Test of Hybrid Target at KEKB LINAC

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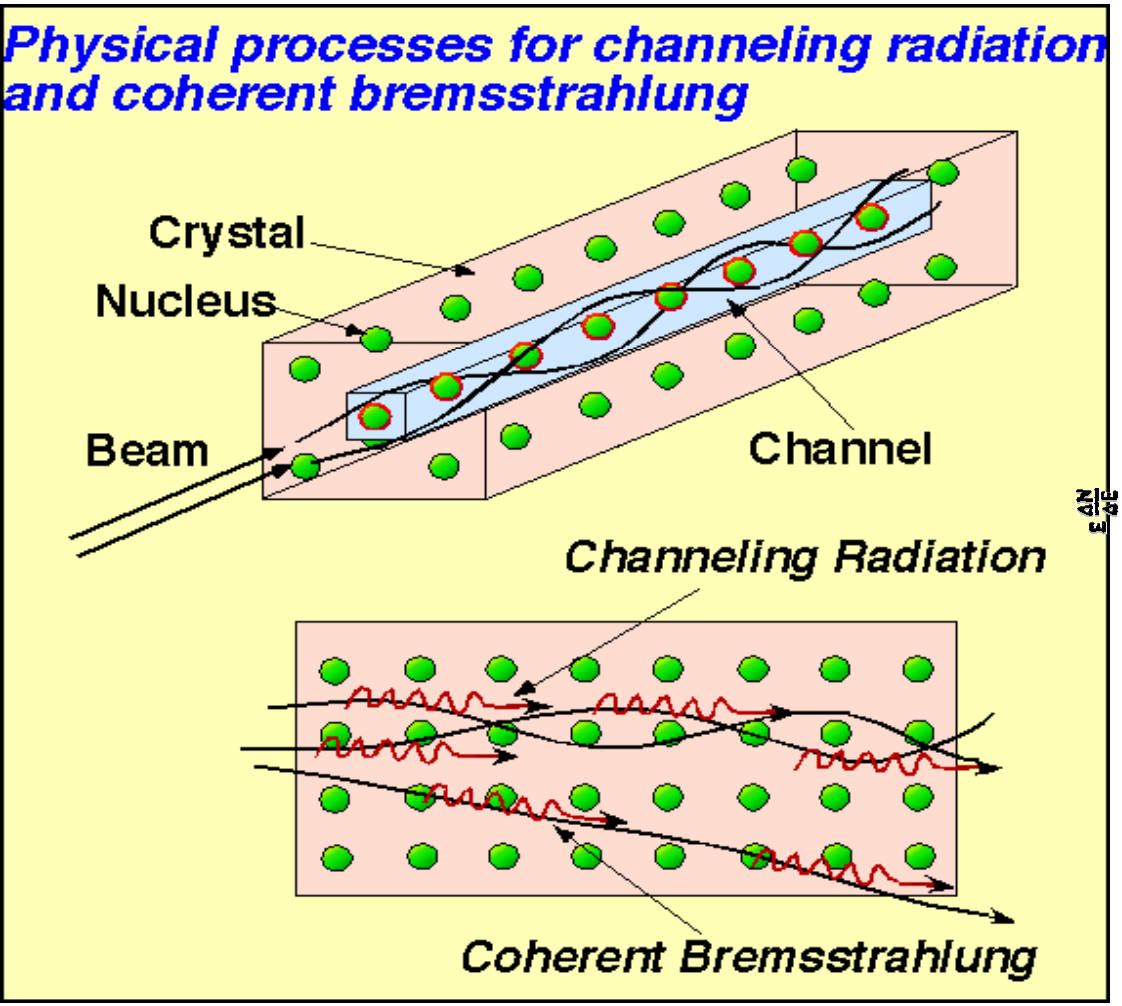
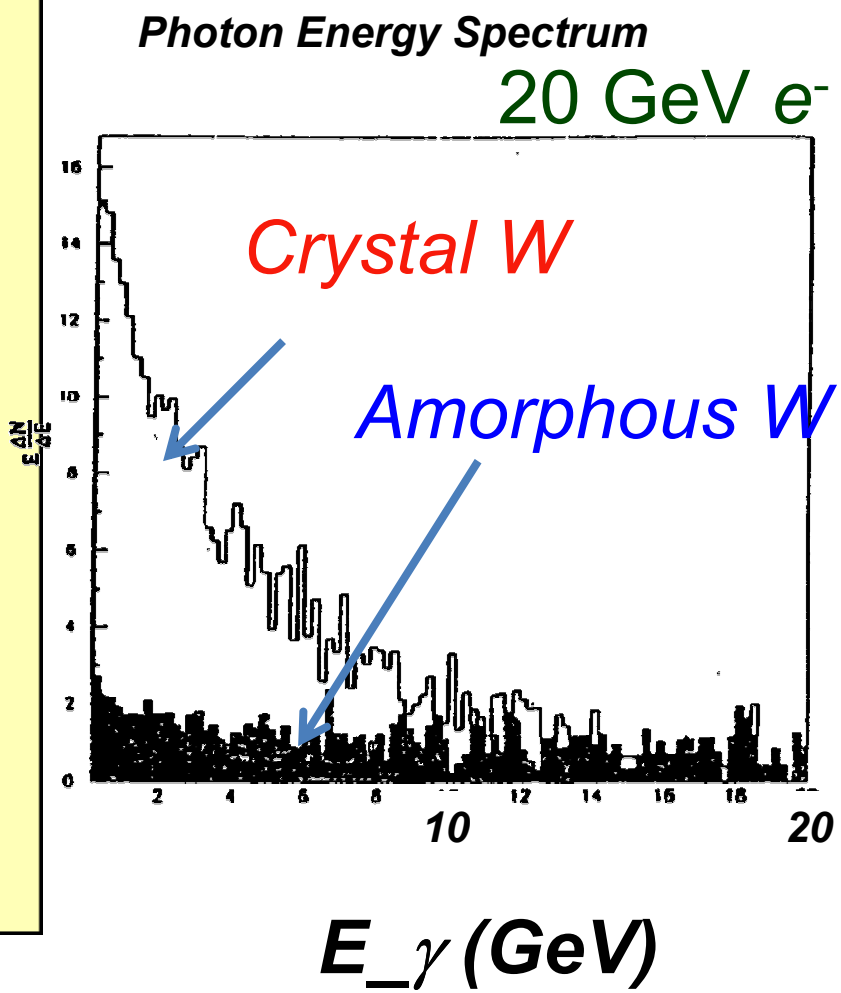
2009/6/

