# DESY and Uni HH: Survey

**CLIC Collaboration working meeting addressing the 2012-16 workpackages**

- Positron Source Simulations
  - **Polarized e+ using helical Undulator**
  - **e+ target and collimation issues**
  - **Spin tracking, rotation and flipping**
- e+ polarimetry at and near the source
- BDS related issues: see Jenny's talk at 2.40 pm

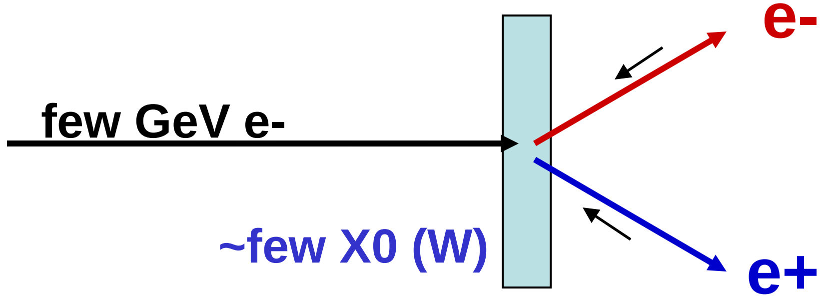
# We are part of the ILC/CLIC positron source group

– **Hamburg (Uni, DESY):**
  - Gudrid Moortgat-Pick, Olufemi Adeyemi, TonyHartin, Valentin Kovalenko, Larisa Malysheva, Andriy Ushakov
– **DESY Zeuthen:**
  - Sabine Riemann, Friedrich Staufenbiel

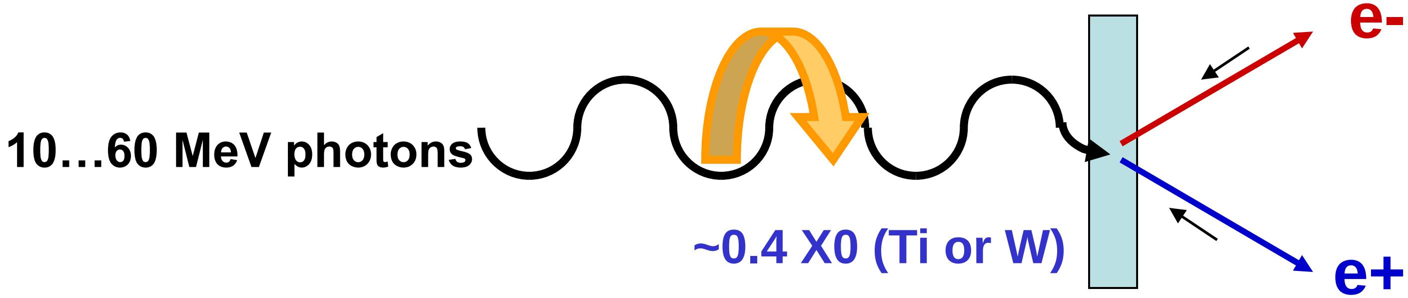
– **Goal: polarized positrons for best LC performance**

# Generation of (polarized) positrons

- Conventional source:

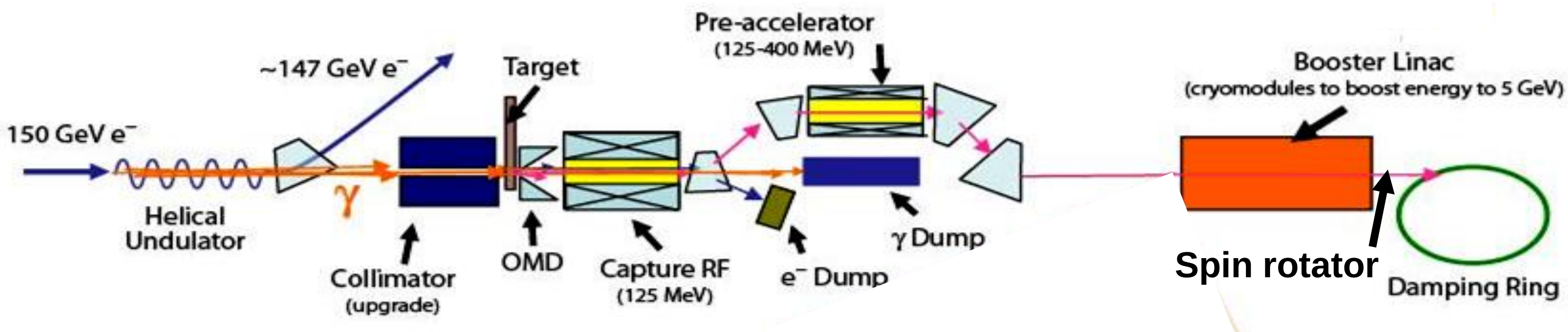



- Circularly polarized photons produce longitudinally polarized positrons and electrons



