Physics Coordinator's View on detector optimization

Keisuke Fujii (KEK)

ILD Soft/Opt WS @ DESY, Feb.26, 2016

Priority No.1 = to realize ILC

What we need =

- **clear physics case**

Priority No. 2 = to realize ILD

What we need =

- **detector design, which is cost effective and technically feasible, to realize the physics**

Hurdles to clear

Summary of the ILC Advisory Panel's Discussions to Date

The ILC Advisory Panel

Official English version available from

http://www.mext.go.jp/component/b_menu/shingi/toushin/__icsFiles/afieldfile/2015/08/05/1360596_3.pdf

3. Recommendations

Based on the investigations and reports by the working groups and discussions by the advisory panel, the panel recommends the following on the ILC project;

Recommendation 1: The ILC project requires huge investment that is so huge that a single country cannot cover, thus it is indispensable to share the cost internationally. From the viewpoint that the huge investments in new science projects must be weighed based upon the scientific merit of the project, a clear vision on the discovery potential of new particles as well as that of precision measurements of the Higgs boson and the top quark has to be shown so as to bring about novel development that goes beyond the Standard Model of the particle physics.

- The objective of the ILC project is to uncover physics beyond the Standard Model through the precision measurements of the Higgs boson and top quark and through searches for new particles. In case of new discoveries beyond the Standard Model, its scientific impact on elementary particle physics will be significant.
- As the ILC project requires huge investment, it is indispensable and essential prerequisite for the implementation to have a clear vision of participation and cost sharing by international partners including European countries and the United States while taking into account mid-term and long-term domestic economic and financial situations.
- From the viewpoint the huge investments in new science projects must be weighed based upon the scientific merit of the project, it is necessary to have a clear strategy of the discovery potential of new particles such as supersymmetry particles which are considered as a candidate of the dark matter, in addition to that of precision measurements of the Higgs boson and top quark, has to be shown so as to bring about novel development that goes beyond the Standard Model.
- It is appropriate to proceed discussion on a possible international cost sharing scheme of the ILC project by not only taking into account the scheme used by CERN but also taking into account the schemes of existing large scale international projects such as the International Thermonuclear Experimental Reactor (ITER)[5] and International Space Station (ISS).

Recommendation 2: Since the specifications of the performance and the scientific achievements of the ILC are considered to be designed based on the results of LHC experiments, which are planned to be executed through the end of 2017, it is necessary to closely monitor, analyze and examine the development of LHC experiments . Furthermore, it is necessary to clarify how to solve technical issues and how to mitigate cost risk associated with the project.

- The specifications of the performance and the scientific achievements of the ILC project depend on the results of LHC experiments in the 13TeV run which is currently going on through the end of 2017. Especially whether new particle(s) can be found or not, and what their mass value(s) would be in case of the discovery, will provide important viewpoint for the judgement.
- It is important to show a clear outlook to address technical and cost issues pointed out at the working group discussions.
- It is recommended to further enhance the maximum efforts to incorporate technology development that can improve the accelerator performance.

Recommendation 3: While presenting the total project plan, including not only the plan for the accelerator and related facilities but also the plan for other infrastructure as well as efforts pointed out in Recommendations 1 & 2, it is important to have general understanding on the project by the public and science communities.

5. Future prospects of the investigation

- We will set up another working group to investigate the issue of necessary human resources and their cultivation.
- We will commission another survey using an external research agency in order to understand the world trends in technology issues related to accelerator construction, and in approaches to reduce the production cost of accelerators.

We need to demonstrate that ILC will advance our understanding of particle physics qualitatively beyond the information that will be available from the results expected from the future stages of the LHC.

We need to be prepared for LHC Run2 results.

Actions to be taken

- LCB and ICFA agreed to send explanations on the following three points to the ILC Panel. Draft has been submitted from the Japanese community to LCB.
  - **… a clear vision on the discovery potential of new particles …**
  - **… It is appropriate to proceed discussion on a possible international cost sharing scheme of the ILC project …**
  - **… solve technical issues and how to mitigate cost risk associated with the project. …**
- **… it is necessary to closely monitor, analyze and examine the development of LHC experiments.**
  - Surely will do.
- **… general understanding on the project by the public and science communities.**
  - Public relation will be reinforced by KEK and AAA.
  - Discussions with scientists of the other fields have been undertaken.

Letter from ICFA to the ILC Advisory Panel of MEXT

Since the “Interim Summary” was translated in English for the international community, and there are so many open issues raised in this Summary, ICFA decided to write a letter to the Panel.
The Panel opened the Summary of their discussions but they did not ask anything to the international community, the purpose of the ICFA letter is just to clarify and to explain the issues raised in the Summary. KEK and Japanese ILC community is preparing the daft in cooperating with LCC and LCB.

Panel made recommendations to MEXT, not us!

0) Preface (based on request from KEK DG)

Appreciation of Panel’s work

“First of all, we would like to express our profound gratitude to the members of the ILC Advisory Panel for seriously considering, in response to a request from the Japanese government, the various issues concerning the hosting of ILC in Japan, which is being promoted by the international community of elementary particle physicists. …..”

High-brow discussions on scope of our field beyond the Panel’s Report
Social effects of fundamental science like ILC and the role of ICFA
Composition of this document

LCC Physics WG is planning to prepare a longer report to backup the ICFA letter by the end of the coming summer.

We (ILD) need to provide materials to be included in the report.

