Considerations on ILC Crossing Angle

- Motivation
- Gamma-gamma collider
- CLIC

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Motivation

- ILC will be a green field lab in a newly constructed town
- Need far future possibilities, as many as possible, though totally unclear now
- May include, e.g.,
  - gamma-gamma
  - CLIC
  - Plasma....
- Try not to exclude them from the beginning
  - I would like to propose ILC tunnel compatible to various projects
  - I am not proposing to construct CLIC in Japan
- As for the crossing angle, reasonable possibilities are
  - ILC 14mrad → 20mrad
  - or CLIC 20mrad → 14mrad
  - The former has an advantage of accepting gamma-gamma, too

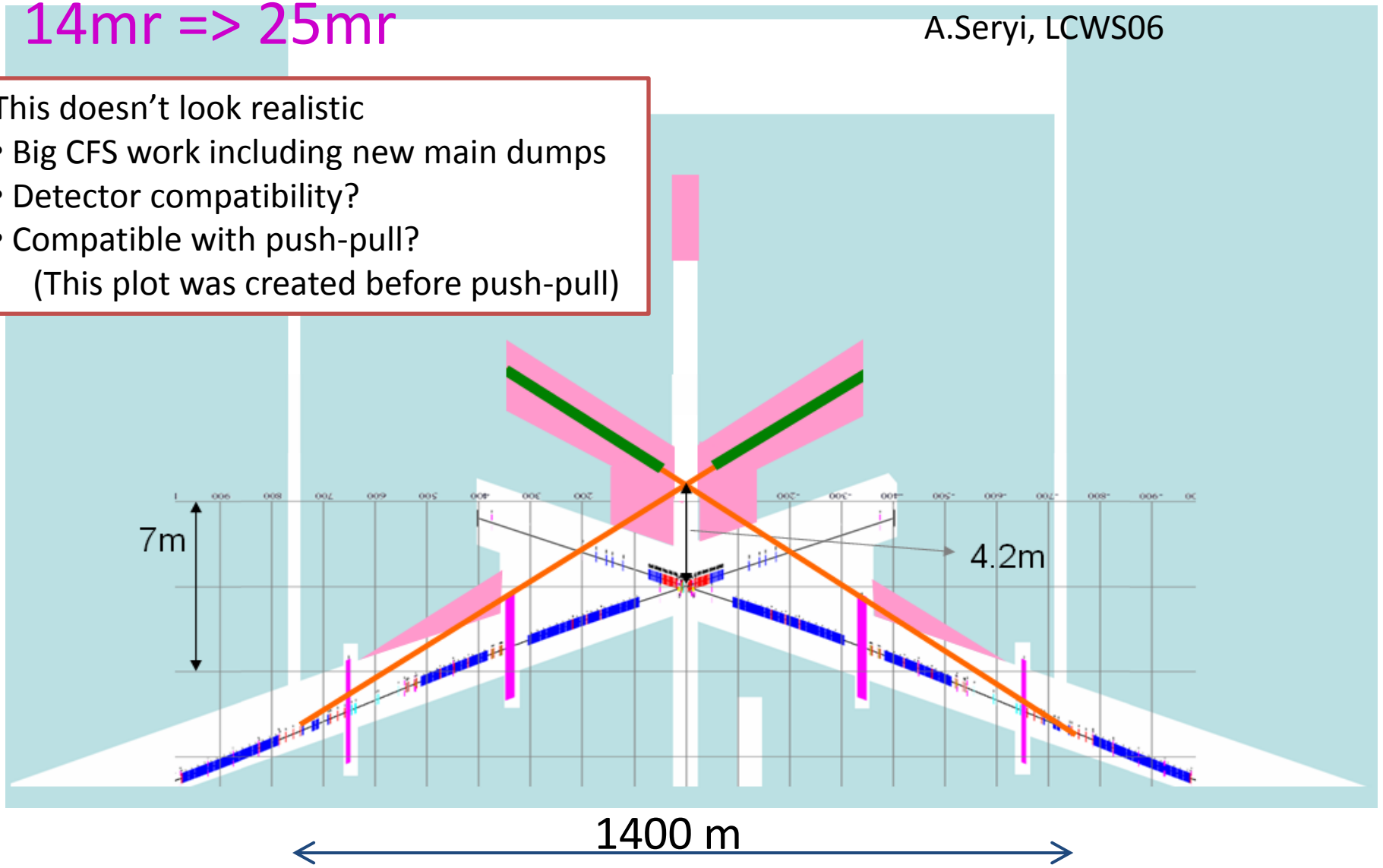
Gamma-Gamma Issue
Design in RDR/TDR

- TDR: Crossing angle 14mrad
  - Gamma-gamma not mentioned
  - 25mrad needed for gamma-gamma
- During the study for RDR, rearrangement for gamma-gamma was discussed
  - 14mrad→25mrad
  - Or 20mrad→25mrad
  - 14mrad→25mrad is better because the two dump systems are too close in the case 20mrad→25mrad (Valery)
- In any case, once going to γ-γ, it is absolutely necessary to switch back to e+e- again
- Not realistic to spend too much time to move to γ-γ

14mr => 25mr

A.Seryi, LCWS06

This doesn't look realistic
- Big CFS work including new main dumps
- Detector compatibility?
- Compatible with push-pull?
  (This plot was created before push-pull)