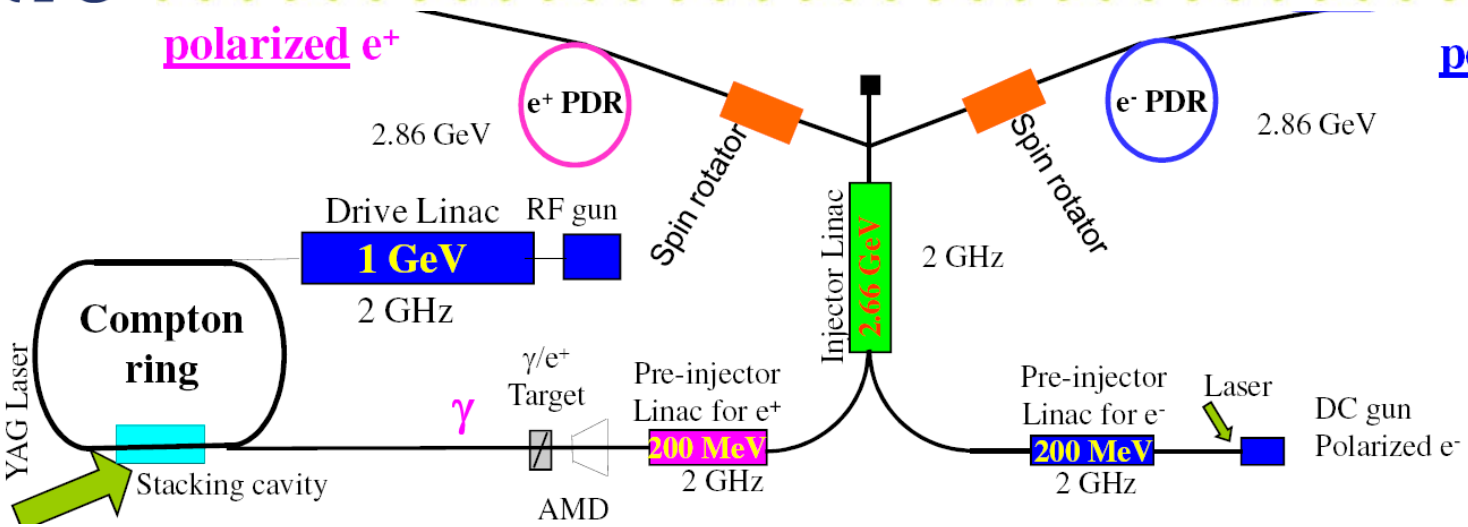

- **Methods to produce polarized photons**
  - **Radiation from helical undulator** (Balakhin, Mikhailichenko, BINP 79-85 (1979)) **⇔ Baseline for ILC**
  - **Compton backscattering of laser light off an electron beam – currently preferred update option for polarized e+ @CLIC**

# ILC Positron Source Layout




- Superconducting helical undulator → Electron beam is used to produce positrons
  - **Polarized positron beam (~22% - 35%) from beginning**
  - **e+ polarization (60%) is upgrade option ⇔ photon collimator to remove photons with lower polarization**
  - **Compton backscattering is considered as alternative option to produce polarized e+**
- Target
  - **Ti alloy wheel, radius 1m, thickness 1.4cm**
  - **Rotating speed 100m/s (1000rpm)**
  - **Design, prototype: LLNL, UK**
- Capture
  - **Flux concentrator (design and prototype: LLNL)**

# CLIC Sources Layout




Rinolfi

- Baseline design with unpolarized e+ source
- e+ polarization is upgrade option
  - **preferred design is Laser-Compton (see** Rinolfi et al., PAC09)
    - Electron ring and optical laser cavity
    - ERL (Energy recovering linac) + laser cavities
    - Electron linac and $CO_2$ laser cavities ⬄ no stacking
  - **Alternative is undulator based e+ source (see also L. Zang et al., PAC09, W. Liu et al. IPAC10 )**

