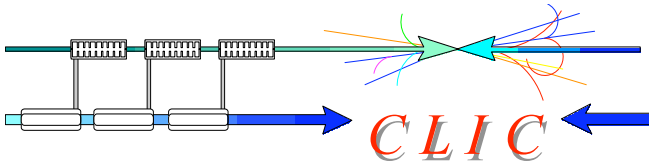

IPAC 10

Baseline Positron Production and Capture Scheme for CLIC

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LABORATOIRE DE L'ACCÉLÉRATEUR LINÉAIRE

26 May 2010 Kyoto, Japan

Foreword

Positron production requirements

1. High energy e^- beam
2. Radiator to produce γ : Amorphous, Undulator, Compton scattering, Crystal ….
3. Converter to produce e^+e^- pairs : material with high Z value (W)
   - Conventional scheme single thick target
   - Hybrid scheme crystal plus amorphous targets
4. Matching lens to focus the e^+ beam

Outline

- CLIC positron complex
- Channelling effect from a crystal target
- Positrons production using an hybrid source
  Amorphous & Capture studies
- Conclusion

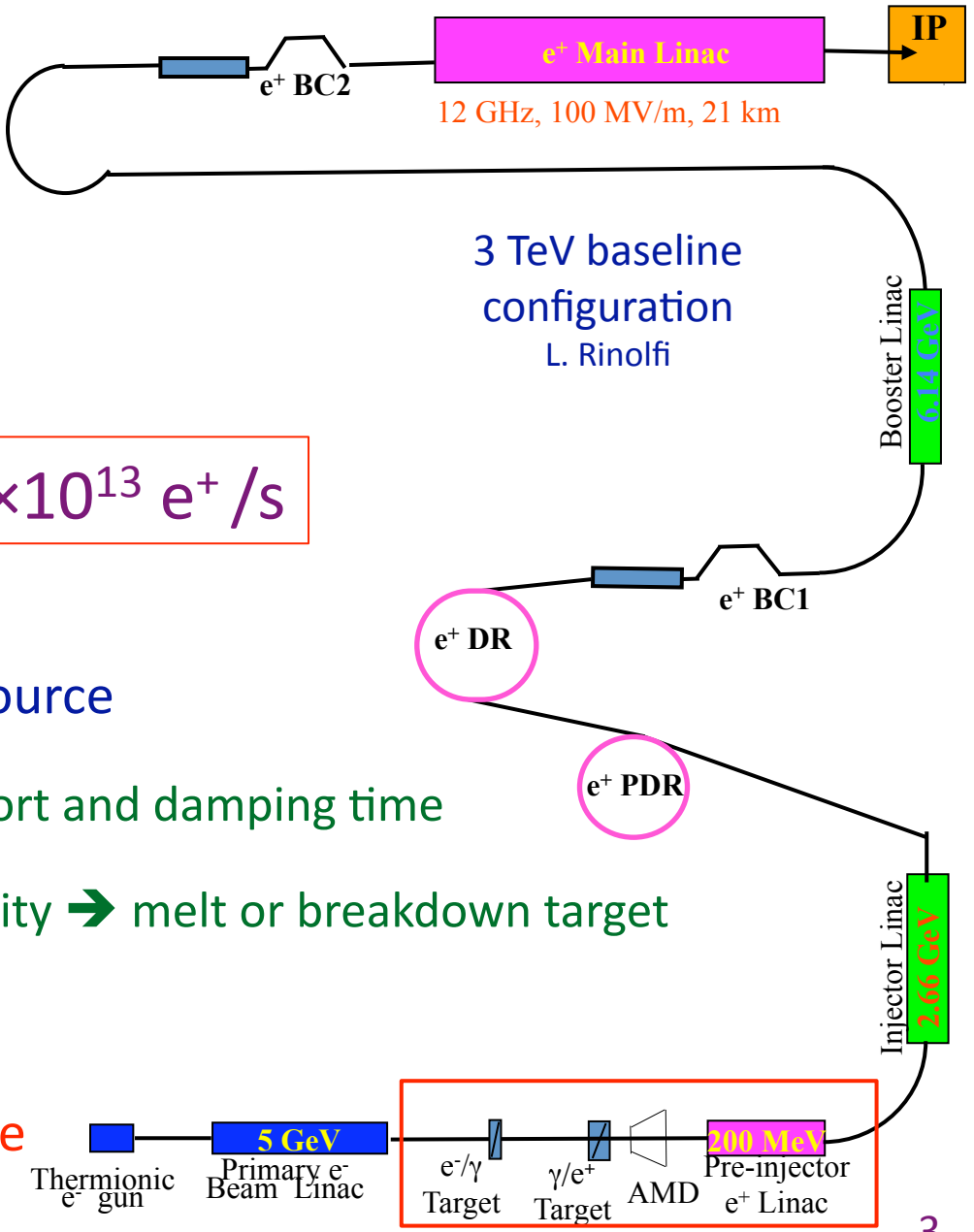
CLIC positron complex

- CLIC : Compact LInear Collider
  - J.-P Delaye's talk on Friday
- Need an intense e^+ source @ IP
  - #e^+/bunch : 3.7× 10^9
  - #bunches/train : 312
  - Repetition : 50 Hz

