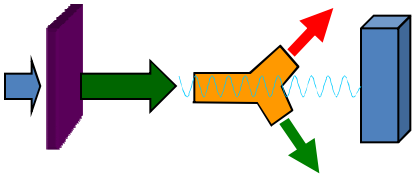


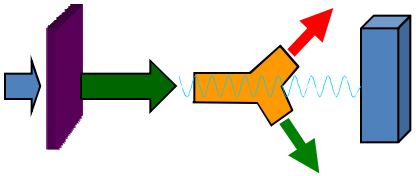
Status of Hybrid target R&D at KEK-LINAC

T.Takahashi

Hiroshima University

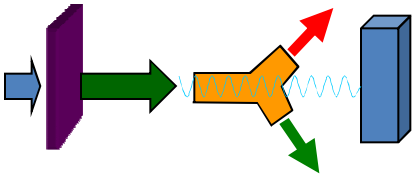
Collaborators:
V. Strakhovenko O. Dadoun, R. Chehab, A.Variola,
T.Kamitani, T.Suwada, T.Omori, J.Urakawa,K.Furukawa,
K.Umemori,Sugimura,M.Satoh,T.Sugimura,S.Kawada, T.Akagi

LCWS/ILC10
Beijing



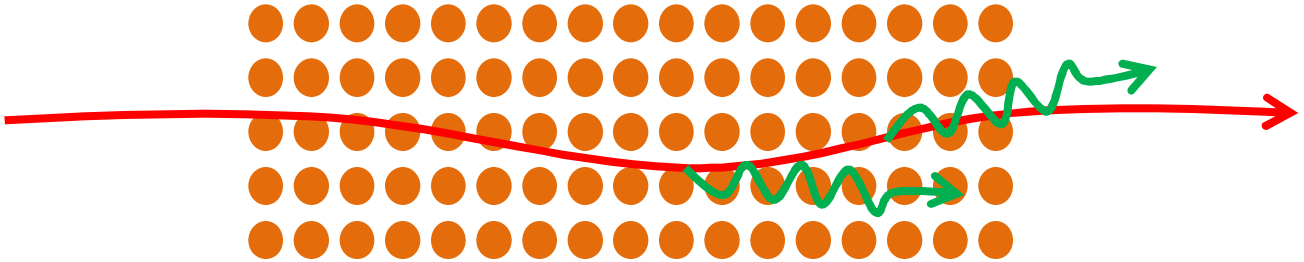
Outline

- Introduction
  - motivation
  - Principle
- Facility
  - KEKB linac
  - Setup
- Preliminary Results
- Outlook

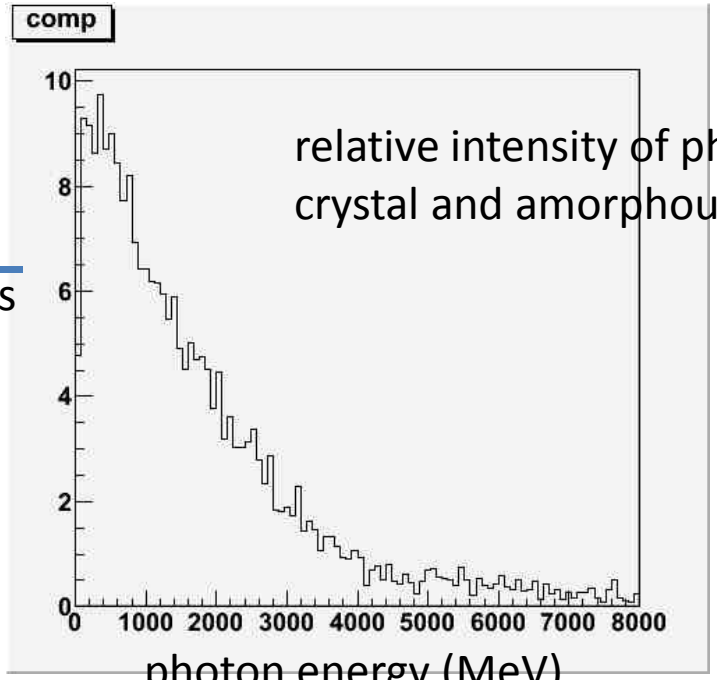


Channeling Radiation

e-

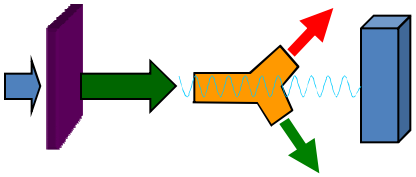


$\frac{\#\gamma \text{ crystal}}{\#\gamma \text{ amorphous}}$



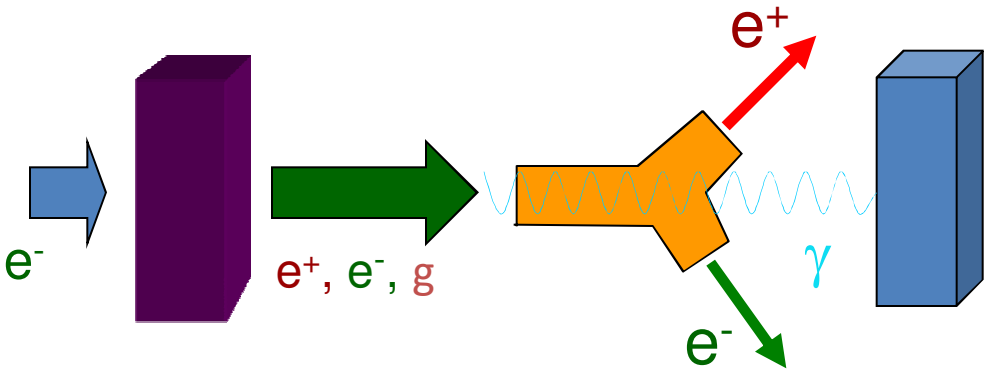
relative intensity of phtons from crystal and amorphous tungsten

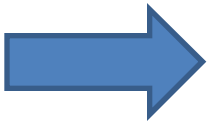
Crystals: converter from high energy electrons to low energy photons