Principle of Crystal Assisted Positron Generation

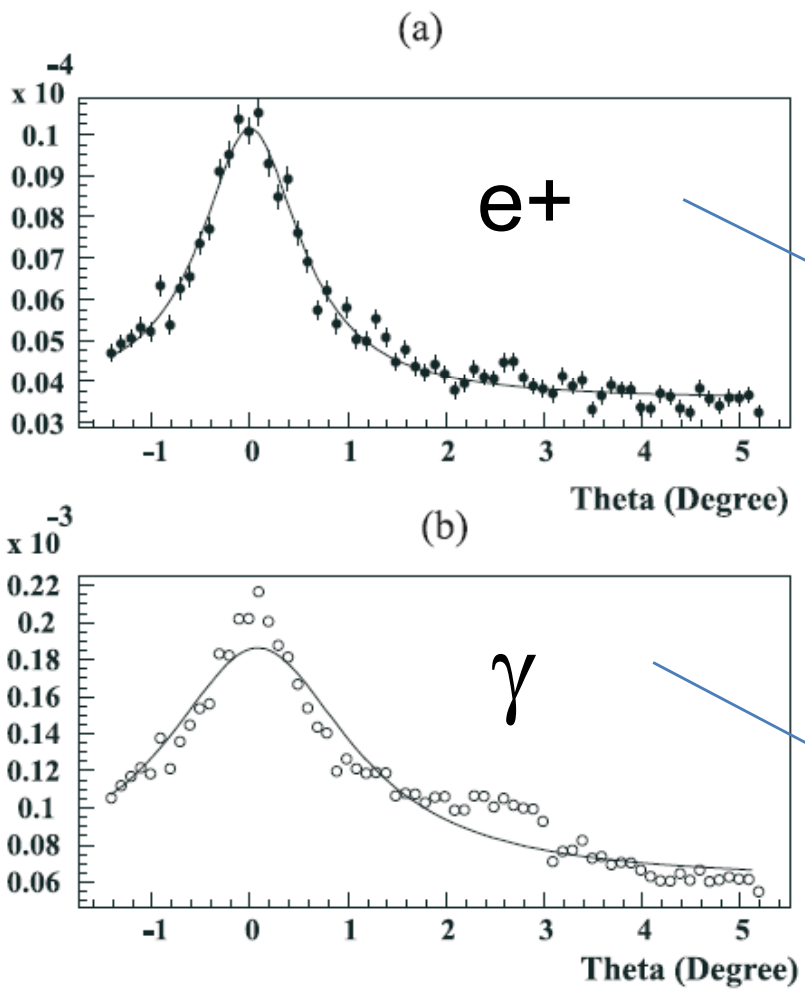
Suwada

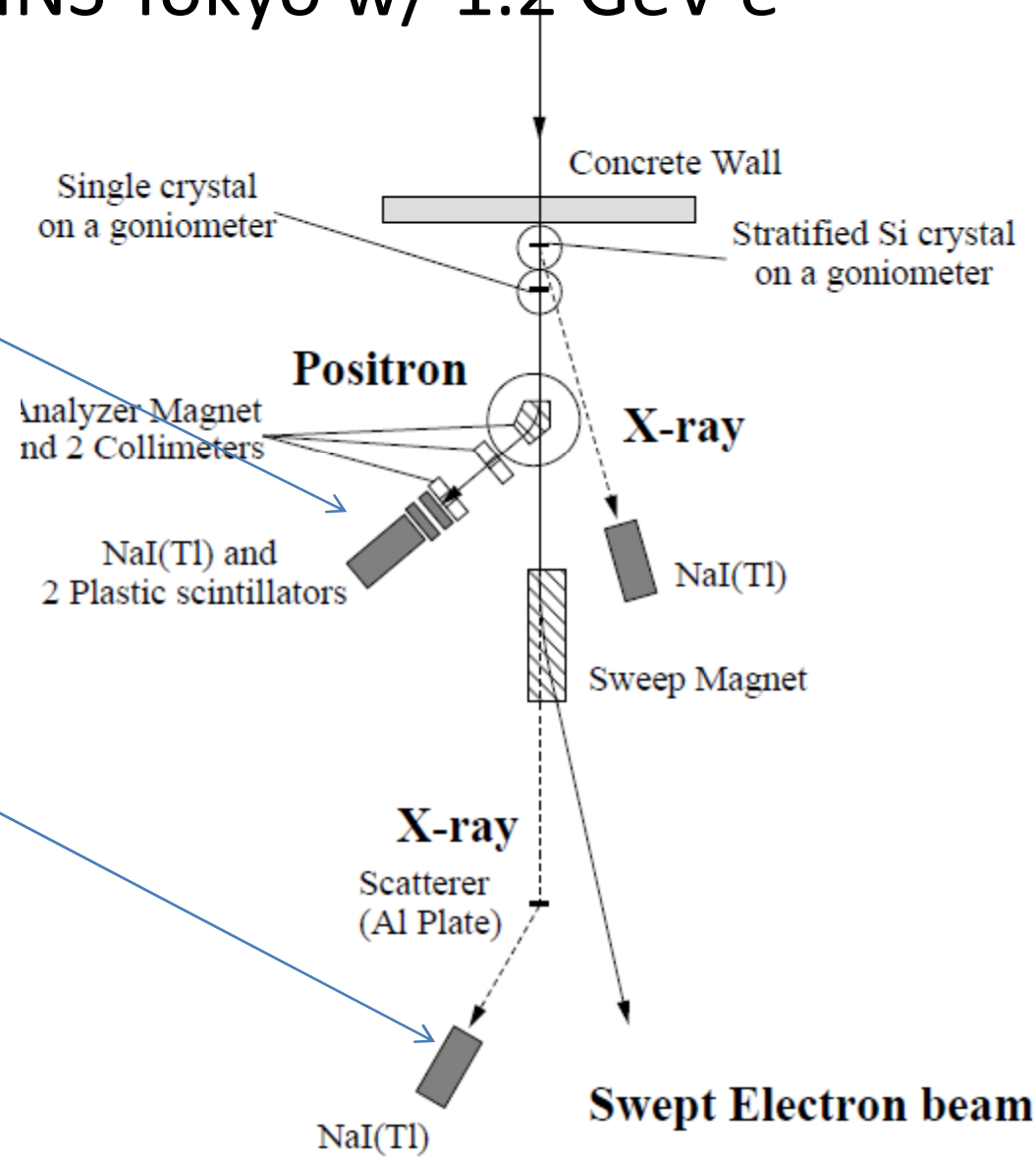




