BDS & $\gamma\gamma$ issues

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Table 3.4: TD Phase Beam Test Facilities Deliverables and Schedule.

Test Facility	Deliverable	Date
Optics and stabilisation demonstrations:		
ATF	Generation of 1 pm-rad low emittance beam	2009
ATF-2	Demonstration of compact Final Focus optics (design demagnification, resulting in a nominal 35 nm beam size at focal point).	2010
	Demonstration of prototype SC and PM final doublet magnets	2012
	Stabilisation of 35 nm beam over various time scales.	2012

BDS in GDE Technical Design Phase plan

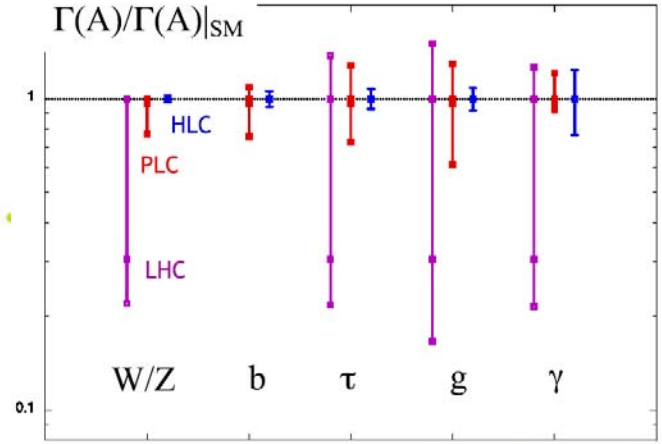
3.3.5 Beam Delivery System

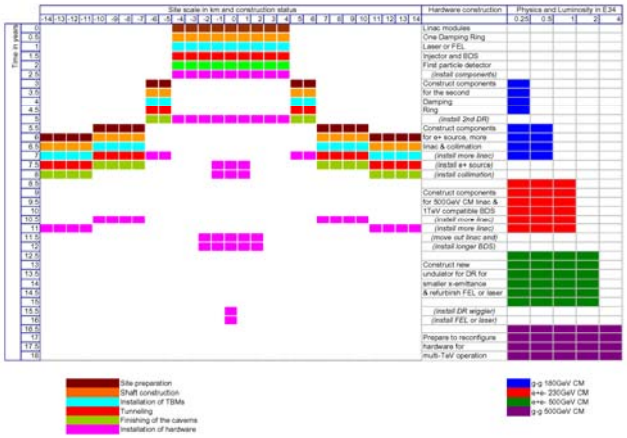
The main R&D focus for the BDS is the ATF-2 programme at KEK which will allow demonstrations of many of the key BDS components and design concepts, the Machine-Detector activity for optimization of the Interaction Region, and design for those BDS subsystems which are critical for system performance or which may expand the physics capabilities of the collider. Examples of R&D are:

- Development of instrumentation (e.g. laser-wires), algorithmic control software, beam-based feedback systems and emittance-preservation techniques to achieve the small beam-size goals (2010)
- Developing of IR Interface Document defining MDI specifications and responsibilities (2010) and design or optimised IR (2012)
- Development of the prototype of the Interaction Region SC Final Doublet (2012)
- Development of Interferometer system for FD stability monitoring (2012)
- Design of the beam dump system (2012)
- Tests of SC and PM Final doublet at second stage of ATF2 (2012)
- Design studies for the photon collider option (2012)
- Collimation and dump window damage tests at ATF2 (2010)
- Development and demonstration of the SCRF crab-cavity system (2010)

