Experiments at FCC-ee : feed back from Rome and next steps.

Scope: MDI, physics, phenomenology related to FCC-ee
Summary of information can be found in
the introduction talk of Patrizia Azzi,
concluding talks by Michelangelo and myself.

Main conclusions from ROME meeting on FCC-ee physics

MDI acc-exp working group started and *working* !

-- asymmetric beam crossing has brought SR problem back to real axis

-- soon will be in position to attack magnet integration

-- Luminosity measurement requires attention but problem is well posed

-- detector simulation study (with great help from CLIC work!) started

Detectors and experiments will take usefully all luminosity the machine can give (pile-up< 10^{-3})

-- «baseline» is a good start, more welcome (we won't do anything that prevents it!)

-- discovery potential is in precision measurements, rare decays, invisible width (detector!)

-- top beam energy needs to be set to 185 GeV for top couplings measurements

Continuous beam energy calibration at O(10^{-6}) precision @ Z and W (resonant depolarization)

➔ central to precision measurements

➔ need a joint acc-exp working group to converge on strategy.

No obvious need identified so far for longitudinal polarization at any energy

-- top quark couplings can be measured well using top quark polarization

-- high statistics @ Z (and e.g. final state polarization (tau))
should allow precision on $\sin^2\theta^{lept}_W$ with more than adequate precision < 10^{-5}

-- high luminosity brings much more $\Delta\alpha_{QED}(m_z)$ @ 310^{-5} , $\Delta\alpha_S(m_z)$ @ ~10^{-4}

Monochromatization for s-channel e+e- → Higgs @ 125.2 GeV looks promising (off sessions)

Some of the main Challenges

M. Boscolo

- Synchrotron Radiation is the main constraint for IR design and it drives the IR d
- Feasibility of magnetic system -main detector magnet, final focus elements, investigated, als
- Luminosity mea are part of the IR design challenge: very close to IP
- Accelerator and detector sustair
- Underground infrastructure is a challenge it itself, of course, together with MDI group compatibility with FCC-hh option has t

Good progress and work by M. Sullivan, H. Burkhardt, picked up by E. Perez and A. Kolano

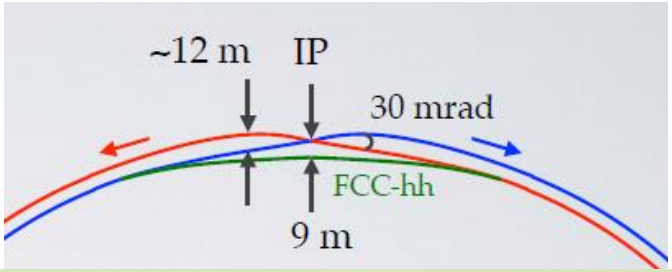
Herman Ten Kate is in charge, but not active yet,
Main parameters of a baseline detector have been given to him some (important) conceptual work was done by Mike Koratzinos, but we must move to the next, professional, level.

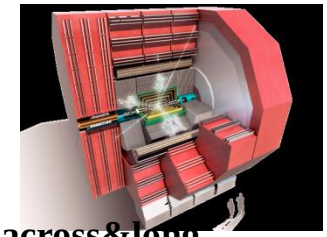
Good progress being made by M. Dam – design requirements for low angle luminomiters with relative precision of 0.1permil have been presented.

Here we have an interesting set of opportunities and constraints due to
-- location of the booster in the cavern
-- shift in position between ee and hh IRs results in loss of space for ee detector

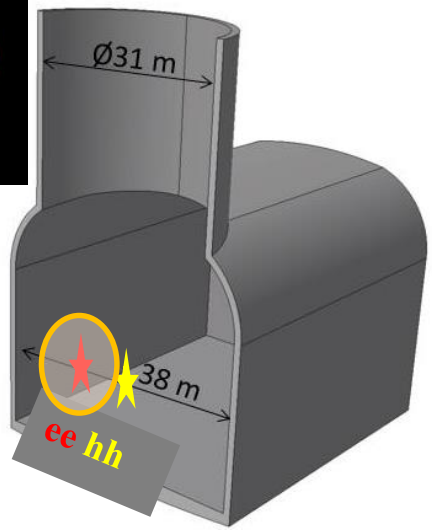
FCC-ee Machine Detector Interface

charge: come up with a plausible design and necessary technical R&D or measurements
Started February 2016; chairs Manuela Boscolo (LNF), Nicola Baccchetta (INFN-Padova/CERN)