Experiences in Japan

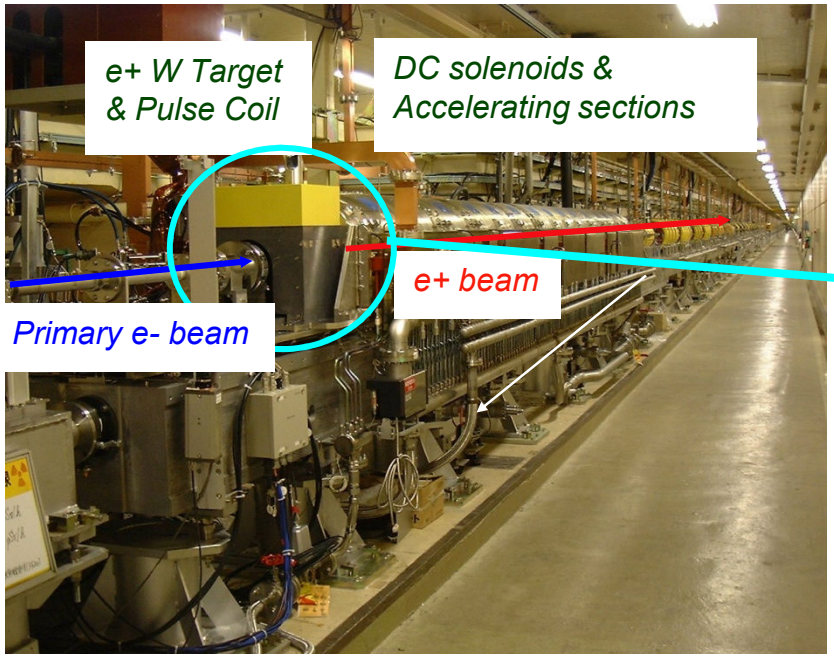
- First experiment at INS Tokyo w/ 1.2 GeV e-