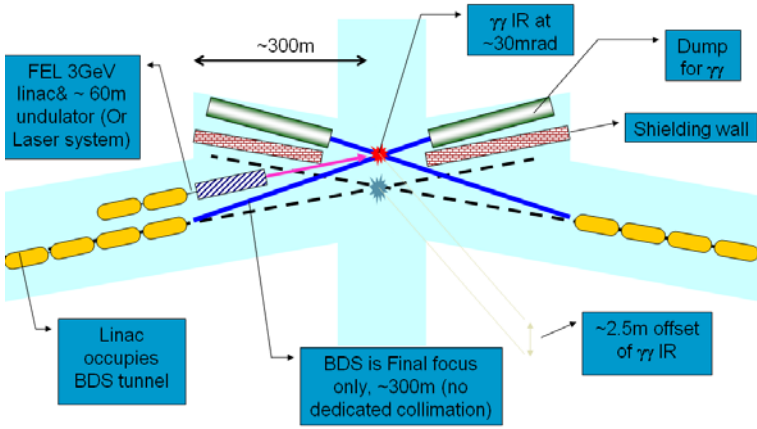
Report on staging

Stage	E CM (GeV)	Mode	E reach (GeV)	BDS (km per side)	Total site (km)	Lumi E34	Physics program (yrs)	Features
1st	180	$\gamma\gamma$	128	0.3	8.8	0.25	2	Single DR
2nd 3rd	180	$\gamma\gamma$	128	0.3	8.8	0.5	2	Faster kicker or second DR
4th	230	e^+e^-	230	0.8	12.1	0.9	3	Add e+ source Lengthen BDS Add dedicated collimation
5th	500	e^+e^-	500	2.2	27.2	2	5	Lengthen BDS to 1 TeV layout
6th	500	$\gamma\gamma$	400	2.2	27.1	4.5	2	Lower DR x-emittance





180GeV CM $\gamma\gamma$ initial configuration



- GDE panel evaluated $\gamma\gamma$ as 1st stage – a report edited by M.Peskin, T.Barklow, J.Gronberg and A.S., with contribution from P.Garbincius, et al was prepared
  - Considered physics case, machine configuration, IP parameters, laser or FEL photon driver, tentative cost
  - The report assumed that mass of Higgs is 120 GeV
- The report also compared
  - 180 GEV CM photon collider PLC (costs 52% of ILC RDR)
  - 230 GeV CM e+e- collider HLC (costs 67% of ILC RDR)

Summary of the staged program for ILC discussed in the report

Stage	E CM (GeV)	Mode	E reach (GeV)	BDS (km per side)	Total site (km)	Lumi E34	Physics program (yrs)	Features
1st	180	$\gamma\gamma$	128	0.3	8.8	0.25	2	Single DR
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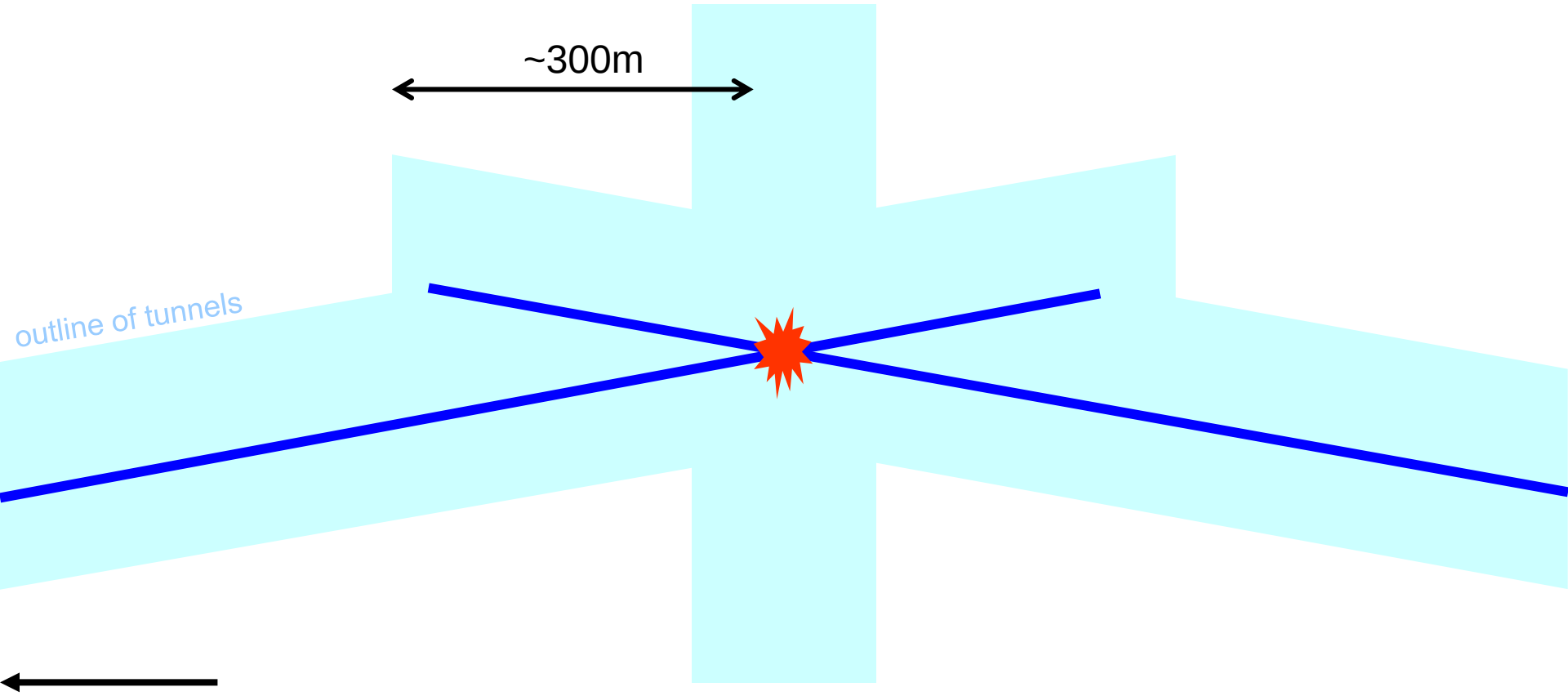
The 5th stage is the ILC RDR machine.
The 6th stage would be the final run before a (multi-TeV) energy upgrade