} 5.8×10^{13} e^+ /s

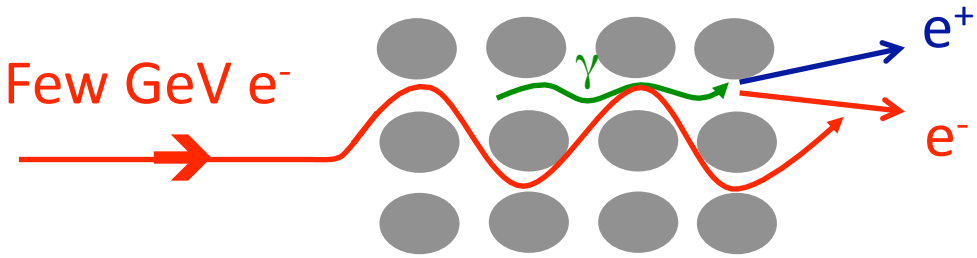
- Limitation from the conventional source
  - Large e^+ emittance values ➔ transport and damping time
  - Heating and energy deposition density ➔ melt or breakdown target
- CLIC e^+ production baseline

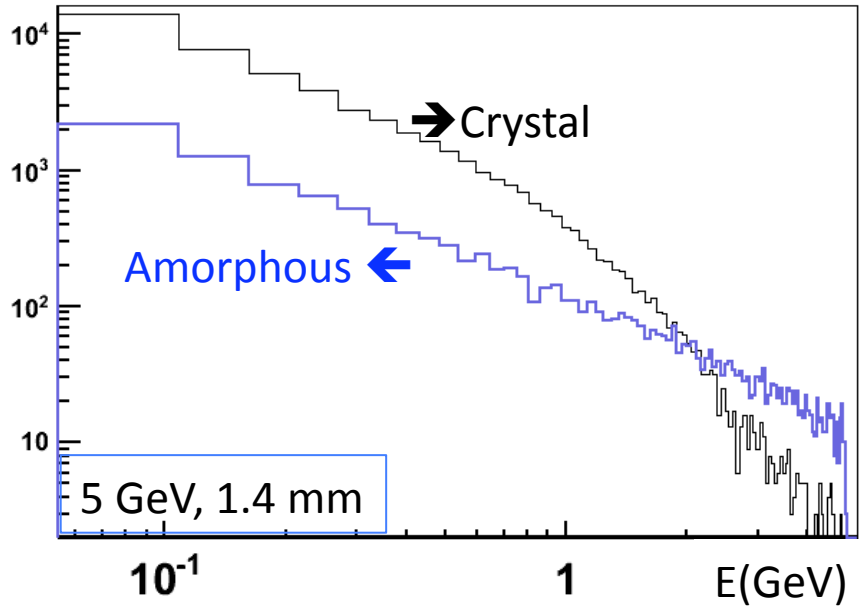
Crystal + Amorphous ➔ Hybrid Source



Channelling effect from a crystal target

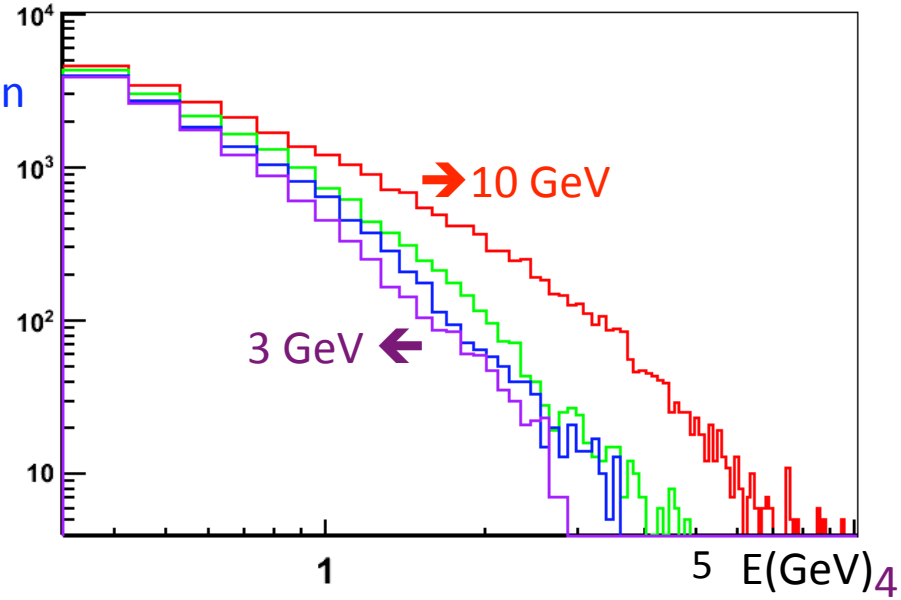
- A few GeV electron beam aligned to a <1 1 1> oriented crystal