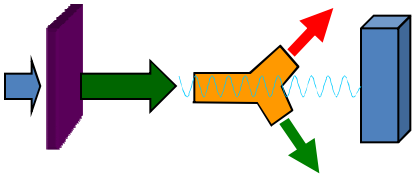
Hybrid target for positron source

- Chehab, Variola, Strakhovenko Scheme for LC positron sources





Experimental study for further development

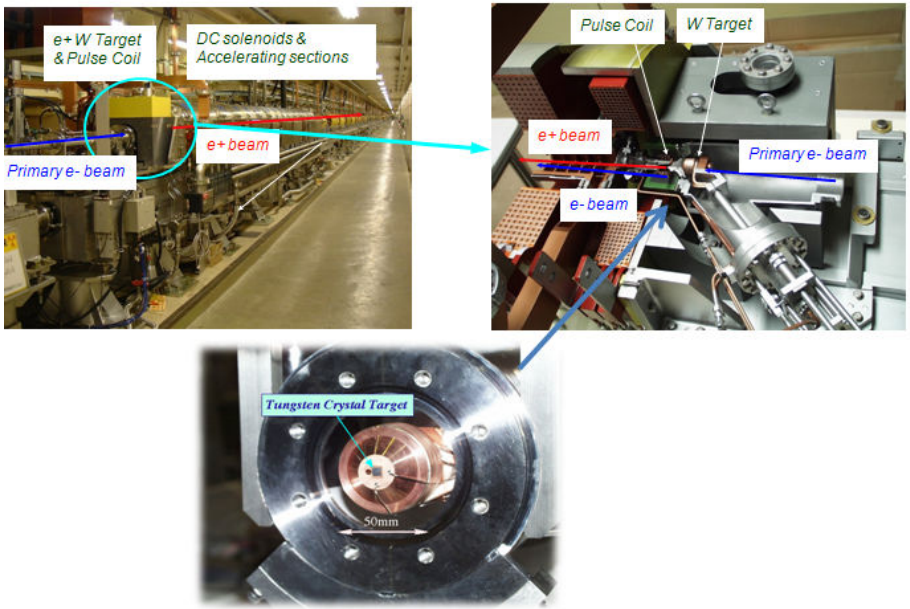


KEKB LINAC

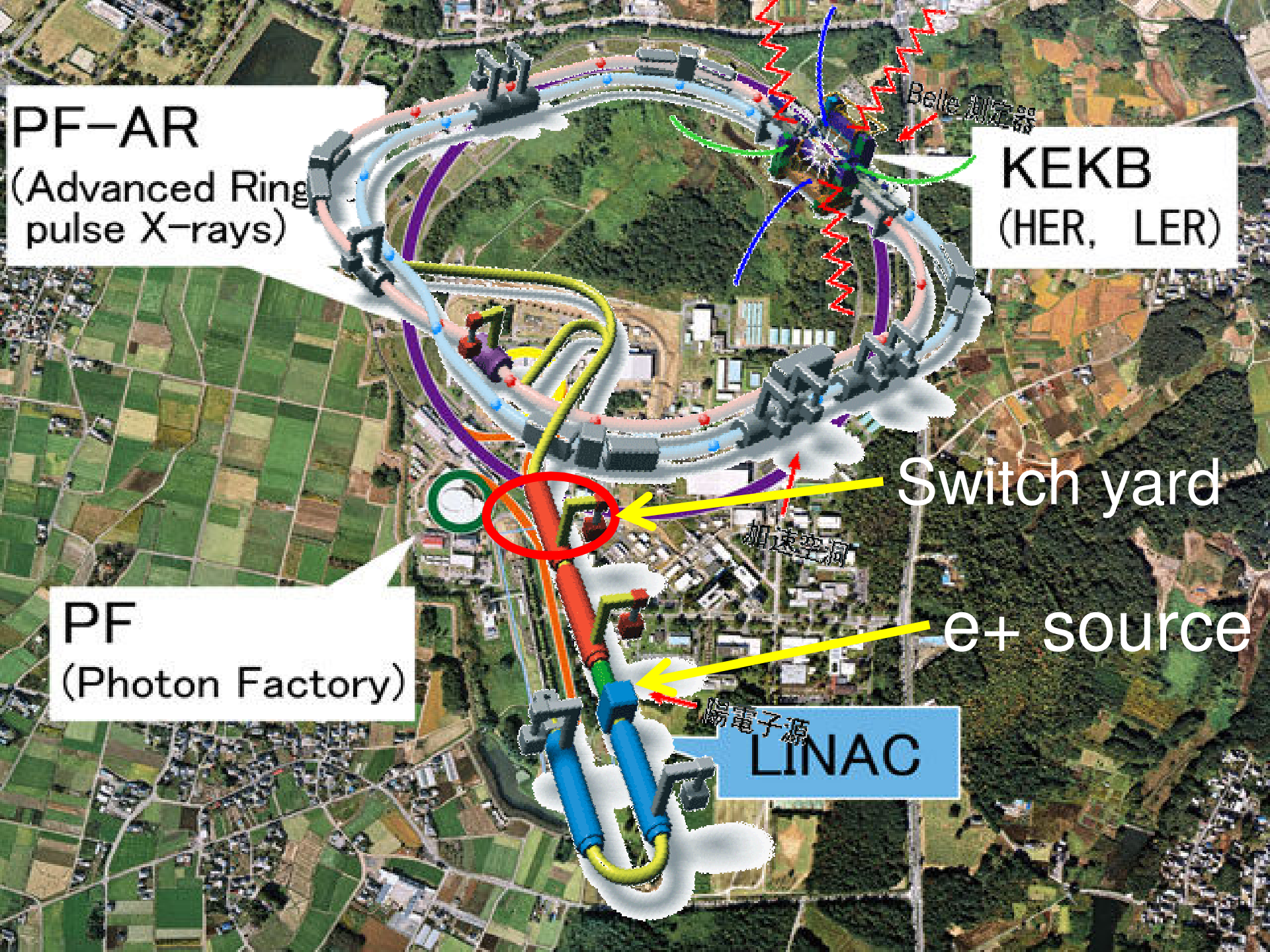
- KEKB LINAC
  - E(beam) : 8GeV Bunch Charge: ~nC

Experiences with crystal targets for KEKB

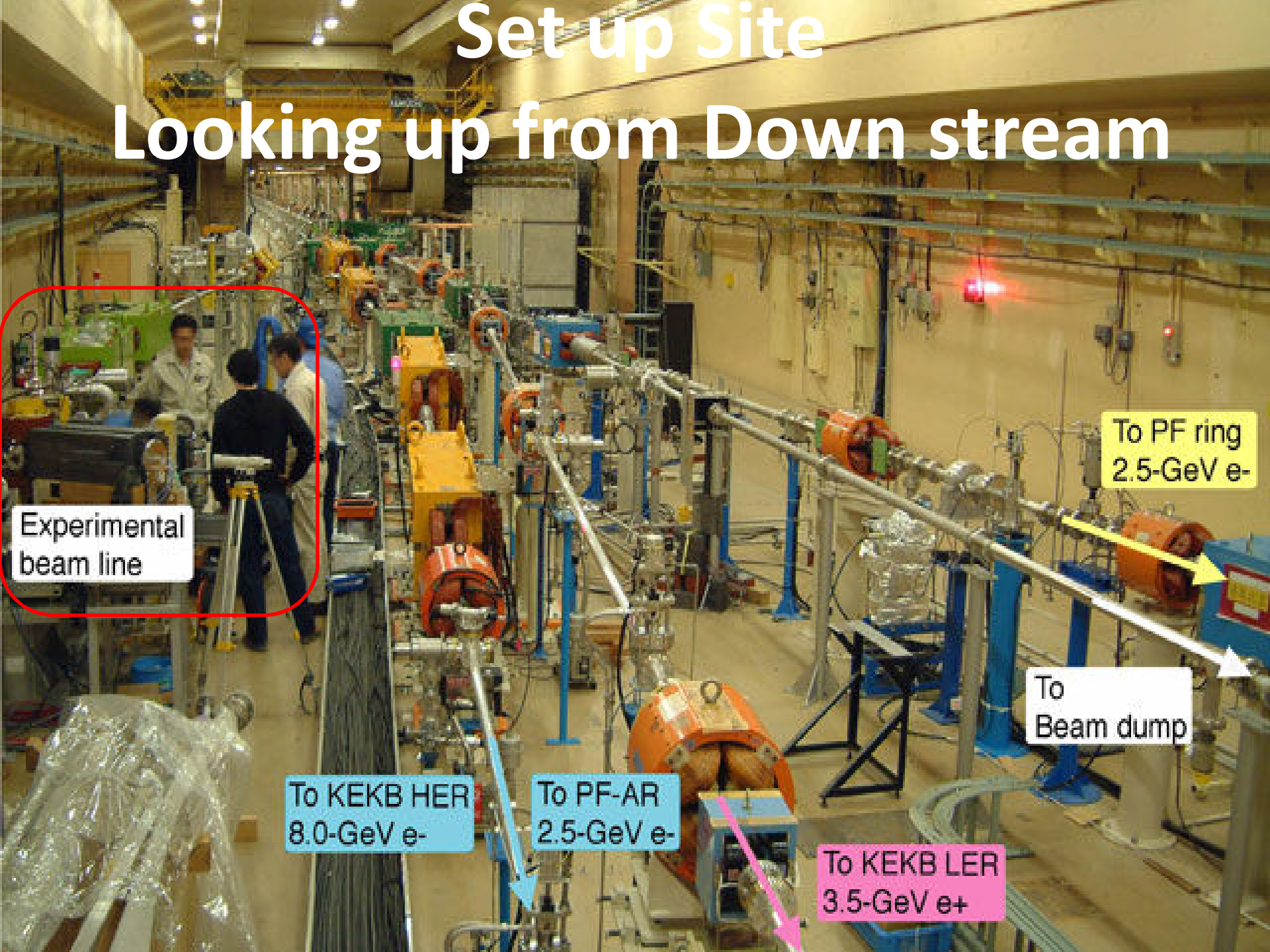
Positron Souce for KEKB Injector



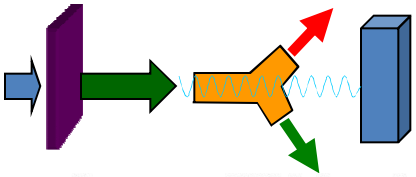
- Ideal for R&D for hybrid target


PF-AR
(Advanced Ring
pulse X-rays)
KEKB
(HER, LER)
Switch yard
e+ source
PF
(Photon Factory)
LINAC