# Positron flux at LC

Positron target, collection optics are 'similar' for ILC and CLIC

→ Very close collaboration of ILC and CLIC positron source groups

| | CLIC 500 | CLIC 3000 | ILC (RDR) | ILC (SB2009) |
|---|---|---|---|---|
| e/bunch | $0.68 \times 10^{10}$ | $0.37 \times 10^{10}$ | $2 \times 10^{10}$ | $1\text{-}2 \times 10^{10}$ |
| #Bunches/pulse | 354 | 312 | 2525 | 1312 |
| Pulse rep rate | 50 | 50 | 5 | 5 |
| Pulse duration (ns) | 177 | 156 | $10^6$ | $10^6$ |
| Bunch separation(ns) | 0.5 | 0.5 | 350 | 740 |
| e+/sec | $1 \times 10^{14}$ | $0.54 \times 10^{14}$ | $2.7 \times 10^{14}$ | $1.3\text{-}2.7 \times 10^{14}$ |

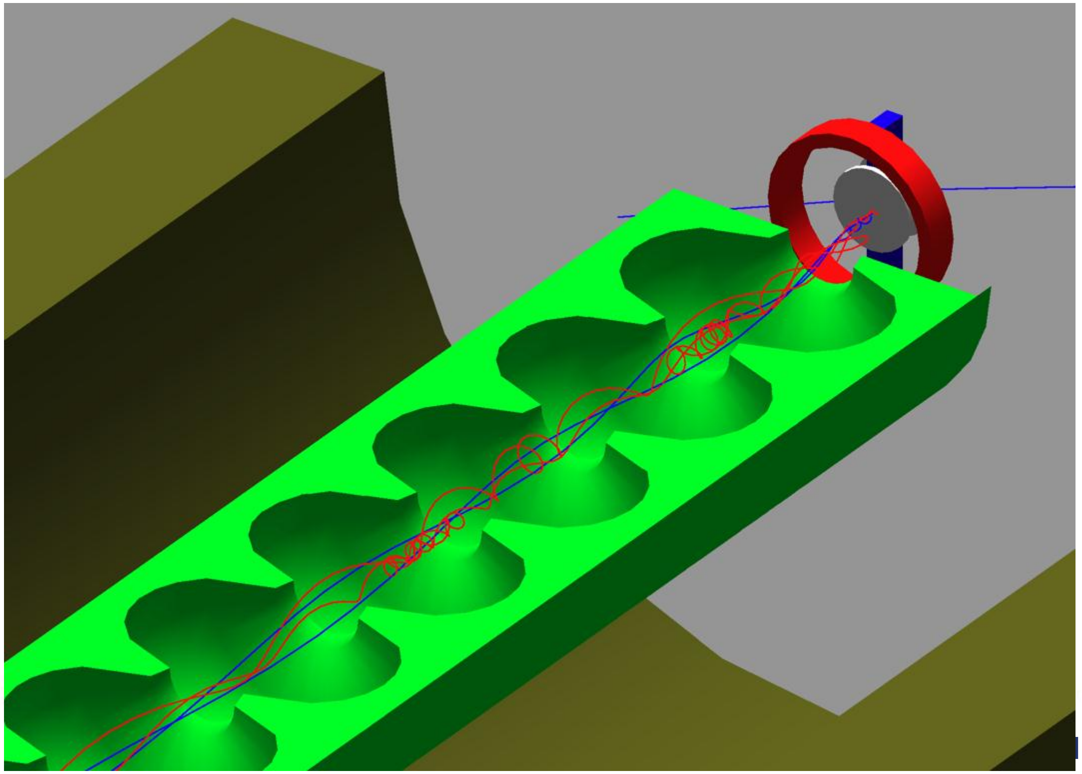
ILC **yield: ~0.02 polarized e+ / γ**

→ huge heat load on

- **e+ production target**
- **Photon collimator of undulator based source**

# Positron Source Modelling

- **P**olarized **P**ositron **S**ource – **Sim**ulation (PPS-Sim)
  - **Optimization of yield and polarization of e+ source**
  - **Different possibilities of e+ production are implemented and can be easily chosen by the user**
  - **Particle and spin tracking up to capture section**
  - **Based on Geant4 with polarized electromagnetic processes, Qt4 und ROOT (developed in DESY Zeuthen)**