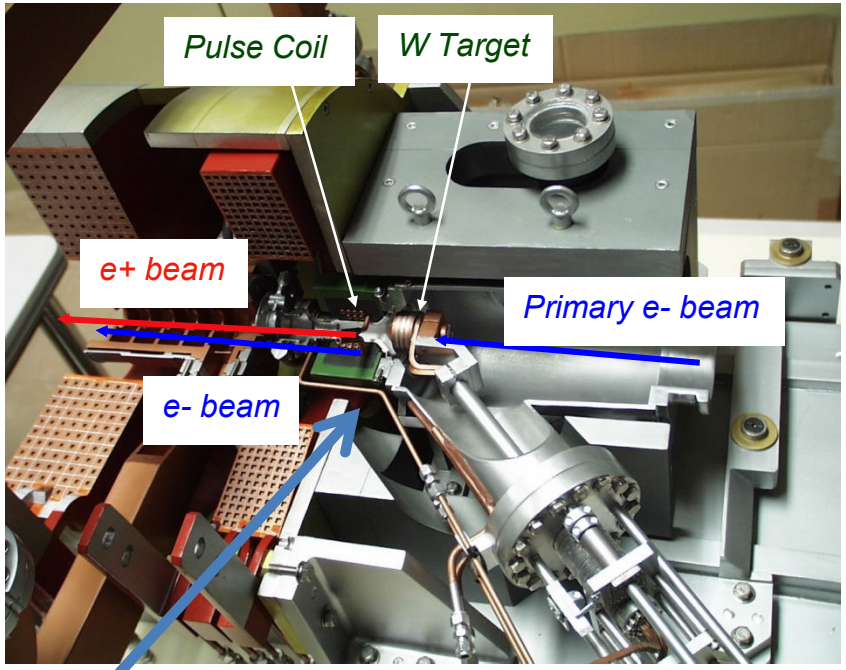


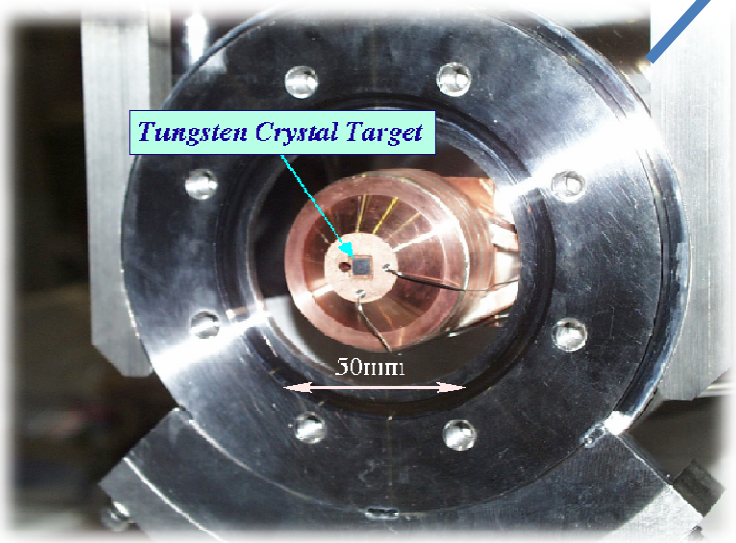


Angle of Si w.r.t. e-

Positron Souce for KEKB Injector

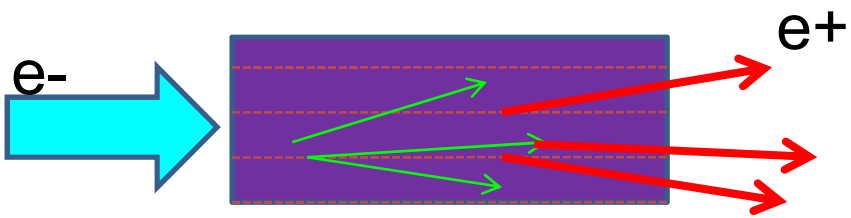




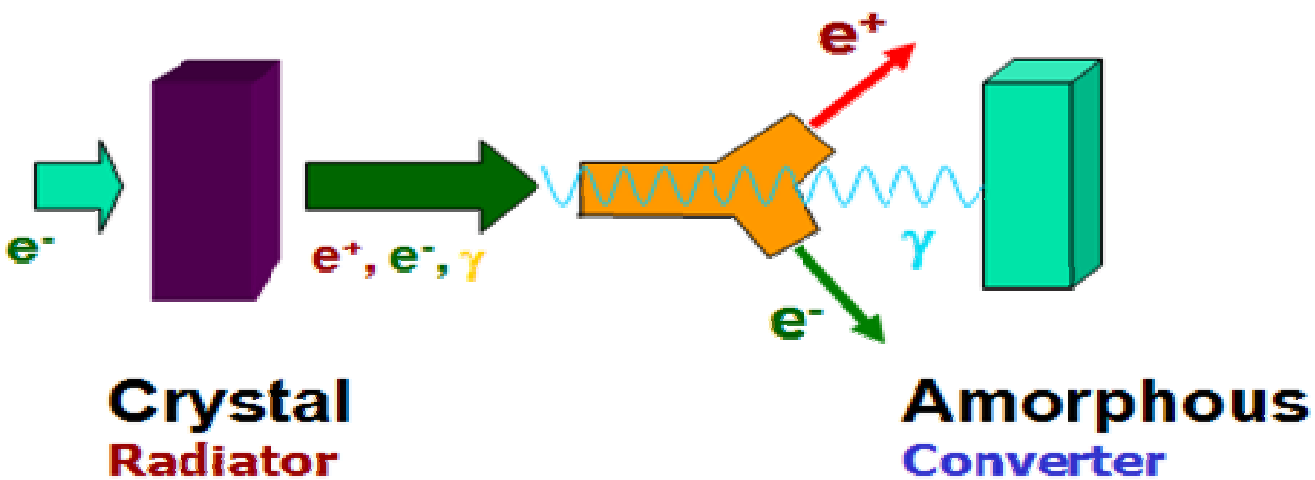


Hybrid Target for ILC/CLIC

- Single crystal target works but does not help to relax heating problem



- Hybrid target proposed by Chehab et. al.



reduce heat deposit in converter by ~1/5

POSITRON SOURCES USING CHANNELING FOR ILC & CLIC

- **1-CLIC:**
- **ACCEPTED POSITRON YIELD**
- *** For an incident e- beam with σ = 1 mm => η = 1 e+/e-**
- *** For an incident e- beam with σ = 2.5 mm => η = 0.9 e+/e-**
- **PEDD**
- **Assuming an incident e- pulse of 2.34 10^{12} e-, we have :**