the physics analysis working group in ILD is very active…

ILD Physics and Detector Optimisation Studies										
Analysis Contact	**email**	**supervisor/collaborator**	**institute**	**Topic**	**ECM**	**Full / Fast**	**Status**	**last present.**	**Asian meeting**	**Comment**
Physics Analyses										
Abhinav Dubey	abhinav@epx.phys.tohoku.ac.jp		Tohoku	Heavy Higgs search (Neutral)	500/1000	Full Sim	abandonned	Jan-07	Feb-06	e+e- ? HA ? 4b
Akimasa Ishikawa	akimasa@epx.phys.tohoku.ac.jp		Tohoku	H-->Invisible	250 /350 / 500	Full Sim	almost done	Nov-19		almost done
Alexey Drutskoy	Drutskoy@itep.ru		ITEP	H->tautau CP	?	?	planned			
Ali Ebrahimi	aliakbar.ebrahimi@desy.de	JL	DESY	Higgs mass from H->bb	500	Full Sim	just started			
Brian van Doren			Kansas U	?						
Claude Duerig	claude.duerig@desy.de	JL	DESY	ee->ZHH, 2x H->bb	500	FullSim	ongoing	Nov-26		Kinfit, ME, Jet Finding
Daniel Jeans	jeans@icepp.s.u-tokyo.ac.jp		Tokyo	H->tautau CP	500	FullSim	ongoing		Dec 12	Kinfit, angular reco
Davide Mellini		Marcel Vos / LAL	IFIC	ttH	600 !	?	planned			currently working on ttH at ATLAS
Emi Kou		Francois LeDiberder	LAL	HO ew corrections ttbar prod		Pheno	ongoing			Whizard / Madgraph interface…?
Felix Mueller	felix.johannes.mueller@desy.de	JL	DESY	ee-> nunu H, BRs & ZH/WW	350	FullSim	almost done	Nov-26		
Graham Wilson			Kansus U	W mass measurement	161/350/500	?				
Hale Sert	hale.sert@desy.de	JL	DESY	Light Higgsinos, dM <= 1 GeV	500	SGV & FullSim	ongoing	Oct 22		has to hand-in thesis in early 2015
Hiroaki Ono	ono@ngt.ndu.ac.jp	Akiya	NDU	Higgs BR, Z->ll,qq	250/350	FullSim	ongoing			H-->bb,cc,gg & H-->WW*, updating with mH=125GeV
Jacqueline Yan	rinrin84@gmail.com	Daniel Jenas	Tokyo	Higgs leptonic recoil	350	FullSim	ongoing		Mar 13	comparison with 250 GeV, next focus on mass
Junping Tian	tianjp@post.kek.jp	Keisuke/Claude/Jenny	KEK	ee->vvHH, 2x H-->bb	1000	Full Sim	almost	Feb-18	Feb-20	need be updated to mH=125GeV, being considered as one early publication
Junping Tian	tianjp@post.kek.jp	Keisuke	KEK	vvH with H-->bb, WW*, ZZ*	500	Full Sim	almost			For total width study, only full hadronic decay of ZZ* remains to be done
Junping Tian	tianjp@post.kek.jp	Keisuke	KEK	H->invis Z-> leptonic	500	Full Sim	done			For total width study, only full hadronic decay of ZZ* remains to be done
Junping Tian	tianjp@post.kek.jp	Keisuke	KEK	ZZ-fusion production eeH	500	Full Sim	ongoing			H-->bb done, going to explore anomalous HZZ coupling, particularly CP violation effect
Koya Tsuchimoto	tsuchimoto@azusa.shinshu-u.ac.jp	Katsushige	Shinshu	single W process, W mass and TGC	250/500	Full Sim	ongoing	Jan-21	Feb-27	motivated by impact of ScECAL on JER, going to be a master project
Madalina Chera	madalina.chera@desy.de	JL	DESY	SUSY Point 5 chi->Z/W->qq	500	FullSim & SGV	ongoing	Feb-18		Comparison LoI, DBD, SGV
Marça Boronat		Marcel Vos / LAL	IFIC	top mass in continuum	500	Gen. Level	ongoing			new method, ~ 6 months
Marcel Vos			IFIC	top couplings	500	FullSim	ongoing			Jet finding
Mark Thomson	thomson@hep.phy.cam.ac.uk		Cambridge	Higgs hadronic recoil & invis	250/500	FullSim	done			
Mark Thomson	thomson@hep.phy.cam.ac.uk		Cambridge	Higgs hadronic recoil & invis	350	FullSim	done	Oshu		publication in prep
Martin Perelló		Marcel Vos / LAL	IFIC	single top, A_FB at threshold	350	FullSim	ongoing			take over from Nacho
Masakazu Kurata	kurata@icepp.s.u-tokyo.ac.jp		Tokyo	ZHH, HH->WWbb	500	FullSim	ongoing		Feb-27	PID, jet pairing, kin fit!
Mikael Berggren	mikael.berggren@desy.de		DESY	Sleptons, reco and disc. reach	500/ …	SGV	ongoing	Dec 10		incl. selectrons from S.Caiazza
Moritz Habermehl	moritz.habermehl@desy.de	JL	DESY	modelindep WIMPs	350/500	FullSIm & extrap	starting	Nov-19		Taking over from A.Chaus, focus on systematics
Nacho Garcia		Marcel Vos / LAL	IFIC	top quark couplings to gamma and Z	500	FullSim	almost done	Dec 10		arXiv
PhD MPI			MPI	tbd						
Postdoc MPI			MPI	tbd						
Rashid Mehdiyev	Rashid.Mehdiyev@carleton.ca	Alain Bellerive	Carleton	H->mumu	350/500	SGV	starting			
Shin-ichi Kawada	s-kawada@huhep.org	Taikan / Tomohiko	Hiroshima	H-->tautau	250/500	Full Sim	almost	Nov-19	Feb-06	updating with mH=125 GeV
Shun Watanuki	watanuki@epx.phys.tohoku.ac.jp	Jan	Tohoku	CP mixture in leptonic recoil	250	FullSim	ongoing	Nov-05		Fitting techniques, systematic error of mass, CP
Shun Watanuki	watanuki@epx.phys.tohoku.ac.jp	Jan	Tohoku	Higgs recoil mass	250	FullSim	done	Nov-05		Fitting techniques, systematic error of mass, CP
Sviatoslav Bilokin	bilokin@lal.in2p3.fr	Roman Poeschl, Dirk Zerwas	LAL	top couplings	500	FullSIm	ongoing			title of thesis: "Top quark production at the ILC and optimisation of Particle Flow Algorithm
Takuaki Mori	takuaki@icepp.s.u-tokyo.ac.jp	Tomohiko	Tokyo	Radiative Natural SUSY benchmark	500	Fast/FullSim	starting			input for gaugino mass unification plot
Tatsuhiko Tomita	tomita@epp.phys.kyushu-u.ac.jp	Taikan	Kyushu	Higgs hadronic recoil	250 / 350 ?	FullSim	ongoing	Mar 4		ISR tagging, cut opt for model independency / LEAVING?
Tino Calancha	calancha@post.kek.jp	Akiya	KEK	H-->mumu, H-->gam gam	250/500/1000	Full Sim	ongoing		Feb-20	now mainly on H-->gam gam at 250 GeV, and H-->mumu at 250 and 500 GeV
Tomohiko Tanabe	tomohiko@icepp.s.u-tokyo.ac.jp		Tokyo	electroweakino scan	500	SGV	ongoing			need scan points
Tomohisa Ogawa	ogawat@post.kek.jp	Junping / Keisuke	KEK	Higgs recoil mass	250/350	SGV	ongoing			PhD project
Tomohisa Ogawa	ogawat@post.kek.jp	Junping / Keisuke	KEK	anomalous HVV coupling	?	Physsim?	ongoing		Mar 13	PhD project
Yorgos Voutsinas	georgios.voutsinas@desy.de	JL/FG	DESY	Light Higgsinos, dM <= 1 GeV	500	FullSim	starting			Taking over from Hale, focussing on VXD requirements
Yuji Sudo	sudo@phys.kyushu-u.ac.jp	Taikan	Kyushu	ttH	500	FullSim	ongoing			looking at systematics, cut opt / MVA
Yuko Shinzaki	shinzaki@epx.phys.tohoku.ac.jp	Jan / Akimasa	Tohoku	Charged Higgs search	250	Full Sim	ongoing		Jan-15	e+e- ? WH ? W(WZ) / GONE TO INDUSTRY
Trong Hieu	trong.hieu.tran@llr.in2p3.fr	Vincent Boudry	LLR	tau reconstruction in ee->Z->tau tau		Full Sim	ongoing			
Imad Laktineh	imad.baptiste.laktineh@cern.ch		Lyon	ZZ, WW production	?	?	planned			SDHCal
Imad Laktineh	imad.baptiste.laktineh@cern.ch		Lyon	ee->ZH->fully hadronic	?	?	planned			SDHCal
Detector Optimisation										
Benjamin Boitrelle	benjamin.boitrelle@desy.de	IM Gregor	DESY	VXD time/point res optimisation	350	FullSim	starting			Physics benchmark: H->ccbar
Dan Yu	dan.yu@llr.in2p3.fr	Vincent Boudry	LLR	ECAL optimization		Full Sim	ongoing			
Hiroki Sumida		Taikan	Kyushu	Ecal Layer Opt		Full Sim	ongoing	Jan-14		
Mikael Berggren	mikael.berggren@desy.de	JL	DESY	Tracker optimisation		SGV	ongoing	Feb-11		
Sergei Schuwalow			DESY	FCal Opt				Jan-07		
Steven Green		Mark Thomson	Cambridge	HCal optimisation		FullSim	ongoing	Jan-14		
Tino Calancha	calancha@post.kek.jp	Akiya	KEK	photon energy resolution, momentum resolution	500/1000	Full Sim	ongoing			Physics benchmark: H->gammagamma, H-->mumu
Tomohisa Ogawa	ogawat@post.kek.jp	Junping / Keisuke	KEK	SiW vs SciW ECAL, TPC radius	250/350	Full Sim / SGV	almost done	Nov-12		Physics benchmark: H->invisible, leptonic recoil with various TPC radius (SGV); continue
Yorgos Voutsinas	georgios.voutsinas@desy.de	JL/FG	DESY	VXD time/point res optimisation	500	FullSim	starting			Physics benchmark: light Higgsinos
Reconstruction & Analysis Tools										
Bo Li		Keisuke	Tsinghua	KalTest		FullSim	ongoing	Jan-21		inhomogeneous B-Field
Brian van Doren		Graham	Kansas U	pi0 reconstruction		FullSIm	ongoing			application: eg Higgs mass reco
		Frank Gaede	DESY	aidaTT tracking		FullSim	ongoing	Nov-05		
Dan Yu	dan.yu@llr.in2p3.fr	Vincent Boudry	LLR	Particle ID development		Full Sim	ongoing			
Daniel Jeans	jeans@icepp.s.u-tokyo.ac.jp		Tokyo	Garlic		FullSim	maintenance			
Daniel Jeans	jeans@icepp.s.u-tokyo.ac.jp		Tokyo	tau fitting		FullSim	maintenance			
Daniel Jeans	jeans@icepp.s.u-tokyo.ac.jp		Tokyo	pi0 reconstruction		FullSim	ongoing	Jan-07		
Eldwan Brianne	eldwan.brianne@desy.de	MB	DESY	Particle Flow in SGV		FullSim & SGV	ongoing			paused due to Calice testbeam
Frank Gaede			DESY	DD4HEP		FullSim	ongoing	Nov-05		
Hale Sert	hale.sert@desy.de	JL	DESY	mu/pi separation for E<2 GeV	500	FullSim	done	Mar 4		has to hand-in thesis in early 2015
Junping Tian	tianjp@post.kek.jp	Keisuke	KEK	matrix element package (physsim)		Full Sim	ongoing			implement major LCME class in SM, support anomalous coupling, more development on c
Junping Tian	tianjp@post.kek.jp	Keisuke	KEK	overlay removal, seed based	1 TeV	Full Sim	ongoing		Feb-06	for nunuHH at 1TeV
Junping Tian	tianjp@post.kek.jp	Keisuke	KEK	realistic color singlet jet clustering		Full Sim	ongoing			Mini-jet based, incorporating new Geogi Algorithm
Marcel Vos	marcel.vos@cern.ch		IFIC	systematic uncertainties			just started	Feb-11		
Mark Thomson		NN? Masakazu???	Cambridge	Pandora PFA		FullSIm	maintenance			
Masakazu Kurata	kurata@icepp.s.u-tokyo.ac.jp		Tokyo	dE/dx and Calo PiD	500	FullSim	ongoing	Oct 1		physics benchmark:ZHH
Masakazu Kurata	kurata@icepp.s.u-tokyo.ac.jp	Tomohiko/ Taikan / Jan	Tokyo	LCFI			ongoing			
Masakazu Kurata	kurata@icepp.s.u-tokyo.ac.jp		Tokyo	vertex charge, pi0 attach	500	FullSim	ongoing			physics benchmark:ZHH, tt
Mikael Berggren	mikael.berggren@desy.de		DESY	Colour Singlet Truth Jet Finder			done	Oct 1		will be in next release, physics appl: ZHH ADAPT TO HIGGS SAMPLES
Mikael Berggren	mikael.berggren@desy.de		DESY	SGV Maintenance		SGV	stable			several improvements in pipeline
Moritz Habermehl	moritz.habermehl@desy.de	MB	DESY	Whizard 2 comissioning			ongoing			new GuineaPig interface, physics appl: WIMPs
Nacho Garcia		Marcel Vos / LAL	IFIC	Jet reconstruction	500	FullSim	ongoing			application: top couplings
Shaojun Lu		Tino Calancha	DESY/KEK	MC Production				Feb-04		
Sviatoslav Bilokin	bilokin@lal.in2p3.fr	Roman Poeschl, Dirk Zerwas	LAL	b jet charge	500	FullSIm	ongoing	Feb-11		application: top couplings
Sviatoslav Bilokin	bilokin@lal.in2p3.fr	Roman Poeschl, Dirk Zerwas	LAL	Matrix element method	500	FullSIm	plan			application: top couplings
Sviatoslav Bilokin	bilokin@lal.in2p3.fr	Roman Poeschl, Dirk Zerwas	LAL	PFA development		FullSIm	plan			improving PandoraPFA
Taikan Suehara	suehara@phys.kyushu-u.ac.jp	Shin-ichi	Kyushu	tau finder	250/500	Full Sim	almost			optimization
Tino Calancha	calancha@post.kek.jp	Akiya	KEK	Covarince matrix of four momentum, event by event mass resolution		Full Sim	ongoing			done for charged track in H-->mumu, can start for H-->gam gam
Yorgos Voutsinas	georgios.voutsinas@desy.de	FG	DESY	mini-vector tracking in VDX/SIT		FullSim	nearly done			
Yorgos Voutsinas	georgios.voutsinas@desy.de	FG	DESY	ILD Performance		FullSim	ongoing	Feb-18		
	PFA -> write email to Mark									