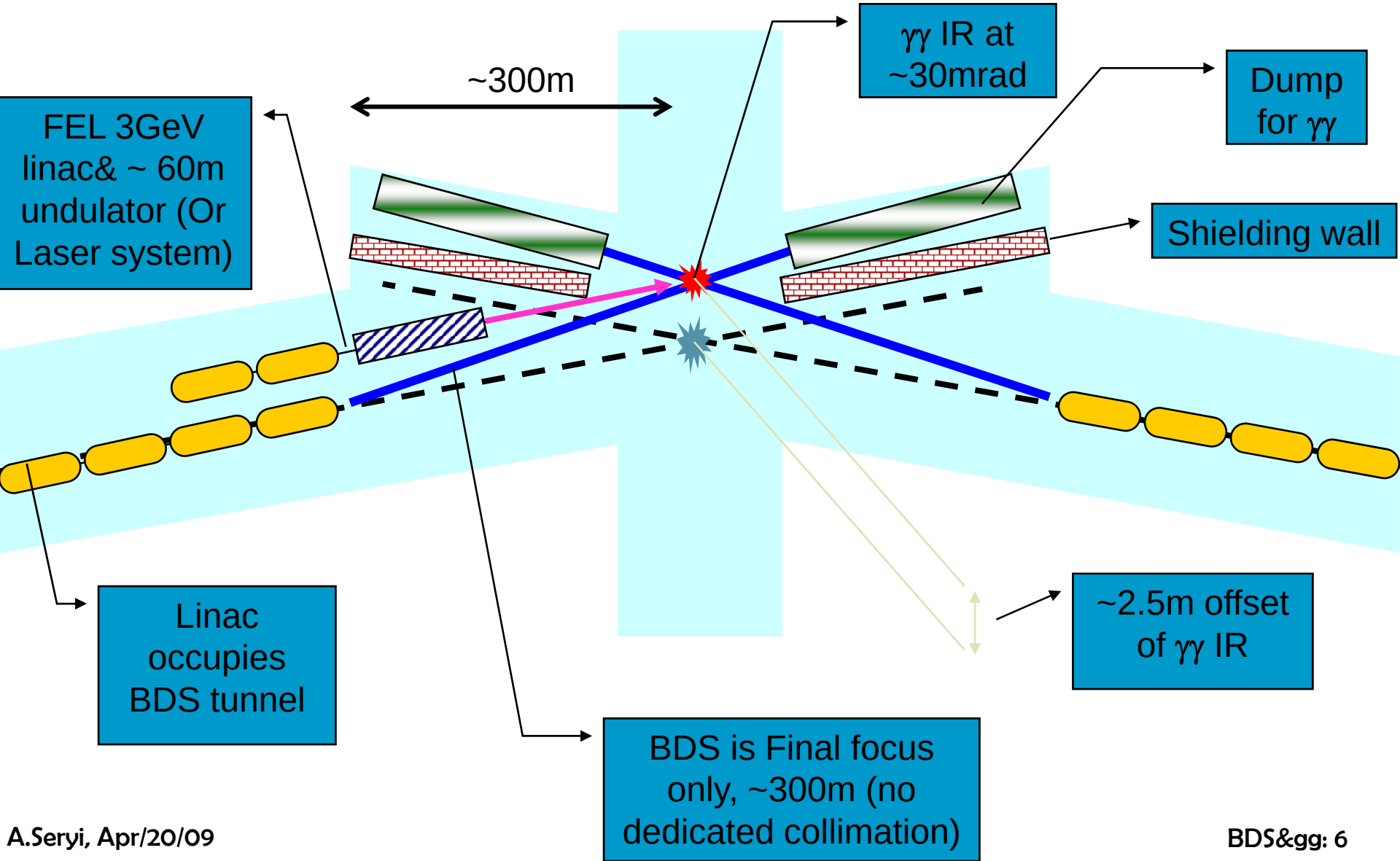
1TeV CM Beam Delivery System (BDS)

eventual configuration of BDS (or baseline RDR)