	CRYSTAL		AMORPHOUS	
	PEDD/e- (GeV/cm3/e-)	PEDD/total J/g	PEDD/e- (GeV/cm3/e-)	PEDD/total J/g
σ=1mm	2	38	2.5	48.5
σ=2.5mm	0.35	6.8	0.8	15.5

- **An entirely amorphous target, 9 mm thick, with the same incident e- beam would have provided the same accepted yield and a PEDD of 150 J/g (σ=1mm) or 40 J/g (σ=2.5 mm). This shows the advantages of an hybrid scheme leading to a unique target with a PEDD < 35 J/g using an e- beam with σ= 2.5 mm.**

POSITRON SOURCES USING CHANNELING FOR ILC & CLIC

- **INCIDENT BEAM:** **an incident electron beam of 10 GeV**
- **TARGETS:**
- **CRYSTAL: a 1 mm thick W crystal <111> orientation**
- **AMORPHOUS: a 8 mm thick amorphous target**
- **CAPTURE SYSTEM: AMD with decreasing field from 6 to 0.5 Tesla on 50 cms Accelerating field is 18 MeV/m, peak [SW]**
- **RESULTS: accepted yield: 1.8 e+/e- (σ^{-}=1mm)**
- **1.5 e+/e- (σ^{-}= 2.5 mm)**
- **PEDD: assuming an incident e- bunch of 2. 10^{10} e-**

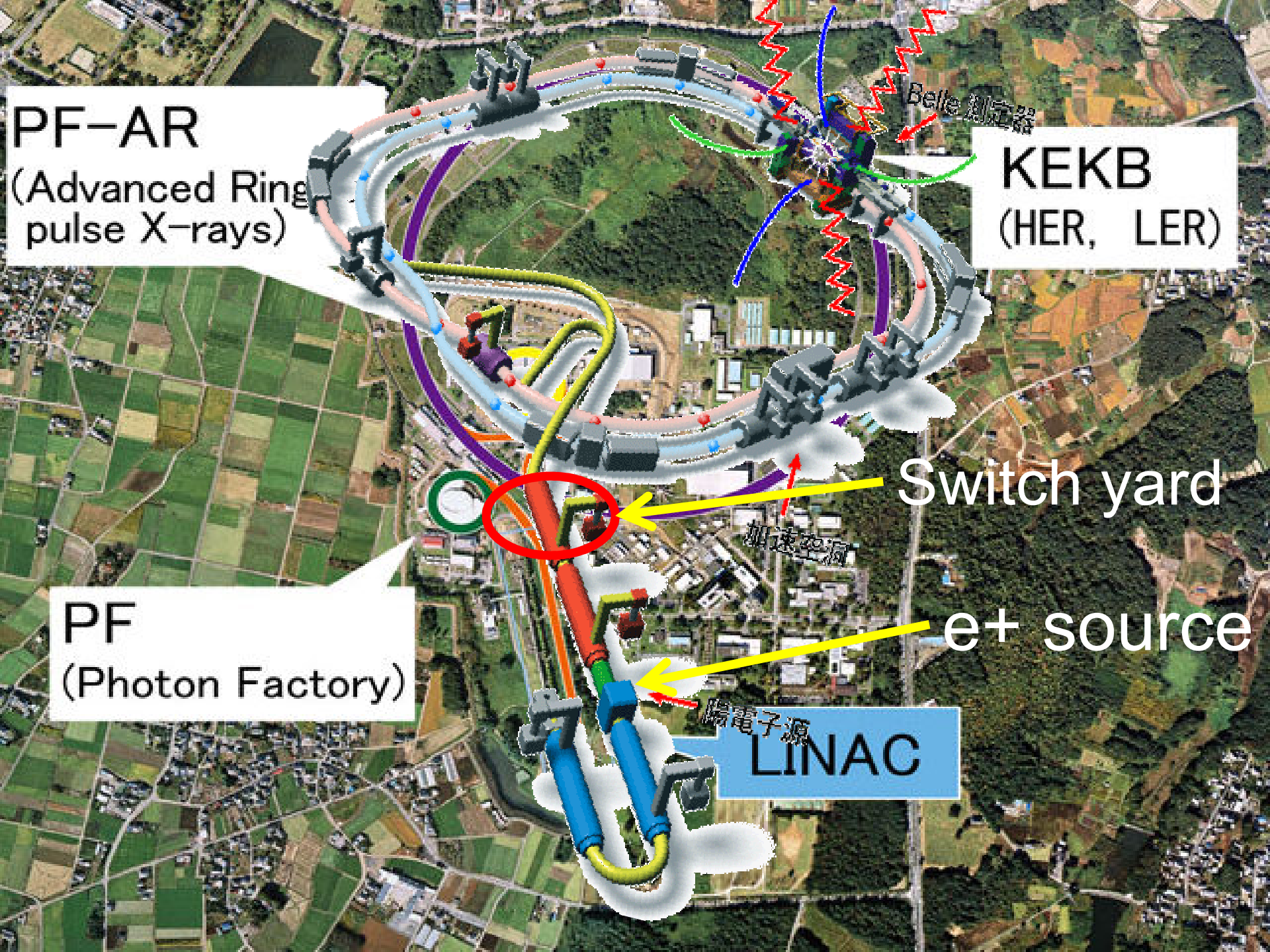
	crystal		amorphous	
	PEDD/e-	PEDD/bunch	PEDD/e-	PEDD/bunch
σ^{-}=1mm	2 GeV/cm3	0.33 J/g/bunch	7.5 GeV/cm3	1.25 J/g/bunch
σ^{-}=2.5mm	0.35 GeV/cm3	0.058 J/g/bunch	2 GeV/cm3	0.33 J/g/bunch