the physics analysis working group in ILD is very active…

ILD Physics and Detector Optimisation Studies										
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Akimasa Ishikawa	akimasa@epx.phys.tohoku.ac.jp		Tohoku	H-->Invisible	250 /350 / 500	Full Sim	almost done	Nov-19		almost done
Alexey Drutskoy	Drutskoy@itep.ru		ITEP	H->tautau CP	?	?	planned			
Ali Ebrahimi	aliakbar.ebrahimi@desy.de	JL	DESY	Higgs mass from H->bb	500	Full Sim	just started			
Brian van Doren			Kansas U	?						
Claude Duerig	claude.duerig@desy.de	JL	DESY	ee->ZHH, 2x H->bb	500	FullSim	ongoing	Nov-26		Kinfit, ME, Jet Finding
Daniel Jeans	jeans@icepp.s.u-tokyo.ac.jp		Tokyo	H->tautau CP	500	FullSim	ongoing		Dec 12	Kinfit, angular reco
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Emi Kou		Francois LeDiberder	LAL	HO ew corrections ttbar prod		Pheno	ongoing			Whizard / Madgraph interface…?
Felix Mueller	felix.johannes.mueller@desy.de	JL	DESY	ee-> nunu H, BRs & ZH/WW	350	FullSim	almost done	Nov-26		
Graham Wilson			Kansus U	W mass measurement	161/350/500	?				
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Jacqueline Yan	rinrin84@gmail.com	Daniel Jenas	Tokyo	Higgs leptonic recoil	350	FullSim	ongoing		Mar 13	comparison with 250 GeV, next focus on mass
Junping Tian	tianjp@post.kek.jp	Keisuke/Claude/Jenny	KEK	ee->vvHH, 2x H-->bb	1000	Full Sim	almost	Feb-18	Feb-20	need be updated to mH=125GeV, being considered as one early publication
Junping Tian	tianjp@post.kek.jp	Keisuke	KEK	vvH with H-->bb, WW*, ZZ*	500	Full Sim	almost			For total width study, only full hadronic decay of ZZ* remains to be done
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Koya Tsuchimoto	tsuchimoto@azusa.shinshu-u.ac.jp	Katsushige	Shinshu	single W process, W mass and TGC	250/500	Full Sim	ongoing	Jan-21	Feb-27	motivated by impact of ScECAL on JER, going to be a master project
Madalina Chera	madalina.chera@desy.de	JL	DES							Comparison LoI, DBD, SGV
Marça Boronat		Marcel Vos / LAL	IFIC							new method, ~ 6 months
Marcel Vos			IFIC							Jet finding
Mark Thomson	thomson@hep.phy.cam.ac.uk		Cam							
Mark Thomson	thomson@hep.phy.cam.ac.uk		Cam							publication in prep
Martin Perelló		Marcel Vos / LAL	IFIC							take over from Nacho
Masakazu Kurata	kurata@icepp.s.u-tokyo.ac.jp		Tok							PID, jet pairing, kin fit!
Mikael Berggren	mikael.berggren@desy.de		DES							incl. selectrons from S.Caiazza
Moritz Habermehl	moritz.habermehl@desy.de	JL	DES							Taking over from A.Chaus, focus on systematics
Nacho Garcia		Marcel Vos / LAL	IFIC							arXiv
PhD MPI			MPI							
Postdoc MPI			MPI							
Rashid Mehdiyev	Rashid.Mehdiyev@carleton.ca	Alain Bellerive	Car							
Shin-ichi Kawada	s-kawada@huhep.org	Taikan / Tomohiko	Hiro							updating with mH=125 GeV
Shun Watanuki	watanuki@epx.phys.tohoku.ac.jp	Jan	Toh							Fitting techniques, systematic error of mass, CP
Shun Watanuki	watanuki@epx.phys.tohoku.ac.jp	Jan	Toh							Fitting techniques, systematic error of mass, CP
Sviatoslav Bilokin	bilokin@lal.in2p3.fr	Roman Poeschl, Dirk Zerwas	LAL							title of thesis: "Top quark production at the ILC and optimisation of Particle Flow Algorithm
Takuaki Mori	takuaki@icepp.s.u-tokyo.ac.jp	Tomohiko	Tok							input for gaugino mass unification plot
Tatsuhiko Tomita	tomita@epp.phys.kyushu-u.ac.jp	Taikan	Kyu							ISR tagging, cut opt for model independency / LEAVING?
Tino Calancha	calancha@post.kek.jp	Akiya	KEK							now mainly on H-->gam gam at 250 GeV, and H-->mumu at 250 and 500 GeV
Tomohiko Tanabe	tomohiko@icepp.s.u-tokyo.ac.jp		Tok							need scan points
Tomohisa Ogawa	ogawat@post.kek.jp	Junping / Keisuke	KEK							PhD project
Tomohisa Ogawa	ogawat@post.kek.jp	Junping / Keisuke	KEK							PhD project
Yorgos Voutsinas	georgios.voutsinas@desy.de	JL/FG	DES							Taking over from Hale, focussing on VXD requirements
Yuji Sudo	sudo@phys.kyushu-u.ac.jp	Taikan	Kyu							looking at systematics, cut opt / MVA
Yuko Shinzaki	shinzaki@epx.phys.tohoku.ac.jp	Jan / Akimasa	Toh							e+e- ? WH ? W(WZ) / GONE TO INDUSTRY
Trong Hieu	trong.hieu.tran@llr.in2p3.fr	Vincent Boudry	LLR							
Imad Laktineh	imad.baptiste.laktineh@cern.ch		Lyo							SDHCal
Imad Laktineh	imad.baptiste.laktineh@cern.ch		Lyo							SDHCal
Detector Optimisation										
Benjamin Boitrelle	benjamin.boitrelle@desy.de	IM Gregor	DES							Physics benchmark: H->ccbar
Dan Yu	dan.yu@llr.in2p3.fr	Vincent Boudry	LLR							
Hiroki Sumida		Taikan	Kyu							
Mikael Berggren	mikael.berggren@desy.de	JL	DES							
Sergei Schuwalow			DES							
Steven Green		Mark Thomson	Cam							
Tino Calancha	calancha@post.kek.jp	Akiya	KEK							Physics benchmark: H->gammagamma, H-->mumu
Tomohisa Ogawa	ogawat@post.kek.jp	Junping / Keisuke	KEK							Physics benchmark: H->invisible, leptonic recoil with various TPC radius (SGV); continue
Yorgos Voutsinas	georgios.voutsinas@desy.de	JL/FG	DES							Physics benchmark: light Higgsinos
Reconstruction & Analysis Tools										
Bo Li		Keisuke	Tsin							inhomogeneous B-Field
Brian van Doren		Graham	Kan							application: eg Higgs mass reco
		Frank Gaede	DES							
Dan Yu	dan.yu@llr.in2p3.fr	Vincent Boudry	LLR							
Daniel Jeans	jeans@icepp.s.u-tokyo.ac.jp		Tok							
Daniel Jeans	jeans@icepp.s.u-tokyo.ac.jp		Tok							
Daniel Jeans	jeans@icepp.s.u-tokyo.ac.jp		Tok							
Eldwan Brianne	eldwan.brianne@desy.de	MB	DES							paused due to Calice testbeam
Frank Gaede			DES							
Hale Sert	hale.sert@desy.de	JL	DES							has to hand-in thesis in early 2015
Junping Tian	tianjp@post.kek.jp	Keisuke	KEK							implement major LCME class in SM, support anomalous coupling, more development on
Junping Tian	tianjp@post.kek.jp	Keisuke	KEK							for nunuHH at 1TeV
Junping Tian	tianjp@post.kek.jp	Keisuke	KEK							Mini-jet based, incorporating new Geogi Algorithm
Marcel Vos	marcel.vos@cern.ch		IFIC							
Mark Thomson		NN? Masakazu???	Cam							
Masakazu Kurata	kurata@icepp.s.u-tokyo.ac.jp		Tok							physics benchmark:ZHH
Masakazu Kurata	kurata@icepp.s.u-tokyo.ac.jp	Tomohiko/ Taikan / Jan	Tok							
Masakazu Kurata	kurata@icepp.s.u-tokyo.ac.jp		Tok							physics benchmark:ZHH, tt
Mikael Berggren	mikael.berggren@desy.de		DES							will be in next release, physics appl: ZHH ADAPT TO HIGGS SAMPLES
Mikael Berggren	mikael.berggren@desy.de		DESY	SGV Maintenance		SGV	stable			several improvements in pipeline
Moritz Habermehl	moritz.habermehl@desy.de	MB	DESY	Whizard 2 comissioning			ongoing			new GuineaPig interface, physics appl: WIMPs
Nacho Garcia		Marcel Vos / LAL	IFIC	Jet reconstruction	500	FullSim	ongoing			application: top couplings
Shaojun Lu		TIno Calancha	DESY/KEK	MC Production				Feb-04		
Sviatoslav Bilokin	bilokin@lal.in2p3.fr	Roman Poeschl, Dirk Zerwas	LAL	b jet charge	500	FullSIm	ongoing	Feb-11		application: top couplings
Sviatoslav Bilokin	bilokin@lal.in2p3.fr	Roman Poeschl, Dirk Zerwas	LAL	Matrix element method	500	FullSIm	plan			application: top couplings
Sviatoslav Bilokin	bilokin@lal.in2p3.fr	Roman Poeschl, Dirk Zerwas	LAL	PFA development		FullSIm	plan			improving PandoraPFA
Taikan Suehara	suehara@phys.kyushu-u.ac.jp	Shin-ichi	Kyushu	tau finder	250/500	Full Sim	almost			optimization
Tino Calancha	calancha@post.kek.jp	Akiya	KEK	Covarince matrix of four momentum, event by event mass resolution		Full Sim	ongoing			done for charged track in H-->mumu, can start for H-->gam gam
Yorgos Voutsinas	georgios.voutsinas@desy.de	FG	DESY	mini-vector tracking in VDX/SIT		FullSim	nearly done			
Yorgos Voutsinas	georgios.voutsinas@desy.de	FG	DESY	ILD Performance		FullSim	ongoing	Feb-18		
	PFA -> write email to Mark									

47 physics analyses

+

9 det. opt. analyses

+

29 analyses on tools

Junping Tian @ LCWS15

all analyses are motivated to answer some of the questions

physics case

1. ultimate precision reach in Higgs and top couplings? (deviation -> new physics + scale; pattern -> BSM fingerprint)
2. can we discover new particles and its nature? (extra Higgs, SUSY, composite, dark matter, Z')
3. can we precisely know the radiative correction? (mH, mt, mw, α s)

detector optimisation

4. impact of detector size, granularity, B-field, etc.? (impact on physics performance)
5. can we justify our sub-detector technologies from physics point of view? (e.g. TPC)
6. can we control systematics? (calibration of ecm, p, JES, flavour tagging eff.)

accelerator properties

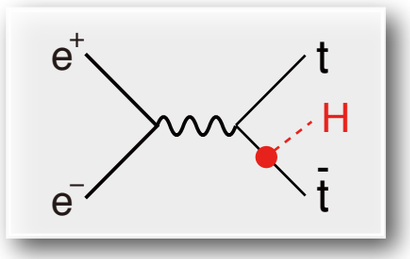
7. impact of centre-of-mass energies? (optimal running)
8. impact of beam polarisations?
9. impact of beam induced backgrounds?

The detector optimization should constructively interfere with the physics studies!

The detector optimization must be performed with the best high level reconstruction tools!
Otherwise we might end up with compromising physics.

Top Yukawa and Self-coupling!

$e^+e^- \to t\bar{t}h$



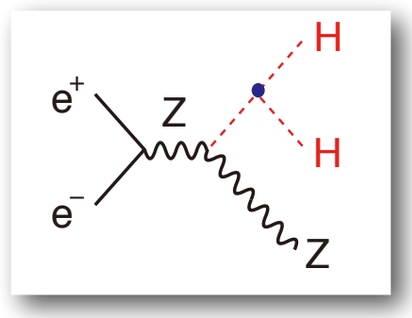
Direct coupling measurements, no Γ_h enters here.

evaluation space parameters

$$\boxed{\sigma \times BR} \to \sigma = (\sigma \times BR)/BR \to \textbf{coupling}$$

Self-coupling measurement is very difficult.
We need to muster all the possible improvements here!