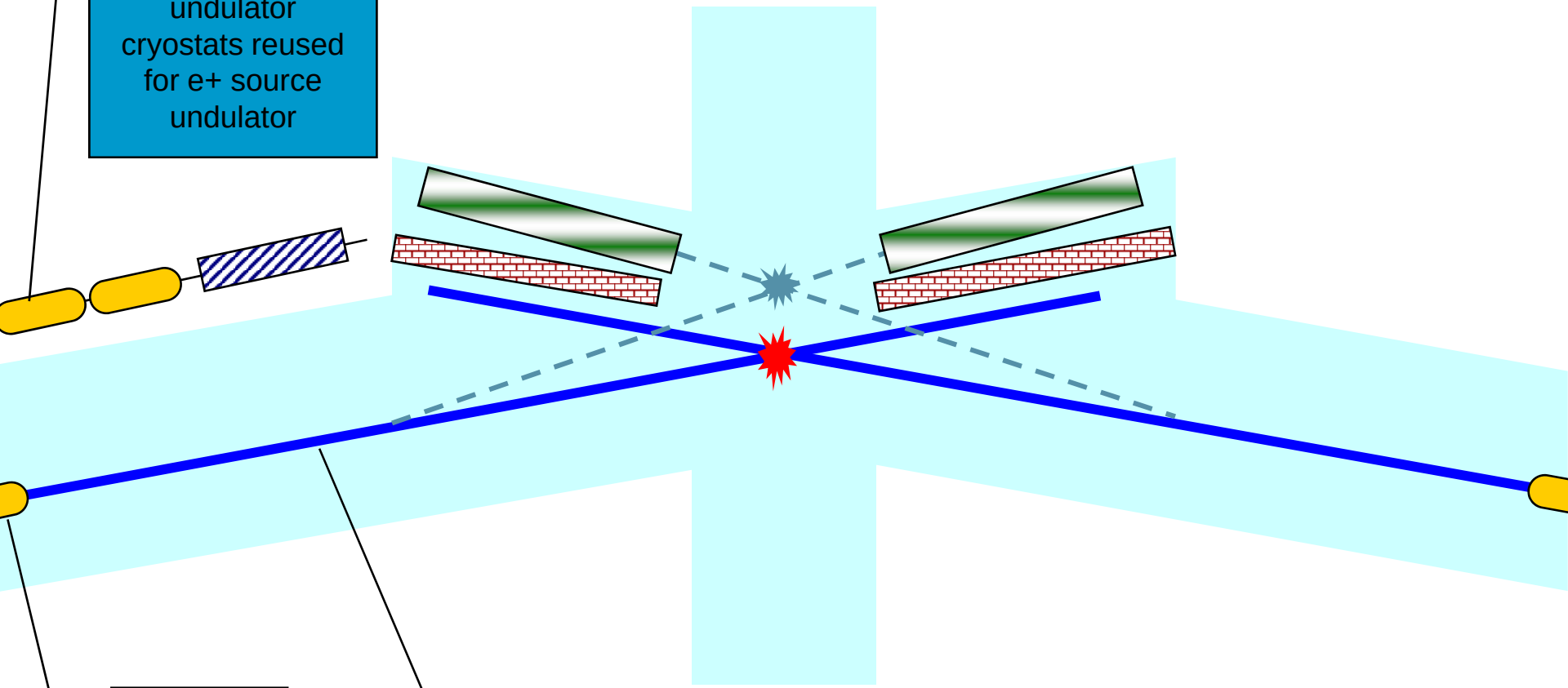


BDS to ~2.2km from IP

180GeV CM γγ initial configuration



Reconfiguration of 180GeV CM γγ to 230GeV CM e+e-