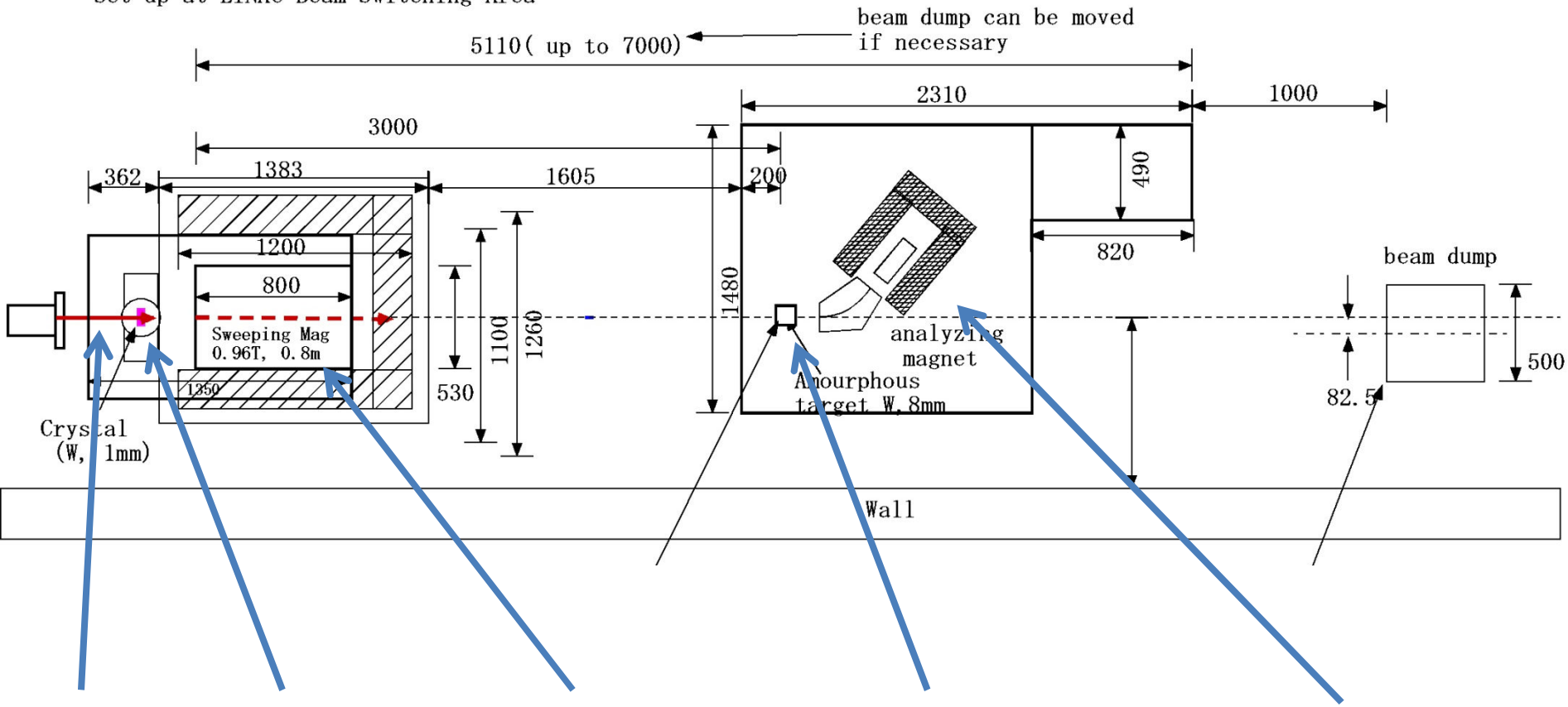
Set up Site
Looking up from Down stream



Setup



Set up at LINAC Beam Switching Area



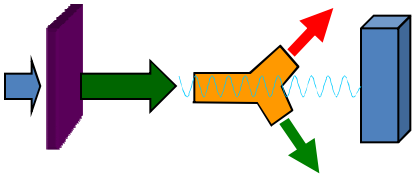
8GeV e-

1mm
W crystal

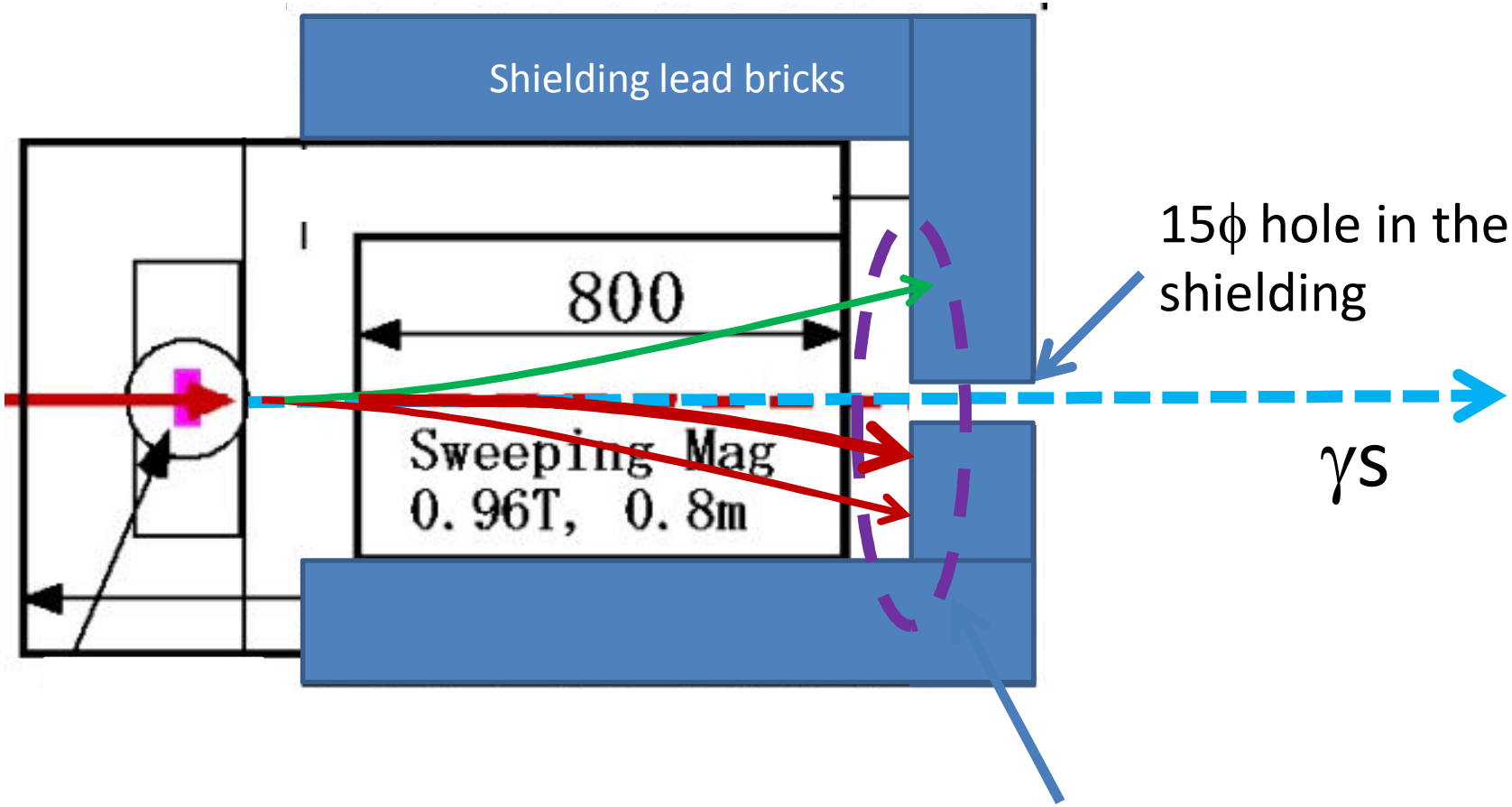
Sweeping Magnet
0.96T 0.75m

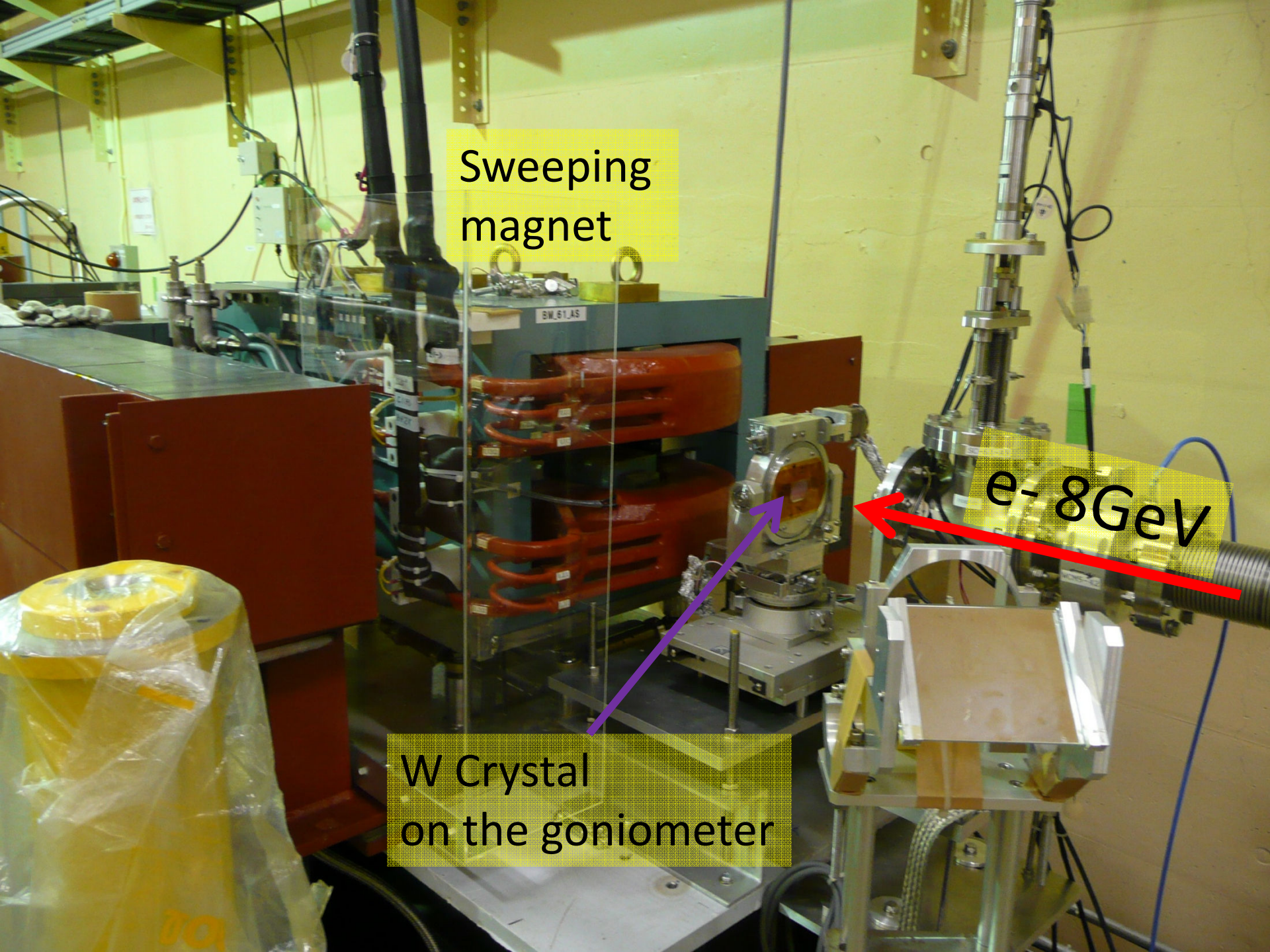
amorphous W
8 mm
18 mm

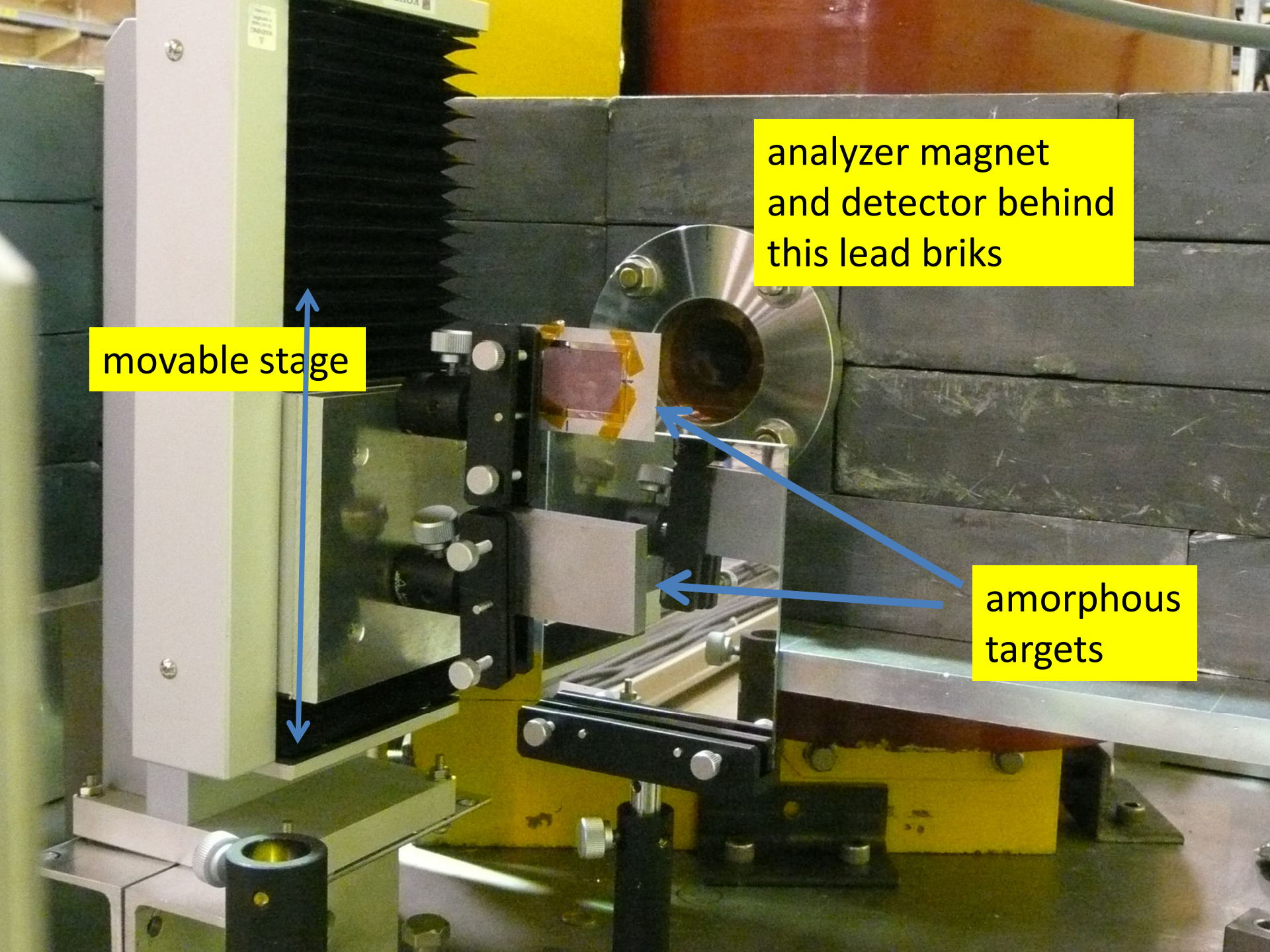
Analyzing magnet
5 ~ 30MeV

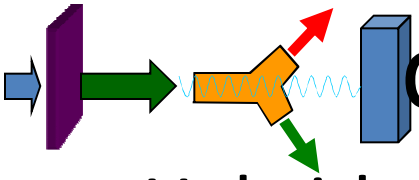


Around the crystal target




Sweeping
magnet
e- 8GeV
W Crystal
on the goniometer


analyzer magnet
and detector behind
this lead briks