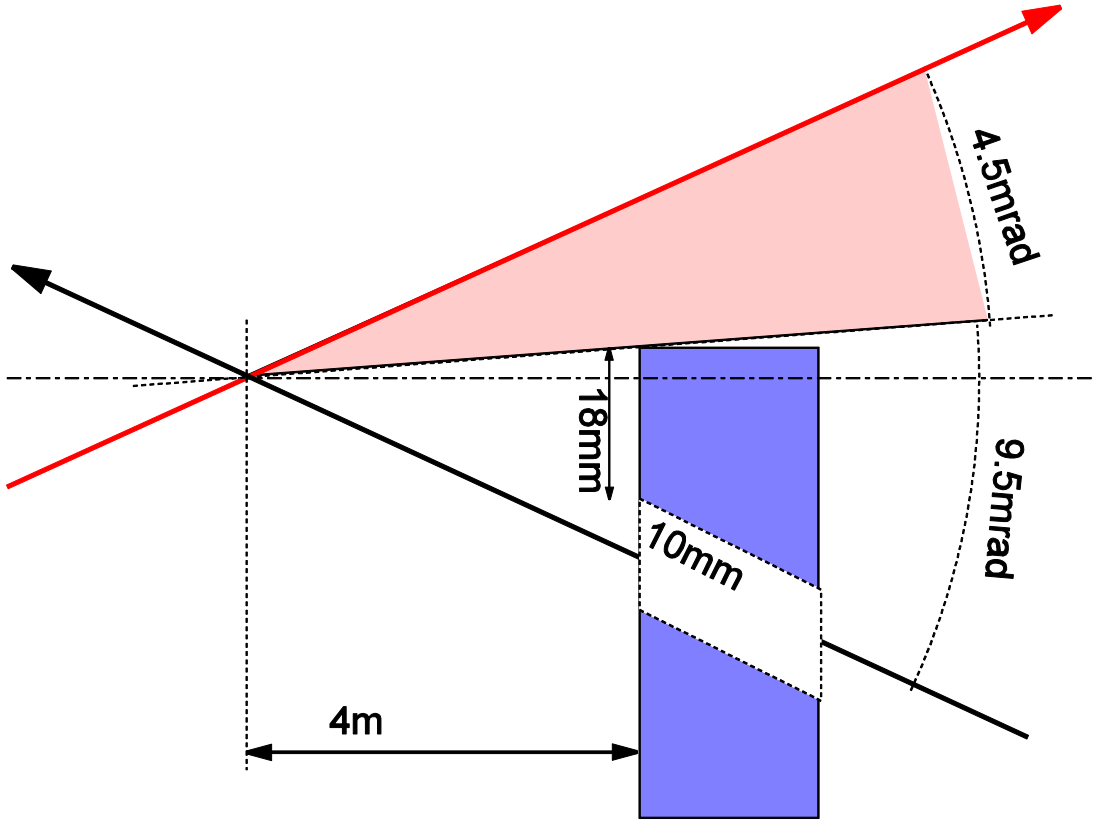


- additional angle is 5.5mrad (=(25-14)/2) and detector need to move by about 3-4m

IR Geometry

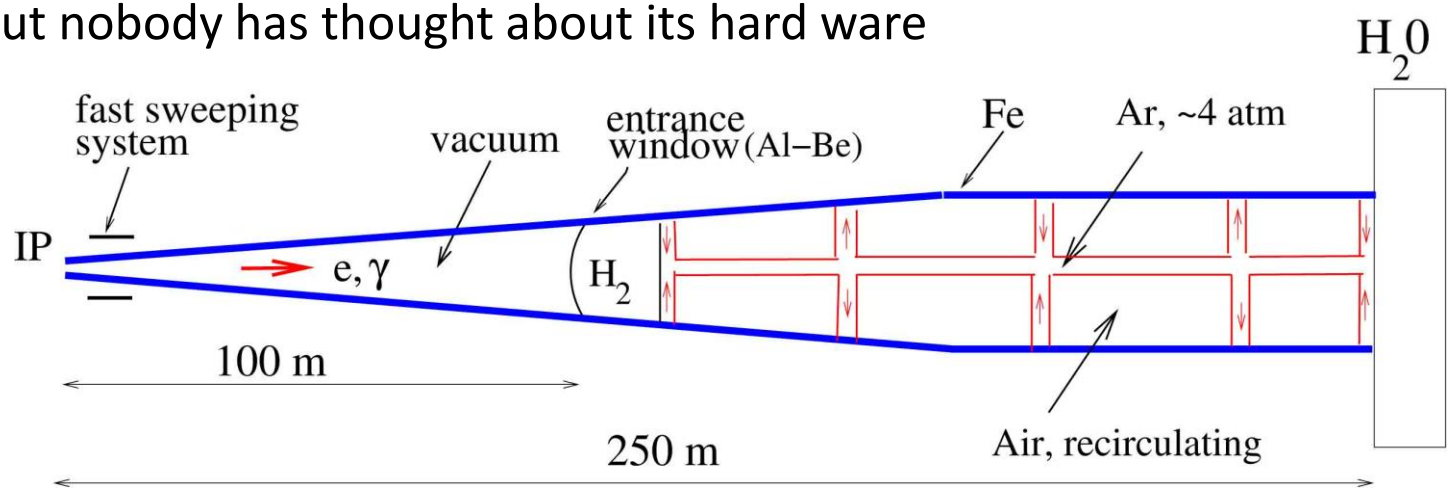
crossing angle	angle for outgoing beam
14 mrad	4.5 mrad
20 mrad	10.5 mrad
25 mrad	15.5 mrad

The required angle for outgoing beam is proportional to sqrt(N/σ_z)



Possible Trade Off

- **Adopt 20mrad for e+e- from the beginning**
- Should be satisfied with 20mrad in γ-γ too.
- This should be possible if sqrt(N/σ_z) is reduced
- Luminosity may be a bit lower
- Even in this case a change of beam dump is necessary at switching to γ-γ
  - ~10MW photon dump
  - Small angle (1/γ), straight.
  - Telnov proposed diffusion in high-pressure Argon gas.
  - But nobody has thought about its hard ware



What must be studied for the Compatibility with γ-γ ?