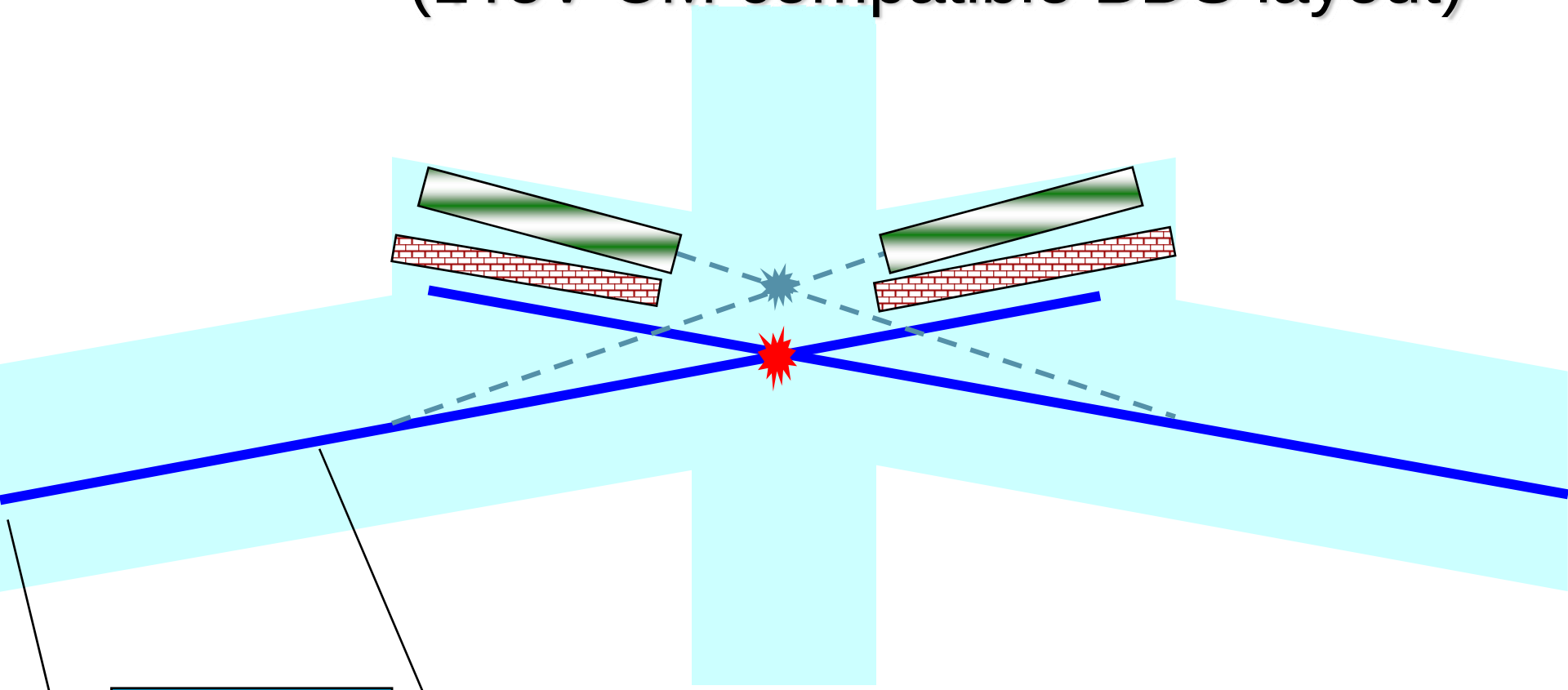


FEL cryo-modules reused for linac, undulator cryostats reused for e+ source undulator