movable stage
amorphous
targets



data shown today

- Hybrid

8mm W amorphous

e 8GeV

sweep mag

γ

1mm W Crystal

on axis (aligned to the beam)

off axis (not aligned to the beam)

positrons from the target momentum analyzed

temperature at the end of the targets by thermocouples

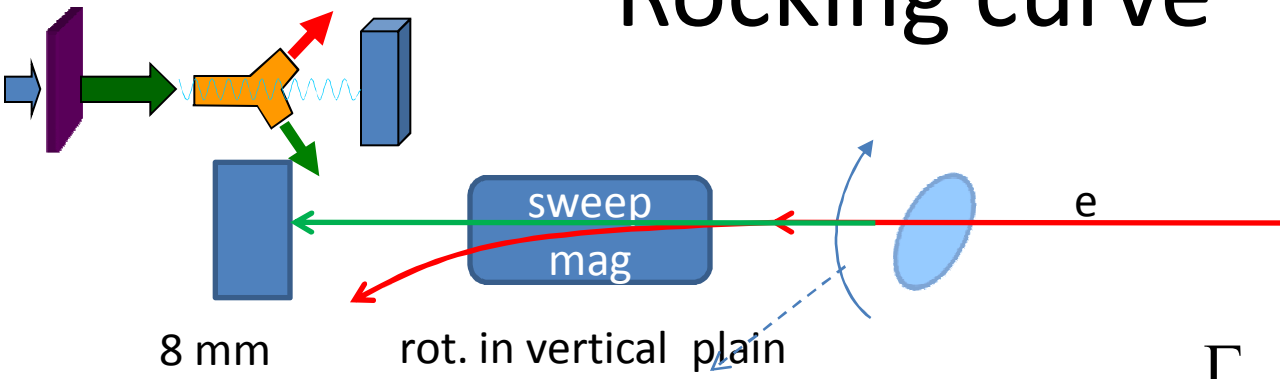
- Conventional

e 8GeV

W amorphous

8mm or 18mm

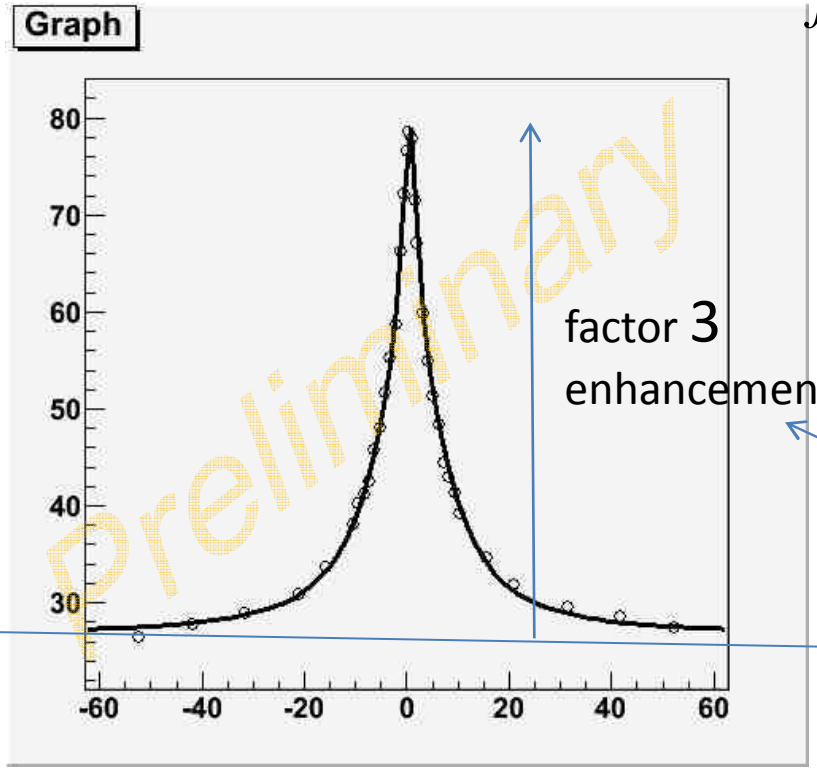
Rocking curve



$$f(\theta) = A\frac{\Gamma_1}{(\theta - \langle\theta\rangle)^2 + \Gamma_1^2} + B\frac{\Gamma_2}{(\theta - \langle\theta\rangle)^2 + \Gamma_2^2} + Const$$