- How large is the luminosity reduction with the smaller angle 20mrad compared with the traditional γ-γ design 25mrad ?
  - Decrease N/σ_z by factor $(15.5/10.5)^2 = 2.2$
  - e.g., reduce N by factor 1.5, increase σ_z by 1.5
- What do we lose in e+e- in the change 14mrad → 20mrad ?
  - Luminosity does not change
  - Lose some forward angle coverage
  - Angle between solenoid and beam (DID/anti-DID issue)
  - Timing tolerance of crab cavity
  - What else?
- IR and dump system design
  - must be compatible with later installation of γ-γ dump

CLIC

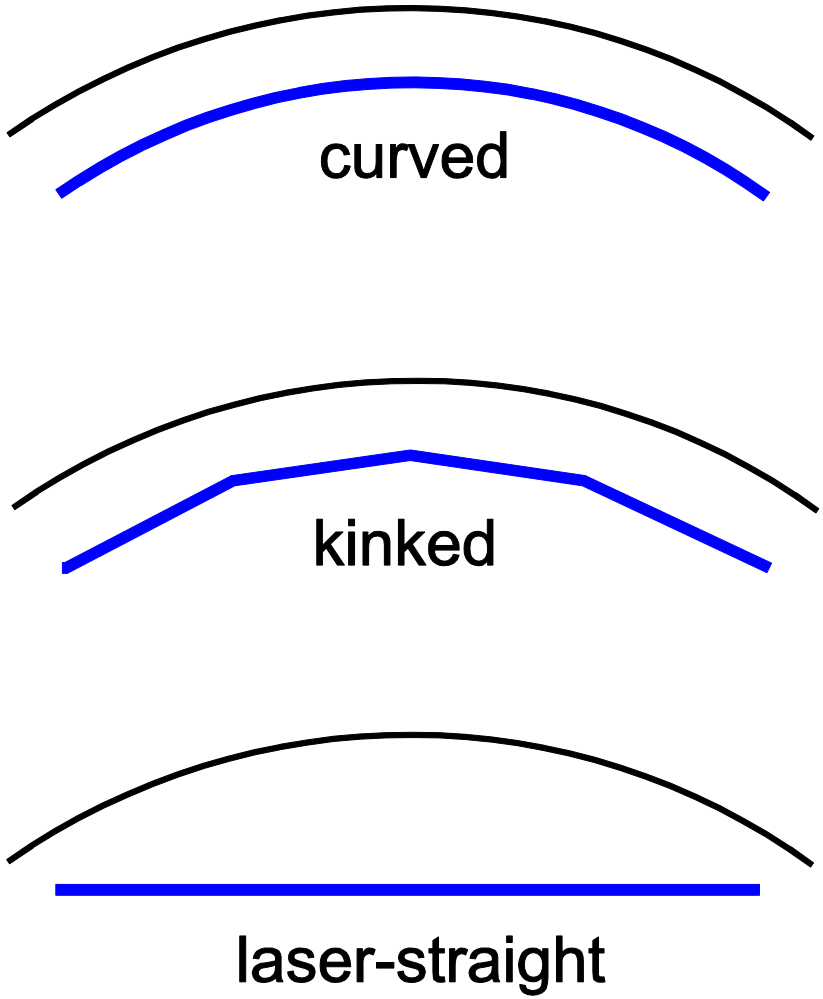
- Can ILC tunnel accommodate CLIC in the far future?
- Difference in the tunnel shape
  - Crossing angle : 14mrad vs. 20mrad
  - Geoid-following vs. laser-straight
  - Offset due to undulator scheme
- Note:
  - Cost saving by reuse of tunnel is ~1.2B$
    - CLIC-ILC General Issue Group Interim Report 1
    - http://ilcdoc.linearcollider.org/record/31959/files/CLIC_ILC_Interim-Report_Final-1.pdf
    - In addition, save 0.25B$ if reuse Main linac klystron for CLIC driver (but CLIC frequency must be changed 12GHz→11.7GHz)