- Enhancement of γ production w.r.t. to pure Bremsstrahlung process
- Due to energy deposition constraints
  - Thin crystal target
  - Converter downstream the crystal
    - Sweeping off the charged particles between the crystal and the amorphous targets

E_e-(GeV)	t(mm)	N_γ/N_{e-}	$<E_\gamma$ (MeV)>
10	1.0	22.5	300
5	1.4	20.0	160
4	1.5	18.5	130
3	1.6	15.5	110



Hybrid source : CLIC positrons baseline

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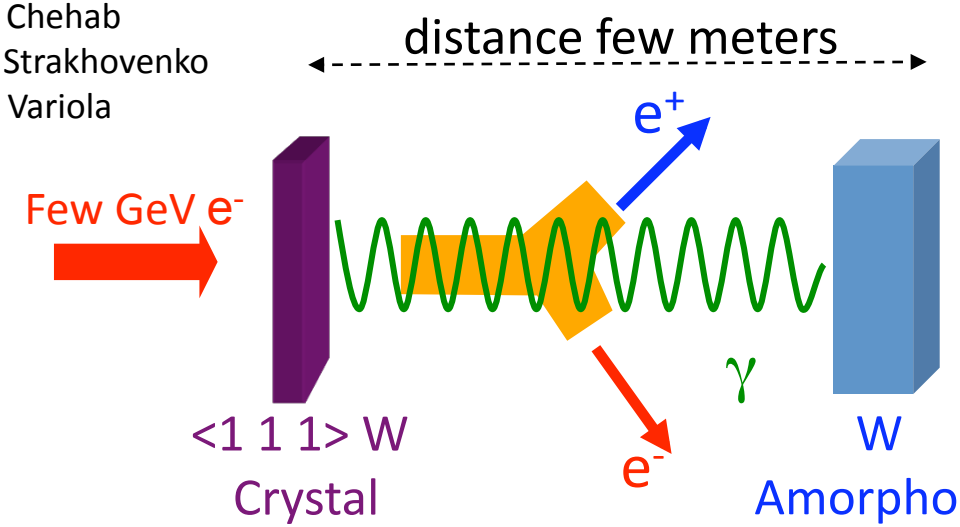
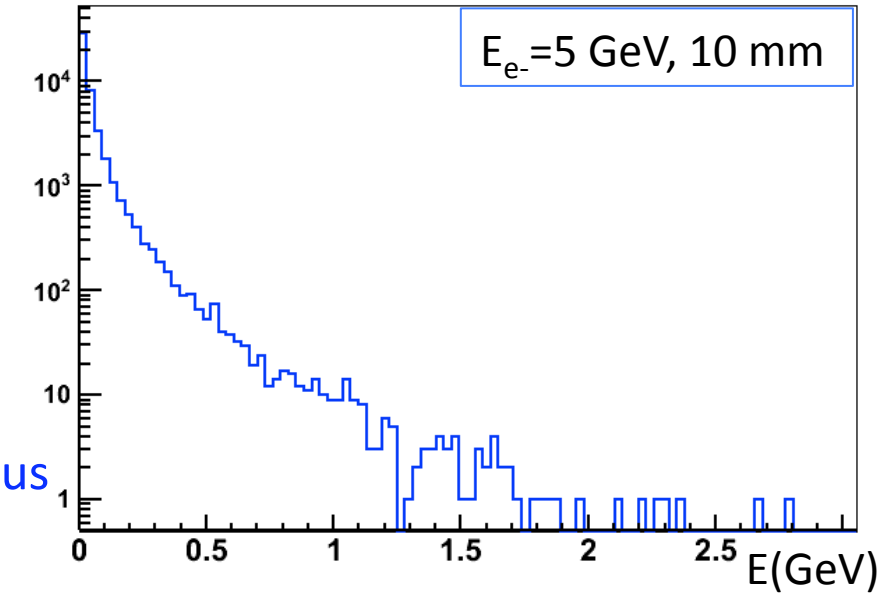
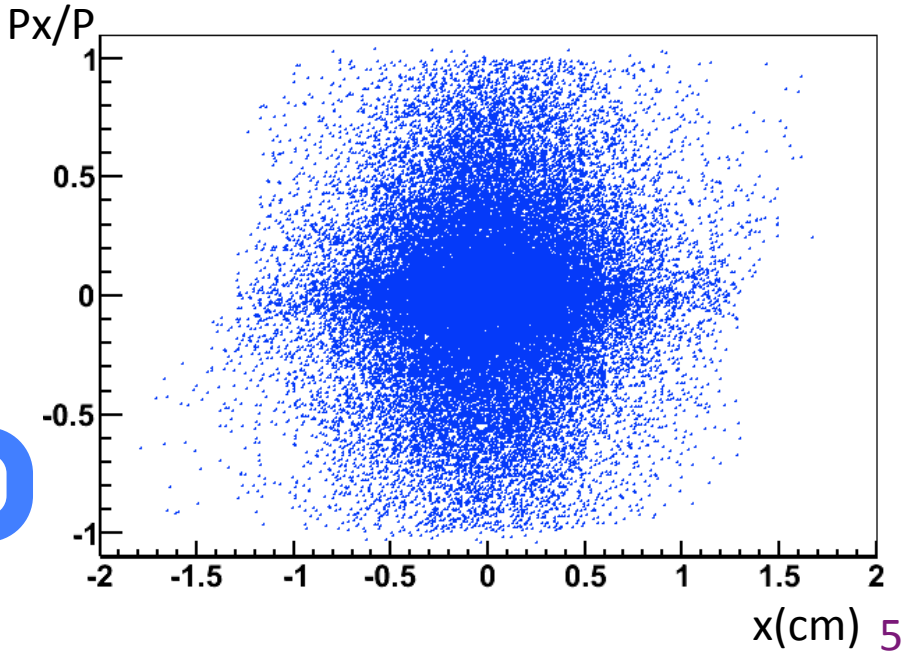
V. Strakhovenko
A. Variola

