC topical workshop	5 (Task 5.4)	M36	XLINAC web pages
XPOL topical workshop	5 (Task 5.5)	M36	XPOL web pages
XCOLL topical workshop	5 (Task 5.2)	M48	XCOLL web pages
XRING topical workshop	5 (Task 5.3)	M48	XRING web pages
XLINAC topical workshop	5 (Task 5.4)	M48	XLINAC web pages
XPOL topical workshop	5 (Task 5.5)	M48	XPOL web pages

XBEAM time line & other community meetings



G. Franchetti

next step:

1st XBEAM meeting, room *B*,
tomorrow, Friday 14 June 9:00-12:00

photo courtesy Marica Biagini