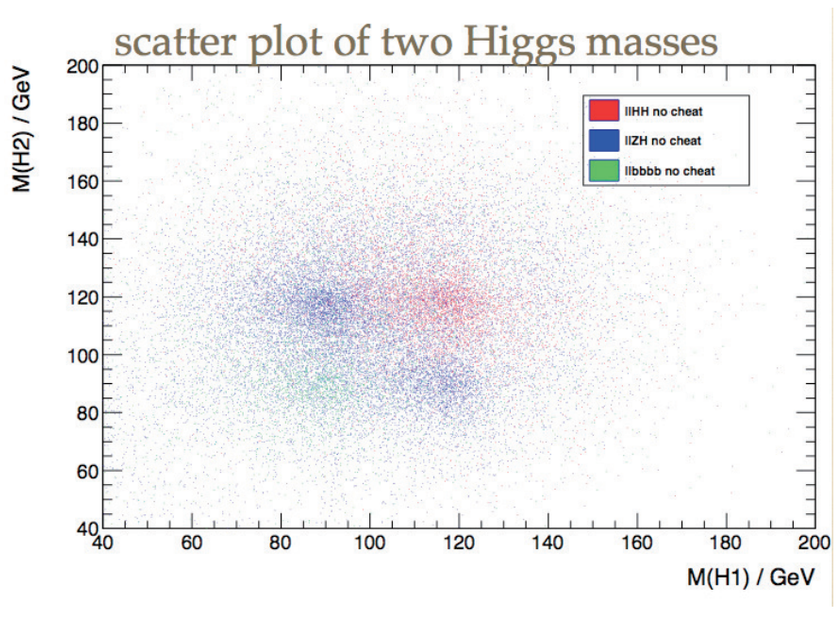
$e^+e^- \to Zhh$

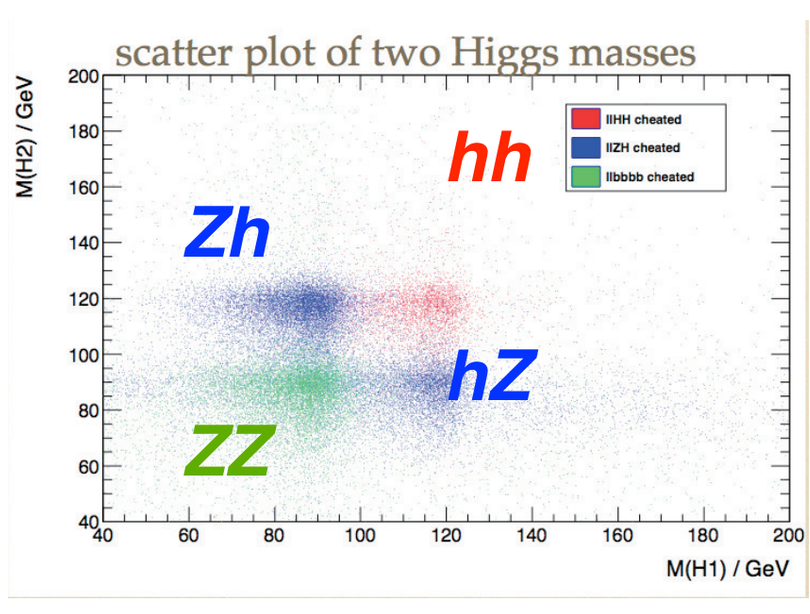


b-tagging

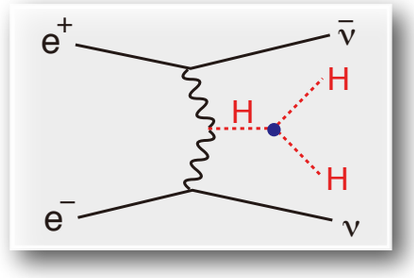
lepton ID

Jet clustering limits M_{JJ} resolution now





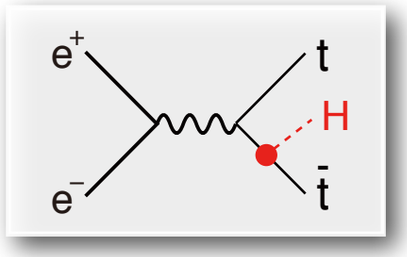
$e^+e^- \to \nu\bar{\nu}hh$



but, potentially room for 40% improvement here!

Top Yukawa and Self-coupling!

$e^+e^- \to t\bar{t}h$



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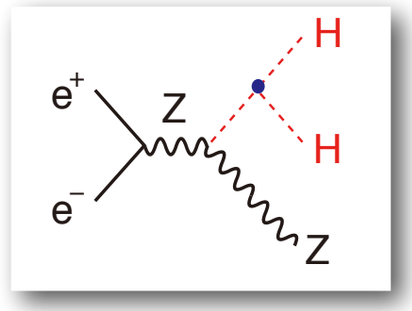
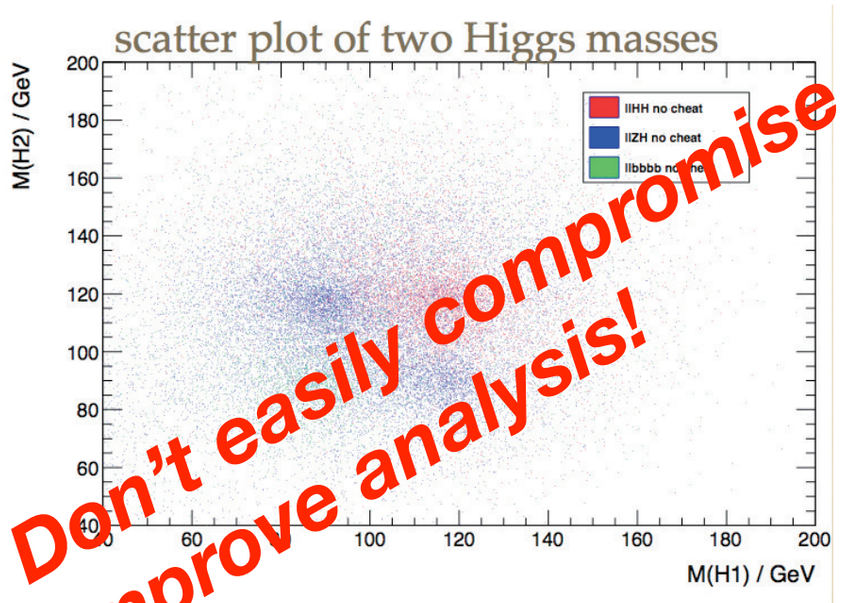


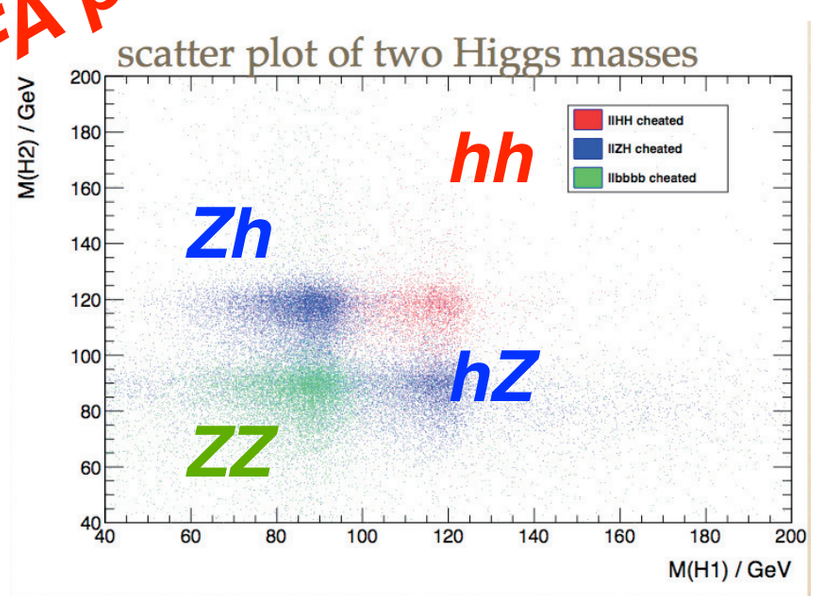
b-tagging

lepton ID

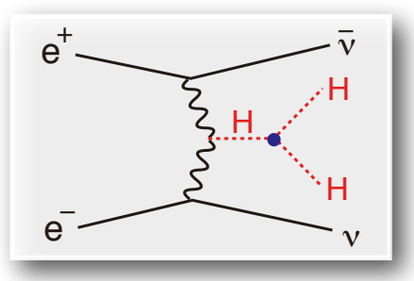
Jet clustering limits M_{JJ} resolution now

Don't easily compromise PFA performance!
Improve analysis!





$e^+e^- \to \nu\bar{\nu}hh$



but, potentially room for 40% improvement here!

Optimization Space

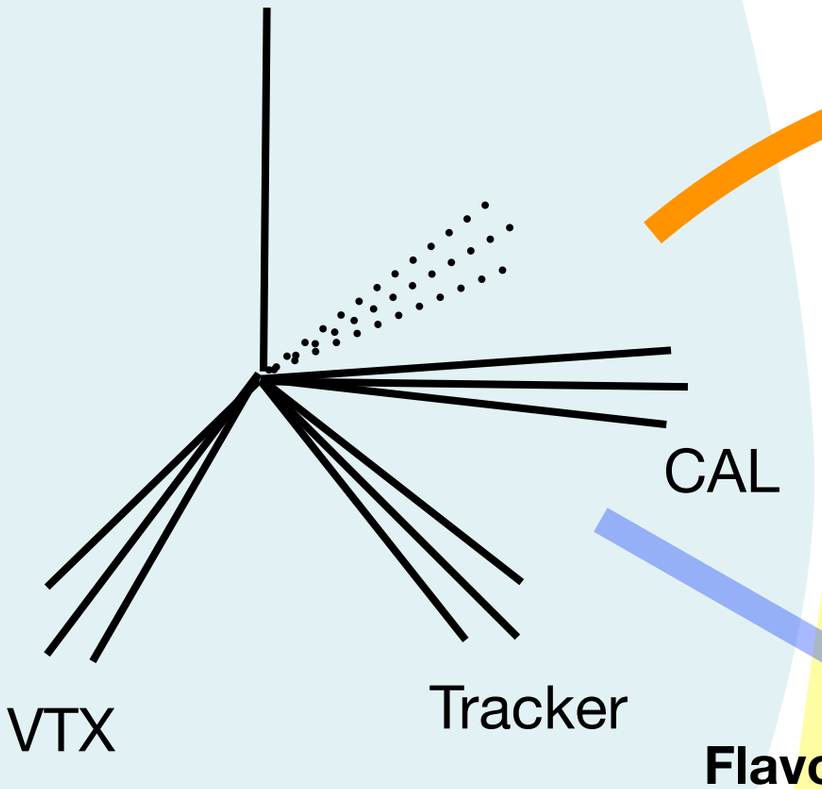
physics-driven optimization

Global parameters

R, L (CAL), θ_{min}, ...