Linac moves out

BDS lengthened to ~0.8km per side, dedicated collimation constructed

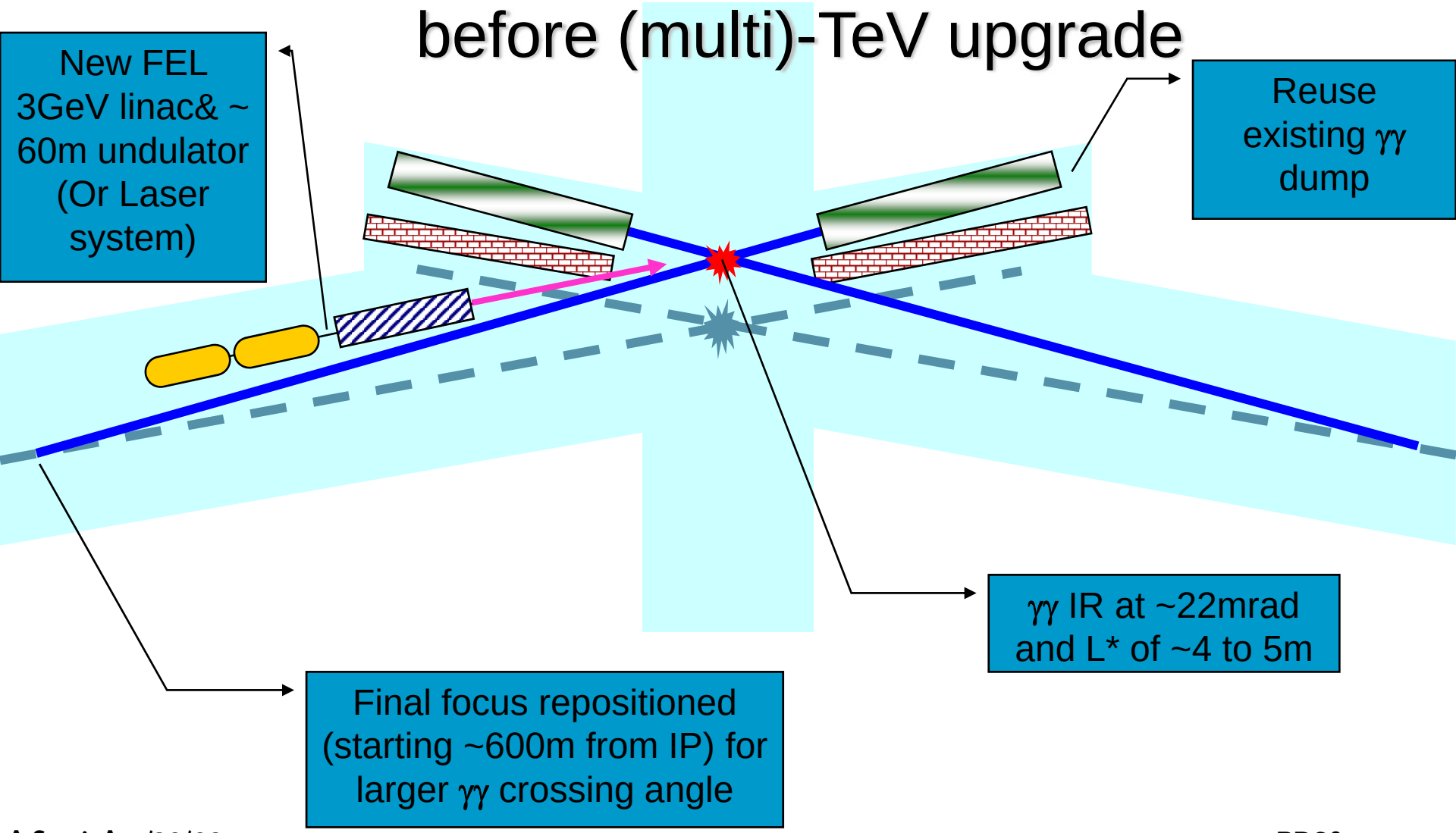
Reconfiguration of 230GeV CM e+e- to 500GeV CM e+e- (1TeV CM compatible BDS layout)



Linac moves out to ~2.2km from IP

BDS lengthened to ~2.2km per side, missing magnet scheme for 500GeV CM

Reconfiguration of 500GeV CM e+e-
(1TeV CM compatible BDS layout)
to 500GeV CM γγ
before (multi)-TeV upgrade



ILC stages, main parameters of the beam

Stages	single DR	faster kicker	2nd DR	e^+ & linac	more linac	coda
Case ID	1	2	3	4	5	6
ECM [GeV]	180	180	180	230	500	500
Mode	$\gamma\gamma$	$\gamma\gamma$	$\gamma\gamma$	e^+e^-	e^+e^-	$\gamma\gamma$
Polarization	yes, yes	yes, yes	yes, yes	no,yes	no,yes	yes,yes
Energy reach [GeV]	128	128	128	230	500	393
N	2.0E+10	2.0E10	2.0E10	2.0E10	2.0E+10	2.0E+10
n_b	660	1320	1320	1320	1320	1320
DR kicker time [ns]	6	3	6	6	6	6
Min DR perimeter [km]	1.2	1.2	2.4	2.4	2.4	2.4
DR perimeter [km]	3	3	3	3	3	3
No. of DRs	1	1	2	2	2	2
Length of 2 BDS [km]	0.6	0.6	0.6	1.6	4.5	4.5
Geographic grad. [Mev/m]	22	22	22	22	22	22
Length of 2 linacs [km]	8.2	8.2	8.2	10.5	22.7	22.7
Site length est. [km]	8.8	8.8	8.8	12.1	27.2	27.2
t_{sep} in linac [ns]	480.0	480.0	480.0	480.0	480.0	480.0
I_{av} in train [A]	0.0067	0.0067	0.0067	0.0067	0.0067	0.0067
f_{rep} [Hz]	5	5	5	5	5	5
P_{beam} [MW]	1.0	1.9	1.9	2.4	5.3	5.3