$$\Gamma_1 = 3.4 \pm 0.1$$

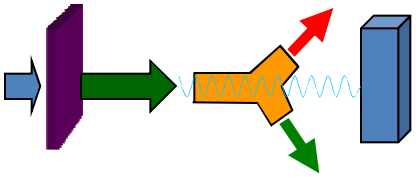
$$\Gamma_2 = 17.7 \pm 0.4$$

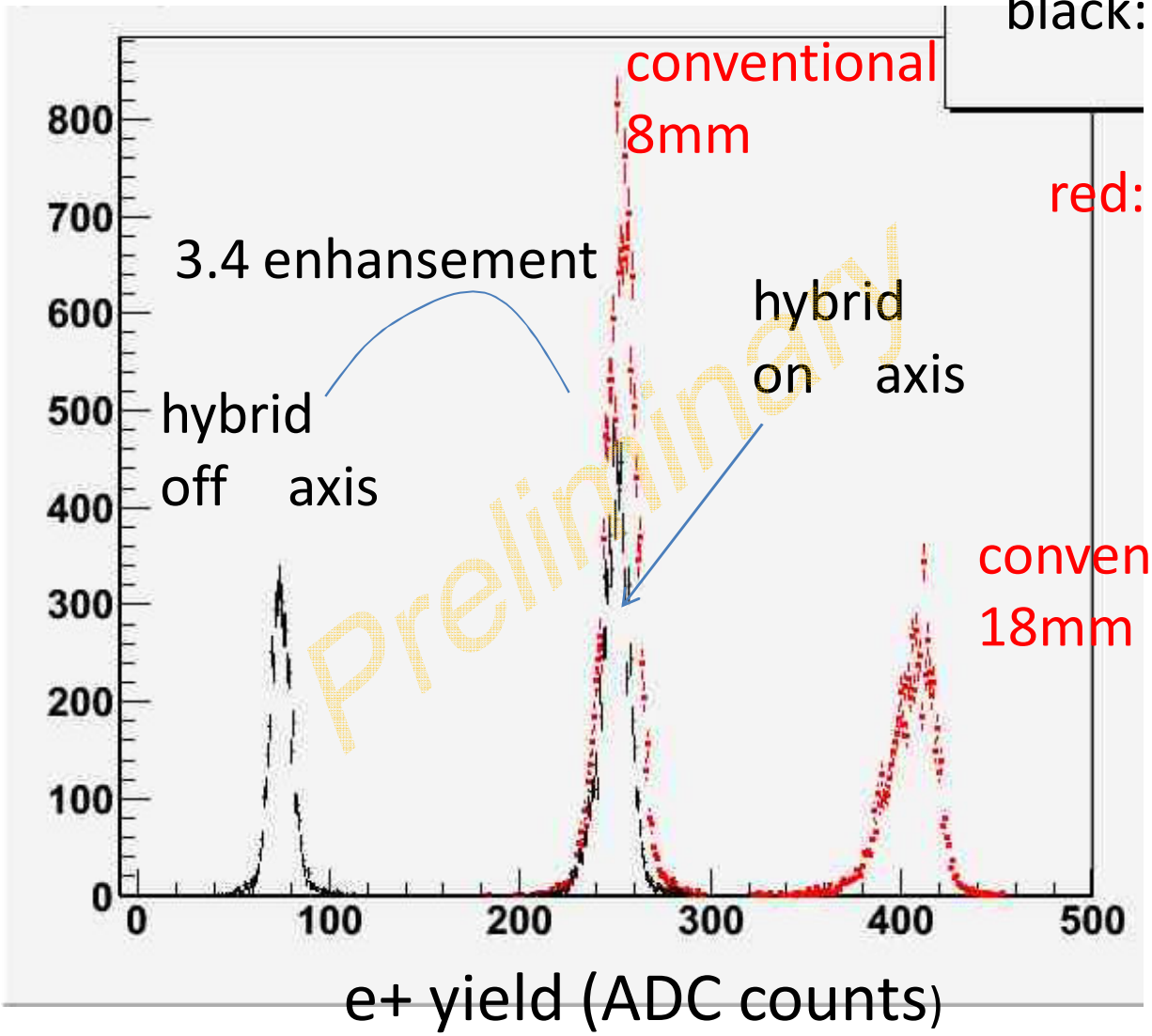


it was 1.2 in 2009 Sep data
we found the detector was
saturated in previous exp.

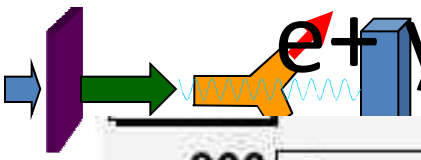
same for horizontal rotation

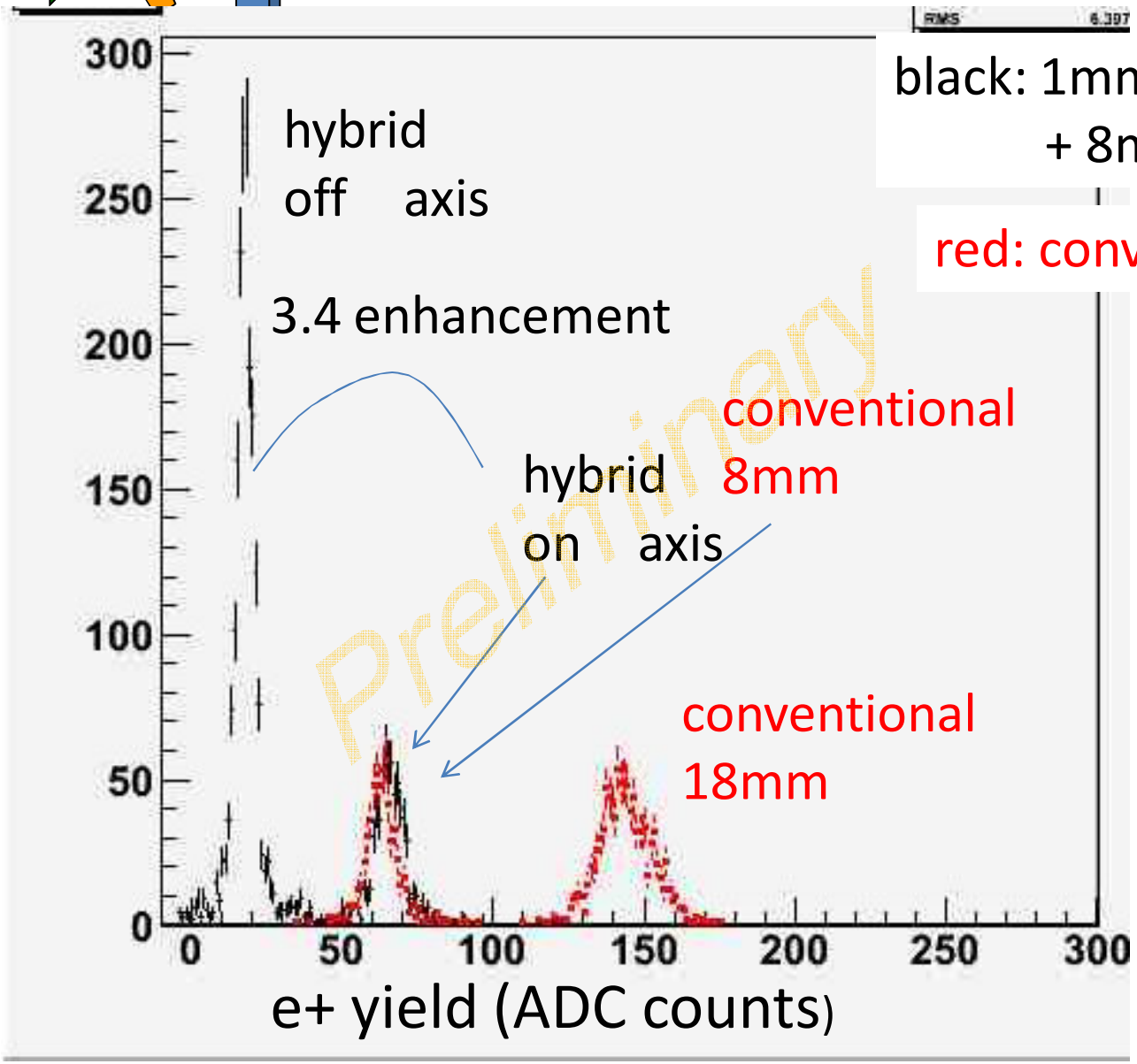
e+ yield (20MeV)





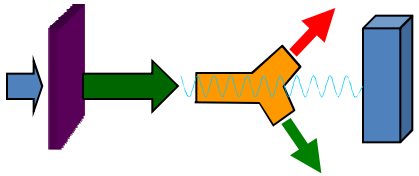
e+ yield (10MeV)



