ILC KAS e+ source

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Status of KAS

- BCD/RDR: KAS is defined as giving full ILC format beam, but 10% intensity
  - **500 MeV electron beam driver, which is almost identical to NC part of main e- source.**
  - **W-Re alloy target, capture, and PPA.**
  - **Placed in near of 5 GeV e+ driver.**
- In discussion of Minimum Machine,
  - **Remove KAS:only undulator**
  - **Minimal KAS: Single bunch 500 MeV e- driver, sharing other down stream parts (target, capture, etc.) with undulator.**
  - **Extend-able KAS: KAS with 10% ILC format and is upgradable to full ILC format beam.**

KAS or *KAS* (E.Paterson)

- We need to review the design ***requirements*** for a KAS and its cost/benefits to overall ILC operation.
- RDR design has everything (except polarization) at 10% intensity…Injector, L-band linac, tgt/capture section and pre-accelerator. *Large and expensive!*
- An extreme alternate ***KAS*** could be a compact S-band single bunch linac whose e- beam uses the photon E+ tgt, capture and pre-accelerator, producing single bunches at a few % intensity.
- *Inexpensive, compact and could fit between the undulator and target alongside the photon and high energy e beam!*

Extendable KAS (1)

- In the initial phase, $3X_0$ W-Re for high e+ intensity.
  - 700 MeV SC accelerator (36m) can generate 32 % intensity e+ beam.
- This beam is more useful for commissioning.
- The target can be replaced when undulator e+ is ready for the commissioning. KAS becomes a small backup with a few % intensity with $0.4X_0$ Ti-alloy target.

Extendable KAS (2)

- In a mentime, 400m drift space for undulator gamma is enough to accommodate
  - 6 GeV linac for conventional e+ source with the full intensity.
  - 4 GeV linac for linac laser compton e+ source.
- Tunnel for undulator section is therefore compatible to all schemes which we have considered. Even after completion of tunnel, we can switch e+ scheme among them.
- Because of this flexibility, the extendable KAS minimizes unexpected risks.

What is role of KAS (1)

- BCD/RDR KAS has the dedicated system down to PPA because
  - **To avoid conflicts between e- and e+ (KAS should not be e- side)**
- If the undulator is moved to 250 GeV(end of linac), it is a reasonable thought sharing components between main e+ source and KAS.
- Role of KAS is not changed:
  - **All systems down to DR are fully coupled.**
  - **Conflicts between (e- RTML + ML) and e+ source is avoided by KAS.**
  - **Ignoring KAS has significant impacts on longer MD and low availability.**

What is role of KAS (2)

- Assuming that undulator is placed at 250 GeV, several difficulties in operation is arisen.
  - **Undulator section should be tuned whenever the energy in ML is changed (energy scan).**
  - **Low yield for low energy operation less than 300 GeV CME.**
- KAS recovers (shorten) the re-commissioning time by keeping the e+ source “alive”.

Redefinition of KAS (1)

- RDR KAS assume
  - **Identical e- injector based on DC photo-cathode gun.**
  - **Bunching section.**
  - **NC L-band linac.**
  - **Target, capture, and PPA**
- KAS do not have to have everything down to PPA in the new layout.
- Possibly, downstream from target can be shared with the main e+ source.

Redefinition of KAS (2)

- By the way, there is no significant reason assuming DC photo-cathode gun for KAS driver.
- RF Photo-cathode gun makes it much simpler system and cheaper.
  - **L-band RF Gun (FLASH type)**
  - **No bunching section.**
  - **One RF section, which is identical to ML : 1 klystron drives 3 cryomodules.**

Redefinition of KAS(3)

- By considering the sharing, three options are possible
  - **A)Sharing target, capture, and PPA (Cheapest option)**
  - **B)Dedicated target, capture, but shared PPA (Moderate option)**
  - **C)Dedicated target, capture, PPA (Most expensive option)**
- How can we decide which one is the best (or better)?