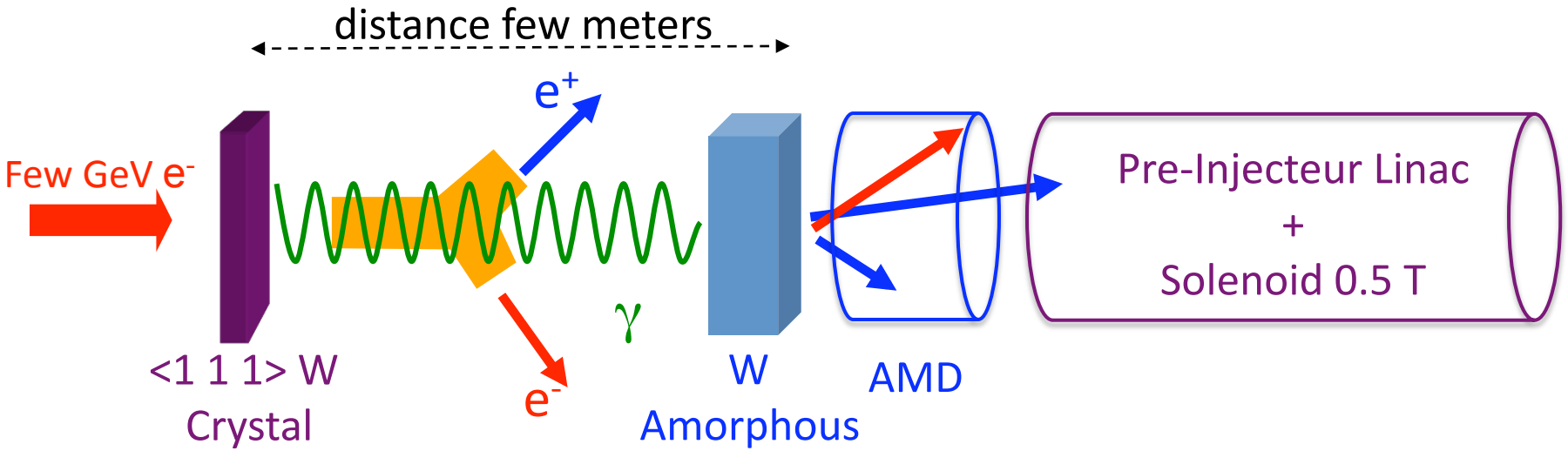




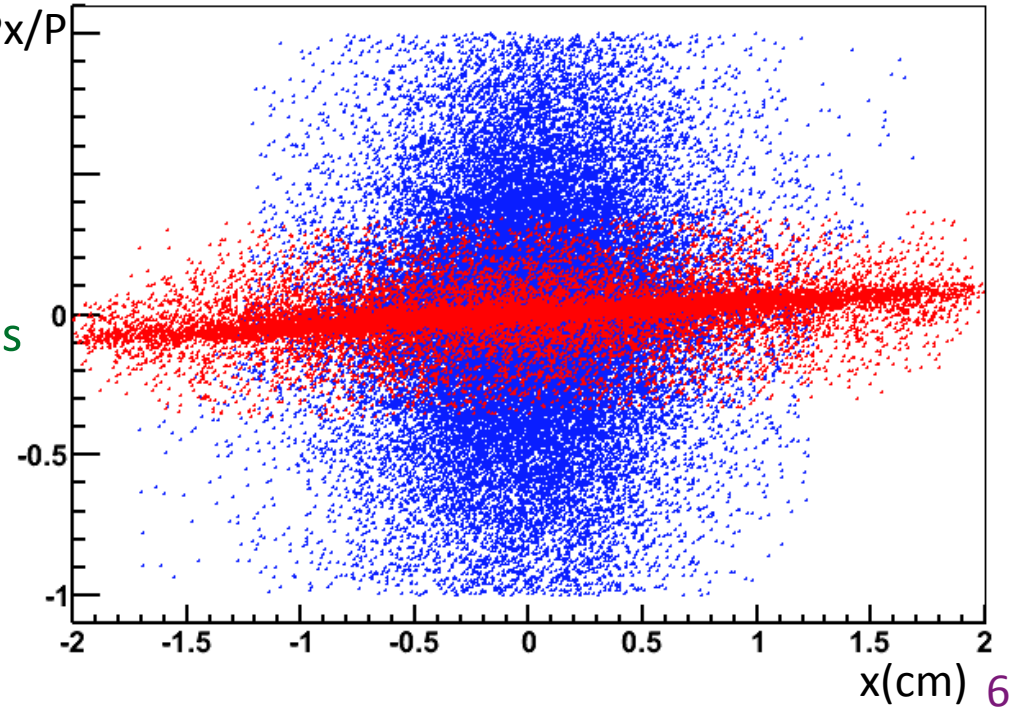
- Crystal thickness few mm
- Amorphous thickness several mm
- e^+ yield (Ne^+/Ne^-) : 5 to 15
- $<E_{e+}>$: 40 to 70 MeV
- After the amorphous
  - Large angles & small dimension
- Matching lens
  - Adiabatic Matching Device (AMD)



AMD effect on the positron beam



- $B(z)=B_{min}/(1+\alpha z)$
  - B_{max} = 6 T, B_{min} =0.5 T, L=0.2 m
- After the AMD
  - Small angles & large dimensions easier to transport
- e^+ yield (Ne^+/Ne^-) : 1 to 4
- $<E_{e+}>$: 50 to 110 MeV