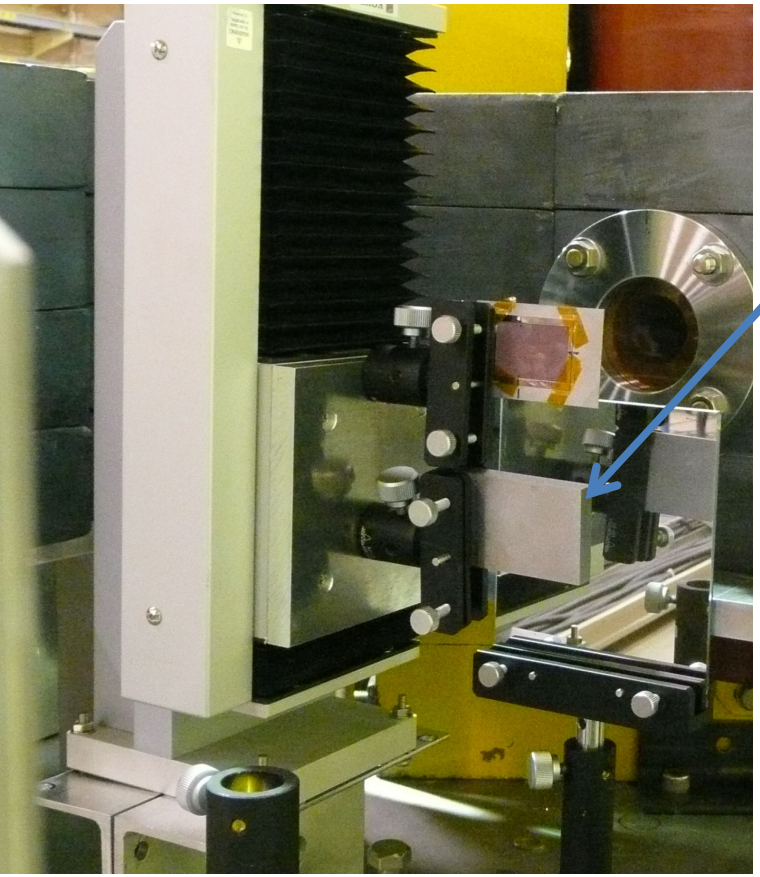


black: 1mm W crystal
+ 8mm W amorphous

red: conventional



Temperature measurements



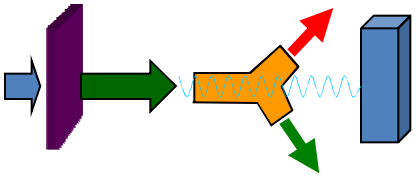
Attach thermocouples behind the target.

$T_{\text{thermal diffusion}}$ ~ 100ms for Tungsten

Slower diffusion via target holders

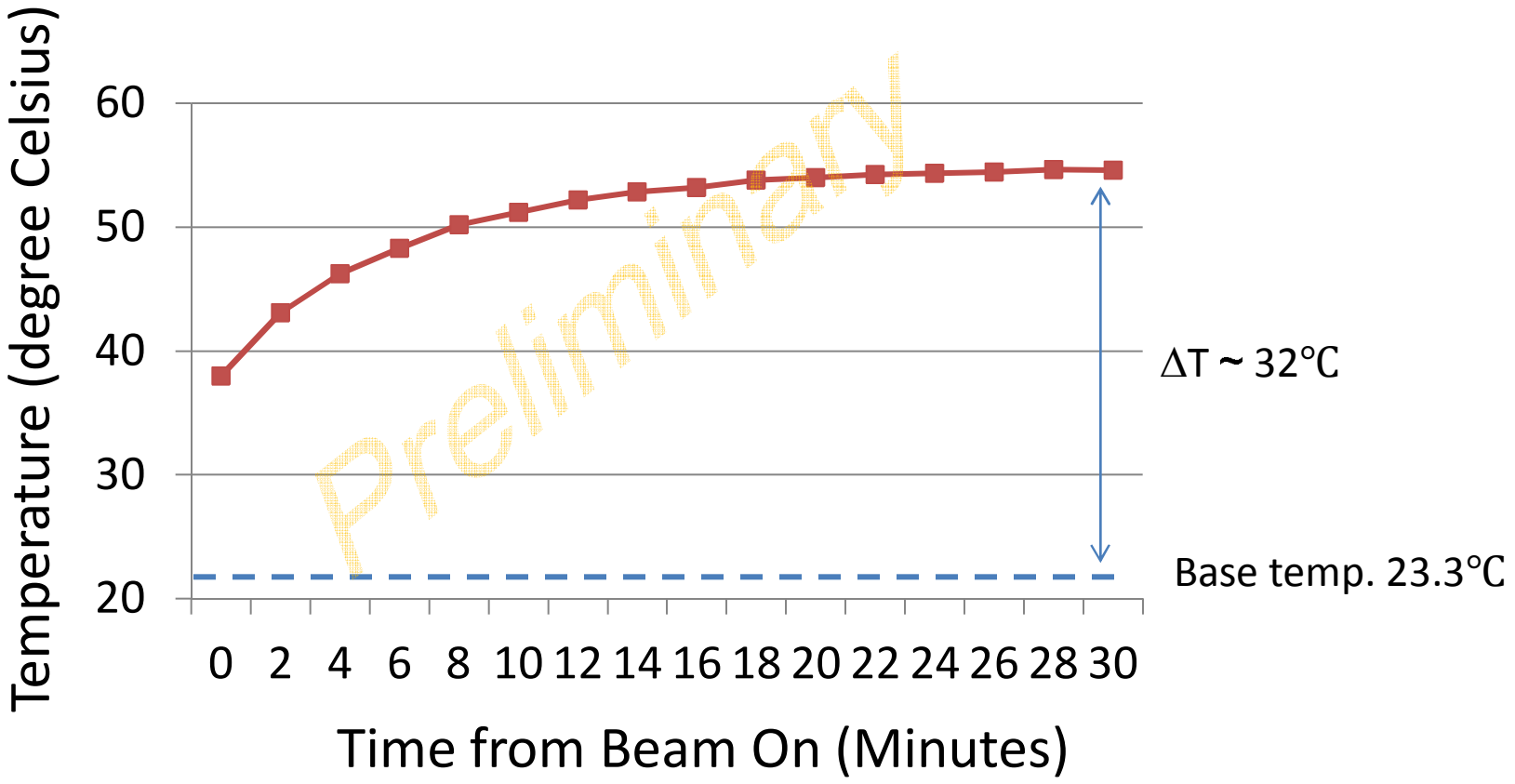
only recorded temperature after reaching equilibrium

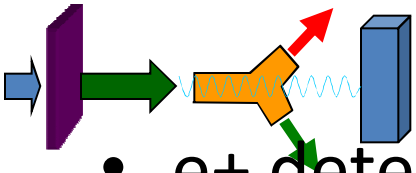
Corresponds to TOTAL energy deposit on the targets



Example of Temperature Measurement

Temperature of the 8mm amorphous target for the hybrid case

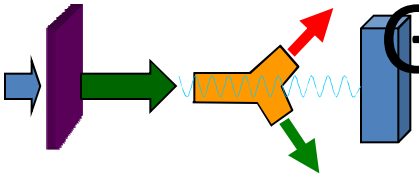




How they look like

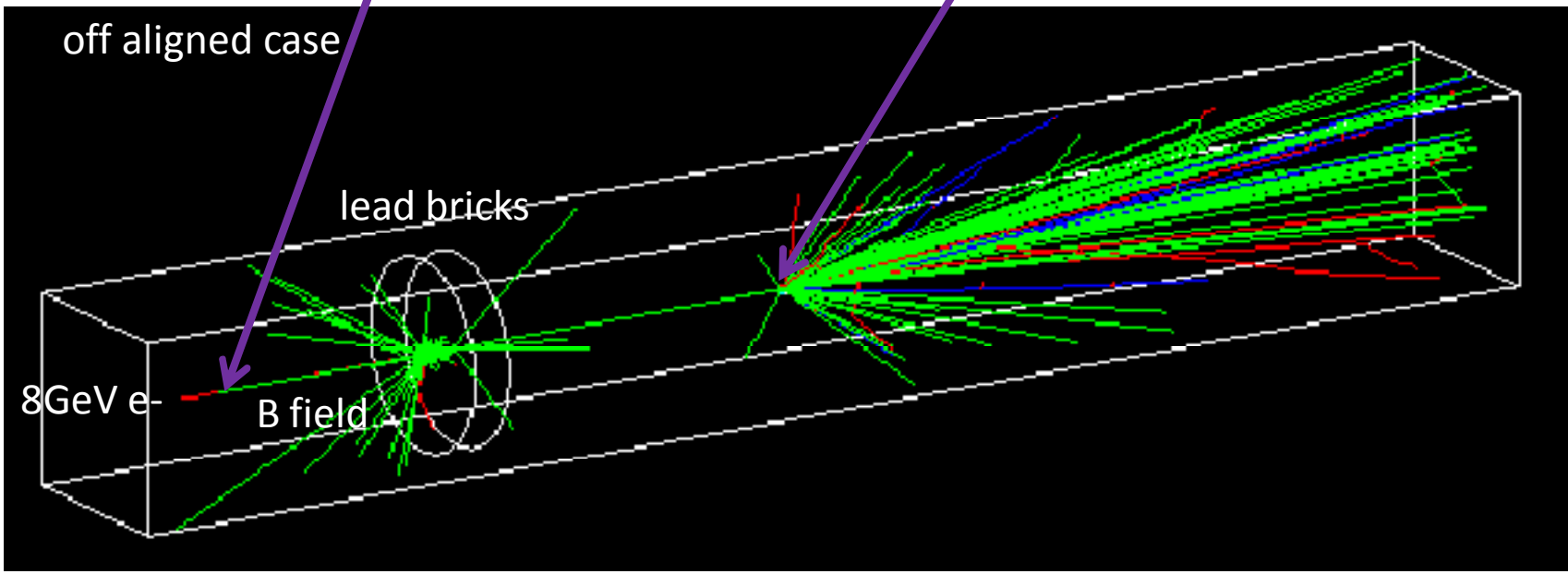
- e+ detected in hybrid configration
  - on axlis/off axis ~ 3.5
- hybrid on axis and conventional with 8mm W
  - e+s are almost same
- temperature rise of amorphous targets
  - For 8mm tungsten
    - hybrid 32.1 ℃
    - conventional 24.7℃
  - for 18 mm tungsten
    - hybrid 110.0 ℃
    - conventional 130.0 ℃
- e+ at 20 MeV and 10MeV
  - 20MeV/10MeV ~ 3.9

Can we understand the these?