Options

	Option A	Option B	Option C
RF photo-injector	Yes	Yes	Yes
SC e- booster	Yes	Yes	Yes
Target	No	Yes	Yes
Capture RF	No	Yes	Yes
PPA	No	No	Yes

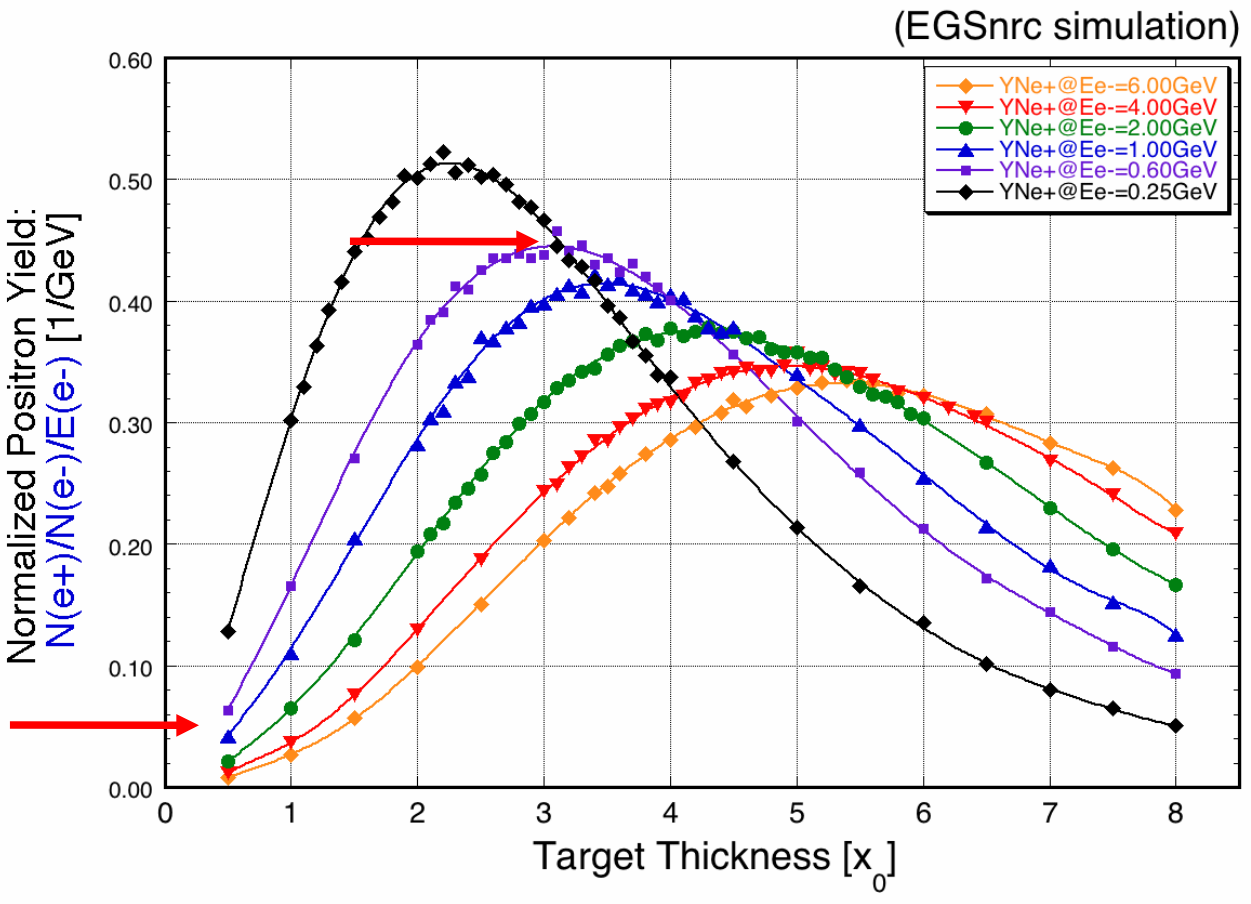
- RF photo-injector : NC RF cavity, Laser, 1 klystron
- SC e- booster: 3 cryomodule, 1 klystron
- Capture RF: 2 SW+3TW, 5 klystrons
- PPA: 8 TW, 8 klystrons

Value Engineering

- Value engineering is one of the frame work to decide the configuration in balance of cost and performance.
- Solution is decided by figure of merit with respect to the cost: Value.
- Figure of merit: positron yield (Y_{e+}).
- Solution maximizes value: $V=Y_{e+}/Cost$.