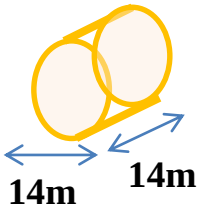




Typical e+e- detector
(ILD, CLIC-SID) is 14m across&long
W. Klempt



Asymmetric IR helps (a lot)
with Synchrotron Radiation
Displaced w.r.t. hh collision point (and cavern?)
leaves 10m between IR and (preliminary) cavern ➔



Constraints on detector:
- **-- small L* ~ O(2m)**
- **-- 30mrad crossing leads to transverse field on the beam => need**
- **-- two beam pipes entering detector + small L* lead to delicate d**
- **-- wrt LC detectors: probably need to reduce magnetic field (2T?**
  ➔ overall size might be wider.
- **-- first studies of beam induced backgrounds taking place.**

Fitting a 14m-wide detector in a 18m-wide space is 'just'
and will become 'very just'
if FCC-hh detector cavern shrinks!
(to be watched)
And what if we would like it bigger?

Towards detector design for FCC-ee

intend to produce two different designs:

-- a baseline design based on an adaption of an ILC or CLIC detector design.

-- a design based on the specific aspects of the FCC-ee, Z factory in particular, probably aimed and long-lived particles and excellent PID for rare decays.
(take advantage as much as possible of large cavern for FCC-hh)

will receive help– very welcome and positive!

-- (2.5 FTE) from CLICDP group

-- two applied fellows to work on

-- the integration of the FCC-ee detector in the interaction region (in particular the lumi detector, but not only) - Supervisor Emmanuel Perez, CMS

-- the full simulation and the geometry of the FCC-ee detector, starting from CLIC existing material - Supervisor Andrea Dell'Acqua, ATLAS

-- We have got one technical student to work the production tool for simulated events (common to FCC-ee and FCC-hh).

Brainstorming meeting foreseen on 4 July by Vidyo conf (G. Rolandi)
Responsibilities not assigned yet. <u>This activity needs to be reinforced and organized</u>.
Aim at organizing dedicated workshop in the fall.

Energy calibration and polarization (A joined accelerator-experiment effort)

-- many important outcomes of FCC-ee physics program are based on the assumption that continuous calibration (every 10' or so) can be realized using resonant depolarization of spectator beams. Precision 100 keV on E_{CM} up to 80 GeV

-- no real objection to the scheme

-- this activity needs to be organized (two drafts already of mandate betwen JW and AB)

What has been achieved so far

-- General study of scheme, use of wigglers and expectations based on LEP (AB, MK, JW)

-- calculations of expected polarization levels Eliana Gianfelice (incl wigglers, orbit corrections and shift between spin tune and energy)

-- This is very high quality work, she understands our needs quite well, and we should absolutely keep her on board.

-- more exotic schemes by I. Kopp. We need to understand realism, cost and usefulness

Memory from LEP is not lost (Guy Wilkinson, AB, MK, Mike Hildreth etc…) but needs to be captured before too long!

FCC-ee Energy and Polarization

The mandate for a joint WG between Accelerator and experiments is being drafted.

WG Priorities:

1. Implement the IP magnetic systems in the simulation to check that they don't kill polarization even in absence of collisions; make sure that they don't kill the relationship between spin tune and energy.

2. Make sure the operation with wigglers is not crazy and that a viable design including dealing with the radiation can be made. (or establish the limits of operating with wigglers)

3. Evaluate the feasibility of running with monitoring bunches.

4. Go over the LEP systematic errors and identify those that would remain in a continuous mode of operation; find/propose the necessary measurements to cure them. (e.g. energy spread measurement)

5. Design the polarimeter setups for e+ and e- and their location in the ring.

Physics Studies Organization

Physics Studies Coordination
A. Blondel, P. Janot (EXP), J. Ellis, C. Grojean (TH)

EW Physics (Z pole)	Diboson Physics (MW)	Higgs Properties	Top Quark Physics
R. Tenchini, F. Piccinini S. Heynmeier, A. Freitas	R. Tenchini, F. Piccinini S. Heynemeier, A. Freitas	M. Klute, K. Peters S. Heynemeier, A. Freitas	P. Azzi, F. Blekman S. Heynemeier, A. Freitas