Crossing Angle

- Crossing angle (for e+e-)
  - 20mrad for CLIC (3TeV), 14mrad for ILC
    - More precisely, these are angles between the two linacs
    - CLIC 500GeV adopts 18mrad as the crossing angle with the linac angle 20mrad (This change does not require civil engineering)
  - Are these really necessary?
- What must be studied?
- What does ILC lose in e+e- in the change 14mrad → 20 mrad ?
  - Luminosity does not change
  - Lose some forward angle coverage
  - Angle between solenoid and beam (DID/anti-DID issue)
  - Timing tolerance of crab cavity
  - What else?
- What does CLIC lose in the change 12mrad → 14 mrad ?

Laser-straight vs. geoid-following

- CLIC: laser-straight
- ILC: geoid-following
  - BDS is laser-straight
- Too late to change ILC to laser straight
- Does geoid-following allow 3TeV?
- Emittance increase by radiation is tolerable
- The largest issue now seems to be the calibration error of BPMs (beam position monitor)
- This can be solved in 20 years, I believe



Offset Due to Undulator Scheme

- Electron linac and electron BDS is not on the same line due to the undulator scheme
- About ~2m offset
- Is this acceptable for 1.5TeV beam with CLIC emittance?
- ~800m will be available for installing the necessary bends

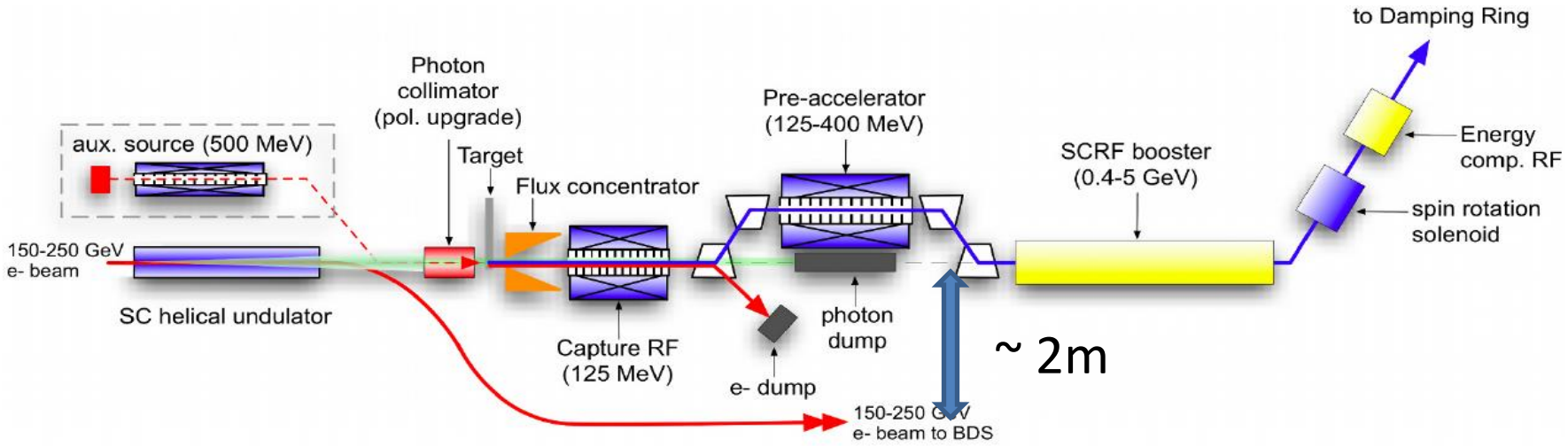


Figure 5.4. Schematic layout of Positron Source. Beamline sections are defined in Section 5.3.

Summary

- If we can make the ILC tunnel compatible (at least not incompatible) to various projects, this will greatly expand the future possibility of the ILC lab and the town
- We should unify the crossing angle of ILC and CLIC
- I prefer 20mrad because of the compatibility with gamma-gamma
- Serious studies should be done in the next half year or at most one year by the time detailed CFS design starts