B-field

Material budget



Local, detector component parameters

Internal & scale-invariant

Technology choice

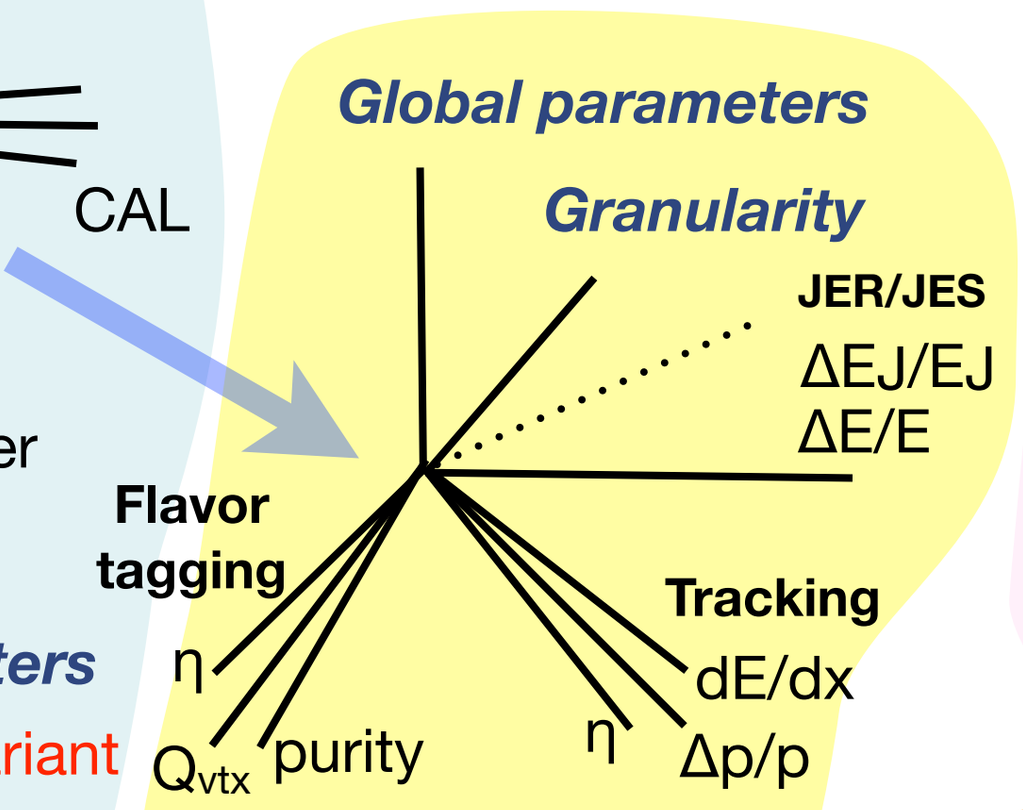
detailed design

Make them as orthogonal or diagonal as possible !

Optimization (grid search) based on finite number of detector models

Full simulation

Global parameters



Detector Performance Aspects

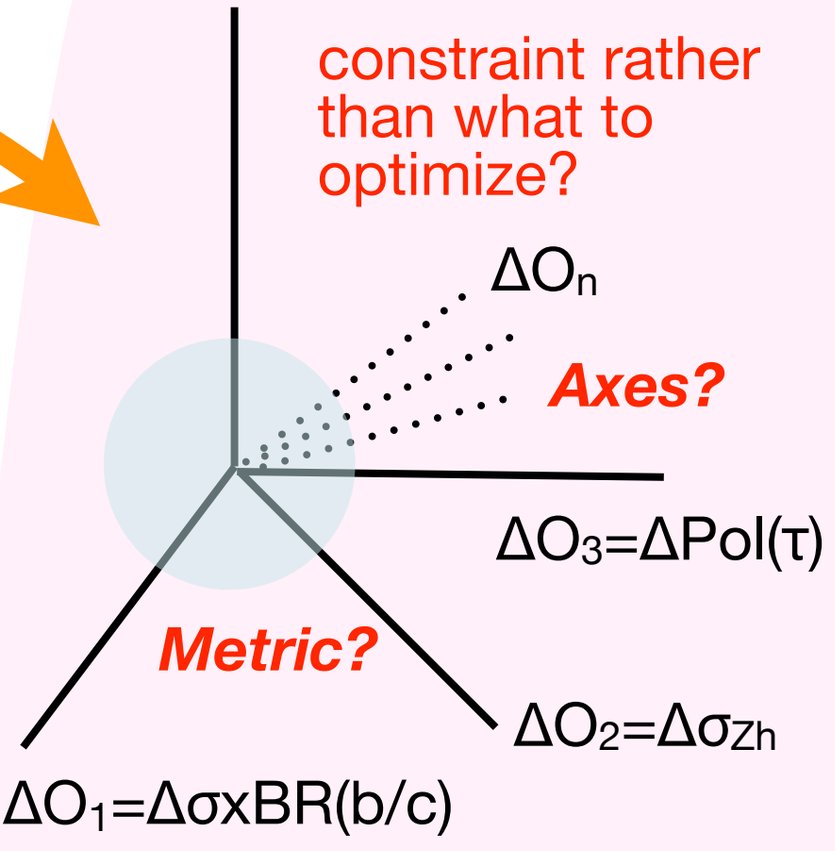
Flavor tag, PID, low Pt tracking, …

Fast Simulation

parametric study

Cost = fn(R,L,granularity,..)

constraint rather than what to optimize?



Physics performance

Benchmark ***observables*** for evaluation

New benchmark?

→***Mikael's talk on detector benchmarks***

The observable axes of the evaluation space should be chosen based on physics and the metric has to be defined so as to give higher weight to the axes of higher importance in terms of physics (Precision Higgs & Top, BSM searches)

But in practice it is impossible to do all the analyses for all the grid points in the detector optimization space.

Personal Choice as of ALCW14

- ***Select the most demanding ones as orthogonally as possible***
  - Momentum resolution
    - **recoil mass** — **σ: $e^+e^-\to Zh$, $Z\to l^+l^-$**
  - Flavor tagging / Particle ID / Q_{jet} ID
    - various **higgs** processes, **top**, W/Z → b/c/τ — **σxBR: $e^+e^-\to Zh/\nu\nu h$, $h\to bb/cc/gg$**
    - various processes including leptons → e/μ/(others π, K, p) pt thresh. for ID?
    - **top, W** → vertex charge — **A_{FB}(tt): $e^+e^-\to tt$**
    - **τ** → π^0 reconstruction — **CP($h\to\tau\tau$): $e^+e^-\to Zh$, $h\to\tau\tau$**
  - PFA
    - **single boson processes**: eeh, ννh, evW, νvZ, eeZ, … — **σxBR: $e^+e^-\to Zh$, $Z\to qq$, $h\to$invisible**; **m_W/m_Z: $e^+e^-\to$evW, νvZ, eeZ**
  - Hermeticity (low angle veto, pt thresh.)
    - **DM** → γ+nothing (single photon) — **σ: $e^+e^-\to\gamma$+nothing**
    - **higgsinos** → γ+soft particles (ISR tagging) — **σ, m_X, Δm_X: $e^+e^-\to\gamma$+soft particle(s)**
    - γ-pointing → Invisible to invisible — ***σ,* m_X, cτ: $e^+e^-\to$2 non-pointing γs**
  - luminosity spectrum — **m_t: $e^+e^-\to tt$**
  - beam induced BGs / 2-photon pileup
    - bunch tagging → all processes — for all the above
    - Z_{vertex}

We need to confirm that the detector design meets the physics needs.
Pay also sufficient attention to systematic errors: flavor tagging, lumi, pol, …

benchmark processes for detector optimisation

process	physics	detector	Ecm
H—>cc	BR	c-tag JER	any
H—>μμ	BR	high P tracking	500 GeV
H—>ττ	BR, CP	τ reconstruction, PID track separation	250 GeV
H—>bb	M_H, BR	JES, JER b-tag	500 GeV
H—>invisible Z—>qq	Higgs Portal	JER	250 GeV
eνW—>eνqq	M_W, TGC	JES, JER	500 GeV
tt-bar—>6-jet	top coupling A_{FB}	b-tag, JER jet charge	500 GeV
$\chi_1^+\chi_1^-$, $\chi_2^0\chi_1^0$ near degenerated	natural SUSY	low P tracking PID	500 GeV
γXX	WIMPs	Photon ER & ES Hermiticity	500 GeV

in total 9 = 5 (Higgs) + 2 (EW) + 2 (BSM)

→ ***Junping's talk on detector benchmarks***

Impact of H20

Is 10Hz operation at at 250 GeV with x2 as many bunches really no problem?

Systematics and Calibration Issues

Detector should be designed to allow calibration and control of systematics to match the expected precisions

b-tag, JES, E_{beam} (p-scale: J/ψ calib.), lepton ID
→ILD Systematics WG: M. Vos, G. Wilson, T. Suehara

→Z-pole running? →Jenny (as a member of ILC parameters WG) is preparing a questionary

Summary

- Have boundary conditions changed?
  - H20 scenario
    → e.g. ***higher precision (sub-%) higgs studies***
      → We need better control of systematics and calibration scheme.
      → Prepared for 10Hz operation at 250GeV x2 as many bunches.
      → BG, pile up.
  - MEXT's request for a clear vision on new particle discovery potential taking into account development of the LHC experiments
    → e.g. naturalness suggests ***compressed mass spectrum***
      WIMP searches with mono-photon detection
- For detector optimization, we need to set the right axes in the evaluation space:
  - We need to choose appropriate benchmark processes so as to orthogonalize / diagonalize the detector aspects to be optimized. → done
  - For the metric for the evaluation space, we now know that we'd better put enough weight to ***precision Higgs and Top*** studies and ***BSM*** scenarios with compressed mass spectra.
- Analysis improvements
  - We need to control systematics more than ever and detector design must allow this.
  - If the physics performance is limited by analysis rather than the detector performance, try to improve the analysis!
  - Don't easily compromise PFA performance but improve jet or color-singlet clustering (crucial for self-coupling measurement)!