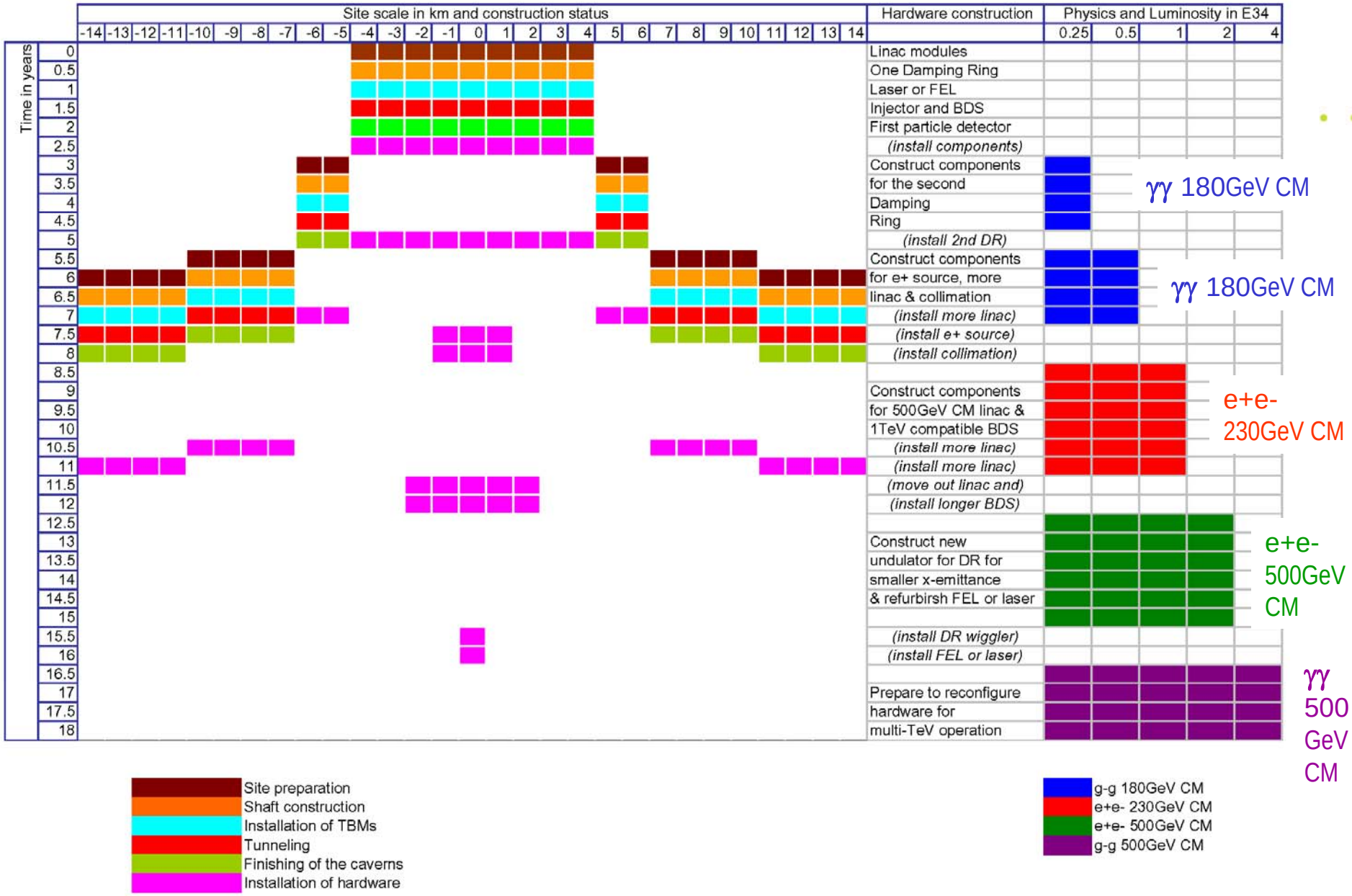
ILC stages, parameters of laser or FEL drivers, conversion and IP