Positron yield & PEDD shape

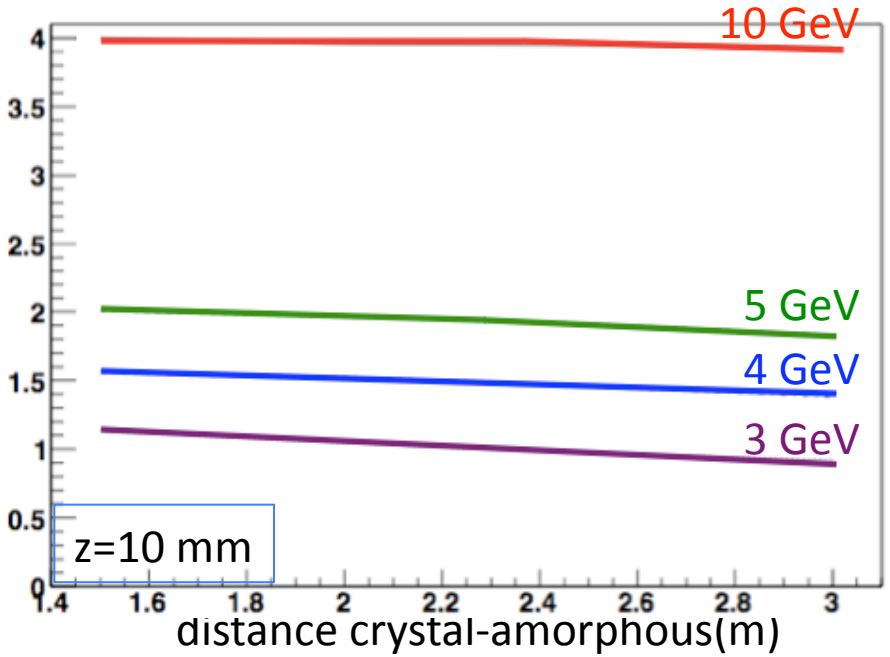
Distance crystal – amorphous studies

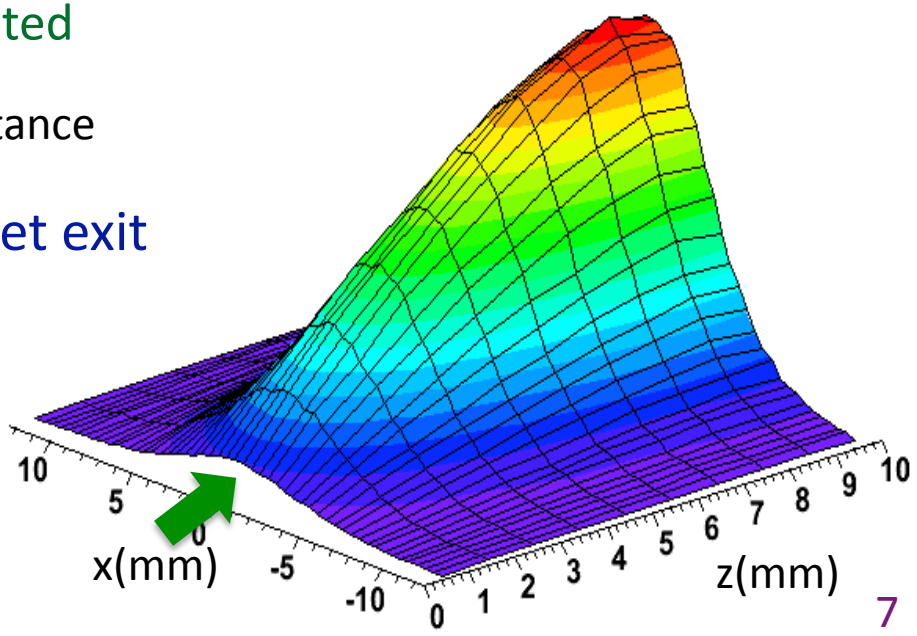
- For fix amorphous target thickness the e^+ yield varies slightly
  - AMD large geometrical acceptance
- Long distance is preferable
  - Space for dipole implementation
  - ↗ γ spot size ↘ energy density deposited

  Up to the limit of the AMD geometrical acceptance
- The energy density is max. @ the target exit
- From SLC experiment

  Peak Energy Density Deposition (PEDD)