- **It is quite clear that the hybrid target cannot sustain the 2820 bunches and that distributed targets system must be considered.**

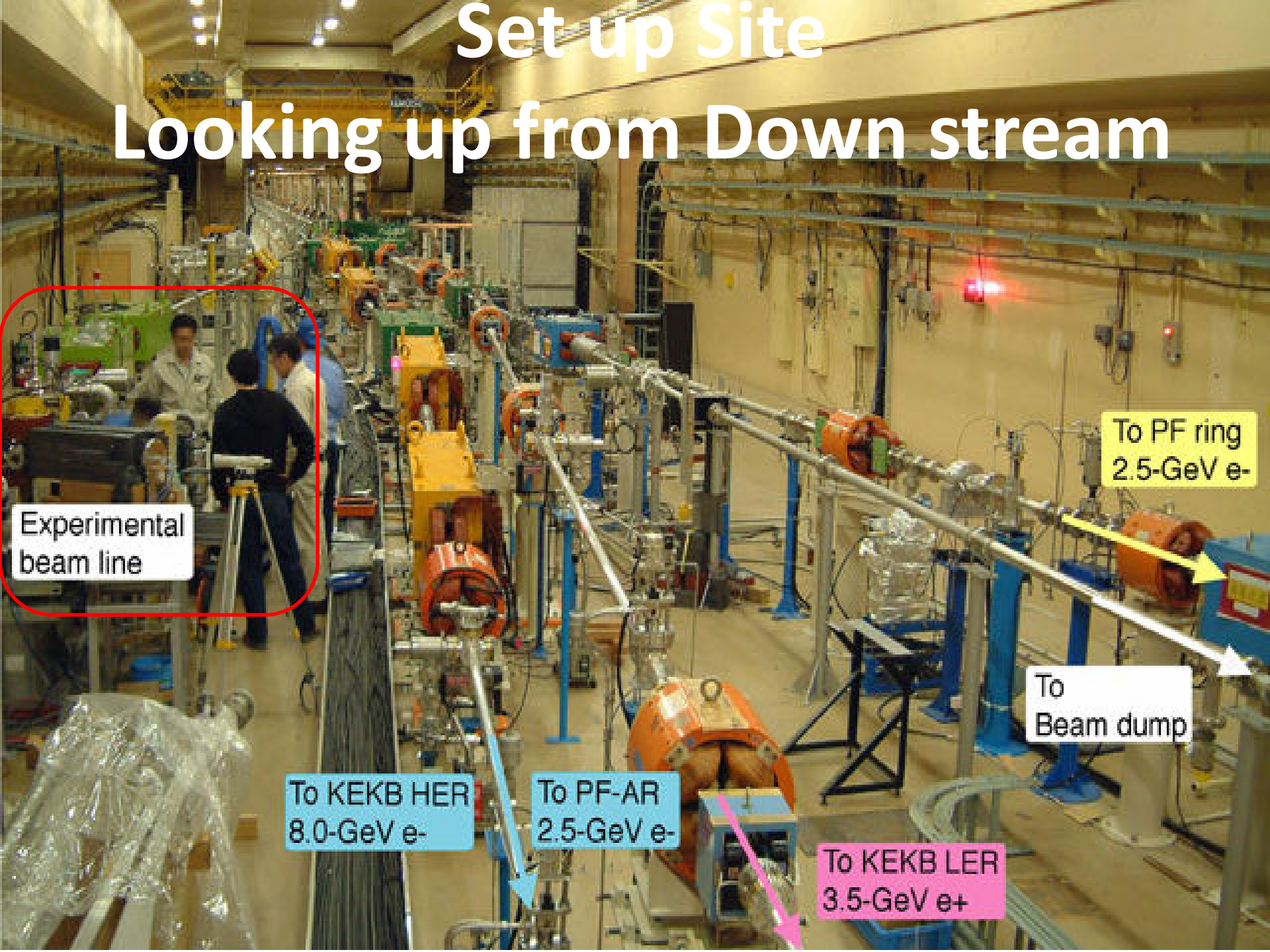
Issues for Hybrid Target

- Hybrid target s would work if
  - positron yield is as estimated
  - heat deposit is low as estimated
  - target system (scheme) is properly designed
    - 300Hz scheme by Omori for the ILC
    - Damage threshold reported by previous experiments is applicable for the system
  - no foreseen problems