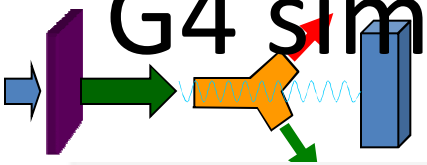


Geant4 Simulation

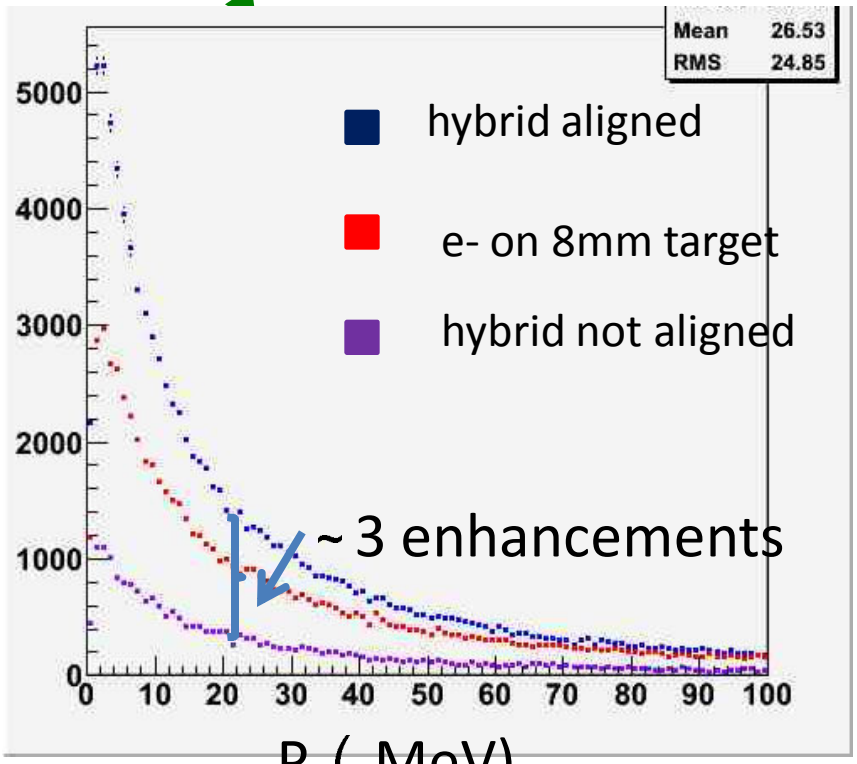
- γs from crystal
  - put simulation date to Geant4
- crystal off aligned
  - 8GeV e- to 1mm amorphous + 8mm amorphous

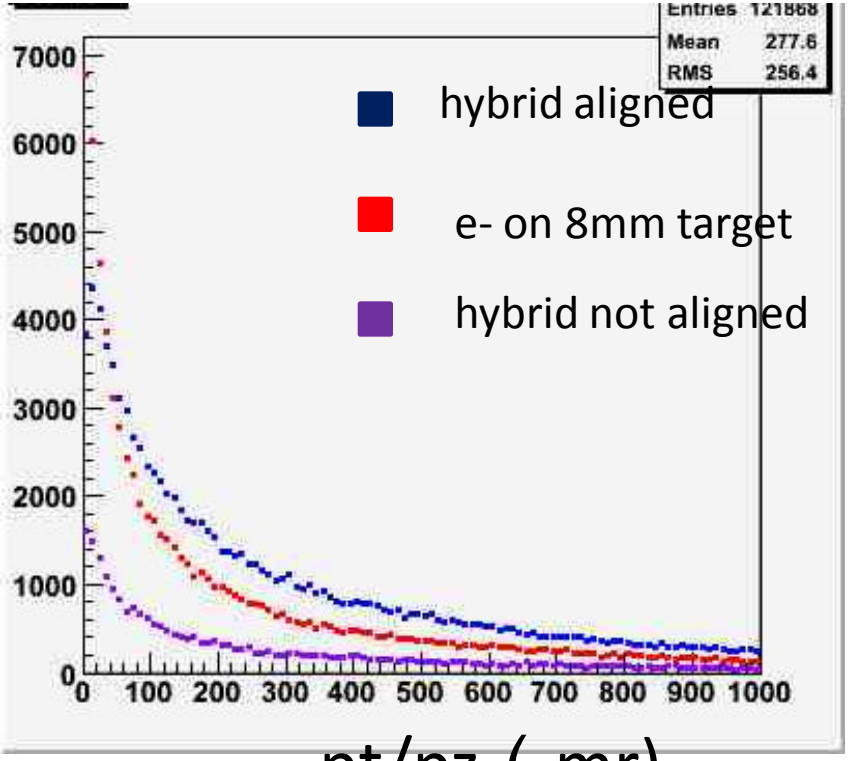


G4 simulation: ALL e+ from targets



corresponds to 1000 e- injunction





hybrid v.s. conventional

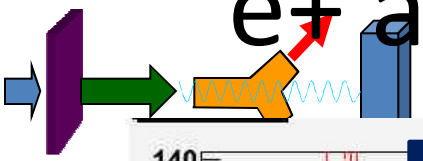
total number of e+ is larger for hybrid (factor 2)

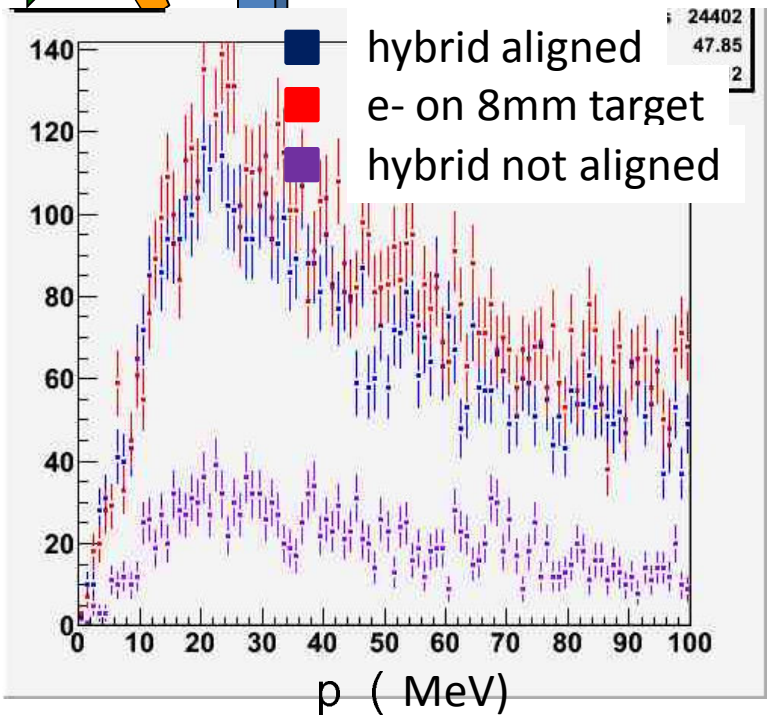
-> larger dEdX and then larger temperature rise for hybrid