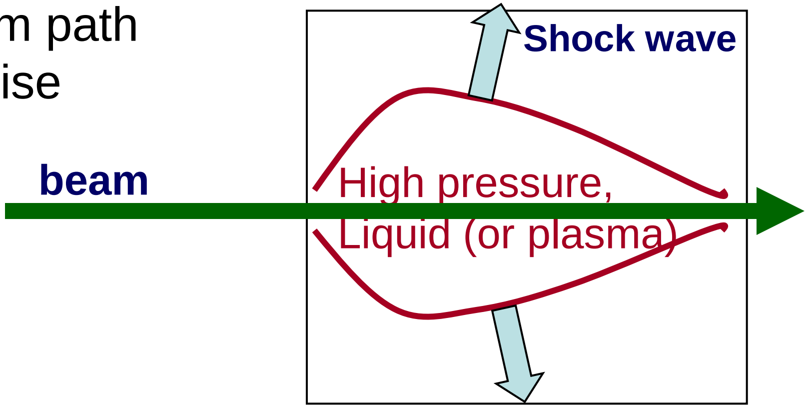


**Web page:**
http://pps-sim.desy.de

Schaelicke, Ushakov

# Problems: Target and collimator material

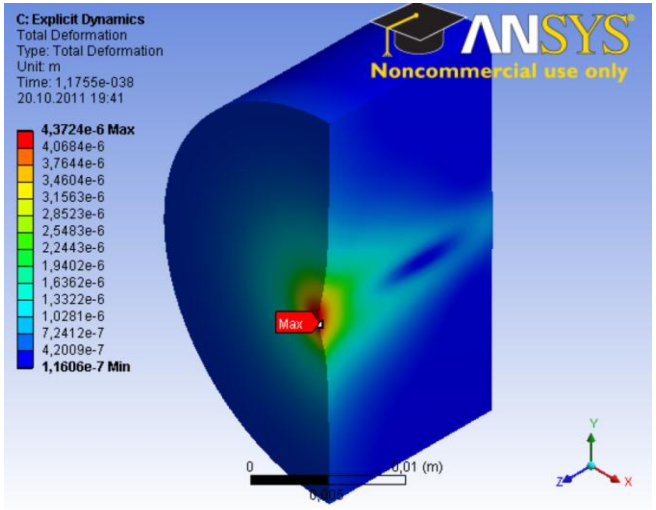
- high peak energy deposition density in materials
  - Thermal stress,  high pressure (even shock waves)
    - Energy deposition along the beam path
      - instantaneous temperature rise
      - instantaneous pressure rise



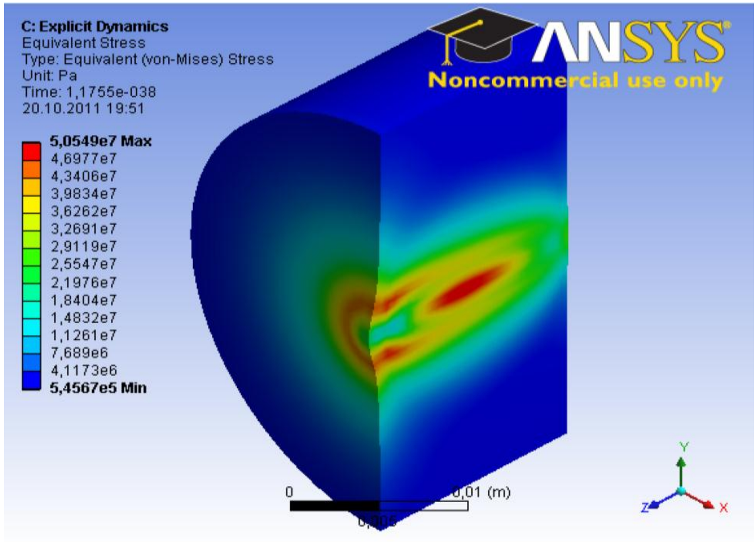

→ damage or lifetime reduction of material
- So far, SLC target is ‚benchmark'
  to trust simulations for LC materials, codes should be validated by experiments
- Radiation aspects
  - activation
  - Material damage (displacement per atom)
  - remote handling

# Material stress studies

- PhD student (Olufemi) develops hydrodynamical model to simulate shock wave creation and propagation
- ANSYS simulations are ongoing to study stress in materials due to intense beams (Andriy, Friedrich)




Deformation (left) and equivalent stress in target (Ushakov)