Synergy with FCC-hh physics, LC physics, LEP physics

QCD and γγ Physics	Flavor Physics	New Physics	Global Analysis,Combination, Complementarity
D. D'Enterria P. Skands	S. Monteil J. Kamenik	M. Pierini, C. Rogan M. McCullough	J. Ellis

Develop the necessary tools

Understand experimental conditions

Offline Sofwtare	Online & Trigger	MDI
C. Bernet, B. Hegner, C. Helsens	C. Leonidopoulos, E. Perez	N. Bacchetta, M. Boscolo

Synergy with FCC-hh, LC, LHC

Joined with FCCee-acc

Detector Design
A. Cattai, M. Dams,
G. Rolandi

Set constraints on possible detector designs to match statistical precision

Synergy with Linear Colliders and others

WG activities

Individual plans of Working groups can be found here
https://indico.cern.ch/event/495687/

-- workshop on QCD (D. d'Enterria & P. Skands) was very successful and published.
now planning a workshop on
'Fragmentation and Jet Structure from LHC to FCC-ee' for 23-25 of November

-- workshop on physics behind precision (feb 2016) proceedings being produced.
-- addresses the important question: why do you need all this luminosity at the Z ?
-- to reach high precision :
-- further theoretical calculations will be necessary (Heinmeyer and Freitas)
-- input for precision can be gained thanks to availability of high statistics.
P. Azzi, F. Blekman, P. Janot et al.

-- «New physics» group (M. Pierini) about to publish write-up.

-- Flavour WG very active. Now focusing on PID; considerable interest in Z factory.

-- top and Higgs working group waiting for full simulation framework to be ready.

-- next Monday: 'what if X750' will discuss impact of possible LHC discovery on FCC-ee

MORE

FIRST LOOK AT PHYSICS CASE OF TLEP has now 218 quotes and counting.
The existence of FCC-ee and hh as machines for the future is now well established in community. (update would be desirable for FCC-ee)

Still: much work to do to enlarge base of support
FCC-ee perception in community is improving, but still quite fuzzy.

Please use attached brochure and point to the following:
The developments of baseline designs for an energy-frontier hadron collider and a luminosity-frontier electron-positron collider form the core of the study.

There is a consensus that an e+e- machine is needed.
-and- ILC not going forward very fast, CEPC not as fast as anticipated…

All time scales similar
FCC-ee accelerator
Technologies are ready.

Need to reinforce theoretical support group
Matthew Mc Cullough is now at CERN for 6 years and enthusiastic, agreed to assist Christophe and John.

Need to ensure presence at conferences to publicise work and capabilities
Speakers board for FCC-ee (Klute, Azzi, Blondel, Grojean)
Please answer when prompted for nominations for talks, dont hesitate to nominate yourself.

Summary

- FCC-ee combines several new concepts invented and successfully demonstrated during the last 20 years
- FCC-ee offers extremely high luminosities in the energy range from *Z* to ttbar; combined w. precise energy calibration at *Z* & *W*
- FCC-ee may serve as spring board for the FCC-hh 100 TeV pp collider, bringing a large tunnel, infastructure, cryogenics, time, addt'l physics motivations + performance goals for FCC-hh
- FCC-ee technology is ready; ongoing R&D aims at further increasing efficiency, making FCC-ee a truly „green accelerator"
- optics fulfils all requirements, matched to FCC-hh footprint, baseline luminosity performance is predicted with confidence
- FCC-ee would provide superb discovery potential & a great first step towards 100 TeV; FCC-ee/hh = powerful combination at EF

Planning

VCs every month for MDI and experiments.

-- next month

4 July detector dedicated VC

18 July MDI VC

25 July Physics VC (incl. reheasals for ICHEP talks)

-- in fall 2016:

-- detector mini-workshop

-- FCC-ee in front of LHC/HL-LHC discovery (phenomenology, November)

-- Fragmentation and Jet Structure from LHC to FCC-ee (23-25 November)

-- Higgs physics workshop

Leading to:

-- end January 2016: FCC-wide physics and detector workshop (in preparation)

and

-- FCC@Berlin in May2017