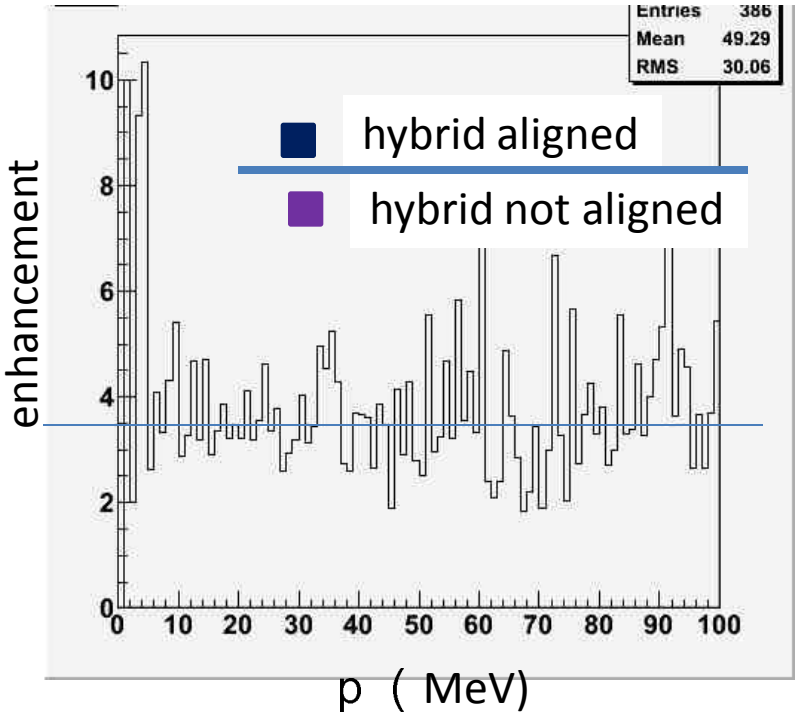
lager angular distribution fof hybrid

# of e+ in detector depends on acceptance of the detection system

e+ after acceptance cut pt/pz < 50mr







# of e+ is same for hybrid and conventional → consistent with the experiment

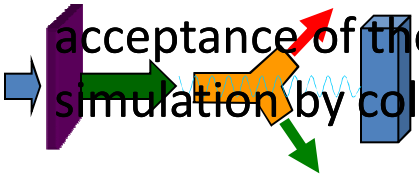
deffernece for on/off aligned crystal is about factor 3 →almost same as the exp.

e+ yield at 20MeV and 10Mev

factor 2 ~ 3 difference by simulation

←→ factor 4 difference in the exp.

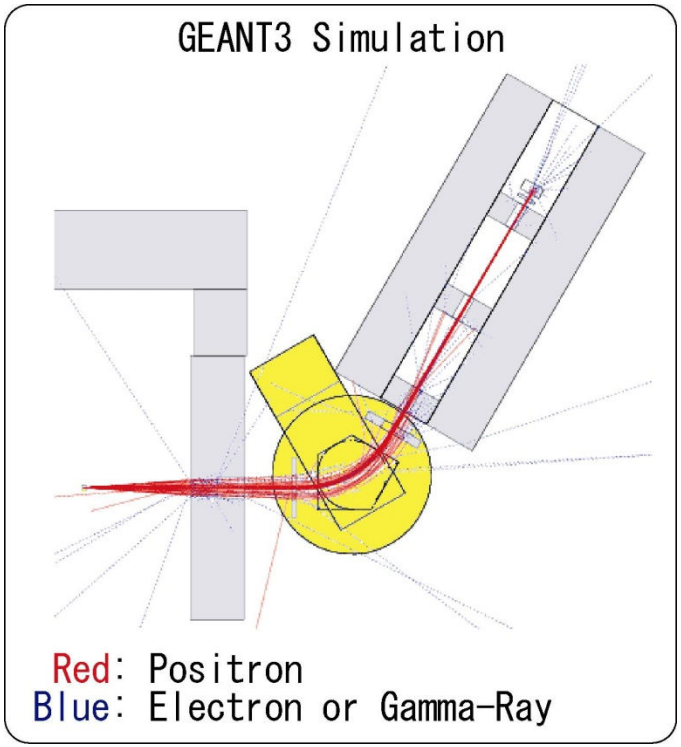
no discrepancy as
the detection system
has p dependent acceptance



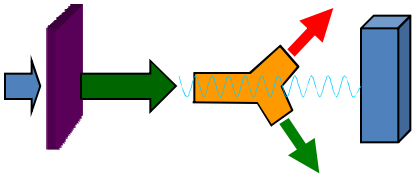
acceptance of the spectrometer has been studied with Geant simulation by colleagues of Tokyo Metropolitan University

$$\delta P \delta\Omega = \Delta P \Delta\Omega \frac{N_1}{N_0}$$

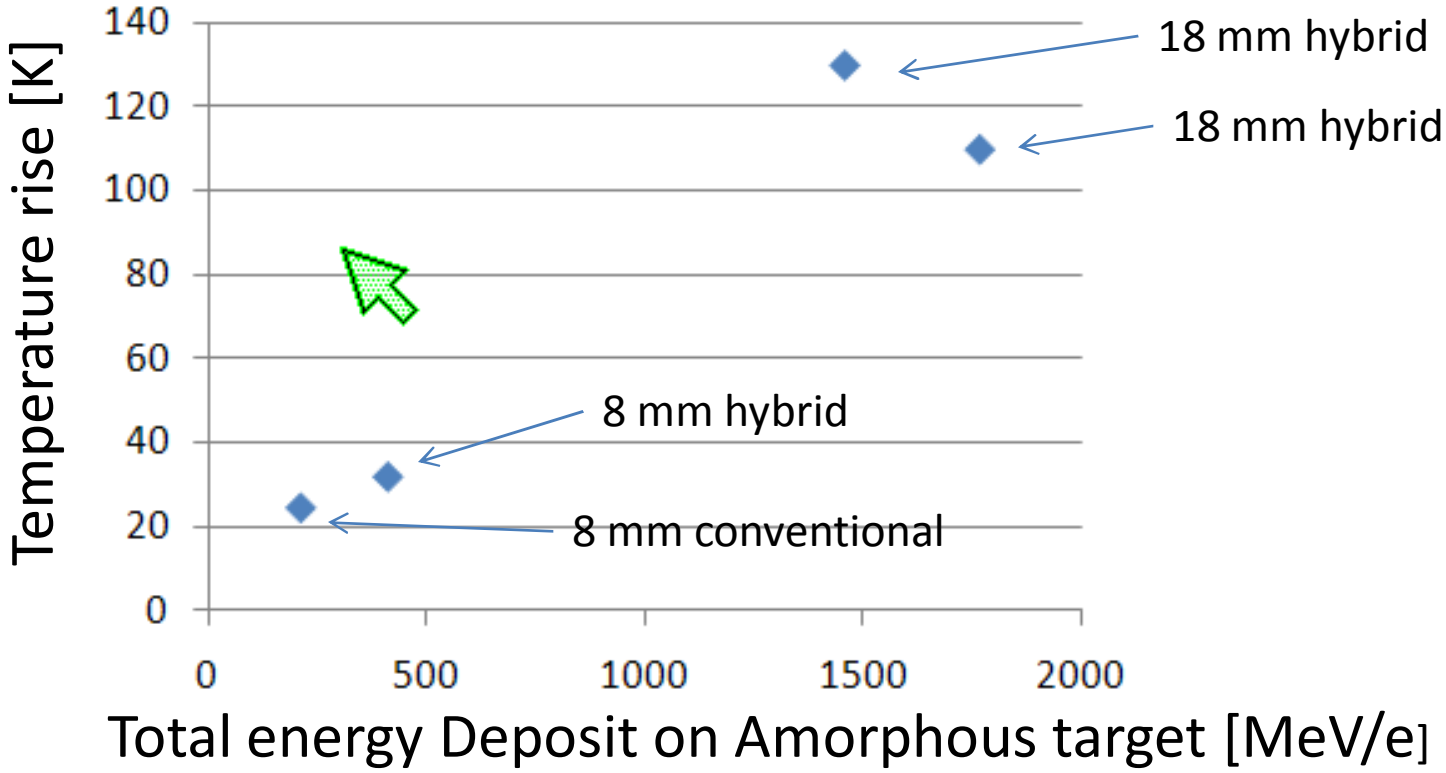
Positron Momentum Pe+ (MeV/c)	Acceptance $\times 10^{-4}$ (MeV/c·Sterad)
5	1.08+ 0.03
10	2.47+ 0.07
15	3.80+ 0.10
20	4.81+ 0.12



$0 \leq \theta \leq 0.08$, $0 \leq \phi \leq 2\pi$,
$0.8\ P_0 \leq P \leq 1.2 P_0$

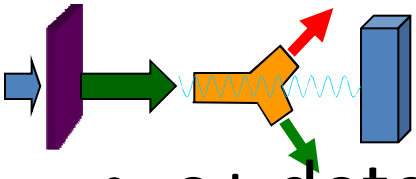


Temperature and Energy Deposit



- Too soon for conclusion
  - consideration for heat dissipation is necessary

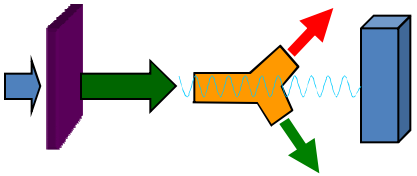
Summary



- e+ detected in hybrid configration
  - on axlis/off axis ~ 3.5
- e+ yield for hybrid on axis and conventional
  - e+s are almost same
- e+ at 20 MeV and 10MeV
  - 20MeV/10MeV ~ 3.9

Appeared to be understandable

- temperature rise of amorphous targets
  - energy deposit - temperature ,,, yet to be studied



Status and outlook

- We successfully demonstrated positron generation with hybrid target
- Simulation study is underway
- To understand feasibility for positron soucre
  - Comprehensive understanding is necessary theoretically as well as experimentally
    - Peak Energy Deposit Density as well as total energy loss
    - Positron yield with capture system
    - dependences on beam energy target thickness (crystal and amorphous)

next beam time on April 10 , 11