Positron Yield

- Drive beam : 700MeV, 100 % intensity electron
- $0.4X_0$ target (sharing target, A) makes ~4% intensity.
- $3X_0$ target (dedicated target, B and C) makes ~32% intensity.



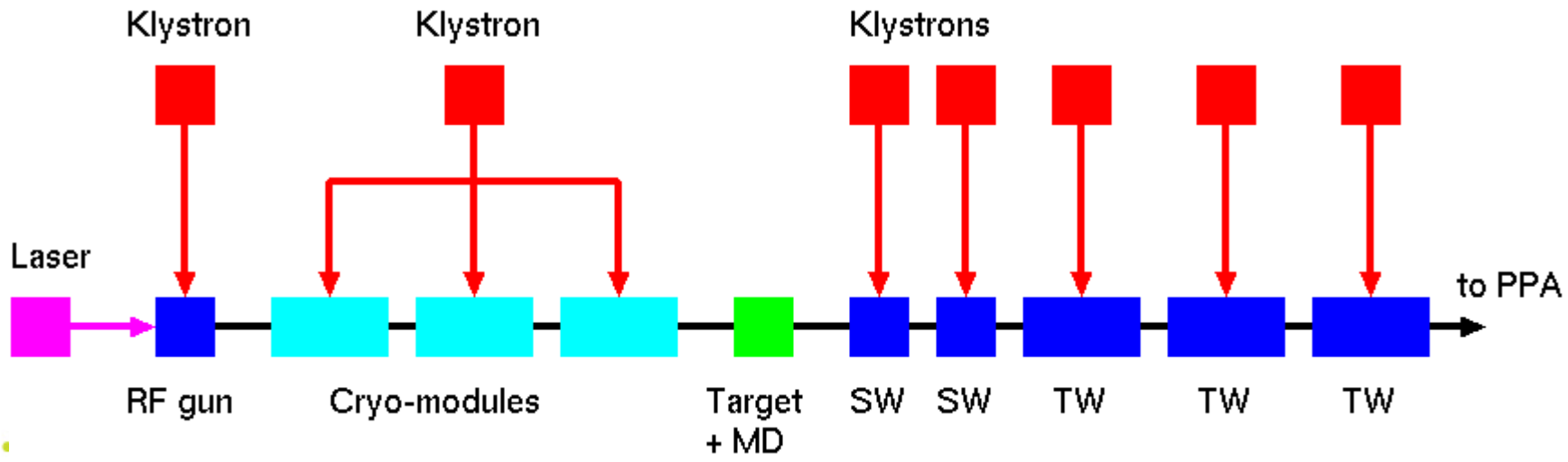
Redefinition of KAS(3)

	Relative Cost	Ye+	V=Ye+/Cost
Option A	0.25	0.04	0.16
Option B	0.58	0.32	0.55
Option C	1	0.32	0.32

- Option A is the cheapest, but the performance is much lower.
- Option B and C have the same performance, but C is more expensive.
- Based on value engineering, Option B is the best solution.

New KAS

- L-band RF gun (FLASH type)
- One RF section (1 klystron drives 3 cryomodules, 24 cavities) is capable accelerating up to 700MeV.
- Sharing PPA, but dedicated Target, MD, capture RF



Target for KAS

- Energy deposition density for KAS is 1/10 for that of e- driven.
- Several target candidates have been considered for e- driven; Those method can be used for KAS because of the less energy deposition density.
- The following targets look feasible,
  - **36m/s tangential speed rotating W-Re target (it is only 1/3 of that of undulator target)**
  - **Single crystalline radiator + W amorphous converter.**
  - **Liquid metal target**

Summary

- In the layout (central injector + undulator @250GeV), KAS and main e+ can share components, but role of KAS does not change.
- More time is spent for commissioning in energy scan. KAS becomes more important.
- RF photo-injector + SC e- booster is a better solution.
- Based on the value engineering, dedicated target and capture, but sharing down stream from PPA (option B) is the best solution.