Stages	single DR	faster kicker	2nd DR	e^+ & linac	more linac	coda
Case ID	1	2	3	4	5	6
ECM [GeV]	180	180	180	230	500	500
Mode	$\gamma\gamma$	$\gamma\gamma$	$\gamma\gamma$	e^+e^-	e^+e^-	$\gamma\gamma$
e-γ conversion :						
wavelength [micron]	0.6	0.6	0.6			1.0
conversion coeff.	70%	70%	70%			70%
x	2.85	2.85	2.85			4.75
ξ_2	0.15	0.15	0.15			0.30
Energy Reach [GeV]	128	128	128			393
Disrupted e^- beam:						
E_{min} [GeV]	4.0	4.0	4.0			6.5
Disruption angle [mrad]	10.1	10.1	10.1			9.1
Photon driver – laser:						
wavelength [micron]	0.525	0.525	0.525			1.05
flush energy [J]	5.0	5.0	5.0			5.0
cavity power enhanc.	$\times$ 300	$\times$ 300	300			$\times$ 300
Average laser P [W]	110	220	220			220
Photon driver – FEL:						
λ [micron]	0.6	0.6	0.6			1.0
Drive energy [GeV]	3.0	3.0	3.0			3.0
Bunch charge	7.0E10	7.0E10	7.0E10			7.0E10
Undulator length [m]	70	70	70			70
Beam-to-γ effic.	15%	15%	15%			15%
Flash energy [J]	5.0	5.0	5.0			5.0
Average beam P [kW]	222	444	444			444
Undulator period [cm]	20.0	20.0	20.0			20.0
Undulator max field [T]	1.1	1.1	1.1			1.4
Undulator strength K	20.6	20.6	20.6			26.2
generated λ [micron]	0.62	0.62	0.62			1.00

Stages	single DR	faster kicker	2nd DR	e^+ & linac	more linac	coda
Case ID	1	2	3	4	5	6
ECM [GeV]	180	180	180	230	500	500
Mode	$\gamma\gamma$	$\gamma\gamma$	$\gamma\gamma$	e^+e^-	e^+e^-	$\gamma\gamma$
IP Parameters:						
$\gamma\epsilon_x$ [m]	1.0E-05	1.0E-05	1.0E-05	1.0E-05	1.0E-05	2.5E-06
$\gamma\epsilon_x$ [m]	3.6E-08	3.6E-08	3.6E-08	3.6E-08	3.6E-08	3.6E-08
β_x [m]	4.0E-03	4.0E-03	4.0E-03	1.1E-02	1.1E-02	1.5E-03
β_y [m]	4.0E-04	4.0E-04	4.0E-04	2.0E-04	2.0E-04	4.0E-04
Travelling focus	no	no	no	yes	yes	no
z-distribution	Gauss	Gauss	Gauss	Gauss	Gauss	Gauss
σ_x(geom) [m]	4.8E-07	4.8E-07	4.8E-07	7.0E-07	4.7E-07	8.8E-08
σ_y(geom) [m]	9.0E-09	9.0E-09	9.0E-09	5.7E-09	3.8E-09	5.4E-09
σ_z [m]	4.0E-04	4.0E-04	4.0E-04	3.0E-04	3.0E-04	3.0E-04
U_{av}	0.017	0.017	0.017	0.020	0.063	0.326
δ_B	0.013	0.013	0.013	0.010	0.039	0.576
P(Beams.) [MW]	0.01	0.02	0.02	0.02	0.21	3.04
n_γ	1.76	1.76	1.76	1.21	1.71	7.82
H_D	3.55	3.55	3.55	1.51	1.51	6.16
L(geom) [/cm^2/s]	2.4E33	4.9E33	4.9E33	5.31E33	1.15E34	4.4E34
L (G-Pig) [/cm^2/s]				8.8E33	1.9E34	
Physics [yr]	2	2		3	5	2

Conceptual schedule

- Next slide shows a conceptual schedule
  - PED (eng. & design) phase not included
  - Construction phase 3 years, with same $/year as in Harrison's plan
- Short construction time for first stage => physics start earlier
  - Schedule is likely optimistic, and perhaps could not be achieved unless existing lab engaged & facilities reused
  - Schedule may allow continuity of the CFS contract
- Hardware and more tunnels for next stages constructed simultaneously with the physics runs of the first stage
- May allow variation of the upgrade path, after the first stages



Tentative construction schedule for staged ILC, together with schedule of physics.
Not supported by detailed engineering analysis and is for illustration only.