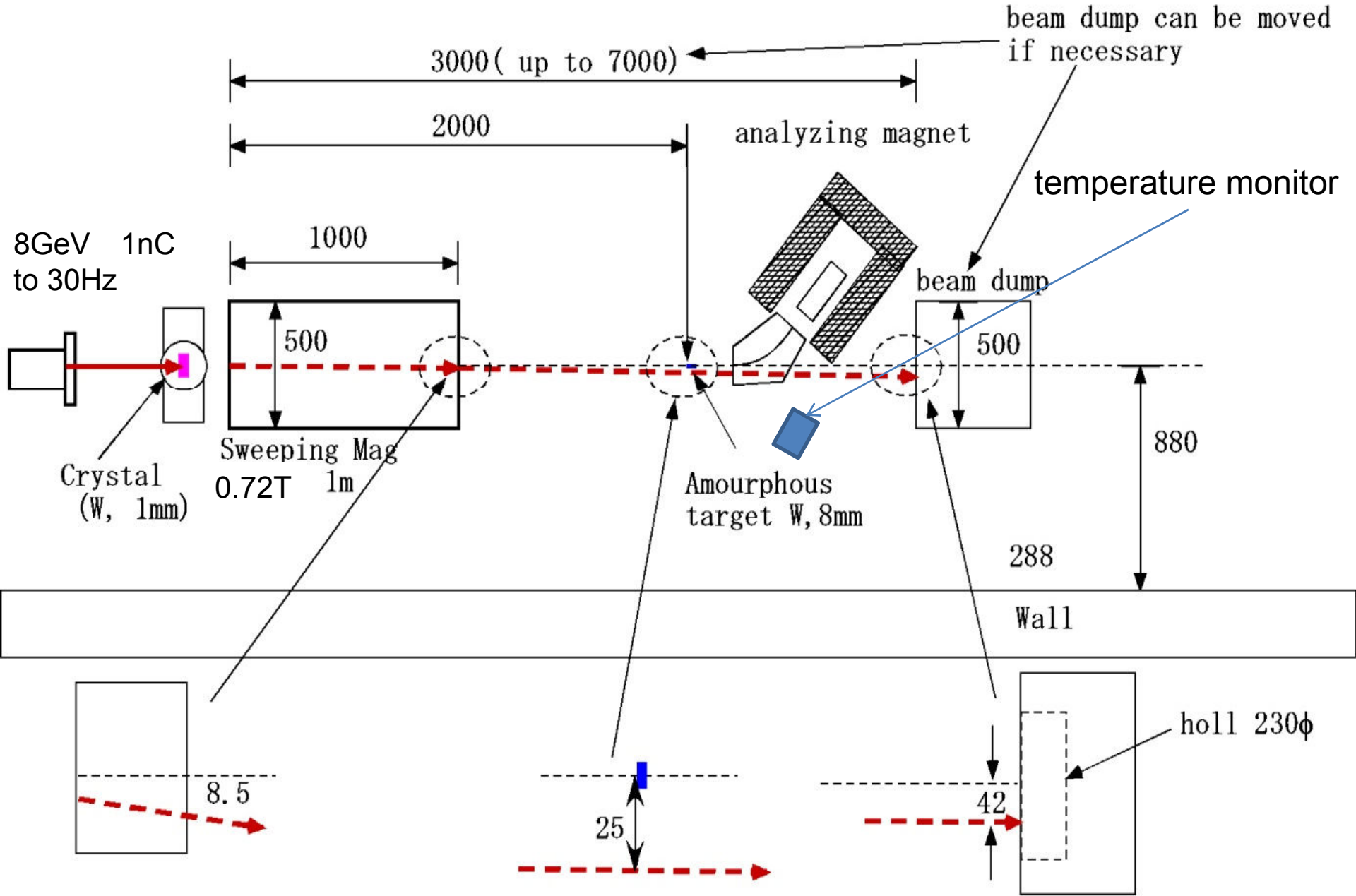
→ test it with existing facility


PF-AR
(Advanced Ring
pulse X-rays)
Belle 測定器
KEKB
(HER, LER)
Switch yard
加速空洞
e+ source
PF
(Photon Factory)
陽電子源
LINAC

Set up Site
Looking up from Down stream



Set up plan


beam dump can be moved
if necessary
3000(up to 7000)
2000
analyzing magnet
temperature monitor
8GeV 1nC
to 30Hz
1000
beam dump
500
500
880
Sweeping Mag
0.72T 1m
Crystal
(W, 1mm)
Amourphous
target W,8mm
288
Wall
holl 230ϕ
8.5
25
42

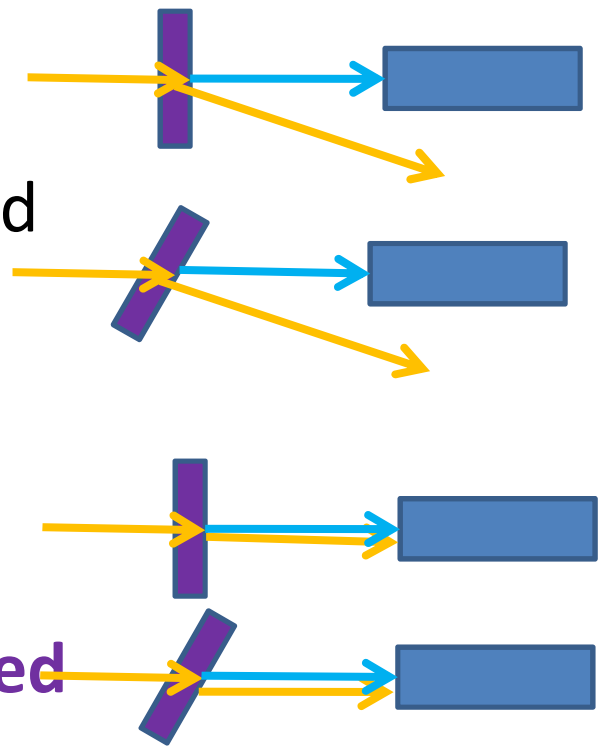
ATF magnet reused for the channeling exp.

magnet (1.2T/500A, 1m-long)

PS, 300A, Temporary

Experimental procedure and check points

1. Positron Yield (analyzing magnet 20-30MeV)
   1. Sweeping magnet ON
      - **1.1 Positron yield: crystal aligned**
      - 1.2 Positron yield: crystal non aligned
      - 1.3 rocking curve
   2. Sweeping magnet OFF
      - 2.1 Positron yield: crystal aligned
      - **2.2 Positron yield: crystal non aligned**



- yield for 1.1/1.2 ~5?
- yield for 1.1/2.2 ~1?