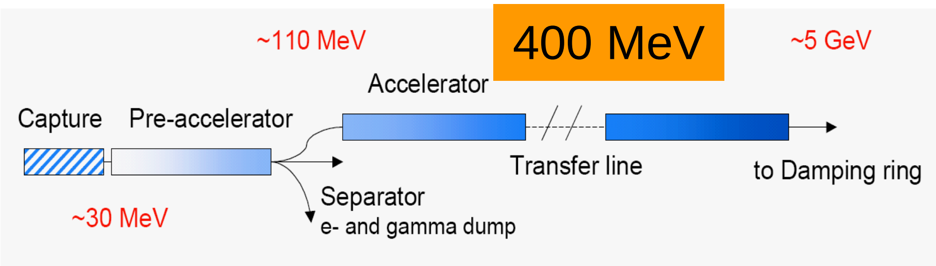

- Plan to use DESY facilities to test material stress and to benchmark the simulation tools (Friedrich, Andriy)
  - **e- beams (FLASH, 1.2 GeV), PITZ (25MeV)**
- Results are also interesting for machine protection
- Experience and collaboration is welcome

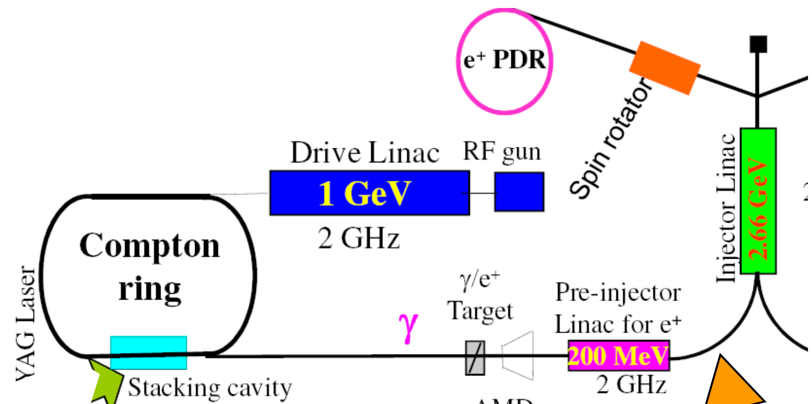
# Spin tracking

- Goal: perform spin tracking from start to end
- ILC e+ source
  - **Lattice needed**
  - **Spin tracking and e+ source: spin rotation**
  - **Equipment for rapid helicity reversal under work (helical undulator yields only one polarity)**
  - **ILC e+ source lattice/ spin rotation work started (Larisa, Valentyn)**

# Polarimetry at the e+ source

- Polarisation measurement downstream the capture section; E > 125 MeV
  - Large size of positron beam (σ ~ 0.5…1cm)
  - High intensity of positron beam
  - Do not need very precise measurement




Proposal (see Alexander et al., EUROTeV-Report-2008-91):

- Bhabha polarimeter operated at
  - 400 MeV (ILC)
  - 200 MeV (CLIC)
- Downstream the damping rings: Compton polarimeter, but spin orientation is transverse (details: Alexander, Starovoitov, LC-M-2007-014, 2007)

