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## DRAFT: Meros User's Guide <sup>a</sup>

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<sup>a</sup>For **Meros**<sup>TM</sup> Version 2.0 in **Trilinos**<sup>TM</sup> Release 8.0



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## DRAFT: Meros User's Guide<sup>†</sup>

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### Abstract

meros abstract

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<sup>†</sup>For **Meros**<sup>™</sup> Version 2.0 in **Trilinos**<sup>™</sup> Release 8.0

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# **1 Introduction**

Meros is a segregated preconditioning package. Provides scalable block preconditioning for problems that coupled simultaneous solution variables such as Navier-Stokes problems.

Adding a citation to test bib[1].

## 2 Block Methods

### 2.1 Pressure Convection-Diffusion (PCD)

Factory for building pressure convection-diffusion style block preconditioner. This class of preconditioners were originally proposed by Kay, Loghin, and Wathen (ref) and Silvester, Elman, Kay, and Wathen (ref).

Meros 1.0 currently implements the PCD preconditioner, a.k.a. Fp preconditioner.

The LDU factors of a saddle point system are given as follows:

$$\begin{bmatrix} A & B^T \\ B & C \end{bmatrix} = \begin{bmatrix} I & \\ BF^{-1} & I \end{bmatrix} \begin{bmatrix} F & \\ & -S \end{bmatrix} \begin{bmatrix} I & F^{-1}B^T \\ & I \end{bmatrix}, \quad (1)$$

where  $S$  is the Schur complement  $S = BF^{-1}B^T - C$ . A pressure convection-diffusion style preconditioner is then given by

$$P^{-1} = \begin{bmatrix} F & B^T \\ & -\tilde{S} \end{bmatrix}^{-1} = \begin{bmatrix} F^{-1} & \\ & I \end{bmatrix} \begin{bmatrix} I & -B^T \\ & I \end{bmatrix} \begin{bmatrix} I & \\ & -\tilde{S}^{-1} \end{bmatrix} \quad (2)$$

where for  $\tilde{S}$  is an approximation to the Schur complement  $S$ .

To apply the above preconditioner, we need a linear solver on the (0,0) block and an approximation to the inverse of the Schur complement.

To build a concrete preconditioner object, we will also need a 2x2 block Thyra matrix or the 4 separate blocks as either Thyra or Epetra matrices. If Thyra, assumes each block is a Thyra EpetraMatrix.

### 2.2 Least Squares Commutator (LSC)

Factory for building least squares commutator style block preconditioner.

Note that the LSC preconditioner assumes that we are using a stable discretization an a uniform mesh.

The LDU factors of a saddle point system are given as follows:

$$\begin{bmatrix} A & B^T \\ B & C \end{bmatrix} = \begin{bmatrix} I & \\ BF^{-1} & I \end{bmatrix} \begin{bmatrix} F & \\ & -S \end{bmatrix} \begin{bmatrix} I & F^{-1}B^T \\ & I \end{bmatrix}, \quad (3)$$

where  $S$  is the Schur complement  $S = BF^{-1}B^T - C$ . A pressure convection-diffusion style preconditioner is then given by

$$P^{-1} = \begin{bmatrix} F & B^T \\ & -\tilde{S} \end{bmatrix}^{-1} = \begin{bmatrix} F^{-1} & \\ & I \end{bmatrix} \begin{bmatrix} I & -B^T \\ & I \end{bmatrix} \begin{bmatrix} I & \\ & -\tilde{S}^{-1} \end{bmatrix} \quad (4)$$

where for  $\tilde{S}$  is an approximation to the Schur complement  $S$ .

To apply the above preconditioner, we need a linear solver on the (0,0) block and an approximation to the inverse of the Schur complement.

To build a concrete preconditioner object, we will also need a 2x2 block Thyra matrix or the 4 separate blocks as either Thyra or Epetra matrices. If Thyra, assumes each block is a Thyra EpetraMatrix.

## **2.3 SIMPLE**



### **3 Examples**

## **A Meros configure Options**

## References

- [1] H. C. ELMAN, D. J. SILVESTER, AND A. J. WATHEN, *Finite Elements and Fast Iterative Solvers*, Oxford University Press, Oxford, 2005.

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