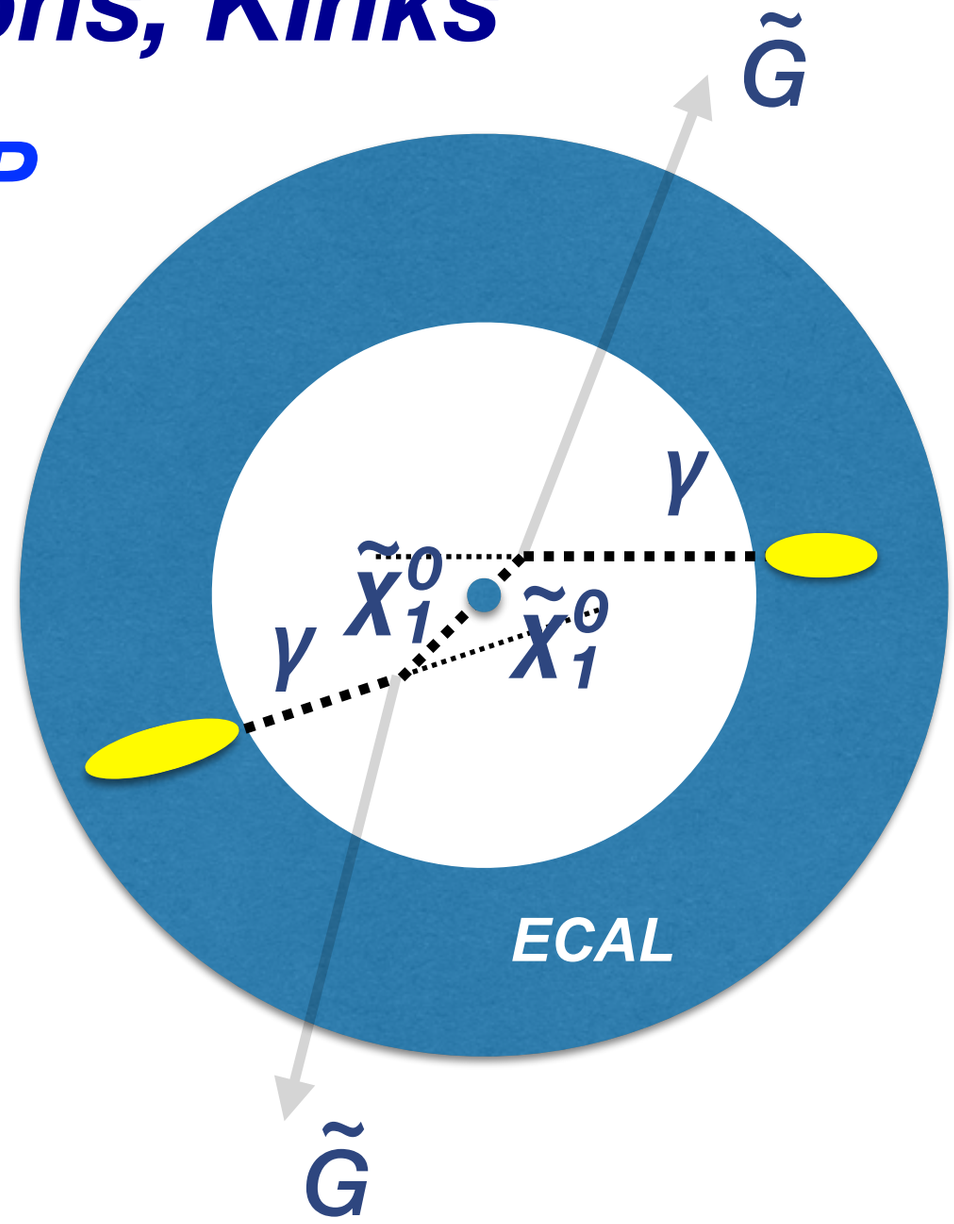
Backup

Non-pointing Photons, Kinks

Light gravitino + neutralino NLSP

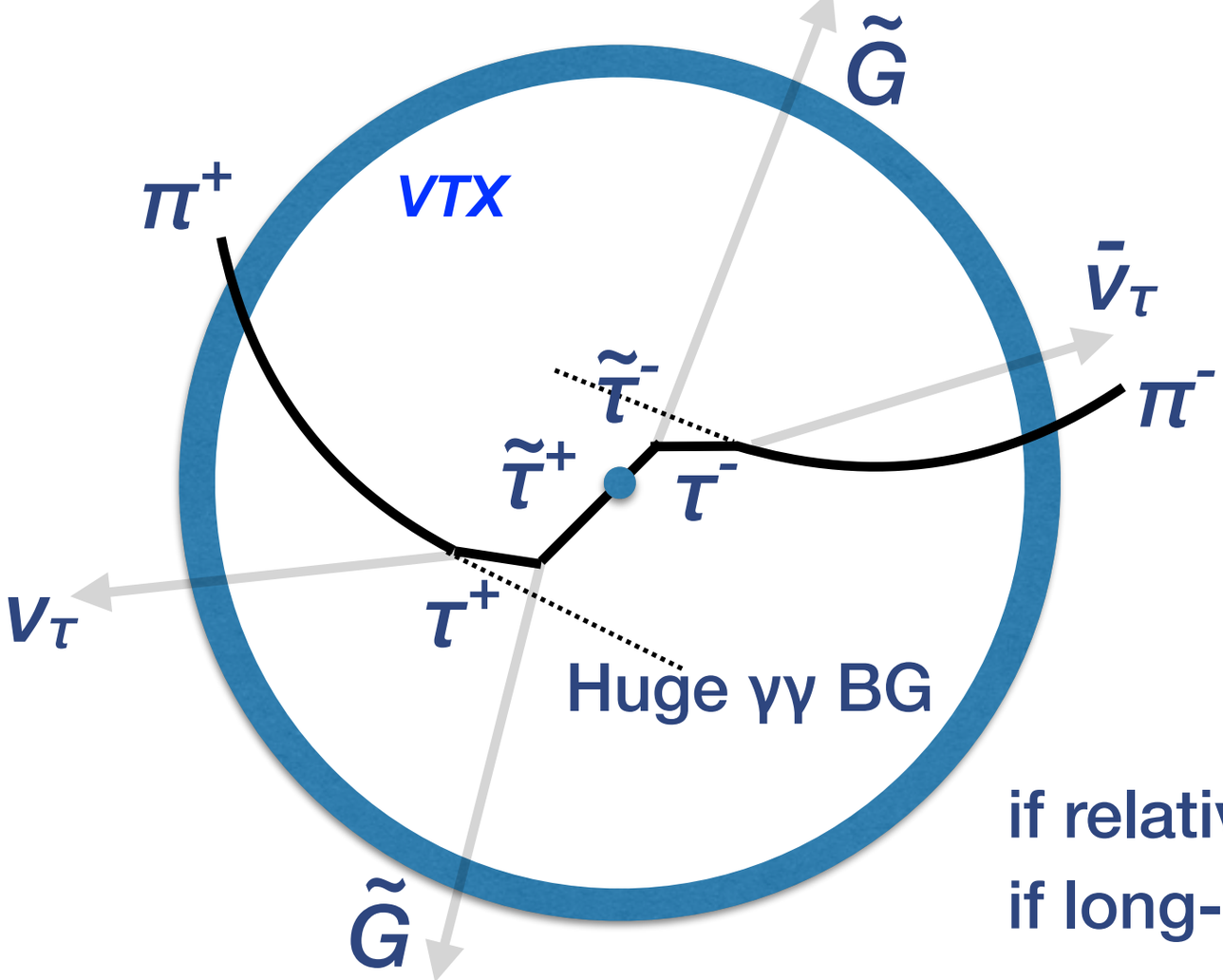
$$e^+e^- \to \tilde{\chi}_1^0\tilde{\chi}_1^0 \to \gamma\tilde{G}\gamma\tilde{G}$$

if long-lived → ***non-pointing γ's***



Light gravitino + stau NLSP

$$e^+e^- \to \tilde{\tau}_1^+\tilde{\tau}_1^- \to \tau^+\tilde{G}\tau^-\tilde{G}$$



if relatively short-lived → ***displaced vertex***

if long-lived → ***kinks***

Non-pointing Photons, Kinks

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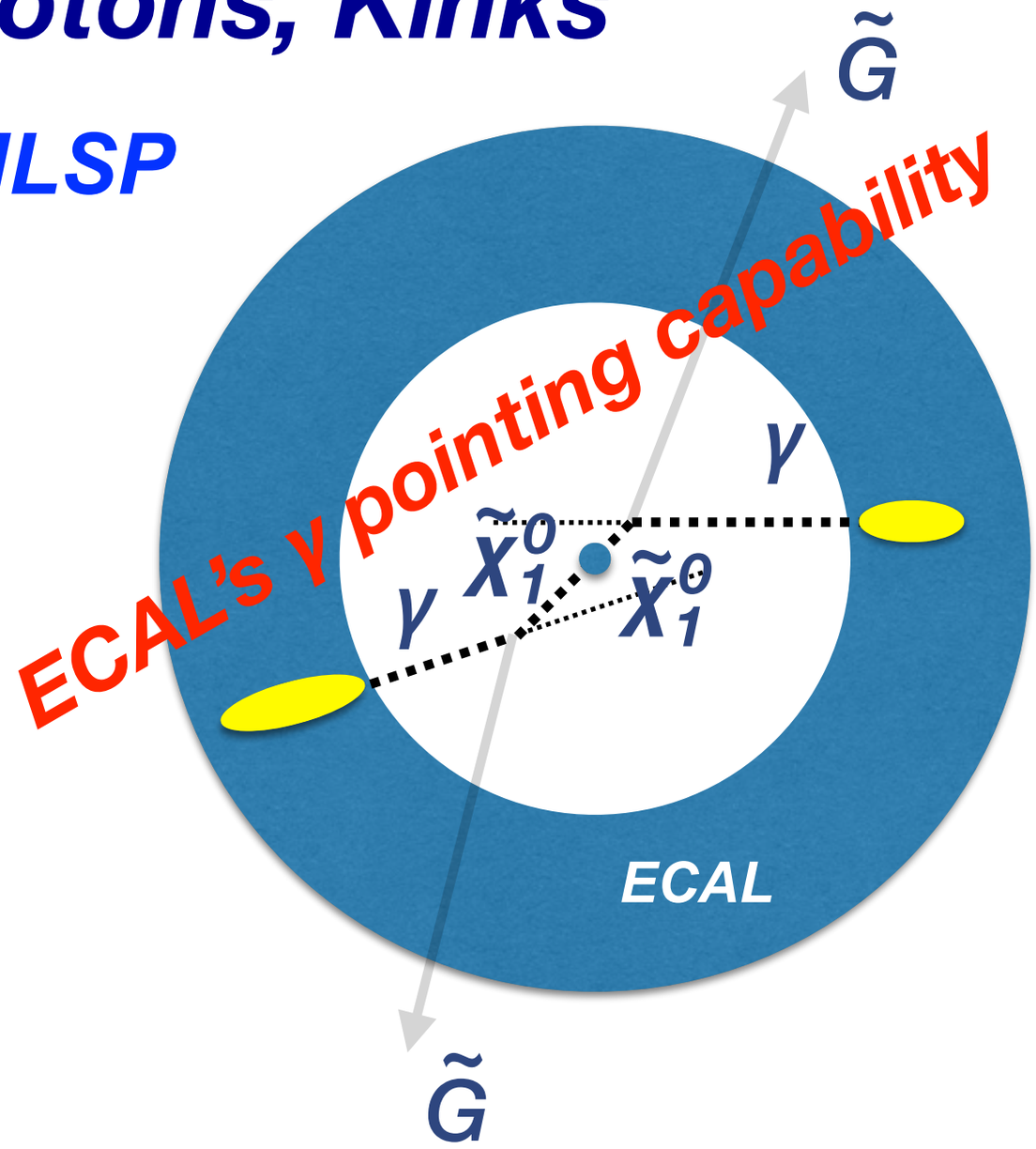