# Summary

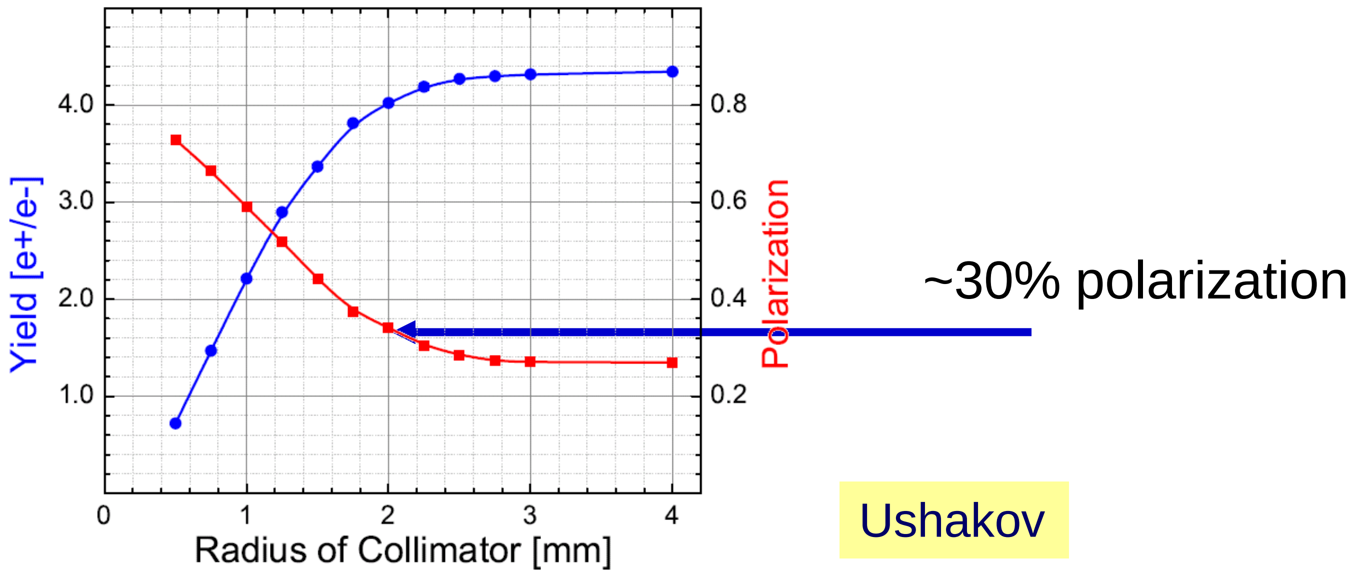
- ILC/CLIC collaboration for e+ source exists since years
- Contributions to ILC from DESY/U Hamburg group
  - **Source design optimization**
  - **Lattice, spin rotator and spin-flip design**
  - **Tolerance and misalignment studies**
  - **Realistic spin tracking from start to end**
  - **Target and collimator material stress simulations**
  - **Material test / shock wave experiment (?)**
  - **Low energy e+ polarimetry**
  - **Our manpower is limited but save until summer 2012 (HH) and 2013 (Zeuthen)**
- Tools for ILC source can be applied for CLIC
  - **Support for polarized source is possible**
  - **Source optimization, spin tracking, low energy polarimetry**

# Backup

# ILC: e+ Polarization

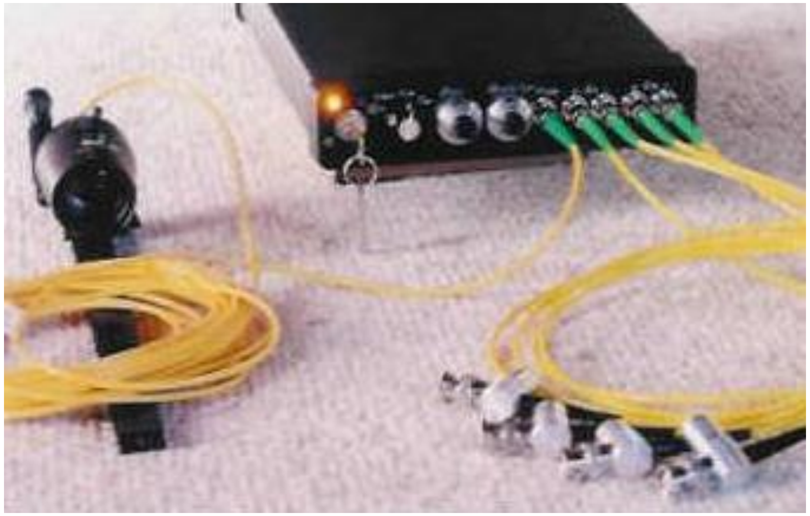
## Drive e- beam: 250 GeV (6T AMD assumed)

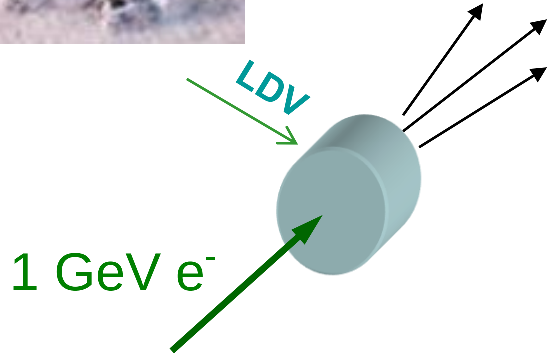
Yield and Polarization vs
Radius of **Virtual** Collimator




Ushakov

- → 60% e+ polarization requires $R_{col}$ ≤1mm
- → Higher intensity of γ beam to produce enough positrons → heat load density on target increased, but within acceptable limits






- **VISAR** **(Laser Doppler Vibrometer, LDV)**
  - **Commercial systems available**
  - **Sensitivity: 0.02m/s [0.002m/s] with 50ns [500ns] resolution time (see http://www.mfaoptics.com/FiberDVI.htm )**

  → **measurement of shockwaves possible**