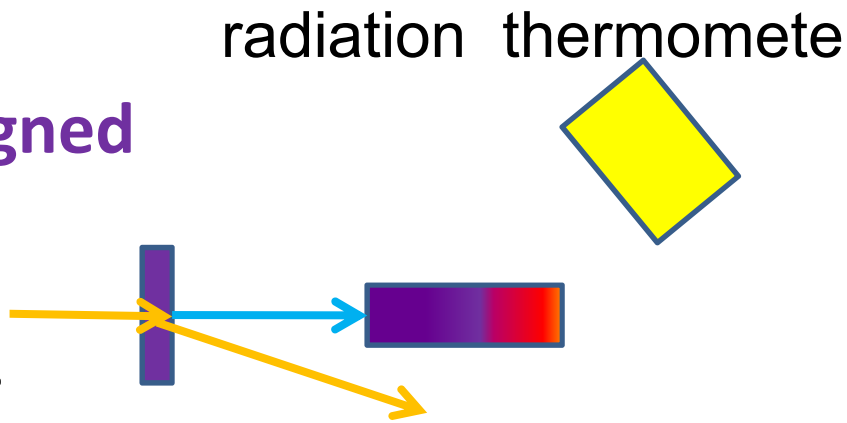
Temperature of amorphous target

1. Sweeping magnet ON

   1.1 Positron yield: crystal aligned

   1.1.1 temperature vs positron yield

   1.1.2 changing repetition

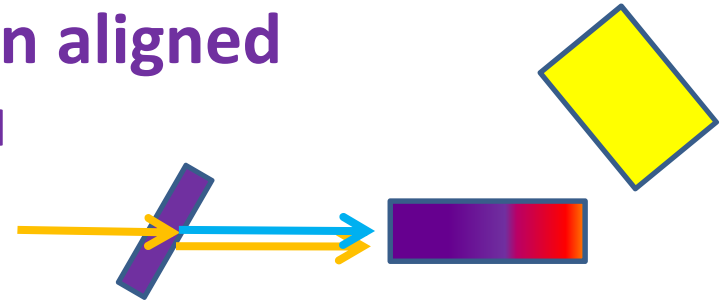


2. Sweeping magnet OFF

   2.1 Positron yield: crystal non aligned

   2.1.1. temperature vs positron yield

   2.1.2 changing repetition



- Temparature 1.1/2.1 ~1/3~1/5?

Momentum and angle dist

- momentum measurement
  - 10MeV ~ 40MeV covered by existing analyzing magnet
  - care to aviod multiple scattering is necessary for low momentum measurement
- angular distribution
  - put analyzing magnet on movable table
    - we did it before

probably in next year

out come from the meeting yesterday

- In addition to 8mm amorphous, thin converter is preferable to measure photons from crystal
  - put them on movable table
    - possible, matter of manpower
- should consider size and distance from crystal of amorphous target
  - angular divergence of photons
    - Linhard angle ~ 0.5mr, $1/\gamma$ ~ 0.05, θ_{MS} in crystal ~ 1mr
- Air Chrenkov detector downstream of amorphous for the alignment
- Acceptance of analyzing magnet?

Schedule

- July '09
  - Installation of sweeping magnet
- July ~ Aug. '09
  - W crystal will be delivered ~ Aug. 10
  - preparation of the exp.
    - DAQ, Detectors, ,,,,
- September '09
  - first time window for the experiment
- By March '10
  - seeking time widow for another experiment
- April '10 ~
  - momentum, angle measurement
  - possibility of beam time after KEKB shutdown for upgrade

yield,
temparature

Prospect for the KEKB experiment

- What we will learn from KEKB LINAC exp. are
  - positron yield by hybrid target
    - relative yield to amorphous target
      - positron yield at 30 MeV in 2009 exp.
  - converter(amorphous) target temperature
    - comparison of hybrid and amorphous target
      - normalized by positron yield at 30MeV in 2009 exp.
    - equilibration temperature (not instantaneous)
  - momentum, angular distribution
    - up to 40 MeV possible ?
    - angular distribution in 2010

Further issues for positron sources

- What we will not learn from KEKB LINAC exp are
  - PEDD in amorphous target
    - observable is equilibration temperature of the target
    - PEDD is by calculation
  - Damage threshold of the amorphous target
    - 35J/g applicable for ILC scheme?
      - 44 bunches in 264 ns or 132 bunches in 992ns
  - effect of temperature on crystals
    - in case of multi-bunch injection
      - needed to be below Debye temperature
      - can be tested by heater

Summary

- test of Hybrid target at 8 GeV electron beam at KEKB LINAC
  - preparation during summer shutdown time
  - beam time possibility in September 2009
- demonstrate basic property s this year
  - e+ yield and temperature of the target,
- more can be possible next year