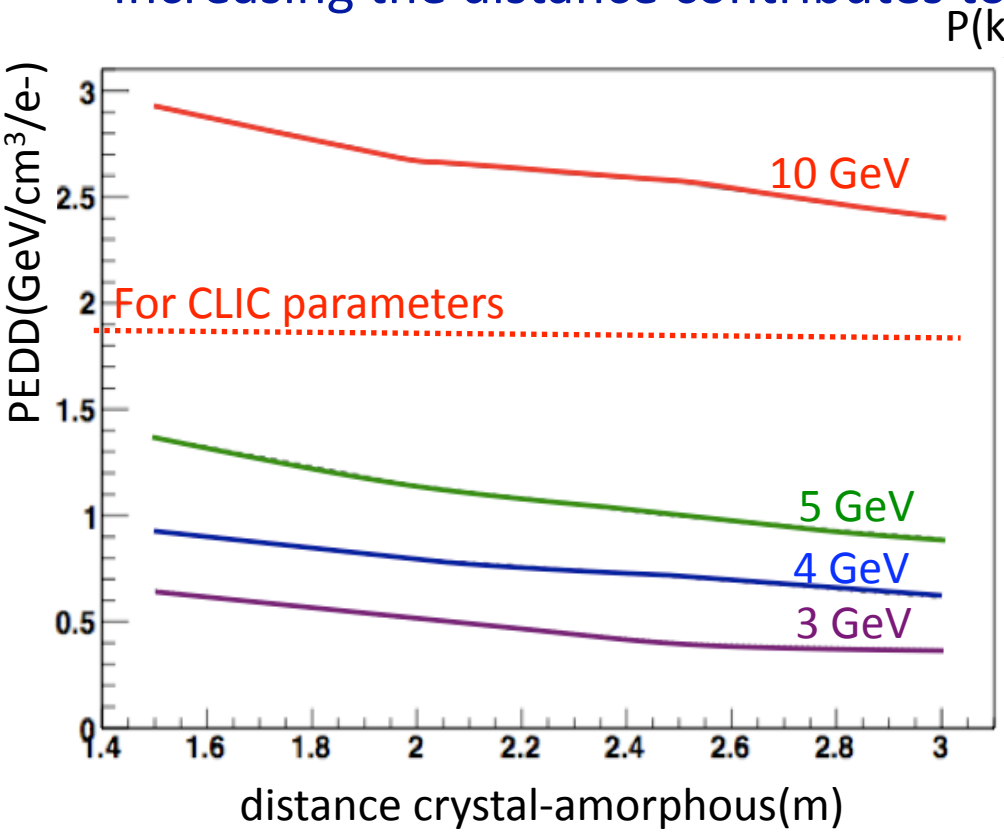
  PEDD[W] < 35 J/g

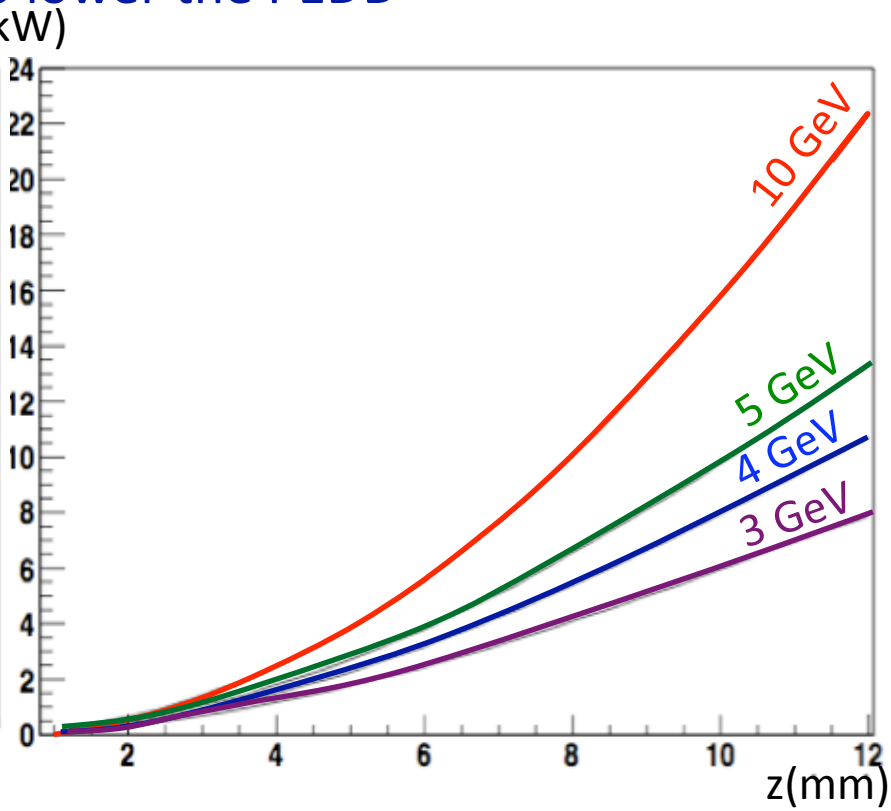




Energy deposition studies

- Increasing the distance contributes to lower the PEDD





PEDD & total power considerations

Selected parameters : 5 GeV, z=10 mm & d=2m

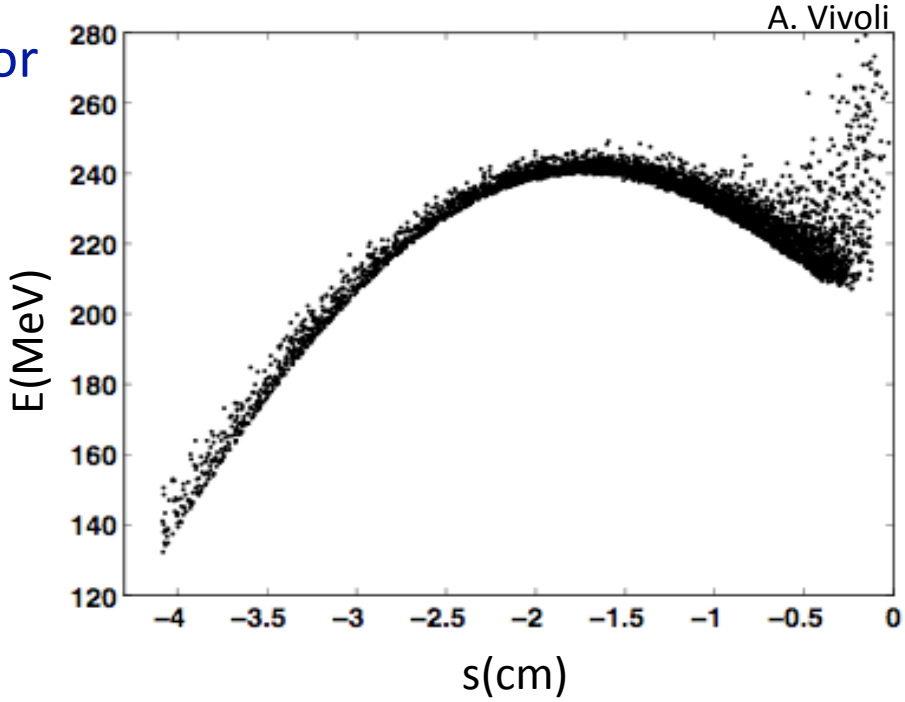
➔ Average power ≈ 10 kW

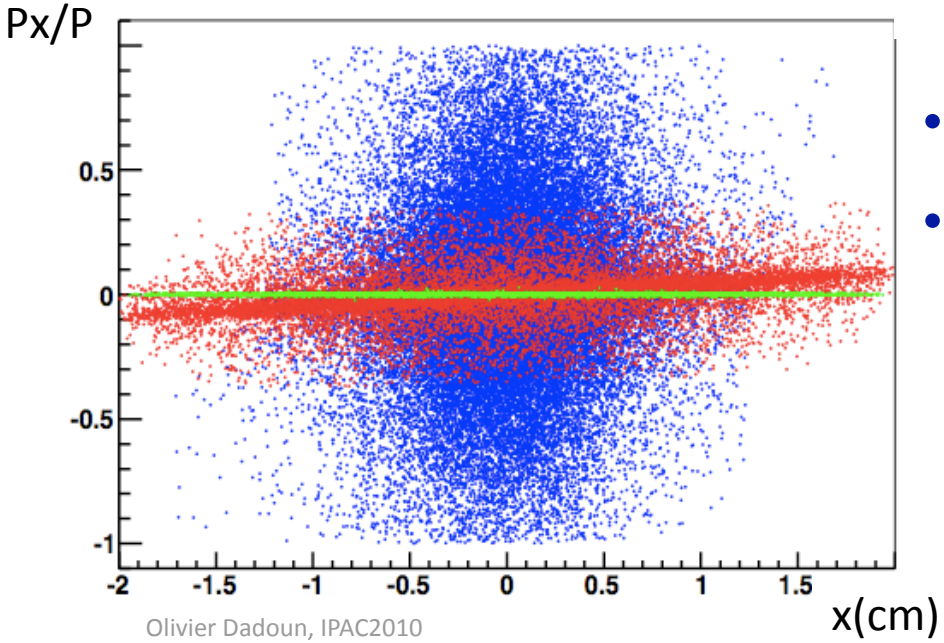
➔ PEDD ≈ 22 J/g (60% of margin before breakdown)

e^+ phase space at the exit of the Pre-Injector Linac

- Downstream the AMD Pre-Injector Linac
  - 2 GHz cavities
  - E=10 MV/m
- After 40 m
  - ε_{norm}(rms) ≈ 7.4×10^{-3} m×rad
  - 200 MeV
  - e^+ yield (Ne^+/Ne^-) ≈ 0.8

A. Vivoli





- Is this yield enough ?
- Recent studies request to increase by 25%-35% this yield

➔ Increase by 25%-35% the e^- intensity

➔ Average power : 12.5 – 13.5 kW

➔ PEDD : 28 – 30 J/g

Conclusion

- CLIC e^+ production and capture baseline for 3 TeV
  - ✓ Positron yield
  - ✓ Average total deposition reasonable
  - ✓ PEDD below the maximum & still some margin
- Study in progress : hybrid solution for ILC
  - At the IP : 5 × the requested e+ for CLIC
  - Time structure modification (A. Variola)
- Further development
  - Continue the beam positrons transport studies : Injector, Pre Dumping Ring …
  - 0.5 TeV CLIC option studies
  - Channelling effect implementation in Geant4