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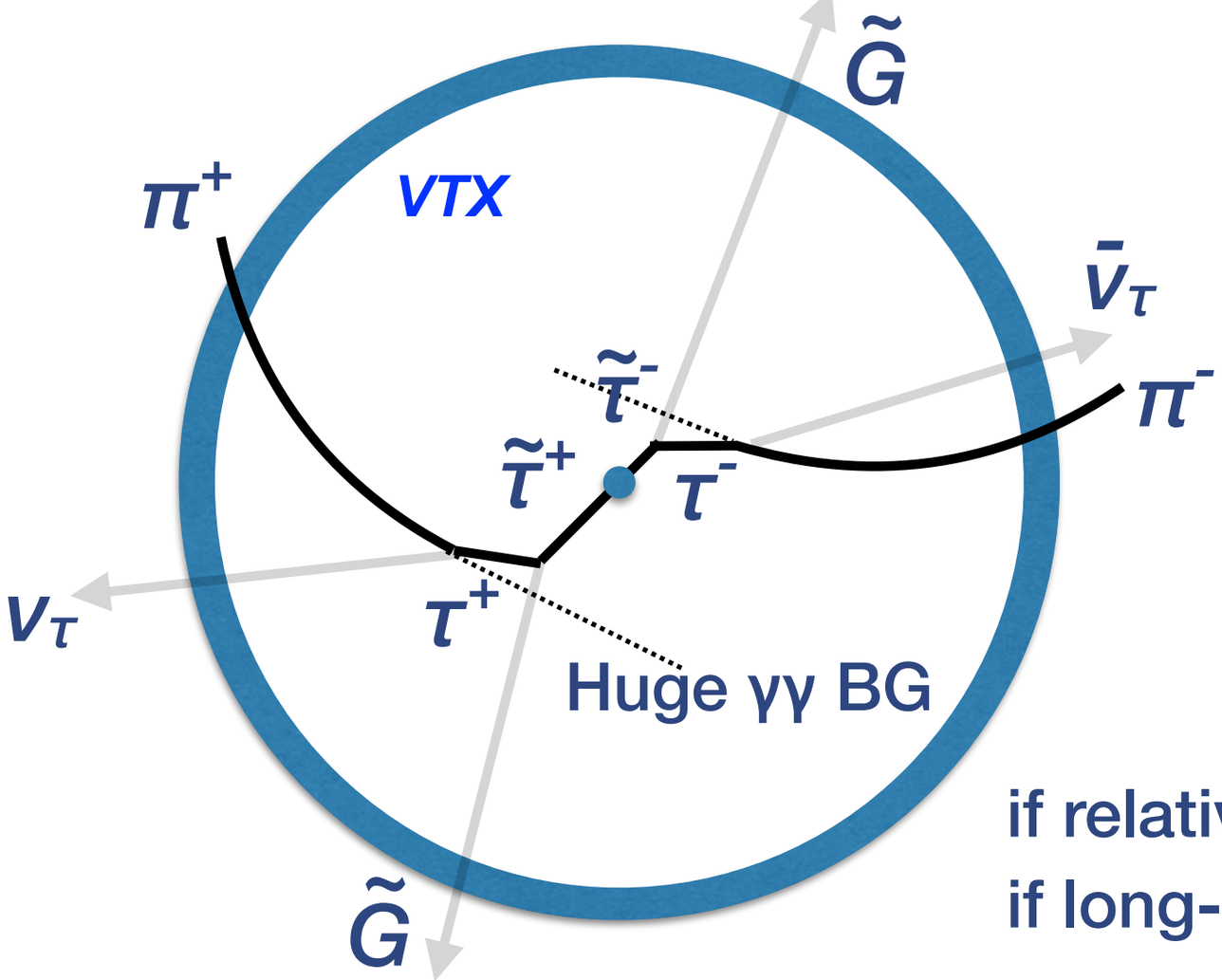

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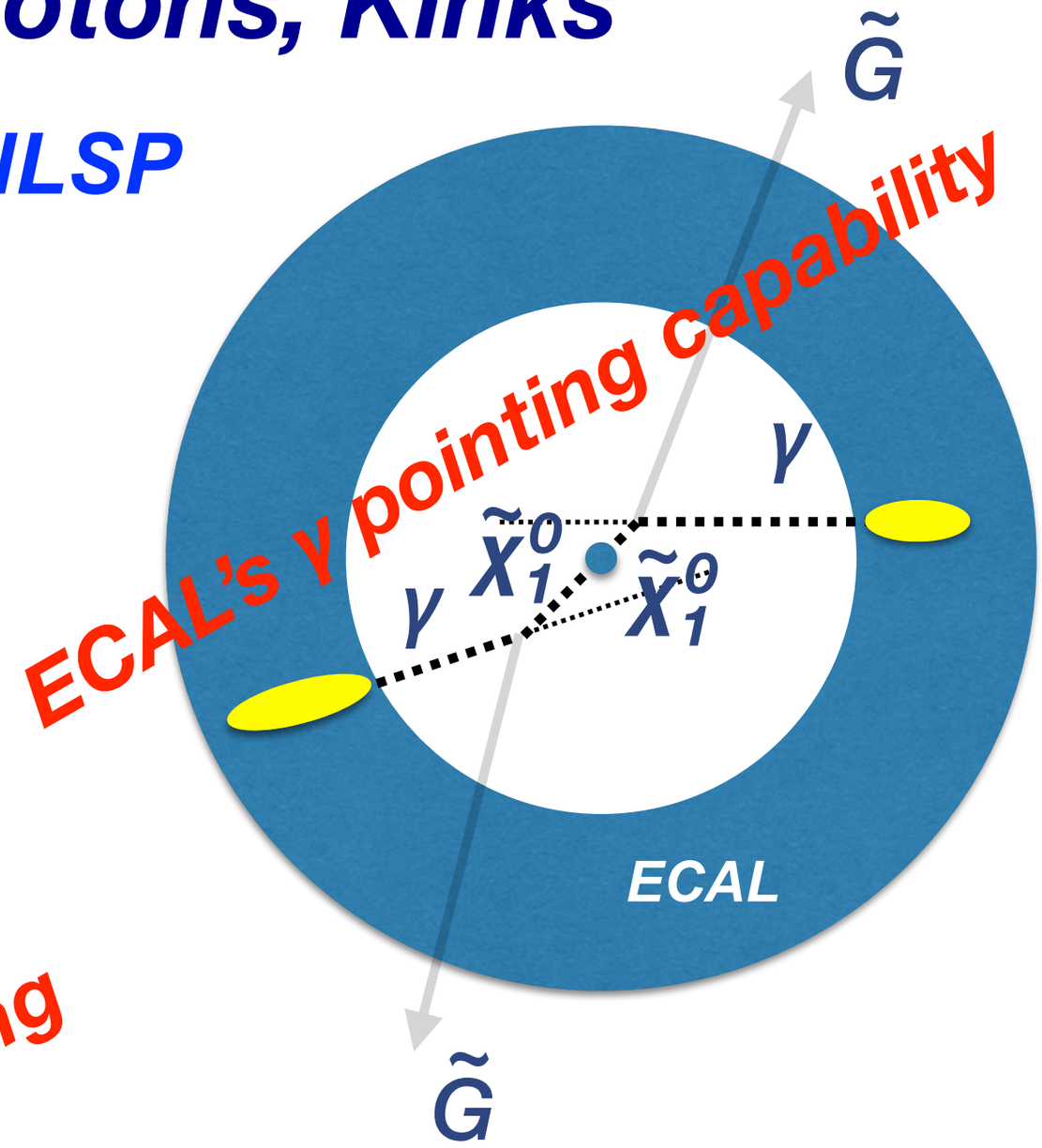

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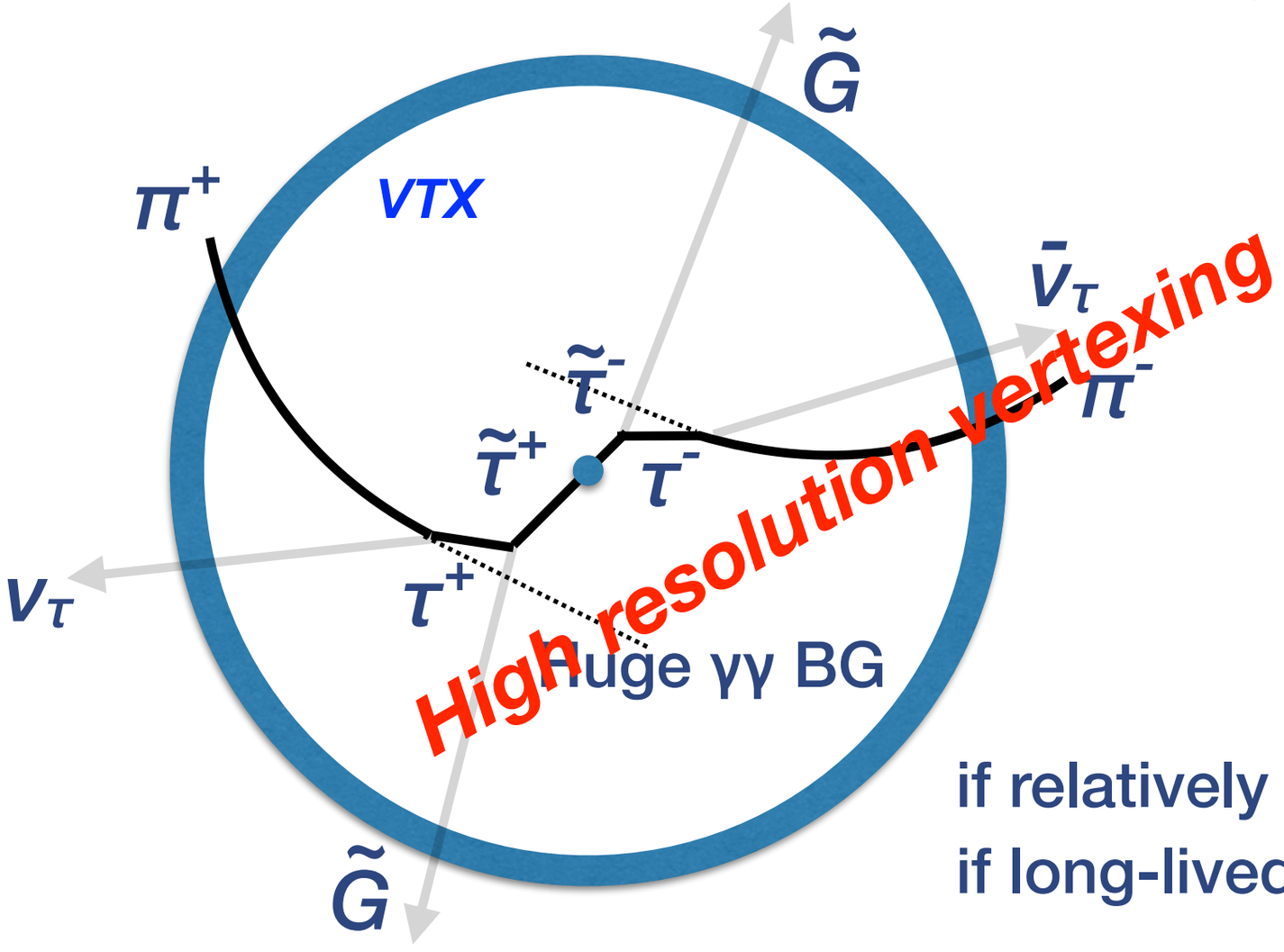

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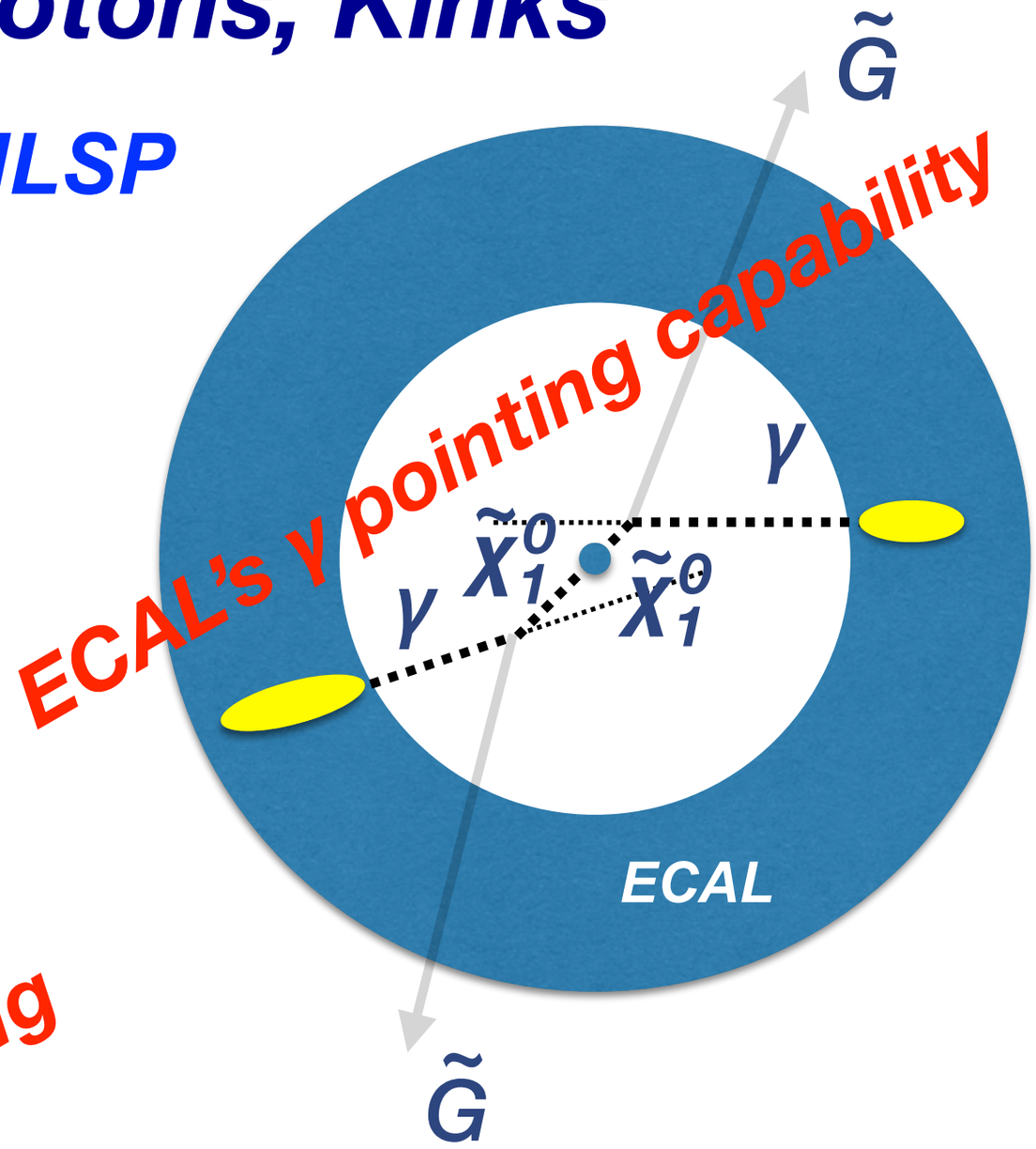

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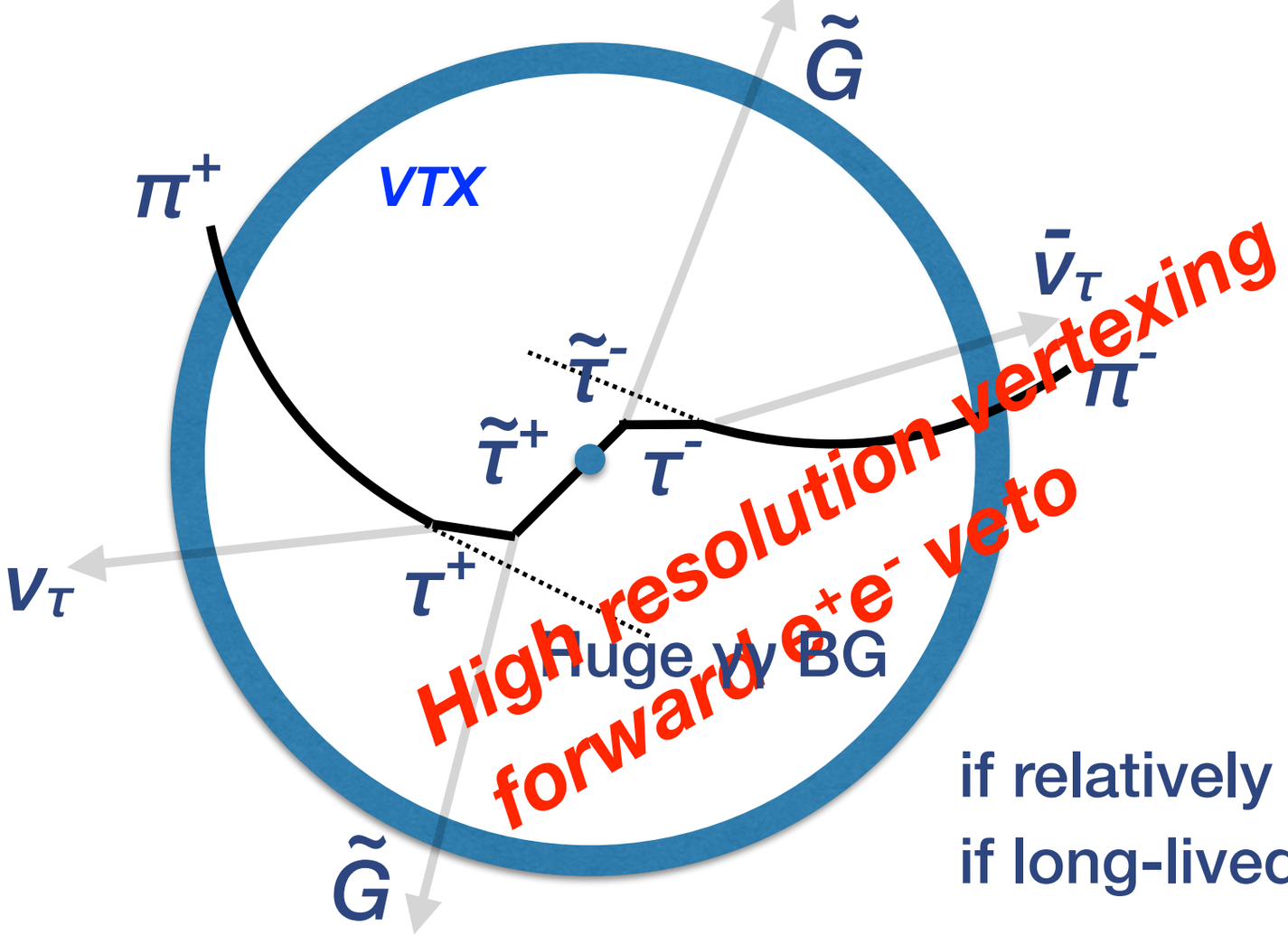

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Don’t forget CP violating phase!

$h \to \tau^+\tau^-$

correlation of impact parameter vectors
→ angle between decay planes

Desch, et al.
Phys.Lett.B579 (2004) 157

$h \to \tau^+\tau^-$

use $\tau^+ \to \rho^+\nu \to \pi^+\pi^0\nu$
→ π^0 reconstruction

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Phys.Rev.D88 (2013) 076009

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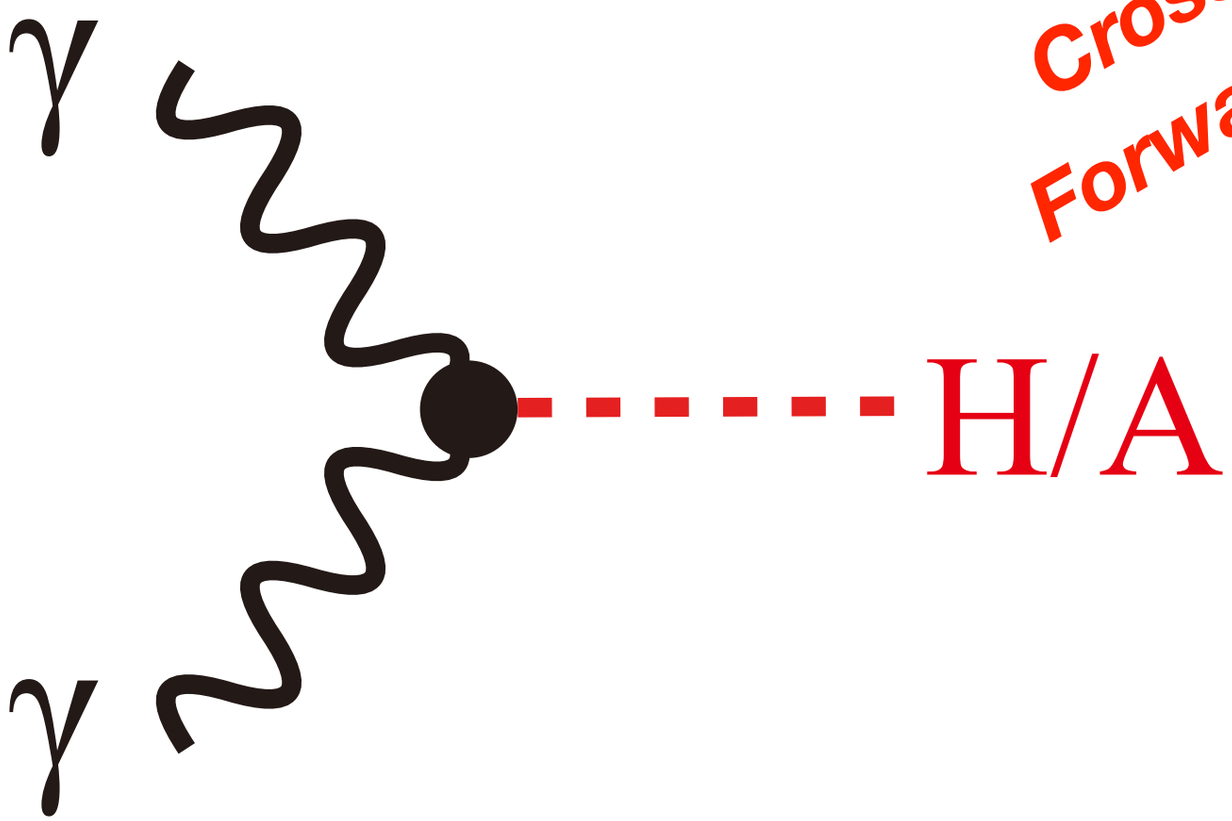
π^0 reconstruction

Harnik, et al.
Phys.Rev.D88 (2013) 076009

S-channel Heavy Higgs Production

Don’t forget the γγ option



Crossing angle
Forward tracking/ECAL

Maybe a dedicated detector for the γγ option?

Relevant Experimental Issues

Acceptance

- $p_{t,min}$ (as determined by B-field, θ_{min}, R_{min})
  - **tracking** → low p_t tracks (compressed spectra)
  - **flavor tagging** (material budget, angular coverage) → for low θ tracks
  - **particle ID (mu/π/e/γ)** → for soft/low θ tracks
- **θ_{veto}** (missing pt, ISR-tag) for e/γ → for μ,hadron, too

Resolution

- **momentum** (tracker): $\Delta p_t/p_t^2$ → recoil mass
- Jet Energy Resolution (***JER/PFA***):
  - what processes are driven by JER? → single bosons
    - but many others are mostly driven by jet clustering
- **two-track**, **displaced vertices** (kink), **non-pointing photons**
- **π^0 reconstruction**

BG tolerance

- vertex detector ***occupancy***
- pileup mitigation using ***time stamping*** (Tracker/CAL), vertex detection

Systematics control

- monitoring of machine parameters: E, luminosity, polarization
  → need to know the ***luminosity spectrum*** (ttbar threshold)
- E_{jet} scale, p scale, flavor tagging, …